Appendix 1

Archaeomagnetic Results from 13–19 Roxburgh Street, Kelso

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General Introduction to Archaeomagnetism

Archaeomagnetic dating is based on two basic facts. First, the Earth's magnetic field gradually changes in both direction and strength. Second, many archaeological materials, particularly those that have been fired, are able to retain a memory of the geomagnetic field from the time when they were fired, deposited or chemically altered. The measurement of the directions preserved in fired samples can usually be measured within 2–3°, and by collecting several samples, the final errors can be reduced to 1–2°. Observations of the changes of the geomagnetic field in London extend back to 1600 AD and show average changes in direction of 0.25° per year, so that dating within some ±5 years is theoretically possible. In practice the errors are somewhat larger, reflecting anisotropy, inhomogeneity and refraction (Aitken 1974; Tarling 1983), but are still generally of the order of ±10–25 years. However such accuracy also depends on knowing the direction of the geomagnetic field throughout archaeological time. Such records can only be constructed using the magnetization of archaeological materials of known age to determine a British archaeomagnetic curve. This curve is now quite well established for some periods, but greater precision is still desirable, even for the better known times.

The actual process of study involves the sampling of archaeomagnetic materials in the field. For directional studies, these are ideally *in situ* fired materials, such as hearths and kilns. All materials lie in the Earth's magnetic field and gradually acquire new magnetizations, but these can be easily removed by either heating them (in zero magnetic field) to 100–150°C or by placing them in alternating magnetic fields of some 10–15 mT. In practice, most samples are subjected to alternating magnetic fields in a series of steps up to 50–60 mT and the direction initially changes as the later magnetizations are removed, and then remains constant when the original magnetization has been isolated. The reliability with which this has been isolated is measured using a stability index (Tarling and Symons 1967), which corresponds to unstable if less than 1 and stable if more than 2.5. These directions are then combined and the radius of an error circle defined ($alpha_{95}$) within which there is a 20:1 probability that the true direction lies.

As the Earth's magnetic field direction gradually changes across Britain, the observed directions are converted to a location, Meriden, which is central to England and Wales. This direction can then be compared directly with the British archaeomagnetic curve. (This correction could introduce a further error of 1–5 years.)

Table 10 Archaeomagnetic Results from the kiln at 13–19 Roxburgh Street, Kelso
Most stable directions

Sample	Int	Decl	Incl	SI	AF
1	0.1	195.1	61.0	1.1	0–50
2	5.6	36.7	70.6	7.4	20–50
3	30.6	359.0	67.5	38.6	20–40
4	62.2	15.3	56.5	7.1	5–40
5	119.8	9.4	62.5	6.3	5–15
6	149.8	15.8	64.3	14.7	7–15
7	28.5	12.3	58.6	14.5	10–40
2–7	–	14.0	63.7	6.0 (alpha95)	
3–7	–	10.9	62.0	5.0	

Int = Intensity in mA/m units
SI = Stability Index
AF = peak field (AF) mT

The results

Heated stones were examined from the floor of a late medieval corn-drying kiln excavated in central Kelso (55.5°N, 2.4°W). The site code is KL83, context number 382.

Samples 1–5 were from a single blackened and reddened sandstone block, sample 6 was from a small sandstone wedge and 7 was from a grey sandstone block. The initial intensity of magnetization (per unit volume) was moderately high in all except sample 1 (Table 10). All samples also showed high to very high stability to alternating magnetic fields, with the exception of sample 1 which showed metastable properties. Samples 2–7 also showed single component remanence throughout their coercivity spectra (0–50 mT), but no component was isolated in sample 1.

The results from sample 1 are clearly inconsistent with all other samples, reflecting their lower intensity and lower stability. The results from this sample are therefore omitted from further analysis.

The samples from all three stones show broadly similar directions, although somewhat more scattered than would be expected for such stability, but it is not due to local magnetic effects as the orientation was by sun-compass. The scatter is not due to movement of the samples after their original cooling as the same degree of scatter is indicated for samples from the same stone. Only one specimen, 3, has a direction that is similar to the present geomagnetic field (352.8°, 69.4°), but this sample also shows the highest stability – thus suggesting that there are no effects due to the present field. However even ignoring sample 1, the results are still somewhat scattered, with sample 2, the next lowest intensity being the most deviant.

