Evaluating Archaeological Field Survey with Tephrochronology: A Case Study from Southern Iceland

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Cover Photograph: The cover image is a surface model for the site in Haugatungur, discussed in the article. It shows a cluster of small, round topographic features around a large enclosure-like feature. Tephrochronology is used to assess how these features formed. Image: Institute of Archaeology, Iceland; arrow indicates North.

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Evaluating Archaeological Field Survey with Tephrochronology: A Case Study from Southern Iceland

This photo essay reports on the field recording and interpretation of tephra (volcanic ash) stratigraphy in Skaftártunga, Iceland. Trenches were dug to establish whether topographic features observed on the surface were archaeological structures or the result of earth's surface processes. Excavations exposed about 35 square metres of vertical stratigraphy. Although all the features proved to be natural formations, the stratigraphy did record phases of erosion and stabilisation reflecting changing human impacts on the landscape. This illustrates the potential of an outstanding tephra record to enhance our understanding of the past.

Figure 1. The research areas in southern Iceland by Þinggil (above) and Haugatungur (below). Surface features are highlighted in orange in the aerial photographs and consist of embankments around larger basins, upstanding ring features and circular mounds. The locations of excavations are marked in red and labelled A, B & C. Mapping by Stefán Ólafsson.

Introduction

Field surveys are an essential part of archaeological investigations. In one form or another, they have been undertaken in Iceland since the 19th century. It was not until the late 20th century, however, that systematic archaeological surveys became standard practice driven by legislation enacted in 1989 and updated in 2012. All cultural remains in Iceland more than 100 years old are classified as archaeology and protected by law. Recent surveys in different parts of the country have revealed many surface features that form a crucial part of a copious archaeological record.

In the years 2013–18, an archaeological field survey was conducted in Skaftártunga, (Fig. 1). Alongside the survey, some test trenches were excavated to gather dating evidence on abandoned settlements (Hreiðarsdóttir et al. 2014, Hreiðarsdóttir 2014, 2015, 2016 and 2020, Hreiðarsdóttir & Þórsdóttir 2024). During the survey some unusual features were identified at two locations where place names, archival sources, and landscape analysis suggested assemblies (regional socio-political gatherings dating to the 10th–14th century) might have been held. The first location is within the property of the farm of Flaga in *Haugatungur* (e. *Plains/Tongues of Mounds*), at about 200 m above sea level (Fig. 1). In this area, about 70 small features, sugges-

Figure 2. Haugatungur, Skaftártunga, section A. Above (view to south-east): ring structure (right) and mound (left) restored to their original form after the trenches were backfilled. Below (view to north-east): the open trenches through the ring structure (foreground) and the mound (background)

tive of booths common at assembly sites in Iceland, can be seen alongside a large basin enclosed by a bank. At the second location, c. 8 km to the north, within the property of the farm of Gröf and close to *Þinggil* (e. *Assembly Ravine*), two large circular basins with enclosing banks and several circular booth-like features were recorded about 220 m above sea level.

In 2023 three large trenches and a small square pit were cut into surface features on these sites (Fig. 1). The trenches did not reveal any archaeology, but they did contain a wealth of environmental data made visible by the tephra stratigraphy. The assessment of these tephra records illustrates how field observations can be used to reconstruct environmental change and

