Report of the
Skagafjörður Archaeological Settlement Survey
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Additional copies of this report and other reports, as well as much of the raw data can be downloaded from http://sass.ioa.ucla.edu

Note to Readers

This an interim report on the majority of the activities of the Skagafjör›ur Archaeological Settlement Survey (SASS) during the summer of 2002. As it is an interim report, it is incomplete and unpolished. This report has several substantial and important omissions. It covers much of the remote sensing and follow-up excavations. It also outlines the results of our work on organic content of turf walls. Finally, it includes our prelimary interperation of the settlement pattern. There is no bibliography, or acknowledgments. The work of Doug Bolender (soil phosphate), Tara Carter (soil deposition) and Bob Daniels (Surface Survey) are not included.

Introduction

Because of the written sagas, Viking Age and Late Norse Iceland (874-1300 AD) is one of the best case studies for understanding the social structure of chiefdoms. The sagas are ambiguous as to what kind of settlement pattern might have existed and how it changed over time. According to the most interpretations of the saga descriptions of Commonwealth Iceland, the society had no formal system of elite finance. Chiefs did not receive any payment unless they performed a service and farmers could choose any chief, within their quarter, to give allegiance. While sagas single out some farmers and chieftains being wealthy and powerful, what that wealth or power was, where it came from, or how it was maintained is not clear. Much of the wealth must have been derived from the land and farm production, but how wealth was centralized has been subject to much debate (e.g., Byock 2001; Durrenberger 1988; Vésteinsson 2000; McGovern, et al. 1988; Þorláksson 1992).

It is not clear if the differential wealth and power of farmers and chiefdoms is reflected in a two-tier settlement hierarchy. In chiefly societies based on semi-functional mechanisms, central places in redistribution networks often become larger than other settlement sites creating distinct settlement hierarchies (Peebles and Kus 1977; Service 1975). The settlement pattern may be, as Gilman (1995) proposes for Germanic societies, based on exploitation rather than production and therefore a settlement hierarchy should not be apparent until long after social stratification has been institutionalized. Unbiased settlement pattern results should help us begin to clarify the distribution of wealth and power across Viking Age Iceland and how it changed as the society became more complex. That is, how did the settlement configuration change as Iceland experienced the growth of regional power, the institution of taxes and rents, and was finally the incorporated into the Scandinavia monarchical system?

Archaeological Survey in Iceland has advanced substantially since 1879 when members of the Icelandic Archaeological Society first organized reconnaissance to locate sites related to the Saga literature (Friðriksson 1994:8). Archaeological survey now comprises a well-developed series of procedures and methods for the identification and assessment of archaeological sites based on documentary review, informant interviews, and field walking to identify visible remains (e.g., Friðriksson and Vésteinsson 1998; Ólafsson 1996, 1999; Sveinbjarnardóttir 1992; Traustadóttir 2000). The results of archaeological survey provide basic tools for both research into and cultural heritage management of, the important and fragile archaeological resources of Iceland. However, a whole series of environmental conditions bias the results of archaeological survey to such an extent that survey results may be too incomplete for settlement pattern analyses.

Settlement Patterns

Archaeological survey can provide broad estimates of basic socio-economic parameters of past societies. The results of archaeological survey are usually presented as settlement patterns, which plot the location, size, and date of settlements across the landscape and show the relationship of settlement to the distribution of critical resources. The control of land and resources is a central part of the creation, maintenance, and change of social power (e.g., Childe 1958; Earle 1991; Finley 1973; Malinowski 1935; Mann 1986). Critical resources are claimed and owned by establishing property rights (the ability to exploit and the ability to exclude - Demsetz 1967; Hunt and Gilman 1998; Munzer 1990). Property rights over resources are often established by living near them. Not surprisingly, settlement patterns are sensitive to changes in the distribution of social power (e.g., Billman and Feinman 1999; Parsons 1972; Vogt and Leventhal 1983; Willey 1953).

