

Keflavík on Hegranes: Cemetery Excavation Interim Report 2015



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Picture on front page – Drone photo of the Keflavík cemetery.



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Introduction

The summer of 2015 was the first of three planned years of excavations at the early Christian cemetery at farm Keflavík on Hegranes in the region of Skagafjörður, North Iceland. The excavation is the third phase of Skagfirska kirkjurannsóknin (Skagafjörður Church Project) and is a collective effort of the Skagafjörður Heritage Museum and the Fiske Center of the University of Massachusetts Boston. The collective project goes by the name Skagafjörður Church and Settlement Survey (SCASS). The excavation season started on the 6th of July and finished on the 14th of August. The first two weeks were spent cleaning the surface and removing a 20th century rubbish heap overlying the western part of the cemetery, the actual cemetery excavation extended over four weeks.

Site discovery

The cemetery at Keflavík was discovered in October 2013, when the electricity company, RARIK, plowed down a high voltage mains line through the homefield of the Keflavík farm. It was the farmer, Þórey Jónsdóttir, who noticed and reported archaeological remains in a trench that had been dug to facilitate the connection of a low voltage line to the main high voltage line. In the western section of the trench three cuts were visible, all lying under an unbroken line of the 1104 tephra. Human leg and foot bones were retrieved from the spoil heap confirming that the cuts were burials. The graves were oriented east-west suggesting it was a Christian cemetery, and fragments of badly preserved timber indicated the presence of coffins. The existence of a Christian cemetery was not wholly unexpected as a medieval cartulary dating to 1394 recounts that a priest was paid for his service at Keflavík¹, indication that there was an operating family chapel at the time. However, there is no mention of a cemetery and burial was not permitted at late medieval household chapels. The results of the Skagafjörður Church Project point to early cemeteries being present at all later household chapel sites, as the chapels seem to have been a

continuation of early Christian household churches which, as a rule, were associated with a cemetery.

Prior to the discovery of the early Christian cemetery in 2013, Keflavík had been surveyed in connection with the Skagafjörður Church Project. In 2008 the farm and its satellite farmsteads were registered and a number of test trenches were excavated. The 10th-11th century farmstead was located in the homefield east of the medieval-early modern farm mound but no unequivocal evidence for a cemetery was found in association with this site (Zoëga and Sigurðarson 2009). In the summer of 2012, extensive geophysical survey was conducted in the homefield. Again, there was no clear evidence of a cemetery (Bolender, et al. 2015). When the cemetery was finally located it was situated at the eastern edge of the medieval-early modern farm mound and just 20m west of the homefield boundary of the earliest farm. The 2015 excavation indicates that both farmstead locations were occupied during the 10th century although it has not yet been determined if the occupations were contemporary.

In 2014 a joint project of the Skagafjörður Heritage Museum and the University of Massachusetts Boston, called the Skagafjörður Church and Settlement Survey (SCASS) received a large research grant from the National Science Foundation (NSF). The aim of the project is to systematically survey for the oldest settlement and church history in the area of Hegranes, a rocky promontory in the middle of the Skagafjörður region. The area is well suited for study as it is geographically distinct and there is evidence for possible cemeteries at nine of the 12-13 original farms.

The complete excavation of one cemetery in Hegranes was part of the long-term plan for the SCASS project but funding for such an excavation was not included in the initial 3-year NSF budget. Excavation was originally planned as a follow up to the survey when and if a suitable cemetery was found. A prerequisite for the full excavation of a cemetery was that it would be situated somewhere excavations would not get in the way of

¹ Diplomatarium Islandicum, III: 530.

every day farming activities and that no later architectural remains would need to be excavated in order to get down to the original level of cemetery. Good skeletal preservation was also paramount, as skeletal analysis lies at the heart of the household component of the early farmstead cemeteries. When the Keflavík cemetery was discovered in 2013 it emerged as an ideal candidate for a complete excavation. The evidence from the trench suggested there was only 30-50cm of soil on top of the cemetery and that skeletal material was sufficiently well preserved to warrant a full excavation. However, since the site was not included in the NSF budget an application was submitted to the Icelandic Archaeology Fund, who granted a large enough grant for the cemetery excavation. Hence, Icelandic archaeologist could be hired to work on the project alongside the American team of specialists and students.

Primary objectives for the cemetery excavation:

1. Determine the typology of church and cemetery.
2. Investigate the temporal aspects of church and cemetery.
3. Determine the number and typology of graves.
4. Examine temporal, spatial, and gendered variation in burial customs.
5. Osteological examination of the demographic characteristics of the burial population, such as age, sex, and stature profiles.
6. Osteological examination of the health and diet of the burial population.
7. Investigate the relationship among farmstead size, establishment date, relocation and the establishment and closure of the cemetery.
8. Investigate the history of cemetery and church use in relationship to the institutionalization of the Catholic Church in Iceland.

Methodology

Excavation utilized a single context methodology following protocols modified from the Museum of London Archaeology Service (Westman (ed.) 1994). Graves were systematically recorded using a modified version of the Burial Record Form developed by the

Arizona State Museum, University of Arizona. Spatial measurements were made in the field using a Topcon robotic total station and based on orthorectified photogrammetry composite images. All measurements and excavation geometries are stored in an ESRI-formatted geodatabase. Excavation data including context descriptions, grave excavation records, as well as sample, find, and photographic registries have been entered into a FileMaker relational database. Geophysical survey grids were established from total station measurements for accurate correlation with the excavation results. Output from geophysical surveys has been integrated into the geodatabase structure. Original and processed geophysical datasets are stored on the SCASS servers in Iceland and Boston.

Site opening

The early Christian cemetery at Keflavík is located on the eastern edge of the old farm mound, which was occupied until 1979 when the dwelling was moved to a new location on the east side of the farm (Pálsson 2010). The area around the electrical trench that initially identified the cemetery was surveyed using geophysical techniques in an effort to define the boundaries of the cemetery. The first survey employed a CMD Explorer multi-sensor electromagnetic conductivity meter. Unfortunately the electrical lines dominated the survey. A follow up ground penetrating radar (GPR) survey was conducted using a Malå X3M radar system that was equipped with a 500 MHz antenna. Based on these surveys an area of approximately 23x25 meters was targeted to encompass the cemetery, church, and enclosure walls. Most of the area lay to the east of the farm mound and coring revealed that there was little cultural material in the soil above the Hekla 1104 tephra layer. The western edge of the targeted excavation area overlapped the eroding eastern edge of the mound. Two 1x2 meter test pits were placed at the edge of the mound to determine the stratigraphic sequence and preservation of the mound (TP1 and TP2, see below). These test pits were used to guide the opening of the excavation area. The turf and upper layers of soil were mechanically cleared guided by the test pits and coring. Mechanical



Figure 1. Test pit locations before turf removal for cemetery excavations.

excavation was carefully supervised to check for any architectural features or intact middens. In general, the area was cleared down to the Hekla 1300 tephra. It is clear that almost the entire edge of the farm mound above the Hekla 1300 layer was made up late 20th century rubble and a large, intrusive cesspit that was dug out and filled with rubbish in the second half of the 20th century.

After the cemetery area was opened the bottom half of the cesspit was excavated to remove all metallic remains and the entire area was shovel scraped to produce a relatively smooth surface in preparation for additional geophysical survey. The area was then measured by total station to create a topographic surface for modeling the GPR results. The area was then surveyed using a CMD Mini-Explorer multi-sensor electromagnetic conductivity meter at a 0.20 meter transect interval. The same spacing was used for an additional GPR survey. GPR has been used effectively to identify individual graves and skeletons in Iceland.



Figure 2. Test Pit locations after turf removal and during cemetery excavations.

Test pits

The three test pits excavated on the eastern edge of the Keflavík farm mound all exhibit the same basic sequence, with about 75% of the deposits above the 1300 tephra layer. Most of the deposits are composed of what appears to be various types of ash. Some of the ash deposits are laminated, while most others appear to be without depositional structure. The steepest and deepest parts of the mound would appear to be primarily 20th century material.

Test pits 1 and 2 were excavated into the mound in advance of mechanical clearing for the cemetery excavation (Figure 1). Both of these test pits suggested that there was little structure and minimal pre 1300 deposits at the eastern edge of the farm mound. Both

Table 1. Contexts for Test Pit 1.

Context	Description	Context Above	Context Below	Stratigraphic Dating	West Wall Depth (cm)	Notes
111	Disturbed	Ground Surface	112	After 1300	0-60	Heavily disturbed topsoil
112	Pink ash and gray ash	111	113 & 1300	After 1300	60-155	
113	Pink ash and burnt turf	112	1300	After 1300		Akin to cxt 110 in TP2
1300 Tephra	Gray	112 & 113	114	1300	170	
114	Pink ash and gray ash	1300	1104	1300-1104	155-170	
1104 Tephra	White	103 and 104	End of excavation	1104	170	

test pits' sidewalls were mostly removed as part of mechanical clearing. Neither of these test pits were excavated all the way down to sterile. Neither of these test pits had flotation samples taken. In both cases, the west walls remain as a context for potential excavations into any structural deposits adjacent to the cemetery (Figure 2).

Test pit 3 had flotation samples taken below the 1104 tephra layer as well as a complete tephra sampling regime. The second black tephra identified in test pit 3 appeared in several places along the margin of the mechanically cleared area. It is unclear if the bottom tephra is the 1000 or a potentially earlier tephra from ~950. Only one tephra was present between 1104 and H3/H4. Both the 1000 and the ~950 appear in sequence

in other portions of the cleared area. While there is potentially material below the second (~950) tephra in other parts of the mechanically cleared area, test pit 3 clearly yielded a pre-1000 establishment date.

Test pit 1

Test pit 1 established an initial depth and context for the 1104 tephra layer in the eastern edge of the farm mound (about 170 cm). The deposits, below the disturbed ground surface were almost all ash, except for one small deposit of burnt turf [113], which is probably in a secondary context. No structural remains were identified. The deposits were unconsolidated.

TP 1

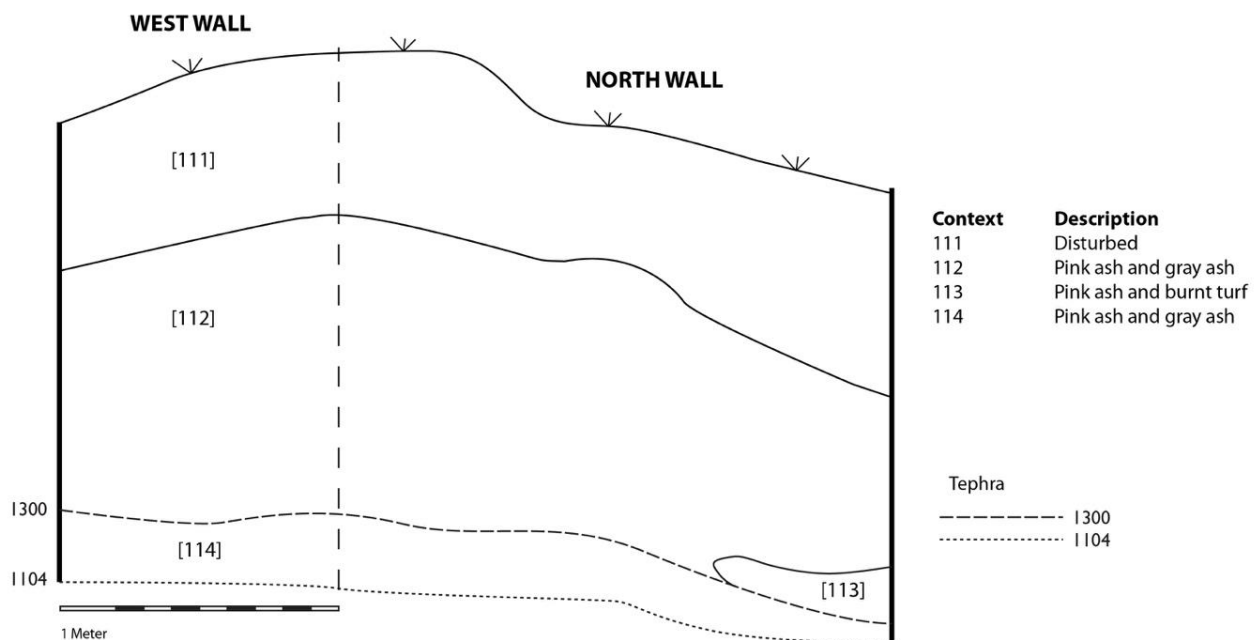


Figure 3. Test pit 1 profile.

Table 2. Contexts for Test Pit 2.

Context	Description	Context Above	Context Below	Stratigraphic Dating	Depth (cm)	Notes
101	Disturbed surface	Ground Surface	1776	After 1776	0-24	
1776 Tephra	Gray/black	101	102	1776	24	
102	Pink ash and gray ash	1776	103 & 104	1776-1104	24-60	Possibly Fill
103	Pink ash and gray ash	102	108 & 107	1776-1104	60-90	
104	Pink ash and gray ash	101	109	1776-1104	60-90	Cut into context 103 & 108
105	Pink ash and gray ash	103 and 104	106	1776-1104	90-100	
106	Pink ash and gray ash	103 & 104	108 & 107	1776-1104	90-100	
107	Pink ash, charcoal, and gray ash	103 & 104	109	1776-1104	80-100	
108	Turf	103 & 104	109	1776-1104	90-120	Probable turf wall w/1104 mostly on east side
109	Pink ash and gray ash	104, 108, & 107	110	Before 1776	120-140	
110	Greasy and black	109	Unexcavated	Before 1776	140	

Test pit 2

Test pit 2 presented some poorly preserved structural deposits in the western end of the excavation. At the same time, the sequence also exhibits substantial 20th century disturbance. Context 104, a pit in the western end that cut through most of the sequence, has a substantial amount of rubber, plastic, and other 20th century material. Context 108, in the western end of the excavation, may be a poorly preserved turf wall that contains the Hekla 1104 tephra in some of the turf wall material. Context 109 appears to be a well-preserved ash deposit under the probable [108] wall. No Hekla

1300 tephra was identified in the sequence, therefore most of the dating is rather broad. The excavation was terminated at [110] because the deposit was a potential floor. Context 110, only appeared in the western 15 cm of the excavation and the deposit was not excavated.

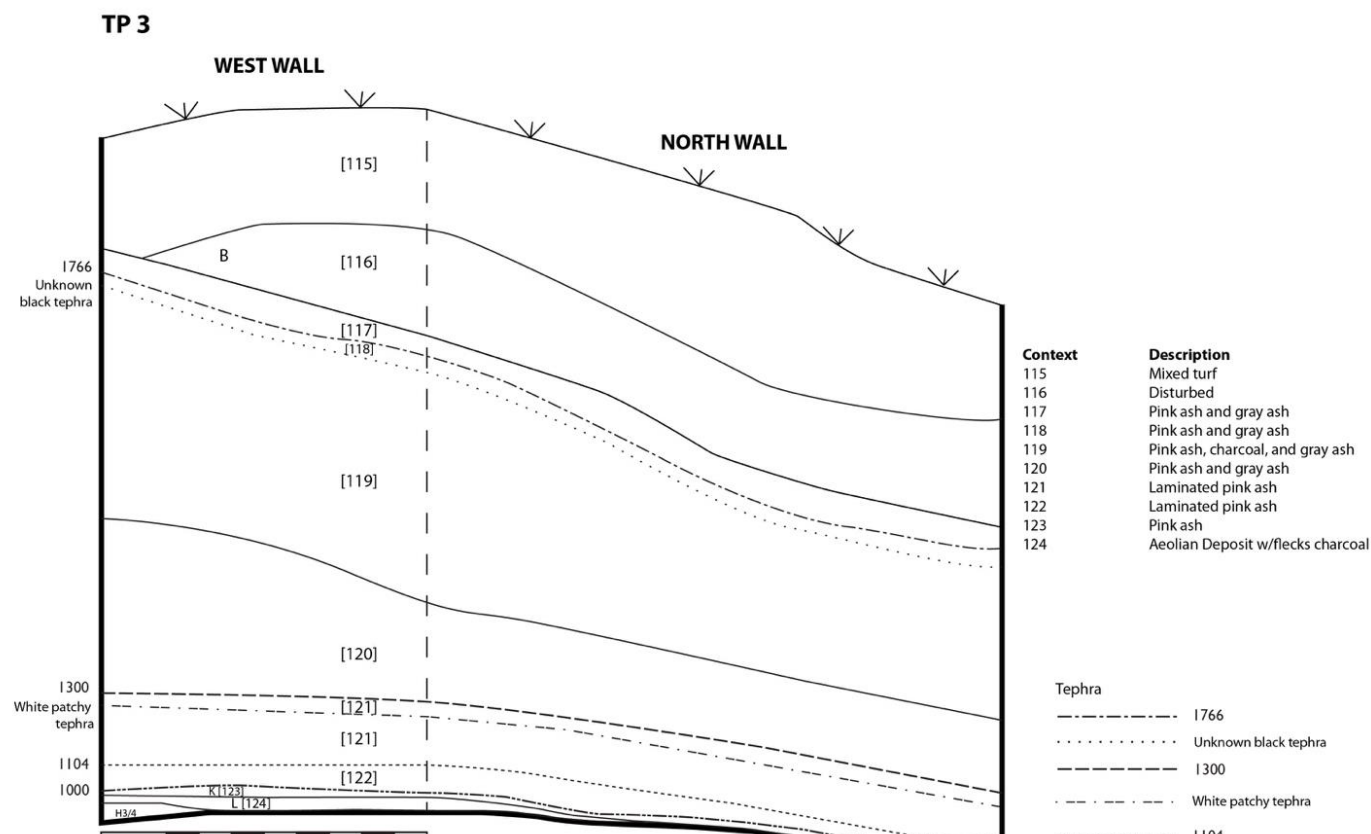


Figure 4. Test pit 3 profile.

Test pit 3

stratigraphic relationship to the cemetery. The

Table 3. Contexts for test pit 3.

Context	Description	Context Above	Context Below	Stratigraphic Dating	Sample #	Notes
115	Mixed turf	Ground Surface	116 and 117	After 1776		
116	Disturbed	115	117	After 1776		Possibly Fill
117	Pink ash and gray ash	116	1766 Tephra	After 1776		Bone inclusions (both burnt and unburnt)
1766 Tephra	Black/gray tephra	118	118	1766		
118	Pink ash and gray ash	1766	Black tephra	1776-1300		
Black tephra	Black/gray tephra	118	119	1776-1300		
119	Pink ash, charcoal, and gray ash	Black tephra	120	1776-1300		
120	Pink ash and gray ash	119	1300	1776-1300		
1300 Tephra	Gray tephra	120	121	1300		
121	Laminated pink ash with bits of white patchy tephra	1300	1104	1300-1104		
1104 Tephra	Yellow-White Tephra	121	122	1104		
122	Laminated pink ash	1104	1000	1104-1000	1	
1000 Tephra	Gray tephra	122	123	1000		
123	Pink ash	1000	124	1000-Settlement	2	
124	Aeolian Deposit with flecks of charcoal	123	H3-H4	Settlement	3	
H3-H4 Tephra	Yellow Tephra	124		Prehistoric		

Test Pit 3 is the only test pit excavation that was completed. It was excavated after mechanical clearing to get a better Viking Age context for dating, particularly a farmstead establishment date. It was placed based on a coring program to identify the earliest ash midden deposits that were accessible with a 2.5m deep test pit. No structural deposits were encountered. The sidewalls of TP3 are still intact.

Cemetery excavation

For the most part, the cemetery was well-preserved with only limited disturbance and later intrusive cuts. There was, however, a large cesspit cut into the northwestern section of the churchyard. The pit was dug in early 20th century and later cleaned out and filled with rubbish sometime in the 1960s. The upper half of the fill was removed by machine during the site opening but the lower section, which was cut through preserved layers of the cemetery, was removed by hand. Material was not systematically sieved or collected from the pit. The pit was cut entirely through the stratigraphic horizons associated with the cemetery and into sterile, prehistorical soils. There are graves a short distance to the east of the cesspit cut but there are no grave cuts in the profile of the cut and there is nothing to suggest that any graves were located entirely within the area of the cut and removed. The digging of the cesspit completely truncated a section of the cemetery enclosure wall and extended a couple of meters into the churchyard. The profile exposed by the cesspit cut revealed a number of tephra layers and their

cemetery enclosure wall is later than the Vj~1000 layer. A layer of ash and charcoal midden deposit included the Vj~1000 and ~950 tephra layers but ended above the 871±2 *landnám* tephra. The deposition of ash and charcoal is indicative of a domestic dwelling and, taken in consideration with the domestic remains in the homefield, suggests that there may have been two domestic occupational areas on the farm in the 10th century.

