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.