Settlement patterns are spatially ordered systems of land use that represent the way groups used the landscape (Hester, Shafer and Feder 1997). The analysis of settlement patterns comprises a suite of techniques, such as site catchment (the distribution of resources in relation to sites), territories (the area in between sites), and central place studies (the distribution of large and small sites). Information about the relative size and occupation dates of individual sites allows patterns to be seen that reveal political dynamics which are especially apparent in comparative contexts. Results of these studies can be fruitfully contrasted between regions and between time periods to understand how critical resources are created or controlled. We present below a first step towards gathering the data necessary to carry out various settlement pattern analyses in Iceland.

Smith and Parsons (1989) have identified the specific problems, as well as the advantages, of archaeological survey in Iceland. They note a series of significant biases that make settlement pattern analysis in Iceland challenging. There are few surface artifacts and no native pottery. Therefore, site identification primarily depends on the surface preservation of architectural remains and dating sites usually requires excavation. There has also been extensive land modification (e.g., mudslides, flooding, land leveling, soil erosion and aeolian soil deposition). Finally, early Icelandic settlements are small, dispersed, and easy to overlook.

The preservation and visibility of sites varies by region so that in different areas the likelihood of discovering archaeological remains varies. In areas with little aeolian soil deposition or modern land alteration, old ruins may be clearly visible on the surface. In the highly productive lowland areas much of the past landscape has been buried and surface remains have been erased by modern farming activity such as plowing and field leveling. Where the probability of site discovery varies systematically, as likely in Iceland, then the resulting settlement pattern analyses can be fundamentally skewed (Colins 1975; Schiffer, Sullivan and Klinger 1978). In Iceland, because soil deposition and farm abandonment vary systematically with elevation and region (Dugmore and Buckland 1991; Guðbergsson 1996; Johannesson 1960), preservation and site discovery probabilities are probably systematically biased as well.

Because the conditions for surface survey in Greenland present fewer biases, researchers have conducted several Norse settlement pattern studies there (e.g., Berglund 1990; Christensen 1990; McGovern 1983, 1992). The results suggest that there is a general correlation between settlement density and fertility. The exception, a lower than expected settlement density around around the bishop's farm, suggests a minor settlement hierarchy (Keller 1990). Several proposals for specific settlement pattern sequences have been suggested for Iceland (e.g., Durrenberger 1988, 1989, 1992; Herschend 1994; Vésteinsson 1998, 2000; Smith 1995: Þorláksson 1992) but the factors detailed by Smith and Parsons (1989) have hindered the gathering of archaeological data that would allow for a critical evaluation of these proposals.

The primary goal of the Skagafjörður Archaeological Settlement Survey (SASS) is to address these survey biases with the addition of intensive sub-surface remote sensing to survey protocols in an attempt to make settlement pattern analysis more reliable and productive. Commonwealth settlement patterns are essential for understanding early Icelandic social structure and could provide an important comparison with other chiefly societies without such extensive written records. The project has developed a protocol of coring, remote sensing, and test excavation that, while slow, substantially reduces survey biases. While we have only intensively surveyed a very small region of Skagafjörður (Figure 1), the results are suggestive of significant changes in household organization and property in the first 200 years following the settlement. The settlement pattern results suggest that from the settlement in 874 AD until 1000, large farms were widely dispersed across the landscape with little hierarchy among sites. Between 1000 and 1100 AD, small farms were established around the pre-existing larger farms resulting in a two-tiered settlement hierarchy. Finally, in about 1100 AD the large farms shift to new locations, were they remained until the 20th century. One the result of this pattern is that many of the original Viking Age occupations are currently under modern homefields where they are at substantial risk from farming activity. Overall, we find that it is essential for both research and cultural heritage management

Figure 1: Map of Skagafjörður, showing land claims, based on Landnámabók. Chiefly land claims are highlighted in Black. The Langholt region (Figure 4) is boxed in white

to produce unbiased settlement patterns and we have found that sub-surface survey must be a large component of such reconnaissance.

Turf Farmsteads in Skagafjörður

The main targets of survey in Iceland are the remains of turf structures. This is true for both regular pedestrian and sub-surface survey. In pedestrian survey, remains are identified and mapped where they are preserved above the surface. In subsurface survey, the buried turf remains must be distinguished from the surrounding soil based on their geophysical properties.