Cemetery architecture

The layout of the Keflavík cemetery is similar to other early Christian household cemeteries in Skagafjörður. The primary elements include a circular wall enclosing the cemetery and a central church. The cemetery is located on the east side of the farm mound. An entrance on the west side of the cemetery likely faced the main dwelling structure but this area of currently buried under the main farm mound. The cemetery was constructed on a gentle slope that falls from west to east by 2 meters. There is no current evidence of major landscape modifications to level the surface prior to construction.

Cemetery Enclosure Wall

Like most early Christian cemeteries in Iceland, the Keflavík cemetery was enclosed by a circular wall. The cemetery enclosure wall was constructed of turf and near circular and measures approximately 15/18



Figure 5. Overview of the Keflavik cemetery excavation showing main architectural features and graves.

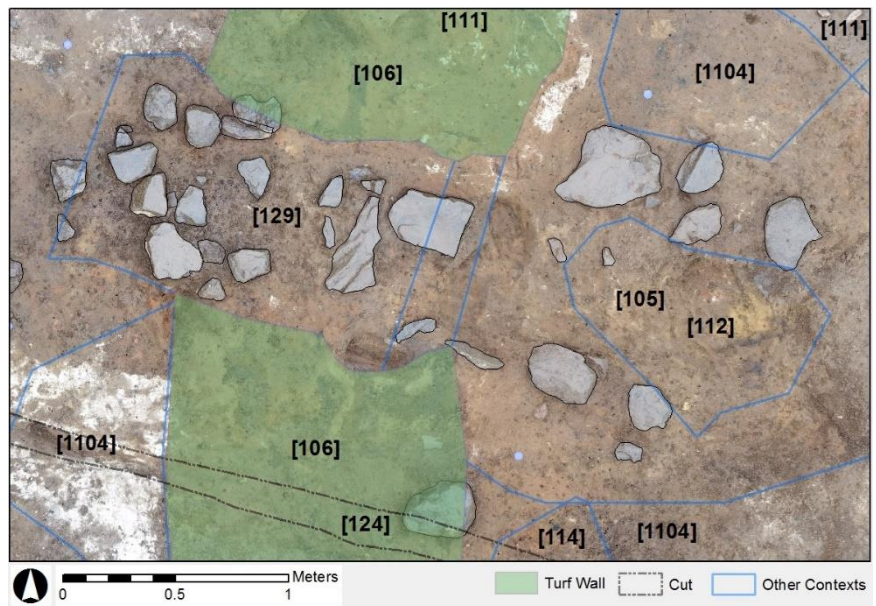
meters (interior/exterior diameter). There does not appear to have been a stone foundation but large sections of the wall were removed and the surviving sections have not been removed. The wall was constructed before the Hekla 1104 eruption; the tephra collected against both the inside and outside of the wall neatly outlining its circumference in white (Figure 5).

Large sections of the enclosure wall were almost entirely removed post-1104. On the north and east sides of the cemetery, the wall remains consist of little more than a few, thin patches of turf block and the outline created when the white 1104 tephra fell against the, then standing, walls. The best preserved section of wall is around the cemetery entrance in the west and

the southwest quadrant. This is also the section most heavily damaged by later pitting. Here the wall is preserved in section about 20 centimeters tall. From the thin remains of the wall it appears to have been constructed from *hnaus* blocks on the exterior and interior faces with a fill of mixed turf. There is little evidence of significant wall fall or slumping suggesting that the upper layers of the wall were deliberately removed, probably as part of the general closure of the cemetery, and either taken to another location or spread out.

The cemetery entrance is located at the western most side of the cemetery enclosure (figure 6). It is oriented slightly south of east on the same alignment as the church. While the entrance generally lines up with the western entrance to the church they are not exactly in line: the entrance actually points at the southwestern corner of the church and someone walking from the entrance to the church would have to proceed due east from the entrance to arrive at the church door. The entrance was stone paved and a few stones were placed immediately next to or in the turf wall such that the entrance may have been the only section of the enclosure wall with a stone foundation. There are surviving turf blocks tracing both sides of the entrance. The blocks would have reinforced the wall but also would have resulted in a neatly finished look. The turf is similar in appearance as the turf in the pre-1104 phase of the church and may have been constructed at the same time. It is unclear if the stone pavement extended past the edge of the wall into the interior space. There are flat stones to the north and south that could represent a continued pavement but the middle, the immediate extension of the entrance, is lacking stones. These could have been removed by the later intrusive pit [112]. Further excavation to the east may reveal more of an interior pavement if it did, in fact, exist.

The entrance appears to have been part of the original pre-1104 enclosure wall construction. The absence of any in situ Hekla 1104 tephra in the entrance itself



indicates that it was used after 1104 and was not part

Figure 6. Cemetery entrance [129] and associated contexts.

of the general turf fill event that preserved the tephra throughout the rest of the cemetery.

The Cemetery

The cemetery is largely defined by burials (see below) but there are additional features of the cemetery space. The two main features are deliberate layers of turf fill that were added to the cemetery surface and a channel cut through the south side of the cemetery to control drainage.

The Hekla 1104 tephra layer was remarkably well preserved in the cemetery. The in situ layer clearly outlines the inside and outside of the cemetery enclosure walls and covered the entire space up to the edges the church in near continuous sheet (figure 5). The preservation of the in situ layer is due to a layer of turf fill [110] that was added to the cemetery shortly after the eruption, which effectively capped the layer. The preserved 1104 tephra shows a largely flat cemetery surface with some dips, mostly associated with the drainage channel [124] in the south and graves in the north that appear to have settled after they were filled.

Turf fill layers are common in early Christian cemeteries in Skagafjörður. The post-1104 turf fill layer [110] covered the entirety of the cemetery. It varied in thickness from a few centimeters up to about 20 centimeters were it filled in dips in the old cemetery surface. It was thickest north and south of the church. The fill consisted of mixed dark red and blackish-brown *mýrartorf*. The fine and mixed texture and mottling of the turf indicates that the material was not deposited as coherent turf blocks and the absence of any white Hekla 1104 tephra in the turf in the fill suggest that the turf came from some already standing structure that was built before 1104. There is at least one additional early fill layer prior to the Hekla 1104 tephra fall. This layer was not investigated in 2015 and it is unclear if it was part of the initial construction sequence at the cemetery or a later addition.

The inhabitants at Keflavík made deliberate efforts to control water flow and drainage around and within the cemetery. So far, two channels have been identified, one tracing the outside of the southwest part of the cemetery enclosure wall [107] and the other running from the cemetery entrance through the cemetery to the south of the church [124] (Figure 7). Both features were dug before the Hekla 1104 tephra fell. Both channels likely were dug to aid in drainage. The western side of the cemetery faces uphill and water would have run down from outside the cemetery enclosure to collect against the wall or into the cemetery where it would have pooled against the western gabled end of the church. The channel outside the cemetery enclosure [107] runs along the outside of the cemetery enclosure wall closely following the curving wall to the south and east. At the southernmost extent of the cemetery enclosure the channel ceases to follow the wall and instead runs directly east down slope. Both channels appear to have been dug deliberately.

Channel [124] initially appeared as a linear break in the white Hekla 1104 tephra layer. Upon investigation it was clear that tephra actually dips following the shallow contour of the channel. The western most section of the



Figure 7. Drainage channel [124] with cross section shown in upper center.

channel, which runs through the cemetery enclosure wall just south of the paved entrance, is narrow, about 15 centimeters at the top and has a deeper incised channel at its base around 5 centimeters wide. The deeper section appears to have been excavated by water coursing in the channel rather than deliberate construction and was active after the 1104 tephra fell. The section of channel in the cemetery is wider and shallower (about 25 centimeters in width and only about 10 centimeters deep). The smoothly rounded bottom of the channel indicates a low-energy water flow and that it may have been covered with grass or other vegetation as exposed soil would have almost certainly eroded into a more deeply cut water course. Some aeolian fill between the bottom of the channel cut and the tephra indicate that it had partially filled before the 1104. The end of the channel was not investigated in 2015. It may simply end or go under the eastern side of the cemetery enclosure wall.

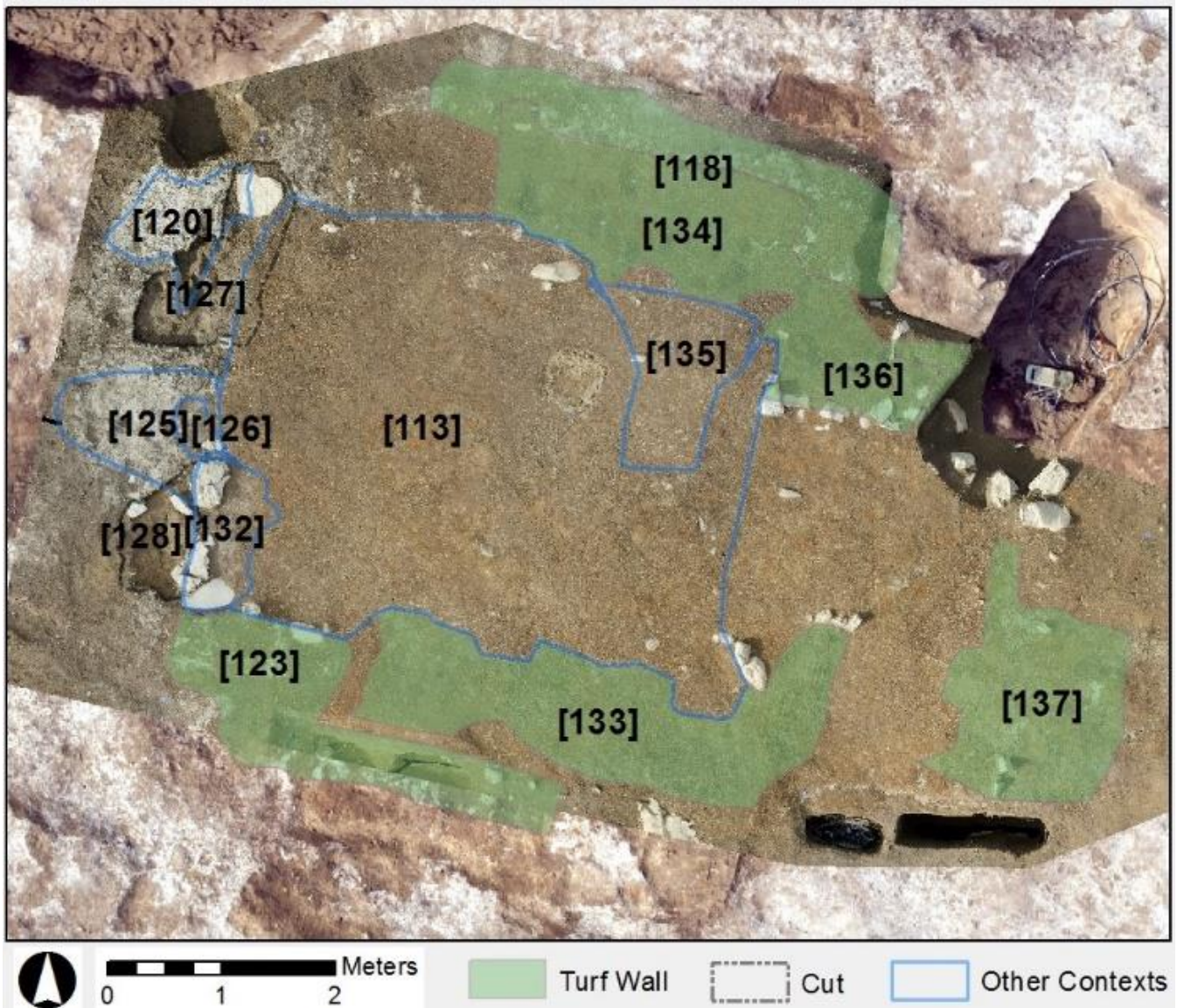


Figure 8. Church.

The Church

The central church as was only partially excavated in the 2015 summer excavation season (figure 8). This work primarily consisted of carefully exposing and cleaning the architecture for description and mapping. Most of the contexts were left intact for excavation in 2016 but some of the post-1104 construction phases were removed from the western end of the church. Thus the boundaries, descriptions, and interpretations presented are highly preliminary and subject to revision upon further excavation.

Even in this limited excavation, it is evident that there were at least two phases of construction. A turf and wooden structure built in the 11th century and then a

modification and partial reconstruction of that structure after the 1104 tephra fall. Both the 11th century and post-1104 phases of the church were constructed of turf and wood. Turf was not generally used in early 11th century churches in Iceland and all known examples from Skagafjörður were wooden buildings with sunken corner postholes. If Keflavík follows this pattern, then it is likely that there was an earlier wooden church at the site. Additional excavation is required to determine if there was an earlier church.

The church was constructed of wood and turf. The building was rectangular with interior dimensions of approximately 4.7 x 3.5 meters (west-east x south-



Figure 9. View from the west side of the church facing east. Arrows show the eastern orientation of the church and the location of Gljúfurárdalur in Blönduhlíð.

north) with a small choir extension measuring approximately 2.3 x 2.1 on the east. There is a hint that the structure was slightly expanded after 1104.

The church is in the approximate center of the churchyard. The spacing from the north and south walls to the interior of the enclosure wall is nearly identical (ca. 4.7 m for the outer edge of the pre-1104 turf wall). There is more open space in the western half of the churchyard between the entrance in the enclosure wall and the western front of the church but the presence of the choir extending from the eastern end of the church makes it difficult to determine how the church was centered west-to-east in the cemetery. If only the main church structure is counted, it is a greater distance from the back of the church to the eastern edge of the cemetery than it is in the west. If the choir is included with the church structure, then it extends well into the eastern part of the cemetery.

The church is oriented to the south of east. This alignment is replicated in other features in the

cemetery such as the entrance in the enclosure wall and many of the graves. Based on this alignment the cemetery appears to be oriented toward Gljúfurárdalur in Blönduhlíð on the eastside of Skagafjörður (figure 9).

The late 11th century church.

The late 11th century church survives as a series of turf wall foundations and contact lines were the Hekla 1104 tephra fell against the edge of the turf and wooden walls. Traces of wood were found at the edges of the structure. The church had turf walls around the choir on the east end: [136] and [137]. Turf walls were also on the north and south sides of the church: [133] and [134]. These walls only extended about $\frac{3}{4}$ the total length of the walls and left the western end of the wooden structure exposed. There is no evidence of a turf wall on the western gabled end of the church.

All of the pre-1104 turf is similar. Reddish-brown with brownish-black layers. The turf included small bits of



Figure 10. Cross section of the church wall in the northeast corner of the choir, exposed by the electrical trench originally dug by RARIK.

fine blackish tephra (possibly K 860) and gray-greenish tephra possibly the 871±2 *landnám* layer, the as of yet undetermined mid-10th century layer, or the Vj~1000 tephtras. Where the turf walls were preserved well enough to discern the construction style, they were made with an outer and inner layer of rectangular *hnaus* blocks with thick layers of *strengur* making up the wall core (figure 10). The use of *strengur* in the wall cores indicates a relatively high investment in the construction and it is possible that the *hnaus* blocks making up the wall facade were alternated with *strengur* courses.

The choir end of the church was the least well preserved. The turf style was less distinct than the main church walls but was likely some sort of *hnaus* construction but as of yet the block dimensions and pattern are unclear. The recent trench dug by the electrical company damaged the north end of the choir. Much earlier the northeastern corner of the choir was

truncated by a cut with gravelly fill. There is more gravel in and around the wall, which may result from weakly concreted stones used in the construction. The southeast corner is also indistinct in the current limited exposure.

The interior structure of the church was clearly made of wood. Remnants of a wooden sill were found in the choir, at the western end of the north wall, and along the gabled west end of the church. The turf fill inside the church [113] was not compacted and had limited evidence of activity. The church interior probably had a wooden floor.

The post-1104 church reconstruction

As with addition of a new layer of turf fill across the cemetery, the church was also partially reconstructed after fall of the Hekla 1104 tephra. It is not clear if the resurfacing of the cemetery and the reconstruction of the church were done at the same time but they both seem to have occurred shortly after the fall of the tephra. The main visible features of the reconstruction are the edition of new turf to the north and south walls, a reconstruction of the foundation and entrance on the western end of the church, and the possible addition of stone post-pads under the main church posts along with the addition of stones under some of the wooden sills.

Both the north and south church walls appear to have been largely removed post-1104 and new turf was added on top of the old foundation. A new façade of turf with Hekla 1104 tephra was added abutting the outside of the old turf wall and the walls were extended further to the west with the result that the new walls were both longer and wider than the earlier walls. The end of the new turf wall on the north side of the church [118] is unclear but the new wall on the south side [123] extended all the way to the gable end of the church on the west.

The western end of the church was subject to the most extensive renovation (figure 11). The foundation on the

south of the entrance was removed and rebuilt with new stone and turf, which included the Hekla 1104 tephra [132]. A new entrance ramp was added the church. The old church does not appear to have had a pavement: Hekla 1104 tephra fell on a flat surface against the western end of the old church. In the reconstruction, the tephra was covered, and preserved, by the addition of a ramp made up of mixed gravel, soil and turf [126]. A few flat stones were set into the surface of the new ramp suggesting a pavement. The ramp ended with a small layer of turf construction [125] that would have been immediately against the wooden church wall or possibly under the church threshold. The turf is relatively clean and soft and was probably protected by the doorway threshold.

Some of the mechanical aspects of the reconstruction are also evident. Two shallow pits [127] and [128] were dug against the western end of the church. Both cuts were made after the Hekla 1104 tephra fell. The purpose of these pits was initially elusive but it seems likely that they were excavated under the wooden gable to help pry the structure up so that the foundation could be repaired. The cut and fill on the north side of the entrance extended a short distance under the likely location of the wooden wall. The cut on the south side originally extended under the wall and into the interior of the church but the inside part was filled by the new foundation [132]. The new foundation is on the south side of the church, near where the earlier channel was dug to guide water from the cemetery entrance south of the church. The channel and new foundation suggest that there was significant water damage to the southwest corner of the church before 1104. The channel was probably dug to mitigate further damage but when the church was reconstructed after 1104 the household took advantage of the opportunity to repair the foundation as well.