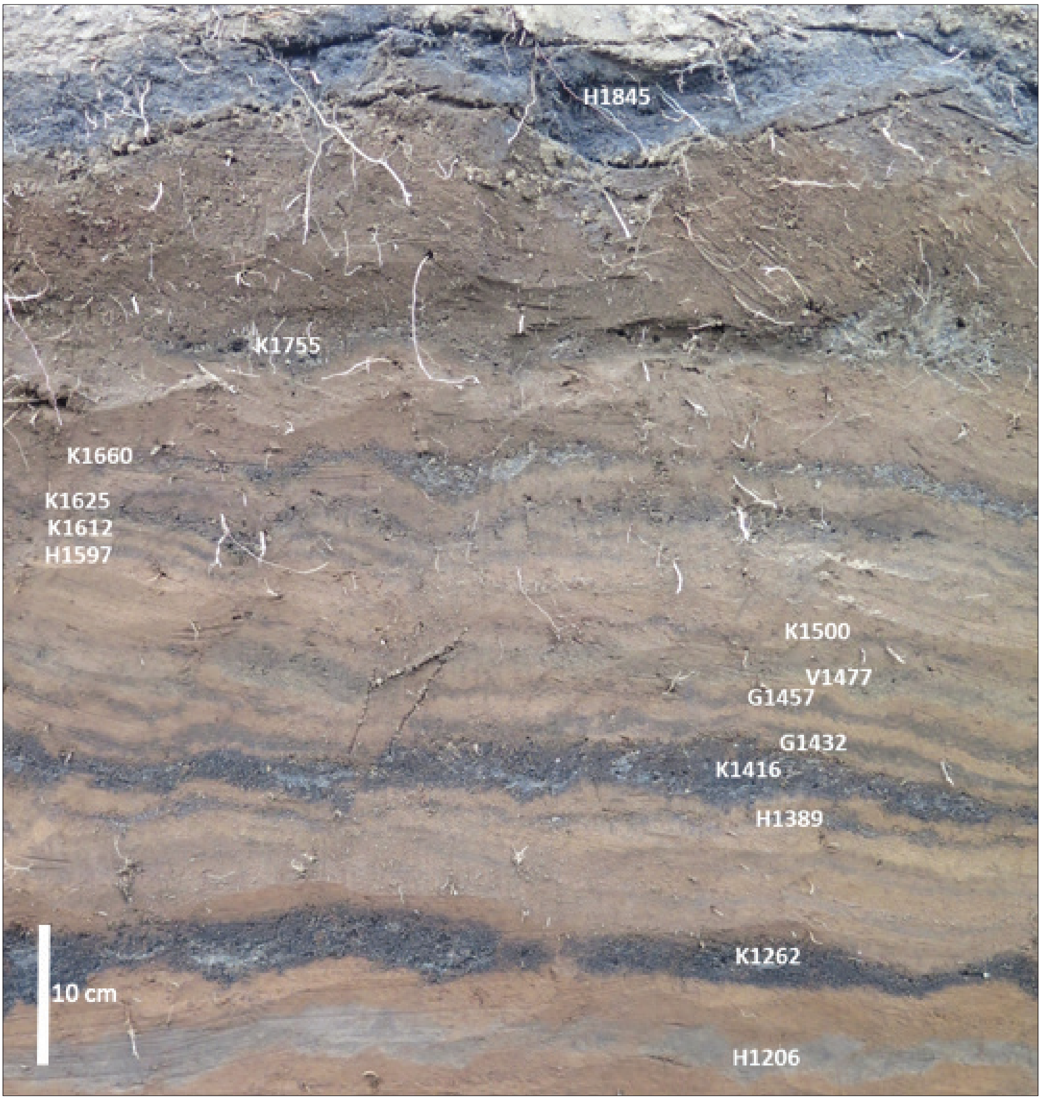

Figure 3. Haugatungur, Skaftártunga. A section through the ring structure, showing tephra layers formed between 1206 AD and 1845 AD. Numbers indicate calendar dates from written sources, initials indicate the volcanic origins of the tephra layers. In this and other figures in the essay, the following applies: ‘K’ from Katla, ‘H’ from Hekla, ‘G’ from Grímsvötn, ‘V’ from Veiðivötn. Note the distinctive characteristics of the layers, defined by colour and thickness, grain composition, and grain size (for location see inset photo in Figure 4).