Skagafjörður has good conditions for the preservation of turf architecture. Turf is the root mass cut from the upper portion of a peat bog and once dried, the material is a light, flexible, and durable building material with good insulation properties (see contributions to Myhre, Stoklund and Gjærder 1982; Urbanczyk 1999). Once a turf house is abandoned, the strips and blocks of turf erode and fall in various directions, usually only leaving the bottom of the wall intact, but surrounded by a substantial area of turf fall. Probably because of relatively dry and mild weather, lowland Skagafjörður has a remarkable number standing turf structures in various states of decay (Sigurðardóttir 2002). It is likely that in the coastal and fjord areas of Skagafjörður, turf structures abandoned during the Viking Age would have been buried rapidly, preventing their destruction by the wind and weather. Soil deposition studies (Guðbergsson 1975, 1994) indicate that most of the 30 to 90 cm of aeolian soil that has accumulated in lowland Skagafjörður over the last 1100 years from eroding highland areas, was deposited during the first 250 years of settlement (from 874-1100 AD, see also Thorarinsson 1961). The rapid burial of lowland areas means there could be a substantial number of early structures preserved under the present landscape.

However, good conditions for preservation of turf structures do not necessarily imply that the identification of the early sites with substantial turf architecture is unbiased. Once buried, the small air pockets in turf that make up most of its volume, are compressed, substantially reducing the volume. The combination of the reduction in turf volume and the deposition of substantial aeolian soils means that well-preserved compressed turf structures can be completely buried, with little sign of their existence on the ground surface. In some cases, community memory and other documents are accurate enough to locate buried structures, even without surface signs as a guide. In other cases, turf structures have been rebuilt on the same location, century after century, creating farm mounds which mark the location of earlier structures (Snæsdóttir 1990). Lowland Skagafjörður has excellent conditions for the preservation of the early landscape and the number of sites preserved may well be close to the number of sites that existed. We could take advantage of this excellent preservation for settlement pattern research, if the the majority of sites could be identified.

The SASS protocol

Starting in 1998, first in Mosfelsdalur and then in Skagafjörður, we began to develop a protocol for identifying buried sites, away from farm mounds, in lowland areas that have received substantial soil deposition. We believed that the most important parameter to evaluate, in preparation for settlement pattern analysis, was the likelihood of preserved habitation sites and farmsteads that were neither visible on the surface nor specifically recorded in documents or community memory.

Identifying sites not apparent on the surface has been a preoccupation of archaeologists around the world. In general, besides intuition, there has been three basic approaches to sub-surface survey: shovel test pits, chemical analysis, and remote sensing (e.g., Ammerman 1981; Eidt 1973; Kvamme 2003; Nunez 1990; Read 1986; Schiffer, Sullivan and Klinger 1978; Wood and Johnson 1978; Weymouth 1986; Weymouth and Woods 1984). Like many surveys, we have combined them and, with the addition of standard surface survey, hope to have produced a protocol that systematically identifies both visible and buried archaeological sites throughout an entire region.

After a modern farm was selected for examination, a traditional document survey was carried out that included pedestrian survey, where structures and farm mounds mentioned in various sources were associated with distinct features in the landscape. Farm mounds, or other visible structures on the surface were mapped and their GPS coordinates recorded. If the visible structures appeared to have any depth to them, cores were taken to identify midden areas—which seem to have the best conditions for volcanic ash preservation. If a midden was present, a 1 x 1 m test trench was excavated down to prehistoric soil in the area of richest and deepest ash deposit to determine occupation span.

At the same time, targeted soil cores were taken around the fields of the farm to ascertain soil depth. For this initial subsurface survey, we used Eijkelkamp single gouge augers at 50 meter intervals. This program also identified drained wetlands, areas where remains should be visible (e.g., regions that have had little soil deposition or substantial erosion), and areas that have been substantially altered by earthmoving. Where conditions indicated that structures could be preserved we cored every 25 meters using Oakfield peat samplers, which produce better preserved soil cores, to record tephra layers (Table 1), stratigraphic sequences, and take soil samples for environmental reconstructions and phosphate levels. Cultural material identified in soil cores – such as charcoal, peat ash, and burn bone fragments – were found often to predict the presence of early structures.

