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Early farming landscapes have been of particular interest for archaeologists, but research has always been hindered by problems of dating. No longer. Soetkin Vervust, Tim Kinnaird & Sam Turner report on a novel, and cost-effective, way of charting the history of ancient field systems

OSL-PD: Shedding light on ancient fields

Archaeologists are used to dating artefacts or sites. But what if you are interested in the wider history of landscapes? How did people use them in the past, and how did that shape their modern character? Knowing the age of ancient landscape features like field boundaries is important if we are to address such questions, but it has proved very challenging. We have trialled a new approach to dating earthworks – optically stimulated luminescence profiling and dating (OSL-PD). Not only does it work, but it is practical and cost-effective. Its impact on landscape history could be transformative.

The challenge

The boundary features which divide Britain's landscape into fields provide some of its most characteristic elements. In many lowland regions hedges, walls and lanes are associated with earth banks; on moors and mountains the earthworks themselves often provide the boundaries. In many parts of the country, however, the true age of these boundaries remains a mystery. Dating earthworks has been a major challenge for archaeologists.

Earthworks typically derive from long histories of landscape exploitation. It is rarely clear when they were first created or how they developed with time. Historic maps and records usually take the story back only a few hundred years – and rarely beyond the early 18th century. To understand earlier periods, landscape researchers have had to rely on the morphology of the boundaries, or relationships between boundaries and other features.

For example, it is sometimes possible to establish the approximate age of earthworks through association with independently dated sites like settlements. Related features like ditches may contain fills which can be dated scientifically, though the complexities of interpreting formation processes make this difficult – ditches could have been cleared out regularly in the past. By painstakingly examining the stratigraphic relationships between features, analytical surveys based on fieldwork, aerial photography and lidar can be used to create narratives of landscape change. This has been done most successfully in remoter uplands, for example on the prehistoric field systems of Dartmoor and Salisbury Plain. Nevertheless, in other parts of the country attempts to date patterns like the "co-axial" fields of East Anglia by retrogressive map analysis (in which ancient systems are sought by progressively removing apparently younger boundaries) continue to provoke controversy. Even in clear-cut cases, these techniques generally produce broad period sequences which lack chronological detail.

Excavations of agricultural earthworks rarely yield more than a few indeterminate finds. Even when the artefacts can be dated with confidence, it is difficult to know whether they are in primary contexts (i.e. deposited at the time of loss or breakage), or secondary contexts (i.e. redeposited from elsewhere) and thus not dating the creation or use of the feature. Radiocarbon dating of ecofacts and soils suffers from similar problems: it is generally not possible to tell whether samples have been redeposited from another location or disturbed after deposition, so that any dates produced may not relate to the original construction. Researchers have tried to mitigate the impact of animal and root disturbance using bulk soil samples, but this tends to produce overestimates of the age because much older carbon fractions are present in the environment.

A solution?

A potential solution to this conundrum lies in optically stimulated luminescence, or OSL, which can be used to date sediments found in archaeological settings. It provides a direct age estimate of the last time quartz or feldspar minerals in a sediment were exposed to enough light to reduce a previous luminescence signal to zero, and effectively reset the OSL clock.

Luminescence is caused by exposure of minerals to naturally occurring ionizing radiation, from radioisotopes in the sample and the surrounding sediment, and through incoming cosmic radiation. Once a sediment is buried and protected from light (beneath a field bank, for example), this radiation causes electrons to slowly accumulate in defects in a mineral’s crystal lattice. Subsequent exposure to light causes the trapped electrons to be released very quickly, each emitting a photon of light in the process, which can be measured in a laboratory. The intensity of this luminescence signal is directly proportional to the radiation dose the minerals received each year since they were last exposed to sunlight, known as the annual dose rate.

Depositional events like the burial of an old ground surface or the construction of an earthwork can be dated directly from the sediment itself. The OSL age is determined by dividing the apparent or burial dose by the annual dose rate. The typical age range for luminescence dating is from zero (completely bleached) to around 200,000 years, making it well suited not just for dating events with timescales of thousands of years, but also recent phenomena with event resolutions of several tens of years.

Like radiocarbon dating, however, OSL dating comes with the limitation that a date relates only to the specific location in the soil profile that is being sampled. Time and cost constraints typically limit the number of dating samples to just one or two per profile, which increases the risk of unreliable dates from redeposited sediment or material unrelated to the construction or use of an earthwork.

