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Stone Artefact Assemblages and Mobility, Sedentism and Occupation Duration

A Case Study from Northern New Zealand

Alexander Finn Jorgensen

Abstract

This thesis examines the broad issue of the assessment of pre-European contact Māori mobility in New Zealand through the technological analysis of flaked stone artefacts, those categories of lithics generally referred to as informal tools. It sets out a comparison of lithic technological attributes across time and space, from a number of archaeological contexts on Ahuahu (Great Mercury Island) and a single context from the Auckland region of the Hauraki Gulf. The assemblages provide a way of evaluating measures of mobility using lithic artefacts in a situation where technology, transport methods and land use over time by the groups that produced the artefacts in question can be controlled in ways that are not always possible elsewhere in the world. The focus is on the technological organisation that the lithic assemblages represent, the accumulation of those assemblages in the archaeological record, and the corresponding inferences that are made with respect to mobility and occupation duration at specific locations in the landscape. The research suggests there is no strong evidence arising from the analysis of the stone artefact assemblages that would suggest that the technological organisation (as it relates to lithics) of Māori living on Ahuahu or in coastal Auckland changed appreciably over the course of the pre-contact period of New Zealand’s history. Spatial and technological analyses of the assemblages can however give insights into occupation duration and the taphonomic processes influencing assemblage composition. The overall picture of the technological signature presented and the level of change that appears to have occurred over this time is instead one of stability and continuity, but with some evidence for lithic recycling practices and the persistent use of particular places in landscapes. It is therefore not possible to use lithic technological organisation to support suggestions of major shifts in pre-European Māori socio-economy in the study areas.
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Table of Contents

Abstract ................................................................................................................................. ii
Acknowledgements ............................................................................................................. iii
Table of Contents ............................................................................................................... v
List of Figures .................................................................................................................... xii
List of Tables ..................................................................................................................... xvii

Chapter 1. Introduction ........................................................................................................ 1
   1.1. Interaction between mobility, settlement systems and lithics ................................. 3
   1.2. Mobility and sedentism and New Zealand archaeology .......................................... 5
   1.3. Thesis organisation ................................................................................................ 9

Chapter 2. Introduction to conceptual underpinnings of this thesis ................................. 11
   2.1. General frameworks for mobility and sedentism ...................................................... 13
   2.1.1 Societal Organisation ......................................................................................... 14
   2.1.2 Archaeological approaches to mobility ............................................................. 18
   2.1.3 Site designations and settlement patterns ......................................................... 20
   2.1.4 Portable material culture and technological organisation .................................. 24
   2.2. Lithics and mobility .............................................................................................. 26
   2.2.1 “Site” and artefact typologies ............................................................................. 31
   2.2.2 Manufacture and use-life ................................................................................... 33
   2.2.3 Raw material diversity and sourcing ................................................................. 37
   2.2.4 Local versus non-local material ......................................................................... 40
   2.2.5 Refitting ............................................................................................................. 41
   2.3. Factors that affect the formation of archaeological lithic assemblages .................. 43
   2.3.1 Accumulations research ..................................................................................... 46
   2.3.2 Time perspectivism ........................................................................................... 48
   2.4. Chapter Summary ................................................................................................. 51

Chapter 3. The New Zealand discourse concerning settlement systems, mobility and lithic artefacts ................................................................................................................. 52
   3.1. Introduction ............................................................................................................. 52
   3.2. Overview of the ways in which mobility and sedentism have been conceptualised in New Zealand archaeology ................................................................. 52
3.3. NZ lithic studies ................................................................. 63
3.3.1 Typological/functional studies ........................................ 65
3.3.2 Explicitly archaeological approaches ............................. 67
3.3.3 Explicitly Technological Studies ..................................... 69
3.3.4 Spatial studies ............................................................... 79
3.3.5 Sourcing studies, trade and exchange networks ............... 85
3.4. Chapter Summary .......................................................... 90

Chapter 4. Physical Setting of Excavation Zones and Dataset Background .......................... 93
4.1. Ahuahu background and history ...................................... 93
4.1.1 Traditional Māori accounts and tenure ........................ 97
4.1.2 European contact .......................................................... 99
4.2. Previous archaeological research on Ahuahu .................... 100
4.3. Devonport excavation zone background ......................... 102
4.4. Lithic raw material sources and types .............................. 104
4.4.1 Tahanga basalt ............................................................. 105
4.4.2 Ahuahu (Tamewhera) basalt ....................................... 107
4.4.3 Motutapu greywacke ................................................... 107
4.4.4 Ahuahu chert .............................................................. 108
4.4.5 Obsidian ................................................................. 111
4.4.6 Other lithic material .................................................... 114
4.5. Chapter summary .......................................................... 116

Chapter 5. Excavation Zone and Area Descriptions ...................................................... 117
5.1. Excavation zone background ......................................... 117
5.2. Excavation methodology ............................................... 119
5.3. Spatial analysis ............................................................. 119
5.4. Oneroa Beach Excavation Zone – EA1 and EA2-5 ............... 120
5.5. EA1 spatial analysis ......................................................... 124
5.5.1 Distribution of Tahanga basalt artefacts in EA1 ............... 124
5.5.2 Distribution of Chert Artefacts in EA1 ............................. 125
5.5.3 Distribution of Mayor Island obsidian in EA1 ................ 126
5.5.4 Distribution of Coromandel Volcanic Zone obsidian in EA1 ........................................ 127
5.5.5 Tool and core distributions in EA1 – all raw materials .... 128
5.5.6 Vertical stratigraphic Representation – Tahanga basalt .... 129
5.5.7 EA1 summary ........................................................................................................130
5.6. Excavation Areas 2-5 ..............................................................................................132
5.7. Stingray Ridge Excavation Zone – EA12-17 Upper, EA12-17 Lower and EA26 ..135
5.8. Excavation Areas 12-17 ........................................................................................140
5.9. EA12-17 Upper artefact spatial distribution .........................................................140
5.9.1 EA12-17 Upper Tahanga basalt .................................................................141
5.9.2 EA12-17 Upper chert ......................................................................................142
5.9.3 EA12-17 Upper Mayor Island obsidian .........................................................143
5.9.4 EA12-17 Upper Coromandel Volcanic Zone obsidian ..................................144
5.9.5 EA12-17 Upper Ahuahu basalt .................................................................145
5.9.6 EA12-17 Upper tool and core distributions ...................................................146
5.10. EA12-17 Lower artefact spatial distribution ......................................................147
5.10.1 EA12-17 Lower Tahanga basalt distribution ................................................147
5.10.2 EA12-17 Lower chert distribution ..............................................................148
5.10.3 EA12-17 Lower Mayor Island obsidian .........................................................149
5.10.4 EA12-17 Lower Coromandel Volcanic Zone obsidian ................................150
5.10.5 EA12-17 Lower tool and core distributions ..................................................151
5.11. EA12-17 combined vertical stratigraphic distribution of artefacts – Tahanga basalt and Ahuahu chert ...........................................................151
5.12. EA12-17 Upper and EA12-17 Lower Summary .................................................153
5.13. EA26 Artefact spatial distribution ....................................................................154
5.14. EA51 (Te Matuku) ............................................................................................159
5.15. EA51 artefacts spatial distribution ....................................................................163
5.15.1 EA51 Tahanga basalt spatial distribution .....................................................163
5.15.2 EA51 Chert spatial distribution ....................................................................164
5.15.3 EA51 Mayor Island Obsidian .......................................................................165
5.15.4 EA51 Coromandel Volcanic Zone obsidian spatial distribution ..................166
5.15.5 EA51 tool and core distributions ..................................................................166
5.16. EA51 Summary .................................................................................................168
5.17. Tamewhera Excavation Zone ..........................................................................169
5.17.1 Faunal remains .............................................................................................171
5.18. EA102 Spatial analysis .....................................................................................172
5.18.1 EA102 Tool and core distributions ...............................................................176
5.19. EA103 Spatial analysis ....................................................................................177
Chapter 6. Analytical Methodology ................................................................. 200
  6.1. Background ......................................................................................... 200
  6.2. Assemblage and artefact size parameters ........................................... 202
  6.3. Measurement instrumentation.............................................................. 204
  6.4. Metric recording software and attribute data categories .................... 204
    6.4.1 Raw material .................................................................................. 204
    6.4.2 Maximum length, width and thickness of the artefact ...................... 205
    6.4.3 Complete flake length, width and thickness .................................... 205
    6.4.4 Exterior platform angle .................................................................. 207
    6.4.5 Weight ........................................................................................... 208
    6.4.6 Flake Class ..................................................................................... 208
    6.4.7 Cores ............................................................................................. 209
    6.4.8 Tools .............................................................................................. 210
    6.4.9 Cortical cover .................................................................................. 210
    6.4.10 Flake termination .......................................................................... 211
    6.4.11 Raw material colour .................................................................... 211
  6.5. Statistical analysis .................................................................................. 212

Chapter 7. Technological Analysis ................................................................. 213
  7.1. Introduction ......................................................................................... 213
  7.2. Physical metrics ................................................................................... 214
    7.2.1 Mayor Island obsidian to Coromandel Volcanic Zone obsidian percentages by assemblage ................................................................. 216
  7.3. Artefact maximum dimensions: maximum length, width and thickness .............................................................................................................. 218
    7.3.1 Tahanga basalt metrics .................................................................... 218
7.3.2 Chert metrics
7.3.3 Mayor Island obsidian metrics
7.3.4 Coromandel Volcanic Zone obsidian metrics
7.4. Metrics Summary
7.5. Fragmentation ratios
7.5.1 Basalt fragmentation ratios
7.5.2 Chert fragmentation ratios
7.5.3 Obsidian fragmentation ratios
7.6. Flake metrics
7.6.1 Basalt complete flake metrics
7.6.2 Chert complete flake metrics
7.6.3 Mayor Island obsidian complete flake metrics
7.6.4 Coromandel Volcanic Zone complete flake metrics
7.7. Minimum number of flake to core ratios
7.8. Core volumes and morphology
7.8.1 Chert core volume and morphology
7.9. Obsidian core volumes
7.11. Cortical to non-cortical flake ratios
7.11.1 Tahanga basalt cortical to non-cortical ratios
7.11.2 Chert cortical to non-cortical ratios
7.11.3 Mayor Island obsidian cortical to non-cortical ratios
7.11.4 Coromandel Volcanic Zone obsidian cortical to non-cortical ratios
7.13. Non-tool to tool ratios
7.13.1 Tahanga basalt non-tool to tool ratios
7.13.2 Chert non-tool to tool ratios
7.13.3 Mayor Island obsidian non-tool to tool ratios
7.13.4 Coromandel Volcanic Zone obsidian non-tool to tool ratios
7.15. Tool type percentages
7.15.1 Tahanga basalt tool type percentages
7.15.2 Chert tool type percentages
7.15.3 Obsidian tool type percentages
7.16. Exterior platform angle versus platform depth
7.16.1 Tahanga basalt exterior platform angle vs platform thickness
Chapter 8. Discussion ................................................................. 305
8.1. The Wider New Zealand Context ................................................................. 307
8.2. Basic attributes of the lithic assemblages .................................................. 315
8.2.1 Raw material ............................................................................................... 315
8.3. Post-depositional taphonomic processes and their impact on individual artefact morphology .............................................................................................................. 318
8.4. Technological metrics .................................................................................. 319
8.5. Artefact attributes relating to manufacture and intensity of use .................. 320
8.6. Tahanga basalt divergence .......................................................................... 320
8.7. Reduction intensity/economisation for chert and obsidian ......................... 322
8.8. Selection of flakes for specific purposes – recycling .................................. 324
8.9. Tamewhera Tahanga basalt ......................................................................... 326
8.10. Tamewhera obsidian ................................................................................ 327
8.11. Implications of recycling practices for the assessment of human behaviour from the archaeological record ................................................................. 328
8.12. Technological analysis: conclusion ......................................................... 331
8.13. Spatial patterning ....................................................................................... 332
8.14. Time Averaged Deposits .......................................................................... 336
8.15. Chapter summary ..................................................................................... 337

Chapter 9. Conclusion .................................................................................. 339
9.1. Wider implications for lithic analysis in archaeology .................................. 344
9.2. Questioning the narrative .......................................................................... 346
9.3. Future directions ......................................................................................... 347
9.4. Concluding remarks .................................................................................. 349

References ....................................................................................................... 350
List of Figures

Figure 1.1. Conceptual Framework ........................................................................................................... 8
Figure 2.1. Interrelationship of conceptual frameworks for lithic analysis, formation studies and mobility/sedentism .......................................................................................................................... 12
Figure 2.2. Model of prehistoric settlement patterns in New Zealand .................................................... 16
Figure 2.3. Modified Framework for conduct of Technological Organisation studies 29
Figure 3.1. Spatial distribution of artefact material at site 261, Pouerua ........................................... 82
Figure 4.1. Coromandel Peninsula and islands and areas mentioned in the text ................................. 94
Figure 4.2. Ahuahu geology and recorded chert sources ....................................................................... 96
Figure 4.3. Recorded pre-European contact archaeological sites ......................................................... 102
Figure 4.4. Masonic Tavern Sites R11/2517, R11/2518 and R11/2519 ............................................... 104
Figure 4.5. Raw material types. A: Ahuahu (Tamewhera) Basalt, B: Obsidian (Mayor Island), C: Motutapu Greywacke, D: Ahuahu Chert, E: Tahanga Basalt .................................................. 105
Figure 5.1. Ahuahu Excavation Zones .................................................................................................. 117
Figure 5.2. Devonport Excavation Zone ................................................................................................. 118
Figure 5.3. Excavation Areas 1 and 2-5 ............................................................................................... 120
Figure 5.4. Radiocarbon Dates for EA1 ................................................................................................. 122
Figure 5.5. Spatial Distribution of EA1 Basalt Artefacts ..................................................................... 125
Figure 5.6. Spatial Distribution of EA1 Chert Artefacts ...................................................................... 126
Figure 5.7. Spatial Distribution of EA1 Mayor Island Obsidian Artefacts ............................................. 127
Figure 5.8. Spatial Distribution of EA1 Coromandel Volcanic Zone Obsidian Artefacts ..................... 128
Figure 5.9. Spatial Distribution of EA1 Tool and Core Artefacts .......................................................... 129
Figure 5.10. Vertical stratigraphic distributions of EA1 basalt and FCR ............................................ 130
Figure 5.11. Excavation Areas 2-5 on top of the dune ....................................................................... 133
Figure 5.12. Radiocarbon Dates for EA2-5 ......................................................................................... 133
Figure 5.13. Stingray Ridge T10/1114 from Stingray Point Pa ................................................................ 137
Figure 5.14. Plan of excavations, T10/1114, Stingray Ridge ............................................................... 137
Figure 5.15. Storage pit, T10/1114 .................................................................................................... 138
Figure 5.16. EA26 bin pit ...................................................................................................................... 139
Figure 5.17. Radiocarbon Dates for EA12-17 Upper and Lower .......................................................... 139
Figure 5.18. EA12-17 Upper basalt artefact distribution ................................................................. 141
Figure 5.19. EA12-17 Upper chert artefact distribution .................................................. 142
Figure 5.20. EA12-17 Mayor Island obsidian artefact distribution ................................ 143
Figure 5.21. EA12-17 Coromandel Volcanic Zone obsidian artefact distribution ......... 144
Figure 5.22. EA12-17 Ahuahu basalt artefact distribution ........................................... 145
Figure 5.23. EA12-17 Ahuahu basalt three-dimensional artefact distribution looking east. 145
Figure 5.24. EA12-17 Upper tool artefact distribution and core artefact distribution .... 146
Figure 5.25. EA12-17 Lower Tahanga basalt artefact distribution ............................... 148
Figure 5.26. EA12-17 Lower chert artefact distribution .............................................. 148
Figure 5.27. EA12-17 Lower Mayor Island obsidian artefact distribution ................. 149
Figure 5.28. EA12-17 Lower Coromandel Volcanic Zone artefact distribution .......... 150
Figure 5.29. EA12-17 Lower tool artefact distribution .................................................. 151
Figure 5.30. EA12-17 Upper and Lower combined three-dimensional representation of basalt artefact distribution .......................................................... 152
Figure 5.31. EA12 and EA17 Upper and Lower combined three-dimensional representation of chert artefact distribution ........................................................................ 152
Figure 5.32. EA26 Tahanga basalt artefact distributions ............................................. 155
Figure 5.33. EA26 chert artefact distributions ......................................................... 156
Figure 5.34. EA26 Mayor Island obsidian artefact distributions ............................. 156
Figure 5.35. EA26 Coromandel Volcanic Zone obsidian artefact distributions ..... 157
Figure 5.36. EA26 tool and core distributions ......................................................... 157
Figure 5.37. Three-dimensional spatial distribution of EA26 tool and artefact distributions 158
Figure 5.38. Position of EA51 ................................................................................. 159
Figure 5.39. EA51 looking north-west ..................................................................... 160
Figure 5.40. Radiocarbon Dates for EA51 (Te Matuku) ........................................ 162
Figure 5.41. Spatial distribution of EA51 Tahanga basalt artefacts ....................... 163
Figure 5.42. Spatial distribution of EA51 chert artefacts ........................................ 164
Figure 5.43. Spatial distribution of EA51 Mayor Island obsidian artefacts 165
Figure 5.44. Spatial distribution of EA51 Coromandel Volcanic Zone obsidian artefacts ... 166
Figure 5.45. EA51 Tool and core artefact distribution .............................................. 167
Figure 5.46. Three-dimensional spatial distribution of EA51 stone artefacts ......... 167
Figure 5.47. Tamewhera Excavation Zone, showing Excavation Areas ............... 170
Figure 5.48. Radiocarbon dates for Tamewhera Zone ......................................... 170
Figure 5.49. Stone-lined hearth in EA102, Tamewhera .......................................... 173
Figure 5.50. Overview of EA102 excavation on completion ............................... 173
Figure 5.51. EA102 artefact distributions and density plots..........................175
Figure 5.52. Spatial distribution of EA102 tool and core artefacts ..................176
Figure 5.53. Stone-lined hearth and drain feature in EA103, Tamewhera. ..........177
Figure 5.54. Completed excavation EA103, Tamewhera................................178
Figure 5.55. House terrace EA103, Tamewhera from the west......................179
Figure 5.56. EA103 artefact distributions and density plots..........................181
Figure 5.57. Spatial distribution of EA103 tool and core artefacts ..................182
Figure 5.58. Overview of EA106 excavation .............................................184
Figure 5.59. EA106 artefact distributions and density plots .........................185
Figure 5.60. Spatial distribution of EA106 tool and core artefacts ..................186
Figure 5.61. Overview of EA108 excavation on completion............................187
Figure 5.62. EA108 artefact distributions and density plots..........................188
Figure 5.63. Spatial distribution of EA108 tool and core artefacts ..................189
Figure 5.64. Masonic Excavation Area.......................................................193
Figure 5.65. Stone-lined hearth being excavated by the author......................194
Figure 5.66. Radiocarbon Dates for Devonport Excavation Zone.....................195
Figure 5.67. Masonic artefact distributions and density plots.......................197
Figure 5.68. Masonic tool and core distributions .........................................198
Figure 6.1. Artefact and complete flake length and width measurements..............206
Figure 6.2. Platform dimensions ................................................................207
Figure 6.3. Artefact and complete flake thickness, exterior platform angle measurements..208
Figure 7.1. Proportions of raw material composition by weight per Excavation Zone assemblage. .................................................................216
Figure 7.2. Average length, width and thickness for all Tahanga basalt artefacts >20mm in maximum dimension excluding cores by Excavation Zone. ..........................220
Figure 7.3. Average maximum length, width and thickness for all chert artefacts >20mm in maximum dimension excluding cores by Excavation Zone. ........................................221
Figure 7.4. Average length for all Mayor Island obsidian artefacts >20mm in maximum dimension excluding cores by Excavation Area. .................................................222
Figure 7.5. Average length for all Mayor island obsidian artefacts >20mm in maximum dimension excluding cores by Excavation Zone. .................................................223
Figure 7.6. Average complete flake length, width and thickness for all Tahanga basalt artefacts* >20mm in maximum dimension excluding cores by Excavation Zone. ..............233
Figure 7.7. Average complete flake length, flake width and flake thickness for chert from all Excavation Zones ................................................................. 235
Figure 7.8. Average Mayor Island obsidian complete flake length, width and thickness for all Mayor Island obsidian artefacts >20mm in maximum dimension, excluding cores, by Excavation Zone. ................................................................. 237
Figure 7.9. Average Coromandel Volcanic Zone obsidian complete flake length, width and thickness for all Coromandel Volcanic Zone obsidian artefacts >20mm in maximum dimension, excluding cores, by Excavation Zone. ................................................................. 240
Figure 7.10. Lin et al. 2013: 736 Figure 11 ........................................................................................................ 273
Figure 7.11. Complete flake exterior platform angle vs platform thickness for Tahanga basalt artefacts >20mm in maximum dimension by Excavation Zone. ................................................................. 275
Figure 7.12. Stone artefact exterior platform angle vs platform thickness for chert from all Excavation Areas ................................................................................................................ 276
Figure 7.13. Stone artefact exterior platform angle vs platform thickness for all obsidian sources from all Excavation Areas ............................................................................................................. 277
Figure 7.14. Diagram demonstrating suggested effect on platform angle due to variation in core shape......................................................................................................................... 279
Figure 7.15. Log platform area versus log artefact weight for all Tahanga basalt complete flakes >20mm in maximum dimension by Excavation Zone ............................................................................... 283
Figure 7.16. Log platform area versus log artefact weight for all chert complete flakes >20mm in maximum dimension by Excavation Zone ............................................................................................................. 284
Figure 7.17. Log platform area versus log artefact weight for all Mayor Island obsidian complete flakes >20mm in maximum dimension by Excavation Zone ............................................................................................................. 285
Figure 7.18. Log platform area versus log artefact weight for all Coromandel Volcanic Zone obsidian complete flakes >20mm in maximum dimension by Excavation Zone ............................................................................................................. 286
Figure 7.19. Average length, width and thickness for all Tahanga basalt artefacts >20mm excluding cores by Tamewhera Excavation Areas. ..................................................................................................................... 294
Figure 7.20. Average length, width and thickness for all Tamewhera basalt artefacts >20mm excluding cores by Tamewhera Excavation Areas. ..................................................................................................................... 294
Figure 7.21. Average length, width and thickness for all chert artefacts >20mm excluding cores by Tamewhera Excavation Areas. ..................................................................................................................... 295
Figure 7.22. Average length, width and thickness for all Mayor Island obsidian artefacts >20mm excluding cores by Tamewhera Excavation Areas. ..................................................................................................................... 296
Figure 7.23. Average complete flake length, width, and thickness for all chert complete flakes >20mm for Tamewhera Excavation Areas. ................................................................. 297

Figure 7.24. Average complete flake length, width, length to width ratio and thickness for all Mayor Island obsidian artefacts >20mm for Tamewhera Excavation Areas.......................... 298

Figure 8.1. Ahuahu chert artefact showing secondary cortical patination on dorsal and ventral surfaces, and subsequent retouch on distal and lateral margins............................................. 326
List of Tables

Table 2.1. Indices of sedentism and mobility and their general correlation with the archaeological record ........................................................................................................ 19
Table 5.1. EA1 Artefact (n), total weight, average maximum length, width and thickness by raw material type ........................................................................................................ 123
Table 5.2. EA2-5 Artefact (n), total weight, average maximum length, width and thickness by raw material ... ........................................................................................................ 134
Table 5.3. EA12-17 Upper Artefact (n), total weight, average maximum length, width and thickness by raw material ........................................................................................................ 141
Table 5.4. EA12-17 Upper Artefact (n), total weight, average maximum length, width and thickness by raw material ........................................................................................................ 147
Table 5.5. EA26 Artefact (n), total weight, average maximum length, width and thickness by raw material ........................................................................................................ 154
Table 5.6 EA51 Artefact (n), total weight, average maximum length, width and thickness by raw material ........................................................................................................ 163
Table 5.7. Tamewhera Excavation Zone artefact (n), total weight, average maximum length, width and thickness by raw material ........................................................................................................ 171
Table 5.8. Proportions of raw material composition by weight per Tamewhera Excavation Area assemblage. ........................................................................................................ 191
Table 5.9. Proportions of raw material composition by weight for Masonic Excavation Area assemblages ........................................................................................................ 195
Table 6.1. Practical considerations of debitage analysis ........................................................................................................ 201
Table 7.1. Assemblage weight by raw material per Excavation Zone assemblage. ........................................................................................................ 215
Table 7.2. Obsidian source ratios for obsidian artefacts by weight from all Excavation Areas ........................................................................................................ 217
Table 7.3. Fragmentation ratios for Tahanga basalt artefacts from all Excavation Zones. ........................................................................................................ 227
Table 7.4. Fragmentation ratios for chert artefacts from all Excavation Zones ........................................................................................................ 229
Table 7.5. Fragmentation ratios for Mayor Island obsidian artefacts from all Excavation Zones ........................................................................................................ 230
Table 7.6. Fragmentation ratios for Coromandel Volcanic Zone obsidian artefacts from all Excavation Zones ........................................................................................................ 231
Table 7.7. Average complete flake length, width and length to width ratios for Tahanga basalt from all Excavation Zones ................................................................. 234

Table 7.8. Average complete flake length, width and length to width ratios for chert from all Excavation Zones .......................................................................................... 236

Table 7.9. Average complete flake length, width and length to width ratios for Mayor Island obsidian from all Excavation Zones ............................................................... 238

Table 7.10. Average Coromandel Volcanic Zone obsidian complete flake length, length to width ratios for all Coromandel Volcanic Zone obsidian artefacts >20mm in maximum dimension .................................................................................................................................. 240

Table 7.11. MNF to core ratios for chert artefacts from all Excavation Areas ................................................................................................................................. 243

Table 7.12. MNF to core ratios for Mayor Island obsidian artefacts from all Excavation Areas ......................................................................................................................... 244

Table 7.13. MNF to core ratios for Coromandel Volcanic Zone obsidian artefacts from all Excavation Areas ........................................................................................................ 246

Table 7.14. Chert core median volume (cm$^3$) and core rotation ratios ........................................... 248

Table 7.15. Mayor Island obsidian core average volume in cm$^3$ .......................................................................................................................... 250

Table 7.16. Coromandel Volcanic Zone obsidian core median volume in cm$^3$............................ 251

Table 7.17. Non-cortical to cortical flake ratios for basalt artefacts from all Excavation Zones .................................................................................................................................. 254

Table 7.18. Non-cortical to cortical flake ratios for chert artefacts from all Excavation Zones .................................................................................................................................. 256

Table 7.19. Non-cortical to cortical flake ratios for all Mayor Island obsidian artefacts from all Excavation Zones .............................................................................................. 258

Table 7.20. Non-cortical to cortical flake ratios for all Coromandel Volcanic Zone obsidian artefacts from all Excavation Zones .............................................................................. 259

Table 7.21. Non-tool to tool ratios for Tahanga basalt artefacts from all Excavation Zones ................................................................................................................................. 263

Table 7.22. Non-tool to tool ratios for chert artefacts from all Excavation Zones .................. 264

Table 7.23. Non-tool to tool ratios for Mayor Island obsidian artefacts from all Excavation Zones .................................................................................................................................. 265

Table 7.24. Non-tool to tool ratios for Coromandel Volcanic Zone obsidian artefacts from all Excavation Zones ......................................................................................................... 266

Table 7.25. Utilised unmodified flakes and modified tools for Tahanga basalt artefacts (including Masonic greywacke) from all Excavation Zones ........................................ 269
Table 7.26. Utilised unmodified flakes and modified tools for chert artefacts from all Excavation Zones
.................................................................................................................................................. 271
Table 7.27. Utilised unmodified flakes and modified tools for obsidian artefacts from all Excavation Zones
.................................................................................................................................................. 272
Table 7.28 Obsidian complete flake average platform angles by Excavation Zone based on source .................................................................................................................................................. 280
Table 7.29 Summary of statistically significant outlying metrics by Excavation Area........289
Table 7.30. MNF to core ratios for chert artefacts from all Tamewhera Excavation Areas..299
Table 7.31. MNF to core ratios for Mayor Island Obsidian artefacts from all Tamewhera Excavation Areas .................................................................................................................................................. 300
Table 7.32. MNF to core ratios for Coromandel Volcanic Zone obsidian artefacts from all Tamewhera Excavation Areas .................................................................................................................................................. 300
Table 7.33. Non-tool to tool ratios for chert artefacts from all Tamewhera Excavation Areas .................................................................................................................................................. 301
Table 7.34. Non-tool to tool ratios for Mayor Island Obsidian artefacts from all Tamewhera Excavation Areas .................................................................................................................................................. 302
Table 7.35. Non-tool to tool ratios for Coromandel Volcanic Zone obsidian artefacts from all Tamewhera Excavation Areas .................................................................................................................................................. 302
Chapter 1. Introduction

Stone artefacts are the most durable of all archaeological entities, and their study has long been at the forefront of archaeological research throughout the world. They form part of the earliest record of human culture (Odell 2004) and the modification of stone material by humans is so universal across space and time that the study of stone artefacts has its origins in the discipline of archaeology itself (Shott 2015). As stone artefacts have been studied over the past couple of centuries terminology has evolved that allows a certain commonality of analysis, whether dealing with Mousterian technology in Europe (Kuhn 1994), the stone tool industries of the first settlers of the Americas (Surovell 2009), or the lithic artefacts of pre-European contact Australian Aborigines (Holdaway and Stern 2004). In archaeological discourse, lithic artefacts have a long tradition of use as a way to assess the subsistence strategies, relative mobility and settlement systems of past groups (Close 2000, Dibble et al. 2016, Holdaway and Stern 2004).

New Zealand was the last major landmass on earth to be settled by humans (Davidson 1984). For a period of about 500 years from the early 14th century AD until the beginning of the 19th century AD and the first regular contact with European seafarers, the east Polynesian colonisers of New Zealand, who became known as Māori, settled a temperate, geologically and environmentally diverse landmass many times larger than their homelands. Their impact on the environment was considerable, resulting in a landscape changed through deforestation and swidden horticulture, and the large scale extinctions of avian megafauna (Anderson et al. 2014). In adapting an East Polynesian lifeway to a new environment, the question of the degree to which that lifeway incorporated a hunter-gatherer mobility system is one that has framed the New Zealand archaeological discourse for some time (Davidson 1984, Walter et
In the early period of colonisation, during a relatively short period of time before extinction of that avian megafauna, and regional extirpation of marine megafauna (probably only 100 years for the avian megafauna (Perry et al. 2014) and 200 years for pinnipeds in the North Island (Smith 2011)), it has been suggested that a more traditional Polynesian horticultural/maritime subsistence strategy shifted to a more mobile hunter-gatherer economic subsistence strategy (Walter 2004, Walter et al. 2010).

This thesis examines the broad issue of the assessment of pre-European contact Māori mobility through the technological analysis of flaked stone artefacts, those categories of lithics generally referred to as informal tools (although there are some exceptions to this), anddebitage during a period of proposed significant change in socio-economy. The data sources for this research comprise a variety of archaeological contexts taken from two study areas, Ahuahu (also known as Great Mercury Island), and the inner Hauraki Gulf, that provide extensive evidence for pre-European Māori occupation. As a consequence, a comparison of lithic technological attributes across time and space, while being able to precisely attribute lithic material to source, is possible. The assemblages provide a way of evaluating measures of mobility using lithic artefacts in a situation where technology, transport methods and land use over time by the groups that produced the artefacts in question can be controlled in ways that are not always possible elsewhere in the world. As such the research is also able to control for a number of variables such as lithic material, lithic source, archaeological context, geographical context, and temporal context, and assess the impact of those variables in turn.

By comparing the technological attributes of lithic material recovered from a variety of excavation contexts, it is possible to evaluate the degree of variation in lithic technological organisation represented, and link such variation, or lack of variation, to evidence for change or stasis with respect to mobility patterns and settlement systems. It is important to note that this thesis does not attempt to make a direct correlation between certain lithic assemblage
signatures and certain lifeways, be they at the mobile or sedentary end of the mobile/sedentary continuum (Kelly 1992). Rather, it uses the lithic assemblages to evaluate the evidence for change in lithic technological organisation over time and the possible impact of different archaeological contexts. The composition of the assemblages are used to examine depositional trajectories and assess the evidence for the duration of occupation at particular locations in the landscape. In evaluating occupation duration, or the evidence that a location has been repeatedly used over time, spatial and technological patterning of lithic artefacts is assessed through the statistical analysis of artefact attributes and their combination with provenience. Variation in artefact technological or spatial attributes over time can indicate that persistent places were used in similar or divergent ways. How these factors interact is introduced in the following section.

1.1. Interaction between mobility, settlement systems and lithics

One of the problems with conceptualising mobility is that often the research that has been undertaken archaeologically has focussed on presumed hunter-gatherer societies, and when it comes to more sedentary societies such as low-level food producers (Smith 2001), structural evidence such as houses and storage can take over as indices (although this approach is changing – see for example Holdaway and Wendrich 2017). It is not often that the portable material culture of more sedentary societies is used as the lens through which to examine mobility; more often such studies are framed in terms of occupation duration. And in a sense, this is mobility on a different scale, or at least frequency.

As Sellet et al. 2006: (i) note
As important as subsistence strategies are in dictating human movement, factors other than the search for food also structure population mobility and its archaeological effects. Information gathering, raw material collection, social networking, trade, mate search, and population fission present mobility needs that contrast those of daily food searches. Although usually considered most pertinent to hunter-gatherer societies, mobility strategies are significant components of more sedentary adaptations. Residential mobility, hunting, wild plant resource gathering, pastoral nomadism, labor exchange, and a range of social and demographic movement are vital tactics among food producing social systems of all sizes.

Indeed, if lithic analysis can be used to understand certain aspects of human lifeways, and specifically in this instance the lifeways represented by a certain pattern of mobility and the production of stone tools, as represented in the archaeological record, then the study of New Zealand’s archaeological record is a prime candidate. As noted above, New Zealand was first settled around 1280 to 1320 AD (Jacomb *et al.* 2014, Wilmshurst *et al.* 2008, Walter *et al.* 2017), and by the early 1800s European contact was widespread and influential. This comparatively short chronology of New Zealand’s pre-European contact occupants can be seen as a positive factor that lessens the impact of many longer term processes, both cultural and natural, in terms of complicating the archaeological record. This is not to state that archaeological interpretation or analysis in the New Zealand context is easy; just to note that some of the factors at play in other locales, such as great time depth, large environmental cycles and fluctuating resources, may be less influential drivers of patterning in the archaeological record. While there were certainly faunal extinctions and considerable human-caused changes in vegetation over the period from settlement to European contact (McGlone and Wilmshurst 1999, Perry *et al.* 2012), the fact that the timing of these events is
relatively well dated (Perry et al. 2014) means that their influence can be accounted for to a
greater degree than in other parts of the world.

1.2. Mobility and sedentism and New Zealand archaeology.

In the complex and fluid interplay of pre- and post-European contact Māori socio-political
structure, concepts of land tenure and kinship ties mean that dealing with comparatively
recent historic disputes concerning land occupation are far from straightforward.

In an influential 1996 paper, H. Allen stresses the importance of understanding the
interrelationship between kinship, economy and mobility, and how such relationships may be
represented in the archaeological record. This rejects an approach which ascribes certain
archaeological site types to the actions of particular social units (H. Allen 1996, Holdaway
2004: 23, M. Allen 2012: 305, Jackson and Smith 2013), given the difficulties with the
identification of particular social units – be they iwi, hapu or whanau – due to the fluid nature
of such units over time: “Settlement pattern archaeologists were correct in expecting that the
archaeological remains should mirror the local/social organisation of the prehistoric society
responsible for their creation. However, they were in error in accepting the social
anthropologist’s idealised version of social organisation and in expecting that this would
leave an ideal imprint in the ground” (H. Allen 1996: 671).

Nevertheless, many conceptual frameworks for understanding the nature of pre-contact Māori
settlement-subsistence and mobility behaviours have fallen back on these idealised social
units and their predicted archaeological signatures. A range of settlement and mobility
patterns have been posited for pre-contact New Zealand over the years and models for the
development of “Classic” pre-contact Māori culture are still focussed on material culture
changes, the relationship between mobility, horticulture and social structure, and subsistence

In present-day New Zealand, the nature of current and past Māori land tenure is immensely important. As part of an ongoing process, compensation for past grievances, reparations and acknowledgements of wrong-doing, the New Zealand government is in mediation with any number of iwi (Māori tribes) and constant examination, interpretation and, in some cases, vilification of what most would agree is New Zealand’s founding document, the Treaty of Waitangi, continues.

These disputes, discussions and mediations happen at national and local levels. In the world of heritage management and the often fraught intersection between the rights of indigenous peoples and the rights of landowners, evidence for occupation duration can have a lasting impact on all parties (Kristiansen and Davis 2015, Gillespie 2016, Hutchings and La Salle 2017). In New Zealand, the nature of pre-European occupation of an area or “site”, in terms of its degree of permanence or transience, has more than academic interest (see for example Waitangi Tribunal Report “The Hauraki Report, Volume I, Wai 686, 2006”). Aside from the bigger picture issues of regional land settlements and compensation for iwi, issues of particular land occupation and the relationship the indigenous inhabitants have with it are played out in courts of law as well as over the negotiating table. From a legal standpoint, the application of the Resource Management Act 1993 (RMA) and Heritage New Zealand Pouhere Taonga Act 2014 (HA), the primary statutes that govern the protection of New Zealand heritage in general and archaeological sites in particular, occasionally result in a ruling on the nature of pre-European Māori occupation of land. A good example is Gannet Beach Adventures Limited v Hasting District Council.¹ The case concerned the application

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¹ Gannet Beach Adventures Ltd v Hastings District Council [2005] NZRMA 311.
for consent to build a tourist lodge on a site on a cliff-top at Cape Kidnappers in the Hawkes Bay region. Opponents to the application raised the issue of the significance of the site to Māori. The High Court of New Zealand examined the evidence put before it for permanent pre-European occupation of the location in evaluating the locale’s pre-European heritage value (Nolan 2011: 890). The court looked at the question in light of section 6(f) of the RMA. The relevant section provides:

6. Matters of national importance –

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance: …

(f) the protection of historic heritage from inappropriate subdivision, use, and development.

In its judgement the court specifically considered evidence for permanent occupation and the use of the land by Māori in pre-European times:

“In terms of s6(f), we have briefly mentioned some historic factors already…the Cape area generally has strong associations for Māori and for the iwi of Ngati Kahungunu in particular. There are middens on the site, but no evidence of permanent occupation [emphasis added]. It seems that the headland was primarily used as a lookout point to watch for any seaborne threat.”

Thus the court has focussed on evidence that the location in question was only occupied for the purpose of disposing waste and/or as a lookout (and there is no indication as to the nature of archaeological evidence introduced to support this) in determining what weight to give arguments for the relationship of Māori to the particular land in question. In one brief
paragraph, the judgement encapsulates many of the issues that are raised in this thesis: site conceptualisation and functionality, the nature of the archaeological record at a particular point in space, its relationship to the behaviour of people who were responsible for the creation of it, and the periodicity of occupation that it represents.

The conceptualisation of the research undertaken in this thesis is set out in Figure 1.1. Mobility strategies and settlement systems are examined through both the way in which lithic technological organisation is manifest in the informal stone tools produced, and how the discard and accumulation of those stone tools inform taphonomic processes and use of particular locales within a landscape. The organisation of this thesis in order to undertake this examination is set out in the next section.

![Conceptual Framework](image-url)
1.3. Thesis organisation

Chapter 2 introduces the theoretical background to the methodology and analysis of lithic artefacts undertaken in the later chapters. It outlines the conceptual links between mobility, occupation duration and lithic analysis, and considers the ways in which archaeological “sites” are conceptualised as functional representations of specific human behaviours, bounded activity areas, or the cumulative outcome of generalised human behaviour and post-depositional processes.

Chapter 3 examines New Zealand case studies and approaches to the analysis of pre-European Māori mobility and settlement systems in a thematic review of the way in which archaeologically-derived lithic assemblages have been studied from the late 19th/early 20th century through to the present day. These studies will serve to contextualise the approach taken in the research undertaken to evaluate the evidence for stasis or change in mobility strategies and settlement systems.

Chapter 4 outlines the physical, historical and archaeological background of the study areas from which the lithic assemblages analysed were obtained. It then reviews the geological raw materials from which artefacts were created, their characteristics and geographical source locations in order to provide background for the types of stone artefacts excavated.

Chapter 5 outlines the archaeological excavations, their locations and their collection methodologies and presents the results of the spatial analysis for the distribution of the lithic artefacts in relation to the Excavation Areas.

Chapter 6 is a short chapter that sets out the analytical methodologies for the technological examination of the lithic assemblages that was utilised in recording the various attributes of the artefacts.
Chapter 7 sets out the results of the lithic technological analysis for all the lithic assemblages from the six Excavation Zones, and discusses the implications their measures and results have for the interpretation of the variability, or lack of variability, presented in the assemblages across archaeological contexts.

Chapter 8 discusses the results from chapters 5 and 7 and their implications for the evaluation of change in technological organisation that may be linked to change in mobility strategy, together with the ways in which the results can be incorporated into thinking about the formation of the archaeological record and the relevance of persistent places in New Zealand.

Chapter 9, the final chapter, brings together concluding thoughts about the impact of the results for the archaeological narrative concerning mobility in New Zealand. It then incorporates a discussion concerning the wider implications for lithic studies worldwide, and the ways in which lithic analysis can be used to gain insights into human landscape use.
Chapter 2. Introduction to conceptual underpinnings of this thesis

This thesis examines the ways in which the analysis of lithic artefacts can provide evidence for the mobility strategies of pre-contact Māori society and their archaeological context. Such an analysis requires movement through a number of linked concepts and inferences. Mobility strategies and settlement systems should be reflected in a society’s technological organisation (Binford 1980) and technological organisation should be able to be inferred from the lithic artefacts that are associated with that society. A study of the acquisition, production, use and re-use of stone tools allows an evaluation of technological organisation, but such a study of archaeologically recovered lithic assemblages also requires consideration of the natural and cultural formation processes that influence the assemblages after their components have initially entered the archaeological record. The study of mobility strategies or settlement systems archaeologically has been approached in a variety of ways. Figure 2.1 summarises the conceptual approaches and the sub-categories of archaeological evidence that relate to those. It is important to note at the outset that while such approaches to mobility and sedentism, formation processes and lithic technology studies are treated in separate sections, there is a high degree of interrelationship and overlap, and as such the categories should not be thought of in linear terms, but in a holistic sense:

“Given the discussions of technological organization in particular and context in general, archaeologists are of course well aware of the need to interpret stone artifacts in ways that reflect associations with other types of archaeological data. But perhaps because lithic analysis has come to be viewed as a specialist pursuit, a general understanding of the importance of context has not always translated into
methodological discussions. Studies of particular artifact types, core morphologies or reduction and resharpening sequences continue to feature in conferences and publications. The challenge archaeology faces is to truly break with the twentieth century approaches and develop alternatives that deal with the complex variability required for understanding context in both its processual and post-processual forms.”

(Holdaway and Douglass 2012: 127)

Figure 2.1. Interrelationship of conceptual frameworks for lithic analysis, formation studies and mobility/sedentism
As is apparent from Figure 2.1, and echoing Binford’s (1980) juxtaposition of the fluid nature of human society and the static nature of the archaeological record, “…obstacles to reconstructing prehistoric mobility stem from the very nature of the endeavour: understanding characteristics of a dynamic human settlement system by using the archaeological record, essentially a static residue” (Sellet 2006, Thacker 2006). Leaving aside for the moment issues concerning the conceptualisation of the archaeological record as “static” (see discussion below), this problem raises a number of important questions. Does the dynamic human settlement system leave an archaeological residue that can be interpreted in terms of mobility? Can we distinguish between continuous sedentary occupation and repeated but short term visits, perhaps on a seasonal basis? And can we distinguish between repeated seasonal occupation and continuous short term occupation in the absence of strong seasonal indices? Archaeologists have used a variety of tools, proxies and techniques to try to get closer to answering these questions and this chapter uses the framework outlined in Figure 2.1 to discuss those methodologies.

Accordingly, this chapter will review the conceptual underpinnings of current thinking about mobility and sedentism, the analysis of lithic assemblages, and accumulations research and formation theory in order to set the scene for the analysis to follow. Section 2.2 reviews the broad area of evaluating mobility and sedentism archaeologically.

2.1. General frameworks for mobility and sedentism

Why do the mobility strategies of societies matter to archaeologists? As Kelly (1992: 43) notes: “It is important that we learn to recognize the various forms of mobility archaeologically, because the ways people move exert strong influences on their culture and
society.” Mobility influences societies at a basic level. How individuals and societies moved (or didn’t move) within a landscape is fundamental to understanding the different manifestations of socio-political complexity, the interrelationship between territoriality, subsistence practices, agricultural intensification, trade and exchange. Whatever the scale or scope, all need to be understood at some level in terms of individual and societal movement: “Systematic means of gauging sedentism at variable social and temporal scales are necessary to evaluate models of the behavioural and social organisational changes associated with the adoption of food production and the emergence of political complexity, among other research topics” (Gallivan 2002: 535).

Many anthropological narratives have at their heart changes in mobility; the so-called Neolithic Revolution and its model for a shift from hunting and gathering to farming, from nomadism to sedentary villages, is a prime example (Rafferty 1985: 115-118, Watkins 2010, Winterhalder and Kennet 2009, Zeder 2006).

2.1.1 Societal Organisation
At the most basic level, defining and categorising mobility in human society is not straightforward: “Mobility is not only universal, but also multidimensional” (Gallivan 2002: 536). Binford’s (1980, 1982) conceptualisation of residential, logistical and territorial mobility forms a useful starting point for understanding the mobility of societal groups that have hunting and gathering as their primary subsistence strategy. The first two divisions refer to either the movement of the entire group from place to place (residential mobility), or the movements of individuals or sub-groups for foraging purposes from a residential base (logistical mobility). Territorial or long-term mobility sees cyclical group movements across
a defined region according to resource type and availability (Kelly 1992:44-45, Greenlee 2001:221). Sedentism is often conceptualised in relative terms (Kelly 1992: 45), with societies perceived as more or less “sedentary”, once having achieved what Rafferty defines as a threshold level of “permanence” (1985: 116). As Close (2000: 50) states: “Mobility patterns (or strategies) are reconstructions of palimpsests of multiple, individual movements, so that what is probably most commonly identified is range, either annual or longer term (sensu Binford, 1982:7). Even this, however, is far from certain.” In New Zealand, pre-contact Māori mobility patterns are usually conceived as falling somewhere between logistic and territorial mobility (Davidson 1984), with an emphasis on logistic mobility and a foraging hunter-gatherer lifeway focussed on the exploitation of now extinct terrestrial avian megafauna and regionally extirpated marine mammals in the early period (Anderson et al. 1996, Walter et al. 2006, Smith 2011), and a greater emphasis on horticulture in the later pre-contact period. There is some scope for regional variation at all periods, however, and the importance and continuity of horticulture in the north of the South Island and in the North Island is probably underestimated in models focussing on big-game hunting in the early period (Davidson 1984, Prickett 1982). Nevertheless, a model of pre-contact Māori settlement systems and Binfordian logistic mobility strategies drawing on a proposed “transient village” (Anderson and Smith 1996) and site types whose relative permanence is conditioned by their designation as residential bases or specialised activity locations is the framework within which much of New Zealand archaeology functions; a good example is Figure 2.2 (Smith 2011).

Current frameworks acknowledge that all human societies will fall somewhere along a “mobility-sedentism” continuum that runs from highly mobile societies that typically undertake hunting and gathering subsistence practices or nomadic pastoral strategies reflecting very short to short term occupation of a particular location in the landscape,
through to completely sedentary agricultural societies whose continual site occupation runs to the hundreds, if not thousands of years (Rafferty 1985, Kelly 1992, Close 2000, Gallivan 2002: 536). Modern analogues and ethnographic studies undertaken over the past hundred years or so form the basis for many frameworks for understanding hunter-gatherer mobility patterns at one end of the spectrum; the recorded landscape use and technological organisation of these more recent groups have been projected on to prehistoric societies (Binford 2001, Kelly 2013, Olszewski and al-Nahar 2016).

Figure 2.2. Model of prehistoric settlement patterns in New Zealand. A: Inter-relation of functionally discrete sites utilized by a community. B: Territorial shifts of a community over time (Smith 2011: 5).
The linking of a subsistence strategy based on horticulture and residential sedentism has often been analysed in terms of a “dualistic epistemology” highlighting the differences between hunter-gatherer and agricultural societies (Smith 2001: 2-5). However, Smith also outlines the conceptualisation of a “middle ground” between hunter-gatherer and agricultural societies that focusses on “low-level” food production. The low-level food production concept has subsequently been incorporated into models examining associated levels of mobility/sedentism (Holdaway et al. 2010). This “middle ground” could be seen as a conceptual framework for understanding pre-European Māori socio-economic structure, whereby the archaeology of a society known to have incorporated a variety of food acquisition/production schemes is examined through aspects of its portable material culture.

Additionally, settlement systems (“…the physical organisation of people, both through the annual seasonal cycle and across the landscape” (Greenlee 2001: 220)) and, in particular, the importance of understanding past landscape use, have received increasing attention. However, such attention has often been focussed on inland systems and pedestrian overland travel; Bailey (2004, 2010), for example, has noted a systemic theoretical marginalisation of the importance of coastal environment and corresponding coastal subsistence strategies in world prehistory. Binford (1968), however, was an exception. He saw coastal sedentism as encouraging population growth and movement (Bailey 2004: 45), and the link between sedentism, coastal or island resource exploitation, horticulture and socio-political development has also been explored by others in a variety of archaeological contexts (Rowley-Conwy 1983, Bailey 2004: 46, Van der Veen 2005, Sassaman 2004: 234, Keegan et al. 2008, Thompson and Tuck 2010). Arnold (1992) provides a good example of a typical model, documenting the emergence of chiefdoms on the Californian Channel Islands in the period just before, and during, first European contact in the 16th century AD. Central to the
model is the relationship between a maritime society more heavily reliant on marine resources than mainland groups (ibid: 65-66), and proposed political responses to environmental stresses. In New Zealand, the ability to move people and materials such as lithics and other trade and food items by canoe (waka), together with the use of such water transport for fishing, contrasts with the mobility scenarios for many hunter-gatherer societies whose primary method of transport is pedestrian.

Ultimately, it is the shifts of societies along the mobility/sedentism and hunter-gatherer/horticulturalist continuums, and the corresponding changes in socio-political structures, that have exercised archaeological theorists for some time; the situation in pre-European New Zealand provides an interesting test-case for such conceptual frameworks. Specifically, the incorporation of an explicitly maritime-based settlement system rubric into theories of low-level food production and mobility is ideally suited to archaeological investigation in the context of northern New Zealand.

2.1.2 Archaeological approaches to mobility

The identification and analysis of archaeological indicators of sedentism and mobility has for some time been debated and refined in archaeological literature: “Assessing the type of settlement mobility…across the landscape is a common theme in archaeological research…It is…conditioned by the aerial size of the archaeological sites recorded and/or excavated, the cultural material recovered from those contexts, the spatial arrangement of features or materials within sites (where discernible or available), and reconstruction of the paleoclimate and habitat.” (Olszewski and al-Nahar 2015: 1).
A catch-all summary of general areas of interest related to mobility identification would include economic subsistence, settlement size, village plan, house shape, building materials (i.e. permanence), storage, public architecture (monumentality), material culture repertoire, and site maintenance behaviours (Berelov 2006: 124, Table 2, reproduced below). Once again, the presentation of the dualistic epistemology in terms of either/or categories is, as noted above, problematic, but serves to usefully highlight the typologically focussed interpretive mechanisms applied to the archaeological record.

<table>
<thead>
<tr>
<th>Indices</th>
<th>Sedentary</th>
<th>Mobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic subsistence</td>
<td>Agriculture and village-based pastoralism</td>
<td>Herding, hunting, and gathering</td>
</tr>
<tr>
<td>Settlement size</td>
<td>Large (&gt;0.5 ha)</td>
<td>Small (&lt;0.5 ha)</td>
</tr>
<tr>
<td>Village plan</td>
<td>Agglomerated</td>
<td>Dispersed</td>
</tr>
<tr>
<td>House shape</td>
<td>Rectilinear</td>
<td>Curvilinear</td>
</tr>
<tr>
<td>Building materials (i.e., permanence)</td>
<td>Stone, mud brick</td>
<td>Wood, brush, and thatch</td>
</tr>
<tr>
<td>Storage</td>
<td>Formal, private and occasionally centralized</td>
<td>Frequently absent, occasionally communal</td>
</tr>
<tr>
<td>Public architecture (monumentality)</td>
<td>Common, particularly at large sites</td>
<td>Limited to ritual pilgrimage sites</td>
</tr>
<tr>
<td>Material culture repertoire (i.e., diversity)</td>
<td>Highly varied including imports</td>
<td>Low diversity</td>
</tr>
<tr>
<td>Site maintenance behaviour</td>
<td>Formal dumps or middens</td>
<td>Casual cleaning</td>
</tr>
<tr>
<td>Ritual activity</td>
<td>Intramural and extramural</td>
<td>Extramural</td>
</tr>
</tbody>
</table>

Table 2.1. Reproduced from Berelov 2006: Table 2, Indices of sedentism and mobility and their general correlation with the archaeological record
The sections below will review these archaeological approaches and methods to the categorisation of mobility strategies, starting with approaches to interpreting intra-site structure and the designation of activity zones, the internal differentiation of areas, and the synchronic and diachronic relationships of features to one another. This will lead in to a discussion of settlement pattern approaches, and the location of particular aggregations of archaeological features or material in the landscape. Studies that focus on portable material culture (especially lithic) assemblages are reviewed in Section 2.

2.1.3 Site designations and settlement patterns

At the largest spatial scale, attempts to associate a settlement pattern with particular societal traits are often rooted in attempts to understand the ways in which the society moved about the landscape and made use of the environment. The assumption is that if one can identify the component parts of a settlement “system” at any period, then the scene is set for greater insight into mobility strategies and change over time in terms of cultural practices concerning trade, subsistence, economics and political structure. Often these component parts are designated as particular site types, usually relating to a specific function or activity thought to have taken place at that point in the landscape. However, identifying settlement systems presents a number of difficulties related to the identification of site types, the spatial and temporal scales and resolutions that are represented and the interpretation of the archaeological record given its fragmented nature.