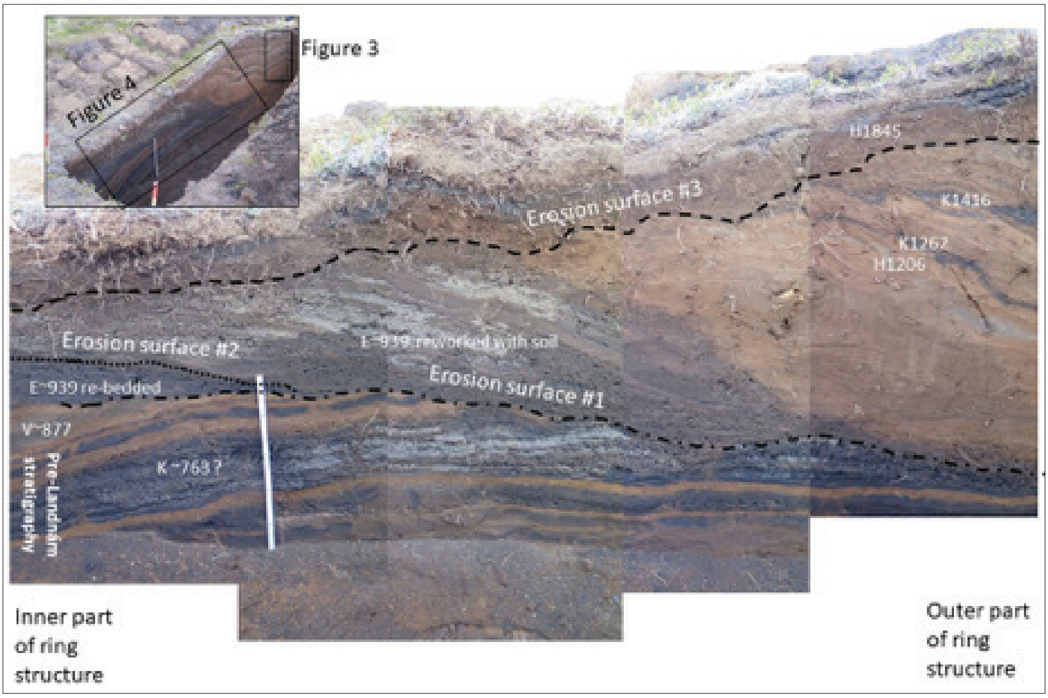

Figure 4. Haugatungur, Skaftártunga, looking north-west (main picture). Ring structure section (A). At ~939 AD the land surface below the centre of the surface 'ring structure' was stable, but the land outside the rim was eroded creating a sloping erosion surface cutting into the surrounding pre-settlement sediments (erosion surface #1). The remaining sediments were left in a mound centred under the present ring structure. Airfall deposits from the ~939 AD Eldgjá eruption stabilised where the land surface had not eroded above the ~877 AD tephra, but only after initial deposits were disturbed, destroying the original stratigraphy. The mound was probably topped by a scrub heath or woodland vegetation which stabilised the depth of tephra deposit now visible in the stratigraphy. A second erosion surface cuts across surviving Eldgjá ~939 AD deposits (erosion surface #2). Erosion surfaces #1 and #2 stabilise with a dome of Eldgjá ~939 AD mixed with aeolian soil forming in the centre of the present ring structure. From 940's AD to mid-17th century AD, a mound grew with the formation of overlying andosol plus tephra layers. In the mid-late 18th century AD, the summit of the mound eroded to create a central deflation hollow (erosion surface #3). By the early 19th century AD, this re-stabilised and the whole area was covered with an aeolian soil before the deposition of the Hekla tephra in 1845 AD. The white vertical scale is 50 cm in length.

