Geoarchaeology — by J. and P. Forsyth

One of the most positive trends in classical archaeology has been the increasingly interdisciplinary nature of the study of ancient sites. No longer is it sufficient for archaeologists to work alone, perhaps aided by a group of students; instead, at more and more excavation sites one finds architects, botanists, chemists, and, especially, geologists. At no site is the value of such interdisciplinary work more evident than at Akrotiri, the location of a Bronze Age city on the Aegean island of Thera (also known as Santorini).

Thera was, and still is, an active volcano, and sometime in the Late Bronze Age it experienced one of the most massive explosive eruptions known to humankind. Not only was the city at Akrotiri buried under metres of volcanic debris, but the entire island was physically altered: where once land had been now stood an imposing caldera, created when the volcano's depleted magma chamber collapsed inwards and the Aegean sea rushed in.

For the past 25 years archaeologists and historians have been trying to reconstruct the sequence of events that befell the thriving settlement at Akrotiri. Now, with the help of geologists, the eruption itself is well understood: the volcano announced its "reactivation" with at least one earthquake, scattered a thin layer of "precursor" ash over the island, then let loose with an imposing pumice fall of around 6 metres; next came a violent "base surge" that covered the pumice layer with additional volcanic debris to a depth of 12 metres, and, as if the preceding were not enough, next came two successive pyroclastic flows which added another 60-90 metres to the blanket of debris enshrouding the island. When the eruption was finally over, the island of Thera was uninhabitable, and the city of Akrotiri was lost beneath many metres of debris.

Geology, however, has been able to tell us even more about the eruptive process and its effects on Akrotiri. It is now clear that the large pumice fall that took place early in the eruption actually preserved the buildings at Akrotiri, filling their interiors and thus stabilizing their walls; it was the "base surge" phase of the eruption that did the real damage: the upper parts of buildings that were not packed with pumice were quickly "blown away" in this almost unimaginably violent event.

Had the contribution of geologists to our understanding of what happened at Akrotiri stopped here, our debt to them would still be significant. However, the tools of geological science are now adding to our knowledge in a fascinating way: by using the non-invasive technique of "ground-probing radar" (GPR), Dr. F.W. McCoy, Jr., of the University of Hawaii, is providing archaeologists with "maps" of what lies buried under still unexcavated structures.

What, first of all, is GPR? Ground-probing radar works like other radar, except the radio waves it makes are sent into the ground instead of into the air. All radar uses the same basic principle: a brief blast of radio waves is emitted, then, while keeping an accurate time measure, the "reflections" are detected. Radio waves travel at the speed of light, about three hundred million metres per second (3×10^8 m/s), so the time to travel a hundred metres is one third of a millionth of a second. Such short time intervals require extremely accurate clocks. For example, suppose a reflection is detected after two one hundredths of a millionth of a second. This is the time for the radio waves to go from the antenna to the object they reflect from, then travel back to the antenna. The time for a "one-way" trip would be one one hundredth of a millionth of a second. Distance travelled can be calculated by multiplying the speed (3×10^8 m/s) by the one-way trip time (1×10^{-8} s) to get 3 metres. A computer does the calculations and displays the distances on a scaled graph.

The ground-probing radar unit has a moveable antenna which is pulled at a constant speed along the ground as it sends radio waves into the earth, and detects the reflections, which are sent to a computer that measures their strength and calculates the depth below ground of the various reflectors. Some materials, such as smooth hard stone, are better reflectors, producing a stronger reflected signal. The strength of the reflected signal is shown by the colour displayed on the computer. The reflectors usually allow some of the radio waves to pass through and reflect from material underneath. The end result is a multicoloured chart with jagged horizonal bands of various colours showing the depth and type of reflectors beneath the surface. The geologist interprets this chart based on past experience, aided by excavations, wells, or cliffs where subsurface materials can be seen.

We were indeed fortunate to be able to work with Dr. McCoy and his GPR equipment this past June. Two sites had been selected for GPR investigation: 1) the large building known as Xeste 2 within the excavation at Akrotiri; and 2) the field to the west of the excavation, thought by some to be the site of the city's harbour.

The "harbour site" was carefully divided into grids and the GPR equipment dragged by hand over each section. By watching the computer screen, we could "see" what lay beneath the metres of volcanic debris in this area, and while we must wait for Dr. McCoy to analyse the results in detail, it seemed quite likely that this was indeed once a harbour.

A GPR investigation was next made at Xeste 2, a 3-storeyed building with a northern facade of fine ashlar stone. The entire interior of this imposing structure is still buried in pumice, so Dr. McCoy was hoping to find evidence of internal walls that would assist the archaeologists in successfully excavating what must have been one of the most important buildings in the city. Once again, a methodical series of "runs" was made over the structure, to the puzzlement of the hordes of tourists that crowd the site during the summer months. It was clear that at least one collapsed wall lay beneath our feet, but, once again, it will take Dr. McCoy some time to finish the complete analysis.

For a classicist, participation in such a project was a unique opportunity to witness "geoarchaeology" in action. One can only hope that more archaeologists at other sites will take advantage of this emerging discipline, for the final result will not only be more precise excavation, but also more information gleaned from otherwise "silent" ruins.