Areas that had received at least 30 centimeters of soil over the last 1100 years, with good stratigraphic preservation, and were without modern electrical contamination (for example, buried iron structures, pipes, power lines, telephone cables, etc.) were then selected for conductivity survey with the EM-31. The EM-31 is usually carried at hip-level and can record apparent ground conductivity readings while the operator walks over the surface. The transmitter and receiver coils are separated by 4 meters. The transmitter coil emits an alternating current that induces a secondary magnetic field, the strength of which is an indication of the overall apparent ground conductivity. The instrument has an effective penetration depth of 6 meters with most of the apparent ground conductivity reading coming from 1.5 meters below the surface. We have found that the horizontal resolution can be as small as 50 cm.

Turf walls, even when buried and compressed, seem to resist electrical currents more than the surrounding environment. This is probably due to lower clay content in turf, which still has a high organic content compared to the surrounding soil matrix. Therefore, turf walls can be identified with the EM-31 as linear low conductivity anomalies (for example see Figure 2: EM-31 UTM North 7277570).

There are many other surface and subsurface conditions that will create linear low conductivity readings, not just buried turf walls. Therefore, any reading that could be a turf wall was investigated with a power auger, which excavates an 8 inch bore hole — just large enough to reliably identify turf walls and midden deposits. The small, but deep auger holes minimize disruption of the electrical properties of the

Table 1: Tephra Layers in Skagafjörður

Date (AD)	Tephra	Thickness	Color	Social event
871 ±2	Landnám	>0.5 cm	Green	Settlement
1000	Veiðivötn-Dyngjuháls	0.5 cm	Blue	Conversion
1104	Hekla 1	1 cm	Yellow	Tithe
1300	Hekla	>1 cm	Gray-Blue	Little Ice Age
1766	Hekla	>0.5 cm	Black	

soil.

Keeping soil disturbance to a minimum is important because when a turf wall was identified we used the Syscal Kid resistivity meter, which provided a more detailed assessment of the sub-surface. Each of the Syscal Kid's 24 metal stakes must be in good contact with the ground. The instrument then measures the electrical resistance between all of the stakes, two at a time. Rather than one reading at a single spot, like the EM-31, the Syscal Kid provided several readings at different depths on the same spot, which can be interpolated to create a pseudo-profile of the subsurface. Several profiles can be combined to get a good idea of the wall or building orientation (Figure 3).

Finally, several test trenches were excavated into, what was anticipated to be the outside walls of the identified structure. Not only do the test-trenches provide critical ground truthing to the remote sensing readings, they provide necessary material for dating the site.