The assignment of a typological/functional designation to a particular location presenting certain types of archaeological evidence is a common occurrence in the discipline, and is often a key plank in any argument relating to the mobility strategy of the past society that
produced the record studied. Designating particular locations as short-term hunting camps, nucleated villages, or garden sites results in inferences about their place on the mobile-sedentary continuum. Thus on an inter-site level, the search for the presence of archaeological remains that suggest functionally different areas of settlement based on the accumulation of artefacts, the internal site proxemics of particular locales and so forth, has been the result of much survey work. In New Zealand, for example, the presence of archaeological material in coastal areas on the Coromandel Peninsula has often seen sites designated as “seasonal fishing camps” or “working floors” (for example: Leahy 1970, 1974, and Harsant, 1985) on the basis of spatially limited excavation (or even just surface collection of archaeological material), with little or no chronological control, be it relative or absolute (see also Smith 2011, and Figure 2.3 herein). This idea that we can see site “types” that might fit into an idealised settlement pattern is fraught with difficulty, and cuts to the core of problems with settlement patterning as a tool for identifying mobility.

The essence of the problem is the conceptualisation of a “site” as a meaningful unit of observation (Dunnell 1992), and in New Zealand the unit is no clearer than in any other part of the world (Phillips and Campbell 2004). Even leaving aside fundamental issues of “lumping” and “splitting” (see Davidson (1982) for example) and where to draw a boundary around geographical limits of archaeological evidence (Dunnell 1982: 36), much of the discourse concerning the typological categorisation of a site presupposes that the site itself reflects some sort of discrete functional entity that can be confirmed through the identification of a number of attributes. There are two corollaries here, however. The first, outlined by Dunnell, is that the site as defined by the archaeological record (and, more particularly, the accumulation of archaeological material at a particular location over time) is the product of the archaeologist’s observation, as opposed to an ontological entity. The
second issue, as Holdaway et al. (2008) note in their discussion of Binford’s analysis of the “Mask” site (Binford 1978), is that increased occupation duration (leading to the increased accumulation of archaeological material) means increasing complexity, and that the ability of “an archaeologist to decipher what the function of the site might be” is correspondingly reduced (ibid: 123). As a consequence, I will avoid using the term “site” as a typological/functional construct and use it as a synonym for a location within a landscape, a usage also consistent with heritage legislation in New Zealand, as discussed in more detail in Chapter 8.

Many studies have examined settlement patterns and internal proxemics, and the relative permanence and shape of residential structures, to draw conclusions about the archaeological indicators of sedentism (Rafferty 1985, Kelly 1992, Gallivan 2002, Ramenofsky et al 2009, Seymour 2009b, 2009c). Gallivan (2002: 542-543), for example, has employed a statistical analysis of residential feature relationships to identify attributes associated with residential stability and to calculate a use-duration index in order to measure residential stability and use-duration for the James River Valley in Western Virginia, USA. In another example, G. Jones (2005) sets out the archaeological evidence for the relationship between intensive gardening and mobility patterns, and also argues for the proximity of residential settlement to gardening areas due to the intensive labour required to maintain productive field systems: “Cultivation intensity can be measured as much by investment in the land itself as in more archaeologically visible features such as field boundaries and agricultural facilities, and the identification of intensive land-use, albeit small-scale, with the consequent investment in a particular location, can have major implications for issues of land tenure” (ibid: 174). Specific New Zealand examples include Turner’s re-evaluation of Anderson’s (1989)
categorisation of the Waitaki River mouth site as a temporary moa\(^2\)-processing area (Turner 2000: 6, 307-310) and the debate between Jacomb and Anderson concerning Jacomb’s designation of a structure excavated at Rakaia as a residential dwelling (Jacomb 2005, 2006, Anderson 2006). Tied in with these processes are site maintenance behaviours – the accumulation of lithic artefacts, for example, the evidence for cooking and the resulting patterned distributions of fire-cracked rock, midden location and size. In essence, “…as intensity of occupation increases – either through increased length or duration of occupation, or through increased numbers of inhabitants at the site – the placement of activities and the nature of maintenance becomes more formalised.” (Graham 1993: 38).

A variety of studies have characterised house type and shape as diagnostic of the degree of sedentism exhibited by the people that constructed them. Distinctions have been drawn between circular and rectangular residential structures, the former being identified as indicative of more short-term use within a mobile lifeway, the latter displaying greater degrees of sedentism (Flannery 2002, Berelov 2006, Cutting 2006). The distinction has been justified using both ethnographic analogy and arguments drawn from differing construction techniques and planning requirement. Similar arguments are made for the types of building materials used: stone versus wood or rushes, for example. The size, placement and simple existence of storage structures, be they for food or material culture, and their association with residential features, can also give insights for mobility (Eerkens 2003, Kent 1999, Kuijt 2004, Prince 2004, Smith 2003, Jorgensen 2009). Storage structures can be communal or personal, inside or outside houses, constructed for food crops for long-term seasonal storage or as

\(^2\) Moa is the generic term for nine species of extinct endemic flightless birds generally placed in the Ratite family. They represented the largest terrestrial avifauna in New Zealand at the time of Polynesian colonisation and most species appear to have become extinct within 150-200 years of human arrival in NZ (Perry et al. 2014).
caches of material artefacts for safekeeping – all strategies that when viewed in conjunction with other factors can steer the observer towards differing interpretations of mobility or the length of period of occupation. And to reiterate: the categories here are not mutually exclusive, and are overlapping to a degree – one will be inextricably linked with others. Fire feature distributions, for example, be they hearths or ovens, will be related to internal settlement proxemic considerations – that is, how structures are orientated with respect to each other and the landscape – hence cultural rules concerning cooking areas form part of an overall organisational rubric that is reflected in site proxemics (Wandsnider 1996, Clark and Ligonis 2010, Gallivan 2002, Petraglia 2002). They can also be linked to archaeological indications of planned abandonment, anticipated mobility and site maintenance. Kent (1999), for example, argued (based on ethnographic and archaeological studies) that the way in which locations were maintained or tidied, the placement of rubbish dumps, fire scoops and the movement of lithic debitage can be probative in assessing whether areas were occupied with a view to moving from temporary occupation to more permanent settlement. Holdaway and others’ work on the movement of lithics encompasses this and the next scale, whereby contrasting patterns of lithic and fire-feature distributions indicate differing levels of site use redundancy in Australia and the Fayum in Egypt (Holdaway et al. 2010, Holdaway et al. 2015).

2.1.4 Portable material culture and technological organisation

Another way to examine the mobility strategies is to investigate technological organisation through the remnant portable material culture. This is often undertaken in two ways: an examination of the material artefacts themselves, both individually and as part of variable assemblages, and by looking at the accumulation or creation of those assemblages at
particular locales. By characterising a society’s technological organisation we are able to infer the settlement needs that the organisation of the technology has evolved to enable. This can involve the identification of unambiguous horticultural implements or hunting tools within particular archaeological contexts, or the combination of such material artefacts in assemblages that change over space and time. For example, a decrease in biface and projectile point tools coupled with the appearance of small villages has often been associated with an increase in horticulture and decrease in residential mobility (e.g. Gero 1989: 103).

It is argued here that settlement pattern evidence can be seen as strongly determinative only at the extremes of sedentism or mobility. A city such as Pompeii is a good example of a sedentary extreme – as it has been “frozen in time”, we can see from the investment in the infrastructure, public and private buildings, their layout and the nature of the material culture that the inhabitants were “sedentary” – but does that mean everyone in the city conformed to the same pattern of mobility? Obviously not – at any given point in time the population of the city would have included merchants visiting, family members visiting family members, and the absence of citizens who would normally have been present for the same reasons. Some buildings within the city would have been more temporary in nature than others; in function and design they may have only been in use for months. At the other end of the spectrum, in hunter-gatherer-forager societies, Andrefsky (2009) suggests that a wide range of exotic lithic material indicates a high degree of mobility for that group – a large range allows the acquisition of a broad collection of material (but note the alternative argument that longer or persistent occupation or use of a particular place allows more opportunity for a wider range of less common materials to be discarded and thus increases the raw material diversity of an assemblage (Holdaway 2004)). Yet conversely, in the most sedentary of categories, the city, we would also expect to see the broadest range of material culture from a
wide range of sources – in this case because of the size and mercantile power of the city populations. There are of course issues of scale: cities tend to be conceptualised as one large contiguous site, whereas the sites associated with a hunter-gatherer group are characterised as small and ephemeral. Yet if conceptualised in terms of persistent use of a territory (or indeed a simple spatial parameter), then the only difference is the number of people present at any particular point in time at any place. In the Māori example, the “village” is characterised as the site type at the most sedentary end of the spectrum, but even this is couched in terms of its transience. Rather than use a spatial referent, the difference between a ‘permanent town’ and a ‘transient village’ may be better understood as a difference in the level of interaction between people and things as Hodder (2006: 240-257), for example, argues when considering Çatal Hüyük. In a town these interactions, or, as Hodder puts it, “material entanglements” (ibid: 241) are likely to be greater in quantity and variability in terms of the accumulations of material things than the types of interactions among people who, for example, exhibit high residential mobility. The archaeological record of these interactions may be expressed by studying portable material culture, and it is the relationship between a particular class of portable culture – stone artefacts – and mobility that is examined in the next section.

2.2. Lithics and mobility

Section 2.1 outlined a number of archaeological criteria that have been used by archaeologists to evaluate the degree of sedentism or occupation duration that might be suggested by the archaeological evidence at a particular location. One of those broad criteria related to the nature of portable material culture assemblages, in that by evaluating the technological
organisation inferred by portable material culture assemblages, it is argued that insights are able to be gained into the mobility-related human behaviour that produced the archaeological record. Further, the informative nature of the structure of such portable material culture assemblages is derived from the relevant assemblage’s material diversity/homogeneity, typological diversity/homogeneity, spatial patterning, and association with structural features such as houses, hearths, storage pits and the like.

In this section I review the ways in which lithic artefacts recovered from archaeological contexts have been used to infer such mobility-related behaviour. To do this I divide the approaches into a number of sub-sections, relating to the different focuses and causal inferences that studies have taken. These are by no means mutually exclusive and many are overlapping to greater or lesser degrees, but in order to review them in a sequential fashion, a degree of compartmentalisation is necessary. Before the various approaches to lithic analysis are reviewed, however, it is desirable to provide some basic frameworks as to why the analysis of lithic artefacts might be informative or useful for the study of human behaviour as it relates to mobility.

Lithics are the most durable of all artefacts, and therefore are often the predominant, if not the only, archaeological evidence that is recoverable in many circumstances (Andrefsky 2005: 201). But because they are procured, manufactured and used in ways that can be tracked and quantified, they can provide a wide variety of potential information about the lifeways of their producers:
Lithic assemblages result from a complex series of interrelationships involving technology, raw material selection, lithic economy, site function, and settlement/subsistence systems. Archaeologists must analyse the entire set of relationships if meaningful data concerning human behaviour is to be obtained… To some degree, depth of understanding in lithic studies is correlated with the ability to identify, and thus control, one or more variables across the prehistoric landscape and in the cultural system (Thacker 1996: 102).

The longevity of stone artefacts means that they are informative not just due to the information they preserve about their manufacture and use, but also in the way they accumulate in the archaeological record over time. Accordingly, stone artefact analysis is “…designed to determine how variable conditions affect both the form of artifacts and the composition of assemblages as a means of informing on the behavior of people in the past. With the exception of variability attributable to the physical properties of conchoidal fracture, it could be argued that other sources of variability, at all geographic and temporal scales, are determined by the archaeological context in which the stone artifacts are found, an observation that is partly subsumed within the study of technological organization …” (Holdaway and Douglass 2012: 121). As Bailey (2007: 209) notes: “Material objects by definition have duration, a duration that extends from at least as early as the time when they were first created to the current moment of observation or discussion, and indeed will most likely extend far into the future. Moments in time that leave no material traces are unknowable, at least from the archaeological past.” The physical provenience of stone artefacts in three dimensions will also preserve information about their history of deposition and the post-depositional processes, both cultural and natural, that they have been subject to.
In addition to their durability, stone artefacts (with the exception of larger objects such as grindstones) are generally portable. Durable portions of portable material culture offer a window into the mobility strategies of their creators because the only way they can move (intra-site taphonomic processes notwithstanding) is through human agency. Tracing the movement of an object through its creation, use and discard provides a proxy for the movement of its creator and user, and for the technological milieu that the creator and user operates within. It is argued that the technological organisation of a society will reflect the mobility strategies that are embedded in its lifeway, and understanding that technological organisation can thus go some way to informing long term land use patterning.

A basic premise of the technological organisation approach to lithic analysis is that the technological strategies of the people that produced them can be inferred from the manufacture, use, re-use and discard of stone artefacts. This concept is encapsulated in Figure 2.4.

![Diagram of Technological Strategies](image)

**Figure 2.3. Modified Framework for conduct of Technological Organisation studies (after Nelson 1991: 59) (Reproduced and modified from Carr and Bradbury 2011: 312, Figure 2)**
Hence there are a number of ways in which lithic analysis, that is, the study of stone artefacts, has been directly used to attempt to gain insights into the mobility strategies of the people or groups of people that produced the artefacts. The study of mobility through the analysis of lithic artefacts has evolved over time, but several somewhat inter-related approaches can be postulated; these approaches look at the study of the physical attributes of the artefacts themselves, and the deposition and accumulation of the artefacts in space and time. These approaches have been extended to examinations of the distribution of different stone artefact types, the amount of re-working they present and the stage in an artefact’s construction at the point at which the artefact enters the archaeological record. It is important to note, however, that “…lithic analysis refers to a method of comparing, assessing and studying stone tools and debitage. To my knowledge there is no unifying theory associated with this archaeological data set.” (Andrefsky 2009: 86). This lack of unifying theory means a wide variety of lithic-based approaches need to be considered and reviewed; in order to do this I have divided approaches into broad areas corresponding with the bottom two lines of Figure 2.4 and the ways in which those categories are investigated through archaeological studies.

The first subsection will investigate the way in which artefact form, or “type”, and the context in which they are found (i.e. their relationship to other archaeological evidence such as structures or faunal remains) has been used to infer “site” function or type, and the activities that were undertaken at a particular locale. The second subsection will review the ways in which the study of the manufacture and use-lives of stone artefacts might reflect the differing degrees of economisation and contextualise technological organisation. The third and final subsection looks at the ways in which the composition of archaeological assemblages of stone artefacts are evaluated in terms of their raw material diversity, the
physical movement and accumulation of stone material, and the variability in the physical attributes or metrics of the assemblages.

Before setting out these subsections, however, the concept of an “assemblage” should be briefly considered. Most studies look at stone artefact assemblages, rather than individual artefacts in isolation, to build a picture of the technological organisation of the society that made them. Artefacts, once discarded, enter the archaeological record and form assemblages, the variability in composition of which have been long discussed (Shott 2015: 4). This thesis looks at the composition of stone artefact assemblages and the inferences that can be made about human behaviour relating to mobility systems from such assemblages. By using the term “assemblage” I adopt a general definition: an assemblage is a group of spatially or temporally associated artefacts – that is, a collection of artefacts that are contextually related archaeologically, bearing in mind that the definition of context will be related to the research problem at hand (Holdaway and Stern 2004: 17). Some definitions of “assemblage” go further to suggest that the spatial or temporal relationship must be in such proximity that “one could argue that they were used or discarded at about the same time by the same group of people” (Odell 2004: 4), but for reasons set out in subsection 3 below, I consider this approach to be too tightly defined; it risks a priori designations that are not subsequently supported by the data to hand.

2.2.1 “Site” and artefact typologies

Multiple lines of evidence are often used to build up a picture of the occupation represented at a particular point in the landscape, a typology of the site that is associated with modes of social organisation and corresponding occupation duration. Material culture repertoire
indices of mobility, as well as dealing with both artefact typologies, the breadth of a material culture assemblage and the implications of those for settlement type and subsistence (Shott 2010), involve an examination of the presence and absence of certain classes of artefact, the evidence for the manufacturing processes of artefacts, and the stages of those processes that might be represented at a particular site (Wandsnider 2008, Holdaway et al. 2010).

Basically, typological analyses use lithic artefacts to inform as to the “function” or “type” of the archaeological site and hence the occupational or depositional history of that location (Andrefsky 2005). They do this by working backwards from assumptions generated by the study of modern ethnographic data (Binford 1980). The mobility strategies of the people thought to be responsible for the archaeological record produced are then inferred from the characterisation of the lithic assemblage; lithic assemblages and their technological and spatial patterning are used to interpret non-portable material culture, i.e. features or structural remains. Classic examples are found in the literature relating to North American pre-contact archaeological evidence, for example the dominance of projectile points or stone knives at a particular site may be seen as evidence of a special purpose temporary hunting or butchery camp, whereas a wider breadth of material and tool types are seen as indicative of more permanent settlement: “The absence of clear contrasts in the distribution of tools, point bases and debitage in early sites implies that the base camp/special use camp dichotomy was weakly developed at best during the early period of occupation, and that therefore the settlement pattern became more complex through time” (Bamforth 1986: 46).

In such approaches, the type, quantity and diversity of stone artefacts at a particular location is used to infer the type of activity that took place there, and hence the duration of
In terms of type, the distinction between *curated* and *expedient* artefacts is often invoked, with the curation being linked with mobility and expedience with sedentism (Binford 1979, Bamforth 1986, Shott 1996). Curation as an archaeological concept is ambiguous; for example, it can refer to the transport of artefacts from location to location, or to tool design that focusses on formal tool types that are immediately available for use when required (Shott 1996, Holdaway and Stern 2004: 78). It can nevertheless be distinguished from expedient tools which are then manufactured as needed, whether from cached material or locally available resources (Nelson 1991: 63). Expediency is thus related to predictability of place and use of tools and reflects a degree of certainty in relation to the location of and access to raw material that, it is argued, is more likely within a less mobile society. Whether curated or expedient, these concepts are framed to allow an evaluation of the technological organisation (Nelson 1991) of the group(s) that produced the assemblage.

2.2.2 Manufacture and use-life

Another way to investigate the technological organisation of a group of people through material culture is to examine the manufacturing processes that create artefacts and the use-life of those artefacts following manufacture. In terms of lithic studies, this approach has often been examined through the lenses of the *chaine opératoire* concept (especially in Europe) and the “reduction sequence” concept (especially in North America and Australia) (Leroi-Gourhan 1964, Shott 2003, Andrefsky 2009, Bar-Yosef and van Peer 2009, Holdaway and Douglass 2011, Tostevin 2011). In terms of definitions, Holdaway and Stern describe a

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3 The reverse of this is to look at the accumulation of artefacts over time to evaluate duration of occupation and infer site type as a consequence; this approach is covered in Section 3 below.


chaîne opératoire as “…an attempt to document the processes involved in the manufacture, use and discard of tools, with the aim of identifying the conceptual patterns that gave rise to those activities” (Holdaway and Stern 2004: 85), while Shott broadly defines a reduction sequence as “…the culturally and physically patterned way that people reduced pieces of stone to useful tools.” (Shott 2003: 95-96). Shott (ibid: 95) maintains there is little practical difference between the two approaches, at least with respect to lithic analysis, while Tostevin (2011) suggests that a chaîne opératoire approach is a more wide-reaching conceptualisation that locates the study of lithic artefacts within a broader epistemology of material culture studies – although accepting that with respect to the study of lithic artefacts only, he is in agreement with Shott (ibid: 352). Regardless, manufacturing process studies consider the lithic reduction process, suggesting that understanding the reduction sequences or the chaîne opératoire related to the manufacture and use of tools can give an insight into the functional nature (i.e. the activity or activities that were undertaken at that spot) of the archaeological site and hence site type.

To take this further, there is an assumption that there are universal ways of reducing or knapping stone material to produce desired end-products (as the manufacture of stone tools, or the stone components of composite tools, such as hafted adzes), and that these sequences can be identified through experimentation and comparison of large stone tool and debitage assemblages. Accordingly, it can be argued that the analysis of the type of tools and waste flakes present within an assemblage can reveal the stage in the manufacturing process, or particular type of reduction process, that is represented at a particular point in archaeological space or time. If this information is able to be “plugged in” to an ideal framework, or multiple frameworks of mobility or sedentism, then the assemblage can be seen to provide evidence of behaviour relating to the provisioning of place or person, the anticipated mobility.
of the manufacturer, or the range of human behaviour represented by the type of tools that are present. These are in effect arguments by proxy for the movement of individuals and groups, rather than arguments for the movement of the lithics themselves. They also rely on the ability to identify “types” of flake and tool; to organise the material into a pre-existing schema that reflects the imagined intention of the tool-maker. Herein lies the greatest problem for this approach – the combination of assuming a particular “intentionality trajectory” for the creation of particular types, and assumptions as to the technological trajectory or sequence for the manufacture of the tools themselves.

In the first instance, the concept of a tool maker creating a tool through the sequential reduction of stone with an idealised picture of the finished product in his or her head throughout the process, and subsequently that finished tool and the manufacturing debris relating to its manufacture then finding its way into the archaeological record at the same or different points in space and time, may be true in certain limited circumstances, but it has been shown to be fraught with difficulty in many cases. Numerous studies have shown that the final product of an initial manufacturing process, such as an adze, or arrowhead, may then over the course of its life be broken, modified, reused and ultimately discarded in ways that bear little or no relation to the intention of the original maker (Dibble et al. 2016). This problem is further exacerbated by the recognition that many tool “types” were used in many different ways, even when present in their idealised original form. In the same way that we today might use a screwdriver to open a tin of paint, or a teaspoon to apply window putty, a stone adze may have been used not just for wood-working, but as a weapon, or to butcher a large animal. Thus to make functional assumptions about tool types and their use, and then use those assumptions to inform as to the mobility strategies of the tool-owners, is problematic.
The second issue also relates to intentionality of the tool-maker, but in a different way. Often the tool manufacturing process will not be one whereby a particular sequence is initiated to “release” the idealised tool from the raw material, but will involve the creation of a large number of flakes of differing shapes and sizes so as to provide a population of artefacts from which “useful” or desired morphologies can be selected (Holdaway and Douglass 2012). So if there is a degree of non-directed flake production, whereby it is not the specific type that is the hoped for outcome of and particular strike of the hammerstone, but rather the production of a range of outcomes, then the contextualisation of any particular assemblage within a technological sequence becomes problematic when the twin factors of selection and equifinality are brought into play.

Related to reduction intensity studies are methods which evaluate the most efficient ways for a knapper to produce particular flake shapes, or flakes which produce desired functional attributes such as cutting edge maximization. Thus, studies such as Lin et al. (2013) have evaluated the way in which a knapper can manipulate technological attributes such as exterior platform angle to produce flakes that are both long in terms of cutting edge and light in terms of requiring the least mass of raw material to produce the length of edge.

In summary, these approaches examine the economisation strategies that might be employed in the manufacture and transport of lithic tools and how they might be measured or quantified: evidence for intensive reduction, “curation” or behaviours that suggest inefficient
or “wasteful” use of raw material invoked to characterise the mobility signature of an assemblage.

2.2.3 Raw material diversity and sourcing

Another way of looking at assemblage variability and its relationship to technological organisation is to examine the movement of the stone artefacts themselves, as opposed to inferring movement of cultural groups from typological-functional stages in a manufacturing process. Studies that examine the raw material type and relative proportions of an assemblage use the physical movement of lithic artefacts as a proxy for the movement of people and the economic strategies that the movement might represent. At its simplest: “People who were more mobile in the past had greater opportunity to access raw materials than people who were more sedentary… People spending a greater amount of time at one location (i.e. greater occupation span) will make proportionally greater use of locally abundant materials because there is less opportunity to resupply from distant sources” (Holdaway et al. 2008: 124).

The physical attributes of the artefacts that make up an assemblage can also be used to look at the nature of that assemblage in terms of its “completeness”. A starting point of the reduction of a stone cobbled into multiple smaller flake artefacts, be they formal tools or debitage, is the basis for this approach. By examining metrics such as the range of flake sizes, the number of flakes to cores present, the percentage cover of the cortical surfaces of the cores and flakes and departure or variation from the “complete” assemblage can inform as to whether flakes or cores have been removed from the locale at which the assemblage was found, or whether
indices of reduction such as cortical coverage or rotation of cores suggest the movement of artefacts from an assemblage due to anticipated future use (Dibble 1995, Douglass 2010).

Primarily the geological origins of lithic material are used to evaluate absolute distances moved and, in conjunction with technological attributes of the artefacts, the technological organisation strategy that governs the modes of movement (for example trade and exchange networks, the provisioning of place/stockpiling of material).

Raw material diversity is often evaluated through studies that use a variety of techniques to identify both the geological types of material used to create the tools and the location in the landscape that those raw material types occur naturally. As Morales (2016: 242) notes: “The ratio of raw material availability and mobility dynamics determine the economic aspect of stone tool use, exploitation and discard (Bamforth: 1990). It seems obvious then that the formation of the lithic archaeological record is highly influenced by the way in which humans interact with landscape and resources.” As such these approaches deal with the physical movement of lithics in terms of their distance from geological source, movement which has implications for the nature of the strategies used to procure the material (for example direct or embedded procurement) (Morrow and Jeffries 1989, Brantigham 2003, Tomaso et al. 2016), and the movement of material after procurement (trade and exchange networks).

A number of studies have incorporated an analysis of the movement, preservation and relative frequencies of raw materials, especially of lithics, to provide insights into prehistoric mobility (Rafferty 1985, Kelly 1992, Holdaway et al. 2010, Walter et al. 2010, McCoy et al. 2010). Holdaway et al. (2010), for example, use flake to tool and cortex ratios to assess
degrees of mobility and prehistoric coping strategies for varying subsistence resource
availability in Australia and Egypt. Cortical cover has long been used in lithic studies to
evaluate the degree of reduction being undertaken with respect to a specific assemblage:
roughly, fewer cortical artefacts relative to non-cortical artefacts equals more reduction
(Shiner 2007: 40).

Some recent studies have used a more sophisticated cortex-ratio method to infer movement of
cores or flakes into or out of assemblages (Dibble et al. 2005, Douglass et al. 2008, Douglass
2010, Phillipps 2012) and thus make inferences about the mobility strategies that these ratios
might indicate. Calculating the cortex ratio where cobble sizes and surface areas can be
estimated with a reasonable degree of accuracy allows for an estimate as to the over- or
under-representation of cortical artefacts in an assemblage, and thus whether the assemblage
has been supplemented by cores or flakes, or depleted of artefacts in those categories
(Phillipps 2011: 113). This method shows much promise with respect to certain
archaeological assemblages; however, it requires a basic knowledge of the likely volume and
surface area of the original cortical cobbles from which flakes were struck. This is possible
in some cases in places where the lithic raw material is available in cobbles of limited size
ranges, such as in some Australian and Egyptian contexts (Douglass 2010, Phillipps 2012).
However, the New Zealand context provides a number of obstacles to similar
characterisations, as will be discussed in more detail in Chapter 6 (Methodology).

Actual movement can be looked at in a variety of ways. The geochemical composition of a
particular artefact can be characterised in terms of its origin from a particular geological
source: “Inferred patterns of mobility are frequently based upon sources of raw materials for
stone artifacts (e.g., Bracco, 1995; Amick, 1996; Féblot-Augustins 1997a)” (Close 2000: 50). The distance from the geological source to the place at which the artefact entered the archaeological record can be used to examine the likely method of transport and/or the social mechanism that moved the artefact (Eerkens et al. 2008). In New Zealand, Walter and colleagues (2010) use changes in the relative abundance of Mayor Island obsidian (See Chapter 4, section 4.4.5) in the archaeological record to analyse flux in long-distance trade networks and changing social relations. In the North Island, McCoy et al. (2010) have examined the relationship between changing obsidian source distances over time to examine the archaeological visibility of pre-European territories in the Northland region. In a similar vein, Eerkens et al. (2008) have examined prehistoric mobility strategies based on obsidian sourcing evidence in California.

2.2.4 Local versus non-local material

Once sourced, the relative proportions of different raw materials present in a lithic assemblage can also be used in a slightly different way to evaluate not movement per se but occupation duration. Often, material will be categorised as local, to a particular site, or non-local, depending on the distance to geological source from the site in question. Measures of locality vary widely, however: for some studies, material within a 10 km radius is seen as local, and beyond 10 km as non-local or “exotic” (Clarkson 2008: 308). Other studies describe non-local material as that which is sourced from a distance greater than 150 km from the archaeological site from which the artefacts are recovered (Walter et al. 2010: 505). These differences may be due to aspects of the surrounding terrain and the breadth of suitable material for stone artefacts available, known ethnographic analogues for the territorial ranges of hunter-gatherers in similar environments, or differing modes of transport (such as water-borne mass transport),
but essentially the arguments made for assemblage composition and relative sedentism are broadly similar. In essence, arguments run that “as occupation span is lengthened, archaeological assemblages will become increasingly dominated by artefacts acquired locally” (Surovell 2009: 77) – in other words, that short-term occupations should have relatively high proportions of transported artefacts because in the early phase of an occupation things brought in to the site from elsewhere will dominate toolkits. However, Holdaway (2004) argues precisely the opposite: diversity in material will increase with length of occupation because with increased occupation span there is more opportunity (absolute time) for the rarer (non-local) artefacts to “drop out of the dynamic cultural system and into the static archaeological record” (ibid: 115) (arguments about the non-static nature of the archaeological record notwithstanding). Both approaches serve to highlight the importance of factoring in occupation duration. It is important to note, however, that the relationship between local or non-local material is not necessarily straightforward, and the implications for technological organisation and mobility even less so. As Bamforth notes: “Any relationship between mobility and technology, though, is powerfully affected by access to raw material, which may be low because of regional scarcity or for other reasons.” (Bamforth 1990: 99).

2.2.5 Refitting
Refitting studies look at reassembling the component parts of a reduced cobble, and can be used to both track the nature of the reduction by looking at the order of flake detachment, and the movement of the flakes themselves. Refitting is extremely time consuming and very difficult to achieve over any great distance – at least a meaningful distance in terms of human behavioural decisions (but see Close (2000)) – and as such has more often been used to
evaluate intra-site formation processes, although the identification of activity areas within occupation horizons has also been undertaken (Holdaway and Stern 2004: 209).

Such taphonomic concerns can be brought together under the general heading of formation studies, and it is this aspect of lithic assemblage formation that is reviewed below.
2.3. **Factors that affect the formation of archaeological lithic assemblages**

In the previous section I outlined the frameworks that researchers have constructed and worked within with respect to the use of lithic analysis concerned with the procurement, manufacture and use of stone artefacts to characterise technological organisation, and from that to infer mobility strategies, occupation duration and settlement systems. In other words, researchers using these approaches are concerned with the artefacts in their systemic context (*sensu* Schiffer 2010: 21-24, Figure 3.1). This section reviews the ways in which artefacts move from the systemic to archaeological context, looking at the final stage of their systemic existence (discard) and their accumulation in an archaeological context (ibid: 22). One can suggest that the emphasis in assemblage-orientated approaches lies predominantly (but not exclusively) in the relationship between pre-depositional activities and deposition itself, whereas deposit-orientated approaches are more concerned with the relation between depositional and post-depositional processes (Lucas 2012: 113). As Andrefsky notes: “All the recent literature on lithic artefact and site formation processes suggest that stone tools and debitage accumulate on sites based on unique sets of circumstances that often include multiple episodes of lithic artefact production, reduction, deposition and re-use.” (Andrefsky 2009: 88).

These aspects have been brought under the rubric of formation theory, an area of archaeology that has perhaps been under-examined recently with respect to artefact studies in particular (Lucas 2012: 65, 96) and within archaeological theory recently: “Although we applaud attempts to explain archaeological variability and change in terms of social processes involving factors such as gender, agency, and power, many of these arguments using
prehistoric or even historic data are unconvincing because of the failure to take into account formation processes.” (Skibo and Schiffer 2008: 6-7).

The accumulation of artefacts over time provides another line of reasoning for the evaluation of mobility strategies and settlement systems as “…accurately estimating occupation duration is critical to addressing a number of problems central to archaeological research, including the formation of artifact assemblages, the nature of human mobility strategies and settlement systems, and the estimation of population size. These issues are fundamental to understanding the social, economic, and political organization of human societies” (Varien and Potter 1997: 196).

Rather than look directly at technological organisation, formation studies are more interested in understanding the ways in which accumulations of artefacts in the archaeological record can be used to analyse the duration of occupation within parts of a landscape. There is considerable overlap in the two approaches, and the study of assemblages from the point of discard practice is necessarily informed to some degree by technological or typological characterisations of the discarded material; but the primary direction of the research is not to characterise those technological or typological characterisations in and of themselves but to use them to understand patterning in the accumulation of artefacts. Accordingly, we move from examining the human behaviour related to the creation and use of the artefact itself to the human behaviour reflected in the creation of an archaeological deposit through discard/refuse organisation and site abandonment.
Thus lithic assemblage formation is influenced by a multitude of factors, from the initial creation as a part of a reduction or operational sequence, through each individual artefact’s life history, through to the cultural and natural processes that influence the assemblage prior to its collection and finally the techniques employed to collect/excavate. If we can imagine an “ideal”, or in fact entirely artificial or experimental scenario where a drill point is manufactured at a particular point in space and time from a single cobble and every part of that reduced cobble is deposited where it fell, it is easy to see the types of contemporary and post-depositional factors that will distort that assemblage from the point of deposit. In the first instance it is likely that the desired end-product will be removed from the locale of manufacture and incorporated into a composite tool whose other components (other than the stone drill-point) do not survive in the archaeological record unless under exceptional circumstances due to their organic nature. Second, there is the likelihood that debitage flakes will be removed for use as informal cutting or scraping tools that don’t necessarily reflect the knapping intentions of the tool-maker, but are nevertheless useful as tools in their own right. Third, settlement maintenance practices may mean that flake material is either moved about within the settlement or removed from it completely, depending on the intention of the occupiers as to the way in which that location is to be used in the future. Thus movement of artefacts may be deliberate but completely unrelated (in terms of intentionality) to their manufacture or use.

Once a location is abandoned, or more accurately, once a particular episode of human behaviour that causes the deposit of cultural material ceases, a variety of taphonomic processes comes into play on the material so deposited and the matrix within which it is found. Lithic assemblages may be buried, exposed by the process of erosion and reburied again, and during periods of exposure, recycled by individuals from populations that have no
direct cultural, spatial or chronological relationship to the population that was responsible for the original creation of the assemblage, and then deposited again. In addition to natural processes such as hydrologically driven erosion or aeolian sediment deposition and human recycling or repurposing of stone material, subsequent human land management practices will also have the potential to influence the position and condition of lithic assemblages (Foley 1981: 173-4). Trampling by agricultural stock may result in the movement and fragmentation of lithics, as might ploughing and agriculturally driven vegetation changes (Foley 1981, Bamforth 2002, Hovers et al. 2014). Earthworks relating to later building and habitation will also result in movement of lithic artefacts and in some cases subtle physical alterations of the artefacts themselves (such as damaging cutting edges of flakes, smoothing edges through repeated movement or patinas deposited through prolonged exposure to the elements).

2.3.1 Accumulations research

One way of conceptualising the formation of archaeological deposits and assemblages is to focus on the accumulation of materials in the archaeological record and how that process holds information about the duration of occupation at a particular place (Lucas 2012: 110). Accumulations research programmes are often based on the use and disposal of single artefact category (Gallivan 2002: 536, Varien and Mills 1997) such as cooking pot sherds, but spatial patterning of discarded items has also been an ongoing focus for occupations of varying degrees of continuity and absolute chronology, from Binford’s (1978) original Mask site ethnographic analysis through the European Palaeolithic (e.g. Shott 2008, Machodo et al. 2013) or the North American pre-contact period (e.g. Varien and Ortman 2005, Sullivan 2008, Surovell 2009).
Many models use some sort of variation of Schiffer’s famous discard equation, which evaluates the numbers of a particular artefact type normally in use, the amount of time during which that artefact type is discarded (occupation span) and the use-life of the artefact (Schiffer 2010: 35, Gallivan 2002). Assemblages are analysed in terms of their spatial density and the breadth of their variability with respect to relative frequencies of typological, functional and technological attributes (the “Clarke effect”, which posits that as the duration of occupation of a site increases, the variety of discarded artefacts correspondingly increases (Varien and Potter 1997: 195, Schiffer 2010: 35). As Kent (1993: 64) noted: “…people who intend to occupy a site briefly will have a different material culture assemblage, at least in size, if not in kind, from those who anticipate a long occupation.” Additionally, site maintenance practices as reflected in the spatial patterning of the accumulation of artefacts may be an indication of occupation duration and ultimately site type (Gallivan 2002, Surovell 2009). Evidence of spatial patterning of artefacts that is informed by the shape of structures, features and the internal proxemics of a particular location can offer insights as to the degree of anticipated mobility or sedentism (Kent 1993, Seymour 2009); clearing of refuse to certain zones or rubbish dumps, or the identification of certain activity-specific discard practices in particular areas, have all been used to evaluate occupation duration (Sullivan 1992, Wandsnider 1996, Bamforth et.al. 2005).

Evaluating occupation duration from the accumulation of material culture is by no means a straightforward process, however. Of primary importance is the incorporation of models into the analysis of the archaeological record that are explicit in their understanding of the formation processes that influence the structure and visibility of the archaeological record.
(Wandsnider 1996, 2008, Surovell 2009), especially in archaeological environments that display limited temporal depth and/or indistinguishable chronological sequences (as is often the case in New Zealand). One of the difficulties with concepts of occupation span and residential mobility is that they rely (as do many other models) on the ability to estimate, at least broadly, the numbers of people occupying a particular place at a particular time. When dealing with the sort of distorted samples that the archaeological record provides, it can become next to impossible to estimate, calculate or infer either number of people, the area of the particular place or the depth of the particular time in anything other than in the broadest sense. Discard rates, for example, rely on knowing parameters such as the original number of artefacts that can never accurately be estimated. The concept of a lithic “toolkit” is also problematic. The “toolkit” is used as a descriptive term for the composition, both in terms of material type and tool type, of a particular hypothetical starting point for an assemblage, i.e. the potential universe from which an archaeological assemblage is drawn. However, this again relies on presumptions that are difficult to accurately quantify at the outset. Toolkits themselves have the potential to be so variable, at both the ethnographic level and the archaeological level, as to be meaningless in terms of a starting point for analysis. There is a fundamental problem with attempting to create models that rely on absolute values or measures of occupation span or discard rates.

2.3.2 Time perspectivism
If the foregoing accumulations paradigm can been seen to be centred on the formation of assemblage variability as a result of human behaviour vis-à-vis discard of artefacts, then post-discard influences are sometimes examined through another paradigm, broadly termed time perspectivism (Bailey 1981, 2007). At the most fundamental level, time perspectivism
examines the interrelationship between the time scales and natural and cultural processes under which the formation of the archaeological record operates. The time perspectivism argument runs that the formation of the archaeological record is affected by different processes working at different tempos or scales (Wandsnider 2008). Lucas sets time perspectivism as a counter to accumulations research (Lucas 2012: 109), but I would argue it is a complementary approach that is more concerned with acknowledging and identifying the processes that influence assemblage accumulation. Evaluating the degree to which deposits and assemblages are conditioned by taphonomic processes while they accumulate and after final abandonment of an area allows a more fundamental comparison of those assemblages with respect to their physical attributes. Time averaged deposits are the result of differential place use over time as opposed to short-term occupations or single-function locations (Douglass 2010: 79.) One of the advantages of the New Zealand context is that the tempos and scales that archaeologists are dealing with are not long-term in the strict geological sense, and due to the occupational period of about 700 years, constitute a relatively short period in the context of world prehistory.

The combination of accumulations research and the conditioning of time perspectivist approaches can be brought together in the concept of persistent place use: “Persistent places are places that were repeatedly used during the long term occupation of a region. They are neither strictly sites (that is, concentrations of cultural materials) nor simply features of a landscape. Instead they represent the conjunction of particular human behaviours on a particular landscape” (Schlanger 1992: 97). As such, repeated use or occupation may result in a cumulative palimpsest (Bailey 2007) and lithic assemblages can become time averaged (Stern 1994), potentially blurring the differences in assemblage attributes that may reflect changes in technological organisation, or ways in which occupation duration can be
ascertained. However, this longer term patterning does allow a better understanding of mobility at a landscape level (Holdaway and Wandsnider 2006, Olszewski and al-Nahar 2015) through the identification of intensely used locations. Further, precise three-dimensional recording of lithic artefacts at such locations can allow better understanding of formation processes (both accumulative and taphonomic) through spatial analytical techniques, cluster analysis and the combination of assemblage artefact technological attributes to spatial data (Wandsnider 1996, Machado et al. 2013, Hovers et al. 2014).

As a caution to this approach, Sullivan suggests that “…surface cumulative palimpsest assemblages register long-term consequences of human activities, floor contact assemblages measure short term technological configurations, and there is little correspondence between surface and subsurface lithic assemblage composition” (Sullivan 2008:40). However, this rather begs the question as to the typological/functional designation of a “floor” and the potential for time-averaging of floor deposits themselves. While discard of lithics cannot necessarily inform as to the precise activities that occurred at the point of discard, they can inform as to longer term land-use patterning (Schlanger 1992: 97) and thus settlement systems in a broad sense: “We may not be able to tell where in a landscape people used artefacts that were subsequently abandoned at one location, but a concentration of locations indicating the presence of persistent places will allow us to differentiate favored from unfavored [locations within] landscapes” (Holdaway et al. 2008: 124).
2.4. **Chapter Summary**

This chapter has reviewed the ways in which researchers have conceptualised the study of mobility strategies and settlement systems using the archaeological record and, in particular, lithic assemblages. It has outlined two broad conceptual approaches: the first focusses on the technological organisation, how this is reflected in the attributes of stone artefacts, and how this in turn may be used to infer mobility strategy. The second looks at the accumulation of artefacts at particular points in the landscape and the post-depositional processes that might affect the accumulated assemblage. It is in effect the study of the nature of occupation duration at a particular locale (Holdaway *et al.* 2007: 179), and using the accumulation of portable material culture is beneficial because other evidence such as the presence of specific structural components such as storage pits or house foundations, for example, do not always relate directly to mobility strategies (Edwards 1989, Hardy-Smith and Edwards 2004). We need to have some understanding of the mechanisms influencing the formation processes that have produced the archaeological record, and hence assemblage, that is studied. On a related note, we need to examine the taphonomic processes that may be physically altering the artefacts themselves or at least the nature of the assemblages excavated. And we need to contextualise the technological organisation of the lithic traditions of the people producing the artefacts within a suite of complementary archaeological evidence.

The following chapter, Chapter 3, reviews past approaches that have been taken in terms of New Zealand research within the above discourse, with a particular focus on the study of chipped stone artefacts.
Chapter 3. The New Zealand discourse concerning settlement systems, mobility and lithic artefacts

3.1. Introduction

The previous chapter outlined approaches to the archaeological record and occupation duration, settlement patterns and mobility strategies. It reviewed the ways in which the analysis of lithic assemblages can be used to inform these larger conceptual frameworks. Finally, it looked at the impact of formational processes and the conceptualisation of time in archaeology as factors that influence spatial patterning, assemblage attributes and change over time. This chapter will largely mirror that review through the lens of New Zealand archaeological research, beginning with mobility and settlement patterns. The analysis of flake stone assemblages in New Zealand follows; however, the area of formation processes and time averaging has been chronically under-studied in the New Zealand context. Save for recent PhD research undertaken in respect of Māori rock-art (O’Regan 2016), little attention has been paid to formation processes, at least outside of faunal studies (for example, McGovern-Wilson 1992), and as a consequence this chapter will focus primarily on the first two broad categories of archaeological discourse in New Zealand.

3.2. Overview of the ways in which mobility and sedentism have been conceptualised in New Zealand archaeology

As noted in Chapter One, H. Allen (1996) presented a critique of models that linked archaeological site typologies to the actions of social units, emphasising the difficulties
associated with prescribing an idealised societal organisation and searching for the archaeological imprint of same (Ibid: 671).

Nevertheless, many conceptual frameworks for understanding the nature of pre-contact Māori settlement-subsistence behaviours have fallen back on these idealised social units and their predicted archaeological signatures. A range of settlement and mobility patterns have been posited for pre-contact New Zealand over the years and models for the development of “Classic” pre-contact Māori culture are still focussed on material culture changes, the relationship between mobility, horticulture and social structure, and subsistence shifts between hunter-gatherer and horticulturalist economies (Davidson 1984, Allen 1996, Walter et al. 2006). The major contributors to these models, broadly focused on “settlement patterns” and, in essence, tracking continuity and change in the nature of occupation of regions, are briefly reviewed below.

Green (1963) and Groube (1964) pioneered settlement pattern/economic approaches, with Green’s paper (revised in 1970) proposing a series of six phases concerning the evolution of Māori culture from the earliest "settlement phase" through "developmental", "experimental", "proto Māori", "classic Māori" and "early European Māori" phases. It was an explicitly evolutionary approach which identified differing site and feature types with different time phases and geographical areas of settlement. His description of the phases took into account regional variation in climate, culture, economy, settlement type and ecological orientation within each phase, which was also afforded a chronological time period in keeping with the theories about the timing of the first Māori settlement of New Zealand that was prevalent at the time.
Les Groube’s 1964 MA thesis, *Settlement Pattern in Prehistoric New Zealand*, and subsequent paper of almost identical name (Groube 1965), took the opposite approach to Green's evolutionary theory. Groube argued for site types and settlement patterns that reflected a move to functionally specific sites (and hence a rise in logistical mobility) and in essence a simplification of the settlement pattern over time. He was also the first to introduce the concept of a “hamlet” as opposed to a “village” in the New Zealand context for what we would now term “kainga” (undefended settlements comprising five or six dwellings and two domestic units) (Groube 1965: 49, Green 1990: 25). Groube’s little-cited 1967 paper, *Models in Prehistory*, builds on the idea of simplification of settlement pattern, and interestingly argues that the concept of the “archaic” as a non-horticultural phase is flawed due to a lack of research undertaken in the northern part of New Zealand (Groube 1967: 21-22).

Around the same time as Green's and Groube's papers were published, Buist's North Taranaki study (1964) saw a focus on a particular site type, in this case the pa. Buist attempted to look at understanding the evolution of pa by considering the implications of their position in the landscape (Buist 1964: 38). After categorising different pa types he then looked at their distribution according to topography, his zones being coastal, flatland, foothills and ridge top (Ibid: 39). Overall his analysis concluded that the location of pa related to cultural and economic aspects of Māori society; for example, coastal pa related to fishing activities, whereas pa on arable land related to agricultural pursuits of the Māori population (Ibid: 43), mirroring the functional designations of Groube (1964) and the implications for movement within the landscape according to economic drivers.
In a ground-breaking research programme, focussed on a considerably smaller geographical area than in the studies referred to thus far, Foss Leach and Helen Leach's Wairarapa research programme, summarised in *Prehistoric Man in Palliser Bay* (1979), was a multi-disciplinary programme that combined extensive survey and targeted excavation (Phillips and Campbell 2004: 92). The stated objective of the programme was to "construct a well documented regional culture history by the close study of its prehistoric communities, investigating as many facets of their culture as possible." (Leach and Leach 1979: 4-5). While a regional culture history approach may seem to reflect Green's earlier work in Auckland, in fact a programme undertaken in Wairarapa drew more upon the direction initiated by Taylor (1948) and Clarke (1954) in the USA and Great Britain respectively and Shawcross (1967) in New Zealand (Leach and Leach 1979: 5). Leach and Leach painted a picture of a mixture of permanent settlement and seasonal occupation of particular sites associated with particular resource groups (thus a mix of residential and logistic mobility). Ultimately, it was proposed that, as a result of environmental drivers, especially a deterioration in the climate, coastal settlement moved inland and ultimately permanent, sedentary occupation of the region was abandoned.

Janet Davidson's work on Motutapu Island in the Hauraki Gulf saw for the first time a priority placed on the acquisition of a comprehensive archaeological data set through survey (Phillips and Campbell 2004: 90). In her 1978 summary of her work on the island in the 1960s, Davidson (1978) noted in particular the difficulties of identifying whether a spread of features across the landscape should be recorded as one site or several. Davidson also discussed the difficulties associated with either lumping or splitting features into sites. Davidson's summary also included a brief discussion of the favoured locations for settlement sites from a typographic and environmental point of view. She noted that ridges, hilltops and
spurs appeared to be favoured locations for settlement irrespective of aspect. She does suggest, however, that the primary driver for settlement appears to be the location of "a well-drained piece of land close to cultivations" (Davidson 1978: 331-332).

Geoff Irwin’s spatial approach to the study of pa was an attempt to look at the context of a local settlement system through the study of fortified sites (Irwin 1985: 1). The particular study region Irwin was interested in was that of Pouto in the South Kaipara Harbour of the North Island of New Zealand. Irwin looked closely at the spatial distribution of pa and undefended sites in his study region, paying particular attention to environmental variables such as topography, elevation and soil type. The Pouto study area was also compared against the distribution of pa clusters in other coastal areas in the North Island. No detailed analysis of environmental variables was undertaken; however, a basic statistical analysis of site type versus soil type together with site type and elevation was employed. A nearest-neighbour analysis was undertaken to look at patterns of clustering and disbursement of pa sites and undefended sites. The location of pa were plotted against soil type and other typological variables. Ultimately Irwin attempted to track the evolution of pa location within a settlement system and proposed a change in social relations over time, a move away from the subsistence-based or environmental explanations for mobility and sedentism outlined in the preceding paragraphs (Phillips and Campbell 2004: 94).

The volumes and papers concerning the South Island Shag River site (Anderson et al. 1996, Anderson and Smith 1996), set out the “site type” for the “transient village” (sedentary villages that were re-located after a matter of decades (or less) following depletion of surrounding resources (Anderson and Smith 1996, Walter et al. 2006: 280, 282)) in the South
Island and it is arguable this study represents an example of the application of an idealised version of social organisation and its archaeological imprint (Allen 1996: 671). In a dedicated volume (Anderson et al. 1996) and paper in *World Archaeology* (Anderson and Smith 1996), the authors describe the excavation and interpretation of a 14th century coastal site in the North Otago region of the South Island. The site was first investigated in the late 19th century, then excavated with varying degrees of precision by Teviotdale in the 1920s, and finally excavated systematically by the authors in the late 1980s. Anderson and Smith, referencing Rafferty’s (1985) diagnostic characteristics of sedentary settlement, outline an argument for a large site with a functionally discrete internal organisation, an extremely high number and variety of artefacts and considerable volumes of faunal evidence, suggesting continuous occupation for some 20-50 years (Anderson and Smith 1996: 360-363). However, a detailed look at the reported archaeological evidence suggests that this is not necessarily the only interpretation that could be made.

The designation of Shag River Mouth as a continuously occupied sedentary village is problematic. The radiocarbon determinations, while consistent with this proposition, do not provide conclusive evidence in support of it either, and are not enough to justify continuous occupation. Much store is placed in the presence of a number of “hearths”, excavated by Teviotdale in the 1920s and described by Allingham (1996: 22) as features that “…appear to have been deposits of ash usually kerbed with a rectangular arrangement of stones”. Teviotdale believed these features marked house or hut sites and these designations are supported by Anderson and Smith (1996: 276). However, as the authors state, “It is a moot point whether each hearth represents a former house” (ibid: 277), and they go on to note the scarcity of posthole evidence for structures, save for an “amorphous semicircular [sic] band” (ibid: 277) of shallow stake-holes associated with a “reasonably intact” hearth. Functionally
discrete areas (central butchery and cooking area flanked by middens and bordered by dwellings and specialised stone-working sites on the fringes) are interpreted from the spatial combination of Teviotdale’s observations and the late 1980s excavations, providing “…the appearance of a single, integrated village site” (ibid: 277). Stone-working area designation and corresponding site functional differentiation is based on flake stone tool distributions (Smith et al. 1996: 101), but with little or no consideration of taphonomic or discard practices. The authors extrapolate the presence of vast numbers of stone artefacts and faunal remains based on an upscaling of excavated volumes of material to the estimated volume of what the authors refer to as the “site”. With respect to fauna for example, a maximum MNI of 70 moa at an average MNI of 0.616 per cubic metre from the 113 cubic metres of excavated material is extrapolated out to an estimated 9,240 individuals with a maximum meat weight of 512 tonnes at the site (Anderson and Smith 1996a: 296, table 20.1) based on an estimated total site volume (calculated simply by taking the estimate of 15,000m³). Similarly, an estimated MNI (based itself in large part on bulk sampling of midden material and calculations of estimated total midden volume Higham 1996: 246-7) is then further multiplied to give an estimate of a shellfish MNI of 9,943,515, based on an estimated midden volume of 9000m³ (ibid: 247, table 18.2). The same approach is applied to lithic material, with five complete excavated adzes translating to an estimated site total of 660, and 3,108 stone flakes translating to an estimated site total of 410,532 (Anderson and Smith 1996a: 280, table 20.2). While it is made explicit that these numbers are estimates, they both ignore and contradict arguments mounted earlier that the archaeological evidence represents a single use, integrated settlement that as a whole was functionally differentiated, and as such the distribution of artefacts or faunal remains are not likely to be uniformly distributed over the site. Furthermore, the estimate figures are used to support the proposition that the evidence at

At best the evidence for permanently (i.e. year-round, over a 20-50 year period) (Anderson and Smith 1996: 366) occupied house structures is circumstantial, and it could be argued that there is nothing in the evidence presented that is not also consistent with an interpretation of the location as one that is repeatedly, but not necessarily continuously, occupied, over a period of some decades. As such I would argue that the interpretation of the Shag River Mouth site as a permanently occupied “village” is an example of an idealised site type where the archaeologically derived assemblage of both features and artefacts are accommodated to fit the preconceptions of a village rather than the other way round.