The most reliable estimate for the geomagnetic field at the time of last firing is thus provided by the mean direction of samples 2–7, with an option of the better defined mean direction of samples 3–7. When corrected to Meriden, the directions mostly fall east of the current archaeomagnetic curve, but the 95% confidence circles intersects the curve for the last half of the 16th century, with the more precise determination lying overlying it between 1560 and 1580.

Appendix 2

Resistivity Surveys at Wester Kelso/Floors Castle *by P S Spoerry The Border Burghs Archaeology Project and School of Archaeological Sciences, University of Bradford. June 1984*

The primary object of the resistivity surveys described here was to indicate the best places for excavation, with known areas of archaeological interest.

The earliest available Ordnance Survey map of the Kelso area has a plan of the Duke of Roxburghe's ornamental gardens, which covered much of the eastern end of his estates during the 19th century (OS 1857a). The gardens are arranged on a cruciform pattern complete with trees and paths. The main feature of interest is the siting of a market cross at the centre of the gardens, the site of the former upper market of Kelso, which was abandoned by the end of the 18th century. In October 1983 a resistivity survey was carried out in the area around the site of the market cross. Resistance anomalies associated with the ornamental gardens were expected. Of more interest were any other anomalies that could not be explained as part of these gardens. These, it was hoped, would yield information concerning the medieval settlement of Wester Kelso, thought to have been sited here.

Survey area 1 (illus 21)

The survey was carried out using a Bradphys Two resistivity instrument together with a twin-probe configuration. The data obtained was initially analysed by means of a hand-drawn contour plan and later by computer-drawn dot-density plots.

The results

The following anomalies were identified on the dot-density plot. They are compared as percentages of the mean resistance value. High resistance was shown as a concentration of dots, low resistance as empty space.

A A long narrow area of low resistance, parallel with the edge of the survey and with the existing garden to the north-east. It had values of between 5% and 35% below the mean resistance value.

B A semi-circular 'hole' of low resistance, 5% to 35% below the mean resistance value. It merged with A and delineated the northern edge of C.

C A roughly rectangular area of high resistance, with two spurs projecting towards the south. It had a range of values of between 10% and 35% above the mean.

D A long strip-like feature of high resistance, 15% to 50% above the mean resistance value. It ran approximately north/south across the survey area and became hazy where it was in contact with C.

E An area of high resistance, up to 40% above the mean value. It was of indistinct shape but seemed to have some linear qualities on a roughly east/west axis.

F A long narrow low resistance feature, up to 45% below the mean value. It ran approximately east/west and was cut by D. It broadened out towards the west end.

G A low resistance feature, 5% to 20% below the mean value.

H, J These were small, roughly circular areas of low resistance. Neither was more than 20% below the mean resistance value.

K A high resistance feature, 5% to 30% above the mean value. It had no definite shape or form.

Interpretation

A This feature seems to have been associated with the vegetable garden that runs along the edge of the survey area. It could either be a result of the gardening itself or have come from the erection of the garden fence.

B This low resistance feature was possibly associated with A, for example it could have been a result of a previous garden fence. However it did seem to be aligned with respect to D and C, and so may have been associated with either of these features.

C This was the most obvious compact area of high resistance identified. It was possibly of earlier origin than D, running underneath D into feature E. However the map of the 19th-century gardens indicates that this feature followed, in part, the lines of one of the garden paths. This anomaly, therefore, probably, arose from the presence of the path. However there are other, possibly earlier, structures accounting for this anomaly.

D This overlay exactly the known east/west path of the 19th-century garden. It was rather blurred at the centre point, either due to other features, or as a result of later damage to the path.

E This was probably a continuation of C. It included the remains of the east/west garden path and probably other features as well, including, of course, the old street line or market area, but nothing definite can really be said about this. Another possibility that cannot be overlooked is the fact that this anomaly could be, in part, natural. After all, the

band of high resistance does follow the edge of the gravel terrace very closely, a point normally having less topsoil.

F This was a band of low resistance. Again it followed the gravel terrace, this time at the base of the slope. This would make sense for a low resistance feature, as the topsoil would be deepest here, unless tampered with by man.

G, H, J These were all small isolated areas of low resistance. They may have been 'tree holes' from the fruit trees that are known to have originally lined the garden paths.

K This high resistance feature again was of obvious deliberate shape, although it was below the gravel terrace near the river. It seems unlikely that dwellings should be placed down here, but again no obvious reason for it can be found.