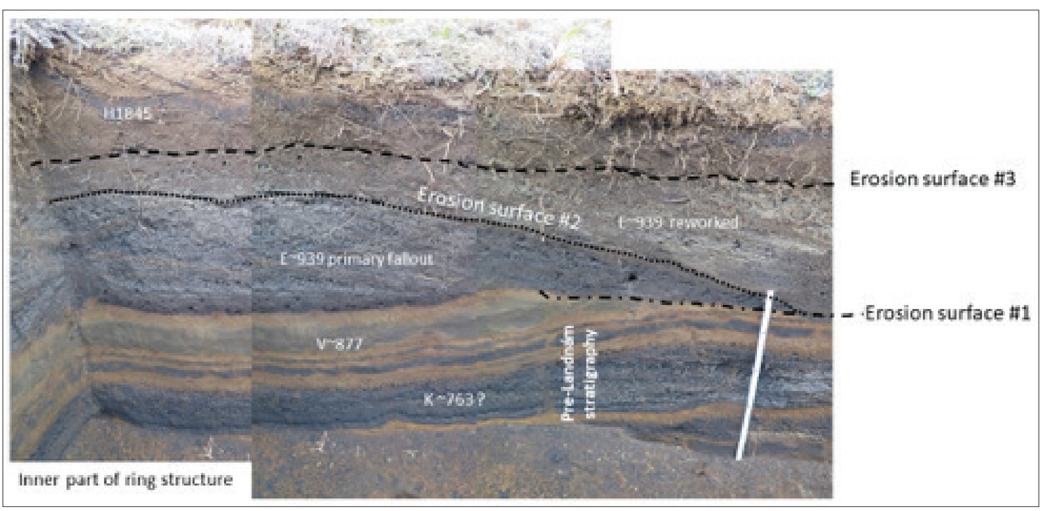

Figure 5. Haugatungur, Skaftártunga looking north-west. A continuation of the left-hand side of the section shown in Figure 4. The white vertical scale is 50 cm in length. For interpretation, see caption to Figure 4.

infer relations between social and environmental processes—data that would be very hard, if not impossible, to identify without the presence of the tephra layers.

Skaftártunga has a rich tephra stratigraphy formed since the retreat of the last island-wide ice sheet about 8,000 years ago. It has frequently received fallout volcanic eruptions forming tephra layers that are well separated in the stratigraphy because of high rates of aeolian (wind-borne) sediment accumulation. The settlement of Iceland (Landnám) occurred in the late 9th century. During the 1,100 years since then at least 22 tephra layers have been spread over Skaftártunga by eruptions of the volcanoes Katla, Hekla, Lakagígar, Grímsvötn, Öræfajökull, Eldgjá, and Veiðivötn. Individual tephra layers have distinctive characteristics, including their stratigraphic location, layer colour and thickness, grain composition, and grain size, that enable them to be confidently identified in the field based on their visible characteristics alone (e.g., Streeter 2011). Tephra layers have been dated precisely using written records and by correlation to traces of the same tephra in ice core records from the Greenland icesheet. They have been used to reconstruct a detailed environmental history of the last millennia for Skaftártunga (Streeter 2011).

In addition to providing a dating framework, high resolution measurements of tephra layer morphology have been used to infer environmental processes and surface vegetation at the time of the tephra deposition (e.g., Streeter and Dugmore 2013a, Streeter and Dugmore 2013b, Dugmore et al. 2020). Vegetation communities of different types (e.g., grassland, moss heath, woodland) and differing status (e.g., well-grazed or not, growing or dormant) have different capabilities for stabilising a surface deposit of tephra (Dugmore et al. 2018). Where thick tephra layers have been stabilised, that is an indication that the surface vegetation could stabilise the fallout and resist its mobilisation by earth surface processes. Cross cut and absent layers indicate erosion surfaces. Re-worked tephra deposits indicate processes of both erosion and deposition. Therefore, tephra layers can be used to infer both local and regional environmental conditions as well as date them.