OSL profiling & dating

Combining conventional OSL dating in the laboratory with practical field profiling methods can offer a solution here. Our research uses portable OSL equipment, which allows the luminescence signals from small soil samples, collected through the entire profile of the investigated earthworks, to be measured on site in real time. The OSL profiling and dating (OSL-PD) method is fast and minimally intrusive, because it requires cutting only a small trench into an earthwork, wide enough to fit a person and deep enough to reach the natural substrate underneath.

Once the sediment stratigraphy is revealed, we immediately cover it under an opaque black tarpaulin, to prevent exposing the samples to sunlight and zeroing their luminescence signal. We then clean the covered section and remove small quantities of soil (5–10gm) at regular intervals (normally <10cm) down the profile for immediate interrogation with the portable OSL reader. Using that information we can construct luminescence-depth profiles in the field for the entire stratigraphy of the earthwork.

The insights this provides into the relative chronology of the feature inform our subsequent strategy for larger dating samples. We collect these from those stratigraphic horizons which we deem most significant to securely date the feature's construction, maximising the effectiveness of the fieldwork. Both the profiling and dating samples are subsequently analysed in the laboratory.

Examining the luminescence behaviour of the whole stratigraphic profile also means the dating samples are not isolated and sediment ages can be contextualised, which provides tighter chronological control on the earthwork's age. It also makes it possible to produce highly-detailed accounts of the earthwork's history, from its construction date to its use and modification over time. One can see for example if the feature was built in a single event or in multiple phases, if it cuts into older layers or was constructed on top of them, and whether a stratigraphic horizon constitutes a single anthropogenic fill, deposited at once, or is the result of gradual sedimentation. In this way, OSL-PD can be invaluable for understanding an earthwork's stratigraphic sequence and correctly defining archaeological contexts.

Having successfully used OSL-PD in the past to demonstrate the medieval date of terraced field systems in Spain, Turkey and Greece, our team from the McCord Centre for Landscape at Newcastle University and the School of Earth & Environmental Sciences at the University of St Andrews applied the methodology in the UK in 2018. Historic field boundaries in two rural case study areas were investigated, both on National Trust land: the Wallington estate in central Northumberland, and the Bosigran farming estate in western

Cornwall. Both showed extensive evidence of earlier agricultural practices, and shrunken and deserted settlements.

Medieval Wallington

The landscape of the Wallington estate, which surrounds a late 17th-century country house, has been heavily shaped by estate management practices and improvements in the 18th and 19th centuries. Today's fields reflect the orderly layout of planned enclosure, with rectangular fields divided up by long, straight, stone-faced banks. In medieval and early modern times, the outlook of the landscape is thought to have been quite different, with more irregular fields and large swathes of still unenclosed countryside, farmed under a collective open-field system. This can best be seen on an estate map of 1728 kept in the Wallington Hall archives, which shows the remnants of this earlier system, before it was subjected to agricultural improvement.

Unfortunately, we are less well informed about the earlier history of these post-medieval fields, as is the case for most of Northumberland. The extent to which the remains of prehistoric, Roman and early medieval landscapes have influenced those of later periods is open to question, because reliable dating evidence is largely lacking. Investigating the possible long-term continuity of boundaries, dykes, lynchets, and other elements of Northumbrian field systems is therefore of particular importance for the region.

For the Wallington estate, retrogressive analysis was used to identify and inventory historic earthwork boundaries still present in the landscape. This led to the selection of five earthworks for further archaeological investigation and OSL-PD sampling. All are depicted on the 1728 estate map, so they definitely existed by the early 18th century and presumably originated at different stages in the enclosure of the local open-field systems. This turned out to be the case. One boundary was found to have been created in the early modern period, more specifically the mid-16th century, consistent with a general pattern of piecemeal enclosure which is well documented across the North East.

Perhaps surprisingly, we found most of the boundaries we investigated to be older, most likely constructed during the Middle Ages. Three earthworks span dates from the 14th to the 11th centuries, while one was probably already constructed in the first millennium AD, most likely in the 6th or 7th centuries. The research demonstrates that medieval farmers were working the area well before local settlements were first recorded in documents, and shows that early field patterns continued to influence the layout of the landscape despite subsequent episodes of reorganisation.

Prehistoric and Early Medieval Bosigran

Our second case study area was the Bosigran farming estate on the north-western coast of Cornwall, in West Penwith. The region has rich archaeology from all periods, and its rural landscapes have long been regarded as especially beautiful and unusually ancient. Impressive granite-and-earth boundaries form small irregular fields, dubbed the “work of giants” by pioneering landscape archaeologist OGS Crawford in 1936.