Moving back to the North Island, Phillips (2000) incorporated a detailed analysis of the archaeological and ethnographic evidence to be found in the Waihou River catchment of the Thames area. The study region Phillips examined is the swampy flatland of the Hauraki Plains in the North Island which is bisected by the lower Waihou River (Phillips 2000: 9). The study incorporates environmental studies for the region, Māori and European histories and archaeological surveys and excavation, making it a multi-disciplinary work. While adopting an explicit landscape approach to answer questions of complexity, specialisation and permanence of settlement, Phillips identifies the issues inherent with settlement pattern models: the assumption of complete knowledge of total site distributions; questions as to contemporaneity of settlement; and the identification of transient as opposed to permanent occupation as it relates to the mobility of pre-contact populations (Phillips 2000: 167).

Phillips details a multi-temporal system that sees long term changes influenced by
environmental factors such as erosion and sedimentation, the development of pa and the exploitation of the Waihou River and its tributaries; mid-term cycles based on the political impacts of particular chiefs; and short term economic cycles most closely related to agricultural factors (ibid: 167-168). Phillips concurs with the interpretations of Davidson at Motutapu and Irwin at Pouto that characterised Māori society as highly mobile and incorporating a flexible territoriality. However, by incorporating a detailed environmental analysis and ethnographic histories, Phillips' work goes further than the scope of either Davidson or Irwin (Phillips and Campbell 2004: 182).

In 2006, Walter and colleagues presented a direct examination of mobility, subsistence and socio-political organisation in pre-contact Māori society (Walter et al. 2006). In this paper, they propose an explanatory paradigm for the development of pre-contact Māori society from initial settlement of Aotearoa/New Zealand to Cook’s arrival that involved a shift in the relative importance of subsistence strategies: from a Polynesian horticultural focus at colonisation, to hunting (focussing on marine (seal) and terrestrial (moa) megafauna) and gathering, and back to horticultural practices following megafaunal depletion, within a span of some 500 years. Concepts of pre-historic mobility and sedentism are inextricably linked to this model, with the basic settlement unit of the “transient village” (sensu Anderson and Smith 1996) interpreted as part of a settlement-subsistence system that was apparent throughout the country across the entire period of pre-historic human settlement (Walter et al. 2006: 281-282). They argue that despite apparent changes in subsistence strategy over the course of New Zealand prehistory (specifically shifts from horticultural dominance to big game hunting and back again), patterns of sedentism/mobility did not appreciably change from initial colonisation to the time of first European contact (Walter et al. 2006, Marshall 2006: 157).
There are a number of difficulties with the positions set out in this paper, and given its direct applicability to the over-arching theme of this thesis, it is worth looking at these in more detail at this point. Central to their argument is the concept of profound subsistence change over time: “New Zealand is an unusual case involving a society moving from an agricultural to a predominantly hunting and gathering base and then, following large-scale faunal depletions, back towards agriculture.” (Walter et al. 2006: 274). However, this is a characterisation based on a selective view of the archaeological record and an over-emphasis on early southern South Island sites. Contrary to the statement, “The New Zealand case is one of very few in which a sedentary, food producing society colonised a region in which food production was either difficult or impossible” (ibid : 286), food production was demonstrably not “difficult or impossible” in large proportions of the North Island and warmer parts of the South Island (such as the Nelson-Marlborough region and parts of Banks Peninsula), and there is abundant, early archaeological evidence for successful horticulture in all these regions, including stone horticultural alignments, garden soils, borrow pits and storage pits (Furey 2006, Anderson 2015: 82). Anderson even suggests that early horticulture in southern regions was abandoned by the end of the sixteenth century (Anderson 2015: 90), suggesting not a transition from hunter-gathering to horticulture, but the reverse. In the north of the North Island, six introduced Polynesian cultigens are known to have been grown at the time of first contact, namely kumara (sweet potato), taro, yams, bottle gourd (hue) and the tree crops ti pore and paper mulberry (aute) (Barber 2004).

The marginalisation of coastal environments in Neolithic subsistence/mobility models (Bailey 2004) is also reflected to a degree in this type of model. In northern New Zealand,
the possibility that a relatively stable subsistence economy that combined horticulture and marine (fish and shellfish, as opposed to seal) resource exploitation existed from the time of initial colonisation through to European contact needs greater analysis. Smith’s (2011) comparison of faunal data from the Hauraki Gulf region in the north and the Otago/Caitlins region in the deep south is a useful synthesis of the archaeological evidence for the exploitation of finfish, shellfish, coastal birdlife and marine mammals in those specific regions, but there is much scope for further research into the integration of these aspects into a more nuanced picture of the interrelationship between marine faunal exploitation and horticulture, as noted by Smith (2011: 34).

In light of the above, the research undertaken herein is undertaken against the backdrop of such previous models, including those taken from predominantly South Island archaeological datasets, which, arguably, when applied to all of pre-contact New Zealand, have the potential to understate the importance of an ongoing, and successful, horticultural facet to overall subsistence strategies in northern New Zealand. By examining lithic artefact assemblages against such a backdrop, evidence for change in lithic technological organisation, formation processes and occupation duration can be evaluated in a geographically constrained island landscape where geological source distance and excavation methodology are held constant. The research also allows an examination of persistent place use in similar environmental zones which potentially contain evidence of long term permanent or long term periodic occupation, and thus permits a critical review of the current New Zealand model for pre-historic mobility patterns and their change or stasis.
3.3. NZ lithic studies

The manufacture and use of stone tools by Māori in the period prior to European settlement has long captured the imagination of scholars and the general public alike. From the very first substantive European contact in the late 18\textsuperscript{th} century, European voyagers collected examples of Māori stone adzes, weaponry and fishing gear and provided basic descriptions and illustrations of same (Best 1912: 13). From the late 19\textsuperscript{th} century on, a few more detailed, predominantly regional studies of stone tools appeared in publications such as the \textit{Transactions of the New Zealand Institute} and since then there have been consistent, if not large in number, studies produced that provide different views on Māori stone tool production, within different theoretical frameworks and approaches. This chapter will review and evaluate the literature relating to stone artefact studies in New Zealand, and set the scene for the analysis to come. It will focus on studies that specifically undertake some metric or spatial analysis of flake stone artefacts rather than review all mention of flake stone tools in New Zealand archaeological reports – to do the latter is beyond the scope of this thesis. In tracking the development of New Zealand lithic studies, it will be argued that an overarching concentration on the association of typology with temporal cultural stages has dominated the field, and that central to these approaches has been the concept that the artefact itself, or assemblages of artefacts, with only limited spatial or temporal archaeological context, are sufficient to speak to the question of change through time. As Sheppard (2004: 149) notes, many of the studies prior to the 21\textsuperscript{st} century concentrated on materials associated with the manufacture of adzes; however, in the last 20 years there has been an upswing in the number of studies that examine the sourcing of obsidian and reconstructing pre-European trade and exchange networks through the movement of obsidian (Moore and Coster 2015, McCoy and Carpenter 2014, Walter \textit{et al.} 2010). The review in this chapter is structured thematically,
allowing for subsection categorisation of works that focus on technological studies of flake attributes, spatial patterning of artefacts and sourcing studies.

In New Zealand, it is suggested that previous archaeological studies of lithics and, in particular, flake stone assemblages, can be split into three phases or approaches:

- First, typological/functional/descriptive studies that are linked to the desire to associate typologies with archaeological cultures or phases (e.g. Archaic or Classic) and reflecting the culture history approach that held sway during the first half of the 20th century

- Second, an approach more grounded in modern archaeological methodologies that might further be divided into three differing research directions:

  o Technological studies focussed on chaîne opératoire type reduction sequences and methods of manufacture – these studies look to explain variation in assemblages through space and time in terms of cultural affinity and technological organisation;

  o Sourcing studies focussed on different raw material types and distances from source, basalt and greywacke, Nelson argillite with respect to adzes, obsidian everywhere, chert to a limited extent
Studies that incorporate spatial distributions of lithic material within archaeological sites

- Finally, studies that combine the three previous approaches to a greater or lesser extent to examine trade and exchange, communication and social interaction and have a theoretical basis to some degree rooted in an analysis of the development of territoriality, resource-driven mobility and the maintenance of social ties.

The following sections of this chapter will examine these themes in turn.

3.3.1 Typological/functional studies

The very early studies referred to above were largely descriptive and concentrated on South Island material (von Haast 1879, Hutton 1897, Davidson 1984). Yet even at this early period, the form of lithic artefacts was being used to support arguments related to cultural affinity, evolutionary processes and faunal resource exploitation, specifically in von Haast’s case relating to his theory that flaked stone tools in New Zealand were the product of an extinct “moa-hunter” culture, ethnically distinct from, and preceding, Māori. Von Haast proposed that the flaked silcrete stone artefacts found in association with the bones of butchered and cooked moa (*Dinornis spp*) at Rakaia in the South Island were Palaeolithic, and contrasted with the more sophisticated Neolithic polished stone tool technology possessed by Māori (Davidson 1984). Von Haast (1872) also appears to have been one of the first authors to note the presence of North Island obsidian in the South Island in association with archaeological remains: “But the most interesting objects [at Rakaia] were small pieces of obsidian, in lithological character identical with that obtained near Tauranga. It is thus evident that a race so remote from our own times must have had communication with the Northern Island…”
Hutton (1897) provides a much less detailed summary of flake stone tools, but his paper interestingly notes the possibility of the use of punches in the fine flaking of adzes (ibid: 131).

The first major review of Māori stone tools in their own right came with Elsdon Best's *The Stone Implements of the Māori* (Best 2005). First published in 1912, this was a comprehensive study that focussed primarily on finished artefacts such as adzes of varying lithic materials, patu and mere (war clubs). There is some discussion of manufacturing processes (hammering, sawing, flaking etc.), but this is a minor aspect of the volume as a whole.

In 1924, Knapp produced what is still arguably the high-water mark in terms of the extreme typological classification of Pre-contact Māori flake stone tools: a paper in the *Journal of the Polynesian Society* entitled “Canoe Building Tools of the Tasman Māori”. Knapp seems to have been an inveterate “splitter”, rather than “lumper” in the typological sense – he details no less than 51 separate types of flaked tool (with accompanying drawings) which he associated with the manufacture of Māori waka (canoes). His tool types included chisels, gouges, push-planes, borers, and scrapers, each classification being in turn further split into sub-variants. While some of his typological forms are no doubt valid in terms of describing the way in which the flaked tools were actually used, and indeed are instantly recognisable in the form of individual artefacts observed in the assemblages analysed in the course of this thesis, only three years later Skinner and Teviotdale (1927) specifically noted that the extent to which Knapp had subdivided his typological classifications was not an approach with which they could agree (ibid: 180). In that paper, Skinner and Teviotdale analysed and
classified a number of artefacts from the Shag River Mouth site on the southeastern coast of the South Island. However, despite their comments concerning Knapp’s typological variety, they too focussed on typological divisions for lithics to a large extent. The Shag River Mouth site will also be discussed in more detail below in the context of later excavations.

3.3.2 Explicitly archaeological approaches

While lithic material continued to be excavated, recorded and described by New Zealand archaeologists over the following decades, the first rigorous systematic technological analysis of flake stone material did not appear until Shawcross’s paper “Stone Flake Industries of New Zealand” appeared in the Journal of the Polynesian Society in 1964. This paper is the first to systematically review both the previous studies of flaked tools undertaken in New Zealand and to critique the use of European/Old World typologies for New Zealand lithics. Shawcross notes that flaked tools may be classified by their form, function, or method of manufacture (ibid: 10) and using a methodology for the analysis and description of flake features derived from a British Museum (1956) handbook on flint implements, and Oakley’s Man the Toolmaker (1958), he analyses and compares three archaeologically-sourced flake assemblages from New Zealand and one experimental assemblage. Two of the archaeological assemblages are from the Coromandel Peninsula, from Kauri Point Swamp and Whangamata respectively, and comprise obsidian and basalt flakes. While the Kauri Point assemblage is large (in excess of 13,000 pieces, albeit with a significant proportion (not precisely specified) of very small flakes of less than 5mm in maximum dimension), there is no discussion as to the size of the Whangamata assemblage other than to note it was collected over the course of a weekend’s excavation. The Whangamata assemblage consisted of a mix
of basalt and obsidian flakes, and it is also uncertain as to whether the lithics Shawcross analysed from this assemblage were solely of basalt, as indicated by Figure 17 (ibid: 19), or included the obsidian flakes also excavated. The third archaeological assemblage was sourced from the Waitaki River Mouth on the east coast of the South Island, and consisted of a large number of silicified sandstone flakes and cores collected from the area, mostly by Lockerbie “under controlled conditions” (ibid 21). Of the three archaeological assemblages, the Kauri Point assemblage was the only one that appears to have been subjected to any rigorous technological analysis, with flake length, breadth, interior platform angles, and platform depths, together with “Length of convex/Straight Edges” and “Diameters of Concave Edges” recorded and graphed. Shawcross also produced an experimental assemblage by flaking a single angular core of obsidian (source undescribed) weighing 455 grams to produce 877 flakes (of which 640 were less than 5mm in greatest dimension). Contour diagrams derived from scattered plots of flake length and breadth dimensions were then produced for the Kauri Point assemblage, Whangamata basalt assemblage, and the experimental assemblage. All plots were deemed “fairly close” (ibid 20), but no attempts to quantify the relationships were made, and Shawcross himself noted the difficulties in making valid comparisons across assemblages with different lithic material proportions that may have reflected adze manufacture (in the case of the Whangamata basalt) and more informal flaking (in the case of the Kauri Point Swamp obsidian assemblage). These difficulties were further compounded in the analysis of the Waitaki River Mouth assemblage, which seemed to only serve as a casual contrast to the northern and experimental lithics. Here Shawcross selected a few pieces to make general points about the assemblage, specifically relating to the apparently greater degree of formal core preparation and blade manufacture when compared to the other assemblages. Complicating matters further was the fact that this southern assemblage was primarily of silicified sandstone and hence a different material from basalt.
and obsidian. Despite the limited nature of the technical analyses, and the lack of control for raw material, sampling strategies or comparison, Shawcross’s paper does represent the first systematic approach to the analysis of stone flake material recovered archaeologically in New Zealand. He suggests that the search for typology in the New Zealand context may be flawed: “…it would seem better to avoid creating a group of tool types and instead assume that the needs of the prehistoric New Zealander for edge tools could often be met by utilitarian selection or slight modification of a suitably angled piece of stone, rather than by preparing an object to some preconceived notion of ideal shape.” (ibid: 17). However, Shawcross characterised the problem with typologies as not the search for types itself, but the subjective manner in which many typologies were created. He argued (ibid 14) that more objectively created typologies were generated “…due to the capacity of the electronic computer to manipulate the very large numbers of factors which arise when the shapes of artefacts are described in objective terms”. This explicit questioning of typological classifications of formal tool “types” in his analysis set the scene for following work, but was a suggestion seldom followed.

3.3.3 Explicitly Technological Studies

In 1969 Leach published “The concept of similarity in prehistoric studies: A test case using New Zealand stone flake assemblages”, a manuscript that looked at the binary classification of New Zealand prehistory into “archaic” and “classic” phases through the lens of comparative studies of flake assemblage attributes. His aim was to look for “culturally meaningful parallels” (ibid: 24), or similarities, across assemblages, using technological metrics and a focus on the manufacturing processes that were implied from them. He notes at
the outset (ibid: 25-27) of the study what he sees as particular problems or difficulties encountered when comparing assemblages, which I have paraphrased here:

1- Stone artefacts are often valuable and almost always portable artefacts that are prone to movement;

2- Parallels in the form of artefacts or site structure lead to possible interpretations of cultural relatedness that are spurious;

3- There is a lack of proper random sampling, and a failure to incorporate an appropriate level of objectivity into the analysis; and

4- There is not enough examination of how to interpret similarity in cultural terms; i.e. a restatement of point 2 above with respect to the emphasis to be placed on artefact functional parameters.

Leach’s analysis incorporated five main assemblages and 17 much smaller ancillary assemblages that represented a variety of archaeological and temporal contexts from the southern South Island. A total of 903 flakes were analysed, using a number of now standard variables such as flake dimensions, platform angles (in this case the interior rather than exterior angles, see Chapter 7) and dimensions, termination types and cortical proportions. Functions were assigned to sites from which the main assemblages were drawn (e.g. butchery site – short occupation, quarry site – multiple occupations, pa site – long occupation), but there was no discussion of the archaeological contexts from which each assemblage was obtained within each site. While explicitly looking to identify and quantify differences and
similarities between the assemblages that might be taken as indications as to the extent of
cultural connectedness between the sites, Leach stressed that the assumption that the
assemblages investigated represented a random representative sample of the total material left
by a prehistoric group was flawed (ibid: 114) (although no particular solutions other than
more comprehensive sampling were put forward). Ultimately, Leach’s results suggested that
the interior platform angle measurement (as opposed to exterior platform angle measurement
(Dibble 1995)) was the most significant variable for purposes of assemblage differentiation,
but whether the differences were the result of site function, occupation duration, seasonal
differences or cultural affinity were left largely moot.

Following Leach (1969), many reports and articles from the 1970s through to the 1990s
included lithic analysis to varying degrees (e.g. Davidson 1970, 1975; Leahy 1970, 1974;
Boileau 1980; Leach and Leach 1980; Harsant 1985, Furey 1990, 1996), but often these
articles were general reports on particular excavations (especially from Coromandel
Peninsula dune sites) rather than lithic-focussed in their own right. An exception is
Kooymans’s (1985) PhD thesis, which undertook a specific analysis of usewear on
porcellanite and silcrete artefacts from assemblages associated with moa remains. While the
main focus of the thesis was and examination of moa exploitation and butchering patterns,
the experimental replication and usewear analysis undertaken on the lithics remains the most
comprehensive study of its kind in the New Zealand context (but see also Frederickson and
Sewell 1990) below). Most other studies looked at basic stone flake attributes, but didn’t go
much further than basic recording and description (in their defence, reflecting the nature and
objectives of the reports). All drew on Shawcross’s (1964) scatter contour method of
examining distribution of length versus breadth, but a few of the papers contained expansions
or comments on the lithic analysis that are worth noting.
In reporting on Motutapu (an island in the Hauraki Gulf in the northeastern North Island) excavations, Davidson (1970) specifically notes a few obsidian artefacts were obviously made from water-rolled flakes, i.e. taken from beach deposits of obsidian created by earlier occupation. This is the first explicit acknowledgement in New Zealand that I have found that lithic material entering the archaeological record at a particular space and time may have been recycled from an earlier context.

Leach and Leach (1980) analysed a large number of flakes and adze preforms from the Riverton site at western Southland, South Island. The site was categorised by the authors as an “adze manufactory” based on the lack of lithic artefacts manufactured from anything other than the adjacent argillite outcrop, and a limited suite of recovered faunal remains (despite the authors acknowledging the “difficult excavation conditions and inappropriate recording methods” (ibid: 139)). Flake types were classified A, B and C, based on whether they were identified as “primary”, “secondary” or broken flakes; the designation of primary or secondary was based on cortex percentages and dorsal scarring. The categorisation of flakes based on their physical attributes was primarily to place them within a reduction sequence relating to adze manufacture, and reflects an overarching concern with adze manufacturing techniques.

In a report on Hotwater Beach excavations (coastal Coromandel Peninsula, North Island), Leahy (1974) used a Chi-square analysis to recalculate obsidian source proportions to account for the stratigraphic layers in which they were found – representing explicit, if
underdeveloped, reference to the importance of understanding taphonomic processes in the patterning of lithic artefacts in archaeological contexts in New Zealand.

In her description of Tahanga basalt flake artefacts from excavations at Hahei Beach (eastern Coromandel Peninsula), Harsant (1985) observes that the selection and use of flakes for tools appears to involve an opportunistic use of waste flakes from adze production, rather than the result of deliberate core production, although no quantitative analysis was undertaken to support this assertion.

Furey (1990) presents a general description of lithic artefacts as part of her report on the excavations of the Whitipiorua site on the Coromandel Peninsula. Her analysis notes that despite the large amount of Tahanga basalt flakes present, complete adzes were poorly represented – fossicking is proposed as one reason for this ratio, but no comparison of complete to incomplete adze ratios from other similar sites is referenced. Over 60kg of lithic flakes were excavated across the site, with the relative proportions being recorded as 45% chert, 35% basalt and 20% obsidian. No further analysis was undertaken other than to note the presence of cortex on flakes and the general mix of sizes. Similar to the two Ahuahu Excavation Zones of EA1 and Te Matuku and the Masonic Tavern Excavation Zone (see Chapter 5), a full range of megafauna (seal, sea lion and moa) remains were present, including moa eggshell.

Returning to work that has at its focus stone artefacts as opposed to overall archaeological site reporting, Challis (1976) presents an analysis of metasomatised argillite artefacts from
the Nelson Region. The majority of the artefacts were flakes, collected following bulldozing of a site prior to road work, and hence the assemblage acquisition was lacking in formal excavation controls and methods. Challis’s analysis is framed within a search for forms, or typology, and stages in production sequence towards those forms or types (despite noting Shawcross’s comments on the selection of suitable flakes rather than manufacturing preconceived forms, noted above). Identification of flakes categorised as primary, intermediate, secondary and final (following Jones 1970) was undertaken, such categories reflecting stages in the preparation of material for adzes and flake tools (flake tools being created from “intermediate” flakes). Analysis was undertaken through the initial visual identification of the raw material, followed by identification of tools and blanks, cores, and finally waste fragments “….according to the stage and technique of processing in which they were produced” (ibid: 470). Two major spatial concentrations of flakes were categorised as “flaking floors”, and were treated as contemporaneous deposits because all of the flake categories that Challis had defined in his study were present in both groupings. Inference about movement of lithic material to and from the study area is based on the nature of the complete adzes recovered from the site, in comparison to the rough-outs, and the apparent discrepancy in the number of flake tools compared to waste flakes. The former, according to Challis, are too few to account for the amount of waste (ibid: 484). The possibility that flake tools were removed elsewhere (on or off site) is advanced as an explanation for this – an early instance of the use of assemblage composition to understand the movement of lithic – but no statistical analysis is undertaken to back up this (or any) assertions in the paper.

Morwood’s 1974 paper compared obsidian assemblages from Great Barrier and Tokoroa (a location in southern Waikato region of the North Island and some 70km from the coast) in terms of their secondary retouch, showing that the majority of the Tokoroa artefacts displayed
secondary retouch, while the levels of retouch from the Great Barrier Island sites were much lower. This suggested that there were differences in the intensity with which the obsidian was used at the site further from a source (Holdaway 2004).

Helen Leach’s 1979 paper entitled “An analysis of an open-air workshop in Palliser Bay” focussed on the identification of stone tool types and functions. She noted that there was no significant difference in utilised edge length for either Mayor Island or Grey obsidian, nor between chert and obsidian artefacts generally, and argued that this reflected similar functionality across material type. She does, however, argue that the slightly greater number of modified edges per artefact on obsidian tools as compared to chert tools suggests that obsidian was used more intensively and that obsidian was more highly valued than chert (p. 148). She explicitly uses technological analysis to attempt to get to the thought processes of the toolmakers themselves: “the discovery that for the scraping tasks chert and obsidian were functionally interchangeable, but that as a material obsidian was more highly valued, demonstrates that by close analysis of industrial assemblages some light can be thrown on the value systems of prehistoric workmen (emphasis added)” (p.150). As with earlier studies, Leach also notes the re-use of broken adzes and adze flakes for other tools, for example drill-points.

In the same tradition as Leach (1969), Jones’s 1984 paper “Lithic waste flakes as a measure of cultural affinity” took a technological approach to adze manufacture and how the understanding of the manufacturing process could potentially lead to better understanding of cultural affinities (ibid: 71). Jones looked for evidence in variation of flaking technique – important to him was whether variation in flaking technique directed toward desired end
*products* (emphasis added) can be related to measured parameters of flakes (ibid: 72) – assuming that flaking takes place with a desired end shape in mind.

The assemblages studied are divided between flake tool and core tool (adze) assemblages, and lithology is key: Jones notes that certain rock types were never used for adzes, for example obsidian, although this is not correct – small obsidian adzes and chisels have been found on rare occasions – but conversely he does not allow for the fact that basalts and other durable “adze-quality” materials are used for things other than adzes. The focus was on early assemblages from the Coromandel/Bay of Plenty regions and southern part of the South Island, with only one being from late in the prehistoric sequence. Jones’s important conclusion relates to the differentiation of flake tools from adze manufacture debris. This differentiation was made on the basis that observed differences in platform angle and maximum thickness relative to flake size were attributed to differences between use of a core to produce flakes for flake tools, and the reduction of a core to produce core tools (e.g. an adze) (ibid: 77-78). Interestingly, Jones notes that “Heaphy” chert and heaphyite artefacts from the South Island sites present a similar technological signature to the obsidian present in Bay of Plenty sites, but obsidian from the southern assemblages is different; this is attributed to conservation of a scarce material.

With two notable exceptions, little work has been undertaken in New Zealand with respect to use-wear analysis of stone tools. Kooyman’s (1985) PhD thesis (noted above) undertook a detailed experimental use-wear study on porcellanite and silcrete artefacts in the context of understanding butchery patterns on moa bones. The level of experimental analysis undertaken by Kooyman was not possible in the context of this research (see below), but his
work in this respect serves to highlight the potential for further study in this area, somewhat contra to Frederickson and Sewell (1991). In that paper, Frederickson and Sewell reported on their experimental work replicating use-wear on obsidian. Experimentally produced flakes were used for a variety of tasks, including woodworking, cutting of flax etc., and then analysed using standardised archaeological methods through blind tests to see if function could accurately be ascribed based on the use-wear presented. They found they could not reliably ascribe function at all, and as such, caution was advised when attempting to ascribe function to archaeologically recovered obsidian tools in the New Zealand context. It should be noted at this point that use-wear analysis is a complex and highly specialised area of archaeological research requiring extensive training and in many cases dedicated experimental programmes and the ability to apply high power magnification techniques (Kooymann 2000). While it has been applied with success in many cases internationally (e.g. Odell 1981, Prentiss and Romansky 1989, Young and Bamforth 1990, Coffey 1994, Shott, 1995, Kooymann 2000, Odell 2001, Marreiros et al 2015), the level of expertise required means that it was not feasible to undertake use-wear analysis as part of the research undertaken for this thesis.

Perhaps the most sophisticated analysis of the 1990s concerning flake technological analysis was undertaken by Turner and Bonica (1994) in their examination of archaeologically recovered and experimentally produced basalt flake assemblages. They created detailed flake typological categories that were based on weight, dorsal surface scarring and cortical cover percentages, and flake shapes, completeness and terminations.
Reflecting the authors’ overarching interest in the manufacture and maintenance of adzes (see also Turner 2000), the paper focused on where individual flakes and flake types might fit into the technological sequence – in effect what the flakes can tell us about the tools themselves rather than the archaeological context in which they were found. However, some interesting suggestions and observations were made concerning the implications of assemblage attributes to occupation duration and mobility. The modification of basalt flakes to specialised tools was linked to inner-harbour sites and potential seasonal (winter) occupation (Turner and Bonica 1994: 27), perhaps reflecting differences in the assemblage attributes of “permanent” occupations versus evidence of transient temporary manufacturing expeditions.

Furey’s two monographs on North Island material culture assemblages from Oruarangi (1996) in the Hauraki Plains region and Houhora (2002) from the far north both contained detailed discussions concerning lithic artefacts, but the focus is primarily on typological forms and formal artefacts. The Houhora volume does, however, contain more detailed analysis of the obsidian and chert flake assemblages; in the case of the obsidian, of which the majority is Mayor Island material, Furey uses excavation layers to look at variability in sources over time, although little patterning in this respect was noted (Furey 2002: 107-109). Chert was similarly analysed, and the small size of chert flakes generally and high percentages of cortex used imply that cobbles of chert were small (ibid: 109-110). Geochemical sourcing was also attempted on the chert artefacts based on a suggestion that the material might have originated from the Coromandel region; however, the results were inconclusive, and no doubt reflect the difficulties in geochemically sourcing chert in general (see Chapter 4 below).
Holdaway’s (2004) study of a large assemblage of obsidian artefacts from the 17th century Bay of Plenty site of Kohika represents the most thorough technological examination of a lithic assemblage undertaken to date in New Zealand. This assemblage stands out both in the number of artefacts and the size of them (ibid: 196). Holdaway also notes the impact that differing excavation techniques may have had on the assemblage composition: the material obtained from the earliest excavation as part of an investigation by the local Historical Society had fewer smaller artefacts, a fact which was likely the result of different excavation techniques being employed from the later university-led expedition. Artefact dorsal flake scarring and edge modification were recorded with a view to characterising the reduction techniques of the knappers working at Kohika. A systematic reduction strategy was proposed (ibid: 196), while there also appeared to have been some intra-site differentiation in terms of artefact density, suggesting that there was a corresponding differentiation in activities in the site (ibid: 196).

3.3.4 Spatial studies

In 1979, Nigel Prickett presented the first major study in New Zealand to look explicitly at artefact distributions intra-site and their relationship to structural evidence. The analysis formed part of the record of the Wairarapa Archaeological Research Programme (WARP) headed by Foss and Helen Leach. Stone artefact numbers and material were recorded in one-square-metre quadrants, which allowed for a coarse-grained examination of broad spatial patterning according to artefact material and typological classification. Tying in concepts of Polynesian divisions of ritual space, Prickett used the distributions of stone artefact types and
assemblage characteristics to propose internal subdivisions of space within a relatively large house structure, according to status and gender.

At the same time, Kath Prickett, also working as part of the WARP programme, presented an analysis focussed on the sourcing, relative proportions and presumed uses of lithic materials across five excavation areas within the larger WARP study region. The analysis tracks percentages of local versus imported lithic materials across the sites and changes of those proportions over time within the sites.

Prickett used statistical tests of significance to evaluate the changes in proportions and, where such changes are statistically evident, suggests that this may represent evidence of change in communication networks over time (as opposed to variability in occupation duration in one locality, as might be argued otherwise). The important point here is that, rather than look at the accumulations of artefacts over time, the changes in proportions and types of artefact are seen as indicative of different communication (mobility) strategies at different periods. A similar argument is made by Walter et al. 2010 (see below). Interestingly, the one site where no stone artefacts were present – the Washpool garden walls site in Palliser Bay (H. Leach 1979) – is, as the name suggests, a horticultural complex. As is discussed in Chapter 4 below, no stone artefacts were encountered in the two analogous horticultural sites on Ahuahu.

unpublished MA thesis record the findings and analysis of the University of Auckland research programme undertaken in the 1980s under the direction of Sutton. There is little in the way of detailed lithic technological analysis reported with respect to the large numbers of lithic artefacts recovered during the multiple seasons of excavations, aside from Brassey’s work on the sourcing of certain obsidian assemblages (discussed briefly below). However, there is analysis of the spatial distribution of artefacts on the various house floors and terraces excavated. This analysis represented a considerable advance on previous work relating to artefact distributions, due to the precision at which artefacts were piece-provenienced. The methodology employed at Pouerua used purpose-built spatial software that enhanced the two-dimensional display of artefacts, be it in terms of their typology or material, in relation to excavation units and identified structures such as postholes, hearths, or combinations of such features (Marshall and Fulton 1987). As a result of these recording protocols, detailed discussion on the clustering of artefacts and their reference (or otherwise) to the structure of the houses that they were associated with was undertaken, and it is worth looking at these excavations in a little more detail at this point, especially in light of the material discussed with respect to Ahuahu Excavation Areas 102 -108 (Chapter 5).

The Pouerua Archaeological Project excavations were undertaken during 1984 and 1985 in central Northland, New Zealand. The excavations investigated features on the large scoria cone known as Pouerua and the adjacent landscape, recording archaeology relating to defended and undefended habitation, storage and horticulture (Sutton et al. 2003). Multiple terraces from both defended and undefended contexts revealed evidence for pre-contact and early contact Māori dwellings, and the methods for the recording of the artefact distributions in those contexts is set out in Fulton and Marshall (1987). Chert was the dominant material type, followed by obsidian; however, a wide variety of geological materials were recorded,
including Tahanga basalt, Nelson-Marlborough argillite and gabbro from unidentified sources. The houses that were identified were generally larger than those that will be discussed in the Ahuahu context, and the influence this might have had in the interpretation of the artefact distributions is discussed in Chapter 5. With respect to artefact distributions, the argument was advanced that: “When artefact distribution and structural evidence are closely matched, it generally indicates a single phase dwelling (Marshall and Fulton 1987). This is consistent with the recovery of artefacts from within a thin layer that has not been subject to later disturbance. In instances of multiple occupation, the artefact distribution becomes blurred and the artefacts are deposited through a greater depth.” (Sutton et al. 2003: 178). The application of this is displayed in Figure 3.1 below.

Figure 3.1. Spatial distribution of artefact material at site 261, Pouerua (from Marshall and Fulton 1987, Figure 3).
There is also some discussion concerning the social organisation of space and the distribution of lithics within house wall lines. However, ultimately it is suggested that archaeologically recorded lithic artefact distribution patterns in the Pouerua excavations cannot be interpreted in this light:

“The general point which is emphasised here is that the lithic assemblages do not corroborate the identification of a status differentiation within complex kainga…[T]here are several strong dissociations between dwellings and lithic assemblages. They apply to each of the following parameters:

- Spatial distribution within dwellings
- Composition of assemblages by artefact forms and inferred functions
  [emphasis added]
- Composition of assemblages by material
- Size of the assemblage expressed as the total weight of lithics recovered or the total number of artefacts present.

The last point implies that the assemblage size cannot be used as a reliable indicator of the duration of site occupation” (Sutton 1994: 89).

Anderson and Smith (1996) and Anderson et al. (1996) have been discussed earlier in this chapter, but it is worth noting here the application of the investigation of the lithic artefact assemblages in those reports on the early Shag River Mouth site, as the distribution and quantities of artefacts form the basis of their arguments relating to the categorisation of the material as indicative of sedentary, year-round occupation.
Flaked stone tools are specifically addressed in Chapter 9 of Anderson et al. (1996), and in reviewing the previous excavations undertaken by Teviotdale at the site from 1915 to 1942, they note that Teviotdale deliberately avoided examining or collecting unmodified flakes, which does raise issues concerning the representative nature of the later lithics recovered. Stone artefacts are categorised according to tool and flake typologies (adzes, drill points, cores, blades, flakes and fragments) on the basis of morphological attributes (ibid :77), reflecting a fairly basic functionalist approach. Flake definitions are reliant on the presence of bulb and platform, and therefore would include the “Complete Flake”, “Proximal Flake”, “Proximal Split” and “Complete Split” flake designations adopted in this thesis (see Chapter 6). Only the tool-types designated as “blades” were additionally ascribed using “Medial Flake” and “Distal Flake” categories. Length, width and thickness measurements are recorded for blades and drill points. A concentration of metasomatised argillite flakes at one area (“SM/A”) was cited as evidence for adze manufacture. A strong reliance on local material is revealed, with local silcretes and cherts dominating.

Tying in Rafferty’s (1985) indicators for sedentary occupation, the authors conclude the lithic assemblages “provide clear evidence of functional differences between parts of the site” (Anderson et al. 1996: 101) which, when combined with breadth of lithic sources and functional tool types, “reflects the diversity of activities that would be expected at a continuously occupied village” (ibid: 280). They propose a continuous occupation of “no more than 50 years” (ibid: 281), which does rather beg the question as to their definition of “transience” in terms of sedentary villages.
3.3.5 Sourcing studies, trade and exchange networks

Important early work was undertaken in the 1970s and 1980s concerning the identification and sourcing of materials such as Tahanga basalt, cherts and obsidians by Moore (1976, 1977, 1988) and Best (1976), and Foss Leach led the charge with respect to the application of X-Ray Fluorescence analysis to obsidian artefacts (BF Leach 1977a and b, BF Leach and Anderson 1978). Felgate (1993) and Felgate et al. (2001) applied this technology to Tahanga basalt, but as will be seen below, most focus on XRF analysis in New Zealand has been on obsidian. A number of studies have been undertaken that invariably look at the nature of obsidian acquisition, and how that acquisition could be characterised in terms of direct access to the source (i.e. going and getting it yourself), or trade and exchange of some nature. I will deal only with a few particular papers in this section that incorporate some degree of explicit theory as to the trade and exchange networks or similar, and have at least some technological analysis of the artefacts themselves.

Returning to Pouerua, Brassey’s (1985) MA thesis on lithics from Pouerua has a primary focus on material type, and also sourcing of those materials, particularly obsidian. He looks at sources of lithic materials (the assemblages are dominated by chert and obsidian), then functions of artefacts. There is some discussion of the functions of the lithic artefacts and he notes that different materials were used for artefacts that apparently fulfilled the same function (p 109, 128), and while inter-site assemblages are compared he does not undertake any intra-site distributional analysis, just lithic source and artefact function variability.
In a paper published in *Antiquity* in 2010, Walter *et al.* set out an argument for changes in the nature of long distance exchange of lithics from initial colonisation to the late pre-contact period throughout New Zealand. Given it is one of the most recent papers discussing pre-contact movement of lithics and people in New Zealand, and does provide some (extremely limited) technological analysis of the obsidian assemblages studied, it is worth looking at this paper in some detail at this point.

Drawing on work undertaken by Irwin (1990) in Papua New Guinea, and Sheppard (1993) in Melanesia, Walter *et al.* (2010) attempt to use variations in relative percentages of obsidian artefacts from different obsidian sources in New Zealand, and the increase in the movement in pounamu (New Zealand nephrite) in the later period, to posit “Coloniser” versus “Trader” modes of human interaction. In the coloniser mode (linked to an “early” period prior to AD 1500), it is suggested early exploration, high mobility, direct access to lithic resources and the desire to maintain kin connections explain an alleged “profligate manner…of early use…” (Walter *et al.* 2010: 510) of Mayor Island obsidian – i.e. non conformity with a distance-decay economising model (ibid: 504, 506). In the later (post-AD 1500) period the movement of nephrite throughout the country is seen as evidence for the “…emergence of ‘trader mode’ exchange in late New Zealand prehistory.” (ibid: 511). The argument follows that the later coloniser trade mode evolved as population increased to the point at which “there were sufficient numbers of stable communities in a region to assure demographic and social reproduction without recourse to long-distance networks” (ibid: 511).

There are, however, a number of problems with the data presented in support of the above hypothesis. There is extremely limited discussion of the archaeological contexts for any of
the assemblages analysed, and it is stated most of the obsidian was attributed to source by visual examination in the field. There is no control or consistency in terms of the assemblages compared with respect to excavation or collection techniques and recording, sourcing, and physical measurements of artefacts (maximum length versus flake length (see Chapter 5), weight etc.). Relative abundance values are relied upon in the absence of explicit methodology with respect to sampling strategies and the absolute number of objects in assemblages. As a consequence, it is difficult to evaluate the size distributions of the individual flake assemblages and hence compare them; average flake lengths are the only metrics provided and then only for the Heaphy and Kawatine sites. Based on the fact that there is no statistically significant difference between the mean length of obsidian artefacts from these sites, they are treated as one assemblage, despite the fact that the two sites are 100km apart.

Their adopted measure of economisation would suggest that changes in mean artefact length by assemblage is necessarily the result of more intensive reduction towards the point of exhaustion of utility. For example: “Most of the unused flakes at both sites [Heaphy and Kawatine] are within a usable size range [emphasis added] indicating a similar lack of economising behaviour” (ibid: 505-506). In this model, no consideration is given to taphonomic processes and the influence they might have had on the assemblages, nor changes in the use (cf. Dibble 1987, 1988, 1995) to which the artefacts within the assemblages were being put. The parameters of “usable size range” are not defined, nor is the justification for placing the artefacts within those parameters.
In their conclusion, the authors suggest the “collapse of the early long-distance networks occurred by AD1500” and that “by late prehistory nephrite was circulating through national trade networks” (ibid: 511), begging the question as to the nature of the “collapse” and the difference between early “long-distance networks” and later “national” trade networks. An alternative possibility might just be that the networks neither collapsed nor changed – the relative proportions of material moved through them simply differed.

That Māori maintained long-distance communication and trade networks that were linked to social and demographic drivers analogous to those outlined for PNG and the Pacific is not an unreasonable notion, and is borne out by early ethnographic accounts of Māori society in New Zealand (see for example Nicholas (1817), Wakefield (1845)). However, the data presented in the paper in question falls a long way short of unequivocally supporting this model one way or the other.

Also looking at distribution networks and relative percentages of obsidians from different sources is a series of papers by Moore (Moore 2011, 2012, 2013; Moore and Coster 2015) that can be characterised as primarily “sourcing” papers, in that aside from source proportions, the only metric measured is the weight of artefacts. Moore notes the difficulties in ascertaining much meaning from relative cortical surface areas on obsidian flakes given the varying potential for naturally occurring cortical cobbles. Pre-transport reduction of cobbles to reduce cortical cover and hence the transport of “waste” material is also mooted as a confounding factor; however, this does pre-suppose that (a) such reduction would have any material effect on carrying weight in the case of obsidian cobbles, and (b) that cortical flakes are not in and of themselves useful for tools.
McCoy and Carpenter (2014), however, do incorporate cortex metrics into an argument for the differentiation of obsidian acquisition strategies into direct access, informal trade and exchange, and formal trade and exchange. They argue for increased evidence for trade and decreased evidence for access to Mayor Island obsidian over time. However, the technological analysis undertaken, especially in terms of reduction sequences and informative potential of obsidian cortex percentages (particularly with respect to pre-transport reduction of cortical surface) is limited. For example, as is noted in Chapter 6, meaningful analysis of cortex coverage percentages is contingent on the calculation of surface area to volume ratios (Dibble et al. 2005, Phillips 2012), which are in turn contingent on relatively accurate estimates of original cobble sizes. It is interesting to note, however, that there is some suggestion of a social aspect to the trade of Mayor Island obsidian in that its aesthetic qualities, as much as it's utility for tool-making, may have influenced its trade potential. In the New Zealand context, this is one of the very few examples of the social aspect of trade and exchange being examined with respect to lithics.

Returning to Pouerua, McCoy et al. (2014) also produce an interesting argument when they suggest that changes in the size of artefact and reduction intensity over time from chronologically distinct assemblages could indicate territorial circumscription; however, they do not account for the possibility of different uses of the same area over time, as opposed to direct access changes (e.g. a house terrace being re-purposed for general stone-working or specialised flax processing).

Finally, McCoy and Robles (2015) suggest that the different proportions of Mayor Island versus Taupo Volcanic Zone obsidian artefacts from seven east coast Otago (southern South
Island) sites indicate the possibility that the Māori groups responsible for the creation of these assemblages had differential contact with the North Island regions that produce those obsidians. This assertion suffers from many of the inadequacies outlined above, in that the sample size of obsidian sourced across the seven sites (total object number 383) is extremely small and as the assemblages are all part of museum collections, little or no provenience control or chronological precision was possible.

3.4. Chapter Summary

As noted in the introduction to this chapter, common to all the approaches outlined herein is a lack of focus on taphonomy or formation studies generally, or the association of assemblages with particular archaeological contexts (other than discussions on limitations of sampling strategies, or single interpretations of a working floor such as H. Leach 1979).

Discussions of mobility focus almost entirely on distance from source (and often straight-line distance from source, irrespective of topography and/or coastal travel) with the exceptions of reduction sequence studies of basalt or argillite, which look at the movement of material at certain stages within a chaîne opératoire. The Shag River Mouth study (Walter et al. 1996, Walter and Smith 1996) stands out in its explicit reference to the archaeological signatures of sedentism to testify to “village” designation, yet even this is based on a debatable extrapolation of artefact numbers from density plots from excavations and very limited actual synchronic structural evidence.
Meaningful technological comparison of assemblages is generally superficial: Leach’s similarity study (1969) and Turner and Bonica’s 1994 paper on flake attributes stand out as notable exceptions here.

Much of the analysis is based on single assemblages and is often incorporated (especially in the case of the Coromandel reports, which are often written up some time after excavation by persons other than the excavators) into site reports.

All in all, while there has been a discernible movement towards the incorporation of multiple lines of evidence in the analysis of lithic assemblages in New Zealand archaeology, often the studies are limited by the lack of control over archaeological context and an inability to begin to evaluate the impact of formation process on the assemblages, together with a legacy focus on typology, be it in terms of artefacts or site function. Little work has correspondingly been undertaken with respect to examining the relationship between lithic assemblages, occupation duration and persistent places in the landscape.

In concert with this, Furey (2004) noted three areas of material culture analysis that have been under-represented in New Zealand archaeological research. The first relates to the study of “informal” stone artefacts:
There has been a strong research focus on adze manufacture and use. However stone flakes from excavations have rarely been analysed in detail, despite the fact that they are the most frequently recovered items. (Furey 2004: 50).

The second concerns site formation processes:

The potential for artefacts to inform on post-depositional site history has rarely been addressed. (ibid: 51)

The third area covers spatial analysis of artefact distributions, both intra- and inter-site:

Although stone flakes are frequently found in sites, precise provenience is rarely recorded. Location plotting has generally been confined to metre squares or smaller subdivisions. (ibid: 51).

The following chapters look to address these under-represented areas in the case studies of assemblages from Ahuahu and the Auckland isthmus. The physical and social backgrounds for those two settings are reviewed in Chapter 4.
Chapter 4. Physical Setting of Excavation Zones and Dataset

Background

This chapter provides background and context to the physical and cultural environments from which the lithic assemblages were obtained. It also describes the primary raw material sources that are represented in the lithic assemblages and provides background to their use by Māori in pre-contact times and their archaeological identification.

4.1. Ahuahu background and history

Ahuahu/Great Mercury Island is situated seven kilometres to the north of the northern tip of Kuaotunu Peninsula in the Coromandel region (Figure 4.1). A plot of sea-levels since the last glacial maximum and submarine topography suggests it would have been connected to the mainland until about 6000-7000 years BP. It is the largest of the islands that form the Mercury Group and the only one of that group in private ownership, the others being owned by the New Zealand government and managed by New Zealand’s Department of Conservation as nature reserves. The other much smaller islands in the Mercury Group have a variety of recorded archaeological features, including stone-faced terraces, stone alignments, pits and lithic scatters.

About seven kilometres in length along its north-west/south-east axis and totalling 1,859 hectares in area, Ahuahu is one of the North Island’s larger offshore islands, behind only Great Barrier, Little Barrier, Rangitoto, Kawau and Waiheke Islands in the Hauraki Gulf, and Kapiti Island off the western coast of the Wellington Region.
It is situated within the larger regional context of the Hauraki Gulf/Coromandel/Bay of Plenty Regional zone. Some 80km or 42.5 nautical miles to the south east lies Mayor Island (Tuhua), a major obsidian source (see below). Thirty kilometres to the north-west is Great Barrier Island, also a source of obsidian.

Figure 4.1. Coromandel Peninsula and islands and areas mentioned in the text

Part of the Coromandel Volcanic Zone, Ahuahu can be divided into three distinct physiographic regions (Edson 1973). The northern third is characterised by a mix of andesitic, rhyolitic and basaltic substrates and is currently mostly open pasture of a variety of
gradients encircling a shallow central harbour (Huruhi) that provides sheltered anchorage in most winds. The narrow central region is a low-lying tombolo comprised of Holocene sediments (Hayward 1976), bounded to the north by a two hectare swamp and to the west and east by sandy beaches. The third region to the south comprises two-thirds of the island, an elevated, rugged central plateau of weathered rhyolite substrate that is relatively infertile compared to the northern zones (Furey 1983). This area was colloquially known as the “badlands” in the past (Mizen 1998), but is currently largely covered in mature Pinus radiata forest which was planted in the 1980s. A narrow strip along the southern coast is more fertile and is well fed by several permanently running freshwater streams. It also contains pockets of possibly remnant broadleaf podocarps (kauri, matai) and regenerating manuka and kanuka, amongst limited pasture. In terms of modern vegetation distribution, aside from the aforementioned Pinus radiata forest in the south, pockets of pohutukawa forest or groves also occur along the southern coast and in the tombolo region. The northern zone is predominantly modern fertilised pasture, with occasional pockets of modern replanted native tree species including kauri. Wright (1976) suggests that prior to human contact the southern zone would have seen kauri-dominated forest on the ridges and uplands, totara-dominated forest inland and pohutukawa-dominated forest on extreme coastal regions. A summary of preliminary charcoal analyses undertaken on archaeologically recovered samples from various parts of the island suggest early and sustained land clearance – kauri, totara and matai appear in any quantity only in the very earliest samples and where those species appear later it is likely they were the remnants of structural building timbers rather than firewood collected from forest situations (Holdaway and Wallace 2017). This contrasts strongly with the situation on the nearby Coromandel coast, where substantial kauri forests were present up until the time of European contact and beyond, and archaeologically derived samples see a strong broad-leaf podocarp presence throughout the pre-contact period (ibid).
Average annual rainfall is in the region of 1100 to 1200mm (Edson 1973, Ahuahu 10 year farm records, Chappell 2013: 16) which is lower than the average Coromandel Peninsula figures, due to orographic rainfall in the Coromandel ranges and the predominant westerly winds. June through September are the wettest months, and January and February the driest. Edson (ibid) suggests a microclimate resulting in annual average temperatures 1-3 degrees above that of the mainland North Island, although this has not been confirmed independently and is considered unlikely given the temperatures at similar latitudes on the mainland. The island is slightly windier than the mainland, and this together with the lower than average rainfall no doubt contributed to the impression of a microclimate as suggested by Edson. Irrespective of rainfall, the island is well served with springs and permanently running
streams, with wetlands still present adjacent to the tombolo, in the north at Tamewhera (see below), and near the southern coast.

The island’s approximately 40km of variable coastline provides a wide variety of coastal environments, from sandy beaches and a sheltered shallow tidal harbour to exposed boulder beaches and rocky cliffs. Accordingly, the marine life recorded is considerable and varied, and this would only have been greater in quantity in the period from first Māori settlement to the time of European contact.

Of shellfish species often exploited by Māori in the pre-contact period, cockle (*Austrovenus stuchburyi*), tuatua (*Paphies subtriangulata*), rock oyster (*Saccostrea commercialis*), cat’s eye (*Lunella smaragdus*), Cook’s turban (*Cookia sulcata*) and whelk (*Cominella spp*) are still common, if not in large numbers (Grace and Grace 1976). A brief underwater survey undertaken in the 1970s (Grace 1976) recorded 51 species of marine fish in the waters around the island. Thirty-one of these species are known to have been harvested by Māori using nets, line, spear and trap fishing (Leach 2006) (specific faunal evidence relating to the study assemblages is outlined in Chapter 5).

4.1.1 Traditional Māori accounts and tenure

Ahuahu has a prominent place in traditional accounts of the settlement of New Zealand by the Polynesian ancestors of Māori. It features in the voyaging legends of the Te Arawa, Tainui and Horouta waka, and in the legend of the Ngati Porou ancestor Paikea travelling to New Zealand on the back of a taniwha (or alternatively, a whale – the “whalerider” myth) (Gudgeon 1892, 1895; Smith 1904).
Ahuahu means to mound up (Best 1924), and three traditional explanations for the island being so named are to be found in reviewing traditional accounts. The first is in reference to the legend of Paikea making first landfall on Ahuahu following his voyage from Hawaiki on the back of a taniwha (or whale) and mounding hot sand over himself to warm himself after the long journey (Wilson 1990). It is also noted, however, that the name might also refer to Paikea’s home island, A’ua’u in the Cook Islands (ibid: 52). A third alternative explanation refers to the mounds or rows of soil in which kumara were grown, and the tradition of the Horouta waka provides that it brought kumara to New Zealand and made first landfall at Ahuahu, where kumara was planted for the first time (Gudgeon 1892: 77). Interestingly, this legend also notes that upon landfall one of the wives of the chiefs of the canoe went ashore and brought fern-root (bracken fern) from Ahuahu onto the waka in contravention of protocol. The implication here is that even at this early stage Ahuahu was both occupied and cleared of forest (hence allowing the propagation of bracken fern as a food resource). Both the Tainui and Te Arawa waka accounts of making landfall at Ahuahu also note that it was already occupied. Nevertheless, whatever the reference, the antiquity of settlement on Ahuahu and its association with horticulture is consistently noted in traditional accounts, and archaeological evidence supports this.

Ahuahu currently falls within the rohe (traditional territory) of the Ngati Hei iwi, who trace their genealogy to the navigator and explorer Hei. Together with their related iwi, Ngati Huarere, they assume primary responsibility for the traditional guardianship of the Mercury Group today.
4.1.2 European contact

Captain James Cook and the crew of his ship the *Endeavour* were probably the first Europeans to sight Ahuahu in November of 1769, although there is no mention of the island (or indeed the Mercury Group as a whole) being occupied by Māori in either Cook’s journal (Beaglehole 1974: 204) or that of Joseph Banks, the *Endeavour’s* naturalist. Cook had spent some time on the mainland at Mercury Bay in preparation for the observation of the transit of Mercury, and the *Endeavour* crew’s interactions with local Māori are well documented. Joseph Banks notes that the islands and mainland of the area to the north of Mercury Bay appeared “virtually uninhabited and infertile” (by which it is suggested there was no obvious evidence of gardening) and that only one “town” (village) was noted during that part of the voyage north through the Colville channel and around to the Hauraki Gulf (see Figure 4.1) (ibid: 432). In fact Cook did not name the islands, despite passing relatively close to the coast of Great Mercury, and the Northern Mercury Island group was actually named “Iles d’Haussez” by D’Urville as he sailed past in 1826 (Haussez being a French government minister who had supported D’Urville’s voyages). Again, no mention of the islands being inhabited is included in D’Urville’s record of that part of his voyage.

There is an account of a massacre in 1830 of a small group of Ngati Maru iwi who were on the island as a war party of Nga Puhi moved south through the region. Estimates of the number of people on the island and killed vary between 30 and 100, but there is no mention that the occupation was either large or permanent (Smith 1904, Mizen 1997). Legal title to Ahuahu was acquired by the New Zealand government over the period 1858-1861, and the memoirs of one of the earliest European residents, Cameron Buchanan (Buchanan 1934), record the island being visited periodically by Māori from the mainland around that time (in particular from the Kuaotunu Peninsula to the southwest of Ahuahu) for mutton-birding and
fishing. Buchanan notes that temporary structures were built very quickly (in a matter of hours) by these mainland visitors for the purpose of shelter for the duration of the expeditions (a few days to a few weeks), but there is no reference to any year-round occupation by any groups at any stage. Based on an account related to him by a worker of Ngati Huarere descent, Mizen suggests that permanent year-round occupation of the island ended when it was abandoned some time around AD1680 following a devastating island-wide fire; however, there is no independent evidence to allow an evaluation of the veracity of this claim.

