

Contents

List of Figures.....	x
List of Tables.....	xiii
Abstract.....	xv
1. Introduction.....	1
1.1. Astronomical Archaeology of British Monuments	1
1.2. Thom’s Research Methodology	2
1.3. Visualising the Past	3
1.4. Software Considerations	3
2. Previous Archaeo-Astronomic Research.....	5
2.1. Sites under Investigative Consideration.....	5
2.2. Specific Research of Sites under Investigation	7
2.3. Investigation into Similar Software Virtual Environments	8
2.4. Research Approach.....	8
2.5. Dating the Sites	9
3. Approach – Methodology	11
3.1. Evaluating a Model	12
3.2. On Site.....	12
3.3. In the Computer Laboratory.....	13
3.4. Mapping	14
3.5. Equipment Employed.....	14
4. Computing the Neolithic Sky	17
4.1. Positioning the Celestial Objects	17
4.2. Stellar Motion.....	18
4.3. Positional Change of Celestial Objects over Time.....	18
4.4. Planetary Data	18
4.5. The Sun	19
4.5.1. Precession.....	19
4.5.2. Date Representation	19
4.6. Stars.....	20
4.7. Heliacal and Acronychal Stars	21
4.8. The Moon	22
4.9. Lunar Limits.....	22
4.10. The Planets	25
5. Changing Environmental Landscape.....	27
5.1. Holocene Environment.....	27
5.2. Foliage.....	27
5.3. Detailed Pollen Investigation	28
5.4. Climate	29
5.5. Human Activity	31
6. Model Construction	33
6.1. The Process of Generating a Model.....	33
6.2. 3-Dimensional Modelling of the Stones	33
7. Topography	39
7.1. GPS and the British Mapping System.....	39
7.1.1. Incorporating the Plate Tectonic and Isostatic Motions	42

7.2. Celestial Programming.....	43
7.3. Ray Tracing.....	44
7.4. The Process of Assembling the Components.....	44
7.5. Animation.....	45
7.6. Overall Accuracy.....	45
8. Investigative Models.....	47
8.1. Site Interrogation Using 3-Dimensional Models.....	47
8.2. Ballochroy.....	48
8.2.1. Modelling Considerations.....	48
8.2.2. Previous Research into Ballochroy.....	48
8.2.3. Land Movement.....	50
8.2.4. General Site Investigation.....	51
8.2.5. Solar Simulations.....	51
8.2.5.1. Winter Solstice.....	51
8.2.5.2. Summer Solstice.....	53
8.2.6. Lunar Simulations.....	54
8.2.6.1. Minor Northern Limit.....	54
8.2.6.2. Major Northern Limit.....	55
8.2.6.3. Minor Southern Limit.....	55
8.2.6.4. Major Southern Limit.....	56
8.2.7. Stellar Considerations.....	56
8.2.7.1. Stars at Summer Solstice.....	56
8.2.7.2. Stars at Winter Solstice Sunset.....	56
8.2.7.3. Stars at Winter Solstice Sunrise.....	56
8.2.8. Planetary Considerations.....	58
8.2.9. Ballochroy Site Discussion.....	59
8.2.10. Dating Ballochroy.....	60
8.3. Nether Largie.....	61
8.3.1. Modelling Considerations.....	62
8.3.2. Land Movement.....	64
8.3.3. Solar Simulations.....	64
8.3.4. Lunar Simulations.....	64
8.3.4.1. Stone 1 Northern Major Limit Setting.....	65
8.3.4.2. Stone 1 Southern Minor Limit Setting.....	65
8.3.4.3. Stone 1 Northern Major Limit Rise.....	66
8.3.4.4. Stone 1 Southern Minor Limit Rise.....	66
8.3.4.5. Stone 1 Southern Major Limit Rise.....	66
8.3.5. Stones 2 & 3.....	66
8.3.5.1. Stones 2 & 3 Northern Limits.....	66
8.3.5.2. Stones 2 & 3 Northern Major Limits Moon Rise.....	68
8.3.6. Stones 2 & 3 Northern Major and Minor Limit Settings.....	68
8.3.7. Stones 2 & 3 Southern Minor Limit Moon Rise.....	68
8.3.8. Stones 4 & 5.....	68
8.3.8.1. Stones Numbered 4 & 5 Northern Limits.....	68
8.3.8.2. Stones Numbered 4 & 5 Southern Limits.....	70
8.3.9. Q Stone Views.....	70
8.3.10. Stone 6.....	71
8.3.11. Stellar and Planetary Considerations.....	73
8.3.12. Nether Large Discussion.....	73
8.3.13. Dating Nether Largie.....	75
8.4. Beacharr.....	76
8.5. Ballymeanoch.....	77
8.5.1. Previous research into Ballymeanoch.....	77
8.5.2. Modelling Considerations.....	78
8.5.3. Ballymeanoch Discussion.....	78
8.5.4. Ballymeanoch Avenue.....	79
8.6. Brainport Bay.....	82
8.6.1. Previous Brainport Bay Investigations.....	83
8.6.2. Modelling Considerations.....	83