There is evidence for repair on the north and south sides of the church as well. The interior edge of the walls on both the north and south side were appear to have been truncated by a thin cut or disturbance between the turf walls [133] and [134] and the turf in the interior fill [113]. For most of its length the gap is about 8-10 cm wide. The gap follows the line defined by

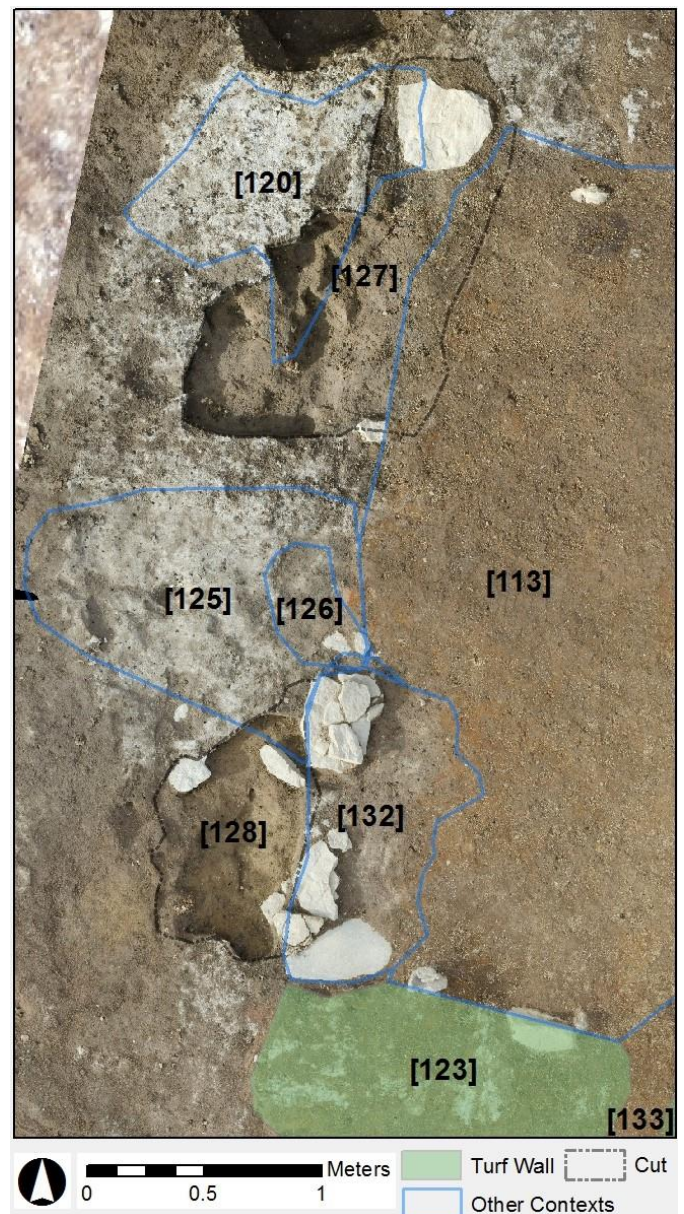


Figure 11. Contexts at the western gable of the church.

foundation stones and suggests that the interior of the wall was cut and the foundation repaired and refilled in the post-1104 reconstruction of the church. The fill between them has a different turf which includes Hekla 1104 tephra. Hekla 1104 tephra also traces the inside contact of the wall. The disturbed area expands at the corners of the church and in the middle of the north and south walls. Flat post pads were either added or replaced at the western corner of the church. The larger areas of disturbance along

the interior edge of the north and south walls also had stones in them, probably to support the wooden sill of

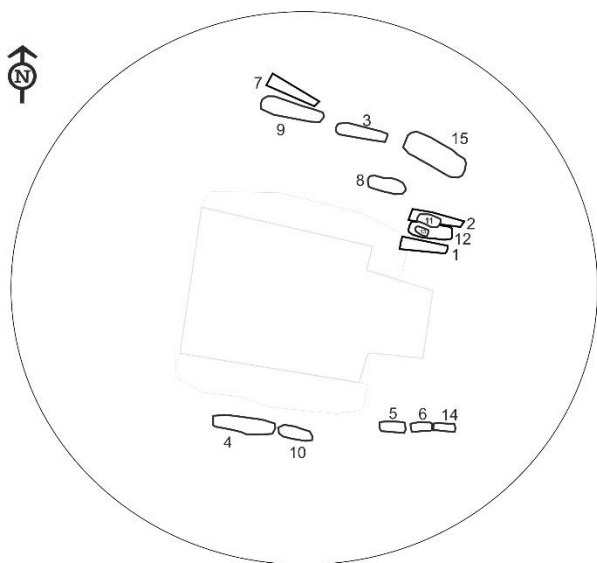


Figure 12. The number of graves and positions within the cemetery.

the church. No post pads were found yet at the eastern corners of the church but there are similar large disturbances at each corner that suggest some alteration of the foundation with the post-1104 reconstruction of the church. At this point it is not clear if the choir was altered during the remodel.

Graves

In total, 14 graves were excavated in the summer of 2015. There were 6 adult (18+) graves, the grave of one juvenile (13-18), one child (3-12) and six infants (~birth-2years). Eight graves were dug after the 1104 tephra fell, five were pre-1104. One grave just south of the church had been emptied post 1104 but other graves included skeletons. The preservation of the skeletal material was generally favorable but one adult grave (9) was packed in glacial gravel and the cortical bone flaked off easily. About half the graves included coffins and many nails/bolts were recovered but no other objects were found in the graves. In all of the graves that did not include coffins, the heads had been propped up and supported so the individual faced east. One interesting feature of the cemetery was the placing of stones to mark the graves on the surface. In a number of graves three were also stones in the surface layer of the gravefill making the surface of the grave more visible meaning they would have been less likely to be cut into. In one grave (1) a thin layer of seems to have been

distributed on the chest area of the individual. There was little evidence of intercutting but many graves still await excavation and a more detailed analysis of grave features and burial customs will be reviewed in the final report.

Grave 1



Figure 13. Skeleton of a female in grave 1.

Grave 1 was one of three burials situated north west of the church choir, and was damaged when the electricity company excavated a trench. The 1104 tephra lay undisturbed over the grave. The excavator had removed leg bones below the knee but some of the removed bones were recovered from the spoilheap. On ther surface a pile of rocks lay at the head end of grave 1 and 12, most probably a grave marker as some graves seem to have been marked on the surface with rocks. The body was interred in a coffin and lay supine with head slightly tilted sideways to the right. Left arm lay straight down the side, partially under the left innominate. The distal right arm was slightly bent over the right innominate. Legs were also straight. An interesting feature was that a thin layer of charcoal dust lay on the internal within the chest cavity. It was not clear how the dust had been deposited in the grave.

Grave 2

Grave 2 was one of three burials situated north west of the church choir, and was damaged when the electricity company excavated a trench. The excavator had removed bones from both feet but some of the removed bones were recovered from the spoilheap. The 1104 tephra lay undisturbed over the grave. The

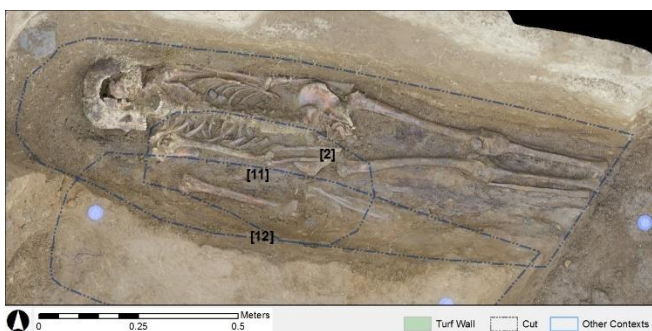


Figure 14. Skeleton of a juvenile in grave 2.

skeleton was that of a juvenile and was interred in a coffin. The body was placed in a supine position. The cranium was displaced to the left, whereas the mandible was still in the original position. Left arm lay straight by the side whereas the right arm was partially bent over the right innominate. The distal right arm and hand lay underneath the left innominate. Legs were straight. The skeleton was well preserved. This was the skeleton of a juvenile. When the grave was dug it had partially disturbed the bones of the left arm of the skeleton in grave 12.

Grave 3

Grave 3 lay north of the 12th century church. It postdated the H1104 tephra. A small group of stones were placed at the foot end of the grave as a grave marker. Small stones were included at the top of the grave-fill, possibly to make it easier to be detected on the surface. It was the grave of an older female. The body had been placed on its back and the head had been propped up with stones. Both arms flexed at the elbow and hands had been placed on the pelvis. Legs were straight.

Grave 4

Grave 4 was situated just south of the 12th century church. It was the grave of an adult individual but it had been emptied sometime in the early 12th century. A few hand and footbones remained but otherwise bones



Figure 15. Skeleton of a female in grave 3.

had been removed. The grave contained the remains of a coffin and a multitude of nails. It could not be determined whether the primary burial was older or younger than the 1104 tephra.

Grave 5

Graves 5,6 and 14 lay in a row just south of the choir of the 12th century church. Grave 5 was the westernmost of the three. It contained the badly preserved bones of an infant. The infant had been placed in a coffin but no nails were found in the graves. The infant had been placed on its side, with flexed legs. The infant grave had been placed on the coffin of an adult, a part of a humerus was exposed at the bottom of the grave when timber was sampled

Grave 6

Graves 5,6 and 14 lay in a row just south of the choir of the 12th century church, all three graves postdated the H1104 tephra. Grave 6 was in the middle of the three. The grave contained the well preserved bones of an



Figure 16. Infant graves 5 (left), 6 (middle) and 14 (right).

infant that had not been placed in a coffin but lay partially on top of the coffin of an adult. The skull had been propped up by placing it in a hollow made in the glacial gravel. The left arm lay slightly flexed over the abdomen but the right one was relatively straight but slightly flexed over the left pelvis.

Grave 7



Figure 17. Skeleton of a female in grave 7.

Grave 7 lay 3 metres north of the church wall under the H1104 tephra. It was placed just north of grave 9. The grave had been dug partially into glacial gravel. Three large stones formed a row at the intersection of graves 7 and 9, obviously a grave marker. The grave contained a coffin which was wider at the head end but tapered towards the foot end. The grave itself was. The grave contained the bones of a female. The skull was tilted to the left, left arm lay straight down the side but the right arm lay slightly over the right pelvis. Legs were straight. A large number of nails were recovered from the grave. Some of them do not seem to come from the coffin, four were in the chest cavity and one in the abdominal area. Otherwise most were lined at the northern edge of the coffin. Four nails were probably a part of the coffin.

Grave 8

Grave 8 lay about a metre from the northern church wall. It post-dated the 1104 tephra. The grave included the skeleton of a child. Stones were in the upper layers of the grave-fill, probably to mark the grave. There was evidence of wood along the right side of the skeleton



Figure 18. The skeleton of a child in grave 8.

which indicates the presence of a coffin. The head-end of the grave was undercut, possibly because it was dug in the winter. The head was slightly tilting to the left. Arms lay down by the sides and legs were straight.

Grave 9 (only partially excavated)

Grave 9 lay alongside grave 7 and was marked on the surface by a row of three large stones. The grave fill included a mixture of grey glacial gravel and earth. At the depth of 55cm the grave-fill became just solid gravel layer, like natural gravel had been reached. However, 10cm into the gravel a skeleton was found. The bottom of the grave was somewhat waterlogged and very difficult to excavate. As the gravel was compacted around the skeleton the bones were fragile and difficult to excavate. As the skull had been exposed, it was removed but the rest of the skeleton was left in situ to be excavated in 2016.

Grave 10

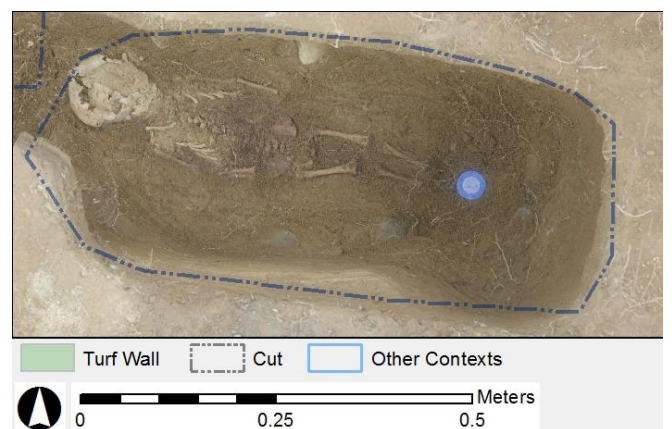


Figure 19. Skeleton of an infant in grave 10.

Grave 10 was situated 2m south of the wall of the 12th century church. The grave was dug post-H1104 and included the well preserved skeleton of an infant. The grave did not contain a coffin. The infant's head was placed in a dug out niche and lay a little higher than the rest of the body. The right arm was slightly bent over the pelvis, the right positioned straight down the infant's left side. Both legs were slightly flexed to the left.

Grave 11

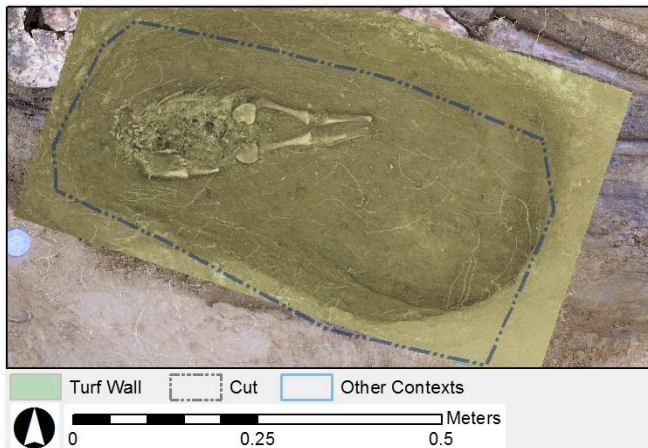


Figure 20. Skeleton of an infant in grave 11.

Grave 11 had been dug into the fill in grave 2. It post-dated the H1104 tephra and included the skeleton of an infant. The infant was not interred in a coffin. As the skull was damaged through excavation but it had obviously been propped up facing east. The arms were straight down the sides and legs were straight.

Grave 12

Grave 12 was the middle grave of three pre-H1104 graves just north of the choir of the church. The grave had been damaged when the electricity trench was excavated and leg bones below the knee were missing, although some bones had been recovered from the spoil heap. The skeleton was that of a young female. There was no evidence of a complete coffin but the body seems to have been placed on wooden boards but there was no other evidence of a coffin. The skull was

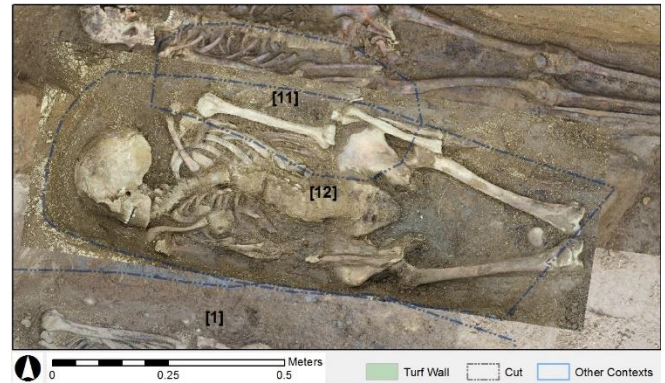


Figure 21. Female skeleton in grave 12.

weirdly positioned, it lay on its side but was posteriorly displaced, probably because of a misaligned vertebrae. There vertebral columns showed a case of severe kyphosis, which means the individual was seriously humpbacked. The skeleton was well preserved.

Grave 13 (damaged)

Grave 12 was that of a neonate that had been interred in the gravefill of grave 12. As there was little to differentiate the grave-fill of the primary interment and the infant grave it was partially damaged during the excavation. Because of this a number of bones were missing and the placement of the body could not be determined.

Grave 14 (see figure 16)

Grave 14 was the easternmost grave of three infant graves that formed a row just south of the choir of the 12th century church. The grave contained the relatively well preserved skeleton of an infant, The infant's head had been positioned in a dug-out niche in the glacial gravel in the bottom of the grave. Both arms were slightly bowed in over the pelvis, but legs were straight. There were some remains of timber in the grave but those most likely belonged to an adjacent grave.

Grave 15 (not yet excavated)

Grave 15 lay in the northern half of the cemetery. A large stone was placed at the head end (west) of the grave. The grave pre-dated the H1104 tephra. Only the first five centimetres were excavated until it was decided to cover the grave and leave it for excavation in 2016.

Finds



Figure 22. A key found next to infant grave 5.

Apart from the large amount of nails/bolts found in the graves, few finds were recovered from the site. Most were stones, but a few nails were also found on the surface, not associated with graves. The most notable find was a Viking-Age iron key that was found on the surface next to the three infant graves south of the church choir.

Post-Cemetery Activity

The few post-1104 graves suggest a limited period of use for the cemetery in the 12th century. The church could have remained active after burial ceased was definitely out of use before 1300 when the black Hekla layer fell on a relatively flat and leveled surface across the church and cemetery.

The church and cemetery show some evidence for deliberate closure and leveling. A layer of mixed turf with Hekla 1104 tephra [109] was on top of the deliberate post-1104 turf fill layer [110]. The mixed layer covered most of the cemetery with the exception of the small surviving southwest section of the enclosure wall and the area of the church. The most likely source for the mixed turf is from the dismantling of the church, which was reconstructed with turf that include the white tephra layer. The church showed little evidence for collapse inside the structure or any wall slump associated with the turf wall. It seems likely that the turf walls of the church were deliberately leveled and the turf spread across the cemetery. The wooden structure of the church also appears to have been removed. While some wood survived where the church

sills sat these were small fragments. Given that small fragments of wood survived, there would have been much more wood if the structure had collapsed in place. There is a historical record to a church services performed at Keflavík in 1394. If these services were associated with a church, it does not appear to have been located at the same site as the early Christian cemetery. The wooden church may have been salvaged for other uses or moved to a new location, possibly the site of a new church.

The interface between the last deliberate turf fill layer [110] and the destruction layer [109] was littered with large, poorly-preserved animal bones and fire cracked rock. These appear have accumulated before the church was dismantled. It seems unlikely that kitchen garbage would have been deposited in the cemetery when it was in use or that it represents some sort of deliberate ritual activity associated with the closure of the cemetery or church. It may represent a period of limited use on the site, for example the continuation of the church after the closure of the cemetery or simply a period of inactivity before the church structure was removed and levelled.

The cemetery area continued to be used for dumping after the walls and church structure were levelled. There are a number of intrusive pit features, [112], [114], [115] and [116], cut into the western half of the area. They are concentrated in and around the cemetery enclosure wall. In general, these pits follow the contours of the cemetery enclosure wall, the cemetery entrance, and the immediate interior of the enclosure wall suggesting that these features were remained at least partially visible when the pits were cut. They are all post-1104 and some may be post-1300; the only features from between 1300 and the late 20th century preserved in this part of the site. Most of the pits consist of charcoal, ash, fire-cracked rock, and animal bones and likely represent the disposal of kitchen waste. Each pit is relatively small and may contain the material from a single cooking event.

Outcomes of the 2015 excavation and future work

The primary goal of the 2015 fieldwork at the Keflavík cemetery was to excavate in its entirety a relatively undisturbed cemetery site in order to get comparative data both for the Skagafjörður Church Project as well as to provide a detailed cemetery and settlement profile for one of the farms examined through the SCASS projet. The site provides information on church development as well as the burial rites and demography of the Keflavík household.

Over the course of six weeks, the entire cemetery was opened, two phases of church construction were identified dating from before and after A.D. 1104, and 15 graves were identified, 13 of which were fully excavated.

A secondary goal was to produce an inventory geophysical survey data of the site using electromagnetics and GPR. Multiple geophysical surveys were completed including surveys with two multisensory electromagnetic conductivity meters (CMD Explorer and CMD Mini-Explorer) and multiple GPR surveys. A total of 54 possible graves were identified in the GPR data (see appendix G).

Goals for 2016:

- Complete excavation of the late-11th century and post-1104 phases of the wood and turf church.
- Finish as many of the remaining graves as possible.
- Compare the possible graves identified in the GPR survey with the excavation record. Assess the use of GPR to remotely map early Christian cemeteries.

The geophysical surveys and partial excavation have also generated new questions:

- How do the placement and demographics of the post-1104 graves compare with the pre-1104 graves?
- Are there variations in body posture, head position, and hand positioning between the pre- and post-1104 graves?
- Is there evidence of a change in burial behavior or the status of the cemetery after A.D. 1104?
- Are there graves under and outside of the cemetery wall as the results of the GPR survey suggest?
- Is there an earlier, wooden church preserved beneath the turf and wood church?

Appendix A: Spatial Controls: survey and excavation grid establishment

The effectiveness and utility of archaeogeophysical methods is highly dependent on the degree of spatial control over the collection, integration, and presentation of the datasets. Accurate grids allow for the precise collection of data and correlation with surface features, pre-existing excavation data, and coring. They are also essential for the integration of various geophysical methods that may show complementary attributes of deposits. Slight differences between the actual location of a geophysical reading and the coordinate assigned during survey can weaken or eliminate the value of archaeogeophysical surveys. Inaccurate surveying can also create anomalies where there are none or hide anomalies that would otherwise be apparent. The effects of inaccurate surveying can be magnified when the data is post-processed and filtered.

Grid Establishment

Two based points were established for the Keflavík excavation using at Topcon Hiper SR differential GNSS. Two rocks were used on the north and south sides of the farm mound (figure 23). Three successive measurements were averaged from the Hiper SR mounted on a tripod using a RTK correction from the local Sauðárkrókur base station via ÍSMAR. These base points were used for all successive total station set ups and site measurements.

Spatial measurements: total station, kite- and pole-based low altitude aerial photography, photogrammetry

Spatial measurements were made using a Topcon total station or based on kite- and pole-based orthorectified images generated from multiple camera positions using Agisoft Photoscan photogrammetry software. All measurements use the ISNET93 coordinate system. For each

photographic run, ground control points (GCPs) were placed in the subject area and measured with the total station for input into Photoscan to generate orthorectified composite images and



Figure 23. GNSS measured base points for total station set up.

Table 4. Keflavík GNSS measured base points. Coordinates are in the ISNET93 coordinate system.