European occupation of the island in the 19th and 20th centuries saw the periodical presence of kauri-gum prospectors, whalers and fishermen; however, the main economic activity was, as it is now, farming (Mizen, 1998). The island was farmed with beef and sheep since the late 19th century, and once supported a large number of goats, although these were removed in the 1980s. The island is currently lightly stocked with sheep and beef cattle; this comparatively low level of stocking has meant that the impact on the archaeological record from stock damage has been relatively low. Recently the island was cleared of rats (both the Polynesian rat/kiore _Rattus exulans_ and the ship rat _Rattus rattus_) and feral cats in a large scale aerial poisoning campaign co-ordinated by the island’s owners and the Department of Conservation; already this removal of human-introduced predators has resulted in a considerable increase in the number and variety of avian species on the island.

4.2. **Previous archaeological research on Ahuahu**

Ahuahu contains every “type” of pre-European site recorded in the New Zealand Archaeological Association Site Recording Scheme (SRS) (Figure 4.3). Limited
archaeological investigation has been undertaken on Ahuahu prior to the Ahuahu/Great Mercury Archaeological Research Project. In 1955 Jack Golson led a team undertaking a preliminary archaeological survey and the excavation of a terrace on Stingray Point Pa (Matakawau), revealing pits containing drainage features and displaying some evidence of reuse over time (Golson 1955). In the early 1970s, Steve Edson spent time on the island undertaking a comprehensive archaeological survey that formed part of his MA research (Edson 1973). In 1983, Louise Furey undertook a detailed survey of the southern zone (the “Badlands”, see above), prior to the planting of the extant Pinus radiata forest. In 1984 Geoff Irwin undertook an excavation of a small pa on the edge of Huruhi Harbour; his excavations revealed a series of occupations and features, tracked the creation of an unusual partially completed ditch and bank defence, and recovered a quantity of lithic and faunal material, none of which has been analysed beyond basic identification (Irwin 2015). In 2009, Furey recorded an exposure of cultural material on White Beach/Oneroa following an unusual storm event (Furey 2009); this became the starting point for excavations at EA1 and is discussed in more detail in Chapter 5.
4.3. Devonport excavation zone background

The Masonic Tavern site (NZAA site reference numbers R11/2404, R11/2517, R11/2518 and R11/2519) was excavated as part of a contract archaeological project prior to redevelopment works on the site of the former Masonic Tavern and carpark in the suburb of Devonport on Auckland’s North Shore (Figure 4.4). Carried out under NZ Historic Places Trust Authority No. 2011-486, the excavations revealed extensive evidence of pre-contact Māori occupation stratigraphically beneath the 19th century historical archaeology. The lithic assemblage that has been included in this thesis for analysis was excavated as part of the first stage of monitoring and rescue archaeology undertaken at the site, and the author was involved in the excavations of both historic and pre-contact material.

The site is located adjacent to the beach known as Torpedo Bay on the southern coast of the peninsula that runs from the suburbs of Takapuna in the north to Devonport in the south on
Auckland’s North Shore. The southern part of the peninsula itself was a virtual island in pre-
contact and early historic times, being connected to the mainland by a narrow strip of land
two kilometres to the north of the Masonic Tavern site. The mangrove swamp that
effectively separated the southern tip of the peninsula from the mainland was reclaimed in the
mid-19th century for a racecourse, and is now a golf course.

Like Ahuahu, average annual rainfall for the region is in the vicinity of 1100mm to 1200mm,
with the months of June, July and August usually the wettest, and January and February the
driest (Chappell 2013: 16).

The Māori name for the area was Takapuna (a name now used only for the suburb at the
northern end of the peninsula), and Torpedo Bay is flanked by two large volcanic cones, Mt
Victoria/Takarunga and North Head/Maungauika, both of which were locations for pa in the
pre-contact period. A further smaller volcanic cone, Mt Cambria/Takaroro, was largely
quarried away in the 19th century. Easy access to fertile volcanic soils and abundant marine
and forest resources would have made the area very attractive to settlement, and there appears
to have been a long history of Māori occupation in the area. Traditional Māori accounts
record Torpedo Bay itself as a landing site of the Tainui voyaging waka (*Te Ara
Encyclopaedia of NZ* online). Radiocarbon dates from a nearby site some 400m away at the
eastern end of the beach (R11/1945) confirm occupation in the 14th and 17th centuries
(Cruickshank 2011, Appendix 3). In the area in and around Torpedo Bay, a full range of
evidence for pre-contact Māori occupation is recorded, including the afore-mentioned pa
evidence (R11/203, R11/2236), middens and stone flake scatters (R11/819, R11/916) and
burials (R11/2403, R11/2986) (Figure 4.3).
4.4. Lithic raw material sources and types

Lithic artefacts of five different geological types were analysed during the course of this research: basalt, chert, obsidian and greywacke. Following analysis to determine specific geological sources (see below), these types were further subdivided into Tahanga basalt, Ahuahu basalt, Ahuahu chert, chert of unknown provenance, obsidian from Mayor Island, obsidian from the Coromandel Volcanic Zone and Motutapu greywacke (Figure 4.5). The differences in flaking quality, durability, cobble size and geological source all had an impact on the type of tools and/or uses to which they were put, and these are described in more detail below.
Figure 4.5. Raw material types. A: Ahuahu (Tamewhera) Basalt, B: Obsidian (Mayor Island), C: Motutapu Greywacke, D: Ahuahu Chert, E: Tahanga Basalt

4.4.1 *Tahanga basalt*

Basalt from the Tahanga/Opito source on the Coromandel mainland, about 8.5 km south of the southwestern tip of Ahuahu (Figure 4.1), is by far the most common basalt artefact in all Ahuahu lithic assemblages. This “technologically superior” (Sheppard 2004: 149) material was used extensively for the manufacture of adzes and other tools throughout northern New Zealand in the pre-contact period (Turner 2000, Turner and Bonica 1994, Davidson 1984, Moore 1976), being very fine-grained for a basalt (it was originally misidentified as a greywacke in the early 20th century (Moore 1976: 80)) and possessing a good combination of flaking properties and toughness.

The material actually originates from six sub-areas within the Opito Bay area (Felgate *et al.* 2001), although no geochemical analysis has yet been undertaken to ascertain whether these sub-sources can be geochemically distinguished from each other. Accordingly, the
overarching term “Tahanga basalt” will be used going forward to encompass all basalt material from the Opito Bay region. As a whole Tahanga basalt is macroscopically distinctive to the extent that Moore noted that “The physical characteristics of the Tahanga basalt are such that the rock type can be recognised among collections of adzes and flakes with some degree of confidence” (Moore 1975:32). The material is dark to medium grey when first flaked; however, it can weather to a light grey over time (Turner 2000: 43).

While Felgate et al. (2001) note that there is some basalt material from the Waitakere Ranges to the west of Auckland that is similar in hand specimen and is thought to have similar flaking properties to Tahanga basalt, no evidence of quarrying or artefactual debris at the source of this Waitakere material has been recorded. Additionally, none of the objects identified macroscopically from archaeological collections and subsequently subjected to XRF analysis have turned out to be from this Waitakere source (ibid: 231), and Turner (2000: Figure 2.2) does not record it as an adze material source in her comprehensive study.

As with Mayor Island obsidian, Tahanga basalt appears to have been moved widely throughout its distribution range early in the immediate post-colonisation period, and it predominates in the North Island as far south as Gisborne at the eastern extremity of New Zealand (Turner 2000). As set out above, it was commonly used in the manufacture of adzes; however, smaller chisels, push-plane tools, drill points and flake scrapers made of Tahanga basalt were also present in the Ahuahu assemblages.
Turner (2000: 41) notes that there is some variation in quality of the material at source, which would have provided an added incentive to undertake roughing-out of adze blanks at the quarry so as to limit failure away from the quarry from invisible internal flaws.

4.4.2 Ahuahu (Tamewhera) basalt

On the northwestern point of the island, adjacent to and beneath the Tamewhera horticultural complex and pa, a basalt/andesite dome is present (Figure 4.2 above, “Mercury Basalts”), and cobbles and outcrops of this material have been used to manufacture basic flake tools. Only present in the Tamewhera and Stingray Ridge assemblages, these flakes are easily distinguished from Tahanga basalt due to their darker colour, coarser grain and large inclusions. No formal tool types have been found that are made of this material and it appears to be a low-grade, easily available material used sporadically.

4.4.3 Motutapu greywacke

In contrast to the Ahuahu assemblages, Tahanga basalt was not present in the Masonic Tavern assemblage; in effect its place was taken by another adze quality material, a greywacke belonging to the Jurassic Waipapa group and known as “Motutapu greywacke” due to its presence in quantity on Motutapu Island in Auckland’s Hauraki Gulf (Davidson 1981). This material is widely available in the form of outcrops and cobbles on Motutapu Island and the southern end of Rakino Island, with Motutapu being the major source (Turner 2000: 43).

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4 Conversely, no Motutapu greywacke artefacts were identified in the Ahuahu assemblages, with the exception of one large water-rolled flake found in the Coralie Bay intertidal zone.
Motutapu greywacke is considerably harder than Tahanga basalt but is more brittle, and as a consequence it is more difficult to work\(^5\) (ibid: 44). It is fine-grained and a distinctive dark grey-green in colour; PXRF analysis of a sample of the Masonic assemblage matched the reference material at the University of Auckland and confirmed its origin. Adzes made from Motutapu greywacke do not appear to have been as widely distributed geographically as those of Tahanga basalt; however, they were certainly not uncommon throughout the Auckland region (Davidson 2011), especially in sites dating to the earlier periods of Māori occupation.

The Masonic greywacke assemblage provided a very similar range of tools, preforms and flakes to some of the Ahuahu Tahanga basalt assemblages.

4.4.4 Ahuahu chert

Despite dominating, or at least featuring prominently in many pre-European lithic assemblages in New Zealand, both excavated and surface-collected, chert\(^6\) has received but a fraction of the attention of obsidian, basalt or argillite artefacts. The reasons for this are two-fold: the inability to source chert to the same degree as the other rock types, through either PXRF analysis or the preparation of thin sections; and the focus of previous technological studies of lithic assemblages on materials connected with formal tool manufacture. Studies

\(^5\) A fact that I could personally attest to when I destroyed a grano-diorite hammerstone attempting to flake an experimental preform from Motutapu greywacke sourced from Rakino Island, at the University of Auckland Māori Studies Department under the guidance of Dante Bonica.

\(^6\) In this thesis I follow Moore’s (1977: 54) suggestion of using chert as a catch-all term for siliceous flakes that may be any one of a number of chert-like rocks, including true chert, flint, jasper, or silicified limestone, but that can only be distinguished by expert geological examination. This also follows conventions for most archaeological studies that incorporate chert artefacts in the North Island that I am aware of – an exception in New Zealand being silcrete blade traditions from the southern part of the South Island (see Leach (1969) for example). Andrefsky (2005: 53) follows a similar approach in the classification of chert. It is submitted that despite subtle geological differences in these siliceous materials their fracture mechanics and utility to Māori were functionally identical.
of obsidian have focussed on movement of this limited resource, and studies of adze-quality basalts, greywackes, argillites and the like have focussed on *châine opératoire*-type analyses of debitage and specialised tool production, in addition to sourcing studies (see Chapters 2 and 3).

The majority of stone tools worldwide are made from cherts (Andrefsky 2009: 78). Chert is distributed widely throughout New Zealand and archaeological material is extremely difficult to source to a particular geological outcrop by any method (Brassey 1985: 35-36, Moore 1977). While more recent studies in North America have made considerable advances in the archaeometric sourcing analysis of chert (see for example Gautier et al. 2012, Parish 2011), no work has been undertaken in New Zealand in an archaeological context. Brassey (ibid) suggests that there are hundreds, if not thousands, of discrete chert sources throughout the country, and Moore notes that large portions of the Coromandel Peninsula and offshore islands (including Ahuahu), Auckland and Northland regions contain chert-bearing formations. It is a tougher, less brittle material than obsidian, but not quite as sharp when freshly flaked.

Throughout New Zealand, the most common formal tool type recorded made of chert is that of the small (often less than 40mm in maximum dimension) flaked triangular drill point, which was hafted to a wooden drill-shaft for use. These points are often found in greater numbers in early sites where they are commonly associated with one-piece fish-hook and bone ornament manufacture (Davidson 1984, Furey 2002: 103).
Ahuahu has several, unexhausted, sources of chert that have been identified by pedestrian survey during the course of the current archaeological research being undertaken on the island (Figure 4.2 above). Additionally, highly siliceous nodules and fragments of petrified wood are found around the coast, as well as in archaeological deposits.

The chert found on Ahuahu ranges in colour from translucent white, through various shades of yellow, red, and brown, to a dark grey material so fine-grained it is sometimes initially confused with obsidian. Often these colours are combined to varying degrees in individual nodules and artefacts. Some of the chert appears in seams of material and as a consequence is largely non-cortical, some is found in large nodules of varying degrees of cortical cover, and some (especially in the case of the cobbles of translucent white material located on the northeastern coast of the island) are found as completely cortical cobbles ranging in diameter from 100 to 250mm.

The chert artefacts analysed as part of the Ahuahu assemblages in this thesis have been assumed to be overwhelmingly from the island sources, following Moore: “It may be reasonably safe to assume that [New Zealand archaeological] sites located in or close to a major chert-bearing region… will contain material obtained almost exclusively from that region.” (Moore 1977: 73).

The Ahuahu chert artefact assemblage will be described in detail in the following chapters; it can at this stage be said to be fairly typical of archaeological assemblages of chert found in the Coromandel region, with a mix of drill points, large numbers of unretouched and retouched flakes, and cores. The limited number of chert artefacts excavated and analysed as part of the Masonic assemblage also display a similar degree of variability in colour as the Ahuahu assemblage described above, but for the reasons already outlined, no attempt has been made to ascribe any particular source to the artefacts. It should be noted, however, that
assuming Moore’s map of chert-bearing formations in the Northland-Auckland-Coromandel region is accurate, no chert occurs naturally on the central Auckland isthmus itself and thus all material recovered in Masonic excavation must be assumed to have come from distances of at least 15-20km overland, or 12km over sea, from the site. Regardless, it would seem it would not have been as readily available as the sources on Ahuahu were for the occupants of Ahuahu.

4.4.5 *Obsidian*

Compared to the islands of Eastern Polynesia from where the ancestors of Māori originated, New Zealand’s North Island has an abundant, easily extractable obsidian resource (Sheppard 2004: 147). As a consequence, it is nearly ubiquitous in archaeological sites the length and breadth of New Zealand, and appears to have been transported large distances within a short period of initial colonisation (ibid, Moore 2012, Walter *et al.* 2010, Furey 2002, Davidson 1987).

A form of volcanic glass, obsidian is brittle when compared to chert or basalt, yet produces extremely sharp flakes when knapped. There are at least 19 (Moore 2012) and possibly up to 27 (Sheppard 2004, Sheppard *et al.* 2011) geochemically distinct obsidian sources in New Zealand, originating from four geological source regions (Moore 2012), all of which occur in the northern half of the North Island, from the Taupo volcanic zone through to Northland. It is likely that most, if not all, “archaeologically significant” sources have been discovered (Sheppard 2004: 151), although as survey and excavation continues, further sources may come to light.
The largest single source of obsidian in New Zealand is located on Mayor Island (Tuhua), 26km off the northern Bay of Plenty coast, and 80km to the south-east of Ahuahu. Mayor Island obsidian (MIO) is a distinctive olive-green colour through transmitted light and is one of the best, if not the best, quality obsidians (in terms of conchoidal flaking properties). It is present in outcropping seams in coastal cliffs, large boulders and colluvial cobbles, and occurs in quantity in Ahuahu assemblages (see Chapter 5). Also present in Ahuahu assemblages are obsidian artefacts from Coromandel sources within the Coromandel Volcanic Zone (CVZ) (Figure 4.1), with the majority from the Cook’s Beach and Hahei coastal sources and a very small minority from the Whangamata (coastal) and Maratoto (inland Coromandel) sources. The Cook’s Beach and Hahei sources are an easy sea journey from Ahuahu (Great Mercury Island), being approximately 13.2 and 12.0 nautical miles by sea from Ahuahu’s southern coast – a distance that could easily be travelled in around three hours in calm weather travelling at a conservative speed of four knots. Mayor Island is some 42.6 nautical miles from Ahuahu and as such would likely be a journey of at least two days by sea, although there are numerous safe landing beaches on both the mainland and offshore islands that would have facilitated a staged journey. Whangamata is about 34 nautical miles south of Ahuahu on the Coromandel coast, and as such would also probably have been a two-day waka voyage.

Coromandel Volcanic Zone obsidians are grey in colour with varying degrees of flow-banding and phenocryst or spherulite inclusions, and as such are easily and accurately distinguishable visually (without the aid of magnification) from Mayor Island obsidian (Moore 2012: 20). They occur primarily as colluvial or detrital cobbles at source or in creek
beds (Moore 2012: Table 1). Somewhat surprisingly, there appears to be no material from Great Barrier Island in the assemblages studied herein, despite its location only 30 km to the northwest of Ahuahu.

Approximately two-thirds of the Masonic assemblage consists of Mayor Island obsidian, with the remainder grey through transmitted light. PXRF analysis of a sample of the grey material from the Masonic assemblage confirms a roughly 50/50 split between Coromandel Volcanic Zone sources (primarily Cook’s Beach and Hahei) and Great Barrier Island sources.

Ethnographic accounts note the use of obsidian artefacts for flax cutting and processing, butchery and ritual scarification following deaths and hair-cutting, with these last two activities being highly *tapu* (sacred) (Maning 1875, White 1875). Other uses would have included bone-working, wood-working and stone-cutting (Bonica pers comm, 2015). Attribution of tool function to individual obsidian flake artefacts through the analysis of use-wear and retouch is problematic (see Frederickson and Sewell 1991, discussion in Chapter 5), but the presence of *Pittosporum sp.* gum residue on certain flakes would appear to confirm the wood-working aspect at least.

Occasionally specific tool forms or ornaments of obsidian are found (the author is aware of one obsidian ornament in the Mizen collection of artefacts held at the Auckland War Memorial Museum), but these are very much the exception; the overwhelming majority of the obsidian from the Ahuahu and Masonic assemblages is broken or complete unretouched or minimally retouched or utilised flakes and cores.
4.4.6 *Other lithic material*

It is useful at this point to note the other known minor sources of artefactual material recovered as part of the Ahuahu assemblages studied.

A handful of small flakes of material that have been confirmed through comparison with University of Auckland reference material as originating from the Ohana argillite quarry on D’Urville Island in the Nelson-Marlborough area of the South Island have been found in the White Beach, Stingray Ridge, and Te Mataku assemblages. Too small in number to undertake any meaningful comparative analysis, these flakes, at least two of which were polished and likely originating from the blade of an adze, nevertheless give some idea of the distances lithic material was being moved to get to Ahuahu. D’Urville Island is 500km in a direct line south-west of Ahuahu and obviously a considerably greater distance over sea and land.

A number of complete and broken sandstone files and abraders (*hoanga*) have been found in all the assemblages studied; the sandstone is of unknown origin, although Bonica (pers comm 2015) has advised that he has seen very similar material naturally occurring in the Raglan area in the west coast of the Waikato region of the North Island.

A very limited number of small hammer stones have been found in all the excavations undertaken on Ahuahu; their origin has not been considered and apart from noting the presence of percussive edge damage, no further analysis was undertaken.
Finally, no artefacts of pounamu (New Zealand nephrite, or greenstone) have been excavated from the Excavation Zones that provide the lithic assemblages for this study. At least two pounamu artefacts, a small adze fragment and an ear pendant, are held in the Auckland War Memorial Museum as part of the Mizen collection of artefacts found over a period of 40 years by the previous owner of Ahuahu, but other than those, it appears that pounamu barely entered the archaeological record on Ahuahu.
4.5. **Chapter summary**

This chapter has detailed the cultural and physical environments from which the stone artefact assemblages analysed in the following chapters were obtained. It has detailed the previous archaeological work undertaken on Ahuahu and set the broad archaeological context for the Devonport Excavation Zone. The lithic raw materials and their geological sourcing have been outlined and the following chapter will look in more detail at the Excavation Areas within each Excavation Zone, and set out the excavations and the spatial analysis of the distribution of the stone artefacts recovered.
Chapter 5. Excavation Zone and Area Descriptions

5.1. Excavation zone background

This chapter provides detailed descriptions of the excavation contexts from which lithic material was excavated to form the assemblages analysed herein. There are five geographical areas (Excavation Zones): four on Ahuahu (Figure 5.1) and one from the mainland of the North Island in the suburb of Devonport on Auckland's North Shore, on the edge of the Hauraki Gulf (Figure 5.2). The Ahuahu Excavation Zones were investigated as part of the Great Mercury Island/Ahuahu Archaeological Research Project, a joint research project undertaken by the University of Auckland and the Auckland War Memorial Museum (Heritage New Zealand Authority Application 2012). The Devonport Excavation Zone was excavated as part of a commercial archaeological dig prior to the redevelopment of the property (further details below).
The Excavation Zones are from a variety of topographical, temporal and typological contexts, as is discussed below. Each Excavation Zone contains one or more excavation trenches (Excavation Area, or EA). On Ahauhu, the Oneroa Excavation Zone on the west coast of the tombolo in the middle of Ahauhu contains EA1 to 5. The Stingray Ridge Excavation Zone immediately to the north of the tombolo contains Excavation Areas 12, 17, and 26. As Excavation Areas 12 and 17 were merged during the course of the excavations, these have been combined to become EA12-17 for the purpose of this analysis. However, as is discussed in more detail below, the lithic assemblage from EA12-17 was divided into two analytical units, EA12-17 Upper and EA12-17 Lower, based on stratigraphic interpretation of depositional episodes. The Te Mataku Excavation Zone on the east coast of Ahauhu, to the north of the tombolo, contains Excavation Area 51. Finally, Tamahera Excavation Zone, on elevated ground in the northwest of Ahauhu, contains Excavation Areas 102, 103, 106 and 108. On the mainland, the Devonport Excavation Zone contains the Masonic Excavation Area.

Figure 5.2. Devonport Excavation Zone
5.2. **Excavation methodology**

All Excavation Areas were excavated by hand, although in the case of the Masonic Excavation Area this was done following the removal of an asphalt carpark and historic outbuildings by mechanical means. For the Ahuahu Excavation Zones, all archaeological features, artefacts above 20mm in maximum dimension and individual pieces of thermally affected rock above 20mm in maximum dimension were recorded in situ using a Leica TS15 robotic total station. For the Devonport Excavation Zone all archaeological features and artefacts above 20mm in maximum dimension were recorded in situ using a Leica GPS 900 total station. For both Excavation Zones, all features, individually recorded artefacts and sample areas were given unique identifier numbers for subsequent incorporation into GIS coverages.

5.3. **Spatial analysis**

The spatial distribution of the artefacts and the digital representations of excavation areas, archaeological deposits and features were plotted and analysed using ArcGIS ArcMap version 10.4 and ArcScene version 10.4 Geographic Information System spatial analysis software. Data from the technological analyses undertaken above were imported and appended to the attribute tables for the GIS artefact distribution shapefiles created by the digital recording teams for the Ahuahu Research Project in the field, and from the excavation team from the Masonic Tavern excavation. Cluster and outlier analysis was undertaken using the Cluster and Outlier Analysis (Anselin Local Moran's I) (Spatial Statistics) tool with $p$-values set at 0.05. Cluster and outlier analyses were run on all quantitative metrics for the assemblages, but only the category “maximum artefact length” returned any significant results and as such only those are reported on the analyses to follow.
Excavation Area 1 (EA1) is located on the foreshore of the largest sandy beach on Ahuahu, and was opened over NZAA site record number T10/944, consisting of a layer of eroding cultural material recorded by Furey in 2009 after an unusual storm event exposed the archaeology by destroying the dune face through wave action (Furey 2009) and cutting the dune back approximately three metres. The beach itself is known as Oneroa or White Beach and is located on the western side of the tombolo zone in the middle of the island. A gently sloping beach, it is about one kilometre in length and is bounded to the north by the large Pa NZAA Site Record Number T10/169, known as Stingray Pa, and a small creek draining from the swamp at the northern extremity of the tombolo.

EA1 was excavated over two weeks in two separate expeditions in February and June 2012. Upon excavation down through the overburden to the cultural horizon, it appeared that the archaeological material related to a single cultural deposit, being a mix of charcoal, thermally affected lithic material,
lithic artefacts and faunal remains consisting of bone and shell. The excavations revealed an apparently in situ fire feature consisting of a dense concentration of charcoal and thermally affected rocks in the centre of the trench, and a row of four small stakeholes along the northeastern profile. The function of the stakeholes is uncertain, but potentially could have formed part of a small wooden fence, wind-break or drying rack.

A mix of bone and shell material was recovered. Of the identifiable shell, both rocky shore and soft shore species were present; given EA1’s proximity to both environments, this was not surprising. A small amount of intact and identifiable bone material was analysed and revealed the presence of at least two species of pinniped (Southern fur seal *Arctocephalus forsteri* and New Zealand sea lion *Phocarctos hookeri*) and the vertebra of a small cetacean (likely a long-finned pilot whale *Globicephala melas edwardii*), notable for an obvious butchery mark that must have been created by a large adze. Smith (1989) argues that pinniped species were regionally extinct in the Coromandel region due to overhunting and the exploitation of breeding colonies by the end of the 15th century AD in this region. Identifiable fish species included snapper (*Pagrus auratus*), kahawai (*Arripis trutta*), butterfish (*Odax pullus*) paketi (*Notolabrus celidotus*) and leatherjacket (*Parika scaber*). Two pieces of moa bone were recorded, but neither was diagnostic to the genus level. Both pieces of moa bone showed evidence of working, so whether the material represented purely industrial bone or the worked remnants of an individual or individuals consumed on site is moot, but given the radiocarbon dates (see below) and the generally accepted timing of regional extirpation for moa (early to mid-fifteenth century AD (Anderson 2003)), the former seems more likely. Three radiocarbon dates have been obtained from the cultural deposit. It should be noted at this point that for all radiocarbon sequences plotted for all the Excavation Zones, a TPQ date of 1800AD has been assumed and incorporated into a Bayesian model using OxCal v 4.3.2 (Bronk Ramsay 2009). No historic (European) material culture has been found in any of the assemblages studied herein, and there is no evidence of any other European archaeology that would suggest that any of the Excavation Zones saw interaction with Europeans, which could have been expected post 1800AD. As such, the date of 1800AD was chosen, being 30 years after the visit of Cook to the area, and the very beginnings of
more frequent European contact. Two of those dates place the accumulation of cultural material in the 15th century (Figure 5.4), and one straddles the period between 1450 to 1640 CE, due to the variability of the Southern Hemisphere calibration curve at this period (Higham and Jones 2004). It is suggested that the overlap of this date probability curve with the curves of the other two narrower curves, and the nature of the faunal material recovered, lends itself to an interpretation that the cultural material was accumulated during the fifteenth century AD, and not after 1500 AD.

![Graph showing radiocarbon dates for EA1.](image)

**Figure 5.4. Radiocarbon Dates for EA1**

Over 2000 lithic artefacts were recorded *in situ*. The overwhelming majority were artefacts of Tahanga basalt, which were also considerably larger than the artefacts of other lithic materials (Table 5.1). Over 120 Ahuahu chert flakes 20mm in maximum dimension or above were also recovered, together with 85 obsidian flakes of over 20mm from both Mayor Island and Coromandel sources. There is little difference in the average maximum dimensions between the non-Tahanga basalt artefacts (Table 5.1). In addition a large quantity of microflakes and fragments (predominantly basalt) were collected from sieved samples.
<table>
<thead>
<tr>
<th>EA 1 Stone Artefact Raw Material</th>
<th>Artefacts (n)</th>
<th>Total Arтеfacts weight (g)</th>
<th>Average length (mm)</th>
<th>Std.Dev. length</th>
<th>Average width (mm)</th>
<th>Std.Dev. width</th>
<th>Average thickness (mm)</th>
<th>Std.Dev. thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tahanga Basalt</td>
<td>1535</td>
<td>15,754.53</td>
<td>41.64</td>
<td>15.81</td>
<td>27.65</td>
<td>11.50</td>
<td>6.96</td>
<td>4.92</td>
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<tr>
<td>Ahuahu Basalt</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Ahuahu Chert</td>
<td>124</td>
<td>2,175.26</td>
<td>36.05</td>
<td>14.38</td>
<td>23.72</td>
<td>9.84</td>
<td>9.08</td>
<td>5.08</td>
</tr>
<tr>
<td>Mayor Island Obsidian</td>
<td>57</td>
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<td>35.09</td>
<td>12.90</td>
<td>22.70</td>
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<td>7.44</td>
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<tr>
<td>CVZ Obsidian</td>
<td>28</td>
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<td>16.94</td>
<td>24.23</td>
<td>9.98</td>
<td>8.40</td>
<td>4.20</td>
</tr>
</tbody>
</table>

Table 5.1. EA1 Artefact (n), total weight, average maximum length, width and thickness by raw material type
5.5. **EA1 spatial analysis**

5.5.1 *Distribution of Tahanga basalt artefacts in EA1*

EA1 was a 12.27 m$^2$ excavation in the foredune of the longest sandy beach on Ahuahu, in which the majority of the archaeological material was recovered from a seemingly single continuous archaeological deposit about 25-35 cm deep, some 1.5 m below the current surface of the dune. As set out above in Table 5.1, the lithic assemblage was dominated by Tahanga basalt artefacts and their two-dimensional distribution and density in the deposit is shown in Figure 5.5 below. As can be seen from the figure, the basalt artefacts are distributed widely throughout the excavation area, with clusters of larger than average artefacts (yellow dots) in the southern extension and a cluster of smaller than average artefacts (green dots) along the northeastern baulk, proximate to the row of stakeholes present in the northeastern baulk of the Excavation Area. Tahanga basalt densities were lower in the centre of the excavation, corresponding with the position of the *in situ* hangi feature and a concentration of fire cracked rocks. Accordingly it can be observed that the planar spatial distribution of basalt bears some correspondence in terms of density to the other archaeologically recorded features.
5.5.2 Distribution of Chert Artefacts in EA1

The 2D distribution of chert artefacts shows similar concentrations of the basalt towards the northeast of the excavation. However, there are considerably fewer chert artefacts in the southwestern quadrant and towards the eroding edge of the excavation area. No significant clustering occurs when analysis by maximum length is undertaken.
5.5.3 Distribution of Mayor Island obsidian in EA1

The distribution of Mayor Island obsidian largely mirrors that of the Tahanga basalt. No significant clusters based on maximum artefact length were noted. There appears to be more obsidian at the southwestern corner of the excavation area when compared to chert. However, there is little else to distinguish the obsidian patterning.

Figure 5.6. Spatial Distribution of EA1 Chert Artefacts, density plot and cluster analysis for maximum artefact length
5.5.4 Distribution of Coromandel Volcanic Zone obsidian in EA1

As noted earlier there were few Coromandel Volcanic Zone obsidian artefacts recovered in the EA1 excavation. Greatest comparative densities of artefacts were recorded in the northern and southwestern areas, but no significant clustering based on maximum artefact length was recorded.
Distributions of the artefacts recorded as tools and cores are displayed in Figure 5.9. Artefacts are defined as tools or cores in accordance with the methodology set out in more detail in Chapter 6, and these attributes and definitions apply to all the subsequent spatial analyses to follow. Cross-checking with the three-dimensional distribution of artefacts confirms that the Tahanga basalt and Mayor Island Obsidian tools in close proximity to the hangi (in-ground oven) area are stratigraphically above, not in the hangi feature. No divergent patterning with respect to the location of cores (including Tahanga basalt adze preforms) is present.
5.5.6 Vertical stratigraphic Representation – Tahanga basalt

Figure 5.10 portrays a three-dimensional representation of the distribution of Tahanga basalt in EA1. Additionally fire cracked rocks (FCR) have been added in the form of small pink dots to provide some indication as to the spatial distribution of anthropogenic stone non-artefact material. The Tahanga basalt distribution suggests that what appeared at the point of excavation to be a continuous cultural deposit is the result of at least two depositional episodes, as evidenced by the gap in vertical distribution of Tahanga basalt artefacts circled in red in Figure 5.10. No statistically significant differences were apparent between any of the average measured metrics for any combination of potential deposit assemblages, however. The earlier depositional episode appears to be related to a hangi and a concentration of in situ fire cracked rocks. The second and later depositional episode may relate to more generalised dumping of material subsequent to the cooking activity.
5.5.7 EA1 summary

EA1 represents an accumulation of cultural material from the 15th century AD. The excavated material stratigraphically presented in the field as a more or less continuous archaeological deposit of thermally affected rock and a lithic assemblage dominated by Tahanga basalt artefacts. However, post-excision analysis of the three-dimensional distribution of the thermally affected rocks and lithics suggest that multiple individual depositional episodes can be discerned. Cluster analysis of lithics based on maximum dimensions did not reveal any clustering of artefacts that would imply differential manufacturing or discard processes were represented. The high density of material in a relatively small excavated area suggests repeated dumping of material within a relatively constrained spatial boundary, raising the possibility that the archaeological material is in effect a kind of “lithic midden” and as such should be viewed as a component of a larger landscape occupation (as opposed to being related to a short term depositional episode representing a typological/functional designation of a lithic “working floor”). As such the
lithic artefact assemblage may represent an accumulated time-averaged deposit that has resulted from repeated use of a particular location for the discard of material, albeit within a specific chronological window. Such repeated use and accumulation of relatively homogenous material in terms of artefact size (within the parameters of the various raw materials) suggests that the combination of spatial and technological analysis of the three-dimensionally provenienced material can provide insights into the accumulation process.
5.6. **Excavation Areas 2-5**

Approximately 70m to the northeast of EA1, a 30m x 30m geophysical survey was undertaken on a flat terrace above a zone of eroding lithic material. Following the identification of a number of anomalies, a series of four 1x1m and 1x2m test-pits was opened over selected anomalies and anomaly-free areas. These test pits were designated Excavation Areas 2 to 5. One hundred and twenty-seven stone artefacts of all raw material types were recovered from the four Excavation Areas.

In addition to the stone artefacts, a very small amount of non-diagnostic fish bone and shell was recovered, mainly from EA2. Individual postholes were recorded in EA2 and EA5, the posthole excavated in EA2 being substantial (25cm in diameter) and dug into the hard paleodune present some 30cm below the ground surface. An *in situ* hangi feature was recorded in the southeastern quadrant of EA4 that was subsequently dated to the mid-17th century AD.

Given the nature of the excavation methodology (relatively small non-contiguous units), it is difficult to evaluate the number of depositional episodes across the terrace that the archaeology represents. The archaeology could be interpreted as relating to a single occupation period, as there was no stratigraphic evidence or evidence of intercutting or overprinted features to suggest multiple repeated occupations. Caution must be noted in this interpretation, however – the more limited excavation areas and shallow nature of the archaeology could be masking repeated occupations, the signatures of which were too subtle to distinguish. There is certainly no evidence other than the stratigraphic profiles to confirm that the occupation evidence from each or any Excavation Area on this terrace was contemporaneous.
Analysis of the spatial distribution of artefacts in the EA2-5 Excavation Area is severely limited by the small size and relative dispersal of the excavation units, so as a consequence such analysis was not undertaken for this dataset. As was the case with EA1, the Tahanga basalt artefacts were on average the largest, followed by Coromandel Volcanic Zone obsidian (albeit with a small $n$ of 10) (Table 5.2). Mayor Island obsidian and chert average maximum dimensions are virtually identical.

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**Figure 5.11. Excavation Areas 2-5 on top of the dune**

**Figure 5.12. Radiocarbon Dates for EA2-5**
<table>
<thead>
<tr>
<th>Artefact</th>
<th>Total Artefacts</th>
<th>Average length</th>
<th>Std.Dev. length</th>
<th>Average width</th>
<th>Std.Dev. width</th>
<th>Average thickness</th>
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<tr>
<td>Tahanga Basalt</td>
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<td>38.52</td>
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<td>20.00</td>
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Table 5.2. EA2-5 Artefact (n), total weight, average maximum length, width and thickness by raw material type
5.7. Stingray Ridge Excavation Zone – EA12-17 Upper, EA12-17 Lower and EA26

Excavation Areas 12, 17 and 26 were excavated as part of a mix of 1m x 1m test pits and larger area excavations undertaken on the top of a ridge to the east of Stingray Point Pa (T10/169) (Figure 5.13). The ridge is broad, bisected by a gravel road, and slopes gradually to the west. Its southern edge is a steep, eroding face that drops to the swamp and back-dune pasture below. The area was excavated over four weeks in November 2012 and February 2013 following the identification of a significant amount of eroding lithic artefacts and thermally affected rock on the southern face of the ridge. No archaeological material had previously been recorded on top of the ridge, and there were no obvious surface features such as depressions, terraces or stone rows indicating archaeological remains. A limited series of initial test pits totalling 6m$^2$ (within EA12) revealed the presence of buried lithic artefacts, postholes and a drain feature within a relatively simple stratigraphic profile that consisted of topsoil, a mixed layer containing the bulk of the artefacts and thermally affected rocks, and a basal layer of firm clay substrate. The area was then investigated more extensively, focussing on determining the extent and direction of the drain feature and sampling a wider area of the ridge.

The drain was revealed to originate from the southern end of a shallow rectangular pit feature whose floor had been dug a small way into the sterile clay substrate. It has been interpreted as a kumara storage pit. The kumara pit measured 5.8m by 2.5m and was orientated NW-SE, with a buttress on the northeastern side. The floor of the pit sloped gently south-eastwards towards the drain, and contained two central post-holes in the northwestern half. The drain ran for at least 7m in a south-easterly direction from the southeastern end of the pit. Microstratigraphic analysis of deposits in the base of the drain suggest that it had functioned repeatedly and effectively to remove water from the pit. It is possible the pit had been
deliberately infilled, as the pit fill was difficult to distinguish from the general mixed stratigraphic layer, although the patterning of stone artefacts recovered from the fill and the area above it, both in terms of the relative sizes and proportions of raw material and their spatial distribution, suggested two different depositional episodes (see chapters 6 and 7). A fire feature adjacent to the pit was radiocarbon-dated to the late 17th to 18th century AD, and a further fire feature on the base of the pit was dated to the 16th century AD, suggesting at least two phases of occupation and use of the location (Figure 5.17). Material from the drain and the fill of a scarp that is possibly the remains of a further, more eroded pit feature (based on its orientation and size) were dated to the late 14th to early 15th century AD, implying human activity on the site well into the early period of Māori settlement of New Zealand (Figure 5.17).

Further excavations revealed little in the way of structure, save for EA26, which contained a rectangular bin-pit 1m long by 0.7m wide and about 0.8m deep. Again this pit seemed to have been deliberately infilled. Also revealed in EA26 was a trench dug for a plastic water pipe that serves the habitation on other parts of the island.

The stratigraphy was deepest in the southeastern baulk of EA12, closest to the edge of the eroding face of the ridge, with the mixed layer being almost 0.5m deep at this point. It is possible that this depth reflects the original depth of the overburden above the clay substrate over the rest of the ridge, and that the thinner layer further to the north is the result of surface deflation and possible stock damage, although stone artefact fragmentation ratios do not suggest stock damage to the artefacts themselves was a major factor (Chapter 7, Table 7.3 to 7.6 inclusive).
Overall, occupation or activity on the Stingray Ridge Excavation Zone of at least three periods, dating from early in the New Zealand sequence to the late pre-contact period, is suggested by the excavations and radiocarbon dates. Activity associated with cooking
appears to be later than the activity associated with the pit features, and the presence of a concentration of charcoal in the base of the EA17 pit suggests that the pit was dug before 1600CE. The early dates from material associated with the fill of the drain and possible eroded pit scarp are difficult to interpret in relation to those features given they could be material from an earlier activity that has been subsequently deposited in these features through natural processes; suffice it to say, these dates simply confirm that anthropogenic burning in this region of some description was occurring or had occurred by the 14th century.

Stratigraphically, the EA12-17 pit complex has been divided into two deposits. The first relates to the fill of the pit and the drain and the second to the overburden capping both the pit fill and the natural subsoil that extends beyond the pit outline and across the rest of the excavation area. As these two deposits appear to relate to two separate depositional event processes, I have divided the artefactual material for analysis accordingly. The C14 dating corroborates this division: a date from a fire feature in the layer above the pit is more tightly dated to the late 17th century, with no overlap of the probability distributions between EA12-17 Upper and EA12-17 Lower at two standard deviations.

Figure 5.15. Storage pit, T10/1114, looking south. The drain exits in the central south wall.
Figure 5.16. EA26 showing bin pit in foreground and diagonal water pipe trench capped with white clay

Figure 5.17. Radiocarbon Dates for EA12-17 Upper and Lower
5.8. **Excavation Areas 12-17**

The EA12-17 Excavation area is the second largest Ahuahu areal excavation and as noted earlier has been split into two deposits for the purpose of analysis: EA12-17 Upper, which comprises the layer of cultural deposit immediately below the topsoil, and EA12-17 Lower, which comprises the deposit that forms the fill of the pit and drain feature. Along with the Tamewhera Excavation Zone, EA1217 Upper is also the only deposit to contain artefactual Ahuahu Basalt material (as opposed to thermally affected fire cracked rocks of that material). The spatial distribution of stone artefacts in these two deposits is discussed in turn, beginning with the EA12-17 Upper layer.

5.9. **EA12-17 Upper artefact spatial distribution**

The EA12-17 Upper lithic assemblage contained broadly similar numbers of basalt and chert artefacts, with the basalt artefacts being a combination of Tahanga and Ahuahu sourced material. The Tahanga basalt artefacts were on average largest and, while the obsidian artefacts were smallest when compared to other materials, there was a difference in average artefact sizes with respect to the two different types of obsidian, with the Coromandel Volcanic Zone artefacts being on average heavier, longer, wider and thicker than the Mayor Island artefacts (Table 5.3).

<table>
<thead>
<tr>
<th>EA12-17 Upper Stone Artefact</th>
<th>Artefacts (n)</th>
<th>Total Artefacts weight (g)</th>
<th>Average length</th>
<th>Std.Dev. length</th>
<th>Average width</th>
<th>Std.Dev. width</th>
<th>Average thickness</th>
<th>Std.Dev. thickness</th>
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<td>19.38</td>
<td>5.84</td>
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</tr>
</tbody>
</table>
Table 5.3. EA12-17 Upper Artefact ($n$), total weight, average maximum length, width and thickness by raw material

5.9.1 EA12-17 Upper Tahanga basalt

The Tahanga basalt from this layer represents one of the lower densities per square metre of the Ahauhu Excavation Zones (Figure 5.18). The majority of the Tahanga basalt artefacts are found in the southern part of the deposit (EA12). Two small clusters of Tahanga basalt artefacts overlie and straddle the boundary of the pit feature; while they do not show any patterning with respect to maximum length, their position would support the proposition that the distribution of material in this layer is not constrained by the pit structure. Very little Tahanga basalt is found in the centre of the excavation zone, to the north and south of the postholes recorded outside the pit.

Figure 5.18. EA12-17 Upper basalt artefact distribution, density plot and cluster analysis by maximum length of artefact.
5.9.2 EA12-17 Upper chert

The basic distribution of chert artefacts in EA12-17 Upper differs from that of the Tahanga basalt, and shows a slightly greater density per square metre (Figure 5.19). The chert artefacts are distributed more evenly across the top of the pit and are also dense adjacent to a small fire feature found in this level in the northeastern corner of the excavation zone. They are also comparatively densely distributed immediately to the south of the line of four postholes running east-west in the middle of the excavated area, and this density also shows a cluster of artefacts with significantly higher maximum lengths (Figure 5.19). Given the overall distribution of the chert material towards the upper vertical extent of this stratigraphic layer (see Figure 5.30 below), this clustering could be the result of a unique depositional episode relating to the use of larger than average artefacts. The distribution of chert tools (see Figure 5.24 below) is also consistent with this hypothesis. Chert artefacts are relatively less dense in the southern quadrant (EA12) when compared to Tahanga basalt.

Figure 5.19. EA12-17 Upper chert artefact distribution density plot and cluster analysis by maximum length of artefact.
5.9.3 *EA12-17 Upper Mayor Island obsidian*

The density per square metre of Mayor Island obsidian artefacts is the lowest of the Ahuahu assemblages at 1.36/m²; however, the EA12-17 Lower and Tamewhera Mayor Island Obsidian assemblages also record densities below 2/m². Mayor Island obsidian artefacts are distributed fairly evenly across the excavation zone, with an area of lower density in the centre where densities of other artefacts have already been shown to be correspondingly low. The limited clustering of material by maximum length occurs in the northern quadrant over the pit structure, but given the number of artefacts in this assemblage it is difficult to draw many conclusions from this.

Figure 5.20. EA12-17 Mayor Island obsidian artefact distribution density plot and cluster analysis by maximum length of artefact.
5.9.4 EA12-17 Upper Coromandel Volcanic Zone obsidian

Coromandel Volcanic Zone obsidian density per square metre is about average for the Ahuahu Excavation Zones (Figure 5.21); however, proportionally more artefacts appear in the central area of the excavation zone when compared to the other raw material distributions. The absolute number of Coromandel Volcanic Zone artefacts is not high, however; and is a lower figure than that for chert artefacts. As was the case with the Mayor Island Obsidian assemblage, the limited clustering with respect to maximum length occurs in the northern quadrant over the pit structure and is patterned in a similar way to the Mayor Island Obsidian as well.

Figure 5.21. EA12-17 Coromandel Volcanic Zone obsidian artefact distribution density plot and cluster analysis by maximum length of artefact.
5.9.5 EA12-17 Upper Ahuahu basalt

As noted earlier, Ahuahu basalt stone artefacts only appear in EA12-17 Upper and Tamewhera assemblages. The EA12-17 Upper Ahuahu basalt is concentrated in the south of the excavation unit and the densest distributions are over the drain feature (Figure 5.22). No significant clustering relating to artefact size is recorded. As is apparent from Figure 5.23, a three-dimensional slice of the artefact distribution and pit and drain feature looking east, the material is concentrated in the very upper layers.

Figure 5.22. EA12-17 Ahuahu basalt artefact distribution density plot and cluster analysis by maximum length of artefact.

Figure 5.23. EA12-17 Ahuahu basalt three-dimensional artefact distribution looking east.
5.9.6 EA12-17 Upper tool and core distributions

The patterning revealed in the artefacts when plotted by raw material in the sections above is if anything amplified when the spatial distribution of tools and cores of all materials are examined. Tools show a particularly defined gap in their distribution either side of the “non-pit” postholes outlined earlier, but otherwise the tools are fairly evenly spread by raw material (Figure 5.24a). Chert cores are the most numerous and show a definite concentration in the south of the non-pit postholes; this concentration does reflect the general density of chert artefacts in that area (see Figure 5.19 above). There are too few cores of other materials to identify any patterning in their distributions.

Figure 5.24. EA12-17 Upper tool artefact distribution (a) left, and core artefact distribution (b) right.
5.10. **EA12-17 Lower artefact spatial distribution**

The EA12-17 Lower lithic assemblage is dominated by Tahanga basalt artefacts, which are more numerous than all the other artefacts combined. Unlike the EA12-17 Upper above, there are no Ahauhu basalt artefacts present. Also unlike the layer above, the Tahanga basalt artefacts are comparatively small and the chert artefacts comparatively large (Table 5.4 – see Chapter 7 for more detailed discussion), while the obsidian artefacts from both sources are of very similar average dimensions.

<table>
<thead>
<tr>
<th>EA12-17 Artefact Material</th>
<th>Artefacts (n)</th>
<th>Total Artefacts weight (g)</th>
<th>Average length</th>
<th>Std.Dev. length</th>
<th>Average width</th>
<th>Std.Dev. width</th>
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**Table 5.4. EA12-17 Upper Artefact (n), total weight, average maximum length, width and thickness by raw material**

5.10.1 **EA12-17 Lower Tahanga basalt distribution**

The plot of the EA12-17 Lower Tahanga basalt artefacts reveals an even distribution and density of material throughout the pit and a substantial number of Tahanga basalt artefacts throughout the drain feature. There is little in the way of clustering with respect to maximum dimension in the pit feature itself and none in the drain feature.
Figure 5.25. EA12-17 Lower Tahanga basalt artefact distribution density plot and cluster analysis by maximum length of artefact.

5.10.2 EA12-17 Lower chert distribution

In contrast with the Tahanga basalt, chert density is more variable, with clusters of chert artefacts in the southeastern, northern and northwestern areas of the pit feature. Somewhat surprisingly, only a single chert artefact appears in the drain feature, midway along its length.

Figure 5.26. EA12-17 Lower chert artefact distribution and density plot and cluster analysis by maximum length of artefact.
5.10.3 **EA12-17 Lower Mayor Island obsidian**

Mayor Island obsidian artefacts are fairly evenly spread within the pit boundary, with a relatively small concentration in the southern half. Only a single Mayor Island Obsidian artefact appears in the drain fill and no significant clusters relating to artefact maximum length are present.

![Map showing artefact distribution and cluster analysis](image)

**Figure 5.27.** EA12-17 Lower Mayor Island obsidian artefact distribution and cluster analysis by maximum length of artefact.
5.10.4 EA12-17 Lower Coromandel Volcanic Zone obsidian

The Coromandel Volcanic Zone obsidian in this layer appears to be densest down the centre line of the pit, with a small cluster of larger artefacts in the centre. Only two Coromandel Volcanic Zone obsidian artefacts were found in the drain feature.

![Figure 5.28. EA12-17 Lower Coromandel Volcanic Zone artefact distribution and cluster analysis by maximum length of artefact.](image-url)
5.10.5 EA12-17 Lower tool and core distributions

In contrast with most other deposits, no cores of any raw material whatsoever were found in EA12-17 Lower. What tools were present were distributed evenly throughout the pit; however, unsurprisingly, given the low numbers of material other than basalt in the drain, only two basalt tools and a single chert tool were located along its length.

![EA12-17 Lower tool artefact distribution](image)

**Figure 5.29. EA12-17 Lower tool artefact distribution**

5.11. EA12-17 combined vertical stratigraphic distribution of artefacts – Tahanga basalt and Ahuahu chert

A three-dimensional plot of the Tahanga basalt and chert artefacts serves to demonstrate the different raw material compositions of EA12-17 Upper and EA12-17 Lower assemblages. As is apparent from Figure 5.30, Tahanga basalt artefacts are distributed relatively evenly in three dimensions, and within both EA12-17 Upper and EA12-17 Lower with a gap in the distribution in the EA12-17 Upper layer between the lines of postholes, albeit with some
Tahanga basalt artefacts below this area in the drain fill. The chert distribution is much more obviously skewed towards the Upper layer with noticeably fewer artefacts in the pit fill and drain, suggesting a later depositional episode more dominant in chert material.

Figure 5.30. EA12-17 Upper and Lower combined three-dimensional representation of basalt artefact distribution

Figure 5.31. EA12 and EA17 Upper and Lower combined three-dimensional representation of chert artefact distribution
5.12. EA12-17 Upper and EA12-17 Lower Summary

The patterning of the stone artefacts above and within the pit and drain feature would suggest that there are at least three archaeological phases observable. The first relates to the creation of the pit, the second relates to the fill of the pit and drain post-abandonment and the third relates to activity above the pit area without reference to its structure. This is demonstrated as noted above by the differential spatial distribution in three dimensions of the artefacts, and the differences in the metrics of artefacts when compared across materials with respect to values such as weight and maximum length. In the EA12 zone, where the archaeological deposits are much deeper, it would appear that there is a more homogenous mix of material with average sizes and weights falling between the two extremes of the EA17 assemblages. As a consequence it is suggested that there is a deflation process going on above the pit which has compressed the archaeological material into a layer above the pit. The artefact distribution above the pit and drain fill layer (EA12-17 Upper), especially the chert, Ahuahu basalt, and tool assemblages, suggests the possibility of the presence of a structure or at least a boundary that results in a higher concentration of material to the north and south of the postholes and a gap in distribution between. The comparatively large number of Tahanga basalt artefacts in the drain fill (when compared to the very few artefacts of other raw materials) is difficult to explain. It does however suggest that the Tahanga basalt assemblage from EA12-17 Lower can be seen as possibly subject to a different manufacturing or depositional process than assemblages of other raw materials; in other words, the way in which the basalt was treated resulted in a different archaeological context from the other materials, despite their broad similarity as stone artefacts.
5.13. **EA26 Artefact spatial distribution**

As noted above, EA26 incorporated two main features: firstly a “bin” pit of approximately half a metre in depth, and secondly a trench relating to a modern water pipe. Both of these are outlined in Figure 5.32. Numbers of artefacts by raw material are broadly similar, although there are comparatively few Mayor Island obsidian artefacts. Those which are present, however, are relatively large when compared to both the chert and Coromandel Volcanic Zone obsidian (Table 5.5).

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<th>Artefacts (n)</th>
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<th>Std.Dev. width</th>
<th>Average thickness</th>
<th>Std.Dev. thickness</th>
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**Table 5.5. EA26 Artefact (n), total weight, average maximum length, width and thickness by raw material**

Two-dimensional representations of the spatial distribution of the artefacts show a concentration of all material in the pit zone and a gap in distribution where the modern trench had cut through the archaeological deposits. When the distributions are broken down by material it is apparent that the chert and basalt assemblages are relatively evenly spread throughout the excavation unit and there is a greater concentration of obsidian material of both sources in the pit area. The obsidian assemblages are also the only ones that display any degree of clustering with respect to artefact size, although this is still limited. Three-dimensional views of the artefact distributions confirm the larger proportions of obsidian
material in the bin-pit fill. Correspondingly a greater proportion of the obsidian tools of both sources are present in the pit fill, although there are only two cores of Coromandel Volcanic Zone obsidian and one core of Mayor Island Obsidian among all the assemblages. As with the two EA12-17 assemblages, the differential in the way artefacts of different raw material have presented in the archaeological record suggests different depositional processes for the obsidian material when compared to chert and basalt.