8.6.3. Land Motion	85
8.6.4. Solar Events.....	85
8.6.5. Brainport Bay discussion	88
8.6.6. Dating Brainport Bay	89
8.7. Dunamuck Farm.....	90
8.7.1. South East Pair	90
8.7.2. Solar Simulations	91
8.7.2.1. Winter Solstice.....	91
8.7.2.2. Summer Solstice.....	91
8.7.3. Quarter Days.....	92
8.7.4. Lunar Simulations	92
8.7.5. North West Trio	92
8.7.6. Stones D and E	93
8.7.7. Stellar Considerations.....	94
8.7.8. Dunamuck Discussion.....	95
8.7.9. Dating Dunamuck.....	97
8.8. Carnasserie	98
8.8.1. Solar Considerations	98
8.8.1.1. The Northern Stone	98
8.8.1.2. The Southern Stone	99
8.8.2. Lunar Considerations	99
8.8.3. Carnasserie Discussion.....	99
8.8.4. Dating Carnasserie	100
8.9. Escart.....	101
8.9.1. Modelling Considerations	102
8.9.2. Solar	102
8.9.3. Lunar	102
8.9.3.1. Southern Limits	102
8.9.3.2. Northern Limits	103
8.9.4. Stellar and Planetary.....	103
8.9.5. Escart Discussion	103
8.9.6. Dating Escart	104
8.10. Tiraghoil	106
8.10.1. Land Motion	107
8.10.2. Modelling Considerations	107
8.10.3. Solar Simulations	107
8.10.3.1. The Quarter Days.....	107
8.10.3.2. Solstices.....	108
8.10.4. Moon Over Mull.....	108
8.10.4.1. Northern Moonrise	108
8.10.4.2. Southern Minor Limit Moon Rise	108
8.10.4.3. Southern Major Limit Moon Rise	111
8.10.4.4. Moonset.....	111
8.10.5. Stellar and Planet.....	112
8.10.6. Tiraghoil Discussion.....	112
8.10.7. Dating Tiraghoil	112
8.11. Kintraw.....	114
8.11.1. Previous Kintraw Investigations.....	114
8.11.2. Kintraw Site Survey Data.....	115
8.11.3. Plan of Kintraw.....	115
8.11.4. Modelling Considerations	116
8.11.5. Land Motion	117
8.11.6. Solar Interrogation.....	117
8.11.7. Discrepancies with Other Research.....	118
8.11.8. Viewing Station	120
8.11.9. Lunar.....	120
8.11.10. Stellar and Planetary.....	122
8.11.11. Kintraw Discussion.....	122
8.11.12. Dating Kintraw	122
8.12. Torbhlaran	123

8.12.1. Modelling Considerations	123
8.12.2. Solar	123
8.12.3. Lunar	124
8.12.4. Stellar	124
8.12.5. Torbhlaran Discussion	124
8.13. An Car	125
8.13.1. Modelling Considerations	125
8.13.2. Solar	126
8.13.3. Lunar	126
8.13.3.1. Southern Major Lunar Limit	126
8.13.4. An Car Discussion	127
8.13.5. Dating An Car	127
9. Society and the Stones	129
10. Interpretation	131
10.1. Does the Approach Meet MacKie's Test Criteria?	131
10.2. Dating Summary	131
10.3. General Observations	133
10.4. Isostasis and Plate Tectonic Motion	135
10.5. Modelling Advantages	135
10.6. New Viewing Perspectives	136
10.7. Self-Indicated or Inferred Positioning	136
10.8. Shaping the Stones	137
10.9. Shadows	138
10.10. Solar Summary: Equinoctial Orientations	138
10.11. Lunar Summary	138
10.11.1. Eclipses and the Lunar Limits	139
10.11.2. The Moon's Perturbation and Land Motion	140
10.12. Hill and Dale, Sun and Moon	140
10.13. Stellar Summary	141
10.14. Planetary Summary	143
10.15. Non-Astronomical Stone Orientations	143
10.16. Cairn Association	143
10.17. Parallels with the Archaeological Record	145
10.18. The Spatial Nature of the Landscape	145
10.19. The Scottish Neolithic Peoples and the Stones	146
10.20. A Final Word on Statistical Analysis	146
10.21. Process Interpretation	148
11. Conclusion	151
11.1. Future Opportunities for This Type of Research	152
11.2. Archaeological Propositions	152
11.3. Future Investigations of Megalithic sites	153
11.4. The New Hypotheses	153
Glossary	155
Bibliography	157
Appendices	165
A Radio Carbon Date Conversion	165
Land Motion Example	166
OSGB Maps Used	167
Solar Julian Calendar	168
Lunar Minimum and Maximum Limit Dates	169
Morning and Evening Twilight	174
Index	175

Chapters 1–5 make reference to plate tectonic and isostatic land motions and how these may impact site orientation. Despite the fact that since 3500 BCE the landmass has rotated approximately 160 metres to the northeast and the land has rebounded by 8 metres on average, this has had a negligible impact as far as any single observation of a celestial event in association with the Scottish horizons is concerned. A fuller discussion of these land movements has been provided as a downloadable appendix.

Also available for download via the same web address are animations generated from the computer simulation runs that were performed as part of the research underpinning the analyses presented. The file names of the individual animation files have been indicated in footnotes where relevant.