From the above conclusions concerning the survey, and also from documentary evidence it was decided in January 1984 to start an excavation over a point in the survey covered by features C, B, parts of E and D. This point was the known centre of the 19th-century gardens, the reputed site of the market cross, and excavation here could determine if the cross was present in this position before the gardens were created. A great deal of activity was visible on the survey at this point, although no definite buildings or other features were evident. As nothing is known to have been built here since the gardens, then these anomalies could represent the remains of Wester Kelso.

The excavation (WK84) and its relationships with the survey data

Subsequently this excavation uncovered the garden paths, virtually intact, following very closely the lines of anomalies D, E and part of C. As had been suggested, anomaly C also represented other buried features, notably areas of stones and compacted pebbles. These were associated with a set of stone steps which ran down into the cellar of Building A (see Wester Kelso/Floors Castle Trench 2), where anomaly B appears. This cellar was approximately 1.5 m deep and filled with rubble and soil. It was damper than the surrounding gravel subsoil and acted as a sump or drain. This explains why it appeared as a low resistance feature on the survey. A series of ridges and pits was all that remained of the platform of Building B to the south-west of the cellar and these were not visible on the survey. However a compacted gravel road surface was found running through the southern end of C and E. This was downhill from the garden path and roughly parallel with it. It was not visible as a distinct entity on the survey, but obviously was partially responsible for the high resistance features C and E. So it seems that C and E were representing features earlier than the garden paths, but the overlapping of these features, together with the paths, caused them to be blurred together on the survey.

Thus, evidence for the former northern end, or Townhead of Kelso was uncovered, and although not discernible as separate features on the survey, these structures did appear as patches of resistance above, and below the background. However no evidence for a market cross, or market place was found, and this leads to the suggestion that the cross was placed here as a centre piece for the 19th-century gardens.

Survey area 1A (illus 21)

Following the excavation, the survey area was extended towards the west to see if the line of the old road could be picked up. If this was possible, it was hoped that other anomalies associated with buildings fronting onto this road could also be found. Four more 20 by 20 m boxes were completed, running parallel with the eastern edge of the survey. Again a Bradphys resistivity meter was used, with a twin-probe array. The anomalies found are outlined below.

L This was a linear high resistance feature, running diagonally across the survey area. It had resistance values of between 5% and 25% above the mean value.

M This was another linear high resistance feature of values up to 15% above the mean resistance value. It crossed feature L and petered out into feature E towards the east.

N This was an irregularly shaped area of high resistance 5% to 20% above the mean resistance value.

P This was an L-shaped area of lower resistance, up to 5% below the mean value.

Q This was a solid block of high resistance 10% to 40% above the mean value.

R An area of low resistance, up to 25% below the mean value, it cut off very sharply along the eastern edge.

Interpretation

L This was obviously the east/west garden path dating to the 19th century. It ran into anomaly E and it became somewhat blurred with the other earlier structures known to have been here.

M This was definitely another linear feature, despite the blurring where it crossed L and its apparent disappearance into area E towards the east. The road surface, uncovered under anomaly E during excavation, would follow a line roughly akin to that of feature M. If extended eastwards, this would take it down a fairly shallow part of the gravel terrace, obviously the best place to put a road. Therefore M, probably, did represent part of the roadway between Roxburgh Street and the old bridge to Roxburgh itself.

N Assuming that M was the old road, then the fact that N was aligned with respect to it may indicate that N represented the remains of some structure following the side of the road. However this is put in some doubt by the distance between N and the

road, M, which is almost 10 m. So if N did represent buildings, then they must have been set back from the road for some reason. While the excavated Building A is right next to the road, Building B is over 5 m from the road. So it would appear that different buildings were set, quite randomly, at different distances from the road edge. Thus it is perfectly feasible for N to have represented building remains.

P This initially looked interesting for its L-shape. However closer inspection shows that it gained this as a result of being cut by D. Without the presence of D, it did not show anything archaeologically significant.

Q This could possibly have been associated with N, perhaps representing a building. However fluctuations in natural resistance could also have been the cause.

Overall, it is apparent that this extension of the survey proved fairly fruitful. A possible line for the old road was found, which follows a perfectly acceptable route considering the local physical geography. Also found have been anomalies that could possibly represent structures associated with this road.

The surveys were carried out by kind permission of His Grace the Duke of Roxburghe.

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