Figure 5.32. EA26 Tahanga basalt artefact distributions.
Figure 5.33. EA26 chert artefact distributions.

Figure 5.34. EA26 Mayor Island obsidian artefact distributions.
Figure 5.35. EA26 Coromandel Volcanic Zone obsidian artefact distributions.

Figure 5.36. EA26 tool and core distributions
Figure 5.37. Three-dimensional spatial distribution of EA26 tool and artefact distributions (Large dots = tools, small dots = non-tool stone artefacts. Blue = Tahanga basalt, Red = chert, Green = Mayor Island obsidian, Black = CVZ obsidian)
5.14. **EA51 (Te Matuku)**

The EA51 Te Matuku site is an eroding beachfront area (Figures 5.38 and 5.39) located to the north of Coralie Bay on the eastern coast of Ahuahu and to the north of the tombolo that forms the middle of Ahuahu. The presence of archaeological material was first recorded in the 1970s by Edson, who noted “early” artefact styles and moa bones. Surface collected eroding archaeological material from the area is now housed in the Auckland War Memorial Museum.

![Figure 5.38. Position of EA51](image)

Storm events occasionally see wave action washing through the area, and this means that in conjunction with occasional stock movements across the site, the deflated part of the exposed cultural layer is subject to ongoing erosion. Grass covering further back off the beach
stabilises the dune and seals the intact cultural material about 1m below the current ground surface (Figure 5.39).

Figure 5.39. EA51 looking northwest. The stream is to the right, and the sea to the left.

In June and November 2013 and June 2015 a series of test pits and larger areal excavations of varying size were undertaken to evaluate the extent of the intact archaeological deposit. These coalesced into what became known as EA51 (Figure 5.39) and it is from this excavation area that the material for analysis was recovered.

Of the locations from which stone artefacts have been sourced for this thesis, this appears to be the earliest archaeological deposit recorded, with four C14 determinations placing the cultural deposit in the early to mid-14th century AD to early to mid-15th century AD (Figure
One radiocarbon determination covering the late 16th to late 17th centuries AD is interpreted as belonging to a later intrusive fire feature. The lithic flake assemblage of over 750 artefacts was comprised predominantly of chert material (79% by weight, see Chapter 7, Figure 7.1) with a smaller component of Tahanga basalt and a relatively small assemblage of obsidian flake artefacts, predominantly from the Mayor Island source. A comparatively broad faunal assemblage was recovered, consisting of fish bone, shellfish, seabird, dog and marine mammal bone, dog coprolites and a small amount of moa bone, likely the Little Bush Moa (*Anomalopteryx didiformis*). The moa material is presumed to be both the remnants of food, due to the presence of vertebral and tracheal ring material, and industrial bone for artefact manufacture. Two *in situ* hangi features were also located. The stratigraphy suggests two possible depositional phases at the site, although how much actual time separates these events is difficult to quantify.

In terms of structural evidence, a row of stakeholes present in the western quadrant of the excavation running northwest to south-east was the only other structural feature present. In addition to the abundant lithic artefact material and thermally affected rock, a one-piece moa bone fishhook and one broken adze pre-form were recovered.
Unlike all the other lithic assemblages analysed, the Te Matuku assemblage is dominated by chert artefacts (Table 5.6). The implications for the results of the technological analysis of the chert assemblage are discussed in detail in Chapter 7. There is comparatively little Coromandel Volcanic Zone obsidian present, and the few Coromandel Volcanic Zone obsidian artefacts are slightly larger and heavier on average than the Mayor Island obsidian artefacts. As with the other assemblages reviewed thus far, the Tahanga basalt artefacts are on average larger than those of other raw materials. No Ahuahu basalt artefacts were present.

Figure 5.40. Radiocarbon Dates for EA51 (Te Matuku)
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Table 5.6 EA51 Artefact (n), total weight, average maximum length, width and thickness by raw material

5.15. EA51 artefacts spatial distribution

5.15.1 EA51 Tahanga basalt spatial distribution

The Tahanga material is spread evenly throughout the excavation zone, save for a prominent concentration of basalt artefacts in the lower centre (southern edge) of the excavation area. However, cluster analysis of this material does not reveal any divergence from the norm in respect of average values for size, shape or tool type.

Figure 5.41. Spatial distribution of EA51 Tahanga basalt artefacts and density plot
5.15.2 EA51 Chert spatial distribution

As is noted in Chapter 6, chert artefacts form the largest percentage by weight of all the Ahuahu Excavation Zone assemblages, and the highest number of chert drill points was also present. The greatest variations on maximum artefact length are at the eastern end, with small clusters of high and low values; however, a concentration of chert material in the lower centre (southern edge) of the excavation (proximate to the concentration of Tahanga basalt material) revealed no anomalous patterning (Figure 5.42). As noted above, chert artefact patterning shows little influence from the FCR/charcoal features. This could be a function of the sheer number of chert artefacts, or possibly that a significant proportion of the chert material was deposited some time after the deposit of the FCR/charcoal features.

Figure 5.42. Spatial distribution of EA51 chert artefacts and density plot
5.15.3 EA51 Mayor Island Obsidian

Mayor Island obsidian artefacts in EA51 seem to be more clustered than Tahanga basalt or chert artefacts, including a cluster to the south-west of the row of small postholes, and this is the only assemblage that is possibly influenced in its spatial distribution by the position of those postholes. This cluster of Mayor Island Obsidian also appears at a slightly higher vertical position in the deposit (Figure 5.46). This could suggest that a proportion of the Mayor Island Obsidian assemblage was deposited at a different time to the Tahanga basalt and chert assemblages; however, the artefact metric and technological analyses undertaken in Chapter 6 do not suggest any criteria by which the Mayor Island artefacts could be distinguished from other Ahuahu Mayor Island Obsidian assemblages.

![Spatial distribution of EA51 Mayor Island obsidian artefacts and density plot](image)

Figure 5.43. Spatial distribution of EA51 Mayor Island obsidian artefacts and density plot
5.15.4 EA51 Coromandel Volcanic Zone obsidian spatial distribution

As noted earlier, there were very few Coromandel Volcanic Zone obsidian artefacts present in this excavation area and as such there is little in the way of meaningful patterning that can be inferred.

Figure 5.44. Spatial distribution of EA51 Coromandel Volcanic Zone obsidian artefacts and density plot

5.15.5 EA51 tool and core distributions

Unsurprisingly chert tools dominate the Figures here, with chert drill points being evenly distributed throughout the exaction area. No strong spatial patterning is evident with respect to either the tools or cores.
Figure 5.45. EA51 Tool and core artefact distribution

Figure 5.46. Three-dimensional spatial distribution of EA51 stone artefacts. Blue dots = Tahanga basalt, Red dots = chert, Green dots = Mayor Island Obsidian, Black dots = CVZ obsidian, FCR/charcoal concentrations in black. Polygons outlined in black indicate deposit and ground surface levels.
5.16. **EA51 Summary**

As was the case with EA1, EA51 provided evidence of cooking and the discard of faunal material along with the stone artefacts, which were dominated by chert material. Again, paralleling EA1, the stone artefact material was present in a cultural deposit about 25cm thick, with considerably more overburden at the western end as the beach dune deepened and sloped upwards to a grassed level (Figure 5.46). As noted above, little Coromandel Volcanic Zone obsidian was present. There does not appear to be any relationship with respect to the distribution of the artefacts and the row of small postholes recorded in the western quadrant of the excavation, other than perhaps for the Mayor Island obsidian. This would suggest that the postholes may relate to an earlier or later occupation than that which was responsible for the deposition of the bulk of the stone artefacts. The ovoid features represent concentrations of FCR and charcoal that were at the same stratigraphic level or slightly below the main concentrations of artefacts. The density plots above suggest that the Tahanga basalt, MI and Coromandel Volcanic Zone obsidian distributions may have some regard to these features as their densities are lower in their immediate vicinity. This patterning is not mirrored in the chert density plot, where the position of the FCR/charcoal features seems to influence the chert distribution far less.
5.17. Tamewhera Excavation Zone

Excavations were undertaken at this location (NZAA site reference T10/214) on a ridge to the east of Tamewhera pa (NZAA site reference T10/217) over four weeks in November 2012 and 2013, and in February 2014. The ridge and surrounding slopes form part of a large, multi-hectare horticultural and residential complex. C14 dating of the excavated terraces (see Figure 5.48 below) suggests occupation later in the pre-European Māori sequence, from the mid-17th century AD to the early 18th century AD. C14 dating of material from core samples taken from the swamp below and to the north of the Excavation Areas does indicate gardening activity at least in the area in the 16th century AD. A series of terraces above stone horticultural alignments was excavated (Figure 5.47), revealing evidence of houses, cooking and middens. A large lithic assemblage of over 600 lithic artefacts comprising mainly chert and obsidian was recovered in association with a variety of structural contexts, together with a relatively small number of basalt flakes of both Tahanga basalt and locally sourced Ahuahu basalt material (Table 5.7).
Figure 5.47. Tamewhera Excavation Zone, showing Excavation Areas.

Figure 5.48. Radiocarbon dates for Tamewhera Zone
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Table 5.7. Tamewhera Excavation Zone artefact (n), total weight, average maximum length, width and thickness by raw material

5.17.1 Faunal remains

Limited faunal remains were found across the excavation areas. Individual shell fragments and valves were scattered throughout EA106, and at the eastern ends of EA102 and EA103. The northeastern quadrant of EA106 saw the only concentrated midden deposits. Cockle (Austrovenus stutchburyi) valves dominated both midden assemblages; however, some large gastropods were present (primarily the rocky shore species Dicathais orbita, Cominella maculosa and Cabestana spengleri), together with some fish bones. Interestingly, the faunal material recovered from Feature 30156 appeared to have been deposited as a single event into a large posthole, suggesting at least two phases of use and function on the terrace.

The fish bones were dominated by post-cranial elements, possibly as a result of the consumption of dried fish (typically fish were dried with the heads removed (Leach 2006)). Five species of fish were identified: snapper (Pagrus auratus), barracouta (Thyrsites atun), leatherjacket (Parika scaber), terakihi (Nemadactylus macropterus) and frostfish (Lepidopus caudatus). All these species except for the frostfish are very common in east coast North Island middens (Smith 2011) and the frostfish has been recorded in South Island middens (ibid: 21).
Broken cranial elements of dog (*Canis familiaris*) were found in EA102, EA103 and EA108; however, due to the fragmented nature of the dog remains, an MNI of one across the three excavation areas cannot be discounted. A small number of rat (*Rattus exulans*) elements were found across the Excavation Areas, including one complete mandible in EA103. No avian bone was positively identified. The tip of a shark’s tooth, probably from a great white shark (*Carcharodon carcharias*), was found in EA103, but this is assumed to have related to ornamental or tool use rather than evidence of consumption.

5.18. **EA102 Spatial analysis**

EA102 was on a north-facing terrace high on the ridge. The rear of this terrace was stone-faced, the facing forming part of the retaining wall of the terrace above. The front of the terrace was also stone-retained, and in total the terrace itself measured approximately 6 x 3m. Obsidian and chert flakes were found immediately under the topsoil. Also present were four stones set into the stratigraphic level below the topsoil to form four sides of a square stone-lined hearth (Figures 5.49 and 5.50). The hearth was constructed by setting four large flat stones on their edge in the ground to form a square feature measuring 0.5m x 0.5m. Despite the presence of the stone-lined hearth, a partial drain, numerous stone artefacts and a small shell midden on the eastern side of the terrace, there were no well-formed postholes found that could delineate the outline of any structure, house or otherwise. A possible interpretation is the terrace at one point having a small pole and thatch house, facing east, which left no structural remains apart from the fireplace. Notably, the artefact distribution was concentrated at the back of the terrace on the southern half, in contrast to the distributions recorded at EA103 and EA106.
Stone artefacts on EA102 are concentrated towards the back of the terrace (the southern half of the Excavation Area), either side of the quadrangular stone hearth. There are no particular differences with relation to the distribution of material by type and the only unusual patterning is the lack of artefacts at the northern half of the Excavation Area. No postholes
were found on EA102 and as such the nature of any structure that may have been on the
terrace is unknown, but given the location of the hearth and the size of the terrace, use as a
house platform at some stage seems likely. The lack of stone artefact material in the northern
half of EA102 could be due to a number of reasons. It is possible that the artefact material
from EA102 has eroded away downhill; however, the fact that the stone-facing retaining and
fill at the northern face of the terrace was largely intact and there is no appearance of
obviously eroded material on the EA103 terrace below suggests that erosion does not account
for the lack of artefacts in its entirety. No significant clustering due to the distribution of
artefacts by maximum length was recorded for any stone artefact raw material.
Figure 5.51. EA102 artefact distributions and density plots. Clockwise from top left: Tahanga basalt artefacts, chert artefacts, Mayor Island obsidian artefacts, Ahuahu basalt artefacts and Coromandel Volcanic Zone obsidian artefacts.
5.18.1 EA102 Tool and core distributions

Tool and core distributions largely mirror the general artefact distributions, although it is interesting to note that all the Tahanga basalt tools all cluster in the south-west quadrant in the area of artefacts that was noted earlier as being of higher vertical position, and therefore could well be tumbledown material from further upslope. As these Tahanga tools represent almost 100% of the Tahanga basalt artefacts in the EA102 assemblage, if they were removed then the material associated more directly with the level of the terrace and hearth would contain virtually no Tahanga material at all.

Figure 5.52. Spatial distribution of EA102 tool and core artefacts
5.19. **EA103 Spatial analysis**

EA103 was on a 6 x 4m terrace immediately below and to the west of EA102. The morphology was similar to that of EA102, being stone- retained at the front and back. Obsidian and chert artefacts were found at the base of the topsoil, and a square stone-lined hearth, measuring 0.5m x 0.5m and constructed of five large flat stones set on their edge in the ground, was revealed. A 25cm wide and 20cm deep drain was found at the back of the terrace, which was also retained at the front and back by several courses of stone.

![Figure 5.53. Stone-lined hearth and drain feature in EA103, Tamewhera.](image)

The terrace contained what was interpreted as a small, well-built *wharepunī* or sleeping house measuring 4 x 3m with a porch area at the eastern end included in the length. In addition to the hearth feature, 21 postholes and two drains were uncovered, together with 406 flake stone
artefacts of basalt, chert and obsidian. The hearth feature was almost exactly 0.5m square and was constructed of five stone slabs set firmly on their edge into the clay surface of the terrace. The house conforms to a pre-European layout, and the orientation and narrow rectangular shape of the postholes, together with the discovery of remnant pieces of kauri in the base of two of the postholes, suggest it was constructed using dressed kauri planks for the frame. The location of the hearth, tucked in the southeastern corner of the wharepuni adjacent to the door, is similar to excavated house examples at Ruahihi Pa in the Bay of Plenty (McFadgen and Sheppard 1984: 19). It was aligned north-south, with a doorway on the eastern wall that would have opened out on to the small porch area.

Figure 5.54. Completed excavation EA103, Tamewhera.
More so than EA102, EA103 provides strong evidence for a house structure in the form of rectangular postholes in addition to the stone-lined hearth. The patterning of the artefacts on EA103 is also considerably different from EA102. There are strong concentrations of material on what is described as the porch area at the front of the house and unlike EA102 material is present at the northern and southern quadrants (the back and front of the terrace). A closer examination of the material according to sub-categories of attributes is further enlightening. When the obsidian material on EA103 is broken down by source it is apparent that the Coromandel Volcanic Zone obsidian material is concentrated to a greater degree around the outside of the outline of the house, whereas the Mayor Island obsidian is distributed across the terrace as a whole in a more even fashion. There is little differentiation in terms of the three-dimensional distribution of the artefacts by material; however, it could be argued that on the basis of the distribution of the grey and black artefacts outlined above
that there are at least two phases of occupation or depositional episodes represented at EA103, possibly reflecting different uses of the terrace over time. The material that is deposited that appears to bear a relationship to the outline of the house likely related to deposition of material while the house was occupied. The deposition of the material such as the Mayor Island obsidian across the top of the terrace could relate to a later occupation of the terrace following abandonment of the house. With EA103, as is the case with EA102, it is assumed that the presence of a stone-lined hearth is indicative of a structure on the terrace at some stage and presumably that sort of structure is in fact a house. However, as no postholes were found on EA102 and the distribution of material is dissimilar from that of EA103, where there is some degree of certainty as to the presence of a house, it must be noted that at the very least the type of structure on EA102, if there was one, would have been different – and it is possible that there was no structure at all.
Figure 5.56. EA103 artefact distributions and density plots. Clockwise from top left: Tahanga basalt artefacts (blue), chert artefacts (red), Mayor Island obsidian artefacts (green), Ahuahu basalt artefacts (pink) and Coromandel Volcanic Zone obsidian artefacts (grey).
5.19.1 **EA103 Tool and core distributions**

Chert cores and tools are distributed around the edges and on the porch area of the house structure, suggesting deposition while there was a structure on the terrace. The situation is not as clear-cut with respect to the other raw materials; obsidian tools of both sources are found both on the porch area and within the boundaries of the house structure. Only two obsidian cores were recorded: one MI core on the porch area and one Coromandel Volcanic Zone obsidian core adjacent to the hearth.

**Figure 5.57. Spatial distribution of EA103 tool and core artefacts**
5.20. **EA106 Spatial analysis**

EA106 is a large terrace, about 10 x 4m, and is on the same north-facing slope as EA102, EA103 and EA108. The terrace was constructed using stone retaining at the front and back faces, although the stones at the rear (southern face) had collapsed across the terrace at the western end. Two excavation areas measuring 4.5 x 4m and 5 x 4m respectively were opened up across the terrace with a 0.5m unexcavated baulk retained between them (Figures 5.57-5.59). The excavations revealed a variety of features and artefacts, including nine substantial postholes which suggest some kind of structure was present. However, unlike EA102, EA103 and EA108, no stone-lined hearth was present and the pattern of postholes did not suggest a house structure. Three fire features, indicated by concentrations of thermally-altered rocks and charcoal, were present together with concentrations of shell and fish bone material. A considerable number of stone flake artefacts were recovered including a small complete Tahanga basalt adze, and a complete fishing lure shank made of the petrified wood found locally on Ahuahu. These and the other lithic artefacts were concentrated at the western end of the terrace (Figure 5.59). The lack of an identifiable formal house structure or stone-lined hearth, together with different artefact density patterns from EA102 and EA103, and the presence of fire features and midden material suggest this may have been a large domestic terrace used for cooking, processing of food and artefact manufacture. The postholes to the eastern end may be evidence of a small raised storage house, or *pataka*, and as is discussed in Chapter 7, the artefact distributions in this area may support this suggestion.
EA106 shows distinct clustering of artefacts of all materials at the western end. There is little patterning in terms of the artefacts by material type or tool type and no quadrangular hearth feature on the terrace. EA106 did contain three small concentrations of faunal material and evidence of a fire feature to the east of the concentration of artefacts. Four large postholes in a rectangular arrangement were discovered to the eastern end of the terrace corresponding with an area without stone artefacts. It is possible that this spatial patterning relates to some form of structure, having been on EA106 at the same time as the stone material was being deposited at the western end. It is interesting to note that two formal artefacts in the form of a small adze and a petrified wood fishing lure were found amongst the concentration of the material at the western end. Little clustering based on artefact maximum length values was apparent for raw material type. Comparison of the radiocarbon dates obtained for EA106 suggests phased occupation over time.
Figure 5.59. EA106 artefact distributions and density plots. Clockwise from top left: Tahanga basalt artefacts, chert artefacts, Mayor Island obsidian artefacts, Ahuahu basalt artefacts and Coromandel Volcanic Zone obsidian artefacts.
5.20.1 EA106 Tool and core distributions

Tools of all materials are overwhelmingly concentrated at the western end of the EA106 terrace. Comparatively few chert cores were present given the quantity of chert material recovered (see discussion below), but these were also concentrated with the main densities of artefacts. The chert tool assemblage contained no chert drill points.

![Figure 5.60. Spatial distribution of EA106 tool and core artefacts](image)

5.21. EA108 Spatial analysis

This small terrace was immediately above the eastern end of EA106 and had a stone-lined hearth protruding through the turf (Figure 5.61). Large natural boulders formed part of the front and back scarps, supplemented with additional smaller boulders on the front edge. The length of the terrace was confined on both sides by large boulders embedded into the sub-soil (Figure 5.61).
Although there were stone artefacts recovered from the base of the topsoil, there were no visible postholes on the terrace surface. Additionally, no Mayor Island Obsidian or Tahanga basalt was recovered. Despite this, the occupation evidence and stone-lined hearth suggest this terrace had a residential function.

The distribution of the artefacts on EA108 was fairly homogenous and given the very small size of the terrace it is moot as to whether any sort of house or sleeping structure could indeed have been fitted on a terrace of that size. This begs the question as to whether a hearth structure can be used as a proxy for the presence of a house or indeed whether a hearth can be evidential for any sort of structure at all. There is little effort required in producing a stone-lined hearth in the Tamewhera area given the large amount of naturally occurring rocks all around the area. Core and tool distributions have been included for the sake of completeness (Figure 5.63), but the very low numbers in either category render detailed comment unnecessary.

Figure 5.61. Overview of EA108 excavation on completion.
Figure 5.62. EA108 artefact distributions and density plots. Clockwise from top left: chert artefacts, Coromandel Volcanic Zone obsidian artefacts and Ahuahu basalt artefacts.
5.22. Tamewhera Excavation Zone Summary

The Tamewhera Excavation Zone, comprising four stone-faced terraces (Excavation Areas EA102, EA103, EA106 and EA108\(^7\)), presents perhaps the most convincing evidence for “sedentary” occupation in a traditional sense when the structural aspects are examined. EA103 is interpreted as containing a small house at some stage in its life due to the presence of a rectangular stone-lined hearth and rectangular postholes. EA102 has a similar hearth in a similar position on its terrace; however, no postholes were discerned during the course of excavation.

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\(^7\) As discussed in Chapter 4, Excavation Area 107 yielded only two chert artefacts in the entire excavation and as a result has not been included in analysis.
As noted earlier, the Tamewhera Excavation Zone is closest to the largest source of Ahuahu basalt and correspondingly revealed the largest Ahuahu basalt assemblage, as opposed to Tahanga basalt. Ahuahu basalt is also the largest raw material source by weight in the EA103 (41.0%) and EA108 (53.31%) assemblages, while chert is the largest by weight in EA102 (55.68%) and EA106 (58.35%). When the Excavation Areas are looked at individually, it is apparent that the relative proportions of artefacts differ markedly. Tahanga basalt makes up around 9-11% by weight of the EA102, 103 and 106 assemblages, while none was discovered in the (admittedly small) EA108 assemblage. Ahuahu and Tahanga basalt make up only 23.29% combined of the material by weight in the EA106 material, with corresponding increases in the proportions of both chert and Coromandel Volcanic Zone obsidian. On the other hand, the small terrace that comprises EA108 has proportionally more Ahuahu basalt, no Tahanga basalt or Mayor Island Obsidian and considerably less Coromandel Volcanic Zone obsidian than all the other Excavation Areas.

EA106 again shows a divergent patterning with respect to the source percentages for obsidian when compared to EA102, 103 and 108. EA106 shows a much higher percentage of grey obsidian as opposed to green obsidian, although there is no distinct spatial patterning in relation to this divergence.
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Table 5.8. Proportions of raw material composition by weight per Tamewhera Excavation Area assemblage.

The C14 dating sequence for the Tamewhera Excavation Zone suggests continual use of the area in the 17th century AD; however, the lack of stratigraphic definition makes isolating depositional processes or events difficult, and viewed as a whole, the lithic assemblages can be thought of as time-averaged. Nevertheless, the combination of C14 dates and the spatial distribution and technological characteristics of the lithic material suggest that different uses of the terraces for different activities over time can be ascertained.
5.23. **Masonic Excavation Area, Devonport Excavation Zone, Auckland**

The pre-European occupation recorded at the Masonic Excavation Area was located about 30m to the north of the current mean high water springs for Torpedo Bay (Figure 5.2), in a sandy matrix that formed part of the dune environment in pre-contact times. Approximately 700m² was excavated as part of the Stage One pre-construction archaeological investigations. The historic 19th century archaeology included brickwork, ceramics, glassware, drains and rubbish pits containing butchered sheep and cow bones relating to three dwellings formerly on the site. Once this material had been removed, pre-contact archaeological evidence of Māori occupation was discovered concentrated in two areas, a fore-dune zone containing a number of burials, and an adjacent swale containing large numbers of lithic artefacts and faunal remains (Figure 5.64), together with a large number of postholes, pit and fire features (including an *in situ* stone-lined hearth (Figure 5.65)). The presence of a house structure surrounding the stone-lined hearth could be inferred from the posthole patterning, but given the number and variety of postholes recorded and the difficulty in ascertaining their contemporaneity in a sandy mobile dune matrix, this interpretation needs to be viewed with some caution.

The faunal remains were extensive and included moa (MNI of 11), a large number of fish bones (primarily Australasian snapper, *Pagrus auratus*), rat, bird and reptile remains (including tuatara), and shellfish including New Zealand cockle (*Austrovenus stutchburyi*) and New Zealand scallop (*Pecten novaezealandiae*). The presence of extinct moa, tuatara and forest parrot species such as the kaka (*Nestor meridionalis*) in the faunal assemblage is consistent with occupation early in the New Zealand sequence.

Also recovered from the excavations of the pre-contact material were a number of coprolites, of which DNA analysis has confirmed a canine origin (Wood *et al*. 2016). Additional DNA
sequencing together with microscopic analysis of pollen inclusions within the coprolites provided some interesting further insights into the environment in which the dogs were living in pre-contact times. DNA signatures for the Polynesian-introduced cultigens bottle gourd, yams and paper mulberry were detected, together with pollen that suggested broad-leaf podocarp forest in close proximity.

![Figure 5.64. Masonic Excavation Area](image)

An analysis of charcoal samples from the site confirmed the presence of large conifers such as kauri, totara and matai, together with puriri, pohutukawa and a variety of short-lived species. The presence of conifers suggests early settlement before such forests were cleared, or later settlement using those large trees for structural timbers (Wallace and Holdaway 2017).
The excavated material culture repertoire was also extensive. The lithic assemblage will be discussed in more detail below, but several complete and broken adzes were found, together with a number of preforms. Worked bone was present, and several complete and broken one-piece fishhooks, together with a barbed bone spear point, were recovered. The flaked lithic material comprised mainly Motutapu greywacke (McAllister pers comm) and obsidian from Mayor Island, Coromandel sources and Great Barrier Island (McAllister 2016). Chert material formed a small but significant portion of the total lithic assemblage. The lithic material was concentrated in the northeastern and southeastern zones of the cultural deposit and was most sparse in the area surrounding the stone-lined hearth (Figure 5.64). All types of lithic material present at the site were evenly represented in this concentrated zone. Fish bone faunal material also followed this pattern, as did the moa remains; however, dog, rat and bird bones were more evenly distributed.
As noted earlier, the Masonic excavation area incorporated a number of postholes and a large, stone-lined hearth structure in the centre. No definitive evidence of a building could be inferred from the posthole features alone given the difficulties in establishing their contemporaneity, but the artefact distributions are informative. Beginning with the Motutapu greywacke artefacts, it is immediately apparent there is patterning in both the density of the
artefacts and the clustering by maximum length. The greywacke artefacts are most densely concentrated in the northeastern quadrant, and this zone sees a cluster of low maximum length values and a number of high maximum length outliers. Towards the southern end is a cluster of high maximum length artefacts. Comparatively little greywacke material is present in close proximity to the hearth, or indeed between the hearth and any of the postholes (the area which would be the interior of any mooted structure). This distinct density patterning and clustering according to maximum length suggests differential manufacturing stages and/or activity zones are represented by spatially distinct areas.

The chert assemblage from the Masonic site is the smallest by weight and artefact number and the chert artefacts display a general lack of density patterning or clustering. Unlike the greywacke, there is little suggestion that the chert is informed to any degree by the structural components of the excavation area.

The distribution patterns for all the obsidian artefacts, irrespective of raw material source, are similar, and mirror the spatial distribution of the greywacke artefacts, if not the clustering by maximum length. There are denser concentrations of obsidian material in the north-east quadrant and few artefacts proximate to the hearth or between it and any postholes.

As noted earlier, the lack of elevation data for the Masonic assemblages prohibits any three-dimensional analysis of the assemblage distributions.
Figure 5.67. Masonic artefact distributions and density plots. Clockwise from top left: Motutapu greywacke artefacts, chert artefacts, Mayor Island obsidian artefacts and CVZ/Great Barrier Island obsidian artefacts.
5.24.1 Masonic tool and core distributions

The patterning of the tool and core stone artefacts largely reflects that of the artefact assemblages in general, and as such it is difficult to suggest any specific spatial areas that are associated with a particular tool or core type or material.

![Masonic tool and core distributions](image)

**Figure 5.68. Masonic tool and core distributions**

5.25. Masonic Excavation Area Summary

The Masonic Excavation Area exhibits a wide range of material culture and faunal remains (and burials) and a similarly broad C14 date range. While the lithic assemblage analysed is primarily sourced from a layer that seems to relate to an early depositional event, the range of C14 dates and finds suggest that the potential for time-averaging is quite high. The overall impression is of a similar patterning of archaeological material to the analogous Ahuahu Excavation Zones of Oneroa and Te Matuku, save for the substitution of Motutapu greywacke material for Tahanga basalt.
5.26. Chapter Summary

As might be expected, the spatial patterning of the stone artefacts analysed in this chapter varies considerably depending on the archaeological context in which they were discovered. Despite this, however, certain commonalities are also present. All assemblages reflect a spatial distribution (in both two and three dimensions) that suggests that they are all to some degree time-averaged; even the most recent chronological assemblage in absolute terms (the Tamewhera Excavation Zone generally and the EA103 assemblage in particular) shows evidence of deposit mixing that is only apparent through the combination of technological and spatial analysis, as opposed to strong stratigraphic evidence.

So is there a difference between sites that can be characterised to a greater or lesser degree as time-averaged, and sites that can have individual depositional episodes identified? There are multiple ways in which sites can be compared without respect to the technological metrics alone, but with a view to spatial and formational aspects as well: chronology, superficial function (composition of non-lithic material and the implications that might have for functional designation), geographical location (susceptibility to specific taphonomic forces based on physical location), and proximity to lithic resources. Ultimately all are time-averaged to a degree and it is where on the continuum they fall that is the key to understanding them. The implications for New Zealand archaeology of the findings set out in this chapter and the following chapters are further discussed in Chapter 8.
Chapter 6. **Analytical Methodology**

6.1. **Background**

General theoretical approaches to lithic analysis and the linking of lithic artefact attributes to human behaviour have been covered in detail in Chapter 2; accordingly, this chapter will focus on the attributes chosen for recording in this thesis and the methodology concerning their measurement. Excavation methodology for the Excavation Zones has been set out in Chapter 5. This chapter outlines the post-excavation analytical methodology. In the first instance, however, some broader analytical issues are discussed by way of introduction to the later analytical techniques.

Stone artefacts have typically been analysed in a variety of ways over the years, and these methods can be reduced to three broad categories: Attribute analysis, Typological analysis and Aggregate (or mass) analysis (Steffen *et al.* 1998). The archaeological questions to be answered by any particular research programme should guide the interplay and ways in which these broad categories are applied, as they all have differing strengths and weaknesses (Table 6.1) and all three have been undertaken to varying degrees in this thesis.
Attribute analysis relates to the recording and analysis of the physical attributes of an artefact and is usual in the form of nominal or ordinal data such as maximum length, width and thickness, weight, volume, platform attributes such as width and surface area, dorsal scar counts and directions. Categories such as raw material type and colour are also included here. Some of these attributes (for example Complete Flake dimensions) will be governed by categorisation of the artefact in terms of its completeness (see discussion on Typological attributes below) and hence the overall analysis is one of reflexive interplay between analytical methods.

Steffen *et al.* (1998:137) subdivide Typological analyses into three sub-categories: “Technological types”, “Flake Completeness” and “Cortical Categories” (Table 6.1). For those sub-categories, Technological types refer specifically to variations in flake morphology and combinations of attributes that allow artefacts to be designated as falling within a certain category based on their position in a reduction sequence (e.g. thinning flakes, bipolar flakes...
(ibid: 138)); however, the definition could be expanded to include tool type designations (e.g. scraper, drillpoint, denticulate etc).

Flake Completeness, or alternatively, Flake Morphology, follows Sullivan and Rosen (1985) to categorise flakes in terms of their rate or type of fragmentation at the point in which they become part of an archaeological assemblage (i.e. post-excavation/collection/recording, as opposed to the point at which they enter the archaeological record). Thus artefacts can be complete flakes, fragments, distal flakes, proximal splits and so on, and these categories as they apply to this thesis are discussed in more detail below.

Cortical Categories simply refer to the extent and nature of the cortical coverage of artefact in question, and are usually single-attribute categories that vary in terms of their number and division points (Steffen et al. 1998). Finally, Aggregate analysis refers to measures undertaken on groups of artefacts rather than individual lithics. Hence initial size-grade sorting and weighing is a fundamental aspect of the approach, often followed by further sorting into categories such as raw material; however, there is no direct observation or recording of flake morphology (ibid: 139).

The analysis undertaken herein uses all of the above methods to some degree, and I now set out in more detail the measures and analysis.

6.2. Assemblage and artefact size parameters

At the outset, the decision was made to record attributes on all artefacts 20mm or greater in maximum dimension. This 20mm cut-off figure is common in lithic artefact analyses (Holdaway and Stern 2004, Fanning and Holdaway 2004, Hall 2004), and limits the effect of post-depositional transport (small artefacts less than 20mm having the potential to move further) (Schick 1987, Fanning and Holdaway 2001). In addition, experimental studies
indicate the overall volume of material unanalysed as a result of this sort of sampling is negligible (Douglas 2010, Holdaway and Douglas 2012: 125). Nevertheless, to adopt an approach more specifically tailored to the assemblages analysed herein in order to evaluate elements of bias that might be introduced by excluding artefacts less than 20mm in maximum dimension, I undertook a brief experimental flake production and core reduction experiment with the assistance and guidance of Dante Bonica of the Māori Studies Department of the University of Auckland. We began with two different sized starting blocks of greywacke material sourced from beach deposits on Rakino Island in the Haruaki Gulf, with a view to quickly reducing the blocks to adze preforms. In the first instance two preforms were created from an original cobble weighing 8347g. The preforms weighed 1870g and 891g respectively. All debitage from the original cobble was collected and size sorted, ultimately through a 20mm sieve. The material that passed through the 20mm mesh aperture was then hand-sorted to remove elongated flakes and fragments that were greater than 20mm in dimension yet passed through the 20mm mesh. The resulting small fragments, chips and dust were then weighed. Of the original weight of 8347g, 316g represented artefactual material less than 20mm in maximum dimension, or 3.7% by weight. The second reduction experiment started with a spall of greywacke weighing 2100g that had been removed from a larger cobble. A small preform was produced and the material was sieved and size sorted in the same fashion as for example 1 above. In this case, 130g, or 6.1% by weight of the original spall, represented material less than 20mm in maximum dimension. The difference in percentages across the two experimental assemblages is probably due to the smaller preform and higher degree of reduction undertaken in respect of the smaller original blank, resulting in a higher number of small trimming flakes. The sub-20mm samples were further sieved through 10mm mesh so as to isolate the material that was greater than 10mm in maximum dimension but less than 20mm. This portion of the sub-20mm sample represents
the material that could conceivably have been measured with any degree of accuracy given the methodology of hand-held callipers. In each case this sub-sample represented 34-35% of the sub-20mm sample, and less than 2-3% of the assemblage weight in total. As a consequence of this experimental data, I am confident that excluding material less than 20mm in maximum dimension and not setting the cut-off at a lower figure such as 10mm does indeed result in a negligible loss of assemblage volume analysed.

6.3. **Measurement instrumentation**

Geometric measurements on artefacts were made to the nearest 0.1 millimetre (using digital callipers). Artefacts were weighed on digital scales to the nearest 0.1 of a gram and angle measurements were undertaken using a stainless steel goniometer to the nearest degree. Identification of use-wear and residue was assisted by the use of a variable 10-63 x magnification binocular microscope.

6.4. **Metric recording software and attribute data categories**

All artefact attributes were entered into a Microsoft Excel database via *E4* computer software, a data-entry programme designed for lithic analysis by Holdaway and McPherron (1996). Attribute data was recorded as follows:

6.4.1 **Raw material**

Artefacts were initially categorised macroscopically as to their raw material type: basalt (or in the case of the Masonic assemblage, greywacke), chert, obsidian or other. Basalt was further sub-categorised at the point of individual artefact analysis as either “Tahanga” or “Ahuahu”. Obsidian was visually characterised as “Mayor Island” or Coromandel Volcanic Zone, following Moore’s (2012) (see Chapter 4) methodology. Ten to fifteen percent of samples of all the obsidian assemblages have been analysed using PXRF to confirm the accuracy of the
visual assessments as to source. One hundred percent of the green attributions were correct and 97% of the grey, so that any visual mis-identification is likely to have had a negligible effect on any subsequent analysis.

6.4.2 Maximum length, width and thickness of the artefact

Maximum length was defined as “the distance between two points furthest apart from each other on the flake, irrespective of its orientation” (Holdaway and Stern 2004: 138). Maximum width was measured at right angles to maximum length (Figure 6.1).

6.4.3 Complete flake length, width and thickness (see also definition of “complete flake” below)

Complete flake length corresponds with Andrefsky’s “maximum flake length” measurement (Andrefsky 2005: 99) and is measured following the axis of percussion from the proximal end to the distal end, or, in the case where irregularity in flake shape means that the line following the axis of percussion intersects with a lateral margin of a flake before reaching the distal end, to a line perpendicular to the axis of percussion running from the most remote distal point. Flake width was measured at the mid-point of the length dimension, and maximum thickness at the intersection of maximum length and maximum width dimensions (Andrefsky 2005: 100-101, Holdaway and Stern 2004: 137-139). This measurement protocol for complete flakes is sometimes described as the “box” method (Dodgandzi et al. 2015) and an assessment of this and other methods of flake measurement conclude that the box method provided the best estimation for the length of edge for a flake (ibid: 9) and is least susceptible to variations in blank morphology (ibid: 11).
Figure 6.1. Artefact and complete flake length and width measurements

6.4.4 Platform dimensions

The maximum width and thickness of striking platforms were recorded. Width was measured as the maximum distance between the lateral margins of the platform and thickness as a line perpendicular to the platform width and between the dorsal and ventral surfaces (Holdaway and Stern 2004: 124-125).
6.4.5 Exterior platform angle

This is the angle between the plane of the platform and the dorsal surface of the flake (ibid: 121-124, Lin et al. 2011).
Figure 6.3. Artefact and complete flake thickness, exterior platform angle measurements

6.4.6 Weight

All weights were recorded in grams.

Flake morphological characteristics

6.4.7 Flake Class

This categorises the artefacts according to their level of completeness and evidence for use as a tool. The categories, following Holdaway and Stern (2004), are as follows:

1. Complete flake: Flake with platform or identifiable point of percussion, complete lateral margins and identifiable termination;

2. Proximal flake: Flake with platform or identifiable point and axis of percussion, complete lateral margins but no distal end (i.e. no identifiable distal termination due to breakage);
3. Distal flake: Flake with identifiable distal termination and axis of percussion, complete lateral margins but no identifiable platform or point of percussion;

4. Medial flake: Flake with no identifiable platform or point of percussion, or distal termination, but complete lateral margins and identifiable ventral surface;

5. Angular fragment: Artefact with no identifiable platform attributes and only one or no lateral margins identifiable;

6. Complete split: Flake with identifiable proximal and distal ends and partial platform but presenting only one complete lateral margin due to a longitudinal fracture along or parallel to the axis of percussion;

7. Proximal split: Flake with identifiable proximal end and partial platform but presenting only one complete lateral margin due to a longitudinal fracture along or parallel to the axis of percussion.

6.4.8 Cores

These artefacts display negative flake scars and tend not to have a ventral surface (although large flakes that have been used as cores may well possess a ventral surface) (Holdaway and Stern 2004: 179). In other words, they are what Andrefsky refers to as “objective pieces”; artefacts that have been modified by having had one or more flakes detached from the object piece (the core) (Andrefsky 2005:12). As noted, larger flakes can also serve as cores, and where the pattern of flake removal from flakes is judged to be the result of retouch to produce a tool from the flake (based on the final morphology of the artefact and additional evidence for use-wear) rather than to generate flakes for tools, then the artefact would have been defined as a flake tool (see 7i below). Cores can be further divided as to the direction(s) from which flakes have been removed, typically unidirectional (flake scars originating from a single platform), bi-directional (two opposing platforms) and multidirectional (two or more platforms of non-patterned orientation) (Holdaway and Stern 2004: 180).
6.4.9 Tools

All of the above categories could be modified by the suffix “tool”. This means that the artefact in question also displayed some form of macroscopic use-wear or retouch on one or more margins that suggested the artefact had been used or designed for a specific purpose. This does not mean that all artefacts that were not designated as a tool were not used (i.e. were debitage/waste flakes from the production of some other tool), but that their use could not be verified without microscopic analysis, or that even then, their use may have left no discernible traces. When designated as a tool, the artefacts were further categorised into broad tool types based on the degree or type of retouch and morphology. The types are not intended to definitively assign function to the artefacts (see discussion concerning typology in Chapter 2), but follow lithic analysis convention to afford some degree of descriptive shorthand. With this proviso in mind, the only formal tool designations of relevance to the assemblages studied herein are “Drillpoint” and “Adze”. The tool type categories recorded were as follows:

i. Scraper: One or more lateral margins showing macroscopic unifacial retouch or use-wear;

ii. Utilised tool: Small amounts of edge damage on one or more margins;

iii. Drillpoint: Bifacial retouch to form triangular point, often resulting in a triangular pyramid shape. Could be hafted (common) or hand-held (less common, c.f. borer (Knapp 1924: Figure 1b));

iv. Adze: Finished or unfinished (preform, broken preform) woodworking tool designed to be hafted.

6.4.10 Cortical cover

The cortex of an artefact is the remnant weathered external surface of the original cobble from which the artefact has been struck. Cortex can be present on the dorsal surface of a
flake and was recorded in terms of its percentage cover: No cortex, 1-50% and 50-100%. As noted in Chapter 2, a variety of studies have used a method for calculating the ratio of percentage cortical cover of flakes to an expected value for cortical cover based on a hypothetical cobble cortical cover, to infer relative depletion of numbers of cores or flakes into or out of assemblages, and thus draw conclusions about the transport of flakes or cores (Dibble et al. 2005, Douglass 2010, Phillips 2011). There are some limitations to this approach relating to control of initial cobble size in particular, which means it is not easily applied to the New Zealand context and accordingly such approaches were not employed in the analysis undertaken herein.

6.4.11 Flake termination
Where an identifiable distal margin was present, the nature of that termination was recorded, based on four subcategories: (a) feather, (b) plunge, (c) hinge and (d) abrupt. The type of termination can inform on the way in which the material was being flaked and as such allow inferences as to knapping skill and raw material exploitation; changes in the relative proportions of these termination categories could suggest changes in these variables.

6.4.12 Raw material colour
As individual obsidian artefacts were analysed, they were further sub-categorised as “Green” (Mayor Island) or “Grey” (Likely Coromandel Source obsidians, see Chapter 4). Chert artefacts were further subcategorised at the point of individual analysis as “Red”, “Black”, “Brown”, “Yellow”, “White”, or “Grey”, based on the author’s own observations as to the colour variation of chert from initial categorisations and a review of the known source material on Ahuahu.
6.5. Statistical analysis

All statistical calculations and tests were undertaken with IBM statistical software SPSS v22.

Depending on the nature of the underlying data, the sample sizes and the distribution of values, normal or otherwise, a variety of parametric and non-parametric statistical tests were applied to ascertain whether variation in data were significant (and therefore unlikely to be the result of chance). In some cases this was a two-stage process. When independent sample t-tests were applied to data, following the methodology set out in Van Pool and Leonard (2011: 173), ANOVA or non-parametric Kruskal-Wallace tests (and in some cases both) were performed on all data at the outset to determine if there was any statistically significant variability in the distributions of each metric class by material per assemblage. Where the p-values are less than 0.05 for any such test, Bonferroni post-hoc analysis was performed to distinguish the assemblages that are responsible for the statistical significance and to control for Type 1 error rates (Field 2013: 871).

The results of the technological analysis using the parameters and methodology set out above are presented in Chapter 7.
Chapter 7. **Technological Analysis**

7.1. **Introduction**

This chapter sets out the results of the individual artefact analysis of the seven Ahuahu assemblages and the Masonic assemblage. I start by recording and comparing the metrics such as maximum artefact length, width, thickness and fragmentation that relate purely to the physical properties of the artefact and are less concerned with the techniques associated with its production and the designation of flake characteristics. These “non-technological” metrics are most useful for providing a basic picture of the assemblage composition, and assessing the taphonomic processes that may or may not have influenced the assemblages. If for example an assemblage exhibits lithic artefacts that are consistently larger in maximum dimensions than others, across all material types, it may be that some non-cultural size-sorting formation process is affecting the make-up of the assemblage. Following this, I examine in more detail a variety of metrics relating to manufacturing techniques that have been argued to inform as to practices concerning the procurement, manufacture, use and discard of lithic artefacts, and assess the technological signatures that variation or otherwise in these attributes implies.

Each assemblage in this chapter follows the excavation divisions outlined in Chapter 5. The Tamewhera Excavation areas are combined for analytical purposes in the first instance, based on the close chronological and stratigraphic associations. However, the Tamewhera Excavation Zone is split into its component Excavation Zones for further comparative analysis in the final section of this chapter. The assemblages are organised in this section according to their raw material. In this way I am able to compare the same variable across all assemblages, given (as set out in Chapter 5) that it is advantageous to be able to hold the material constant when looking at both technological and non-technological variables. As
Tamewhera basalt is only present in artefactual form in two of the assemblages (EA12-17 Upper and Tamewhera – see Table 7.1 below), it is not included in many of the comparisons, but dealt with separately.

7.2. Physical metrics

Table 7.1 sets out the proportion by weight that each material presents in each assemblage. It is immediately obvious that the EA1 assemblage is dominated by Tahanga basalt, and indeed the Tahanga basalt component of EA1 accounts for more than half the total basalt analysed by weight of all the Ahuahu material (Table 7.1). No Tahanga basalt was recovered at the Masonic site; however, a large number of Motutapu greywacke artefacts were present. It is argued below that Motutapu greywacke is a useful analogue for Tahanga basalt (see also Chapter 4) and as such is treated the same as Tahanga material for the purposes of the comparison at hand.

In calculating the averages for the base metrics, cores have been excluded for the purposes of tabulation and statistical analysis. This has been done as cores can be exponentially larger in weight and volume and thus can result in non-normal distributions of metrics. Where core artefacts have been excluded, it is noted in the figure captions below.

The EA51 and Tamewhera assemblages are dominated by chert artefacts, which make up 79.01% and 53.10% of lithic material by weight per assemblage respectively. The Stingray Ridge assemblages (EA12-17 Upper, EA12-17 Lower and EA26) and EA2-5 assemblages have the most uniform spread of material, and in all cases on Ahuahu, obsidian from both source zones makes up the smallest component by weight. This is not the case with the
Masonic assemblage, however, where chert is the smallest component of the assemblage. This is perhaps not surprising given the known sources of chert on Ahuahu and the lack of known sources proximate to the Masonic site (with the proviso of course that the Masonic site surrounds have not been as extensively surveyed as Ahuahu, and that the intensively developed urban environment that the Masonic site is located on precludes this now anyway). The source designations of the obsidian by assemblage will be dealt with in more detail below, but regardless all obsidian found at the Masonic site (including the Great Barrier Island obsidian) must have been transported further from source than any of the obsidian found on Ahuahu. Furthermore, the total weight of obsidian found at the Masonic site is 75% of the total weight of obsidian found at the combined Ahuahu sites examined here, showing what an important component the obsidian is to the Masonic assemblage. In summary, all materials are represented in varying degrees in all assemblages (with the proviso relating to the Masonic site greywacke outlined above), meaning that cross-assemblage comparisons are possible in all cases.

<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>Tahanga Basalt weight (g)</th>
<th>Tamewhera Basalt weight (g)</th>
<th>Chert weight (g)</th>
<th>Mayor Island Obsidian weight (g)</th>
<th>CVZ Obsidian weight (g)</th>
<th>Total Weight all lithic artefacts&gt;20mm (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>15754.53</td>
<td>0</td>
<td>2175.26</td>
<td>412.36</td>
<td>314.87</td>
<td>18568.91</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>330.65</td>
<td>0</td>
<td>255.9</td>
<td>171.69</td>
<td>74.07</td>
<td>832.31</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>1541.73</td>
<td>160.78</td>
<td>1613.1</td>
<td>141.55</td>
<td>236.61</td>
<td>3693.77</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>460.98</td>
<td>0</td>
<td>149.43</td>
<td>51.58</td>
<td>73.92</td>
<td>735.91</td>
</tr>
<tr>
<td>EA 26</td>
<td>764.98</td>
<td>0</td>
<td>430.21</td>
<td>144.1</td>
<td>261.12</td>
<td>1600.41</td>
</tr>
<tr>
<td>EA 51</td>
<td>1170.03</td>
<td>0</td>
<td>6133.05</td>
<td>398.76</td>
<td>60.94</td>
<td>7762.78</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>669.12</td>
<td>2423.99</td>
<td>4418.92</td>
<td>574.86</td>
<td>509.73</td>
<td>8596.62</td>
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<tr>
<td>Masonic</td>
<td>8341.01</td>
<td>0</td>
<td>1375.75</td>
<td>1597.9</td>
<td>949.82</td>
<td>8341.01</td>
</tr>
</tbody>
</table>

Table 7.1. Assemblage weight by raw material per Excavation Zone assemblage.
Obsidian source percentages by weight vary across Excavation Areas. Across all of Ahuahu, Mayor Island obsidian accounts for 53% by weight and obsidian from the three Coromandel sources accounts for 47%. Weight values were log transformed to normalise their distribution and those log transformed values show a significant difference in the average transformed weight values, meaning Coromandel Volcanic Zone artefacts are on average heavier than Mayor Island Obsidian artefacts (Independent samples t-test: $t = 2.510$ (df 170), $p = .013$).
<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Total weight MIO and CVZ combined (g)</th>
<th>% Mayor Island Obsidian</th>
<th>% CVZ Obsidian</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>639.12</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>245.70</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>327.90</td>
<td>41.67</td>
<td>58.33</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>125.50</td>
<td>41.10</td>
<td>58.90</td>
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<td>EA 26</td>
<td>278.59</td>
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<tr>
<td>EA 51</td>
<td>459.70</td>
<td>87</td>
<td>13</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>963.66</td>
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<td>47</td>
</tr>
<tr>
<td>All Ahuahu</td>
<td>3040.17</td>
<td>53</td>
<td>47</td>
</tr>
<tr>
<td>Masonic</td>
<td>904.12</td>
<td>69</td>
<td>31</td>
</tr>
</tbody>
</table>

Table 7.2. Obsidian source ratios for obsidian artefacts by weight from all Excavation Areas

As noted in Chapter 3, at 80km in a straight seaward route, Mayor Island is approximately three times further away from Ahuahu than two of the Coromandel sources (Cook’s Beach and Hahei), although in real terms to a highly skilled maritime people the greater distance may have had no practical impediment.
7.3. Artefact maximum dimensions: maximum length, width and thickness

7.3.1 Tahanga basalt metrics

With respect to Tahanga basalt assemblages across excavation zones, two sources of statistically significant variability are immediately apparent at the outset (ANOVA, Bonferroni post-hoc, maximum length: $F_{(df/7, 2375)} = 9.164, p <0.001$, maximum width: $F_{(df/7, 2375)} = 10.178, p <0.001$, maximum thickness: $F_{(df/7, 2375)} = 6.969, p <0.001$). There is considerable disparity between the maximum length, width and thickness of the Tamewhera Excavation Zone Tahanga basalt assemblage which has on average larger values than the rest of the Ahuahu assemblages, and the EA12-17 Lower Tahanga basalt assemblage, which has on average smaller values. Removing both these outliers returns non-significant results for all but maximum width, where a small difference in values between the average widths of the EA1 and EA51 assemblages accounts for the significant ANOVA result for this metric (ANOVA, Bonferroni post-hoc, maximum length: $F_{(df/4, 462)} = 1.839, p=0.119$, maximum width: $F_{(df/4, 462)} = 3.630, p = 0.006$, maximum thickness: $F_{(df/4, 462)} = 1.100, p = 0.355$).

It is important to note there were only 19 Tahanga basalt artefacts in the Tamewhera Excavation Zone assemblage, a comparatively low number when compared to the rest of Ahuahu. Taphonomic causes for the discrepancy in Tahanga basalt metrics appear unlikely – as will be noted below, chert and obsidian artefacts from Tamewhera do not demonstrate that same divergence in metrics from the overall population. Additionally, the Tamewhera overall basalt assemblage consisted of both Tahanga basalt (22%) and Tamewhera basalt (78%). None of the other Ahuahu assemblages contained anything like (if any) the amount of local basalt found in the Tamewhera assemblage; the only other Excavation Zone that saw any significant quantity of Ahuahu basalt was EA12-17 Upper, with 10% Tamewhera basalt. Accordingly it is likely that the high proportion of the local material, a noticeably coarser grained rock that contains many more crystalline inclusions and is of poor quality in terms of
its potential for the production of formal tools such as adzes (see Chapter 4), together with a potential difference in the mode of production and use of the basalt flakes at Tamewhera, is the reason for the much larger than average basic metric figures, and this will be discussed in more detail in Section 2 below.

As noted above, the EA12-17 Lower Tahanga basalt assemblage is smaller on average than all other Ahuahu assemblages. The possible reasons for this will be discussed further in Chapter 8.