Point Name	East	North	Elevation
Yard Rock (YARDROCK_AVG_GPS)	477255.509	581902.981	49.068
Southeast Mound (SE_MOUNDROCK_AVG_GPS)	477246.173	581839.376	46.981

corners of the excavation area and pinned in place to use as GCPs for the kite photos. Blue poker chips were used for the pole photos.

Ricoh GR was used with the kite and a Nikon Coolpix A was used with the pole. Both cameras have a fixed 18.33mm f/2.8 lens (28mm equivalent in a 35mm camera) and built in intervalometer, which was set to take photographs every 5 seconds. Both cameras were set to record data in RAW format. RAW photos were converted to TIFF using Adobe Photoshop for photogrammetry modeling in Photoscan.

For kite photos, the Ricoh GR camera was enclosed in layers of closed-cell polyethylene foam inside a Ziploc brand plastic box, which was hung from the kite line via a “Picavet” string suspension. For kite photos, the photo rig was suspended from an Air Affairs Sutton Flow Form 16. This design proved effective in protecting the camera during “hard landings” and in keeping the camera pointed downward at near-vertical angles during flight. Our standard photograph collecting procedure was for the kite operator to walk a loose grid pattern, walking a set number of strides, stopping long enough for the camera to take 2-3 shots, and repeating. When available, a second person stood either directly under the camera or to the side in order to keep the operator appraised of the area being photographed. Kite photos were collected at the beginning of fieldwork before site opening, at two occasions as excavation proceeded, and again at the end of the excavation prior to site closure.

Pole photos were collected of various contexts, structures, and of graves. The Nikon Coolpix A was

suspended from a 4-meter extension pole topped by a mount that allows the camera to self-balance pointing down. For some features, such as the bottom of graves, the camera was simply held by hand and oblique shots were collected in addition to the top-down shots to better aid in 3d modelling of complex features in Photoscan.

The resulting photographs can be georeferenced and used to establish a visual overview of site and surface conditions including the location of visible ruins, vegetation and other surface features to aid in the interpretation of geophysical anomalies. Agisoft’s Photoscan photogrammetry software was used to produce 3d models of features. These models can be output as georeferenced orthophotos and digital elevation models (DEMs) for incorporation in GIS.

Kite-based and pole-based photography datasets include:

- 1) Unprocessed RAW images. Full collection of digital photos from each kite flight and pole run.
- 2) Selected TIFF converted images.
- 3) 3d models in Photoscan format.
- 4) Orthorectified composite images generated from 3d models in Photoscan.
- 5) Digital elevation models generated from 3d models in Photoscan.

Appendix B: Context register

CONTEXT	ID	DATE	TYPE	CLASS	DESCRIPTION
1	DJB	07/30/2015	Deposit	Grave	grave in electrical trench to the south
2	DJB	07/30/2015	Deposit	Grave	grave in electrical trench to the north
3	DJB	07/30/2015	Deposit	Grave	Post-1104 grave on north side of cemetery
4	JJT	07/30/2015	Deposit	Grave	Post-1104 grave south of church
5	SUP	07/30/2015	Deposit	Grave	Post-1104 infant grave south of choir, western
6	AMB	07/30/2015	Deposit	Grave	Post-1104 infant grave south of choir, eastern
7	MHH	07/30/2015	Deposit	Grave	Pre-1104 grave with stones on north side of cemetery
8	BZ	07/30/2015	Deposit	Grave	Post-1104 grave at northeast corner of church
9	MHH	07/30/2015	Deposit	Grave	Pre-1104 stone lined grave south of grave 7
10	JJT	07/30/2015	Deposit	Grave	post-1104 grave intercut with grave 4 (to the east of grave 4) immediately south of the church
11	GZ		Deposit	Grave	Infant grave in grave 2
12	GZ		Deposit	Grave	Pre-1104 grave between graves 1 and 2
13	GZ		Deposit	Grave	Pre-1104 grave in northeast of cemetery with large stone at western end
14	GZ		Deposit	Grave	Post-1104 infant grave, eastern most of three infant graves on south side of church choir (originally numbered grave 7)
101	GZ	07/17/2015	Deposit	Aeolian Deposit	Aeolian including 1300
102	GZ	07/16/2015	Deposit	Midden	Late 20 th century garbage fill in old cesspit.
103	GZ	07/16/2015	Cut		Cut for electrical junction in cemetery, originally excavated in 2013 and expanded and cleaned by GZ in 2013. Reopened and cleaned during 2015 excavation
104	GZ	07/16/2015	Deposit	Fill	Fill in electrical junction trench [103] from 2013.
105	GZ	07/16/2015	Deposit	Collapse	Turf and aeolian mix with H1300 scattered on top
106	GZ	07/20/2015	Deposit	Wall	Cemetery enclosure wall
107	DJB	07/20/2015	Cut		Small erosive trench running along the outside of the cemetery wall in southwest and south
108	GZ	07/17/2015	Deposit	Midden	20th century midden deposit
109	GZ	07/22/2015	Deposit	Collapse	Layer of collapsed and spread out turf inside cemetery. H1104 mixed with turf and aeolian soil.
110	DJB	07/23/2015	Deposit	Mixed Turf	Mixed mýrartorf layer throughout cemetery, thicker and most concentrated in southern and eastern half of the cemetery.
111	DJB	07/23/2015	Deposit	Cultural Layer	Mixed fill with aeolian, thin lenses of ash and charcoal, and mixed turf
112	DJB	07/24/2015	Deposit	Midden	Small intrusive pit in cemetery entrance. Fill consists almost entire of animal bones and fire-cracked rock
113	DJB	07/25/2015	Deposit	Collapse	Possible interior subfloor deposit in church. Would have been under a wooden floor.
114	DJB	07/25/2015	Deposit	Midden	Peat ash layer intrusive to cemetery wall; immediately south of entrance
115	DJB	07/25/2015	Deposit	Midden	Peat ash layer intrusive to cemetery wall to the southeast
116	AMB	07/28/2015	Deposit	Midden	Intrusive pit with ash and charcoal fill
117	DJB	07/28/2015	Deposit	Midden	
118	DJB	07/28/2015	Deposit	Wall	Post-1104 turf wall base on the north side of the church
119	AMB	07/28/2015	Deposit	Collapse	gravel fill
120	DJB	07/30/2015	Deposit	Collapse	collapse at northeast corner of church
121	DJB	07/30/2015	Deposit	Fill	Fill layer under 1104
122	DJB	07/30/2015	Deposit	Upcast	gravelly lenses on 121
123	DJB	07/30/2015	Deposit	Wall	post-1104 turf wall on south side of the church

CONTEXT	ID	DATE	TYPE	CLASS	DESCRIPTION
124	DJB	07/07/2015	Cut	Channel	Shallow drainage channel in west of cemetery running on south side of wall entrance to southwest corner of church.
125	DJB	08/03/2015	Deposit	Threshold	Post-1104 fill/ramp at east entrance of church
126	DJB	08/07/2015	Deposit	Threshold	Small turf layer on post-1104 church entrance ramp [125].
127	DJB	08/07/2015	Cut		Post-1104 cut on in front of western end of the church on the north side of the entrance.
128	DJB	08/07/2015	Cut		Post-1104 cut on in front of western end of the church on the south side of the entrance.
129	DJB	08/07/2015	Deposit	Pavement	Pavement in western entrance to cemetery
130	DJB	08/07/2015	Deposit	Grave	Grave 4 exhumation cut
131	DJB	08/07/2015	Deposit	Grave	Grave 4 original inhumation cut
132	DJB	08/11/2015	Deposit	Foundation	Rebuilt foundation with H1104 turf and stone, south side of the western gable end of the church
133	DJB	08/11/2015	Deposit	Wall	Pre-1104 turf wall base on south side of church
134	DJB	08/12/2015	Deposit	Wall	Pre-1104 turf wall base on north side of church
135	DJB	08/12/2015	Deposit	Fill	Turfy fill with H1104 in northeast corner of church
136	DJB	08/12/2015	Deposit	Wall	Pre-1104 turf wall on north side of church choir
137	DJB	08/12/2015	Deposit	Wall	Pre-1104 turf wall on east and south side of church choir
1104	DJB	08/12/2015	Deposit	Tephra	In situ white Hekla 1104 tephra layer

Appendix C: Finds register

FIND	CONTEXT	RETRIEVAL	COUNT	MATERIAL TYPE	DESCRIPTION	ID	DATE
Pjms-36-69	113	Point	1	Bone	Tooth	DJB	7/25/2015
Pjms-36-70	101	Bulk	1	Lithic	Chipped stone	RSS	07/12/2015
Pjms-36-71	101	Bulk	1	Lithic	Whetstone	RSS	07/11/2015
Pjms-36-72	101	Bulk	1	Stone	Chipped stone	LMJ	07/12/2015
Pjms-36-73	6	Point	1	Metal	Iron key	DJB	07/27/2015
Pjms-36-74	121	Bulk	1	Metal	Nail, under H1104 tephra	MHH	07/29/2015
Pjms-36-75	6	Point	1	Metal	Possible nail	AMB	07/30/2015
Pjms-36-76	6	Point	3	Stone	White stones	SJP	08/04/2015

Appendix D: Sample register

SAMPLE	CONTEXT	TYPE	DESCRIPTION	ID	DATE
PJMS-36-1	110	Wood	Wood fragment	DJB	07/25/2015
PJMS-36-2	110	Wood	Wood fragment	DJB	07/25/2015
PJMS-36-3	110	Wood	Wood fragment	DJB	07/25/2015
PJMS-36-4	110	Soil, Intact	H1 interface	AHS	07/27/2015
PJMS-36-5	5	Wood	Grave 5 wood from coffin	SUP	07/30/2015
PJMS-36-6	5	Soil, Bulk	Grave 5 soil, upper 10 cm for pH	SUP	07/30/2015
PJMS-36-7	6	Soil, Bulk	Grave 6 soil, upper 10 cm for pH	AMB	07/30/2015
PJMS-36-8	7	Soil, Bulk	Grave 7 soil, upper 10 cm for pH	MHH	07/30/2015
PJMS-36-9	9	Soil, Bulk	Grave 9 soil, upper 10 cm for pH	MHH	07/30/2015
PJMS-36-10	1	Soil, Bulk	Grave 1 soil, upper 10 cm for pH	GZ	07/29/2015
PJMS-36-11	2	Soil, Bulk	Grave 2 soil, upper 10 cm for pH	GZ	07/29/2015
PJMS-36-12	6	Wood	Grave 6 wood	SUP	07/29/2015
PJMS-36-14	8	Soil, Bulk	Grave 8 soil, upper 10 cm for pH	BZ	07/30/2015
PJMS-36-15	1104	Tephra	Tephra sample east of grave 3	BND	07/29/2015
PJMS-36-16	1104	Tephra	Tephra sample north of infant grave 5, 6, and 14	BND	07/29/2015
PJMS-36-17	3	Soil, Bulk	Grave 3 soil, bottom 10 cm for pH	LMJ	08/03/2015
PJMS-36-18	7	Soil, Bulk	Grave 7 soil from abdominal area	MHH	08/03/2015
PJMS-36-19	7	Soil, Bulk	Grave 7 soil, bottom 10 cm for pH	MHH	08/03/2015
PJMS-36-20	135	Micromorph	Soil sample for micromorphology, interior church floor (originally associated with [113])	AHS	08/03/2015
PJMS-36-21	4	Soil, Bulk	Grave 4 ext soil, upper 10 cm for pH	JJT	08/03/2015
PJMS-36-22	4	Soil, Bulk	Grave 4 soil, bottom 10 cm for pH	JJT	08/03/2015
PJMS-36-23	4	Wood	Grave 4 wood from bottom of grave (coffin bottom?)	JJT	08/03/2015
PJMS-36-24	10	Soil, Bulk	Grave 10 soil, upper 10 cm for pH	AHS	08/03/2015
PJMS-36-25	5	Soil, Bulk	Grave 5 soil, bottom 10 cm for pH	SUP	08/03/2015
PJMS-36-26	5	Wood	Grave 5 wood sample coffin at base of grave	SUP	08/03/2015
PJMS-36-27	120	Wood	Context 120 wood from church fill	DJB	08/03/2015
PJMS-36-28	4	Wood	Grave 4 wood fragments	JJT	08/04/2015
PJMS-36-29	4	Metal	Grave 4 nails from coffin	JJT	08/04/2015
PJMS-36-30	4	Bone, Animal	Grave 4 animal bones	JJT	08/05/2015
PJMS-36-31	4	Bone, Human	Grave 4 human bone	JJT	08/05/2015
PJMS-36-32	6	Soil, Bulk	Grave 6 soil, bottom 10 cm for pH	SUP	08/06/2015
PJMS-36-33	4	Soil, Bulk	Grave 4 soil, bottom 10 cm for pH	JJT	08/07/2015
PJMS-36-34	10	Soil, Bulk	Grave 10 soil, bottom 10 cm for pH	AHS	08/07/2015
PJMS-36-35	8	Soil, Bulk	Grave 8 soil, bottom 10 cm for pH	BZ	08/07/2015

SAMPLE	CONTEXT	TYPE	DESCRIPTION	ID	DATE
PJMS-36-36		Soil, Bulk	Grave with large headstones, previously numbered 13, soil pH upper 10 cm of grave fill	BZ	08/07/2015
PJMS-36-37	2	Soil, Bulk	Grave 2 soil, bottom 10 cm for pH	KRW	08/07/2015
PJMS-36-38	3	Soil, Bulk	Grave 3 soil sample from stomach area	LMJ	07/31/2015
PJMS-36-39	3	Soil, Bulk	Grave 3 soil from chest area	LMJ	07/31/2015
PJMS-36-40	4	Wood	Grave 4 large pieces of wood from coffin	JJT	08/07/2015
PJMS-36-41	7	Wood	Grave 7 wood from coffin (3 pieces)	MHH	08/06/2015
PJMS-36-42	6	Wood	Grave 6 small wood fragments from coffin	AMB	07/31/2015
PJMS-36-43	7	Wood	Grave 7 small wood fragments from coffin	MHH	08/06/2015
PJMS-36-44	14	Wood	Grave 14 wood fragments from coffin	AMB	08/05/2015
PJMS-36-45	7	Wood	Grave 7 wood fragments from coffin	MHH	08/06/2015
PJMS-36-46	6	Wood	Grave 6 wood fragments from coffin	AMB	08/03/2015
PJMS-36-47	5	Wood	Grave 5 wood fragments from coffin	SUP	07/31/2015
PJMS-36-48	14	Wood	Grave 14 wood fragments from coffin	AMB	08/03/2015
PJMS-36-49	7	Wood	Grave 7 wood and nail	MHH	07/31/2015
PJMS-36-50	7	Wood	Grave 7 wood and nail	MHH	07/31/2015
PJMS-36-51	7	Wood	Grave 7 wood and nail	MHH	07/31/2015
PJMS-36-52	7	Wood	Grave 7 wood and nail	MHH	08/03/2015
PJMS-36-53	7	Wood	Grave 7 nail and wood from coffin	MHH	08/03/2015
PJMS-36-54	7	Wood	Grave 7 nail and wood from coffin	MHH	08/03/2015
PJMS-36-55	7	Wood	Grave 7 nail and wood from coffin	MHH	08/03/2015
PJMS-36-56	7	Metal	Grave 7 nail	MHH	08/10/2015
PJMS-36-57	7	Metal	Grave 7 nails and wood (8 pieces)	MHH	08/04/2015
PJMS-36-58	7	Metal	Grave 7 nail from under the head of body	MHH	08/04/2015
PJMS-36-59	7	Metal	Grave 7 nails (5 pieces)	MHH	08/04/2015
PJMS-36-60	14	Wood	Grave 14 wood fragments	AMB	08/07/2015
PJMS-36-61	2	Wood	Grave 2 large pieces of wood	KRW	08/07/2015
PJMS-36-62	10	Wood	Grave 10 tiny fragments of wood	AHS	08/04/2015
PJMS-36-63	121	Metal	Context 121 one nail	SUP	08/03/2015
PJMS-36-64	14	Soil, Bulk	Grave 14 soil, bottom 10 cm for pH	AMB	08/11/2015
PJMS-36-65	12	Soil, Bulk	Grave 12 soil, bottom 10 cm for pH	KRW	08/11/2015
PJMS-36-66	12	Soil, Bulk	Grave 12 soil, abdominal area	KRW	08/11/2015
PJMS-36-67	12	Soil, Bulk	Grave 12 soil, pelvic area	KRW	08/11/2015
PJMS-36-68	1	Soil, Bulk	Grave 1 soil, bottom 10 cm for pH	GZ	08/13/2015

Appendix E: Photographic registers

Site and context photos

Photo #	Context	Date	ID	Description	Facing	Folder	Hyperlink
697	TP3	7/15/2015	GSS	Test pit 3	W	EOS	EOS\IMG_0697.JPG
699	TP3	7/15/2015	GSS	Test pit 3	S	EOS	EOS\IMG_0699.JPG
700	TP3	7/15/2015	GSS	Test pit 3	NE	EOS	EOS\IMG_0700.JPG
701		7/15/2015	GZ	H1300 level on top of sw cemetery wall	W	EOS	EOS\IMG_0701.JPG
708	TP3	7/15/2015	GSS	Test pit 3	W	EOS	EOS\IMG_0708.JPG
712	TP3	7/15/2015	GSS	Test pit 3	S	EOS	EOS\IMG_0712.JPG
716	TP3	7/15/2015	GSS	Test pit 3	N	EOS	EOS\IMG_0716.JPG
718	TP3	7/15/2015	GSS	Test pit 3	W	EOS	EOS\IMG_0718.JPG
720	TP3	7/15/2015	GSS	Test pit 3	Above	EOS	EOS\IMG_0720.JPG
721	TP3	7/15/2015	GSS	Test pit 3	W	EOS	EOS\IMG_0721.JPG
728		7/16/2015	GZ	Overview	E	EOS	EOS\IMG_0728.JPG
729		7/16/2015	GZ	Overview	SE	EOS	EOS\IMG_0729.JPG
730	105	7/17/2015		Overview of context [105]		EOS	EOS\IMG_0730.JPG
732	G3	7/17/2015		Grave 3 on the surface	W	EOS	EOS\IMG_0732.JPG
734	G5	7/17/2015		Grave 3 on the surface	W	EOS	EOS\IMG_0734.JPG
737	G6	7/17/2015		Grave 3 on the surface	W	EOS	EOS\IMG_0737.JPG
746		7/17/2015		Overview	E	EOS	EOS\IMG_0746.JPG
747		7/21/2015		Overview	E	EOS	EOS\IMG_0747.JPG
748		7/21/2015		Overview	SE	EOS	EOS\IMG_0748.JPG
749		7/21/2015		Overview	SE	EOS	EOS\IMG_0749.JPG
750		7/22/2015		Electric trench section - south end	W	EOS	EOS\IMG_0750.JPG
751		7/22/2015		Electric trench section - north end	W	EOS	EOS\IMG_0751.JPG
752		7/22/2015		Electric trench section - north end	W	EOS	EOS\IMG_0752.JPG
753		7/22/2015		Electric trench section - north end	W	EOS	EOS\IMG_0753.JPG
754		7/22/2015		Electric trench section - north end	W	EOS	EOS\IMG_0754.JPG
755		7/22/2015		Electric trench - southern corner	W	EOS	EOS\IMG_0755.JPG
757		7/22/2015		Overview of southern half of cemetery	E	EOS	EOS\IMG_0757.JPG
758		7/22/2015		Overview of southern half of cemetery	E	EOS	EOS\IMG_0758.JPG
761		7/22/2015		Overview of electric trench when cleaning	W	EOS	EOS\IMG_0761.JPG
762		7/22/2015		Overview of electric trench when cleaning	W	EOS	EOS\IMG_0762.JPG
763		7/22/2015		Grave 4 on the surface of H1105	W	EOS	EOS\IMG_0763.JPG
764	[110]	7/23/2015		Overview of southern half of cemetery	E	EOS	EOS\IMG_0764.JPG
765	[110]	7/23/2015		Overview of southern half of cemetery	E	EOS	EOS\IMG_0765.JPG
766	[110]	7/23/2015	GZ	Work photo	S	EOS	EOS\IMG_0766.JPG
769	[111]	7/23/2015	DJB	Context [111]	W	EOS	EOS\IMG_0769.JPG
772	[111]	7/23/2015	DJB	Context [111]	S	EOS	EOS\IMG_0772.JPG
773	[111]	7/23/2015	DJB	Context [111]	E	EOS	EOS\IMG_0772.JPG
775	[110]	7/23/2015	GZ	Burnt timber on H1104 under context [110]	E	EOS	EOS\IMG_0775.JPG
776	[110]	7/23/2015	GZ	Burnt timber on H1104 under context [110]	NE	EOS	EOS\IMG_0776.JPG
778	[110]	7/23/2015	GZ	Burnt timber on H1104 under context [110]	Above	EOS	EOS\IMG_0778.JPG
780		7/24/2015	GZ	Overview	SW	EOS	EOS\IMG_0780.JPG
786	[112]	7/24/2015	DJB	Cooking pit with animal bones on walkway		EOS	EOS\IMG_0786.JPG
788	G5/6/14	7/24/2015	GZ	Infant graves 5-7	W	EOS	EOS\IMG_0788.JPG