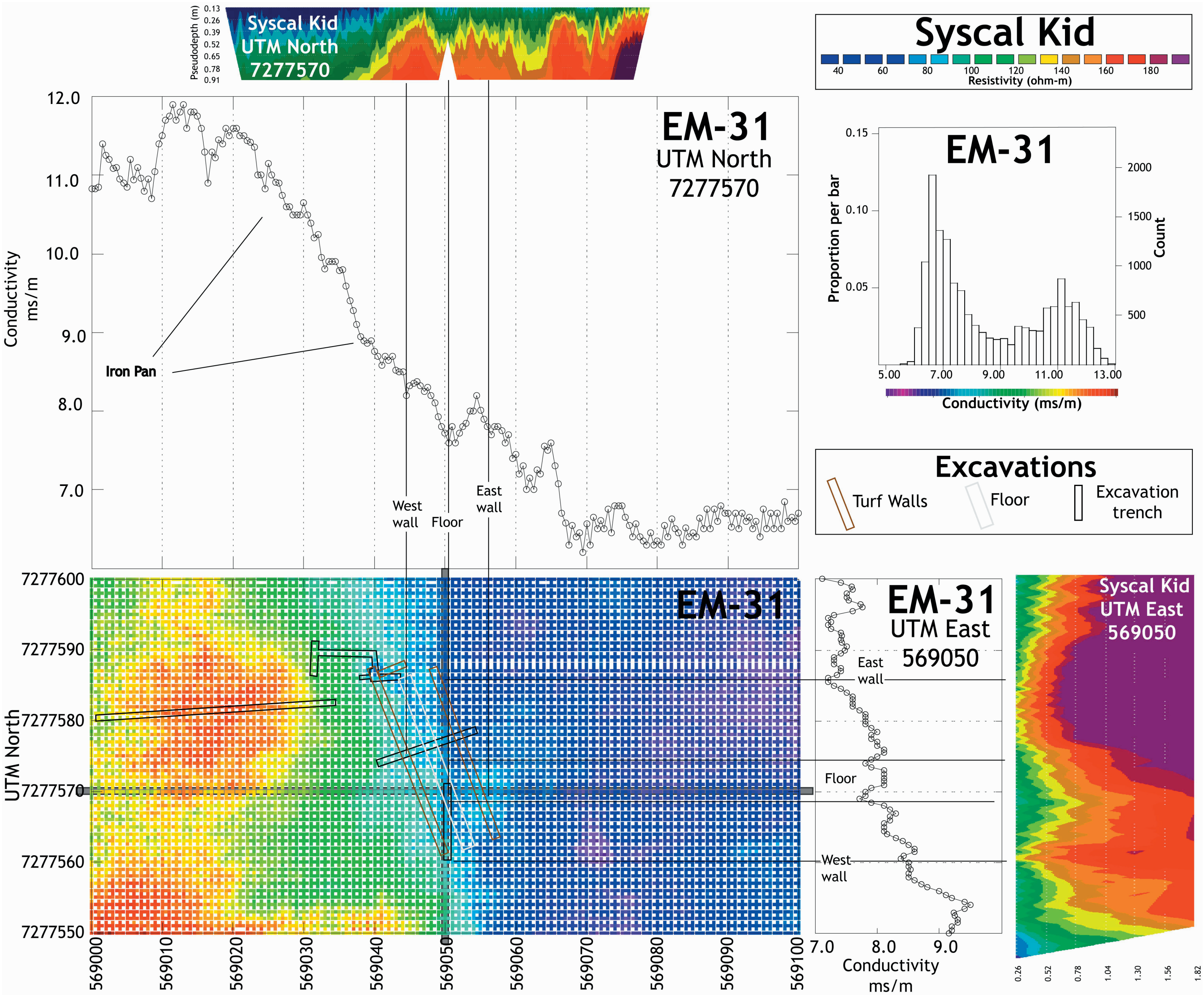
Remote sensing is time consuming and consequentially only a small portion of any farm can reasonably be targeted for survey. The protocol is designed to evaluate the entire landscape by eliminating areas where sub-surface preservation is unlikely and identify ever smaller areas for more intensive exploration. A three person coring team can cover 3 to 10 hectares in a day (depending on coring interval), the EM-31 can cover 0.5 to 2 hectares per day (depending on line density), the auger team can excavate and record 10 to 20 bore holes, and the Syscal Kid can recored 60 to 120 m of pseudo-profile (depending on density, depth, and line length). The protocol takes advantage of the fact that remote sensing is much less subject to size biases (Carr 1982; Clark 1990) than shovel testing and coring, which tend to be better at identifying large sites (Krakker, Shott and Welch 1983; Nance and Ball 1986; Lightfoot 1986; Shott 1987, 1989; Wobst 1983). By combining coring and remote sensing we maximize subsurface survey effectiveness for identifying sites and for examining areas where not sites are likely to have existed. A combined approach gives us reliable positive and negative evidence for settlement pattern analysis.

Establishing reliable negative evidence is critical for settlement pattern analysis. The entire landscape must be evaluated to determine which areas may have once had remains but may no longer be preserved (e.g., deeply plowed fields and eroded areas), which areas have conditions for good turf structure preservation but sites are absent, and which areas have sites. Where fields have been plowed down to prehistoric soil horizons we examine the disturbed deposits for cultural material—even though architectural remains may not be preserved or are unlikely to be detected in the remote sensing. Establishing that areas have conditions for good preservation but are without sites is critical for estimating the level of site dispersion, so important in the case of Icelandic chiefdoms. On the whole, negative or ambiguous results are faster to obtain than positive ones but they are as important for an unbiased settlement survey.