The Masonic greywacke assemblage has been included in the analysis of basalt assemblages as it is considered an analogous material in terms of its potential for formal tool manufacture and the selection of flakes for informal tool use. As is discussed in Chapter 4, it is a common adze manufacturing material and exhibits many of the same physical properties as Tahanga basalt (which, as was noted earlier, was originally mis-categorised as a greywacke by early geologists). An examination of the basic metrics bear this out – the average length, width and thickness values are statistically indistinguishable from the equivalent values for the EA51 assemblage (Independent samples t-test, average maximum length: \( t = -0.486, df = 787 \), \( p = 0.627 \), average maximum width \( t = -1.634, df = 787 \), \( p = 0.103 \), average maximum thickness \( t = -0.438, df = 787 \), \( p = 0.661 \)), which is an analogue in terms of location, age and supplementary archaeological evidence.
Figure 7.2. Average length, width and thickness for all Tahanga basalt* artefacts >20mm in maximum dimension excluding cores by Excavation Zone. *Masonic Greywacke material included in this figure
7.3.2 Chert metrics

Chert maximum dimension distributions are all very similar. Analysis of the metrics for chert using ANOVA sees significant variability in the assemblage metrics for maximum length and width (maximum length: $F_{(df, 1113)} = 3.316, p = 0.002$ maximum width: $F_{(df, 1113)} = 2.251, p = 0.015$, maximum thickness: $F_{(df, 1113)} = 2.972, p = 0.004$); however, post-hoc testing (Bonferroni) shows that significant differences between the Ahuahu assemblages and the Masonic assemblage are the primary causes of this result. Removing the Masonic assemblage sees non-significant results for maximum width ($F_{(df, 1045)} = 1.890, p = 0.079$) and maximum thickness ($F_{(df, 1045)} = 1.549, p = 0.159$), and a significant result only for maximum length ($F_{(df, 1045)} = 3.039, p = 0.006$), which is explained by a difference in the average length of EA1 artefacts and EA12-17 Upper chert artefacts; all other comparisons are statistically insignificant. Overall, then, there is little to separate the distributions of Ahuahu chert metrics, and the Masonic assemblage measurements stand out as being larger on average than the Ahuahu assemblage with the largest average dimensions (EA1).

Figure 7.3. Average maximum length, width and thickness for all chert artefacts >20mm in maximum dimension excluding cores by Excavation Zone.
7.3.3 Mayor Island obsidian metrics

EA1 and EA26 Mayor Island Obsidian assemblage maximum dimensions are on average larger than the other Ahuahu assemblages and the Masonic assemblage, while the EA12-17 Upper assemblage metrics are on average smaller; ANOVA analysis of the Mayor Island Obsidian assemblages confirms significant variation across the groups and Bonferroni post-hoc testing confirms the source of the variation is the larger dimensions for EA1 and EA26 Mayor Island Obsidian assemblages and the smaller average dimensions for EA12-17 Upper (maximum length: $F_{(df\,7,781)} = 7.058, p < 0.001$ maximum width: $F_{(df\,7,781)} = 5.740, p < 0.001$, maximum thickness: $F_{(df\,7,781)} = 2.101, p = 0.041$).

Independent samples t-tests show no statistically significant difference between the metrics for EA1 and EA26 (maximum length: $t = -0.051_{(df\,82)}, p = 0.959$; maximum width: $t = -0.029_{(df\,82)}, p = 0.977$; maximum thickness $t = -0.713_{(df\,82)}, p = 0.478$).

![Figure 7.4. Average length for all Mayor Island obsidian artefacts >20mm in maximum dimension excluding cores by Excavation Area.](image-url)
7.3.4 Coromandel Volcanic Zone obsidian metrics

As with the Mayor Island Obsidian, the Coromandel Volcanic Zone assemblages show significant variation in average metrics values, with the EA1 assemblage again standing out as being larger on average with respect to maximum length, width and thickness. When the EA1 and Masonic assemblages are removed the only statistically significant difference in any of the dimension averages is with respect to the EA12-17 Lower average maximum thickness value (5.71mm) and the average thickness value for EA51 (9.98mm) (t=-2.902, df 29, p = 0.015), but it should be noted that the EA51 Coromandel Volcanic Zone assemblage is comparatively small (n=10).

![Graph](image)

Figure 7.5. Average length for all Mayor Island obsidian artefacts >20mm in maximum dimension excluding cores by Excavation Zone.
7.4. Metrics Summary

In summary, the base metrics for all materials across all excavation zones are very similar. With respect to Tahanga basalt, the Tamewhera Tahanga basalt artefacts were considerably larger on average than the Tahanga basalt artefacts in other assemblages, and the EA12-17 Lower assemblage was significantly smaller in average dimension values. Chert artefact dimensions only saw significant differences between the Masonic assemblage and the Ahuahu assemblages, perhaps not surprising given the different likely source material factors (local versus non-local) or original cobble or block size. The obsidian assemblages are also very similar, with only EA1 consistently standing out as larger in terms of average artefact size for both Mayor Island and Coromandel Volcanic Zone obsidians.
7.5. Fragmentation ratios

Fragmentation ratios were calculated by dividing the number of complete flakes in each raw material assemblage by the number of proximal flakes following the methodology set out in Phillips (2011: 139). Fragmentation of stone artefacts can be the result of a variety of processes: fragmentation at the point of detachment from the core, movement due to downslope erosion, stock or human trampling and depositional processes such as refuse dumping, site maintenance and later disturbance of earlier deposits can all play a part (Douglass and Wandsnider 2012). It is assumed that instances of fragmentation during the course of flake manufacture would have occurred at a constant rate across all assemblages at all times, given the raw materials are the same, so it can be inferred that differences in fragmentation ratios (if any) are the result of taphonomic, not manufacturing, causes. As set out in Chapter 3, Ahuahu has been lightly stocked over the course of its farming history; nevertheless, given the different Excavation Area physical and chronological contexts, it is not unreasonable to expect there may be significant differences in fragmentation ratios across the Excavation Areas. The assemblages from EA1 and EA51 were recovered from relatively deeply buried (> 50cm) sand dune contexts that appear to be at least 500 years old, and the underlying substrate in both cases was more sand. Stingray Ridge and Tamewhera assemblages were recovered from relatively shallow contexts (< 30cm) in open pasture and topsoil that rapidly transformed into a sterile impermeable clay layer. The Stingray Ridge Excavation zone spans both early and late dates, while the Tamewhera Zone is late in the pre-contact sequence. The Tamewhera Excavation Zone is also comparatively rocky and on a much steeper gradient than all the Excavation Zones (notwithstanding the fact that the bulk of the excavated material was recovered from relatively flat built terraces). EA2-5 is on a flat back-dune terrace covered in pasture that in some places went down onto a very hard modified bedrock, and is as such an intermediate or hybrid of the other Ahuahu Excavation Zones. The
Masonic assemblage was recovered from a beachfront dune context and chronological context very similar to EA1 and EA51. However, despite the afore-mentioned differences, fragmentation across the assemblages by material are broadly similar, as will be discussed in more detail below.
7.5.1 Basalt fragmentation ratios

The average fragmentation ratio for Ahuahu Tahanga basalt is 1.97. Chi-square analysis was performed on all zones with \( n > 25 \) for combined complete and proximal flakes. Initial analysis saw a significant result (\( \chi^2 = 24.50, \ df = 4, \ p < .001 \)), as might be suspected given the low ratio (0.5) for the EA12-17 (Lower) assemblage. When this outlier was removed, no statistically significant difference between the ratios for EA1, EA12-17 (Upper), EA26 or EA51 was observed (\( \chi^2 = 6.34, \ df = 3, \ p = 0.96 \)). Thus EA12-17 Lower is significantly more fragmented than the other assemblages. This could be the result of the nature of the depositional history of this assemblage and its comparative age, as will be discussed further in Chapter 8.

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Complete basalt flakes (n)</th>
<th>Proximal basalt flakes (n)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>605</td>
<td>271</td>
<td>2.23</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>9</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>EA 12-17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper</td>
<td>45</td>
<td>31</td>
<td>1.45</td>
</tr>
<tr>
<td>Lower</td>
<td>12</td>
<td>24</td>
<td>0.5</td>
</tr>
<tr>
<td>EA 26</td>
<td>26</td>
<td>13</td>
<td>2.0</td>
</tr>
<tr>
<td>EA 51</td>
<td>38</td>
<td>28</td>
<td>1.36</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>6</td>
<td>6</td>
<td>1.0</td>
</tr>
<tr>
<td>All Ahuahu</td>
<td>741</td>
<td>376</td>
<td>1.97</td>
</tr>
<tr>
<td>Masonic</td>
<td>330</td>
<td>87</td>
<td>3.79</td>
</tr>
</tbody>
</table>

Table 7.3. Fragmentation ratios for Tahanga basalt* artefacts from all Excavation Zones
*Masonic greywacke material included in this table.
The Masonic greywacke assemblage, with a ratio of 3.79, is considerably less fragmented than the Ahuahu assemblages. This could be the result of different taphonomic processes, although it is submitted that this is unlikely given the similar scenario to EA1 and EA51, and the fact that the EA1 assemblage (also appearing to be comprised largely of debitage relating to adze manufacturing) is the closest in terms of fragmentation ratio to the Masonic assemblage. More likely is that the different relative hardness values of Tahanga basalt and Motutapu greywacke (see Chapter 3) result in different fragmentation rates, and as such the difference is simply due to the different physical properties of the two different geological materials.
7.5.2 Chert fragmentation ratios

Aside from EA2-5 and EA12-17 Lower, which have small sample sizes and were not included in the Chi-square analysis, there is no statistically significant difference in the fragmentation ratios for chert flakes between the excavation zones on Ahuahu ($\chi^2 = 2.50$, $df = 5$, $p = 0.648$).

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Complete chert flakes (n)</th>
<th>Proximal chert flakes (n)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>57</td>
<td>14</td>
<td>4.07</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>15</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>39</td>
<td>12</td>
<td>3.25</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>EA 26</td>
<td>23</td>
<td>7</td>
<td>3.28</td>
</tr>
<tr>
<td>EA 51</td>
<td>106</td>
<td>25</td>
<td>4.24</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>74</td>
<td>12</td>
<td>6.17</td>
</tr>
<tr>
<td>All Ahuahu</td>
<td>321</td>
<td>71</td>
<td>4.5</td>
</tr>
<tr>
<td>Masonic</td>
<td>24</td>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 7.4. Fragmentation ratios for chert artefacts from all Excavation Zones
7.5.3 Obsidian fragmentation ratios

Initial analysis of all Mayor Island Obsidian assemblages with a total $n$ of 25 or greater saw a significant result returned ($\chi^2 = 10.26$, $df$ 4, $p = 0.036$). Further testing saw that the Tamewhera Mayor Island Obsidian assemblage was the cause of the significance; Chi-square analysis of the assemblages excluding Tamewhera saw a non-significant result ($\chi^2 = 0.397$, $df$ 3, $p = 0.966$). Tamewhera was thus proportionally more fragmented than the other assemblages.

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Complete Mayor Island obsidian flakes (n)</th>
<th>Proximal Mayor Island obsidian flakes (n)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>40</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>25</td>
<td>2</td>
<td>12.5</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>24</td>
<td>2</td>
<td>12.5</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>8</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>EA 26</td>
<td>11</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>EA 51</td>
<td>35</td>
<td>3</td>
<td>11.66</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>31</td>
<td>10</td>
<td>3.1</td>
</tr>
<tr>
<td>Masonic</td>
<td>155</td>
<td>21</td>
<td>7.38</td>
</tr>
</tbody>
</table>

Table 7.5. Fragmentation ratios for Mayor Island obsidian artefacts from all Excavation Zones

The $n$ values for all the Coromandel Volcanic Zone obsidian assemblages are fairly small and as a result a Fisher’s exact test was run. This returned a non-significant result: ($\chi^2 = 4.127$, $df$ 3, $p = 0.127$).
4, \( p = 0.395 \), suggesting the fragmentation ratios cannot be statistically distinguished according to assemblage.

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Complete CVZ obsidian flakes (n)</th>
<th>Proximal CVZ obsidian flakes (n)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>19</td>
<td>4</td>
<td>4.75</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>8</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>10</td>
<td>4</td>
<td>2.5</td>
</tr>
<tr>
<td>EA 26</td>
<td>20</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>EA 51</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>9</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Masonic</td>
<td>111</td>
<td>19</td>
<td>5.84</td>
</tr>
</tbody>
</table>

Table 7.6. Fragmentation ratios for Coromandel Volcanic Zone obsidian artefacts from all Excavation Zones

7.5.4 Summary

Overall, the fragmentation ratios for all assemblages across the same materials are very similar, with little statistically significant variation apparent. This suggests that irrespective of site age or location, taphonomic processes such as stock trampling are not having a major impact on the physical characteristics of individual artefacts. The particularly low fragmentation ratio for EA12-17 Lower Tahanga basalt will be discussed further in Chapter 8.
7.6. ** Flake metrics **

This section reviews the analysis of artefact metrics that relate more specifically to their manufacture and use. Looking at complete flake metrics as opposed to base artefact metrics can give a better understanding of the technological approaches used by the producers of the flakes in their manufacture. Larger average flake lengths and widths can imply larger cores as starting points, or less intensive reduction; either way, different reduction strategies may be identified. Looking at the ratio of average flake length to average flake width, measured as set out in Chapter 4, can give the analyst an impression of the shape of the flakes produced and the corresponding flaking practices used by the manufacturer (Phillips 2011: 150)
7.6.1 Basalt complete flake metrics

As with maximum dimension averages, the Tamewhera Tahanga basalt assemblage stands out as much larger (on average) in terms of individual artefacts, but it is a very small sample ($n = 6$) and as such has been omitted from the statistical analysis comparing variability amongst the remaining Excavation Zones. When the Tamewhera assemblage is removed, there are no statistically significant differences in the flake metric distributions of any of the Tahanga basalt assemblages (ANOVA, Bonferroni post-hoc: flake length: $F_{(5, 731)} = 2.013$, p = 0.075, flake width: $F_{(5, 731)} = 1.980$, p = 0.080, flake thickness: $F_{(5, 731)} = 0.430$, p = 0.828).

![Graph showing average flake length, width, and thickness for different Excavation Zones](image)

**Figure 7.6.** Average complete flake length, width and thickness for all Tahanga basalt artefacts* >20mm in maximum dimension excluding cores by Excavation Zone. *Masonic greywacke material included in this figure.
<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>Basalt n</th>
<th>Average Flake length</th>
<th>Average Flake width</th>
<th>Length to width ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>605</td>
<td>35.07</td>
<td>31.66</td>
<td>1.11</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>12</td>
<td>31.8</td>
<td>35.98</td>
<td>0.88</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>46</td>
<td>32.37</td>
<td>31.94</td>
<td>1.01</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>12</td>
<td>25.38</td>
<td>21.73</td>
<td>1.16</td>
</tr>
<tr>
<td>EA 26</td>
<td>28</td>
<td>33.44</td>
<td>29.94</td>
<td>1.11</td>
</tr>
<tr>
<td>EA 51</td>
<td>38</td>
<td>30.77</td>
<td>29.16</td>
<td>1.04</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>6</td>
<td>56.71</td>
<td>56.13</td>
<td>1.01</td>
</tr>
<tr>
<td>Masonic</td>
<td>330</td>
<td>28.87</td>
<td>33.42</td>
<td>0.86</td>
</tr>
</tbody>
</table>

Table 7.7. Average complete flake length, width and length to width ratios for Tahanga basalt from all Excavation Zones

There is very little difference in the respective average flake length to average flake width ratios for basalt complete flakes across all Ahuahu assemblages, with the exception of EA2-5. The Masonic assemblage, with a ratio of less than one, suggesting flakes are on average wider than they are long, is possibly the result of the different material and starting cobble shape (Andrefsky 2009: 241). EA2-5 is a very small sample, so the results there must be treated with caution; nevertheless the less than one ratio again suggests a differentiation from the other Ahuahu assemblages. Given the lack of other evidence for manufacture of adzes or any particular formal tool, it is suggested that if real, the difference is possibly due to selection of specific flake shapes for specific tasks.
7.6.2 Chert complete flake metrics

Turning now to chert average flake dimensions and ratios, the flake metrics are all very similar, and statistical testing confirms this; there are no significant differences across all assemblages for flake length (ANOVA, Bonferroni post-hoc: flake length: $F_{(7, 334)} = 1.082$, $p = .375$) and the only statistically significant difference between flake width and thickness distributions is the result of the EA2-5 assemblage which is consistently smaller across both those metrics (ANOVA, Bonferroni post-hoc: flake width: $F_{(7, 334)} = 2.443$, $p = 0.019$, flake thickness: $F_{(7, 334)} = 2.626$, $p = 0.012$). When EA2-5 is removed there are no differences in the flake metric distributions.

![Average complete flake length, flake width and flake thickness for chert from all Excavation Zones](image)

**Figure 7.7.** Average complete flake length, flake width and flake thickness for chert from all Excavation Zones
<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>Chert n</th>
<th>Average Flake length</th>
<th>Average Flake width</th>
<th>Length to width ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>57</td>
<td>28.09</td>
<td>26.69</td>
<td>1.05</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>14</td>
<td>21.99</td>
<td>19.74</td>
<td>1.11</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>41</td>
<td>25.00</td>
<td>23.89</td>
<td>1.05</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>7</td>
<td>27.10</td>
<td>25.16</td>
<td>1.08</td>
</tr>
<tr>
<td>EA 26</td>
<td>23</td>
<td>25.28</td>
<td>19.85</td>
<td>1.27</td>
</tr>
<tr>
<td>Stingray Hillslope</td>
<td>10</td>
<td>23.66</td>
<td>22.95</td>
<td>1.03</td>
</tr>
<tr>
<td>EA 51</td>
<td>104</td>
<td>27.75</td>
<td>23.86</td>
<td>1.16</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>70</td>
<td>27.07</td>
<td>23.85</td>
<td>1.13</td>
</tr>
<tr>
<td>All Ahuahu</td>
<td>323</td>
<td>26.72</td>
<td>23.92</td>
<td>1.11</td>
</tr>
<tr>
<td>Masonic</td>
<td>24</td>
<td>30.34</td>
<td>27.92</td>
<td>1.08</td>
</tr>
</tbody>
</table>

Table 7.8. Average complete flake length, width and length to width ratios for chert from all Excavation Zones

Unsurprisingly, flake length to width ratios are all very similar as well, suggesting little differentiation in manufacturing techniques, or inter-site differentiation in flake shapes selected for use.
7.6.3 *Mayor Island obsidian complete flake metrics*

As was the case with the metrics for maximum length, width and breadth, the complete flake length, complete flake width and complete flake breadth dimensions for EA1 and EA26 Mayor Island obsidian are statistically significantly larger than the other Excavation Zones (ANOVA, Bonferroni post-hoc: flake length: $F_{(7, 316)}=4.389, p<.000$, flake width: $F_{(7, 316)}=4.372, p<.000$, flake thickness: $F_{(7, 316)}=3.957, p<.000$). When EA1 and EA26 are removed there is no variation across distributions for any complete flake metrics for the remaining Ahuahu assemblages (ANOVA, Bonferroni post-hoc: flake length: $F_{(4, 116)}=.605, p=.660$, flake width: $F_{(4, 116)}=1.579, p=.185$, flake thickness: $F_{(4, 116)}=.740, p<.566$).

![Figure 7.8. Average Mayor Island obsidian complete flake length, width and thickness for all Mayor Island obsidian artefacts >20mm in maximum dimension, excluding cores, by Excavation Zone.](image)

237
This EA1 discrepancy is also reflected in the length to width ratio with the EA26 assemblage being the only assemblage that displays a length to width ratio of greater than 1.5 (1.52).

This would suggest that in addition to a difference in size and the implication that the flakes in the EA26 assemblage were being struck from larger cores, they were also being manufactured in a slightly different way so as to affect the length to width ratio. From a technological point of view, this above average flake length is at odds with average core size and core to flake ratios.

<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>MIO n</th>
<th>Average Flake length</th>
<th>Average Flake width</th>
<th>Length to width ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>45</td>
<td>26.57</td>
<td>24.50</td>
<td>1.08</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>27</td>
<td>21.28</td>
<td>21.43</td>
<td>0.99</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>28</td>
<td>19.63</td>
<td>18.63</td>
<td>1.05</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>9</td>
<td>23.04</td>
<td>19.87</td>
<td>1.15</td>
</tr>
<tr>
<td>EA 26</td>
<td>13</td>
<td>30.64</td>
<td>20.15</td>
<td>1.52</td>
</tr>
<tr>
<td>EA 51</td>
<td>41</td>
<td>21.25</td>
<td>20.75</td>
<td>1.02</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>55</td>
<td>21.30</td>
<td>18.58</td>
<td>1.14</td>
</tr>
<tr>
<td>Masonic</td>
<td>188</td>
<td>22.75</td>
<td>23.13</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Table 7.9. Average complete flake length, width and length to width ratios for Mayor Island obsidian from all Excavation Zones
7.6.4 Coromandel Volcanic Zone complete flake metrics

Given the relatively low numbers for some of the assemblages, non-parametric Kruskal-Wallis tests were used to evaluate the null hypothesis that the distribution of flake length, width and thickness values were the same across all assemblages. A non-significant result (p=.549) was returned for flake length, suggesting that the null hypothesis could be retained and there was no difference in distributions among the assemblages. Significant results were returned for flake width (p=.019) and flake thickness (p=.018), however, and further investigation of the data suggested that the EA1 Coromandel Volcanic Zone obsidian values were the cause of the significant result. Consequently, re-running the Kruskal-Wallis tests excluding data from EA1 returned non-significant results for both flake width (p=.451) and flake thickness (p=.232). As is apparent from Figure 7.8, flake widths and thicknesses for EA1 Coromandel Volcanic Zone obsidian were on average greater than all the other assemblages.
Figure 7.9. Average Coromandel Volcanic Zone obsidian complete flake length, width and thickness for all Coromandel Volcanic Zone obsidian artefacts >20mm in maximum dimension, excluding cores, by Excavation Zone.

Flake length to width ratios also showed EA1 as an outlier, with a comparatively low ratio when compared to all others apart from EA2-5 (Figure 6).

<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>CVZ n</th>
<th>Average flake length</th>
<th>Average flake width</th>
<th>Length to width ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>19</td>
<td>28.25</td>
<td>29.76</td>
<td>0.94</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>5</td>
<td>24.34</td>
<td>26.02</td>
<td>0.93</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>8</td>
<td>23.13</td>
<td>19.98</td>
<td>1.15</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>12</td>
<td>28.16</td>
<td>21.73</td>
<td>1.29</td>
</tr>
<tr>
<td>EA 26</td>
<td>25</td>
<td>27.24</td>
<td>22.53</td>
<td>1.20</td>
</tr>
<tr>
<td>EA 51</td>
<td>2</td>
<td>24.93</td>
<td>19.18</td>
<td>1.29</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>17</td>
<td>21.39</td>
<td>19.02</td>
<td>1.12</td>
</tr>
<tr>
<td>Masonic</td>
<td>124</td>
<td>21.5073</td>
<td>20.8448</td>
<td>1.03</td>
</tr>
</tbody>
</table>

Table 7.10. Average Coromandel Volcanic Zone obsidian complete flake length, length to width ratios for all Coromandel Volcanic Zone obsidian artefacts >20mm in maximum dimension

7.6.5 Summary

Overall, flake metrics across all assemblages are very similar. There are no differences between Tahanga basalt assemblages with the exception of the Tamewhera assemblage, which is considerably larger in all dimensions. It is, however, a very small sample and as noted above, Tahanga basalt forms a comparatively low percentage of the lithic artefact material from the Tamewhera Excavation Zone. Chert values show very little difference
either; again, the only statistically significant variation in distribution is from a small sample (EA2-5). All of the other assemblages are statistically indistinguishable.

In both Mayor Island and Coromandel Volcanic Zone obsidian assemblages, EA1 flakes stand out as being longer, wider and thicker on average than the other assemblages, except for EA26 Mayor Island obsidian, which returned similar values to EA1 Mayor Island obsidian.
7.7. **Minimum number of flake to core ratios**

Minimum Number of Flake (MNF) to core ratios reflect reduction intensity; higher values represent increased reduction intensity (Holdaway *et al.* 2008: 127). These ratios are calculated by calculating the Minimum Number of Flakes per assemblage in a manner analogous to the calculation of the Minimum Number of Individuals (MNI) in faunal analysis, and follows the methodology set out in Holdaway and Stern (2004: 114-115). The total number of complete flakes, complete flake tools, proximal flakes and proximal flake tools are added to half the total number of complete split flakes, complete split flake tools, proximal split flakes and proximal split flake tools (these are halved so as to avoid double-counting left and right splits of the same flake in the same way that bivalve shellfish valve counts are often halved when calculating MNI for bivalve shellfish) and divided by the number of cores present in each assemblage. This ratio gives an indication of the intensity of reduction of a given assemblage (Phillips 2011: 130). The MNF to core ratios for the study assemblages are presented in accordance with raw material in tables 7.11 (chert) and 7.12-7.13 (obsidian) below.

In this section I have only compared minimum number of flake to core ratios for the obsidian and chert assemblages. This is because the cores in the basalt assemblages are either non-existent or are presumed to be adze preforms and as such do not reflect a “standard” approach in respect of core reduction; rather, a process by which the core tool, instead of the flake, may be the desired outcome.

The MNF to core ratios for chert artefacts (Table 7.11) are all very similar; no statistically significant differences were identified between assemblages (Pearson Chi-square: $\chi^2 = 6.932$, df 5, $p = .224$). Even the largest chert sample of EA51 showed little difference from the remaining Excavation Zones. The Masonic assemblage also showed a similar ratio to the Ahuahu assemblages despite the lower number of flakes and cores overall.
<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>MNF (Chert)</th>
<th>Core</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>74.5</td>
<td>14</td>
<td>5.32</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>18</td>
<td>7</td>
<td>2.57</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>64.5</td>
<td>16</td>
<td>4.03</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>8.5</td>
<td>0</td>
<td>8.5</td>
</tr>
<tr>
<td>EA 26</td>
<td>32.5</td>
<td>3</td>
<td>10.00</td>
</tr>
<tr>
<td>EA 51</td>
<td>266</td>
<td>40</td>
<td>6.65</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>108.5</td>
<td>26</td>
<td>4.17</td>
</tr>
<tr>
<td>All Ahuahu</td>
<td>581.5</td>
<td>110</td>
<td>5.29</td>
</tr>
<tr>
<td>Masonic</td>
<td>27.5</td>
<td>6</td>
<td>4.58</td>
</tr>
</tbody>
</table>

**Table 7.11. MNF to core ratios for chert artefacts from all Excavation Areas**

The overall MNF to core ratios for all the Ahuahu Mayor Island obsidian assemblages is higher than that for the chert assemblages, suggesting a higher degree of reduction (Phillips 2011, Shiner et al. 2007) of Mayor Island obsidian cores, which is unsurprising given the wide availability of good-quality Ahuahu chert. As with the chert assemblages, there is no significant difference between Mayor Island obsidian assemblage ratios (Pearson Chi-square: $\chi^2 = 3.129, df 5, p = .689$).
<table>
<thead>
<tr>
<th><em>Excavation Area</em></th>
<th>Mayor Island Obsidian MNF</th>
<th>Mayor Island Obsidian Cores</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>43.5</td>
<td>3</td>
<td>14.5</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>28.5</td>
<td>3</td>
<td>9.5</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>29.5</td>
<td>2</td>
<td>14.75</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>9.5</td>
<td>0</td>
<td>9.5</td>
</tr>
<tr>
<td>EA 26</td>
<td>14</td>
<td>1</td>
<td>14.0</td>
</tr>
<tr>
<td>EA 51</td>
<td>38</td>
<td>7</td>
<td>5.43</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>54</td>
<td>5</td>
<td>10.8</td>
</tr>
<tr>
<td>All Ahuahu</td>
<td>250</td>
<td>21</td>
<td>11.90</td>
</tr>
<tr>
<td>Masonic</td>
<td>196.5</td>
<td>16</td>
<td>12.28</td>
</tr>
</tbody>
</table>

Table 7.12. MNF to core ratios for Mayor Island obsidian artefacts from all Excavation Areas

Coromandel Volcanic Zone obsidian, on the other hand, shows much more variability in the MNF to core ratios. No cores were found at all in the EA1, EA2-5, EA12-17 Lower and EA51 assemblages, although this could be a function of the low presence of Coromandel Volcanic Zone obsidian in those assemblages. Of the three Ahuahu Coromandel Volcanic Zone obsidian assemblages with cores, Chi-square analysis shows a significant difference in the MNF to core ratios (Pearson Chi-square: $\chi^2 = 6.856, df = 2, p = .032$). Further investigation of the data confirms that this significant result is due to the EA26 ratio; there is no significant difference between the EA12-17 Upper and Tamewhera assemblages (Pearson Chi-square: $\chi^2 = 2.530, df = 1, p = .118$).
<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>CVZ Obsidian MNF</th>
<th>CVZ Obsidian Cores</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>23.5</td>
<td>0</td>
<td>23.5</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>4.5</td>
<td>0</td>
<td>4.5</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>11.5</td>
<td>5</td>
<td>2.3</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>14.5</td>
<td>0</td>
<td>14.5</td>
</tr>
<tr>
<td>EA 26</td>
<td>25</td>
<td>3</td>
<td>8.33</td>
</tr>
<tr>
<td>EA 51</td>
<td>4.5</td>
<td>0</td>
<td>4.5</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>17</td>
<td>12</td>
<td>1.42</td>
</tr>
<tr>
<td>Masonic</td>
<td>137</td>
<td>11</td>
<td>11.91</td>
</tr>
</tbody>
</table>

Table 7.13. MNF to core ratios for Coromandel Volcanic Zone obsidian artefacts from all Excavation Areas

7.7.1 Summary

Overall, flake to core ratios by material across assemblages show less apparent reduction intensity for chert when compared to Mayor Island obsidian. However, there is no difference within material types across assemblages for chert and Mayor Island obsidian. Coromandel Volcanic Zone obsidian stands out in both the number of Excavation Zones that presented no cores, and the different ratios between those that did: EA26 stands alone for Coromandel Volcanic Zone obsidian in having a comparatively large Coromandel Volcanic Zone obsidian assemblage as a proportion of all obsidian in the assemblage, and comparatively few cores.
7.8. **Core volumes and morphology**

Core dimensions and morphology can give an indication as to the degree of reduction being undertaken with respect to a specific lithic material at a particular place (Andrefsky 2009, Shiner 2007, Phillipps et al. 2016). Broadly, the smaller the core dimensions, the greater degree of reduction displayed; the presence of large cores with considerable “potential” in terms of their ability to produce more useable flakes suggests that economisation of material was not a high priority for the tool makers, either due to the nature of the tools being manufactured or the relative abundance of the material to hand. Similarly, the greater core rotation (i.e. the number of platforms per core from which flakes have been struck) can be indicative of more intensive reduction: small, highly rotated cores are presumed to have been more intensively exploited than large cores with uni-directional or bi-directional flake scarring (Holdaway and Stern 2004, Phillips et al. 2016). As with MNF to core ratios discussed above, only chert and obsidian core volumes have been calculated and compared for the reasons set out in the previous section.

In order to avoid skewing data due to irregularly shaped cores, core volumes rather than core maximum dimensions were analysed. In calculating core volumes the formula for the volume of a scalene ellipsoid \( V = \frac{4}{3} \pi abc \) has been used (where \( a=\frac{1}{2}\)Maximum Length, \( b=\frac{1}{2}\)Maximum Width and \( c=\frac{1}{2}\)Maximum Thickness, rather than volume of a sphere \( V = \frac{4}{3} \pi r^3 \), as this takes into account the differences between ML, MW, MT: if these values move towards equivalence and hence sphericity then the formula approaches that of the volume of a sphere in any case (Phillips et al. 2016). Due to the non-normal distribution of volume values, all core volume data has been Log Normal transformed prior to statistical testing, and median values rather than mean values displayed in Tables 7.14 to 7.16 inclusive.
7.8.1 Chert core volume and morphology

The Excavation Zones with the smallest chert core numbers (EA2-5, EA12-17 Upper, and EA26, see Table 7.14) also have the smallest median chert volumes. Of the assemblages with more than 10 cores, EA12-17 Upper stands out as having significantly smaller mean and median core volumes than EA1, EA51 and Tamewhera (ANOVA, Bonferroni post-hoc: Log transformed core volume: $F_{(3, 98)} = 4.170, p = .008$). EA1, EA51 and Tamewhera chert cores are statistically indistinguishable by core volume (ANOVA, Bonferroni post-hoc: Log transformed core volume: $F_{(2, 82)} = 1.779, p = .175$).

<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>Chert n</th>
<th>Median volume (cm$^3$)</th>
<th>Ratio uni/bi-directional to multiple platform cores</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>14</td>
<td>28.01</td>
<td>6:8</td>
</tr>
<tr>
<td>EA2-5</td>
<td>7</td>
<td>6.58</td>
<td>1:6</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>16</td>
<td>10.08</td>
<td>3:13</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>0</td>
<td>0.00</td>
<td>0:0</td>
</tr>
<tr>
<td>EA 26</td>
<td>3</td>
<td>7.75</td>
<td>1:2</td>
</tr>
<tr>
<td>EA 51</td>
<td>40</td>
<td>24.54</td>
<td>6:34</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>30</td>
<td>28.27</td>
<td>7:23</td>
</tr>
<tr>
<td>Masonic</td>
<td>6</td>
<td>14.71</td>
<td>0:6</td>
</tr>
</tbody>
</table>

**Table 7.14. Chert core median volume (cm$^3$) and core rotation ratios**

It is possible that the variability in mean and median core volume and assemblage size relates to the size of the chert assemblage in each case; EA1, EA51 and Tamewhera chert assemblages are the largest by weight of all the Ahuahu chert assemblages at 2.18kg, 6.13kg.
and 4.42kg respectively. However, EA12-17 Upper is still a reasonably large chert assemblage by weight at 1.61kg and is almost four times the next largest assemblage (EA26: 0.43kg), so the correlation between assemblage size by weight and core volume may not be straightforward.

In all cases cores rotated in multiple directions outnumbered cores with only one or two striking platforms, irrespective of relative core volumes. For those assemblages with more than 10 cores there was no statistically significant difference in the ratios of unidirectional/bi-directional platform cores to multiple platform cores (Pearson Chi-square: $\chi^2 = 4.821, df 3, p = .190$).
7.9. **Obsidian core volumes**

Median core volumes for both Mayor Island Obsidian and Coromandel Volcanic Zone obsidian were both smaller than those for the chert cores, suggesting a different approach to core reduction that probably results from the different nature of the raw material and its availability. Despite the relatively low absolute numbers of obsidian cores, it can be argued that it is likely that the obsidian core artefacts from both obsidian sources were reduced in the same way to the same approximate size, as there is no statistically significant difference between the distributions of the log-transformed core volumes of the two obsidian sources across assemblages (Independent samples t-test: $t = -1.62$, df = 38, $p = .109$), nor any differences between assemblages of the same source material (Kruskal-Wallis non-parametric tests MIO $p=.159$ and CVZ $p=.998$).

<table>
<thead>
<tr>
<th><strong>Excavation Area</strong></th>
<th><strong>Mayor Island Obsidian</strong> n</th>
<th><strong>Median volume (cm³)</strong></th>
<th><strong>Ratio sidia/bi-directional to multiple platform cores</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>3</td>
<td>1.92</td>
<td>0:3</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>3</td>
<td>4.22</td>
<td>0:3</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>2</td>
<td>1.98</td>
<td>0:2</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>0</td>
<td>0.00</td>
<td>0:0</td>
</tr>
<tr>
<td>EA 26</td>
<td>1</td>
<td>8.25</td>
<td>0:1</td>
</tr>
<tr>
<td>EA 51</td>
<td>7</td>
<td>7.74</td>
<td>2:5</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>5</td>
<td>3.01</td>
<td>1:4</td>
</tr>
<tr>
<td>Masonic</td>
<td>16</td>
<td>4.33</td>
<td>2:14</td>
</tr>
</tbody>
</table>

Table 7.15. Mayor Island obsidian core average volume in cm³
This may reflect a normal minimum practical core size that is reached before discard. As with the chert core assemblages, cores with multi-directional platforms outnumbered uni- or bi-directional cores in all cases across both Mayor Island Obsidian and Coromandel Volcanic Zone obsidian, but the small number of cores in total precluded any meaningful statistical comparisons of the ratios of the two core platform direction categories.

<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>CVZ obsidian n</th>
<th>Median volume (cm$^3$)</th>
<th>Ratio uni/bi-directional to multiple platform cores</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>0</td>
<td>0.00</td>
<td>0:0</td>
</tr>
<tr>
<td>EA2-5</td>
<td>1</td>
<td>8.35</td>
<td>0:1</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>5</td>
<td>5.67</td>
<td>2:3</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>0</td>
<td>0.0</td>
<td>0:0</td>
</tr>
<tr>
<td>EA 26</td>
<td>3</td>
<td>4.55</td>
<td>0:3</td>
</tr>
<tr>
<td>EA 51</td>
<td>0</td>
<td>0.00</td>
<td>0:0</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>13</td>
<td>5.58</td>
<td>2:11</td>
</tr>
<tr>
<td>Masonic</td>
<td>11</td>
<td>4.94</td>
<td>3:8</td>
</tr>
</tbody>
</table>

Table 7.16. Coromandel Volcanic Zone obsidian core median volume in cm$^3$

7.10. Summary

The only real inter-site patterning that presents itself when looking at core volumes and core rotation characteristics across Excavation Zones and raw material sources occurs with respect to chert core volumes. EA12-17 Upper has lower median core volumes than the other assemblages, but despite this, it does not appear that these smaller cores have been reduced to the point of minimal flaking utility; they are still larger on average than the obsidian cores of both raw material sources from all assemblages. So while the cores from EA12-17 Upper
may have been more heavily reduced than those from EA1, EA51 and the Tamewhera Zone, it would be difficult to argue that this was as a result of a constriction in the supply of material and consequent increase in economisation of use of that material, given the presumably continued unfettered access to the material and the lack of corresponding core size reduction within the assemblage of a similar chronological age, Tamewhera.
7.11. **Cortical to non-cortical flake ratios**

While it has been noted above that there are considerable difficulties in estimating original cobble or nodule size when it comes to chert or obsidian or basalt cobbles, it is useful to look at the ratios of cortical to non-cortical flakes to ascertain whether there is any variability between assemblages. This is because despite the difficulties with the estimates of cobble size or percentage of cortex cover, it can by hypothesised that if procurement strategies and technological strategies remain the same over time and space on Ahuahu, then one might expect raw material dimensions and corresponding cortical coverage to remain similarly constant. More particularly, in the case of the non-local material, obsidian, if diminished direct access to material resulted in more heavily reduced artefacts, less cortex might appear relative to assemblages from earlier contexts recorded on Ahuahu. Accordingly a comparison that reveals significant variation or patterning in cortical to non-cortical artefact ratios may deliver some insights into the ways in which lithics were being processed or manufactured at a particular site and whether they changed over time. As set out in Chapter 5 (Methodology), cortical measurements on dorsal surfaces were recorded as “non-cortical”, “0-50% cortical” and “50% to complete cortical”. The cortical measures were combined to allow meaningful statistical comparisons with non-cortical frequencies, but the individual cortical category frequencies are discussed in more detail in the case of the chert assemblages, which had higher and more varied cortical coverage percentages.
7.11.1 Tahanga basalt cortical to non-cortical ratios

Tahanga basalt cortical to non-cortical artefact ratios are broadly similar, save for EA1, which has a much higher percentage of cortical flakes. When EA1 is included in statistical testing a significant result is returned (Pearson Chi-square: $\chi^2 = 62.37, df\ 6, p < 0.001$); when the EA1 assemblage is excluded, there is no significant difference in the cortical to non-cortical ratios (Pearson Chi-square: $\chi^2 =4.258, df\ 5, p = 0.515$).

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Tahanga Basalt non-cortical</th>
<th>Tahanga Basalt cortical 1-50%</th>
<th>Tahanga Basalt cortical 50% to complete</th>
<th>Ratio non-cortical to cortical</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>940</td>
<td>241</td>
<td>70</td>
<td>3.02</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>24</td>
<td>4</td>
<td>0</td>
<td>6.00</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>129</td>
<td>10</td>
<td>0</td>
<td>12.9</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>85</td>
<td>8</td>
<td>0</td>
<td>10.63</td>
</tr>
<tr>
<td>EA 26</td>
<td>62</td>
<td>3</td>
<td>0</td>
<td>20.66</td>
</tr>
<tr>
<td>EA 51</td>
<td>120</td>
<td>10</td>
<td>0</td>
<td>12.00</td>
</tr>
<tr>
<td>Tamewhera Tahanga</td>
<td>17</td>
<td>3</td>
<td>0</td>
<td>5.66</td>
</tr>
<tr>
<td>Masonic*</td>
<td>528</td>
<td>138</td>
<td>4</td>
<td>3.71</td>
</tr>
</tbody>
</table>

Table 7.17. Non-cortical to cortical flake ratios for basalt* artefacts from all Excavation Zones
*Masonic greywacke included in this table

This suggests that the EA1 assemblage is the result of a different manufacturing or selection process, and the sheer quantity of EA1 Tahanga basalt artefacts, as mentioned earlier, lends itself to the interpretation that it is derived from the manufacture of core tools (adzes) rather than the production of usable flakes. Masonic greywacke has been included in Table 7.17 by way of particular comparison with EA1; although the materials are different, the cortical to
non-cortical ratios are broadly similar, and Chi-square testing returns a non-significant result at the 0.05 level (Pearson Chi-square: $\chi^2 = 3.254, df 1, p = .080$). Again, as noted earlier, it is arguable that the Masonic greywacke assemblage is, like EA1, the result of adze manufacturing in the vicinity.
7.11.2 *Chert cortical to non-cortical ratios*

Turning to chert cortical to non-cortical artefact ratios, it is apparent there is considerable variation amongst the assemblages, as is borne out by a significant Chi-square test (Pearson Chi-square: \( \chi^2 = 24.64, df = 6, p < .001 \)). The smallest assemblages, EA2-5 and EA12-17 Lower, stand out as having considerably higher ratios (and hence relatively fewer cortical flakes) than the other Ahuahu assemblages. The ratios for EA1, EA12-17 Upper and Tamewhera are similar and statistically indistinguishable from each other (Pearson Chi-square: \( \chi^2 = 2.160, df = 2, p = .347 \)). EA26 and EA51 are also similar and statistically indistinguishable (Pearson Chi-square: \( \chi^2 = .584, df = 1, p = .318 \)).

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Chert non-cortical</th>
<th>Chert cortical 1 – 50%</th>
<th>Chert cortical 50% - complete</th>
<th>Ratio non-cortical to cortical</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>75</td>
<td>31</td>
<td>18</td>
<td>1.53</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>36</td>
<td>3</td>
<td>4</td>
<td>5.14</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>99</td>
<td>68</td>
<td>16</td>
<td>1.17</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>19</td>
<td>5</td>
<td>0</td>
<td>3.8</td>
</tr>
<tr>
<td>EA 26</td>
<td>39</td>
<td>16</td>
<td>0</td>
<td>2.44</td>
</tr>
<tr>
<td>EA 51</td>
<td>362</td>
<td>126</td>
<td>45</td>
<td>2.11</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>197</td>
<td>112</td>
<td>17</td>
<td>1.51</td>
</tr>
<tr>
<td>Masonic</td>
<td>29</td>
<td>19</td>
<td>12</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Table 7.18. Non-cortical to cortical flake ratios for chert artefacts from all Excavation Zones

The considerable variability in cortical cover and ratios of cortical to non-cortical artefacts amongst the assemblages is perhaps not surprising given the variability in raw material...
cortical cover (see chert raw material descriptions in Chapter 4), but will be discussed in further detail in Chapter 8.
7.11.3 Mayor Island obsidian cortical to non-cortical ratios

Well over 90% of each Mayor Island obsidian assemblage is non-cortical. For those assemblages with sufficient cortical flakes to run Chi-square tests (EA1, EA51 and Tamewhera) there was no significant difference in the cortical to non-cortical flake ratios (Fisher’s exact $\chi^2 = .495$, df 2, $p = 0.840$). The relatively high cortical to non-cortical flake ratios suggest that the assemblages are heavily reduced or that the cobbles being reduced were either relatively free of cortex to begin with, or, if completely cortical, were comparatively large.

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Mayor Island obsidian non-cortical</th>
<th>Mayor Island obsidian cortical 1-50%</th>
<th>Mayor Island obsidian cortical 50% - complete</th>
<th>Ratio cortical to non-cortical</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>63</td>
<td>4</td>
<td>0</td>
<td>15.75</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>53</td>
<td>0</td>
<td>0</td>
<td>53</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>54</td>
<td>1</td>
<td>0</td>
<td>54</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>20</td>
<td>2</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>EA 26</td>
<td>20</td>
<td>1</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>EA 51</td>
<td>79</td>
<td>5</td>
<td>1</td>
<td>13.16</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>116</td>
<td>9</td>
<td>2</td>
<td>10.55</td>
</tr>
<tr>
<td>Masonic</td>
<td>373</td>
<td>20</td>
<td>0</td>
<td>18.65</td>
</tr>
</tbody>
</table>

Table 7.19. Non-cortical to cortical flake ratios for all Mayor Island obsidian artefacts from all Excavation Zones
7.11.4 Coromandel Volcanic Zone obsidian cortical to non-cortical ratios

Immediately apparent are far lower cortical to non-cortical flake ratios for Coromandel Volcanic Zone obsidian when compared to Mayor Island obsidian. As noted in Chapter 4, it is likely that the Coromandel Volcanic Zone obsidian was acquired in smaller cobbles, with more complete cortical cover. Accordingly, it is likely higher relative percentages of cortical Coromandel Volcanic Zone material as compared to Mayor Island Obsidian material were being transported to Ahuahu.

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>CVZ Obsidian non-cortical</th>
<th>CVZ Obsidian cortical 1-50%</th>
<th>CVZ Obsidian cortical 50% - complete</th>
<th>Non-cortical to cortical ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>29</td>
<td>3</td>
<td>4</td>
<td>4.14</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>0.66</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>27</td>
<td>8</td>
<td>6</td>
<td>1.92</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>11</td>
<td>8</td>
<td>2</td>
<td>1.1</td>
</tr>
<tr>
<td>EA 26</td>
<td>26</td>
<td>24</td>
<td>1</td>
<td>1.04</td>
</tr>
<tr>
<td>EA 51</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>4.00</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>62</td>
<td>26</td>
<td>3</td>
<td>2.13</td>
</tr>
<tr>
<td>Masonic</td>
<td>170</td>
<td>90</td>
<td>19</td>
<td>1.55</td>
</tr>
</tbody>
</table>

Table 7.20. Non-cortical to cortical flake ratios for all Coromandel Volcanic Zone obsidian artefacts from all Excavation Zones

When Coromandel Volcanic Zone obsidian assemblages are compared, EA1 is the outlier with relatively fewer cortical flakes and a small significant result when it is included in a Chi-square analysis (Fisher’s exact $\chi^2 = 10.03, df 4, p = 0.039$); when the EA1 assemblage is excluded, there is no significant difference in the cortical to non-cortical ratios (Fisher’s exact $\chi^2 = 5.14, df 3, p = 0.162$).
7.12. **Summary**

Cortical to non-cortical ratios have shown variability across assemblages and raw material type. The obsidian (both Coromandel Volcanic Zone and Mayor Island Obsidian) assemblages display the greatest homogeneity between Excavation Zones and the different average ratios between the two raw material types is likely the result of differential cortical cover and core size with respect to the raw material being brought to Ahuahu. The variability among the chert assemblages is considerable, with no obvious patterning as to site age, or depositional context. The variability in the Tahanga basalt (and Masonic greywacke) ratios arguably reflects differing manufacture/use patterning, with the assemblages that seem to be dominated by material originating from core tool (especially adze) manufacture displaying the greatest relative number of cortical flakes.
7.13. Non-tool to tool ratios

As noted in Chapter 5, tools are defined as stone artefacts with macroscopic retouch or use-wear, and the ratios of their representation in the assemblages give an indication as to the intensity of use of a particular material, if not necessarily the type of use, or the function of the artefacts (see earlier discussions in Chapter 2 concerning function with assigning type and function to flake tool, and Sewell and Frederickson (1990) discussed in Chapter 3 regarding the ascription of use-wear morphologies to tool function). Accordingly, a broad definition of tool is adopted to avoid making unfounded functional or typological distinctions that might skew ratios. The intensity of raw material use is inferred from the degree to which flakes are converted to tools; the more tools to un-utilised or modified flakes, the greater the intensity of use (Holdaway et al. 2008: 129).

7.13.1 Tahanga basalt non-tool to tool ratios

The Tahanga basalt situation concerning tools is somewhat different from the other assemblages, especially if it is assumed that the vast majority of the Tahanga basalt flake material was produced as the result of adze manufacture, use or maintenance, as opposed to being flaked from cores with the intention of producing useable flakes (see Chapter 4). The non-tool to tool ratios would tend to support this scenario, with much higher ratios and a consequent lower non-tool to tool conversion rate than the other raw materials. Even so, some interesting and important patterning is revealed. First, the ratios tend to form two groups by Excavation Zone: those with ratios above 25 (EA1, EA2-5 (although this is a small sample with no recorded tools and has been accordingly excluded from the statistical analysis), EA12-17 Lower and EA51; and those with ratios below 11 (EA12-17 Upper, EA26 and Tamewhera). The former group cannot be distinguished statistically (Pearson Chi-square: $\chi^2 = .527, df = 2, p = .783$) and it would appear that the assemblages have formed under the primary auspices of adze manufacture, use and maintenance, with comparatively little
opportunistic selection of flakes for tool use. The latter group sees the Tamewhera Tahanga basalt assemblage as an outlier; EA12-17 Upper and EA26 return a non-significant result following Chi-square analysis (Pearson Chi-square: $\chi^2 = 2.977, df 1, p = .071$). The increased comparative number of tools combined with the lower numbers of Tahanga basalt artefacts for EA12-17 Upper and EA26 (both Excavation Zones being in close proximity, it should be noted) when compared with EA1, suggests that while adze use and maintenance may have been the primary driver for the production of the flake material, a higher than usual number were being selected to use as tools in their own right. The Tamewhera Tahanga basalt assemblage is different again. The comparatively few artefacts coupled with their considerably larger than average dimensions (see Figures 7.2 and 7.5 in this chapter) suggests that they were not the product of adze manufacture at the point at which they were found. There were no Tahanga basalt flakes found in the Tamewhera Excavation Zone that displayed polish or other morphological characteristics that suggested that they were the product of use or maintenance of adzes; indeed the one complete adze and one broken adze recovered from the Tamewhera Excavation Zone were both too small to have been the source of any of the Tahanga basalt flakes recovered from the same areas. Additionally, there is a complete reversal of the usual non-tool to tool ratio pattern: flakes showing macroscopic use-wear and/or retouch outnumber un-utilised and unretouched flakes by almost three to one. Cumulatively, these factors suggest that the Tamewhera Tahanga basalt artefacts were selected from another spatial concentration of Tahanga basalt artefacts – in all likelihood another assemblage with similar attributes in terms of assemblage size and artefact metric variation as EA1 or an analogue. In other words, they are likely the result of recycling or material created earlier as the result of a different manufacture/use process.
<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Tahanga Basalt non-tools (n)</th>
<th>Basalt tools (n)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>1488</td>
<td>47</td>
<td>31.66</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>28</td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>126</td>
<td>12</td>
<td>10.5</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>91</td>
<td>2</td>
<td>45.5</td>
</tr>
<tr>
<td>EA 26</td>
<td>54</td>
<td>11</td>
<td>4.91</td>
</tr>
<tr>
<td>EA 51</td>
<td>125</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>5</td>
<td>14</td>
<td>0.35</td>
</tr>
<tr>
<td>Masonic</td>
<td>631</td>
<td>18</td>
<td>35.61</td>
</tr>
</tbody>
</table>

Table 7.21. Non-tool to tool ratios for Tahanga basalt * artefacts from all Excavation Zones * including Masonic greywacke

7.13.2 Chert non-tool to tool ratios

Chert non-tool to tool ratios are extremely similar across Excavation Zones, with about 90% on average of the chert flakes appearing unmodified. The exception is the EA26 assemblage, which displays a lower ratio and consequently more flakes converted to tools. This outlier results in a weakly significant difference when the assemblages are compared (Pearson Chi-square: $\chi^2 = 12.57$, df 6, $p = .051$). When EA26 is removed from the analysis, the homogeneity across assemblages is confirmed: (Pearson Chi-square: $\chi^2 = .916$, df 5, $p = .969$). The non-tool to tool ratio for the Masonic assemblage is also statistically indistinguishable from the Ahuahu assemblages (Pearson Chi-square: $\chi^2 = 4.456$, df 6, $p = .616$).
Table 7.22. Non-tool to tool ratios for chert artefacts from all Excavation Zones

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Chert non-tools (n)</th>
<th>Chert tools (n)</th>
<th>Ratio non-tool to tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>130</td>
<td>11</td>
<td>11.81</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>39</td>
<td>4</td>
<td>9.75</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>168</td>
<td>16</td>
<td>10.5</td>
</tr>
<tr>
<td>EA 12-17 Fill</td>
<td>23</td>
<td>2</td>
<td>11.5</td>
</tr>
<tr>
<td>EA 26</td>
<td>42</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>EA 51</td>
<td>567</td>
<td>62</td>
<td>9.14</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>330</td>
<td>37</td>
<td>9.19</td>
</tr>
<tr>
<td>Masonic</td>
<td>62</td>
<td>12</td>
<td>5.17</td>
</tr>
</tbody>
</table>

7.13.3 Mayor Island obsidian non-tool to tool ratios

Obsidian non-tool to tool ratios across both raw material sources were generally lower than for chert assemblages, and as such represent more tools per un-utilised flake per assemblage. However, as was the case with the chert assemblages, EA26 Mayor Island Obsidian presents the lowest ratio and as a consequence a significant result is returned when all Ahuahu Mayor Island Obsidian assemblages are compared (Pearson Chi-square: $\chi^2 = 13.461$, df 6, $p = .035$). Again, when the EA26 assemblage was removed from the statistical analysis, a weakly non-significant result was returned (Pearson Chi-square: $\chi^2 = 10.122$, df 6, $p = .071$), although it must be noted that the variation between Mayor Island Obsidian ratios was greater than was the case for chert.
Somewhat surprisingly, the Masonic Mayor Island Obsidian assemblage seemed to present a very low conversion rate from flake to tool. This may be the result of the obsidian being used for a different activity that resulted in less obvious macroscopic use-wear, or perhaps that the comparative abundance of Mayor Island Obsidian at the Masonic site meant that flakes were less intensively used.