In the 1980s West Penwith’s early field systems came under increasing threat from modern farming practices, particularly the removal of boundaries to create larger fields. To help understand this landscape, the Cornwall Committee for Rescue Archaeology, supported by English Heritage and the National Trust, initiated the West Penwith Survey, which recorded the field patterns of the region in detail and established relative chronologies by analysing the physical relationships between boundaries and other features. Periods of origin for the field types were suggested based on their association with independently dated features, such as houses.

A relative chronological framework was also established at Bosigran in this way. Six different types of field boundary were identified, from a coaxial field system probably dating to the Middle Bronze Age (1500–1150BC), through a regular and irregular field system presumed to have Iron Age origins (from 800BC), to medieval strip fields and cliff-dividing boundaries constructed in post-medieval times. Still lacking, though, was absolute dating evidence to back up or question this intricate landscape narrative.

We used OSL-PD to obtain sediment chronologies for five key field boundaries at Bosigran, representing different types of enclosure. One of them formed a main axis of the surviving coaxial field system in Halldrine Croft, a broad strip of rough land on the western edge of Bosigran (Site 1). The system here consists of roughly rectangular fields delineated by low stony banks, which do not appear to have been reused as boundaries in later field systems. A second millennium BC origin had been proposed for the coaxial fields, based on Cornish comparators and through association with four roundhouses.

The OSL-PD research was able to confirm this chronology, placing the construction date of the stone core of the bank between the 17th and 12th centuries BC, most probably around 1300–1400BC (Middle Bronze Age). Apart from the addition on top of the bank of a shallow layer of agricultural soils, in use over the last 2,000 years, no true structural alterations had been made to the original earthwork over time.

A second earthwork which we investigated in detail was a substantial, 1.7m high stone-faced lynchet (Site 3). It forms one of several concentric curving lines in a regular field system, thought to be of late prehistoric origin and still functioning today. The fields had been dated by their association with a small hamlet of Iron Age stone-built roundhouses, later transformed into Romano-British courtyard houses, which are located along the investigated lynchet.

We excavated a narrow trench through this boundary to collect profiling and dating samples from its entire stratigraphy. This confirmed that the stony bank forming the core of the feature was constructed in the Middle Iron Age (450–150BC), as suggested by the West Penwith Survey. The OSL-PD, however, offered important new insights into its history. The bank had been constructed by cutting into a Bronze Age soil, and remained fairly low until early medieval times. It was only during the Middle Ages that the boundary was substantially enlarged in different phases, and the prominent lynchet that currently stands at the site developed. This probably coincided with a change in agricultural management practices as the Romano-British courtyard houses were abandoned, and an early medieval settlement was established at a new location, where Bosigran farm currently stands.

World histories

The research at Bosigran and Wallington, two sites on different geologies and geomorphological settings at opposite ends of England, shows that OSL-PD has the potential to provide chronological definition for earth boundaries that can otherwise be difficult to date precisely. While the results from Bosigran confirm and develop interpretations from earlier archaeological survey, the Wallington study tells a new story for the development of the historic landscape which was hitherto completely unknown.

The team’s work elsewhere in Europe and the Middle East has shown that OSL-PD can also be used to date other types of earthworks, notably the Mediterranean’s highly characteristic agricultural terraces. For example, case studies in Spain, Greece and on the southern and western coasts of Turkey have all identified the later Middle Ages as the key period for terrace construction. The method has the potential to unlock the history of terraces and other earthworks all over the world.

The ability to date soil profiles in detail also opens up possibilities to integrate study of landscape development with a suite of geoarchaeological analyses, including sediment micromorphology, analysis of plant macro- and microfossils (pollen and other remains), geochemistry and soil organic biomarkers. By using these approaches, it will be possible to write detailed histories of land use and farming directly from the soil itself, rather than having to rely only on patchy documentary or archaeological sources.

Finally, studies like the one at Bosigran show that the results of OSL-PD analyses can be linked to other types of landscape archaeology such as analytical survey or historic landscape characterisation. This makes it possible to examine the creation and development of field systems on a much broader scale, helping to highlight the significance of the landscape heritage which surrounds us.

See "Optically stimulated luminescence profiling & dating of earthworks: the creation & development of prehistoric field boundaries at Bosigran, Cornwall," by S Vervust, T Kinnaird, P Herring & S Turner, Antiquity (2020). Soetkin Vervust works at the McCord Centre for Landscape, Newcastle University and the Archaeology Department of the Vrije Universiteit, Brussels; Tim Kinnaird is research officer at the School of Earth & Environmental Sciences, University of St Andrews; Sam Turner is professor of archaeology and director of the McCord Centre for Landscape, Newcastle University