Photo #	Context	Date	ID	Description	Facing	Folder	Hyperlink
789	G5/6/14	7/24/2015	GZ	Infant graves 5-7	SE	EOS	EOS\IMG_0789.JPG
790	G5/6/14	7/24/2015	GZ	Infant graves 5-7	W	EOS	EOS\IMG_0790.JPG
796		7/24/2015	GZ	Grave 4 on the surface of H1104	E	EOS	EOS\IMG_0796.JPG
799		7/24/2015	GZ	Overview	SE	EOS	EOS\IMG_0799.JPG
800		7/24/2015	GZ	Overview	E	EOS	EOS\IMG_0800.JPG
801		7/24/2015	GZ	Overview	SW	EOS	EOS\IMG_0801.JPG
804	[110]	7/25/2015	GZ	Context [110] where it meets the uneven ground covered by H1104	E	EOS	EOS\IMG_0804.JPG
807	[110]	7/25/2015		Context [110] where it meets the uneven ground covered by H1104	E	EOS	EOS\IMG_0807.JPG
808		7/25/2015	GZ	Work photo	S	EOS	EOS\IMG_0808.JPG
809	1104	7/25/2015	GZ	Work photo/1104 tephra	E	EOS	EOS\IMG_0809.JPG
810		7/25/2015	GZ	Work photo	E	EOS	EOS\IMG_0810.JPG
	Sample			Sample of wood at the H1104 - [110]			
811	3	7/25/2015	GZ	interface	Above	EOS	EOS\IMG_0811.JPG
813	G3	7/25/2015	GZ	Grave 3 - cut through [110] and H1104	W	EOS	EOS\IMG_0813.JPG
815		7/25/2015	GZ	Overview	SE	EOS	EOS\IMG_0815.JPG
816		7/25/2015	GZ	Overview	SE	EOS	EOS\IMG_0816.JPG
817		7/25/2015	GZ	Overview	E	EOS	EOS\IMG_0817.JPG
818		7/25/2015	GZ	Overview	SE	EOS	EOS\IMG_0818.JPG
819	G3	7/25/2015	GZ	Grave 3 at H1104 level	W	EOS	EOS\IMG_0819.JPG
820	115	7/25/2015	GZ	Context 115	W	EOS	EOS\IMG_0820.JPG
821	115	7/25/2015	GZ	Context 115	S	EOS	EOS\IMG_0821.JPG
823	110	7/27/2015	GZ	Grave 3 in context [110] section	E	EOS	EOS\IMG_0823.JPG
825	110	7/27/2015	GZ	Grave 3 in context [110] section	E	EOS	EOS\IMG_0825.JPG
826		7/27/2015	DJB	Key found at the bottom of layer [110]	W	EOS	EOS\IMG_0826.JPG
829		7/27/2015	DJB	Key found at the bottom of layer [110]	W	EOS	EOS\IMG_0829.JPG
835		7/27/2015	DJB	Key found at the bottom of layer [110]	E	EOS	EOS\IMG_0835.JPG
851		7/27/2015	DJB	Key found at the bottom of layer [110]	Above	EOS	EOS\IMG_0851.JPG
856	[115]	7/27/2015	AHS	Excavated area of context [115]	W	EOS	EOS\IMG_0856.JPG
857	[115]	7/27/2015	AHS	Excavated area of context [115]	W	EOS	EOS\IMG_0857.JPG
858	[115]	7/27/2015	AHS	Excavated area of context [115]	N	EOS	EOS\IMG_0858.JPG
859	[115]	7/27/2015	AHS	Excavated area of context [115]	N	EOS	EOS\IMG_0859.JPG
860	[115]	7/27/2015	AHS	Excavated area of context [115]	N	EOS	EOS\IMG_0860.JPG
861		7/27/2015	DJB	Overview of church	E	EOS	EOS\IMG_0861.JPG
862	[114]	7/28/2015	AMB	Context [114]	N	EOS	EOS\IMG_0862.JPG
865	[116]	7/28/2015	AMB	Context [116]	N	EOS	EOS\IMG_0865.JPG
867	[116]	7/28/2015	AMB	Context [116]	N	EOS	EOS\IMG_0867.JPG
868	G 8	7/28/2015	BZ	Grave 8 on the surface	W	EOS	EOS\IMG_0868.JPG
870	G8	7/28/2015	BZ	Grave 8 on the surface	W	EOS	EOS\IMG_0870.JPG
873	G5/6	7/29/2015	JST	Graves 5-6 - visible in H1104	W	EOS	EOS\IMG_0873.JPG
874	G3	7/29/2015	LMS	Grave 3 - grave fill	N	EOS	EOS\IMG_0874.JPG
876	[121]	7/29/2015	AMB	Graves 5-6 - on the surface of [121]	W	EOS	EOS\IMG_0876.JPG
880	[121]	7/29/2015	AMB	Graves 5-6 - on the surface of [121]	N	EOS	EOS\IMG_0880.JPG
881	[121]	7/29/2015	AMB	Graves 5-6 - on the surface of [121]	W	EOS	EOS\IMG_0881.JPG
	Graves						
883	1/2	7/30/2015	PAH	Graves 1-2 on he surface	Above	EOS	EOS\IMG_0883.JPG
884	G1/2	7/30/2015	PAH	Graves 1-2 on he surface	Above	EOS	EOS\IMG_0884.JPG
886	G3	7/30/2015	LMS	Grave 3 - grave fill	Above	EOS	EOS\IMG_0886.JPG
888	G7/9	7/30/2015	MHH	Graves 7/9 at surface level	W	EOS	EOS\IMG_0888.JPG
889	G7/9	7/30/2015	MHH	Graves 7/9 at surface level	W	EOS	EOS\IMG_0889.JPG
890	G7/9	7/30/2015	MHH	Graves 7/9 at surface level	W	EOS	EOS\IMG_0890.JPG
891	G7/9	7/30/2015	MHH	Graves 7/9 at surface level	W	EOS	EOS\IMG_0891.JPG

Photo #	Context	Date	ID	Description	Facing	Folder	Hyperlink
894		7/30/2015	GZ	Work photos	N	EOS	EOS\IMG_0894.JPG
895		7/30/2015	GZ	Work photos	E	EOS	EOS\IMG_0895.JPG
896		7/30/2015	GZ	Graves in northern part of cemetery	E	EOS	EOS\IMG_0896.JPG
897	G8	7/30/2015	BZ	Grave 8 - on surface	W	EOS	EOS\IMG_0897.JPG
898	G8	7/30/2015	BZ	Grave 8 - on surface	W	EOS	EOS\IMG_0898.JPG
900	G8	7/30/2015	BZ	Grave 8 - top of gravefill	W	EOS	EOS\IMG_0900.JPG
901	G8	7/30/2015	BZ	Grave 8 - top of gravefill	W	EOS	EOS\IMG_0901.JPG
902	G3	7/30/2015	JMS	Grave 3 - grave fill	S	EOS	EOS\IMG_0902.JPG
905		7/30/2015	DJB	Section in southern cemetery wall	W	EOS	EOS\IMG_0905.JPG
906		7/30/2015	DJB	Section in southern cemetery wall	W	EOS	EOS\IMG_0906.JPG
908	G 7/8	7/30/2015	MHH	Grave 7/9 stone in fill east end of grave	Above	EOS	EOS\IMG_0908.JPG
910	G4	7/30/2015	JST	Grave 4 - stones in grave fill	Above	EOS	EOS\IMG_0910.JPG
911	G4	7/30/2015	JST	Grave 4 - stones in grave fill		EOS	EOS\IMG_0911.JPG
920	G8	7/31/2015		Grave 8 - half excavated	W	EOS	EOS\IMG_0920.JPG
921	G8	7/31/2015		Grave 8 - half excavated	Above	EOS	EOS\IMG_0921.JPG
923	G1-2	7/31/2015		Graves 1-2 on he surface	S	EOS	EOS\IMG_0923.JPG
924	G1-2	7/31/2015		Graves 1-2 on he surface	Above	EOS	EOS\IMG_0924.JPG
925	G5	7/31/2015		Grave 5 on the surface	W	EOS	EOS\IMG_0925.JPG
928	G 3	7/31/2015	LMS	Grave3 - at skeleton level	E	EOS	EOS\IMG_0928.JPG
934	G3	7/31/2015	LMS	Grave3 - at skeleton level	W	EOS	EOS\IMG_0934.JPG
939	G3	7/31/2015		Grave 3 - skull and stone in fill	W	EOS	EOS\IMG_0939.JPG
941	G1/2	7/31/2015	PAH	Graves 1-2 on he surface	N	EOS	EOS\IMG_0941.JPG
942	G1/2	7/31/2015	PAH	Graves 1, 2 and 13on he surface	E	EOS	EOS\IMG_0942.JPG
943	G1/2	7/31/2015	PAH	Graves 1-2 on he surface	S	EOS	EOS\IMG_0943.JPG
944	G1/2	7/31/2015	PAH	Graves 1-2 on he surface	W	EOS	EOS\IMG_0944.JPG
946	G6	7/31/2015	AMB	Grave 6 - rave fill	Above	EOS	EOS\IMG_0946.JPG
947	G6	7/31/2015	AMB	Grave - 6 Grave fill	E	EOS	EOS\IMG_0947.JPG
949	G5	7/31/2015	SUP	Grave 5 - at skeleton level	Above	EOS	EOS\IMG_0949.JPG
950	G5	7/31/2015	SUP	Grave 5 - at skeleton level	Above	EOS	EOS\IMG_0950.JPG
951	G5	7/31/2015	SUP	Grave 5 - at skeleton level	Above	EOS	EOS\IMG_0951.JPG
952	G7	7/31/2015	GZ	Lady in grave 7	W	EOS	EOS\IMG_0952.JPG
954	G8	7/31/2015	BZ	Grave 8 - grave fill	W	EOS	EOS\IMG_0954.JPG
955	G8	7/31/2015	BZ	Grave 8 - grave fill	S	EOS	EOS\IMG_0955.JPG
957	G8	7/31/2015	BZ	Grave 8 - grave fill	W	EOS	EOS\IMG_0957.JPG
958	G3	7/31/2015	LMS	Grave 3 - skeleton half cleaned	W	EOS	EOS\IMG_0958.JPG
960	G3	7/31/2015	LMS	Grave 3 - skeleton half cleaned	S	EOS	EOS\IMG_0960.JPG
963	G3	7/31/2015	LMS	Grave 3 - skeleton half cleaned	W	EOS	EOS\IMG_0963.JPG
966	G5	8/4/2015	SUP	Grave 5 - skeleton level	Above	EOS	EOS\IMG_0966.JPG
967	G5	8/4/2015	SUP	Grave 5 - skeleton level	Above	EOS	EOS\IMG_0967.JPG
968	G5	8/4/2015	SUP	Grave 5 - skeleton level	Above	EOS	EOS\IMG_0968.JPG
969	G5	8/4/2015	SUP	Grave 5 - skeleton level	Above	EOS	EOS\IMG_0969.JPG
971		8/4/2015	GZ	Work photo	NW	EOS	EOS\IMG_0971.JPG
972	G3	8/4/2015	LMJ	Grave 3 - skeleton	W	EOS	EOS\IMG_0972.JPG
973	G3	8/4/2015	LMJ	Grave 3 - skeleton	N	EOS	EOS\IMG_0973.JPG
975	G3	8/4/2015	LMJ	Grave 3 close up of skull w/ stone in left orbital	N	EOS	EOS\IMG_0975.JPG
977	G6	8/4/2015	AMB	Grave 6 west end of G6 w/ rocks	W	EOS	EOS\IMG_0977.JPG
978	G6	8/4/2015	AMB	Grave 6 west end of G6 w/ rocks	Above	EOS	EOS\IMG_0978.JPG
979	G3	8/4/2015	LMJ	Grave 3 close up of skull without stone on left orbital		EOS	EOS\IMG_0979.JPG

Photo #	Context	Date	ID	Description	Facing	Folder	Hyperlink
981	G5	8/4/2015	SUP	Grave 5 - bottom. Bone from adult underneath baby skeleton	Above	EOS	EOS\IMG_0981.JPG
982	G5	8/4/2015	SUP	Grave 5 - bottom. Bone from adult underneath baby skeleton	Above	EOS	EOS\IMG_0982.JPG
984	G5	8/4/2015	SUP	Grave 5 - bottom. Bone from adult underneath baby skeleton	Above	EOS	EOS\IMG_0984.JPG
985	G6	8/4/2015	AMB	Grave 6. Surface West end. Above.	Above	EOS	EOS\IMG_0985.JPG
986	G6	8/4/2015	AMB	Grave 6. West end, skull + ribs	W	EOS	EOS\IMG_0986.JPG
987	G6	8/4/2015	AMB	Grave 6. West end. Skull+ribs	Above	EOS	EOS\IMG_0987.JPG
989	G6	8/4/2015	AMB	Grave 6. W end, skull+ribs	W	EOS	EOS\IMG_0989.JPG
991	G11	8/4/2015	PAH	Grave 11 - skeleton	N	EOS	EOS\IMG_0991.JPG
993	G11	8/4/2015	PAH	Grave 11 - skeleton	S	EOS	EOS\IMG_0993.JPG
994	G11	8/4/2015	PAH	Grave 11 - skeleton	W	EOS	EOS\IMG_0994.JPG
997	G11	8/4/2015	PAH	G11. Looking down on skelton (without N arrow)	N	EOS	EOS\IMG_0997.JPG
998	G7	8/4/2015	MH	Grave 7 - remains of wood from coffin "in situ"	S	EOS	EOS\IMG_0998.JPG
999	G7	8/4/2015	MH	Grave 7 - remains of wood from coffin "in situ", facing S	S	EOS	EOS\IMG_0999.JPG
1001	G6	8/4/2015	AMB	Grave 6 - coffin and humerus of an underlying burial	N	EOS	EOS\IMG_1001.JPG
1003	G6	8/4/2015	AMB	Grave 6 - coffin and humerus of an underlying burial	N	EOS	EOS\IMG_1003.JPG
1004	[123]	8/4/2015	DJB	[123] post-1104 turf wall, SW corner of church	S	EOS	EOS\IMG_1004.JPG
1005	[123]	8/4/2015	DJB	[123] post-1104 turf wall, SW corner of church	E	EOS	EOS\IMG_1005.JPG
1006	[123]	8/4/2015	DJB	[123] post-1104 turf wall, SW corner of church	N	EOS	EOS\IMG_1006.JPG
1008	[120]	8/4/2015	DJB	[120]	W	EOS	EOS\IMG_1008.JPG
1009	G6	8/4/2015	AMB	Grave 6 West end. Skull w/ left hand+femur (proximal).	Above	EOS	EOS\IMG_1009.JPG
1010	G6	8/4/2015	AMB	Grave 6 West end. Skull w/ left hand+femur (proximal).	Above	EOS	EOS\IMG_1010.JPG
1011	[120]	8/4/2015	DJB	Wood at sill in [120], down/west	Above	EOS	EOS\IMG_1011.JPG
1012	[120]	8/4/2015	DJB	Sample 27	Above	EOS	EOS\IMG_1012.JPG
1013	[120]	8/4/2015	DJB	Wood at sill in 120, close up	W	EOS	EOS\IMG_1016.JPG
1016	G8	8/5/2015	BZ	Grave 8 Above. Upper half of skeleton exposed.	Above	EOS	EOS\IMG_1016.JPG
1018	G10	8/5/2015	AHS	Grave 10 Above. First exposure of skull in NW corner wall.	W	EOS	EOS\IMG_1018.JPG
1020	G7	8/5/2015	MH	Grave 7 - Upper skeleton	W	EOS	EOS\IMG_1020.JPG
1024	G7	8/5/2015	MH	Grave 7 - skeleton	W	EOS	EOS\IMG_1024.JPG
1026	G7	8/5/2015	MH	Grave 7 - skeleton	W	EOS	EOS\IMG_1026.JPG
1028	G7	8/5/2015	MH	Grave 7 - Upper skeleton	W	EOS	EOS\IMG_1028.JPG
1029	G7	8/5/2015	MH	Grave 7 - lower skeleton	W	EOS	EOS\IMG_1029.JPG
1030	G6	8/5/2015	AMB	Grave 6. Above facing W. L+R femurs + upper skeleton	W	EOS	EOS\IMG_1030.JPG
1031	[127]	8/5/2015	DJB	Context [127]	W	EOS	EOS\IMG_1031.JPG
1032	[126]	8/5/2015	DJB	Context 126 on 125 turf threshold to church	W	EOS	EOS\IMG_1032.JPG
1033	[126]	8/5/2015	DJB	Context [126] on [125], church wall entrance in background	W	EOS	EOS\IMG_1033.JPG