### 7.13.4 Coromandel Volcanic Zone obsidian non-tool to tool ratios

Turning to Coromandel Volcanic Zone obsidian, a similar variability to Mayor Island Obsidian is displayed, although in this instance it is the EA2-5 and EA51 assemblages that are the outliers which are the cause of the significant difference in ratios at the outset:

Pearson Chi-square: $\chi^2 = 14.024$, df 6, $p = .027$ with EA2-5 included; Pearson Chi-square: $\chi^2 = 8.111$, df 4, $p = .087$ with EA2-5 and EA51 assemblages excluded. It should be noted that

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Mayor Island Obsidian non-tools (n)</th>
<th>Mayor Island Obsidian tools (n)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>50</td>
<td>13</td>
<td>3.85</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>46</td>
<td>7</td>
<td>6.57</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>39</td>
<td>14</td>
<td>2.78</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>17</td>
<td>5</td>
<td>3.4</td>
</tr>
<tr>
<td>EA 26</td>
<td>11</td>
<td>9</td>
<td>1.22</td>
</tr>
<tr>
<td>EA 51</td>
<td>58</td>
<td>20</td>
<td>2.9</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>80</td>
<td>42</td>
<td>1.9</td>
</tr>
<tr>
<td>Masonic</td>
<td>345</td>
<td>31</td>
<td>11.12</td>
</tr>
</tbody>
</table>

Table 7.23. Non-tool to tool ratios for Mayor Island obsidian artefacts from all Excavation Zones
both outlier assemblages were the smallest assemblages by a factor of at least two, and that the relatively small sample sizes in each case are affecting the results. As such, while there is some variation in the ratios of tools to non-tools when the Coromandel Volcanic Zone assemblages are compared, not enough variation is present to suggest any patterning based on Excavation Zone.

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>CVZ Obsidian non-tools (n)</th>
<th>CVZ Obsidian tools (n)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>25</td>
<td>9</td>
<td>2.78</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>9</td>
<td>1</td>
<td>9.00</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>23</td>
<td>13</td>
<td>1.77</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>14</td>
<td>7</td>
<td>2.00</td>
</tr>
<tr>
<td>EA 26</td>
<td>36</td>
<td>13</td>
<td>2.76</td>
</tr>
<tr>
<td>EA 51</td>
<td>9</td>
<td>1</td>
<td>9.00</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>40</td>
<td>37</td>
<td>1.08</td>
</tr>
<tr>
<td>Masonic</td>
<td>254</td>
<td>13</td>
<td>19.53</td>
</tr>
</tbody>
</table>

Table 7.24. Non-tool to tool ratios for Coromandel Volcanic Zone obsidian artefacts from all Excavation Zones

7.14. Summary

Chert, Mayor Island obsidian and Coromandel Volcanic Zone obsidian assemblages all display broadly similar patterning with respect to non-tool to tool ratios, and the differences between the chert and obsidian assemblages could be the result of a number of factors or the combination of those factors: the result of chert being less brittle than obsidian and as such
not showing obvious use-wear; the obsidian use-wear being easier to identify macroscopically due to its lustre; chert being used for different tasks; or chert being mainly selected for modified tools, especially drill points (see Table 7.26 below). If the proposition that proportionally more tools to flakes suggests increased conversion of flakes to tools and/or higher discard of longer use-life artefacts, which may in turn imply more time spent in one location (Phillips 2011: 242), then it could be argued that the relative homogeneity in ratios within raw material type assemblages suggests little change in occupation duration over time or space. EA26 ratios for both chert and Mayor Island Obsidian as outliers could be explained by those assemblages representing a temporally constrained depositional episode relating to a particular type of lithic use behaviour, as opposed to the other assemblages which reflect more “time-averaged” depositional history. The Tahanga basalt ratio variability strongly suggests different activities with respect to the use of that material over space and time. In particular, the evidence for use of recycled flake material at Tamewhera lends weight to the idea that the Tahanga basalt assemblages have to be examined through a different lens than those of other raw materials, and that as a consequence the metrics for that material may give different insights into the human behaviour and depositional processes that led to their entry into the archaeological record.
7.15. **Tool type percentages**

While a number of tool types were recorded during the analysis (see Chapter 4), due to the relatively low numbers of tools it made sense to collapse the tool categories into those that displayed a specific type of retouch or modification. For example, artefacts displaying unifacial trimming to form what is commonly referred to as a scraper (Holdaway and Stern 2004) were categorised as “modified utilised flakes”. Those that were unretouched flakes that displayed some kind of macroscopic use-wear on one or more margins were simply coded “unmodified utilised flake tools”. In this way it is possible to compare ratios of these two categories to each other to see if there are any shifts in the way each particular material was being used across each study assemblage.

7.15.1 **Tahanga basalt tool type percentages**

This includes broken adze preforms in the modified category. There is a high degree of variability in terms of relative percentages across the assemblages, but it is interesting to note the similarities between EA1 and Masonic assemblages, which both provide most evidence of adze manufacture *in situ*, and most adze pre-forms. EA2-5, EA51 and Tamewhera assemblages suggest more opportunistic selection of Tahanga basalt flakes for expedient use.
Table 7.25. Utilised unmodified flakes tools and modified tools for Tahanga basalt artefacts (including Masonic greywacke) from all Excavation Zones *includes 7 adze preform fragments, ** includes 1 adze preform fragment, ***includes 13 adze preform fragments.

7.15.2 Chert tool type percentages

In this section I have also included the number of chert tools that were defined as drill points. Drill points are one of the most commonly found chert artefacts and it is interesting to note that there is an expected high frequency of drill points at EA51, where there is at least some evidence for fish hook making. There is no evidence for drill points at the Tamewhera site, perhaps suggesting that if chert drill points are primarily associated with the manufacture of fish hooks, then no fish hook manufacture was being undertaken, or that it was being undertaken elsewhere. Several drill points were found at the Masonic site and this too has considerable evidence for fish hook manufacture, or at least fish hook use. The overall similarity suggests that the assemblages were being treated in the same way regardless of chronological age or depositional history – this is to be expected given that the availability and form of chert also remains unchanged over time and reinforces the importance of controlling for raw material. The outlier assemblage EA26 may be the result of a particular
activity cluster relating to the unusually large number of drill points – the even spread of drill points throughout the EA (i.e. not limited to the 30041 pit fill) suggests no temporal concentrations.
<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Chert unmodified utilised flakes tools (%)</th>
<th>Chert modified tools (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>0</td>
<td>100 (includes 1 Drill point)</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>56.3</td>
<td>43.7 (includes 5 Drill points)</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>50</td>
<td>50 (includes 1 Drill point)</td>
</tr>
<tr>
<td>EA 26</td>
<td>15.4</td>
<td>84.6 (includes 9 Drill points)</td>
</tr>
<tr>
<td>EA 51</td>
<td>24.2</td>
<td>75.8 (includes 28 Drill points)</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>62.5</td>
<td>37.5</td>
</tr>
<tr>
<td>Masonic</td>
<td>9.1</td>
<td>90.9 (includes 6 Drill points)</td>
</tr>
</tbody>
</table>

Table 7.26. Utilised unmodified flake tools and modified tools for chert artefacts from all Excavation Zones
7.15.3 Obsidian tool type percentages

Obsidian raw material sources were combined on the basis that it was unlikely that there were any specific uses that differentiated on the basis of raw material sources given the similarity in performance of both types. Of the assemblages with over 20 tools, those with the highest percentages of modified obsidian tools are EA12-17 Upper and Tamewhera.

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Obsidian unmodified utilised flake tools (%)</th>
<th>Obsidian modified tools (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1 (n=22)</td>
<td>77.3</td>
<td>22.7</td>
</tr>
<tr>
<td>EA 2-5 (n=8)</td>
<td>37.5</td>
<td>62.5</td>
</tr>
<tr>
<td>EA 12-17 Upper (n=27)</td>
<td>55.6</td>
<td>44.4</td>
</tr>
<tr>
<td>EA 12-17 Lower (n=12)</td>
<td>76.9</td>
<td>23.1</td>
</tr>
<tr>
<td>EA 26 (n=22)</td>
<td>72.7</td>
<td>23.3</td>
</tr>
<tr>
<td>EA 51 (n=21)</td>
<td>66.7</td>
<td>33.3</td>
</tr>
<tr>
<td>Tamewhera (n=79)</td>
<td>53.75</td>
<td>46.25</td>
</tr>
<tr>
<td>Masonic (n=44)</td>
<td>63.6</td>
<td>36.4</td>
</tr>
</tbody>
</table>

Table 7.27. Utilised unmodified flake tools and modified tools for obsidian * artefacts from all Excavation Zones * Mayor Island and Coromandel Volcanic Zone sources have been combined
7.16. **Exterior platform angle versus platform depth**

Lin et al. (2013) have demonstrated that there is a relationship between the most economical production of a cutting edge on a flake and the relationship between exterior platform angle and platform depth. The argument suggests that to maximise the amount of cutting edge that is being produced per weight or shape of flake the exterior platform angle and platform depth can be manipulated by the knapper to ensure the most economical production of flake tools (see Figure 7.10).

![Figure 7.10. Reproduced from Lin et al. 2013: 736 Figure 11](image)

Following this approach, exterior platform angle and platform depth values are plotted in figures 7.11-7.13 below for each lithic material and each assemblage. As exterior platform angles are only calculated on complete flakes, some assemblages were not represented as there were too few flakes to permit any meaningful statistical analysis.
7.16.1 *Tahanga basalt exterior platform angle vs platform thickness*

Three outliers (circled in yellow) are apparent: the EA12-17 Lower, Tamewhera and EA2-5 values. The remaining cluster is circled in red. All three outliers comprise the smallest assemblages, so some caution must be taken in interpreting their relative positions, but at the outset, it seems that Lin et al.’s (2013) prediction of increasing weight with greater average exterior platform angle and platform depth values is borne out for the Tamewhera Tahanga basalt assemblage – as has been shown in Figures 7.2 and 7.5 above, the artefacts and complete flake dimensions are considerably larger for that assemblage. The EA2-5 assemblage with a high average platform thickness and comparatively low average EPA suggests a less economical approach, but as will be outlined further below with respect to the obsidian assemblage values, this apparent difference may also reflect the influence of starting core shape as much as a drive to economisation. Just as the Tamewhera Tahanga basalt artefacts were larger on average, the EA12-17 Lower assemblage is smaller in terms of average artefact and complete flake dimensions, and the comparatively small average platform thickness suggests an interpretation of fine trimming or re-working of core tools such as adzes. This is also suggested by the high non-tool to tool ratio for this assemblage (Table 7.21 above).
Figure 7.11. Complete flake exterior platform angle vs platform thickness for Tahanga basalt* artefacts >20mm in maximum dimension by Excavation Zone (1.00 = EA1; 10.0 = EA12-17 Upper; 15.0 = EA12-17 Lower; 26.0 = EA26; 51.0 = EA51; 100.0 = Tamewhera; 900 = Masonic) *Masonic greywacke included (EA2-5, EA12-17 Lower and Tamewhera outliers circled in yellow).

7.16.2 Chert exterior platform angle vs platform thickness

Average platform thicknesses are all very similar with the exception of the Tamewhera and EA12-17 Lower assemblages. Greater variation is displayed in platform angles; however, the Tamewhera and EA12-17 Lower assemblages still appear as outliers with smaller average EPAs but larger average platform thicknesses. EA12-17 Lower is a small assemblage, but the Tamewhera assemblage is comparable in size to the others. Masonic chert appears mid-range for both EPA and platform thickness when compared to the Ahuahu non-outlier assemblages. With respect to the base metrics for the chert assemblages there was no difference in the size, shape or weight of chert artefacts for Tamewhera when compared to
the other assemblages. In terms of technological assemblages, again there were no differences in respect of flake lengths or length to width ratios. Minimum flake to core ratios were slightly reduced and indeed less than the Ahuahu average. However, the most prominent difference was the lack of drill points as set out in Table 7.26. Accordingly, one explanation for the difference in platform angle and platform thickness values could be differing technological trajectories and desired outcomes. In the case of the Tamewhera assemblage it may be that because drill points were not being manufactured, knapping differed so as to produce more flakes of a particular shape that were not related to an ideal for drill point production.

Figure 7.12. Stone artefact exterior platform angle vs platform thickness for chert from all Excavation Areas. EA12-17 Lower and Tamewhera outliers circled in yellow.
7.16.3 *Obsidian exterior platform angle vs platform thickness*

Both Mayor Island obsidian and Coromandel Volcanic Zone obsidian are projected on the same scatter plot graph in Figure 7.12 so as to compare and contrast the different ways the respective source materials might be flaked and utilised. Two outlier assemblages of both obsidian raw material types (Tamewhera in red and EA12-17 Upper in light green) are circled in yellow. EA51 Coromandel Volcanic Zone obsidian is not included due to its very small sample size. The Mayor Island obsidian values for EA1, EA2-5, EA12-17 Lower and EA26 all cluster in the quadrant that suggests larger overall weight (following Figure 7.9 (Lin *et al*. 2013)), and the same four excavation zones cluster for Coromandel Volcanic Zone obsidian as well, albeit with smaller average platform thicknesses. This may be due to smaller initial core sizes and the nature of the core material (see Chapter 4).

![Graph showing obsidian exterior platform angle vs platform thickness](image)

*Figure 7.13. Stone artefact exterior platform angle vs platform thickness for all obsidian sources from all Excavation Areas. EA12-17 Upper and Tamewhera Mayor Island Obsidian and Coromandel Volcanic Zone outliers circled in yellow.*
In order to evaluate whether there is any difference in the way in which the obsidian from the Coromandel sources and the obsidian from Mayor Island was flaked, average exterior platform angles were calculated using source designation as a filter. The results of these calculations are set out in Table 7.2 below, and two observations can be made. The first is that for all the Excavation Zones other than Tamewhera and EA12-17 Upper, the average exterior platform angle for the Mayor Island obsidian is consistently lower than the average exterior platform angle for the Coromandel Volcanic Zone sources. This could be the result of differences in the original core size of the respective sources, or possibly be due to the different qualities of the respective sources and a corresponding difference in fracture mechanics. The second observation that can be made is that the Tamewhera obsidian average EPAs both reverse the trend observed above (but note the small sample size of the Coromandel source obsidian for Tamewhera), and, more interestingly, that the average platform angles for both sources are statistically significantly smaller (independent samples t-test: $t=-2.741$, $df=101$, $p=0.007$) than the average angles for the other sub-samples. This strongly suggests that the shape of the cores from which the Tamewhera and EA12-17 Upper artefacts were being flaked are different from the shape of the cores from which the remainder of the Ahuahu assemblages were flaked. A lower average platform angle such as displayed in the Tamewhera samples suggests that a significant percentage of artefacts were the result of flaking from a more angular, elongated core, such as would be expected if the core in question was in actual fact a large flake itself. Kooyman notes that bifacial
thinning flakes’ exterior platform angles are generally acute (in the region of 35° to 65° typically (Kooyman 2000: 51)), and it can be argued that given that bifaces are akin to a thin core that have similar morphological characteristics to a large flake Figure 7.14.

Accordingly it is possible, as was argued for above in the case of the Tamewhera Tahanga basalt assemblage, that some of the obsidian material from the chronologically later Tamewhera and EA12-17 Upper deposits are in fact recycled from earlier deposits of obsidian material. This is not to infer that all the material from these assemblages is recycled, just that a large enough percentage of artefacts that possess the thinner core shape (that is inferred from using large flakes as cores (Figure 7.14)), are present to shift the average EPAs towards lower values. Given that archaeological obsidian is still eroding from various locations on Ahuahu today and as such provides an easily accessible source, it is suggested that material brought onto the island in the earlier part of its occupation may have been moved and redeposited at the upper levels of EA12-17 and the Tamewhera Excavation Zone. The implications this possibility has for the
reconstructions of mobility patterns based on sourcing of material and distance to source calculations will be discussed further in Chapter 8.

<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>Mayor Island Obsidian n</th>
<th>Average EPA</th>
<th>CVZ Obsidian n</th>
<th>Average EPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1</td>
<td>32</td>
<td>74.4</td>
<td>10</td>
<td>79.1</td>
</tr>
<tr>
<td>EA 2-5</td>
<td>25</td>
<td>73.1</td>
<td>4</td>
<td>76.8</td>
</tr>
<tr>
<td>EA 12-17 Upper</td>
<td>17</td>
<td>67.70</td>
<td>6</td>
<td>67.16</td>
</tr>
<tr>
<td>EA 12-17 Lower</td>
<td>7</td>
<td>74</td>
<td>9</td>
<td>76.89</td>
</tr>
<tr>
<td>EA 26</td>
<td>11</td>
<td>73.27</td>
<td>16</td>
<td>73.63</td>
</tr>
<tr>
<td>EA 51</td>
<td>23</td>
<td>72.4</td>
<td>1</td>
<td>74</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>29</td>
<td>66</td>
<td>8</td>
<td>61.37</td>
</tr>
<tr>
<td>Masonic</td>
<td>130</td>
<td>72.9</td>
<td>87</td>
<td>73.9</td>
</tr>
</tbody>
</table>

Table 7.28 Obsidian complete flake average platform angles by Excavation Zone based on source

7.17. Summary
Examination of the relationship between exterior platform angles, platform thicknesses and raw material types have thrown up some interesting possibilities. While values for all raw material types are broadly similar across Excavation Zones, Tamewhera assemblages consistently stand out as different to most others. With respect to the Tahanga basalt and obsidian assemblages from Tamewhera, it is arguable that the different characteristics displayed are the result of differing practices in the sourcing and manufacture of the artefacts. In particular, the possibility that Tahanga basalt artefacts and artefacts from both obsidian sources at Tamewhera have been recycled from earlier archaeological deposits cannot be discounted. The obsidian artefacts from Tamewhera display exterior platform angles
consistent with being struck from large flakes, as opposed to cobbles (see Figure 7.13 above). A similar argument can be made for the obsidian assemblage from EA12-17 Upper, which, like the Tamewhera assemblage, is from later in the Ahuahu occupation sequence, and as such both those Excavation Area assemblages are logical candidates for providing evidence of recycling from earlier contexts.
7.18. **Platform characteristics: platform area versus artefact mass**

The relationship between the striking platform area and an artefact’s weight (mass) as a measure of reduction intensity has long been discussed in lithic technological literature (Dibble and Whittaker, 1981; Dibble and Rezek, 2009; Shott *et al.*, 2000). Broadly speaking, as an artefact’s mass decreases proportional to the area of the striking platform, reduction intensity is said to have increased. Difficulties have arisen with the imprecise calculation of platform area using simply platform width multiplied by platform thickness (Clarkson and Hiscock 2011), so the formula for a calculation of the area of an ellipse ($\pi ab$, where $a = \frac{1}{2}$ platform width and $b = \frac{1}{2}$ platform thickness) was used. Following Muller and Clarkson (2016) an ellipse was identified as the most common approximation of the shape of a striking platform, given the nature of the platform shapes presented in the Ahuahu assemblages. As with other analyses undertaken herein, relative similarities between artefact platform area and artefact mass relationships across assemblages were the focus. Values were log-transformed prior to statistical testing due to the non-normal distribution of the data, and assemblages with a sample size of less than 10 were excluded from each analysis. For all assemblages across all raw material types, Pearson’s R correlation coefficients were calculated and $R^2$ values were plotted on scatter plot graphs to evaluate the strengths of the linear relationships between platform area and artefact mass. Non-significant $p$-values denote a non-linear relationship: in other words, if an assemblage or assemblages return non-significant $p$-values while other comparable assemblages return significant $p$-values, it can be argued that the manufacturing and/or reduction processes correspondingly differ.
7.18.1 *Tahanga basalt platform area vs artefact mass*

All Excavation Zones except for Tamewhera return significant correlation statistics reflecting linear relationships between Platform Area and artefact mass. In all cases other than Tamewhera, R values are above .700 and \(p\)-values less than 0.05. Tamewhera Tahanga basalt is the smallest sample but, as might be expected given the discussion in previous sections, might also be expected to be an outlier assemblage; this is confirmed by the correlation coefficient value \((r = .273, N=12, p= .390)\).

![Diagram](image)

*Figure 7.15. Log platform area versus log artefact weight for all Tahanga basalt complete flakes >20mm in maximum dimension by Excavation Zone (1.00 = EA1; 10.0 = EA12-17 Upper; 15.0 = EA12-17 Lower; 26.0 = EA26; 51.0 = EA51; 100.0 = Tamewhera)*
7.18.2 Chert platform area vs artefact mass

Little variation is apparent in the chert assemblages with respect to platform area and artefact mass relationships. EA26 is the only assemblage that returns a $R^2$ value of less than .300; however, it still returns a significant correlation coefficient result ($r^2 = .399, N=27, p= .038$). The only assemblage to return a non-significant correlation coefficient result was EA2-5, the smallest sample, and this was only just non-significant: $r = .550, N=13, p= .051$.

Figure 7.16. Log platform area versus log artefact weight for all chert complete flakes >20mm in maximum dimension by Excavation Zone (1.00 = EA1; 5.00 = EA2-5; 10.0 = EA12-17 Upper; 15.0 = EA12-17 Lower; 26.0 = EA26; 51.0 = EA51; 100.0 = Tamewhera)
7.18.3 Mayor Island obsidian platform area vs artefact mass

The Tamewhera Mayor Island obsidian assemblage records the lowest $R^2$ value and is correspondingly the only assemblage which returns a non-significant correlation coefficient $p$-values ($r = .319$, $N=22$, $p= .148$). All other assemblages returned $p$-values significant to the 0.05 level (2-tailed).

Figure 7.17. Log platform area versus log artefact weight for all Mayor Island obsidian complete flakes >20mm in maximum dimension by Excavation Zone (1.00 = EA1; 5.00 = EA2-5; 10.0 = EA12-17 Upper; 15.0 = EA12-17 Lower; 26.0 = EA26; 51.0 = EA51; 100.0 = Tamewhera)
7.18.4 Coromandel Volcanic Zone platform area vs artefact mass

The sample sizes for the Coromandel Volcanic Zone assemblages as they relate to platform area are considerably smaller than the other raw material categories due to the smaller number of complete flakes in each assemblage, so the comparisons in this section must be treated with some caution. Nevertheless, the variation in coefficient of determination values suggests some patterning: the high $R^2$ values for EA12-17 Upper and Tamewhera reflect a strong linear relationship between platform area and artefact mass for those assemblages (contra the case for the Tamewhera Mayor Island obsidian assemblage). EA12-17 Lower and EA26 both return non-significant correlation coefficient values (EA12-17 Lower: $r = .500, N=12, p= .098$, EA26: $r = .252, N=18, p= .313$), implying little linear relationship.

Figure 7.18. Log platform area versus log artefact weight for all Coromandel Volcanic Zone obsidian complete flakes >20mm in maximum dimension by Excavation Zone (1.00 = EA1; 5.00 = EA2-5; 10.0 = EA12-17 Upper; 15.0 = EA12-17 Lower; 26.0 = EA26; 51.0 = EA51; 100.0 = Tamewhera)
7.19. **Summary**

Platform area versus artefact mass relationships seem to bear out previously discussed anomalies with respect to the Tamewhera Tahanga basalt and Tamewhera Mayor Island obsidian assemblages. In both cases (albeit taking into account the relatively small sample size for Tamewhera Tahanga basalt), platform area/artefact mass relationships differ from the other assemblages in their non-linearity, suggesting differences in the ways in which the artefacts were being manufactured, used, selected or reduced. The possibility that material is being recycled from other archaeological assemblages may be one explanation; material selected from other assemblages on the basis of shape or size may not constitute a sufficiently random sample to replicate the linear relationships demonstrated in other assemblages. The fact that the EA12-17 Upper Mayor Island Obsidian assemblage (which, it is argued earlier, is also likely to be from a depositional episode later in the Ahuahu chronological sequence) has parallels with the Tamewhera Mayor Island Obsidian assemblage is also consistent with this explanation.
7.20. **Section Summary**

Table 7.29 details the nature of the outlying artefact metrics by Excavation Area. There is little consistent patterning to the nature of the outlying categories save for that of the Tamewhera Excavation Area, and to a lesser and parallel degree, the EA12-17 Upper assemblage, as will be discussed in more detail below. In terms of raw material, the obsidian assemblages from both sources show most variability, whereas the metrics from the chert assemblages show most uniformity across Excavation Areas. The Excavation Area outliers are discussed briefly below.

<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>Outliers: Material - nature of variance (Measure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA1 Tahanga Basalt:</td>
<td>- More cortical cover (Non-cortical to cortical ratio)</td>
</tr>
<tr>
<td>Mayor Island Obsidian:</td>
<td>- Larger (Maximum Artefact Dimensions)</td>
</tr>
<tr>
<td>- Larger (Complete Flake Dimensions)</td>
<td></td>
</tr>
<tr>
<td>Coromandel Volcanic Zone:</td>
<td>- Larger (Maximum Artefact Dimensions)</td>
</tr>
<tr>
<td>- Larger (Complete Flake Dimensions)</td>
<td></td>
</tr>
<tr>
<td>- Less cortical cover (Non-cortical to cortical ratio)</td>
<td></td>
</tr>
<tr>
<td>EA2-5 Tahanga Basalt:</td>
<td>- Low EPA/High PT (Exterior Platform Angle vs Platform thickness)</td>
</tr>
<tr>
<td>Coromandel Volcanic Zone:</td>
<td>- Lower number of tools (Non-tool to tool ratio)</td>
</tr>
<tr>
<td>EA12-17Upper Chert:</td>
<td>- Smaller cores (Core Volume)</td>
</tr>
<tr>
<td>Mayor Island Obsidian:</td>
<td>- Smaller (Maximum Artefact Dimensions)</td>
</tr>
<tr>
<td>- Low EPA (Exterior Platform Angle vs Platform thickness)</td>
<td></td>
</tr>
<tr>
<td>Coromandel Volcanic Zone</td>
<td>- Low EPA/(Exterior Platform Angle vs Platform thickness)</td>
</tr>
<tr>
<td>EA12-17Lower Tahanga Basalt:</td>
<td>- More Fragmented (Fragmentation ratio)</td>
</tr>
<tr>
<td>- Low PT (Exterior Platform Angle vs Platform thickness)</td>
<td></td>
</tr>
<tr>
<td>Excavation Area</td>
<td>Summary</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Chert</td>
<td>- Low EPA/High PT (Exterior Platform Angle vs Platform thickness)</td>
</tr>
<tr>
<td></td>
<td>Coromandel Volcanic Zone:</td>
</tr>
<tr>
<td></td>
<td>- Non-linear relationship between PA and Weight (Platform Area vs. Artefact Weight)</td>
</tr>
<tr>
<td>EA26</td>
<td>Mayor Island Obsidian:</td>
</tr>
<tr>
<td></td>
<td>- Larger (Maximum Artefact Dimensions)</td>
</tr>
<tr>
<td></td>
<td>- Larger (Complete Flake Dimensions)</td>
</tr>
<tr>
<td></td>
<td>Coromandel Volcanic Zone:</td>
</tr>
<tr>
<td></td>
<td>- Fewer cores (MNF to core ratio)</td>
</tr>
<tr>
<td></td>
<td>- Non-linear relationship between PA and Weight (Platform Area vs Artefact Weight)</td>
</tr>
<tr>
<td>EA51/Te Mataku</td>
<td>No outliers</td>
</tr>
<tr>
<td>Tamewhera Combined</td>
<td>Tahanga Basalt:</td>
</tr>
<tr>
<td></td>
<td>- Larger (Maximum Artefact Dimensions)</td>
</tr>
<tr>
<td></td>
<td>- Larger (Complete Flake Dimensions)</td>
</tr>
<tr>
<td></td>
<td>- Considerably higher number of tools (Non-tool to tool ratio)</td>
</tr>
<tr>
<td></td>
<td>- High EPA (Exterior Platform Angle vs Platform thickness)</td>
</tr>
<tr>
<td></td>
<td>- Non-linear relationship between PA and Weight (Platform Area vs Artefact Weight)</td>
</tr>
<tr>
<td></td>
<td>Chert:</td>
</tr>
<tr>
<td></td>
<td>- Low EPA/High PT (Exterior Platform Angle vs Platform thickness)</td>
</tr>
<tr>
<td></td>
<td>Mayor Island Obsidian:</td>
</tr>
<tr>
<td></td>
<td>- More fragmented (Fragmentation ratio)</td>
</tr>
<tr>
<td></td>
<td>- Low EPA (Exterior Platform Angle vs Platform thickness)</td>
</tr>
<tr>
<td></td>
<td>- Non-linear relationship between PA and Weight (Platform Area vs Artefact Weight)</td>
</tr>
<tr>
<td></td>
<td>Coromandel Volcanic Zone:</td>
</tr>
<tr>
<td></td>
<td>- Low EPA (Exterior Platform Angle vs Platform thickness)</td>
</tr>
<tr>
<td>Masonic</td>
<td>Motutapu Greywacke (compared to Tahanga Basalt):</td>
</tr>
<tr>
<td></td>
<td>- Less Fragmented (Fragmentation ratio)</td>
</tr>
</tbody>
</table>

Table 7.29 Summary of statistically significant outlying metrics by Excavation Area

289
7.20.1 EA1 Summary

The larger size of the obsidian artefacts from both sources at EA1 may relate to less intensive reduction; however, the comparative lack of cores and the small core sizes in these assemblages complicate this argument. The contradicting values may suggest no direct relationship between reduction intensity and artefact size; an alternative explanation is that the material deposited there may have been the result of deliberate occupation area maintenance and as such represents a mix of manufacturing and depositional episodes. The extra cortical cover present on the Tahanga basalt artefacts is consistent with the assemblage being the result of adze manufacture and in particular the secondary reduction of preforms brought to Ahuahu from the Tahanga source. The large number of Tahanga basalt artefacts supports this proposition.

7.20.2 EA2-5 Summary

This small assemblage sees little in the way of outlying results. The exterior platform angle vs platform thickness values are consistent with the artefacts having been struck from large flakes. As argued above, this provides some evidence for recycling; given the close proximity to EA1 and the large deposit of Tahanga basalt material there, such an argument seems plausible.

7.20.3 EA12-17 Upper Summary

Exterior platform angles vs platform thickness plots for both Mayor Island Obsidian and Coromandel Volcanic Zone suggest evidence for recycling of both sources of obsidian, and the smaller size of Mayor Island Obsidian artefacts is possibly explained by this as well.
7.20.4 EA12-17 Lower Summary

The main point of interest in the EA12-17 Lower assemblages is the statistically significant differences between it and the EA 12-17 Upper assemblages. These differences suggest that the stratigraphic divisions do represent different depositional episodes; however, the patterning of the differences in their respective raw materials is not consistent (for example the EA12-17 Lower Tahanga basalt and chert divergence with respect to platform thicknesses).

7.20.5 EA26 Summary

The obsidian artefacts from this Excavation Area are the only ones that display any significant variation, and not in a consistent way across the two raw material sources. The Mayor Island Obsidian artefacts are larger on average, whereas the Coromandel Volcanic Zone assemblage has fewer cores. These factors, together with the centrality of the bin-pit feature, suggest an argument could be made for a single depositional episode which formed the bulk of the pit fill, but overall there is little to distinguish EA26 assemblages of any kind from the overall Ahuahu picture.

7.20.6 EA51 Summary

It is interesting that the EA51 assemblage does not present any outlying results. As the three-dimensional rendering of the artefact distributions (Chapter 5) suggested, the possibility of multiple depositional episodes means that this may have resulted in the homogenisation of the assemblage, or time averaging.

7.20.7 Tamewhera Excavation Area Summary

The only assemblages to show consistent deviation from the other Ahuahu assemblages and the Masonic assemblage are those from the Tamewhera Excavation Zone. The size and number of the Tahanga basalt artefacts and the high representation of tools in that Tahanga
basalt assemblage have been argued for above as evidence that these artefacts were recycled from earlier archaeological deposits. The non-linear relationship between platform area and weight further indicates the Tahanga basalt at Tamewhera was treated in a different way from the material found at other Excavation Areas. Additional evidence of recycling is suggested by the exterior platform angles of the obsidian assemblages from both raw material sources.

7.20.8 Masonic Summary

Given the different archaeological context, the metrics of the Masonic assemblages (even taking account of the physical differences between Motutapu greywacke and Tahanga basalt) are remarkably consistent with the Ahuahu assemblages overall. Differences in chert dimensions could be put down to different raw material sources, but the obsidian and greywacke assemblages are very similar in character to the EA1 and EA51 assemblages in particular.

The final section of this chapter undertakes a closer examination of the individual excavation areas in the Tamewhera Excavation Zone to evaluate whether there is any internal variation in the patterning of the artefact metrics that might shed light on the nature of the depositional history and the different activities that may be represented.
7.21. Tamewhera artefact metrics

7.21.1 Tamewhera EAs Tahanga basalt

As is noted in Chapter 6, the Tahanga basalt artefacts on Tamewhera are considerably larger and different in form when compared to Tahanga basalt artefacts from other excavation zones on Ahuahu. Despite this there is a high degree of homogeneity between Tamewhera excavation zones. There is no significant difference in terms of average maximum length, average maximum width, or average maximum thickness (Independent Samples Kruskal-Wallis maximum length: $p = 0.222$, maximum width: $p = 0.233$, maximum thickness: $p = 0.085$). However, Tahanga basalt was easily the least common artefactual material, with none at all being found within EA108, and only a handful of artefacts in the other Tamewhera Excavation Areas. In addition to being larger in every dimension, a high proportion of the Tamewhera Tahanga basalt artefacts shows obvious modification either through use-wear or through retouch, suggesting their selection and use as tools as opposed to being the immediate by-products of the production of core tools such as adzes. The lack of corresponding debitage and the uniformity of size and shape suggest these artefacts may have been recycled from material produced elsewhere on the island (the vicinity of EA1 is an obvious possibility given the large amount of Tahanga basalt found there). As a consequence, these artefacts could well have been originally flaked several hundred years before their subsequent selection and modification/use on the Tamewhera excavation zone terraces.
There is no significant difference in terms of average maximum length, average maximum width, or average maximum thickness for Ahuahu basalt artefacts (Independent Samples Kruskal-Wallis maximum length: \( p = 0.413 \), maximum width: \( p = 0.608 \), maximum thickness: \( p = 0.818 \)).
7.21.3 Tamewhera EAs Chert

ANOVA analysis of the Tamewhera chert assemblages confirms significant variation across the groups and Bonferroni post-hoc testing confirms the source of the variation is due to the larger dimensions for EA106 assemblage when compared to the smaller average dimensions for EA103 (maximum length: F(3,341) = 5.103, p = 0.002 maximum width: F(3,341) = 5.106, p = 0.002, maximum thickness: F(3,341) = 5.054, p = 0.002).

Figure 7.21. Average length, width and thickness for all chert artefacts >20mm excluding cores by Tamewhera Excavation Areas.

There are no statistically significant differences between any of the length, width or thickness measurements for Mayor Island Obsidian artefacts for any of the Tamewhera Excavation Areas (notably, no Mayor Island Obsidian material greater than 20mm in maximum dimension was excavated in EA108) based on ANOVA (maximum length: F(2,116) =.583, p = 0.560, maximum width: F(2,116) = .320, p = 0.727, maximum thickness: F(2,116) = 893, p = 0.412). EA103 does, however, display a considerably higher MNF to core ratio.
There is no significant difference in terms of average maximum length, average maximum width, or average maximum thickness for Coromandel Volcanic Zone obsidian (Independent Samples Kruskal-Wallis maximum length: $p = .710$, maximum width: $p = .942$, maximum thickness: $p = 0.210$).

Figure 7.22. Average length, width and thickness for all Mayor Island obsidian artefacts >20mm excluding cores by Tamewhera Excavation Areas.

Figure 7.22. Average length, width and thickness for all Coromandel Volcanic Zone obsidian artefacts >20mm excluding cores by Tamewhera Excavation Areas.
7.22. Tamewhera EAs complete flake metrics

There were insufficient complete Tahanga or Ahuahu basalt flakes, Coromandel Volcanic Zone complete flakes, or complete flakes of any material from EA108 to allow meaningful comparisons, so chert and Mayor Island Obsidian from EA102, EA103 and EA106 are the only raw materials covered in this section.

7.22.1 Tamewhera chert complete flake metrics

Average complete flake metrics for EA106 chert artefacts were larger across all categories. Due to the small sample size from EA102, a Kruskal-Wallis non-parametric test was run; this confirmed a significant difference in the distributions for all three variables (maximum flake length: $p = 0.018$, maximum flake width: $p = 0.041$, maximum flake thickness: $p = 0.035$). Further non-parametric testing confirmed the larger average size for EA106 flake dimensions as the cause of the significant results.

![Figure 7.23. Average complete flake length, width, and thickness for all chert complete flakes >20mm for Tamewhera Excavation Areas.](image)

Figure 7.23. Average complete flake length, width, and thickness for all chert complete flakes >20mm for Tamewhera Excavation Areas.
7.22.2 Tamewhera Mayor Island Obsidian complete flake metrics

No significant differences were apparent across any category for Tamewhera Mayor Island Obsidian flake metrics (Kruskal-Wallis non parametric test: maximum flake length: $p = 0.397$ maximum flake width: $p = 0.713$, maximum flake thickness: $p = 0.279$).

Figure 7.24. Average complete flake length, width, length to width ratio and thickness for all Mayor Island obsidian artefacts >20mm for Tamewhera Excavation Areas.
7.23. Tamewhera MNF to core ratios

7.23.1 Tamewhera EAs chert MNF to core ratios

Lower flake to core ratios for EA102 and EA103 when compared to EA106 may indicate more chert flake manufacture in the former two excavation areas, but there is no statistically significant difference (Pearson Chi-square: $\chi^2 = 3.765, df = 2, p = .166$) between the assemblages. The comparatively low chert flake to core ratios across all Tamewhera excavation areas may represent the relatively low-intensity reduction of a locally sourced material.

<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>MNF (Chert)</th>
<th>Core</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 102</td>
<td>21</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>EA 103</td>
<td>45</td>
<td>14</td>
<td>3.21</td>
</tr>
<tr>
<td>EA 106</td>
<td>42.5</td>
<td>5</td>
<td>8.5</td>
</tr>
</tbody>
</table>

Table 7.30. MNF to core ratios for chert artefacts from all Tamewhera Excavation Areas

7.23.2 Tamewhera EA Mayor Island Obsidian MNF to core ratios

The low number of Mayor Island Obsidian cores present (Table 7.30) prohibits any meaningful intra-assemblage statistical analysis, but when compared to the Coromandel Volcanic Zone obsidian assemblage (see below) it is apparent that there are far fewer Mayor Island Obsidian cores overall, suggesting removal of cores from, or introduction of flakes to, the Tamewhera excavations.
<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>MNF (MI Obsidian)</th>
<th>Core</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 102</td>
<td>12.5</td>
<td>3</td>
<td>4.17</td>
</tr>
<tr>
<td>EA 103</td>
<td>26</td>
<td>1</td>
<td>26</td>
</tr>
<tr>
<td>EA 106</td>
<td>14.5</td>
<td>1</td>
<td>14.5</td>
</tr>
</tbody>
</table>

Table 7.31. MNF to core ratios for Mayor Island Obsidian artefacts from all Tamewhara Excavation Areas

7.23.3 Tamewhara EA Coromandel Volcanic Zone obsidian MNF to core ratios

Comparatively more Coromandel Volcanic Zone cores are present overall, but the bulk are from EA106; this results in a significant difference between the excavation areas (Fisher’s exact Chi-square: $\chi^2 = 7069$, $df=2$, $p = .034$). However, the very low minimum number of flakes present in all Coromandel Volcanic Zone obsidian assemblages contributes to the very low ratios for EA102 and EA106, suggesting the removal of flakes from those areas in particular.

<table>
<thead>
<tr>
<th>Excavation Area</th>
<th>MNF (CVZ Obsidian)</th>
<th>Core</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 102</td>
<td>1.5</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>EA 103</td>
<td>10</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>EA 106</td>
<td>5.5</td>
<td>8</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Table 7.32. MNF to core ratios for Coromandel Volcanic Zone obsidian artefacts from all Tamewhara Excavation Areas
7.24. *Tamewhera* non-tool to tool ratios

7.24.1 *Tamewhera* EAs chert tool to non-tool ratios

EA106 shows a considerably lower non-tool to tool ratio (i.e. more tools are present on EA106) than any of the other excavation areas, for which non-tool to tool ratios are all very similar. This discrepancy between EA106 and the remaining excavation areas is statistically significant (Pearson Chi-square: $\chi^2 = 8.693$, $df = 3$, $p = .033$), and suggests (a) EA106 saw more chert tool use, as opposed to manufacture, than other Tamewhera zones, (b) EA106 saw more flakes being converted into tools, or (c) a combination of (a) and (b).

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>Chert non-tools (n)</th>
<th>Chert tools (n)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 102</td>
<td>80</td>
<td>6</td>
<td>13.3</td>
</tr>
<tr>
<td>EA 103</td>
<td>133</td>
<td>10</td>
<td>13.3</td>
</tr>
<tr>
<td>EA 106</td>
<td>92</td>
<td>19</td>
<td>4.84</td>
</tr>
<tr>
<td>EA 108</td>
<td>25</td>
<td>2</td>
<td>12.5</td>
</tr>
<tr>
<td>Tamewhera</td>
<td>330</td>
<td>37</td>
<td>9.19</td>
</tr>
</tbody>
</table>

Table 7.33. Non-tool to tool ratios for chert artefacts from all Tamewhera Excavation Areas

7.24.2 *Tamewhera* EAs Mayor Island obsidian non-tool to tool ratios

Mayor Island obsidian tool ratios are all very similar and display no significant variation (Pearson Chi-square: $\chi^2 = 3.844$, $df = 2$, $p = .149$). They are generally lower than those of chert, suggesting comparatively more tools; as noted in Chapter 6 this could be the result of the more brittle obsidian displaying more macroscopic use-wear when compared to the harder chert material.
<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>MI Obsidian non-tools (n)</th>
<th>MI Obsidian tools (n)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 102</td>
<td>19</td>
<td>12</td>
<td>1.58</td>
</tr>
<tr>
<td>EA 103</td>
<td>37</td>
<td>12</td>
<td>3.08</td>
</tr>
<tr>
<td>EA 106</td>
<td>22</td>
<td>17</td>
<td>1.29</td>
</tr>
<tr>
<td>EA 108</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 7.34. Non-tool to tool ratios for Mayor Island Obsidian artefacts from all Tamewhera Excavation Areas

7.24.3 Tamewhera EAs Coromandel Volcanic Zone obsidian non-tool to tool ratios

As with Mayor Island Obsidian, Coromandel Volcanic Zone obsidian tool ratios are comparatively low when compared to chert and broadly similar between excavation areas; this is borne out by a non-significant Chi-square result: (Pearson Chi square: $\chi^2 = 5.849$, df 3, $p = .131$). The similarity with Mayor Island Obsidian results suggests the material was being utilised in a similar way and was subject to the same sort of use-wear patterning.

<table>
<thead>
<tr>
<th>Excavation Zone</th>
<th>CVZ Obsidian non-tools (n)</th>
<th>CVZ Obsidian tools (n)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 102</td>
<td>5</td>
<td>5</td>
<td>1.00</td>
</tr>
<tr>
<td>EA 103</td>
<td>20</td>
<td>12</td>
<td>1.67</td>
</tr>
<tr>
<td>EA 106</td>
<td>9</td>
<td>16</td>
<td>0.56</td>
</tr>
<tr>
<td>EA 108</td>
<td>2</td>
<td>6</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Table 7.35. Non-tool to tool ratios for Coromandel Volcanic Zone obsidian artefacts from all Tamewhera Excavation Areas
7.25. **Tamewhera summary**

The differential patterning in terms of artefact metrics and spatial patterning across the Tamewhera excavation areas suggests that there is both continuous and multiple episodic occupations of the areas, a proposition supported by the radiocarbon determinations for the Tamewhera excavation areas.

There is nothing in the comparison of the individual Tamewhera excavation areas that would suggest that there is a single Tamewhera excavation area that accounts for the significant differences between the Tamewhera assemblages and the other Ahuahu assemblages. As is discussed below, the EA106 chert assemblage is the source of all variation between the Tamewhera assemblages. As such it seems that the Tamewhera assemblages, in totality, are different from the other excavation areas analysed in the ways described earlier in this chapter.

Overall, EA106 stands out as presenting different artefact metrics from EA102, EA103 and EA108, and then only in relation to the chert assemblages. The chert artefacts from EA106 are larger in both maximum and complete flake measurements, and the EA106 chert assemblage contains fewer chert cores, but more tools than the other Tamewhera excavation areas. As the obsidian assemblages of both Mayor Island and Coromandel sources do not display a similar divergence, it is unlikely that this variation is due to taphonomic processes. An argument can therefore be made that the chert material was being utilised in different ways in EA106 from the way it was being utilised in the other excavation areas, but other than to factor in the absence of a stone-lined hearth it is difficult to ascribe a different functional aspect to the EA106 terrace based simply on the chert assemblage.
The implications of the various similarities and differences in the spatial and technological patterning of the artefacts from all of the excavation areas are discussed in more depth in the following chapter, Chapter 8.
Chapter 8. Discussion

The New Zealand archaeological narrative has long been rooted in juxtaposed dichotomies that change over time: from a 19th century conceptualisation of a Palaeolithic to Neolithic transition, to 20th century concepts of moa-hunter and farmer, Archaic and Classic, or Hunter-Gatherer and Horticulturalist (e.g. Duff 1956, Green 1963, Groube 1967, Davidson 1984, Anderson and Smith 1996 Walter et al. 2006). The null hypothesis to be tested from the models above would be that there was no change in mobility strategies or settlement systems over time. Kelly (1992) suggests that the socio-economic shifts implicit and explicit in those sorts of dichotomous models, and the concomitant mobility strategies and settlement systems, should be reflected in the archaeological record. As such, the research and analysis described herein was focussed on a particular component of the archaeological record: portable material culture in the form of lithic artefacts. This has been argued elsewhere in the world to be useful in evaluating the technological organisation of a particular group of people (Chapter 2) and as a consequence could test the null hypothesis outlined above. Through this lens, the methodological and analytical approaches that produced the results and analysis in the previous two chapters were a response to the gaps identified in New Zealand lithic archaeological research that were set out in Chapter 3. To recap, Furey (2004) noted:

1. A previous focus on adze manufacture and use, at the expense or exclusion of studies of stone flakes;
2. A failure to incorporate the potential for understanding site formation processes in the study of lithics; and
3. A lack of studies that record and analyse the spatial patterning of lithic artefacts.
To the above could also be added a lack of focus on the temporal aspect of the accumulation of lithic assemblages, discard practices, post-depositional taphonomic processes and the effects that recycling previously deposited archaeological material might have on recovered lithic assemblages. In addressing these concerns in specific case studies, a number of discussion points can be raised, both in a general sense in the way lithic artefacts are examined archaeologically, and in the more specific example concerning how portable material culture can inform pre-contact Māori mobility strategies and settlement systems.

As noted in Chapters 1 and 2, two broad conceptual approaches can be outlined with respect to lithic studies and specifically how lithic artefacts are used to inform mobility strategies and settlement systems. The first relates to technological organisation, how this might be reflected in stone artefact attributes, and how this inferred technological organisational structure may be used to then infer mobility strategy. It is well encapsulated by what Kuhn (2007) refers to as a “raw material economy” approach: “The central idea here is that chipped stone raw materials are limited goods, and that people respond to variation in their abundance or cost by altering their ways of doing things. Raw material costs can be a simple function of the ubiquity of stone or its proximity to a residential site, but other factors, including residential mobility, territoriality, and labor organisation affect access to chippable stone as well” (Kuhn 2007: 271).

The second approach considers the accumulation of artefacts in a landscape over time and the processes that affect their distribution up until the time they are brought into the realm of archaeological study. Broadly referred to as formation studies, Lucas (2010: 75) notes a distinction between the formation of assemblages and the formation of archaeological
deposits; the former deals with understanding how artefacts end up in certain spatial or depositional relationships, and the latter with the formation of the deposit (i.e. the entire matrix of the deposit) as a whole. Thus, human behaviour is not simply seen as manifest in the material culture produced, but by the patterning of the material culture in the archaeological record (ibid: Chapter 4). The accumulation process implied by the patterning can then be used to infer occupation duration at particular locales and thus mobility strategy from that point.

To assume that some sort of functional differentiation relating to the activities that took place at the locations where the lithics were found is problematic. As discussed earlier, a lithic technological signature that suggests intensive reuse of scarce raw materials (as evidenced by, for example, intensive reduction of cores or retouch of tools) coupled with contemporaneous evidence of house structures and an accumulation pattern of artefacts that infers long term occupation can be argued to indicate a sedentary lifeway. Conversely, the association of specific stone tool types with faunal remains of a particular nature can be used to suggest the remains of a temporary hunting camp. As noted in Chapter 3, the New Zealand approach in terms of using lithics to understand different potential settlement systems and mobility patterns has been to adopt a Binfordian site function approach (Anderson and Smith 1996, Walter et al. 2010) and posit trade or exchange networks based on movement between these idealised site types (see discussion below).

8.1. The Wider New Zealand Context

Unpacking the mobility frameworks that relate to pre-contact Māori society has always been problematic from an archaeological point of view. Despite many practitioners cautioning
against the use of a functionalist site typology when assessing the archaeological record of a particular locale (see for example Davidson 1987 with respect to Motutapu Island), a tendency to conceptualise archaeology in New Zealand in terms of site types remains. The concept of the transient village (Anderson and Smith 1996), for example, pre-supposes that a village “type” exists, without an explicit definition of the nature of a village in the pre-European New Zealand context. Similarly, mobility systems and settlement patterns are often portrayed as linked dots on maps, with “base camps”, “fishing camps”, “quarry camps”, and “transit camps” used to exemplify the way in which people interacted with their environment. Generally, the gaps between the dots are largely ignored unless there is some archaeological evidence that suggests people were at a particular point in space and time. As H. Allen (1996) noted, if we have a society that is fluid in terms of its social groupings, with movement of people governed more by politics and kin relationships than economic or environmental drivers, then to expect to see that structure represented in an archaeological record through specific site types that relate to economic or environmental situations is unlikely at best. Yet in New Zealand, even within the legislative frameworks in the form of heritage protection legislation and site recording protocols, the identification of “sites” and “site types” is paramount. For example, the relevant part of the definition of archaeological site in the Heritage New Zealand Pouhere Taonga Act 2014 reads as follows:

**archaeological site** means, subject to section 42(3),—

(a) any place in New Zealand, including any building or structure (or part of a building or structure), that—

(i) was associated with human activity that occurred before 1900 or is the site of the wreck of any vessel where the wreck occurred before 1900; and
(ii) provides or may provide, through investigation by archaeological methods, evidence relating to the history of New Zealand.

In interpreting a site, the New Zealand Archaeological Site Recording Scheme (SRS) then requires site type to be recorded, despite the fact that the type categories are a mix of functional and morphological attributes that give rise to a typological designation. These types can be as small as a GPS point (e.g. the category “Findspot” (Walton 1999)) or as large and laden with interpretation as “pa”, which can cover many hectares and incorporate any number of SRS site types in their own right, e.g. pits, terraces, hearth etc) (ibid).

Figure 2.2 (Chapter 2) is essentially a version of Binford’s idealised conceptualisation of a “collector” based settlement pattern (Binford 1980, Figure 3). The definitions of site type represented in the diagram reflect certain preconceptions in terms of mobility. A “transit camp” is an obvious example (see Figure 2.2). Whether a “transit camp” can be distinguished archaeologically from a forest harvesting camp is moot, but the division into “functionally discrete sites utilised by a community” (ibid) does reflect the way in which much archaeological evidence is interpreted in the New Zealand context. As Davidson (1987) pointed out, this does make it more difficult to move beyond this functionalism and look at approaches that embrace a concept of a continuum of density of archaeological evidence and an understanding of why there is variability in that density. The top-down narrative using ethnographic analogy (Andrefsky 2005: 210) can work if there is a strong idea of what the sites or components of the sites should look like and how they might relate to the ethnography. However, if the underlying baseline (such as the idealised settlement patterns
based on site type/function discussed above) is arguable, then interpretation of the archaeological record is correspondingly uncertain.

Accordingly, the current New Zealand focus (as a result of the framework that the New Zealand Site Recording Scheme (Walton 1999) dictates) is on the identification of “short-term occupations [and/] or single function locations” (Douglass 2010: 79), rather than understanding the processes that result in the formation of archaeological deposits in the way that Lucas (2012) discusses them and the persistent use of a locale for a multitude of behavioural events. If we draw back and think of persistent places in a landscape framework in the sense that certain locales are subject to repeated use over long term occupation of landscapes (Schlanger 1992: 97) (as has been undertaken in Australia and Egypt (Fanning and Holdaway 2001, Douglass 2008, Phillips 2011, Phillips et al. 2016)), then a more nuanced understanding of landscape use and change is possible. The identification of multiple archaeological contexts across a landscape is important, as variability in assemblage composition can only be evaluated when a series of locations is investigated. This in turn has an impact on research design, as multiple assemblages are necessary to allow for meaningful hypothesis testing. Identifying a combination of technological organisation and formation processes is a profitable way to evaluate occupation duration, which in turn allows an evaluation of landscape use and settlement patterns that are less reliant on the identification of functional/typological “site” designations.