Results

Of the five areas in Skagafjörður we targeted for survey, the Langholt region had the best conditions for unbiased survey and that is where we have concentrated much of our effort. Langholt is series of Pleistocene beach ridges on top of a lateral moraine about 100 meters above sea level that divides the main valley of Skagafjörður from Sæmudarhlíð. Because the modern road is higher on Langholt than the traditional trial, most of the modern, non-turf houses have been built away from established farm mounds. Hjalti Pálsson (2001) has recently completed a history of the Langholt farmsteads and historically, the region is representative of a broad cross section of farms. The upper portions of the ridge have suffered some erosion, while the east side of the ridge, towards the main valley, has received substantial soil deposition and widely preserved the 1104 tephra layer (Thorarinsson 1971). On Langholt, we chose farms from different parts based on preservation conditions and created clusters based on large wealthy farms and their immediate neighbors with the idea of covering entire areas of neighboring farms to highlight variation between historically wealthy and poor farms.

Figure 2: Glaumbær composite map. Combines coring, EM-31 conductivity map, EM-31 conductivity survey lines (UTM North 7277570 and UTM E 569050), Pseudoprofiles of those same lines from the Sycal Kid Resistivity meter, and test trenches.



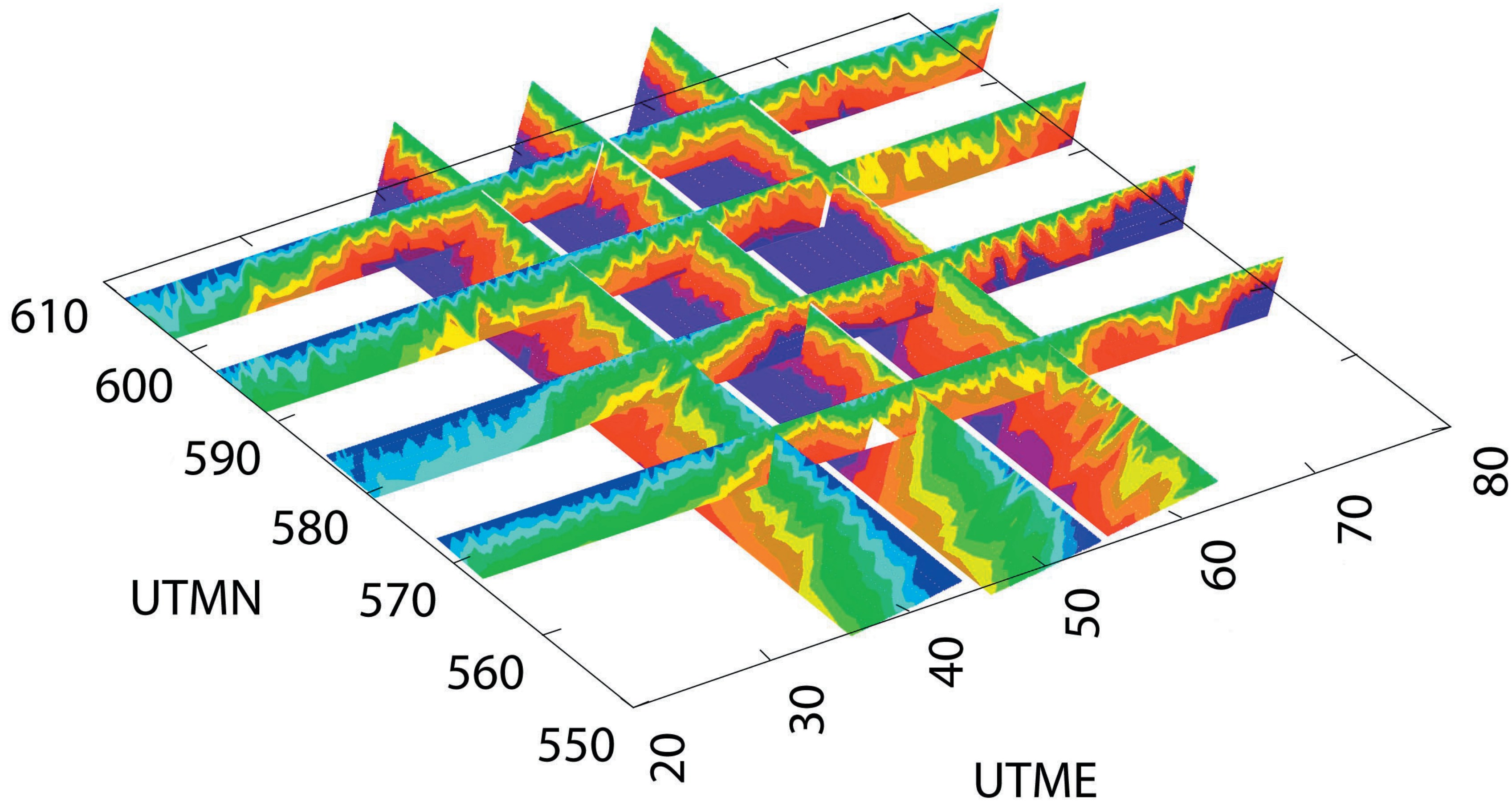


Figure 3: Syscal Kid resistivity fence diagram from Glaumbær.

After two seasons of field survey, we have covered 17 farms at various levels of intensity. On Langholt we have dated 10 sites with excavation, three of which were were well away from farm mounds, not visible on the surface, not recorded in placename records, and not part of local memory. Overall, the survey indicates that early farmsteads seem to fall into two categories, those with midden and structures over an area of at least 2500 m^2 and those under 700 m^2 (Table 2). Interestingly, all of the smaller farmsteads we have identified seem to be established between 1000 and 1100 AD while all of the large farmsteads (over 2500 m^2) seem to have activity that took place before 1000 (Table 3). This implies that a two-tiered settlement hierarchy developed during the Commonwealth period as smaller sites were