Photo #	Context	Date	ID	Description	Facing	Folder	Hyperlink
1034	114	8/5/2015	SUP	Context 114, find #8. Small cut with stones.	Above	EOS	EOS\IMG 1034.JPG
1036	G8	8/5/2015	BZ	G8, facing W (w/n-arrow)	W	EOS	EOS\IMG 1036.JPG
1038	G8	8/5/2015	BZ	Grave 8, Above (facing S) (w/n-arrow)	S	EOS	EOS\IMG 1038.JPG
1041	G8	8/5/2015	BZ	Grave 8, Above (without N-arrow)	Above	EOS	EOS\IMG 1041.JPG
1043	G8	8/5/2015	BZ	Grave 8, Above (without N-arrow)	Above	EOS	EOS\IMG 1043.JPG
1044	G8	8/5/2015	BZ	Grave 8 (without N-arrow)	Above	EOS	EOS\IMG 1044.JPG
1045	G8	8/5/2015	BZ	Grave 8 (without N-arrow). Last pictures before the removal of skeleton	Above	EOS	EOS\IMG 1045.JPG
1046	G8	8/5/2015	BZ	Grave 8 (without N-arrow)	Above	EOS	EOS\IMG 1046.JPG
1047	G10	8/5/2015	AHS	Grave 10 Above, full skull	W	EOS	EOS\IMG 1047.JPG
1050	G7	8/5/2015	MH	S. side of G7. North side of coffin visible, arrow pointing at wood.	Above	EOS	EOS\IMG 1050.JPG
1051	G7	8/5/2015	MH	Side wood remains of coffin.	Above	EOS	EOS\IMG 1051.JPG
1052	G7	8/5/2015	MH	Side mark of coffin.	Above	EOS	EOS\IMG 1052.JPG
1057	G7	8/6/2015	MH	N. Side wood after coffin.	Above	EOS	EOS\IMG 1057.JPG
1060	G9	8/6/2015	MH	Thin wall between Grave 7 and G9, facing S.			
1063	G9	8/6/2015	MH	Showing thin line between G7 and G9.	E	EOS	EOS\IMG 1063.JPG
1064	G9	8/6/2015	MH	Showing thin line between G7 and G9.	Above	EOS	EOS\IMG 1064.JPG
1065	G10	8/7/2015	AHS	Photo of G10 Above with hands exposed	W	EOS	EOS\IMG 1065.JPG
1066	G10	8/7/2015	AHS	Photo of G10 Above with hands exposed	Above	EOS	EOS\IMG 1166.JPG
1068		8/7/2015	BZ	Outlines of 2 graves in the SE part of cemetery	S	EOS	EOS\IMG 1068.JPG
1069		8/7/2015	BZ	Outline of a grave (2 graves in line, this one is to the west)	S	EOS	EOS\IMG 1069.JPG
1070	G9/7	8/7/2015	MH	Coffin from G7	Above	EOS	EOS\IMG 1070.JPG
1071	G9/7	8/7/2015	MH	Coffin from G7	Above	EOS	EOS\IMG 1071.JPG
1072	G9	8/7/2015	MH	Glacial gravel on body in grave 9	Above	EOS	EOS\IMG 1072.JPG
1073	G9	8/7/2015	MH	Glacial gravel on body in grave 9	Above	EOS	EOS\IMG 1073.JPG
1074	G1+2+?	8/7/2015	PAH	Grave 2, skeleton exposed, left side of grave 12 visible	W	EOS	EOS\IMG 1074.JPG
1078	G1+2+?	8/7/2015	PAH	Grave 2, skeleton exposed	N	EOS	EOS\IMG 1078.JPG
1079	G2	8/7/2015	PAH	Grave 2, skeleton exposed, left side of grave 12 visible (w/o N-arrow)	W	EOS	EOS\IMG 1079.JPG
1082	G2	8/7/2015	PAH	Grave 2, skeleton exposed, left side of grave 12 visible (w/o N-arrow)	S	EOS	EOS\IMG 1082.JPG
1083	G2	8/7/2015	PAH	Grave 2 - skeleton (w/o N-arrow)	N	EOS	EOS\IMG 1083.JPG
1084	G1,2+?	8/7/2015	PAH	Grave 2 - skeleton (w/o N-arrow)	N	EOS	EOS\IMG 1084.JPG
1085	G15	8/7/2015	MH	Head end of grave 15, left unexcavated at end of season	W	EOS	EOS\IMG 1085.JPG
1086	G1+14	8/7/2015	PAH	Grave 14 (left) + 1 (right), infant dug into grave 1	W	EOS	EOS\IMG 1086.JPG
1089	G13	8/9/2015	BZ	Grave 15, gravefill - ca. 10 cm depth	W	EOS	EOS\IMG 1089.JPG
1090	G13	8/10/2015	BZ	Grave 15, gravefill, ca. 10 cm depth	Above	EOS	EOS\IMG 1090.JPG
1091	G13	8/11/2015	BZ	Grave 15, gravefill, ca. 10 cm depth	W	EOS	EOS\IMG 1091.JPG
1096	G14	8/16/2015	AMB	Grave 14 - Infant skull (Knife=N)	W	EOS	EOS\IMG 1096.JPG
1097	G14	8/17/2015	AMB	Grave 14 - Infant Skull, ribs, verts	W	EOS	EOS\IMG 1097.JPG
1099	G12/13	11.08.2015	KRW	West profiles of graves 11 and 15	W	EOS	EOS\IMG 1099.JPG
1101	G9	11.08.2015	KRW	West profiles of graves 11 and 15	W	EOS	EOS\IMG 1101.JPG
1102	G9	11.08.2015	KRW	West profiles of graves 11 and 15	W	EOS	EOS\IMG 1102.JPG
1103	G9	11.08.2015	KRW	West profiles of graves 11 and 15	W	EOS	EOS\IMG 1103.JPG
1105	G9	11.08.2015	KRW	West profiles of graves 11 and 15	W	EOS	EOS\IMG 1105.JPG

Photo #	Context	Date	ID	Description	Facing	Folder	Hyperlink
				West wall in grave 4 showing exhumation and inhumation cuts in			
1106	G4	11.08.2015	JJT	grave 4	W	EOS	EOS\IMG 1006.JPG
1107	G4	11.08.2015	JJT	Close up of inhumation cut in grave 4	W	EOS	EOS\IMG 1107.JPG
1111	G14	11.08.2015	AMB	Grave 14 Above	W	EOS	EOS\IMG 1111.JPG
1113	G14	11.08.2015	AMB	Grave 14 Above	W	EOS	EOS\IMG 1113.JPG
1114	G14	11.08.2015	AMB	Grave 14 Above	W	EOS	EOS\IMG 1114.JPG
1116	G12	11.08.2015	KRW	Hand position in grave 12	Above	EOS	EOS\IMG 1116.JPG
1117	G4	11.08.2015	JJT	Grave 4 - west wall after final cleaning	W	EOS	EOS\IMG 1117.JPG
1118	G4	11.08.2015	JJT	Grave 4 - west wall after final cleaning	W	EOS	EOS\IMG 1118.JPG
1119	G4	11.08.2015	JJT	Grave 4 - west wall after final cleaning	W	EOS	EOS\IMG 1119.JPG
1120	G4	11.08.2015	JJT	Grave 4 - west wall after final cleaning	W	EOS	EOS\IMG 1120.JPG
1121	G4	11.08.2015	JJT	Grave 4 - west wall after final cleaning - delete	W	EOS	EOS\IMG 1121.JPG
1124	G12	11.08.2015	KRW	Overview of skeleton in grave 12	W	EOS	EOS\IMG 1125.JPG
1125	G12	11.08.2015	KRW	Overview of skeleton in grave 12	W	EOS	EOS\IMG 1125.JPG
1148	G1	8/13/2015	GZ	Grave 1 with coffin	W	EOS	EOS\IMG 1148.JPG
1150	G1	8/13/2015	GZ	Grave 1 with coffin	W	EOS	EOS\IMG 1150.JPG
1153	G1	8/13/2015	GZ	Grave 1 with coffin	W	EOS	EOS\IMG 1153.JPG
1154	G1	8/13/2015	GZ	Grave 1 with coffin	W	EOS	EOS\IMG 1154.JPG
1160	G1	8/13/2015	GZ	Grave 1 with coffin	W	EOS	EOS\IMG 1160.JPG
1165	G1	8/13/2015	GZ	Grave 1 with coffin	W	EOS	EOS\IMG 1165.JPG
1166	G1	8/13/2015	GZ	Grave 1 with coffin	W	EOS	EOS\IMG 1166.JPG
1166	G1	8/13/2015	GZ	Grave 1 with coffin	W	EOS	EOS\IMG 1166.JPG
1168	[118]	8/13/2015	DJB	Context [118] post 1104, turf in situ next to [134]	E	EOS	EOS\IMG 1168.JPG
1169	[118]	8/13/2015	DJB	Context [118] post 1104, turf in situ next to [134]	E	EOS	EOS\IMG 1169.JPG
1170		8/13/2015	DJB	Turf wall at the east gable of pre 1104 church	W	EOS	EOS\IMG 1170.JPG
1171	G1	8/13/2015	GZ	Grave 1 - skeleton after top of coffin was removed	W	EOS	EOS\IMG 1171.JPG
1172	G1	8/13/2015	GZ	Grave 1 with skeleton and graves 12 and 2 removed	W	EOS	EOS\IMG 1172.JPG
1173	G1	8/13/2015	GZ	Grave 1 with skeleton and graves 12 and 2 removed	W	EOS	EOS\IMG 1173.JPG
1175	G1	8/13/2015	GZ	Grave 1 - skeleton	S	EOS	EOS\IMG 1175.JPG
1178	G1	8/13/2015	GZ	Grave 1 - close up of skeleton with soot on ribs	W	EOS	EOS\IMG 1178.JPG
1181	G1	8/13/2015	GZ	Skeleton in grave 1, skull and ribs	SW	EOS	EOS\IMG 1181.JPG
1182	G1	8/13/2015	GZ	Skeleton in grave 1, skull and ribs	SW	EOS	EOS\IMG 1182.JPG
1184	G1	8/13/2015	GZ	Grave 1 - head end of coffin after removal of skeleton	SW	EOS	EOS\IMG 1182.JPG
1186	G1	8/13/2015	GZ	Grave 1 - head end of coffin after removal of skeleton	W	EOS	EOS\IMG 1186.JPG
1188	G1	8/13/2015	GZ	Grave 1 - overview of coffin and humerus from grave 12	W	EOS	EOS\IMG 1188.JPG

Kite photos for photogrammetry

Date	Camera	Base	Conditions	Photo Range	GCPs	Notes
07/25/2015	Ricoh GR	Fled	Low wind, clear	4996-5423	GPS plates	Overview of cemetery, H1104 partially exposed
07/28/2015	Ricoh GR	Flow Form 16	Clear, bright, windy	6432-6818	GPS plates	Overview of cemetery w 1104 exposed
08/11/2015	Ricoh GR	Fled	Low and rising wind, mostly cloudy	9207-9621	GPS plates	Overview of cemetery at end of excavation

Pole Photos for Photogrammetry

Date	Camera	Description	Photo Range	GCPs	GCP Names
07/17/2015	Nikon Coolpix A	H1104 and wall	1402-1465	Poker chips	Pole chip 1-3
07/18/2015	Nikon Coolpix A	Cemetery	3282-3331	None	
07/24/2015	Nikon Coolpix A	Grave 3 top	1473-1512	Poker chips	Grave 3 GCPCHIP 1-4
07/24/2015	Nikon Coolpix A	Grave 4 top	1583-1654	Poker chips	Grave 4 GCPC 1-10
07/24/2015	Nikon Coolpix A	Graves 5, 6 & 14 top	1517-1568	Poker chips	Graves 5-7 GCPC 1-4
07/27/2015	Nikon Coolpix A	Key	1658-1676	Poker chips	C110 KEY 1-3
07/27/2015	Nikon Coolpix A	Wood on sill in church	1677-1773	Poker chips	C113 SILL GCPCHIP 1-8
07/28/2015	Nikon Coolpix A	Context 119	1839-1903	Poker chips	C119 GCPCHIP 1-7
07/28/2015	Nikon Coolpix A	Grave 8	1782-1832	Poker chips	GRAVE 8 GCPCHIP1-4
07/30/2015	Nikon Coolpix A	Graves 5-6	1915-1948	Poker chips	GRAVE 5-6 GCPCHIPS2 1-4
07/30/2015	Nikon Coolpix A	Graves 7-9	1958-2031	Poker chips	GRAVE 7+9 GCPCHIP 1-4
07/30/2015	Nikon Coolpix A	Graves 1-2	2041-2128	Poker chips	GRAVE 1+2 GCPCHIP 1-4
07/31/2015	Nikon Coolpix A	Graves 1,2,11	2137-2218	Poker chips	GRAVE 1+2+11 GCPCHIP 1-4
07/31/2015	Nikon Coolpix A	Grave 5	2228-2286	Poker chips	GR 5 GCPCHIP 1-6
07/31/2015	Nikon Coolpix A	Various graves	2295-2342	None	
08/03/2015	Nikon Coolpix A	Grave 11 skeleton	2504-2550	Poker chips	GRAVE 11 GCPS 1-4
08/04/2015	Nikon Coolpix A	Grave 7 skeleton	2551-2592	Poker chips	GR 7 GCPCHIP 1-3
08/04/2015	Nikon Coolpix A	Grave 8 skeleton	2593-2624	Poker chips	GRAVE 8 GCP 1-3
08/04/2015	Nikon Coolpix A	Grave 6 skeleton	2625-2644	Poker chips	GRAVE 6 GCP 1-3
08/06/2015	Nikon Coolpix A	Grave 13 top	2652-2673	Poker chips	GR13 GCP 1-4
08/06/2015	Nikon Coolpix A	Grave 4 bottom	2678-2688	Poker chips	GR 4 GCP 1-4
08/06/2015	Nikon Coolpix A	Church western gable	2693-2711	Poker chips	C126_127 GCP 1-4
08/07/2015	Nikon Coolpix A	Grave 10 skeleton	2717-2743	Poker chips	GRAVE 10 GCP 1-4
08/07/2015	Nikon Coolpix A	Grave 2 skeleton	2747-2785	Poker chips	GR 2 GPC 1-3
08/07/2015	Nikon Coolpix A	Cemetery entrance pavement	2789-2809	Poker chips	C129 GPC 1-5
08/11/2015	Nikon Coolpix A	Grave 14 skeleton	2812-2833	Poker chips	GR 14 BOT GCP 1-3
08/11/2015	Nikon Coolpix A	Grave 4 bottom	2842-2866	Poker chips	GR4 BOT GCP 1-4
08/11/2015	Nikon Coolpix A	Grave 12 Skeleton	2880-2927	Poker chips	GR12 GCP1-4
08/11/2015	Nikon Coolpix A	Church	2930-3002	Poker chips	CHURCH GCP 110815 1-8
08/12/2015	Nikon Coolpix A	Grave 1 skeleton in coffin	3032-3050	Poker chips	GR 1 GCP 1-4
08/13/2015	Nikon Coolpix A	Grave 1 skeleton	3054-3084	Poker chips	GCP GRAVE 1 SKEL 1-3
08/03/2105	Nikon Coolpix A	Grave 3 skeleton	2390-2467	Poker chips	GRAVE3 GCP 1-4
08/03/2105	Nikon Coolpix A	Context 125 and 126	2468-2500	Poker chips	C125 GCPS 1-4

Appendix G: Preliminary Results of Ground-Penetrating Radar Survey over the Cemetery at the Keflavík Farm

December 2015

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1.0 Introduction

As part of the 2015 field season, a ground-penetrating radar (GPR) survey was conducted over the cemetery at the Keflavík farm. The primary objectives were to delineate the outer boundary of the cemetery and to detect unmarked burials within its confines. The use of GPR to detect unmarked burials and clandestine graves has been reported widely in the archaeological, forensic sciences, and geophysical literature (e.g., Bevan 1991; Buck 2003; Conyers 2006; Schultz 2007; Ruffell et al. 2009; Fiedler et al. 2009; Doolittle & Bellantoni 2010; Goodman et al. 2007), and has been successfully applied previously at the nearby Stóra Seyla farm (Damiata et al., 2013).

As to whether a burial is detectable by GPR depends on various factors. In particular, a measureable contrast in the geophysical (electromagnetic) property of relative permittivity must exist between the combined elements of a burial and the surrounding naturally compacted soil. The elements of a burial that determine its relative permittivity include: (1) soil moisture content, (2) ground disturbance caused by digging and filling the grave shaft which homogenizes the backfill soil and introduces small air voids into it, (2) skeletal remains, (3) grave goods of sufficient size, if present, and (4) container such as a shroud, vault, coffin or casket, if any. In some instances, a measureable contrast may not exist even though a burial is present. For these cases, the contrast between burial elements and the surrounding undisturbed soil was either insufficient initially or had diminished with time because of, for example, the disintegration of skeletal remains by natural decomposition or through

interaction with the local environment. Based on previous efforts at the nearby Stóra Seyla farm, the ground conditions seem particularly suited for the detection of skeletal remains by using GPR. Summarized below are the field procedures, data analysis and results of the GPR survey that was conducted over the cemetery at the Keflavík farm.

2.0 Field Procedures

The survey was performed using a Malå X3M radar system that was equipped with a 500 MHz antenna. Data were collected along parallel contiguous transects that were separated by 0.2 m and using a vertical scan interval of approximately 0.02 m. The data collection was guided by stretching a fiberglass measuring tape between the endpoints of 1-m spaced transects. However, the actual location along a given transect was determined by using a calibrated wheel attached to the antenna. The survey was conducted in a uni-directional manner from south to north. In total, 116 radargrams (i.e., radar profiles collected along individual transects) were collected and 2434 linear meters were traversed for the survey. In general, high quality data were obtained and depths of interrogation exceeded 1.5 m.

3.0 Data Analysis

The data were processed using GPR-Slice software (see www.gpr-survey.com; Goodman, et al. 1995; Goodman, et al. 2008; Goodman, et al. 2007). The raw vertical scan data were gained, resampled and filtered (background removal and boxcar filters) to produce processed 2-D radargrams (radar profiles). On these radargrams, the presence of strong reflectors is indicated by a black-and-white banding pattern. Note that the raw data were collected in terms of the two-way travel time of reflected energy. To convert to a depth scale, a radar wave velocity of 0.065 m/ns was assumed based on standard curve matching of a few hyperbolic reflections that were identified in the data.

The processed radargrams were next combined to produce a pseudo three-dimensional (3-D) data set. A total of forty horizontal depth-slice images of approximately 0.15 m with 50% overlap were generated to provide detailed spatial information on the location and depth of reflectors (i.e., horizontal plan of strong reflectors at a specific interval of depth that combines data from all radargrams). Overlay depth images were then produced by combining (binning) depth-slice images. These overlay depth-slice images were then incorporated into the GIS database. Interpreting the radar data by using overlay depth-slice images was particularly useful in identifying the outer circular wall of the cemetery, as depicted in Figure 1.

The interpretation of graves relied more on the detailed analysis of individual radargrams. Specifically, the 2-D radargrams were collated and inspected in order to pick coherent and contiguous reflections—i.e., those reflections that are directly traceable from one radargram to adjacent radargrams, which could be consistent with buried features. Graves were identified if the traceable reflections met certain criteria, as discussed below. Figure 2 presents an example of interpreting radargrams; the complete series of the annotated radargrams is contained in the Appendix. Note that a color code has been adopted to help

facilitate comparison between the annotated radargrams and tabulated results. Summarized below are the results and discussion.

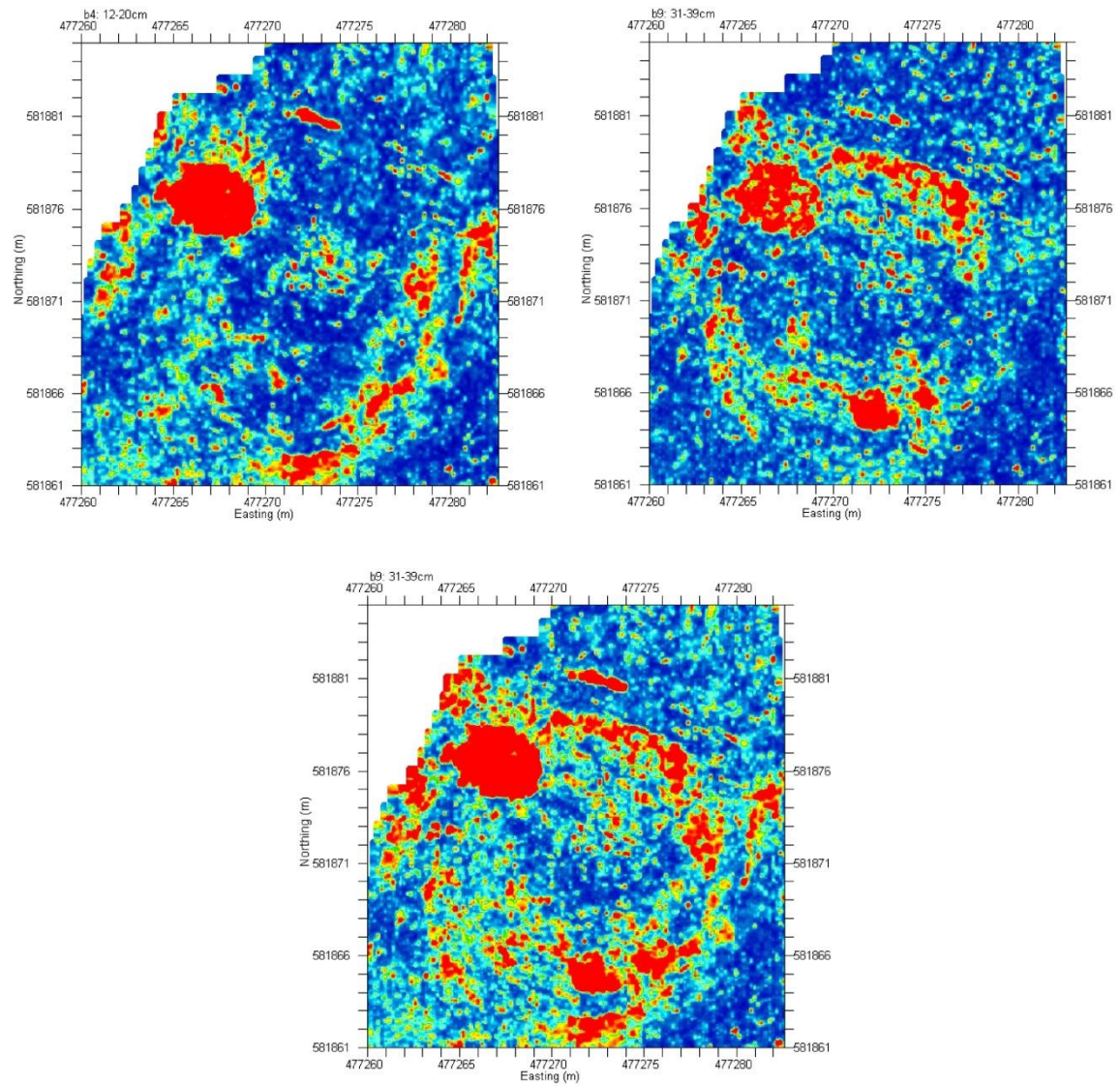


Figure 1. Overlay images highlighting the boundary wall of the cemetery. Upper Left: Overlay image for the depth interval 0 – 20 cm showing delineating the northwestern and southeastern sections of the wall. Upper Right: Overlay image for the depth interval 25 – 40 cm delineating the northeastern and southwestern sections of the wall. Lower: Overlay image 0 – 40 cm showing the entire wall.