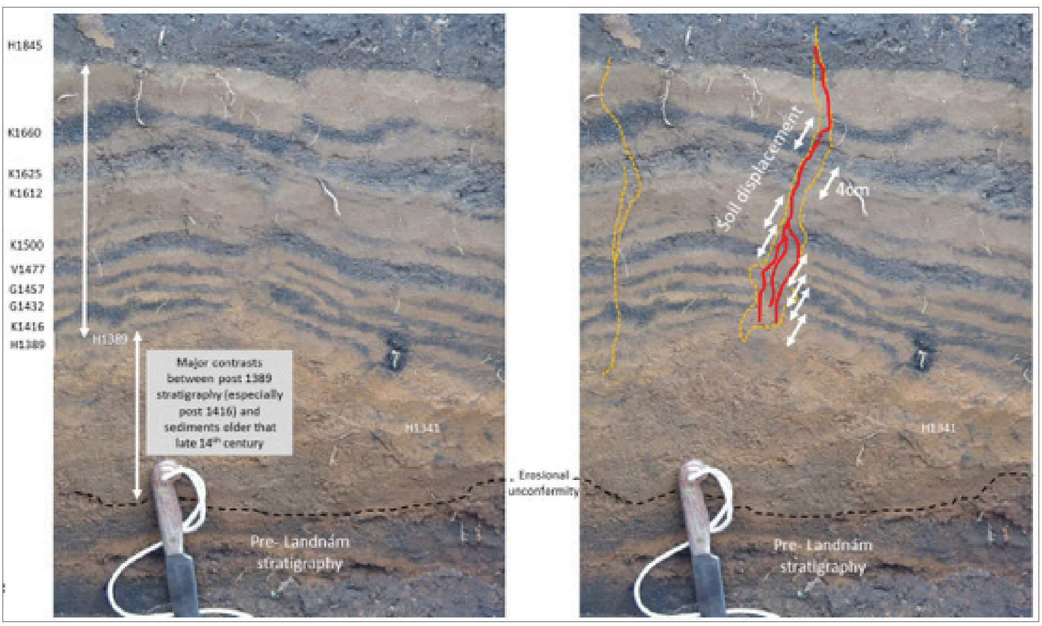

Figure 6. A small pit (B) in Haugatungur, Skaftártunga (looking west) excavated in the centre of a basin contains evidence of mass displacement of the soil contained in the 4 cm offset of tephra layers formed between 1389 and 1660 AD. Earthquake impacts in the 19th century may explain the evidence, although differential frost heave might achieve the same result. The knife handle is 11 cm in length.

The excavations in Haugatungur and by Þinggil

In June 2023 two trenches and a pit were dug in Haugatungur and a further trench at Þinggil (Figs. 1–7). At Haugatungur, the trenches were 3–4 m apart (A in Figure 1) and the pit was sited about 50 m further north (B in Figure 1). Here we focus our attention on the southernmost trench (A) that provided sections through a ring-shaped surface feature and the northern pit (B) in the centre of a large enclosure-like feature. The section at Þinggil (C in Figure 1) was cut through a bank that enclosed a large basin. In all cases the trenches were cut to see what formed the upstanding banks and to date them.

Discussion

The trench dug into one of the many ring structures at Haugatungur (Fig. 1, Trench A, Fig. 2) revealed many tephra layers (Fig. 3) that show it began as a mound formed between ~877 and