Mobility has thus been conceptualised in NZ as the positioning of archaeological entities such as villages (sites, kainga, pa, etc.) while the relationship to the social groupings and movements of people that actually produced the record is uncertain (Allen 1996). That the
technological analysis of one aspect of the portable material culture record does not lend itself unequivocally to a “sedentary” signature might just be because such a signature doesn't exist – and nor should we expect it to. It is submitted that the frameworks for the conceptualisation of pre-contact Māori mobility and settlement systems outlined above have meant that there has been a focus on archaeological examples that appear to conform to a reified ideal of the protohistoric ethnographic record in the later period, or in the case of the early chronology, an ideal of resource-driven shifts (along a continuum from horticulturalist to hunter-gatherer and back to horticulturalist again (e.g. Walter et al. 2006)) that draws on a village and resource exploitation model from East Polynesia, especially the Cook Islands (Walter 1998, 2004). The risk is that in the case of the former, ethnographic accounts of Māori mobility, residential or otherwise, may have only been representative of protohistoric distortions to a pre-contact pattern driven by the desire to trade and control trade with sealers, missionaries etc., corresponding access to muskets and other tools, and the pressure from European settlers (c.f. Holdaway and Wallace 2013). In the case of the latter, the risk is that as the evidence for change in faunal exploitation patterns and resource depletion is far from certain in those northern regions of New Zealand that were more amenable to Polynesian horticultural practices from the time of first settlement (Davidson 1984), there is an overemphasis on the impact of environmentally-driven resource depletion and the residential mobility “forced” by such depletions.

If previous conceptualisations have been phrased in terms of "lookouts" (see Chapter 3 and the discussion of the New Zealand jurisprudential interpretation of occupation duration) or villages (New Zealand settlement pattern approaches generally, Anderson et al. (1996)), "base camps/hunting camps" (Smith et al. 2010), then it can be argued that this is the imposition of modern frameworks on past societal structures. While undoubtedly partly done
to try to communicate concepts to the general public on the one hand, or to see New Zealand as conforming to a wider archaeological or societal trajectory such as the so-called "Neolithic revolution" with the concomitant impact of the introduction of a Neolithic “package” (Zeder 2010) to a pristine environment, these ideals are reflected both in the conceptualisation of settlement patterns, site types and functionalist categories at the landscape scale and typological fallacies at the scale of portable material culture. By understanding assemblage accumulations at different locations within the same environment, and at a remote location in a similar but geographically distinct environment, it is possible to demonstrate that these typological/functional units may not be reflective of how the archaeological record was actually formed. This is not just because the units of analysis are re-examined, but also because the application of excavation methodologies (e.g. three-dimensional recording of provenience using total stations) and analytical techniques (e.g. spatial analysis using GIS and robust statistical analysis of technological measures) can help us understand those accumulation processes. To this end it is suggested that the sort of questions that we ask in New Zealand need to be changed: in particular, to not expect that the study of certain archaeological constructs will give us insight into something like "belief" (O’Regan 2016) or "mobility strategies"; rather, they will build up a more sophisticated picture of landscape use over time.

One of the advantageous features of New Zealand’s relatively short pre-contact period is the fact that we know *a priori* now (cf. von Haast and Palaeolithic/Neolithic) that we are only dealing with one cultural trajectory following initial settlement and the cessation of return voyaging to East Polynesia; variability in assemblages cannot be the result of different cultures producing them; and seasonal variation in terms of the production and use of lithics (as opposed to other types of tool) is likely to be minimal, too, given the relative stability of
resources and climate year-round, despite the acknowledged seasonal movements of people (Davidson 1984: 145-146, Allen 1996).

This picture of cultural origin and continuity, and the comparatively short settlement and occupation period for New Zealand, allows those two aspects of New Zealand’s pre-contact period to be controlled for in ways that are not always possible in archaeological studies in other areas of the world. If cultural affinity can be treated as a constant, and time parameters known to a relatively high degree of accuracy, other potentially variable external conditions can be identified and controlled for: specifically, the spatial parameters of the study areas and past environmental conditions, either in terms of climate, suitability for horticulture or distance from lithic resources. As noted in Chapter 4, in the northern regions of the North Island of New Zealand, and in particular in the two Excavation Zones in this study, the minor climatic or environmental variations that might have occurred in the past are unlikely to have had much impact on the economic base of the occupants of those regions. As a consequence, climate change in the broad sense is unlikely to have driven socio-economic change in either Excavation Zone.

Returning briefly now to the geographical situations of the Excavation Areas: for Ahuahu the basic premise is that as all of the island is in essence one occupation zone, there is no extant reason for differential exploitation of specific raw material types as a result of ecological factors such as proximity to food resources or arable land. So whether a “site” can be characterised as early or late, midden or house, hunting camp or working floor, there is no macro-environmental reason for lithic assemblages to differ.
Despite the location of the Masonic Excavation Area on the mainland of the North Island, environmental conditions on what is an identical latitude and coastal setting mean that the argument for its designation as an analogue for comparison with the Ahuahu record is strong. As a consequence, where there is patterning in either the technological metrics or spatial distribution of assemblages, it is more than likely to have been the result of formation processes, human behaviour in response to factors outside those listed as being “controlled for” above, or both, and how the two influences can best be isolated forms the basis for the following part of the discussion.

So what do the results and analysis set out in Chapters 5 and 7 suggest in terms of a functionalist, site-orientated approach? The four Ahauhu Excavation Zones and the Hauraki Gulf Excavation Zone all provide archaeological evidence (excluding the lithic artefacts) that has been used within a “standard” framework (see Chapter 2, Figure 2.1) for the assessment of degrees of mobility or sedentism. The Oneroa Excavation Zone (EA1), the Te Makutu Excavation Zone (EA51) and The Hauraki Gulf Excavation Zone (Masonic) all contain, in addition to lithic assemblages, considerable faunal evidence relating to the capture and consumption of now-extinct (regionally and nationally) megafauna coupled with chronological evidence confirming all depositional activity occurred prior to 1500AD. The Stingray Ridge (EA12-17 Upper, EA12-17 Lower and EA26) and the Tamewhera (EA102, EA103, EA106 and EA108) Excavation Zones provide the most convincing evidence for sedentary-type structures: Stingray Ridge has storage pits, postholes and spatial patterning suggesting structure at the upper level and Tamewhera has stone-faced terraces, stone-lined hearths and postholes suggesting house or storage structures. The radiocarbon dating of these
two Excavation Zones suggests activity after 1600AD – albeit in the case of Stingray Ridge, with earlier dates present at lower stratigraphic layers. These contexts, which can be differentiated both in time and apparent function, can be compared in terms of the technological signature that the lithic assemblages present, and a more detailed discussion of these attributes follows.

8.2. **Basic attributes of the lithic assemblages**

8.2.1 *Raw material*

The first Polynesian settlers to New Zealand originated from an East Polynesian tropical island geological landscape where lithic resources are distributed in a different way to that of the more continental geology of New Zealand (Walter 2004). It is apparent that very early on in the colonisation sequence, a wide variety of New Zealand lithic sources were discovered and tool stone from those sources was then distributed throughout New Zealand by early settlers (Davidson 1984). While East Polynesian manufacturing techniques and artefact morphologies remained important at the outset, the relative abundance of good quality lithic raw material would have meant that the significance of particular sources of material became less important; the manufacture of tools could be more opportune and less scheduled, and as a result a wider variety of materials and techniques could be used to achieve the same end.

In all cases on Ahuahu, whether local to the island or from off-island, lithic material has been moved some distance to the point of discovery in the archaeological record. None of the excavation areas correspond with the locations of the raw material on the island (with the exception of Ahuahu basalt at the Tamewhera Zone – see discussion below) and therefore
none could be considered quarry sites. The same can be said for the Masonic Excavation Area, although as noted while the source of the chert present there is not known for certain, it is unlikely to be immediately proximate. Thus distance to source is a constant over time, and we might expect to see a decline in particular types of material over time if, for instance, the ability to travel long distances was curtailed. The cycling of the logistical moves that cover the acquisition of each raw material is the only aspect that might vary in frequency due to distance from source: is there any way in which the chert is being treated differently from the obsidian, and if so, is this the result of different materials being selected for and used for different tasks, or does this relate to the different distances from source and consequent different degrees of intensity of use?

Meaningful comparisons between excavated assemblages based on absolute numbers or weights of stone artefacts, or even on numbers or weights of artefacts per square, or cubic, metre, are fraught with difficulty. The spatially restricted nature of most excavation areas, constrained by time, topography and excavation technique, means that keyhole samples, as opposed to large areal excavations, are the norm, and the excavations that provided the lithic assemblages analysed herein are no exception. However, a focus on the relative proportions of raw material in each assemblage (which are themselves at least somewhat representative samples of the archaeological deposits from different contexts) can be insightful.

As noted, all assemblages contain all main raw material types (Ahuahu basalt excluded), and in enough quantities to suggest that the presence of even the least common material in any given assemblage is not there as the result of an inadvertent or “fluke” depositional event, but due to systemic exploitation of that material for tool use or discard of that material at the
locale from which the assemblage was recovered. Arguably, the different proportions of materials relate to the differential manufacturing process, or use of those materials at a given point, as opposed to reflecting scarcity or abundance of raw material. Thus the large quantities of Tahanga basalt and Masonic greywacke in the EA1 and Masonic assemblages respectively are likely the result of the manufacturing process of core tools such as adzes, and the dominance of chert material in the EA51 assemblage may reflect the specialised manufacture of drill-points (perhaps in turn for the production of fishing gear) at the Te Makutu area.

The use of the local Ahuahu basalt for stone artefacts encountered in the assemblages with the most recent chronological signature, EA12-17 Upper and Tamewhera, is interesting in that it sees the manufacture of informal tools from relatively sub-standard material – at least when compared with the flaking quality of the other raw materials evident (however, it should be noted that concepts of quality and standards of material might well be modern constructs that may not have had much relevance in the past (Douglass and Holdaway 2015)). While a reasonable proportion of the non-obsidian and non-chert artefacts at Tamewhera and a very small proportion from EA12-17 Upper were Ahuahu basalt, these flakes revealed no macroscopic use-wear or retouch. This suggests an extremely “expedient” use, whereby material close at hand may have been used to manufacture tools on an ad hoc basis for specific basic tasks. It could be suggested that the presence of a comparatively “sub-standard” local material entering the lithic technology matrix late in the chronological sequence might suggest a response to decreased mobility or some form of territorial circumscription. However, the appearance of the Ahuahu basalt does not correspond with a decrease in the appearance of obsidian or a corresponding increase in the other local material, chert. Accordingly, given the persistence of obsidian and chert, the introduction of Ahuahu
basalt perhaps reflects both the potential for a broader array of activities to have taken place over time at the excavated areas and, indeed, the broader spatial areas of the excavations themselves, rather than being reflective of constrictions in the supply of better quality lithic material.

8.3. Post-depositional taphonomic processes and their impact on individual artefact morphology

As the archaeological contexts for the study assemblages differ, they afford an opportunity to evaluate the degree to which post-depositional processes may have differentially affected the physical metrics of those assemblages. As discussed in Chapter 4, the EA1 assemblage was recovered from beneath 1.5m of dune sand overburden that, due to its coastal location and depth, was unlikely to have been affected by stock trampling. On the other hand, the Stingray Ridge assemblages (especially EA12-17 Upper) and the Tamewhera assemblage were recovered from stratigraphically shallow contexts in areas which had been exposed to considerable stock movement over the past few decades. Countering this, C14 dating of the contexts from which the latter two assemblages were recovered suggest that they were deposited most recently and as a consequence have had less time to have been affected by post-depositional processes. Either way, comparison of assemblage fragmentation ratios across assemblages allows an evaluation of influence beyond those relating to the initial manufacture and deposition of the lithics that could skew basic metrics such as size and weight. As it turns out, fragmentation ratios for the Ahuahu assemblages across all materials show little variation, and as such it is argued that there is a large degree of uniformity in the way post-depositional processes have had a minimal impact on the lithic metrics that have
been identified for analysis. On occasions, fragmentation ratios for particular raw materials show divergence, as is the case for EA12-17 Lower Tahanga basalt, or Tamewhera Mayor Island obsidian, but in those cases the fragmentation ratios for the other raw materials within those assemblages do not vary.

As a consequence, in addition to holding constant lithic raw materials and distance to raw material sources, post-depositional taphonomic processes resulting from direct stock damage (trampling), farming activities generally, and erosive events can also be treated as having a uniform impact throughout the Excavation Zones. Thus irrespective of age or archaeological context, it can be argued that any differences in technological metrics are more reflective of human activity (whether in terms of depositional history or manufacture and use) than they are of non-anthropogenic post-depositional processes.

8.4. **Technological metrics**

Chapter 2 set out a number of ways in the relevant archaeological literature that certain technological metrics, as reflected in the analysis of lithic technology at both artefact and assemblage level, are (a) sensitive to changes in manufacturing process or reduction strategy, and (b) that those changes reflect forms of technological organisation that inform changes in mobility patterns.

The story of the Ahuahu and Masonic analyses, however, seems to be one of continuity rather than change. The following section will look at the results of the analyses in more detail to demonstrate this proposition.
8.5. Artefact attributes relating to manufacture and intensity of use

Metrics relating to flake size, shape and manufacturing techniques generally show uniformity within raw material type classes. The ability to compare the same raw materials across Excavation Zones is important as it removes the possibility that as one material became unavailable, a different material was substituted for the same task or process, yet the different physical properties of that substituted material subsequently see a shift in the technological signature of the assemblage. The presence of a high-quality local material (Ahauhu chert) in abundance is advantageous as it becomes in effect a “control” or baseline material for which changes in technological signature could only be the result of changes in technological organisation, rather than the result of changes in relative abundance of material. Of the different Excavation Zones, only the Tamewhera assemblages can be in any way consistently differentiated statistically with respect to technological measures, in the cases of Tahanga basalt and both Mayor Island obsidian and Coromandel Volcanic Zone obsidian; however, the metrics relating to the locally abundant Ahauhu chert are indistinguishable from the other Excavation Zones.

8.6. Tahanga basalt divergence

One of the main sources of significant variation in the metrics for raw materials relates to Tahanga basalt. Certain assemblages – in particular Tamewhera, but also EA12-17 Upper and Lower) – show significant variation in complete flake length, fragmentation and so on. It is likely that this variation is not necessarily caused by changes in manufacturing technique or the treatment of Tahanga basalt artefacts generally, but is a result of the differential selection of those artefacts from a larger debitage assemblage and subsequent removal to a different
Excavation Zone for use as tools in their own right. Thus where one can identify the potential for individual episodes of deposition (such as in EA12-17 Lower, and without ascribing any particular duration for that depositional event), it may be possible that this individuality is reflected in the metrics; whereas in the case of more time averaged deposits, morphological measurements are being similarly averaged. The evidence for selection of flaked artefacts for tools based on their shape and usefulness for the anticipated tasks ahead, as opposed to the staged production of flakes to achieve specific desired flake morphology, has implications for the ascription of technological attributes of an assemblage to particular points in a reduction process (Holdaway and Douglass 2012). The use of Tahanga basalt on Ahuahu and Motutapu greywacke at Devonport reflects a “hybrid” situation. A single raw material is being used for both core tools with a specific desired morphology (typically adzes), and for more informal tools whereby the production of useful flake shapes is governed as much by chance as by design at the level of the specific artefact. Hypothetical technological trajectories for the manufacture of so-called formal or informal tools are often separated and treated as the result of linear decision-making processes. By the use of the term “hybrid”, I intend to convey a more entangled, reflexive production process that does not lend itself to direct association of stone tool production with either production stages or dichotomous formal/informal tool manufacturing processes.

Adze manufacturing in the New Zealand context is one area (through both archaeological, experimental, and to a lesser degree, ethnographic sources) in which we have a good methodological understanding of the reduction sequence and the possibility of reworking of the artefacts themselves – therefore we can identify the signature of at least the primary manufacture of adzes (Turner and Bonica 1994, Turner 2000). This perversely may provide the best example for studying the examples of opportune (c.f. Binfordian expedient) tool use

321
because it can be argued that in the case of EA1 (and probably the Masonic greywacke flakes, because of the sheer number of artefacts found in conjunction with adze roughouts of the same material) the majority of the basalt flakes produced were the result of the intentional production of adzes (hence a by-product of the production of a desired core shape as opposed to the deliberate production of a particular flake shape). Because there was no intention (we assume) to produce flakes of a specific shape for a specific preconceived tool type in the mind of the knapper (other than that of the adze), there is the possibility that we can use them to look more closely at the way in which flakes of other material (chert and obsidian, for example) were selected (c.f. Holdaway and Douglass 2015).

8.7. Reduction intensity/economisation for chert and obsidian

As noted above, the ability to compare raw material types of known geological origin across both time and depositional context is vital to being able to control for fluctuations in material availability that might not always be possible in other circumstances. As recorded in Chapter 6, while the obsidians across all Excavation Zones are more heavily reduced than the Ahuahu chert (as shown by MNF to core ratios, core volumes, non-tool to tool ratios), there is no apparent change in reduction intensity over time for any one raw material type. This is unsurprising for the locally available and unexhausted supply of Ahuahu chert, but in the case of both obsidian raw material sources, it might be expected that reduction intensity would increase over time as populations increased, concomitantly with increased territoriality or sedentism (McCoy et al. 2010). Thus if the more distant Mayor Island source did become more difficult to access, for example, there is no reflection of this in the technological metrics of the assemblages over time. This could be the result of a variety of forces, and serves to highlight the difficulties in making direct links with certain lithic metrics and changes in
technological use. On the one hand, accessibility and mobility could have remained unequally over time and this is reflected in the stable technological metrics. Alternatively, modes of acquisition could have changed, but the quantity of material arriving on Ahuahu for use may have remained constant. Material could have arrived steadily in earlier times and in larger quantities, but more infrequently in later periods. The reverse could also have been true. Finally, material could have arrived in significant quantities in earlier times and then remained in circulation on Ahuahu through the mechanism of recycling over the course of the island’s occupation.

The variability noted with respect to the chert non-cortical to cortical ratios (Chapter 6) perhaps serves to highlight the difficulties faced when attempting to use cortical cover as an indication of reduction intensity in the New Zealand context for any lithic material. Given the local abundance of good quality chert, it would be reasonable to assume that supply-related factors would have little effect on assemblage characteristics, and this largely holds true for all the Ahuahu chert assemblages. The variability in chert non-cortical to cortical ratios is thus likely to be the result of indeterminable, non-functional factors; for example, the ratios for EA1, EA12-17 Upper and Tamewhera assemblages are statistically indistinguishable, despite their differing depositional and chronological contexts. The variation displayed at Te Matuku for this metric could similarly be the result of the difference in relative chert assemblage size; although given the greater number of formal drill point tools recovered, the impact of greater numbers of such a tool being manufactured must also be considered.
Economisation in terms of efficient flake production is not only evaluated through reduction intensity or cortical cover, as the Lin and colleagues (2013) rubric for the evaluation of the degree of economisation occurring in the manufacture of flakes shows. Interestingly, in the Ahuahu context, the platform angle and thickness values for the two later assemblages for both chert and obsidian sit as outliers (Figures 7.11 and 7.12), but not in a manner that is consistent with more economical use (Figure 7.9), as might be expected with increased sedentism and reduced mobility, especially in the case of obsidian. The lower platform angles in particular might represent not a more profligate use of an abundant raw material, but a different technological trajectory related to recycling of material.

8.8. Selection of flakes for specific purposes – recycling

As has been discussed earlier, there are difficulties with both ascribing stone flake attributes, or typologies, to stages in reduction sequences and the consequent interpretation of whether such a typological characterisation is indicative of a particular function for the site from which the material was recovered. A further confounding factor is the potential for archaeological assemblages to be enhanced or diminished through the process of recycling (Vaquero et al. 2015). Amick (2006: 223) identifies two broad categories of lithic recycling. *Lateral recycling* considers the situation where a worn or discarded tool serves as a core for the production of new flakes or is reworked into a new artefact. In the New Zealand context this is not uncommon, with broken or reduced adzes having been converted to chisels, or to personal ornaments (especially in the case of pounamu objects). In this sense, the object might be seen to be highly curated (cf. Binford 1977), but in terms of its “life-cycle” can be seen to represent an unbroken sequence of manufacture and modification.
until the point of entry into the archaeological record, no matter what functional
transformation it may have undergone.

However, the form of recycling that is more relevant to the assemblages studied herein is
Amick’s concept of secondary recycling (c.f. “reclamation” (Schiffer 2010:34)), where
lithic artefacts are scavenged from the archaeological record and reused, reworked or used as
cores. Thus rather than the chaîne opératoire described above for a particular artefact, in
this case the post-depositional selection of archaeologically visible artefacts is undertaken by
individuals some time later, and often those selected artefacts are then removed completely
from their original depositional context and transported to another point in the landscape.

Often this form of recycling is evidenced by the presence of a double patina on the artefacts
themselves (MacDonald 1991) – a visible weathered flaked surface created due to exposure
to the elements following discard is then further flaked following recycling to expose a
contrasting “fresh” flaked surface. The speed at which a patina will develop on a stone
artefact naturally varies depending on environmental conditions and depositional context, but
the passage of some months or years is generally held to be necessary. Consequently, fresh
flaking evidence/patina differential on a weathered artefact is good evidence of the
disjuncture between initial discard and later reworking.

One chert artefact recovered from Ahuahu demonstrates this process (Figure 8.1); however,
this form of recycling evidence is otherwise rare (Davidson 1970). In the absence of these
rare examples of double-patination, other physical attributes of the lithics may suggest
recycling of material has taken place. Two instances have been suggested from the analysis of the Tamewhera material in particular, and these are discussed in more detail below.

Figure 8.1. Ahuahu chert artefact showing secondary cortical patination on dorsal and ventral surfaces, and subsequent retouch on distal and lateral margins

8.9. Tamewhera Tahanga basalt

Despite its ubiquity in all the other Ahuahu assemblages, Tahanga basalt forms a comparatively small proportion of the Tamewhera lithic assemblage and reflects corresponding low artefact densities. Moreover, those flakes that are present are considerably larger (both in terms of maximum dimensions and flake dimensions), are heavier, and display a much lower non-tool to tool ratio than other Tahanga assemblages or the analogous Masonic greywacke assemblage (reflecting a much higher than usual proportion of flakes with macroscopic use-wear or retouch). These factors, combined with the lack of any evidence for the manufacture or maintenance of Tahanga basalt adzes in the Tamewhera Excavation Zone (or adzes of any material for that matter; it is of course possible that the evidence for manufacture of adzes from Tahanga basalt in the Tamewhera
Excavation Zone has not yet been discovered and that further excavations in the area might reveal this, but given the shallow stratigraphy and extensive pedestrian surveys undertaken throughout the Tamewhera Excavation Zone, suggest that the flakes present at Tamewhera represent a different tool-use trajectory. Thus, based on the evidence to hand it is submitted that the differences outlined above could be the result of flakes being recycled from spatially and probably temporally discrete accumulations of Tahanga basalt flakes. The EA1 assemblage, with its extremely high density of Tahanga basalt flakes, presents an obvious candidate for a source deposit. Additionally, the EA1 Excavation Zone is located in foredunes adjacent to the high tide mark; these dunes are highly mobile through the action of aeolian forces alone, and hence the possibility that the archaeological deposits would be periodically exposed over time is high. The proximity of the sea also presents another mechanism for erosive uncovering; indeed as noted in Chapter 4, the initial modern discovery of the EA1 deposit was the result of it being exposed in profile following a storm event.

8.10. **Tamewhera obsidian**

The possibility that some of the obsidian artefacts (constituting both Coromandel Volcanic Zone and Mayor Island obsidian) from the Tamewhera Excavation Zone represent recycling practices is less clear-cut, but a number of factors support the hypothesis. While most technological metrics show little variation from the other Ahuahu assemblages, the proportion by raw weight of the obsidian assemblage mirrors that of the total Ahuahu proportions as a whole – a pattern that might reflect that the Tamewhera assemblage is a representative or random sample of the whole. Perhaps more convincingly, the technological metrics that do set the Tamewhera obsidian assemblages apart from the rest
(specifically, unusually small exterior platform angles and platform area versus artefact weight values) reflect the sort of manufacturing trajectory that could be the result of the selection of large flakes as cores. As noted in Chapter 6, flaking of bifaces produces lower average exterior platform angles than other technological trajectories, and in this instance a biface can be seen to be analogous to a large flake used as a core. It can be postulated, therefore, that the lower platform angles in the assemblages from Tamewhera, and also those from EA12-17 Upper, reflect large flakes being used as cores at the start of reduction. As it is unlikely that the shape of the cores procured from the two source zones has changed in the time period available due to, for example, depletion of larger nodules for use as core material (we know this was not the case at either source (see Chapter 4)), then one possible explanation is that large flakes were selected from archaeological deposits that might have been periodically exposed over time due to natural erosive processes. The fact that both Mayor Island obsidian and Coromandel Volcanic Zone sources in the EA12-17 Upper and Tamewhera assemblages display the anomalous exterior platform angles/platform thickness values further supports this proposition. Given there is a mix of both sources in all earlier assemblages, and there is arguably little to differentiate the sources in terms of utility, then recycled material would have been selected on the basis of suitability for further flaking as opposed to source, the implications of which are elaborated on below.

8.11. **Implications of recycling practices for the assessment of human behaviour from the archaeological record**

Recycling practices have a twofold impact in the linkage of lithic studies to mobility and lithic technological organisation. In the first instance, recycling sees a disruption of linear or
simplified *chaîne opératoire*/reduction sequence approaches. As a consequence, association of site functions with reduction stages are compromised, and arguments relating to the reduction of material and economising behaviour see uncertainty introduced as to what artefacts might have been recycled into or out of an assemblage. Second, reconstruction of trade and exchange networks or procurement strategies based on sourcing models, distances to sources and relative percentages of particular raw materials fluctuating over time might be influenced not by mobility patterns *per se*, but by exploitation of previously deposited archaeological material.

To expand on the first point above, the behavioural context of recycling becomes important in relation to economising arguments, as exemplified by the case of Tamewhera Tahanga basalt artefacts. In this situation we have a set of technological attributes, such as flake dimensions and non-tool to tool ratios, which have contrasting implications for the use of the material in an economising sense. On the one hand, larger artefacts that have not been reduced to their smallest utilisable units would suggest a profligate use of an abundant resource. But on the other hand, high conversion rates of flakes to tools suggest more intensive use. That the mechanism of recycling can be used to explain this apparent contradiction serves to highlight the importance of technological analyses that incorporate the widest suite possible of analytical techniques.

If there is extremely limited evidence for lithic technological change, what does recycling say about the nature of mobility strategies? Recycling practices have been interpreted as evidence for constriction in the availability of raw material (Wojtcak 2015, Bamforth 1986), with the concomitant arguments for the cause of the constriction and corresponding changes
in mobility (see McCoy et al. 2014 for a New Zealand example). But is the reduced access the result of more sedentary lifeways, increased territoriality influencing unchanged patterns of mobility, or even the result of high mobility that means lithic sources are encountered less systematically? Because of these contradictory equifinalities I concur with Amick (2007: 244): “Because of this contradiction, it is clear that identification of lithic recycling alone is not capable of supporting inferences about prehistoric group mobility.” However, evidence for recycling practices can add weight to arguments for the persistent use of place; instances of recycling might increase over time as more material accumulates to become available for recycling; in other words, recycling in the New Zealand context is only possible through the persistent use of places over time and will accordingly only be a factor in later, rather than earlier assemblages, given that recycling can only occur if there is material to recycle from an earlier activity.

Additionally, what recycling evidence does provide is further confirmation that an approach to understanding assemblage formation that does not presume typological staging and reduction sequences (c.f. the selection of “expedient” flakes as set out in Holdaway and Douglass 2012) is more able to take account of the potential impact of factors that do not relate to intentionality on the part of the manufacturer. When there is evidence of recycling we can be certain that the intention of the original knapper played no necessary part in the final use of the tool, as the time difference between the knapping event and the final use event can be separated by some considerable time and space.
8.12. **Technological analysis: conclusion**

Ultimately, the suite of technological measures applied to the assemblages allows us to infer the differentiation of certain depositional episodes (e.g. EA12-17 Upper and EA12-17 Lower and the contrasting divergence in Tahanga basalt and Mayor Island obsidian flake dimensions), but they do not allow us to differentiate between different manufacturing techniques (due to the lack of variance in measures such as exterior platform angles or length to width ratios, for example) or patterns of lithic reduction or curation that would lead to an interpretation of changing lithic technological organisation. Evidence for recycling suggests that caution is needed when characterising the overall technological attributes of a particular assemblage, but that recycling practice in and of itself is not necessarily evidence for increased or reduced mobility. Thus if previously elucidated arguments for the linkage of a demonstrable change in lithic technological organisation to a change in the nature of mobility strategy/settlement systems hold true, the technological analysis of the study assemblages cannot reject the null hypothesis that mobility patterns or settlement systems did not change appreciably over time.
8.13. **Spatial patterning**

More often than not, stone artefacts accumulate at particular locations in the landscape as the result of multiple episodes of production, use and discard (Andrefsky 2009: 88). The patterning that is subsequently revealed by archaeology is also affected by post-depositional processes (Schiffer 2010). First, the spatial patterning of lithic artefacts in different archaeological contexts shows that in certain circumstances, individual depositional events can be identified, but in almost all cases the duration of that “event” is uncertain.

Little research has been undertaken in New Zealand with a specific focus on the spatial distribution of lithic artefacts generally, *let alone* with reference to the physical or technological attributes of those artefacts. The detailed three-dimensional recording methods undertaken in excavation of the material studied herein allow for a more detailed assessment of spatial patterning.

When examining the spatial distribution of artefacts, it is important to distinguish the kinds of questions asked of the data, especially when the research focus is one concerning the relationship between lithic technological organisation and settlement systems. The distribution of artefacts can be used to infer the nature of an activity (site function) that occurred at a particular locus, the duration of occupation (accumulations research), or shed light on post-depositional processes.

The two assemblages recovered from the two Excavation Zones that provide the most convincing evidence for sedentary-type structures, Stingray Ridge (storage pits, postholes, spatial patterning suggesting structure at the upper level), and Tamewhera (stone-faced...
terraces, stone-lined hearths and postholes suggesting house or storage structures), also produce spatial patterning of some artefacts that appears to be informed by these structures. Examples are the distribution of Mayor Island Obsidian around the EA103 house and the gap in the distribution of all artefacts in the EA12-17 Upper assemblage. As noted in Chapter 2, arguments have been made that suggest a strongly patterned accumulation of artefacts reflects increased intensity of occupation, as the result of more formalised site maintenance activities. However, do the contrasts in assemblage accumulation process and hence patterning between the assemblages associated with structures (Tamewhera, Stingray Ridge) and the assemblages that have less internal patterning (EA1, Te Matuku, Masonic) really reflect contrasting intensity of occupation or site maintenance practices? Or are we simply seeing the same process of accumulation operating on different spatial scales in different depositional environments? The foreshore assemblages certainly do seem to be more in the nature of localised dumps of lithic material, but multiple episodes of formalised disposal of either faunal remains or lithic “waste” or a mix of both still reflect the persistent use of a place over time. It can be argued that the siting of such waste dumps away from obvious structures reflects a similarly long term occupation to that of the apparently more structured patterning of the later sites. Thus with EA1 in particular we may not be seeing the result of a short term special purpose site type (i.e. a “working floor”), but evidence for a larger scale use of that landscape that probably reflects a more general purpose or long term occupation.

The spatial patterning of artefacts at the three larger excavations on Tamewhera are also a good case study for the evaluation of relationships between evidence for terrace function and artefact distribution. As noted above, EA103 tells us that even in the case of the most defined and identifiable instance of a strong relationship between structure and artefact distribution, in a situation where there is limited time depth, post-depositional processes and potential
functional changes in the use of the terrace are still arguable. Further, the patterning of artefacts on EA102 and EA103 are quite different, even though the presence of stone-lined hearths in similar positions on terraces of similar area and construction lends itself to a similar functional designation. Certainly, as noted in Chapter 3, the presence of stone-lined hearths in other parts of New Zealand has been deemed sufficient to designate the presence of houses, and by extrapolation, villages (Anderson et al. 1996). However, on EA102, no postholes, drains or other features were noted other than a small firescoop (Chapter 4). The distribution of artefacts was concentrated at the back of the terrace and on either side of the hearth, with virtually no artefactual material on the front half (Figures 5.51 and 5.52). As noted earlier the gap in distribution on the front half could conceivably be explained by post-deposition erosion, but this is unlikely given the stone-facing of the terrace front should have caught at least some artefactual material as it was moved. It is possible that the hearth post-dates the deposition of the artefacts themselves, which show little patterning with respect to the distribution of raw material or artefact types; but perhaps the more likely scenario is that no substantial structure was ever on the terrace and it was used in a different way from its neighbour EA103.

Another way of looking at assemblage characteristics is to examine the relationship between the nature of tool manufacture and artefact accumulations. This relationship is often reduced to simple dichotomies between “quarries” for primary acquisition and initial flaking of tool stone and “working floors” representing the secondary flaking and finishing of tools. However, as Dibble and colleagues (2016: 24-26) point out in their discussion of “living floors”, this can be a mis-characterisation of a palimpsest of multiple depositional episodes. Certainly, the EA1 and Masonic assemblages, dominated by Tahanga basalt and Motutapu greywacke as outlined earlier, might appear to be the result of single-purpose activities
relating to the secondary finishing of adzes. Nevertheless, both Excavation Areas also saw obsidian and chert artefacts in some quantity, suggesting the most direct or last link to human behaviour was not manufacture, but deliberate organised disposal (as opposed to unplanned abandonment). Thus, understanding the respective roles that different types of lithic raw material play in the lithic technological organisation of a group in question is important in evaluating the nature of the likely depositional events. With the EA1 and Masonic assemblages, we see a large amount of debitage in comparatively dense concentrations that could have accumulated over a very small period of time – conceivably relating to a single adze manufacturing session or perhaps multiple sessions separated by days or weeks. The nature of the manufacturing process that might be represented by a particular accumulation of lithic artefacts from a particular material is not straightforward, especially in the New Zealand context where we have (a) a variety of lithic materials, (b) a wide variety of formal and informal tools and the materials that might be suitable for such tools, (c) different manufacturing techniques (although possibly only flaking versus hammer dressing/grinding in terms of adze manufacture). In the same way, not all materials are equal in terms of their utility for particular tools and tasks and not all assemblages are created equal in terms of the time taken for them to accumulate, and here the idea that the lithic assemblage is a representative sample, reflecting the activities of manufacture, as opposed to deposition, is problematic. The EA1 and Masonic assemblages in particular demonstrate that we should “reject the assumption that the record represents a relatively undistorted sample [emphasis added] of a prehistoric settlement system.” (Holdaway et al. 2008: 132). Hence an understanding of manufacturing processes, and correspondingly perhaps the application of chaîne opératoire-type modelling, is important in understanding the potential rate of accumulation of the assemblage rather than the composition of the assemblage itself.
8.14. **Time Averaged Deposits**

As noted in Chapter 2, time averaged deposits are the result of differential place use over time as opposed to short term occupations or single-function locations (Douglass 2010: 79.)

Shott (2008) and Stern (2004) note that in the Palaeolithic, the differences in the assemblages in terms of their technological makeup/proportionality are largely illusory and dependent on the assemblage size and time averaging. Applying this approach to the assemblages analysed herein, does this mean the most recent assemblages (Tamewhera, EA12-17 Upper, EA2-5) are more useful because there is less time for the patterns that might be more directly related to human behaviour, as opposed to post-depositional processes, to be destroyed? I would argue not, and that this is heading down the path of the Pompeii Premise (Binford 1983, Schiffer 1987) and all its associated critiques (e.g. Murray 1999). Even the comparatively recently deposited Tamewhera assemblages appear to be time-averaged in relation to their own structure (i.e. inter- and intra-site patterning suggests multiple episodes of not-necessarily related activities). Thus while the archaeological record in New Zealand accumulated over a considerably shorter time period than Stern (2004) originally proposed when discussing time-averaging, the concept is still applicable as the processes remain the same (*contra* Lucas 2012: 109). In this light, the proposition that the accumulation of artefactual material with reference to inferred structural remains suggests that criteria for the designation of “sedentary” or village occupation in the later period must be questioned. Does it also mean that the archaeological deposits from the earlier beachfront sites represent a more mobile lifeway? Or do they just represent the designation of a refuse zone which also fits into a larger pattern of internal occupation zone organisation? Contradictory lines of evidence seem apparent when looking at the EA1 and Te Matuku assemblages. On the one hand, both provide evidence for the exploitation of marine and avian megafauna, and thus correspond with a hunter-gatherer framework. Yet the accumulation of lithic material at
these sites suggests that longer term occupation was occurring as well. EA1, with its large Tahanga basalt component and interspersed cooking evidence, could be the result of a designated refuse/adze finishing zone being utilised over some time. The stratigraphy, and in particular the three-dimensional analysis of the position of thermally affected rock and stone artefacts, supports this. Similarly, Te Matuku, with extensive cooking and faunal evidence, lithic manufacture possibly relating to the production of fishing gear, and the absence of major structural components in the vicinity, could also lend itself to the interpretation of a short term “fishing camp” (c.f. Smith 2011). However, the large proportion of Ahuahu chert in the Te Matuku lithic assemblage and the dominance of Mayor Island obsidian in the overall obsidian assemblage could also suggest restricted mobility and a reliance on material from fewer, more local sources. Thus, the technological and spatial data discussed above indicate difficulties in the ascription of technological characteristics to site function in the New Zealand context, with or without taking the further step of ascribing a particular mobility pattern or settlement system to a suite of technological and spatial archaeological data.

8.15. Chapter summary

This chapter has reviewed the results of the analysis undertaken in the research through the lens of the way in which the archaeological landscape is interpreted in the New Zealand context, and the implications that analysis has for the formation of that landscape. The linking of the archaeological evidence to the ascription of functional/technological site types has been questioned, and an alternative approach – one that has at its base a focus on the formation of the archaeological record within a landscape – has been suggested. The analysis of a particular class of portable material culture, that of flaked stone artefacts, has
demonstrated a mechanism for this kind of evaluation, and the implications for this in a broader context will be examined in the concluding remarks in the following chapter.
Chapter 9. Conclusion

This thesis has examined the relationship between large assemblages of lithic artefacts from a variety of archaeological contexts, and the mobility strategies and settlement systems that can be inferred for the people who produced those artefacts. This has been undertaken against a backdrop of a current model for the mobility strategies and settlement systems practised by pre-European Māori and posited examples of cultural change and shifts in these strategies over time. It has been possible to control for many factors, including macro-environmental zonation, that normally contribute to variability. This allowed a focus on variability in the values of certain metrics in contexts with tight chronological controls when compared to similar studies conducted in other parts of the world.

The previous chapter concluded that there is no strong evidence arising from the analysis of the stone artefact assemblages that would suggest that the technological organisation (as it relates to lithics) of Māori living on Ahauhu or in coastal Auckland (the Masonic Excavation Zone) changed appreciably over the course of the pre-contact period of New Zealand’s history. The overall picture of the technological signature presented and the level of change that appears to have occurred over this time, as evidenced by the study assemblages from the study areas, is instead one of stability and continuity. It appears that the stone working technological package that was brought to New Zealand by the first Polynesian colonists as part of an overall socio-economic system was more than adequate in terms of its adaptive capability to be utilised in a traditional manner in terms of the production of food, the acquisition of raw materials for tool manufacture, and ultimately the social structures in which artefact manufacture and use were conducted, at least in the areas for which the study
assemblages might be considered as representative samples, i.e. coastal northern New Zealand. It is entirely possible that this was not the case for different environments such as the south of the South Island, and obviously more work is required to ascertain whether the technological signatures presented herein are repeated elsewhere in the North Island (see sections 9.2 and 9.3 below). However, as set out in Chapter 3, apart from the silcrete blade tradition suggested by Leach (1969) for the southern South Island, previous studies have not identified any great regional variation in lithic technology. While it is not possible to generalise for all of New Zealand on the basis of the work undertaken herein, it is possible to question narratives that have been applied to all of New Zealand in the past. As noted in Chapter 3, the implication flowing from technological stability is a framework that is more akin to the arguments Groube (1967) presented in his critique of the application of a “series of stages in cultural development” (ibid: 3) to New Zealand, than to models that emphasise shifts from horticulturalist to hunter-gatherer and back again (Walter et al. 2006), with their concomitant implications for mobility strategies and settlement systems.

This thesis has at its heart the relationship between portable material culture, specifically flaked stone artefacts, and the mobility/settlement systems of the people who produced them. This is an area that has been widely studied in other parts of the world, but not to any great degree in New Zealand. The study has seen an examination of the specific archaeological links between the behaviour of people, both in terms of their movement within a landscape, and their practices concerning the acquisition, manufacture, use and discard of lithic artefacts, and the formation processes that influence the archaeological assemblages ultimately studied. In a broad sense, I have argued that the way in which archaeological “sites” and deposits are often conceptualised has an influence on the way in which the technological analysis of lithic artefacts is interpreted, and that the emphasis on describing and recording discrete typological and functional units, be it at the site, assemblage or artefact scale, both reifies these units and
is complicated by the influence of formational processes. At a fundamental level, this affects our ability to make links between certain technological “signatures” and lifeway reconstructions.

It is argued that on Ahuahu, and with respect to the Masonic Excavation Zone near Auckland, what is evident are essentially the same processes and the same human behaviours with respect to the manufacture and deposition of lithics, occurring at different spatial scales. The Tamewhera, Stingray and EA2-5 structural evidence allows us to unpick the depositional processes at a finer level than possible at other locations, but in essence the other deposits (EA1, Te Matuku and Masonic) show the same components, only at a larger landscape scale. This presents difficulties with the attribution of a particular “type” designation to an archaeological deposit or material culture assemblage within a particular typologically and spatially defined area, or “site”.

If, as has been argued in chapters 5, 7 and 8, we can distinguish some patterning in the metrics of the Tamewhera and Stingray Ridge artefacts on the basis of their spatial distribution within a period of, for example, 80 years for Tamewhera as a minimum and 400 years for the multiple but relatively simply stratified deposits at Stingray Ridge as a maximum, we must be very cautious about the attribution of technological signatures in terms of reduction sequence variables or life histories worldwide for assemblages with far greater chronological parameters. This is the upside to the short term nature of the archaeological record in New Zealand: it allows us to evaluate processes over a timescale that is unusually precise in the wider context of lithic studies. There are, of course, local contextual factors, which include the fact that there is a fairly pronounced dichotomy between formal and informal tool types in New Zealand and the nature of transport by waka potentially allowed the mass movement of resources under certain circumstances. Add to this the posited low-level logistical mobility for pre-European populations in New Zealand, with socio-economies
that do not fit well with the “classic” forager or hunter-gatherer lifeways. In some ways, therefore, New Zealand pre-contact archaeology can also be seen to be an intermediary between ethnographic analogies derived from contemporary or recent historic observations and the need to rely on actualistic experimental approaches when investigating involving deeper time periods.

Coupled with the argument outlined above concerning chronology is the difference between examining lithic assemblages with a view to establishing absolute characterisations, and examining lithic assemblages with a view to establishing relative characterisations. If any preconceived expectations about the typological or functional nature of the Excavation Area being investigated are set aside at the outset, then the important factor becomes the ability to compare the assemblages to each other independently. Additionally, the attributes of the artefacts that were selected for recording and analysis help to inform on the manufacturing processes and artefact use-life parameters, and the three-dimensional point proveniencing of the artefacts at the point of excavation allows for a comparison of assemblage context to be explored. By adopting this approach, the analysis is also not reliant on typological or functional attributions relating to the morphology or posited use of the artefact. Thus the individual technological “signature”, which is in essence a summary of the particular technological and spatial attributes of the lithics themselves, has relevance only with respect to a comparison with other similarly analysed assemblages; it does not have an essential or stand-alone nature in and of itself that can be placed in an absolute sense on a theoretical mobility spectrum (although as noted earlier, identified relative shifts can indicate change in mobility strategies if assumptions linking technological organisation to mobility strategies hold). So, by abandoning the typological/functional designation of the site at the outset in terms of guiding expectations for analysis, and having looked only at the excavated
assemblages themselves in the first instance, I have adopted an “artefacts-up” approach as opposed to a “site-down” view.

In many ways, how the concept of an archaeological “site” has been applied, both in terms of legislative drafting and common archaeological usage, has not moved on much since Dunnell’s (1982) critique of the use of the site concept in the 1960s and 1970s. As Shott (2008: 59) notes: “If, at least for some purposes, we abandon ‘site’ we can study how spatial scale affects the relationship between assemblage size and composition and patterns of association between artefact classes…”. This is very much the approach adopted in this thesis. In New Zealand, a repeated narrow linguistic description of sites has influenced thinking about typological-functional attributes ascribed to archaeological evidence; if the focus was more on the concept of “place”, and more particularly, persistent places (see below), the methodology applied in this thesis allows for a more refined understanding of the accumulation of archaeological material and the nature of the assemblages recovered.

Somewhat ironically, this could easily be done within the current New Zealand legislative context. The definition of archaeological site (see Chapter 8) explicitly refers to “place” in its operative language, and it is argued that if more attention was given to understanding “place” in this context, then a corresponding shift in terms of understanding the formation of the archaeological record at such places would follow. As noted in Chapter 8, this would then need to be incorporated into research design that permits the comparison of multiple archaeological places across a landscape.

So if we shift focus in this way, and “reject the assumption that the [archaeological] record represents a relatively undistorted sample of a prehistoric settlement system” (Holdaway et al. 2008: 132), then the sort of archaeological narratives based on a non-analogue interpretation of, for example, Binfordian forager ideals (Binford 1982), notwithstanding Binford’s original intent, become harder to sustain.
In the case of the Excavation Zones studied, while the spatial patterning and associated structural remains or lack thereof suggest that some specific activities that were undertaken in the past at a location or place can be identified, the corresponding technological analysis suggests no such differentiation is possible – as stated above, the story appears to be one of overall lithic technological uniformity and stability rather than directional change. The impact of this conclusion also means that we need to re-examine the link between structural evidence and presumptions of sedentism, as is discussed below.

9.1. Wider implications for lithic analysis in archaeology

It is acknowledged here that the lithic variables that form the basis of the research undertaken do not represent or assess all aspects of the material culture of the society the produced them. A vast proportion of portable non-lithic material culture does not preserve well in the archaeological record, even under optimal circumstances and within a chronology as comparatively short as New Zealand’s. However, the lithic analysis described herein has raised some issues regarding the direct connection between the analysis of stone artefacts and the correlation with human behaviour.

It does imply that using lithic analysis to go straight from artefact attributes or assemblage attributes to site type function and hence settlement/mobility system is fraught with difficulty. As Brantingham (2003) notes in the situation for raw material procurement and use: “In some archaeological cases it may be difficult to reject the neutral model. At best, failure to reject the neutral model may mean that intervening processes (e.g., depositional time-averaging) have erased high-frequency adaptive signals in the data. At worst, we may have to admit the possibility that Paleolithic behavioral adaptations were sometimes not responsive to differences between stone raw material types in the ways implied by current archaeological theory.” (Brantingham 2003: 487). Brantingham’s “neutral model” rejects the assumption
that lithic raw material differences necessarily influence procurement, maintenance and
discard of stone artefacts and treats the dynamics of procurement, use and discard as
independent of ascribed functional qualities (ibid: 491). Notwithstanding recent critiques
(Pop: 2016), the essence of Brantingham’s argument, it is submitted, holds true, and serves as
what Pop referred to as a “cautionary tale” (ibid: 1128). Conversely, characteristics of lithic
assemblages, both in technological and spatial terms, can be used to understand how the
archaeological record has formed at a particular locale and thus provide the means to evaluate
duration of the depositional episode(s), which may be either repeated or continuous. Thus the
persistence of a place in terms of the archaeological evidence for human use, or repeated
presence, rather than the typology/function of a place becomes the lens through which that
place is examined. In discussing the nature of movement through a landscape, Ingold (2012:
146-155) argues for an understanding of place not in terms of “occupation” but in terms of
“inhabitation”, emphasising that persistently inhabited places leave a signature (using an
allegory of entwined “knots” from multiple pathways (ibid: 148, 152)); this theoretical
construct is perhaps a more holistic heuristic device for framing the discussion about
persistent places. In other words, if “a persistent place is defined by repeated use of a locale
regardless of individual episode of duration use” (cf. Olszewski and al-Nahar 2015: 5) then
this may avoid the imposition of a modern functional site type construct that may have had no
relation to the way in which the archaeological record accumulated (H. Allen 1996). The
extensive archaeological record on Ahuahu allows us to examine the lithic assemblages
against a backdrop of a series of potential scenarios: seasonal and sedentary occupation,
different human behaviours associated with different activities and the consequent
accumulation of material at persistent places. The spatial analysis undertaken in this thesis
suggests that the accumulation of lithic artefacts was a result of a combination of processes
resulting in time-averaged assemblages – that is, assemblages that reflect the mixing of
material from multiple depositional episodes (as a result of a combination of repeated or persistent place use, taphonomic or post-depositional processes (including lithic recycling)), despite the relatively short time frames involved. This time averaging results in a degree of equifinality in terms of assemblage and individual technological metrics, making it difficult to go from total assemblage characteristics to site type or function; the human behaviour being reflected is the cumulative mix of different behaviours not able to be parsed as a single long-term behavioural average.

9.2. Questioning the narrative

Chapter 3 set out three broad conceptual approaches relating to the study of lithics and their relationship to Māori socio-economic systems. The third and most recent approach noted the desire to link the analysis of lithic material to concepts of the evolution of territoriality, resource-driven mobility and the maintenance of social ties. In looking to understand these processes, it is presumed that insights into the mechanisms behind the change from an East Polynesian founding culture to the Māori culture encountered by the first European can actually be identified archaeologically. However, if the proposed shifts in underlying settlement system and technological organisation that are inherent as drivers of change in this way of thinking are not as prominent, or central, to the story of pre-contact Māori society, what was the cause of the developments that are apparent, such as the emergence of fortified settlements known as pa? As set out in Chapter 3, historically, continuity and change was viewed as the product of different migrations and subsequent replacements of groups of people (von Haast’s (1872) application of the Palaeolithic to Neolithic thesis to New Zealand, or the Great Fleet traditions propounded by S. Percy Smith (1910), for example). Following this, a more environmentally determinative approach became popular; cultural change was seen as a response to variable environmental conditions (e.g. Leach et al. 1979) where the influence of Grahame Clark’s (1939) palaeo-economic paradigm is evident. Davidson (1984)
refined this approach to emphasise different potential trajectories in different regions, but ultimately she (arguably) fell back on similar environmental determinism, just at a regional level. If the results suggested by the analysis herein suggest no evidence for shifts in lithic technological organisation, and thus provide no evidence for corresponding change in mobility systems or settlement patterns, this raises the issue of what explanatory paradigms or alternative narratives should be considered.

In “Archaeology: the loss of innocence”, Clarke (1973) states that “we should note the connexion between time scale, explanation and theory” (ibid: 10), in essence arguing that explanatory paradigms are influenced by the chronologies within which they are bounded. He notes the example of attempting to explain the Mousterian lithic tradition in terms of tribal movements, suggesting that this is the wrong explanation applied to the wrong scale. It is possible that in New Zealand a similar, mirrored fallacy is being propagated, in that explanatory paradigms that work on the longer scale (environmental determinism, a shift from Archaic to Classic Māori culture, or hunter-gatherer to horticulturalist) are being used to try to explain cultural change within New Zealand’s shorter chronology. While proposing an alternative overarching narrative for pre-contact Māori society is beyond the parameters of this thesis, the alternative suggested is an archaeological approach that includes a greater focus on understanding the accumulation of portable material culture at persistent places in the landscape rather than attempting to fit descriptions of such material culture to a pre-conceived idea of directional cultural change.

9.3. Future directions

An expansion of the sort of study of lithics undertaken herein to different environmental and geographic contexts is the obvious first step in further research. As noted in Chapter 3, little technological analysis of stone artefacts has been undertaken in any part of New Zealand, and
as a consequence, the different impact that regional environments might have on socio-technological systems is beyond the scope of this research. Investigation of whether the lithic technological stability is evident in other parts of the country through similar technological studies is one way in which the impact of environment and the resilience of socio-technological systems can be evaluated.

In the New Zealand context, a better understanding of the archaeology of the ancestors of those who settled New Zealand from East Polynesia will only help in being able to evaluate rates and nature of change from first settlement to European contact. As Walter (2004) notes, the East Polynesian connections to New Zealand colonisation are understudied outside of voyaging models and basic artefact typology. Understanding the relationship between settlement systems in East Polynesia (for example in respect to unpicking the concept of the East Polynesian “nucleated village” (ibid: 139)), as they may have existed around the time New Zealand was first settled, will help to establish a base-line for models that seek to determine cultural change.

From the point of view of further refining both our understanding of the chronology of New Zealand archaeology and the potential for evaluating the impact of recycling of lithic material on lithic assemblage composition, advances in obsidian hydration dating (Stevenson and Novak 2011, Stevenson and Rogers 2016) (an area of research that has not to date been successfully applied to New Zealand obsidian for a variety of technical reasons) offer potential for new understanding. Leaving aside the chronological aspect and the obvious advantages of being able to circumvent C14 calibration curve issues generally, the ability to identify different flaking time frames on artefacts within an assemblage, and then potentially different flaking timeframes on individual artefacts, would allow first the identification of recycling practices in the broad sense, and then possibly allow for a better understanding of persistent landscape use (allowing for the fact discussed earlier that persistent landscape use
is a prerequisite for recycling, as there is nothing to recycle for initial colonisers) and post-depositional impacts on older assemblages as “quarry” assemblages.

9.4. Concluding remarks

The assemblages studied here have been taken from a particular environmental and geographical context in an attempt to control for many of the variables that often confound or at least inhibit interpretation of change over time. Additionally, the short chronological depth (irrespective of the vagaries of ultra-precise C14 dating within that period) allows a closer link between the time taken to produce an assemblage of artefacts and the depositional and post-depositional processes that subsequently affect the composition of that assemblage. In essence, it is the study of the kind of archaeological record “low-level food producers” (Smith 2001) might leave behind. The research undertaken suggests that correlations between technological attributes of stone artefact assemblages and mobility patterns/settlement systems are far from straightforward. It does, however, suggest that a methodological approach – one that attempts to understand assemblage accumulations at particular persistent places in a landscape – can offer insights into both the nature of longer term human landscape use, both in terms of environmentally favourable settings and culturally significant locations, and the post-depositional formational processes that affect the archaeological record.
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350


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