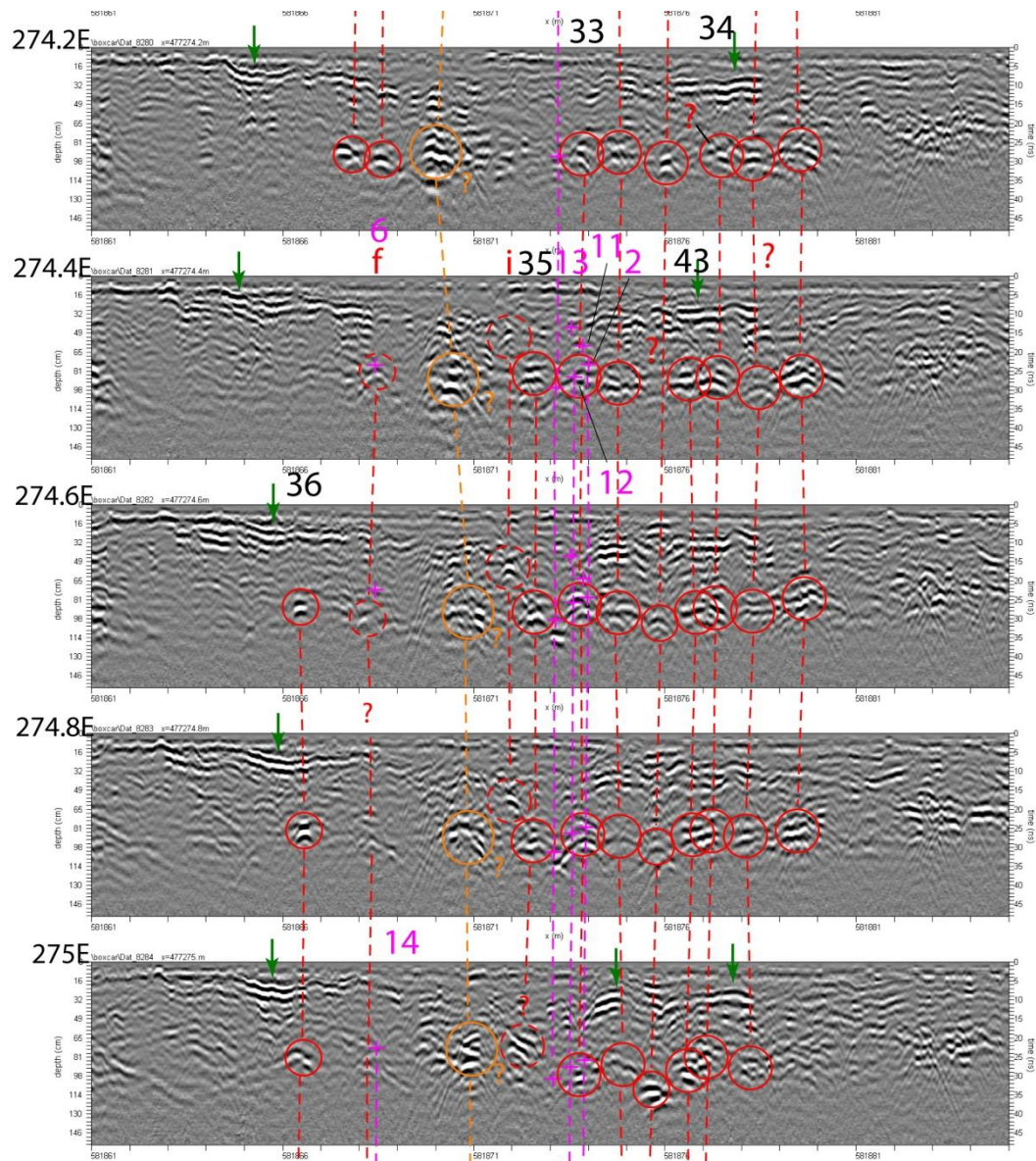


Figure 2. Representative annotated radargrams showing interpreted burials associated with radar reflections. Red solid circles denote probable grave with number being GPR Grave ID. Magenta crosses denote actual grave with number being the Excavation Grave ID. Orange solid circles denote location of buried electrical line. Green arrows indicated compacted turf layer.

4.0 Results and Discussion

Tables 1 and 2 summarize the interpretations of the radar data. A total 36 anomalies have been tentatively identified as probable graves (red solid circles, numeric GPR Grave ID in black), 9 more as possible graves (red dashed circles, numeric GPR Grave ID in red), and an additional 9 as possible infant (small children) graves (red dashed circles, lower-case letter GPR Grave ID in red). The locations of the interpretive burials are schematically illustrated in Figure 3.

The general criteria for the identification of an individual probable grave include: (1) the reflections typically occurred between the depths of 0.5 to 1 m, (2) the reflections are generally confined to within a relatively narrow depth range, typically spanning from 0.1 to 0.2 m, (3) the reflections were typically traceable for at least five radargrams (i.e., x m), (4) the orientation of the main axis of the reflections was approximately east-west., and (5) the general characteristics of the reflections were relatively similar for the most part. Traceable reflections that were interpreted as possible graves lacked one or more of the criteria. Traceable reflections that were interpreted as possible baby graves typically had lengths of 0.4 m (i.e., appeared on three radargrams or less) and at relatively shallow depths of <0.5m.

Note that there are some limitations and caveats to the interpretations. Firstly, closely-spaced graves are often difficult to individually distinguish, although indications of a grave(s) are clearly identifiable. As example in Figure 2, three graves were excavated (Excavation Grave IDs 2, 12 and 13, shown as magenta crosses) which was originally picked as single grave (GPR Grave ID 33). Upon further inspection, some of the radargrams but not all do indicate multiple reflections which would be consistent with more than one grave, but could also be interpreted as individual long bones from a single skeleton. The lack of resolution is attributed to the expanding footprint of the propagating radar wave which is cone-shaped, but which increases in diameter with increasing depth, thus yielding lower resolution of features. Secondly, there is nothing unique about distinguishing an infant grave from other type of features that produce point-source types of reflections, such as a rock. A point source typically refers to any feature whose dimensions are similar to or smaller than the wavelength of the GPR antenna. Thirdly, results of the excavation yielded a grave in the northern part of the cemetery (Excavation Grave ID 7). Initially, some linear features were interpreted in this part of the cemetery (see Appendix), including what turned out to be the grave. The reflections appear weak and inconsistent, and thus were not associated with graves. Further analysis of the radargrams is needed to identify what appear to be a few more graves.

Finally, a re-evaluation of the GPR data will be performed following the complete excavation and removal of graves from the cemetery at Keflavík. The direct comparison between recorded radar reflections to the mapped locations of skeletal remains and burial shafts will be invaluable for determining the resolving capabilities and limitations of GPR, which will provide an important contribution to the fields of archaeology and forensic science, in general, and for future studies in Iceland, in particular.

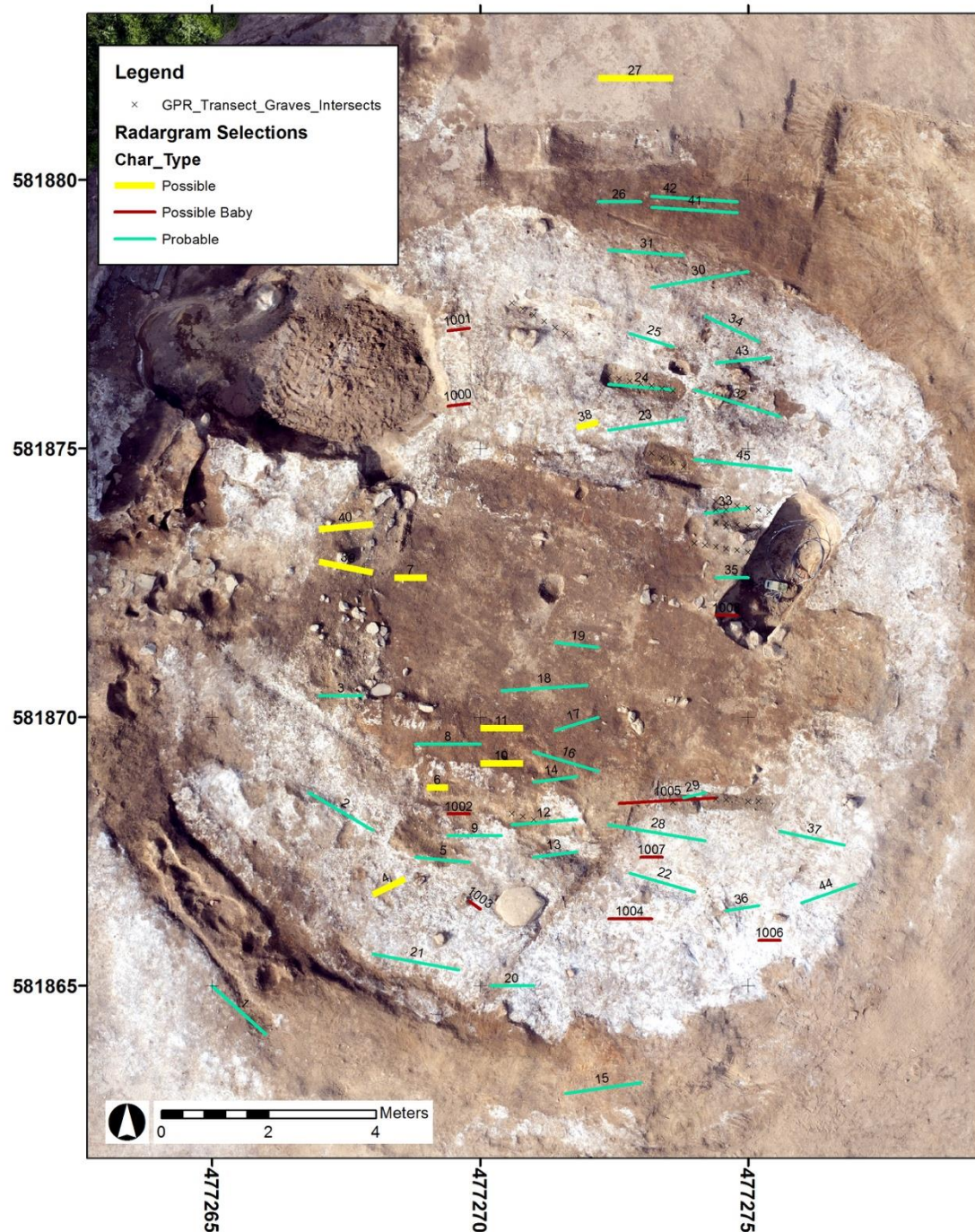


Figure 3. Interpreted blow ground burials associated with GPR reflections at Keflavík cemetery. Labels correspond to Tables 1 and 2. Excavated burials are indicated by the black 'x.'

5.0 Acknowledgments

This work was funded by Cultural Heritage Agency of Iceland's Archaeological Heritage Fund and the United States National Science Foundation (ASSP PLR-1345066 and PLR-1417772). John Steinberg obtained the fixed points and John Schoenfelder laid out the grid and mapped the surface features. Eric Johnson, Joe Treblecock, Ramona Steele, and Collin Lenfest helped perform the ground-penetrating radar surveys, supervised by Brian Damiata and John

Steinberg. John Steinberg and Brian Damiata are responsible for the quality control of the surveys and the interpretation of the radar data. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the supporting agencies, institutions, or individuals. Products or instruments mentioned should not be construed as an endorsement.

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Table 1. Interpreted below-ground burials associated with GPR reflections from Keflavk cemetery (see annotated radargrams; probable grave denoted by solid red circle, possible grave denoted by dashed red circle).

GPR Grave ID	Color Code	Starting/Ending Profile	Start (N,E) ⁽¹⁾	End (N,E) ⁽¹⁾	Length (m)	Approximate Depth to Top (m)	Comments
1	Red (Solid Circles)	8234 – 8239	865.0 , 265.0	864.1 , 266.0	1.35	0.77 – 0.81	
2	Red (Solid Circles)	8243 – 8249	868.6 , 266.8	867.9 , 268.0	1.39	0.81 – 0.89	
3	Red (Solid Circles)	8244 – 8248	870.4 , 267.0	870.4 , 267.8	0.8	0.86 – 0.91	
4	Red (Dashed Circles)	8249 – 8252	866.7 , 268.0	867.0 , 268.6	0.7	0.66 – 0.71	possible grave, two graves on eastern end?
5	Red (Solid Circles)	8253 – 8258	867.4 , 268.8	867.3 , 269.8	1.0	0.85 – 0.95	
6	Red (Dashed Circles)	8254 – 8256	868.7 , 269.0	868.7 , 269.4	0.4	0.95 – 1.0	possible grave may extend to the west
7	Red (Dashed Circles)	8251 – 8254	872.6 , 268.4	872.6 , 269.0	0.6	0.57 – 0.62	possible grave
8	Red (Solid Circles)	8253 – 8259	869.5 , 268.8	869.5 , 270.0	1.2	0.85 – 0.95	
9	Red (Solid Circles)	8256 – 8261	867.8 , 269.4	867.8 , 270.4	1.0	0.80 – 0.85	
10	Red (Dashed Circles)	8259 – 8263	869.15 , 270.0	869.15 , 270.8	0.8	0.62 – 0.75	possible grave
11	Red (Dashed Circles)	8259 – 8263	869.8 , 270.0	869.8 , 270.8	0.8	0.62 – 0.71	possible grave
12	Red (Solid Circles)	8262 – 8268	868.0 , 270.6	868.1 , 271.8	1.2	0.75 – 0.85	
13	Red (Solid Circles)	8264 – 8268	867.4 , 271.0	867.5 , 271.8	0.8	0.85 – 0.95	
14	Red (Solid Circles)	8264 – 8268	868.8 , 271.0	868.9 , 271.8	0.8	0.58 – 0.62	

GPR Grave ID	Color Code	Starting/Ending Profile	Start (N,E) ⁽¹⁾	End (N,E) ⁽¹⁾	Length (m)	Approximate Depth to Top (m)	Comments
15	Red (Solid Circles)	8267 – 8274	863.0 , 271.6	863.2 , 273.0	1.41	0.55 – 0.62	might be two graves
16	Red (Solid Circles)	8264 – 8270	869.36 , 271.0	869.0 , 272.2	1.25	0.68 – 0.75	
17	Red (Solid Circles)	8266 – 8270	869.76 , 271.4	870.0 , 272.2	0.8	0.65 – 0.80	might continue 0.4 to the east
18	Red (Solid Circles)	8261 – 8269	870.5 , 270.4	870.6 , 272.0	1.6	0.60 – 0.70	possibly two graves
19	Red (Solid Circles)	8266 – 8270	871.4 – 271.4	871.3 , 272.2	0.8	0.60 – 0.70	possibly two graves on eastern end
20	Red (Solid Circles)	8260 – 8264	865.0 , 270.2	865.0 , 271.0	0.8	0.70 – 0.80	might extend to the west; intersects buried electric line
21	Red (Solid Circles)	8249 – 8257	865.6 , 268.0	865.3 , 269.6	1.6	0.55 – 0.80	dipping to the east
22	Red (Solid Circles)	8273 – 8279	867.1 , 272.8	866.75 , 274.0	1.25	0.75 – 0.85	might have rock above grave
23	Red (Solid Circles)	8271 – 8278	875.35 , 272.4	875.56 , 273.8	1.4	0.68 – 0.85	
24	Red (Solid Circles)	8271 – 8277	876.2 , 272.4	876.1 , 273.6	1.2	0.70 – 0.75	
25	Red (Solid Circles)	8273 – 8277	877.15 , 272.8	876.9 , 273.6	0.85	0.85 – 0.95	
26	Red (Solid Circles)	8270 – 8274	879.6 , 272.2	879.6 , 273.0	0.8	0.58 – 0.68	
27	Red (Dashed Circles)	8270 – 8277	881.9 , 272.2	881.9 , 273.6	1.4	0.55 – 0.8	possible grave (s), might be two separate graves
28	Red (Solid Circles)	8271 – 8280	868.0 , 272.4	867.7 , 274.2	1.8	0.80 – 0.90	possibly two graves at eastern end
29	Red (Solid Circles)	8278 – 8270	868.5 , 273.8	868.6 , 274.2	0.4	0.85 – 0.90	
30	Red (Solid Circles)	8275 – 8284	878.0 , 273.2	878.3 , 275.0	1.8	0.79 – 0.89	possibly conflating two graves

values

GPR Grave ID	Color Code	Starting/Ending Profile	Start (N,E) ⁽¹⁾	End (N,E) ⁽¹⁾	Length (m)	Approximate Depth to Top (m)	Comments
31	Red (Solid Circles)	8271 – 8278	878.7 , 272.4	878.6 , 273.8	1.4	0.60 – 0.70	
32	Red (Solid Circles)	8279 – 8287	876.1 , 274.0	875.6 , 275.6	1.8	0.80 – 1.0	possibly conflating two graves
33	Red (Solid Circles)	8280 – 8284	873.8 , 274.2	873.9 , 275.0	0.8	0.75 – 1.0	conflated, excavation shows two graves #2 and #12
34	Red (Solid Circles)	8280 – 8285	877.47 , 274.2	877.0 , 275.2	1.1	0.68 – 0.85	
35	Red (Solid Circles)	8281 – 8283	872.6 , 274.4	872.6 , 275.0	0.6	0.70 – 0.80	
36	Red (Solid Circles)	8282 – 8285	866.4 – 274.6	866.5 , 275.2	0.6	0.70 – 0.80	
37	Red (Solid Circles)	8287 – 8293	867.88 , 275.6	867.62 , 276.8	1.23	0.65 – 0.80	
38	Red (Dashed Circles)	8268 – 8270	875.4 , 271.8	875.5 , 272.2	0.4	0.6 – 0.65	possible grave
39	Red (Dashed Circles)	8244 – 8249	872.9 , 267.0	872.7 – 268.0	1.1	0.75 – 0.88	possible grave
40	Red (Dashed Circles)	8244 – 8249	873.5 , 267.0	873.6 – 268.0	1.0	0.65 – 0.80	possible grave
41	Red (Solid Circles)	8275 – 8283	879.5 , 273.2	879.4 , 274.8	1.6	0.68 – 0.82	conflated with D
42	Red (Solid Circles)	8275 – 8283	879.7 , 273.2	879.6 , 274.8	1.6	0.68 – 0.82	conflated with C
43	Red (Solid Circles)	8281 – 8286	876.6 , 274.4	876.7 , 275.4	1.0	0.75 – 0.88	
44	Red (Solid Circles)	8289 – 8295	866.55 , 276.0	866.9 , 277.0	1.1	0.60 – 0.75	
45	Red (Solid Circles)	8279 – 8288	874.8 , 274.0	874.6 , 275.8	1.8	0.70 – 0.85	might be two graves

Table 2. Interpreted below-ground burials associated with GPR reflections from Keflavík cemetery (see annotated radargrams; possible infant grave denoted by dashed red circle).

GPR Grave ID	Color Code	Starting/Ending Profile	Start (N,E) ⁽¹⁾	End (N,E) ⁽¹⁾	Length (m)	Approximate Depth to Top (m)	Comments
a	Red (Dashed Circles)	8256 – 8258	875.8 , 269.4	875.85 , 269.8	0.4	0.6 – 0.7	possible baby grave, might extend 0.4 m to the west under cesspit, jog?
b	Red (Dashed Circles)	8256 – 8258	877.2 , 269.4	877.25 , 269.8	0.4	0.55 – 0.62	possible baby grave, might extend 0.2 m to the west under cesspit, jog?
c	Red (Dashed Circles)	8256 – 8258	868.2 , 269.4	868.2 , 269.8	0.4	0.77 – 0.82	possible baby grave, might extend 0.2 m to the west
d	Red (Dashed Circles)	8258 – 8259	866.58 , 269.8	866.43 , 270.0	0.25	0.68 – 0.75	possible baby grave
e	Red (Dashed Circles)	8271 – 8275	866.25 , 272.4	866.25 , 273.2	0.8	0.5 – 0.7	possible grave
f	Red (Dashed Circles)	8281 – 8282	868.5 , 274.4	868.4 , 272.6	0.2	0.70 – 0.80	possible baby grave, excavation shows two baby graves #6 and #14
g	Red (Dashed Circles)	8285 – 8287	865.85, 275.2	865.85 , 275.6	0.4	0.70 – 0.75	possible baby grave, beneath turf layer?
h	Red (Dashed Circles)	8274 – 8276	867.4, 273.4	867.4 , 273.0	0.4	0.50 – 0.55	possible baby grave
i	Red (Dashed Circles)	8281 – 8283	871.9 , 274.4	871.9 , 274.8	0.4	0.45 – 0.50	possible baby grave, coffin?