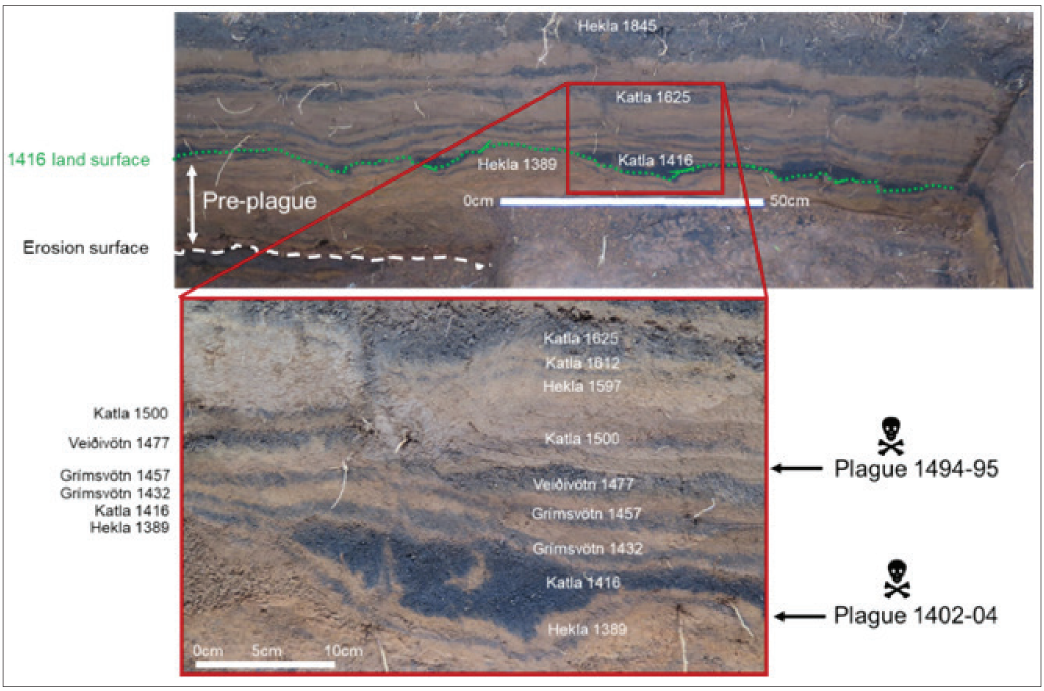

Figure 7. Haugatungur, Skaftártunga. A small excavated pit from the centre of a basin (B- also seen in Figure 6) contains evidence of landscape change in the aftermath of the 15th century AD outbreaks of plague. There are major contrasts between post 1389 AD stratigraphy (especially post 1416 AD) and sediments older than late 14th century AD. Analysis and interpretation: Late prehistoric/landnám-13th century sediments eroded from here as indicated by the absence of tephra layers from Veiðivötn ~877 AD, Eldgjá ~939 AD, Hekla 1206 AD, and Katla 1262 AD. By the 14th century AD, changes in the environment/vegetation enable patchy traces of the Hekla 1341 AD tephra to preserve. In the late 14th century AD, the land surface was characterised by subdued hummocks. The Katla 1416 AD ash fall levelled the surface filling in hollows in the surface vegetation. The fact that the tephra only stabilised in the hollows suggests that the surface vegetation was very short in stature which in turn suggests that the area might have been heavily grazed at the time. Our working hypothesis is that human impacts following the settlement of Iceland destabilised the landscape despite generally favourable climate conditions. A general easing of environmental pressures following the impacts of plague allowed a local landscape stabilisation and uninterrupted aeolian sediment accumulation.

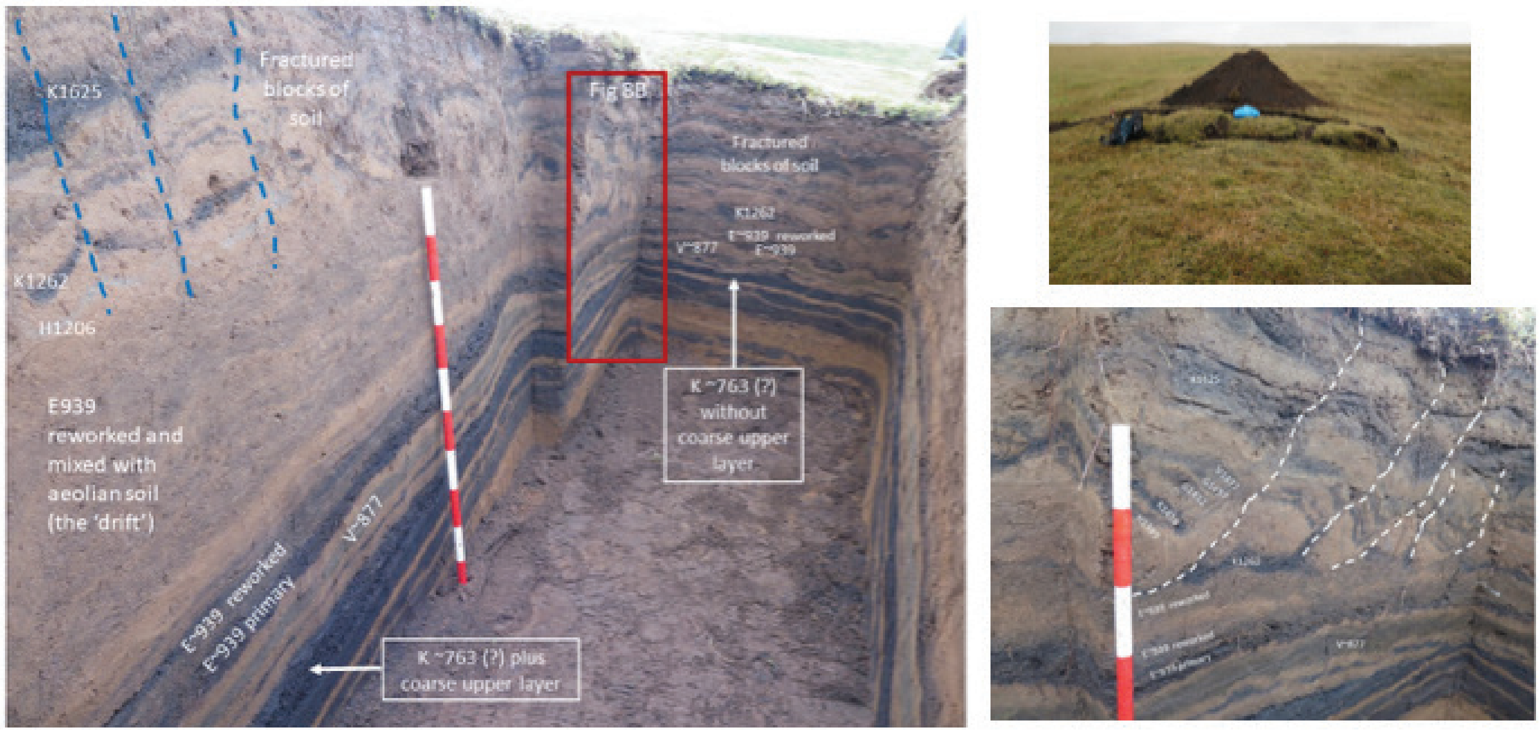

Figure 8. A section through a curving bank at Þinggil, Skaftártunga looking north-east (see C in Figure 1) shows that the feature is natural and initially formed from a stabilised bank of 10th century tephra mixed with aeolian soils. After the 12th century, soils and tephra accumulated in place, amplifying the form of the drift, and much later, earthquakes or frost action caused these upper layers to fracture. The pre-Landnám land surface (layers below the Veiðivötn ~877 tephra (V~877)) was capable of stabilising layers of tephra c. 5 cm thick, although there is evidence of variable preservation for thicker layers (e.g., coarse upper layer of the tephra—probably from Katla in ~763 AD—below the rampart but not below the rampart flanks). The maximum thickness of primary airfall deposits of Eldgjá ~939 AD tephra (E~939) are comparable to the thicknesses of V~877—much of the initial deposit of E~939 does not stabilise and is removed; there is a period of E~939 reworking and mixing with soil. A tephra-free yellow-brown andosol then develops from aeolian sediment that is comparable in thickness to that formed between V~877 and E~939 (i.e., in c. 60 years). A crudely bedded drift of E~939 and soil then forms, creating the form of the rampart and bank visible on the present surface. During the 13th century AD, the drift of E~939 stabilises over a prolonged period from before 1206 AD (on the summit of the rampart) to 1262 AD (on the flank). Soils and tephra layers accumulate from the 13th century to the present day, amplifying the form of the drift of reworked E~939. Post deposition, fracturing of the soils and tephra layers accumulated between 1262 AD and today takes place—this is probably due to frost action, but may reflect impacts of earthquake activity. The bands of red and white on the pole are each 10 cm in length.