¹Add 581000 to Northing values and 477000 to Easting values

Appendix

Preliminary Results of Ground-Penetrating Radar Survey over the Cemetery at the Keflavík Farm

December 2015

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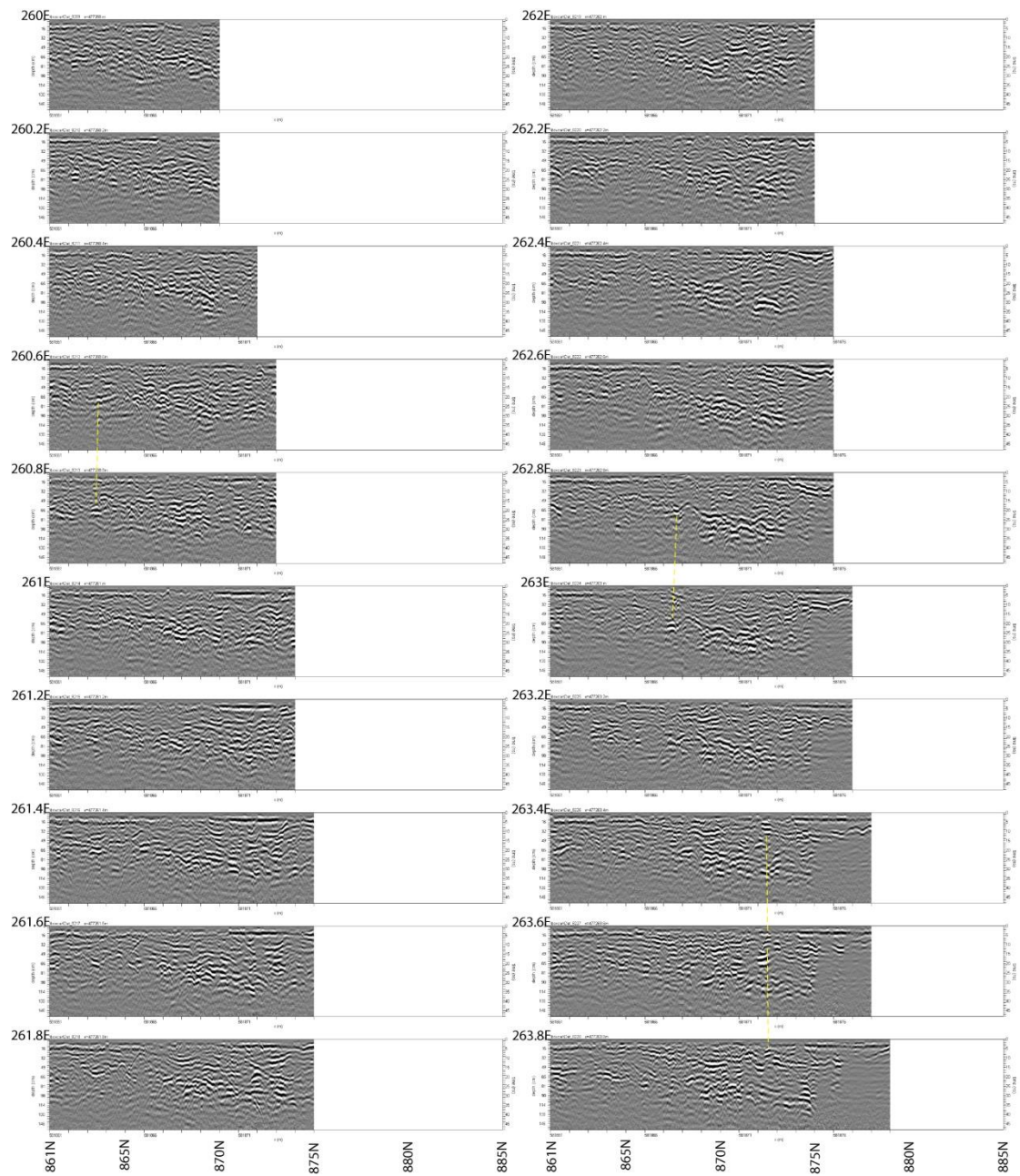


Figure A1. Annotated radargrams for transects 260.0E to 263.8E.

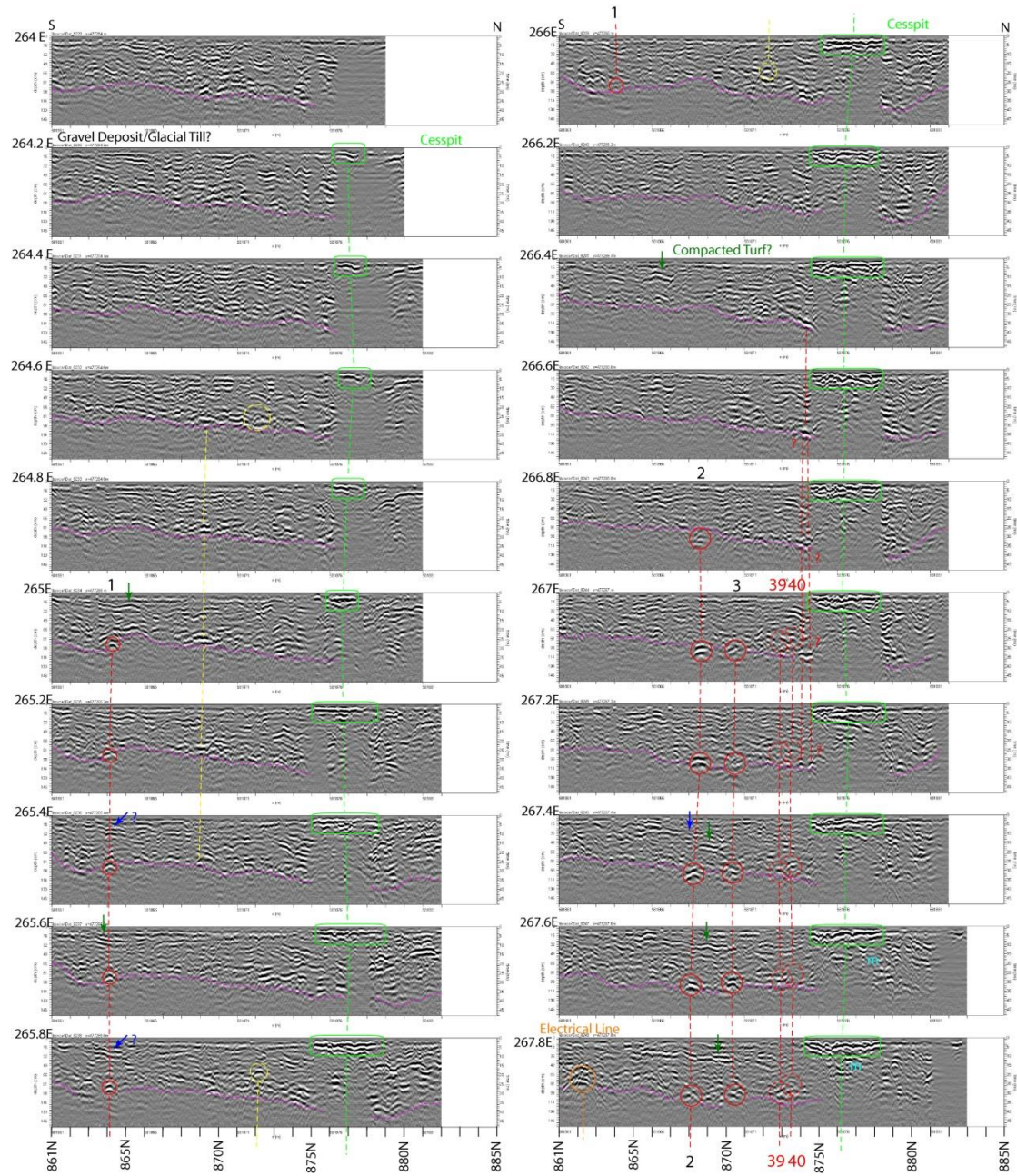


Figure A2. Annotated radargrams for transects 264.0E to 267.

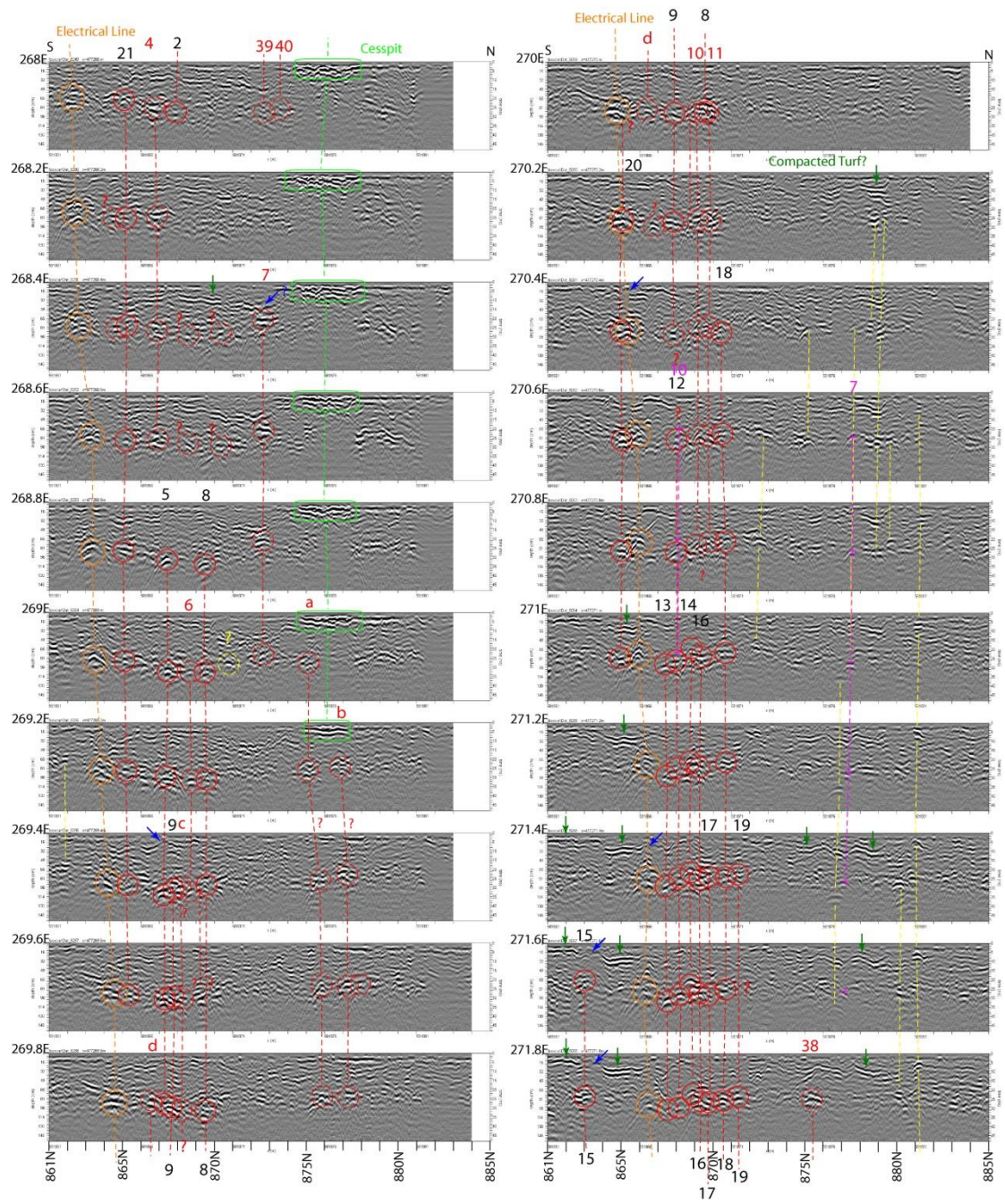


Figure A3. Annotated radargrams for transects 268.0E to 271.8E

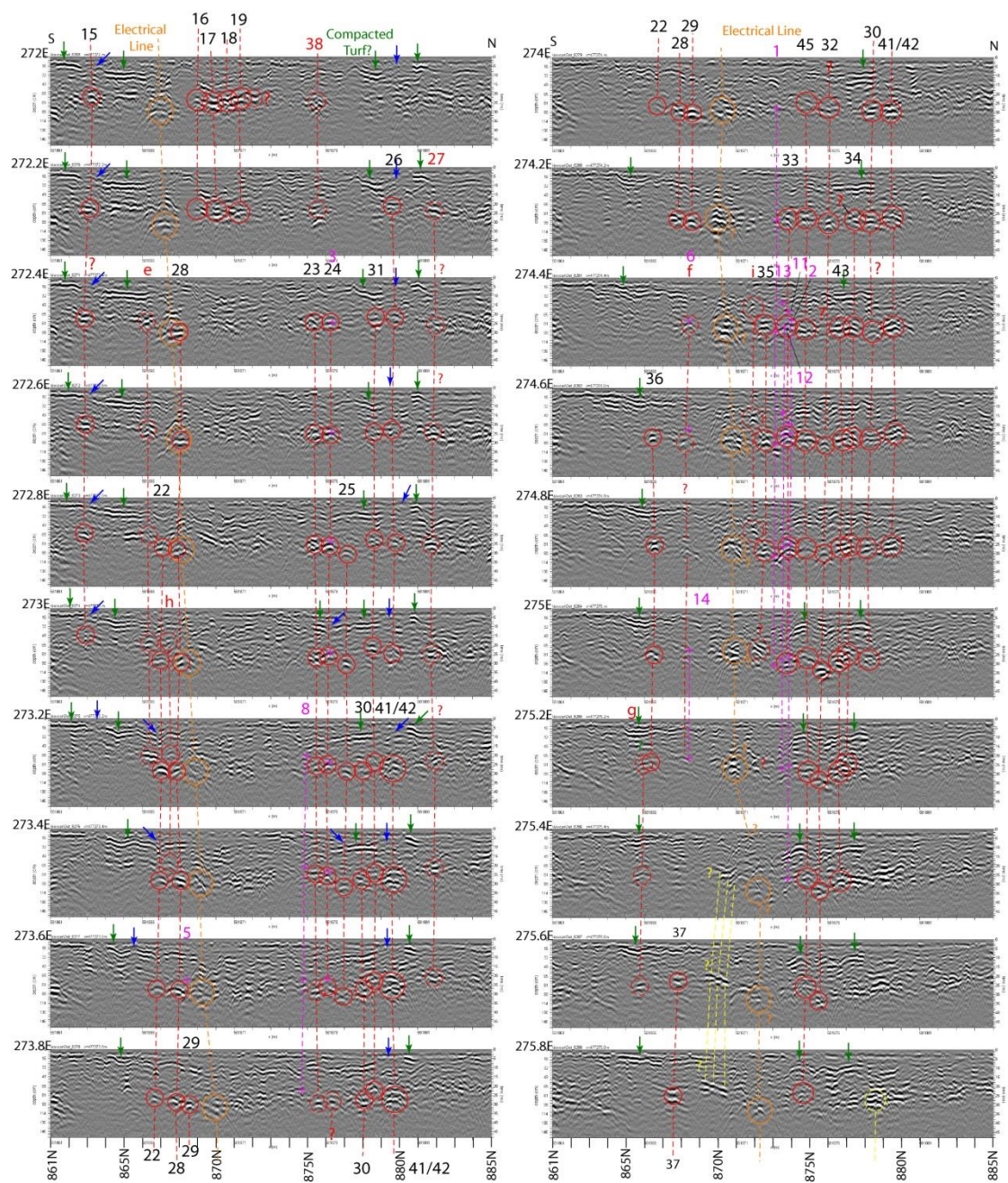


Figure A4. Annotated radargrams for transects 272.0E to 275.8E.

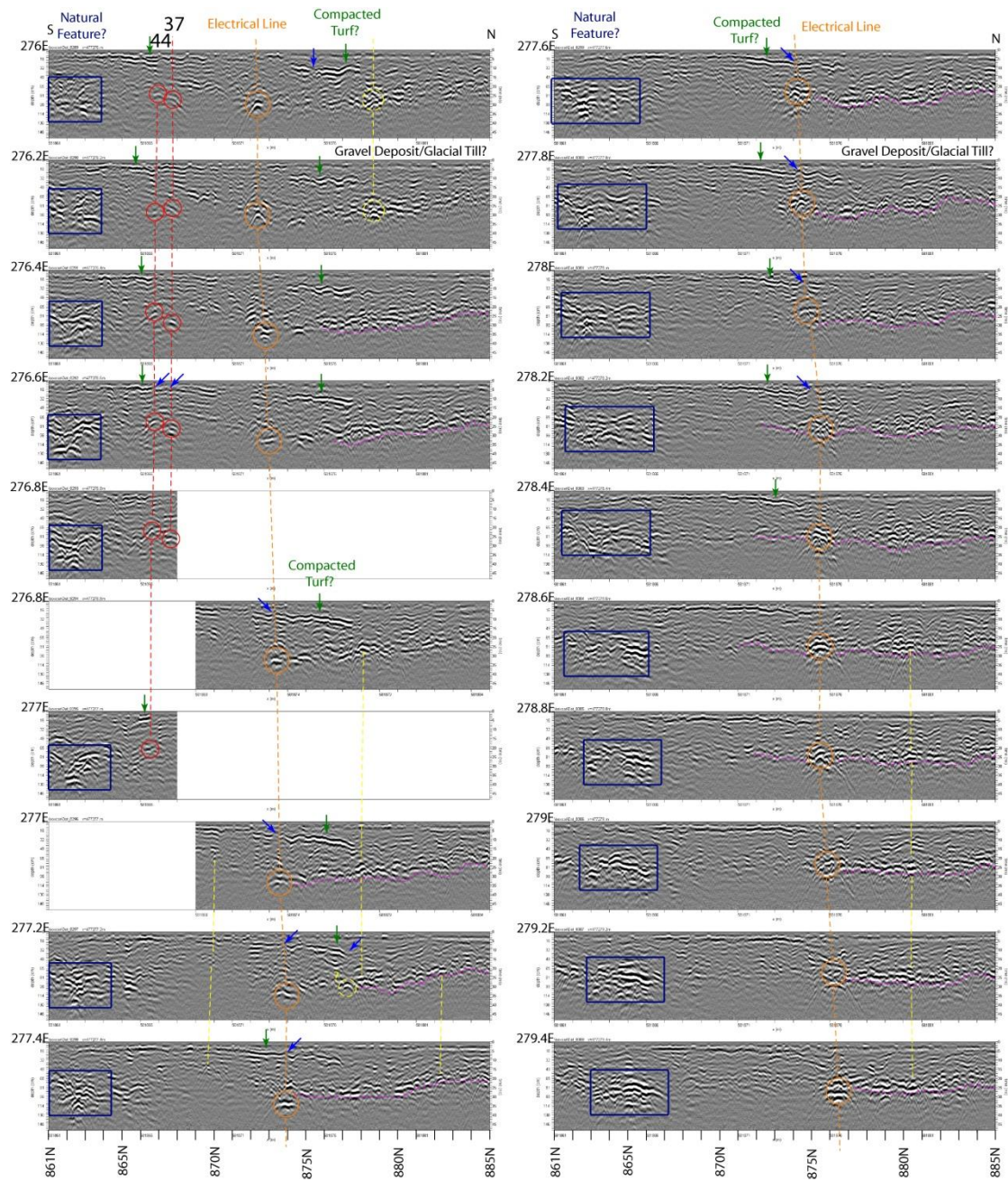


Figure A5. Annotated radargrams for transects 276.0E to 279.4E.

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