~939 AD when soil erosion had stripped away surrounding sediments (Figure 4). Eroding slopes are shown by the truncation of older tephra layers, and evidence for shrubs on the summit of the mound comes from the localised stabilisation of more than 30 cm of airfall tephra from the ~939 AD Eldgjá eruption (Fig. 5). The timing indicates that this erosion was probably associated with the initial impacts of Norse settlement and the introduction of grazing animals (Þórarinsson 1961, Dugmore and Buckland 1991, Dugmore et al. 2009, Streeter and Dugmore 2014).

In the large hollow c. 50 m to the north (Fig. 1, Trench B), the lack of tephra layers between late pre-history and the late 14th century AD (Figure 6) shows that there, the erosion that began soon after Landnám was more persistent. The soil between the erosion surface cut into the pre-historic strata and the tephra from 1389 AD shows that some accumulation was taking place, but it is a shallow deposit and there was insufficient stability for recognisable layers to form. While persistent instability dominated this large basin until the late 14th century, the flanks of the mound to the south stabilised (Figure 4) and grew through steady aggradation of windblown soils and the episodic deposition of tephra layers. The timing of stabilisation at the site of pit B is suggestive, and a persuasive explanation for this is the devastating impact of a plague 1402–4 AD that killed a large proportion of the population and forced a change in land management. Evidence from the surrounding region shows that rangeland erosion rates eased at this time (Streeter et al. 2012).

A picture emerges of a widespread landscape transformation at the time of settlement with areas of stability (Fig. 1, Trench C, Fig. 8) and patches of erosion of differing scales, some of which (around a remnant mound; trench A) stabilise in the following centuries, but others (in a large hollow; pit B) persist until the impacts of plague in the 15th century.

In the 18th century, the summit of the southern mound (Fig. 1, Trench A) erodes to form a ring structure, meanwhile the basin to the north is stable. Climate change could have triggered this renewed erosion. Cold and wet conditions drove the growth of Icelandic glaciers, which reached local high stands in the 18th century. Under these circumstances, the crests of mounds could be exposed to particularly harsh winter conditions, while the low-lying surroundings (such as the basin around pit B) could be protected by snow cover. Vegetation die-back could then expose the summits to deflation and turn mounds into rings with a hollowed-out middle. The 18th century erosion ceased by the early 19th century.

The evidence from the tephra stratigraphy shows that this upland area has undergone phases of erosion, stabilisation, and deposition that have switched back and forth under the influence of different drivers of change, from initial colonisation and subsequent land management to volcanic impact, demographic shock, and climate change. Large scale fracturing of blocks of soils has also occurred (Figures 6 and 8) that may be the result of either earthquake activity or cryoturbation. Our excavations showed that even if the ring, mound, and basin features do not have direct archaeological origin, they do contain rich records of human activities and changing environments that can be integrated with other sources of evidence. Written sources (farm diaries, tax records, etc.), archaeological excavations (providing evidence such as livestock compositions), and palaeoclimatic archives combined with the remarkable evidence gleaned from tephra layers in the soil can provide crucial evidence for threshold-crossing events or resilience. We may infer explanations for adaptation, sustainability, or miscalculation. Important lessons we can learn from the completed experiments of the past can help us decide apt approaches for the future.

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