Table 2: Settlement sites and Tephra dates

Farm	Site #	Area of Midden and Structures (m^2)	Tephra	
			Earliest occupation	Abandoned
Hafsteinsstaðir	SK-071-001	≈650	Between 1000 & 1104	1954
Geitagerði	SK-064-010	≈225	?	?
Torfgarður	SK-106-002	≈400	Between 1000 & 1104	1964
	SK-106-100	≈225	Between 1000 & 1104	Before 1300
Grófargil	SK-089-001	≈400	Between 1000 & 1104	After 1300
Hafsteinsstaðir	SK-071-001	≈400	Between 1000 & 1104	Modern
Meðalheimur	SK-111-201	≈400	?	?
Víðimýri (†)	SK-111-010	?	Before 1104	Modern
Glaumbær (†)	SK-111-010	3,300	Before 1000	Before 1104
	SK-111-010	6,400	After 1104	1952
Stóra Seyla (†)	SK-104-100	3,500	Before 1000	Before 1104
	SK-104-001	3,900	After 1104	1957
Reynistaður (†)	SK-063-009	2,025	Before 1000	Before 1300
	SK-063-010	10,000	Before 1300 Possibly before 1104	Modern

(†) Church Farms

Table 3: Accelerator Mass Spectrometry (AMS) dates.

Farm	Site #	Number	Material	^{14}C Date B.P.	±	$\delta^{13}C$	2 Sigma		
							Date cal (AD)	Probability	Midpoint (AD)
Grófargil	3-089-001	AA55486	Bone (*Bos taurus*)	982	45	-21.7	981-1163	0.996	1072
Glaumbær	3-111-010	AA55489	Bone (*Ovis*)	969	43	-21.3	993-1163	0.987	1078
	3-111-010	AA46688	Charred wood (*Betula pubescens*)	990	46	-28.3	976-1163	0.991	1069
	3-111-010	AA46689	Bone (*Bos taurus*)	1,017	56	-21.3	937-1160	0.924	1048
Stóra Seyla	3-104-100	AA55484	Bone (*Ovis*)	1,012	43	-20.36	959-1129	1.000	1044
Hafsteinsstaðir§	4-071-001	AA55485	Bone (*Ovis*)	1,158	44	-20.77	779-983	1.000	879
Reynistaður	4-063-009	Beta 167781‡	Wood (*Betula pubescens*)	1160	60	-28.4	766-999	0.951	882
	4-063-009	AA46687	Charred wood (*Betula pubescens*)	1,189	32	-28.8	772-899	0.897	836
Meðalheimur*	3-111-201	AA55488	Burnt bone (unknown)	4,110	700	-24.01			
	3-111-201	AA55487	Charred wood (*Betula pubescens*)	5,179	43	-29.24			

* Meðalheimur samples seems to be contaminated.
§ Hafsteinsstaðir dates are earlier than Table 2 suggest.
‡ Conventinal 14C Date

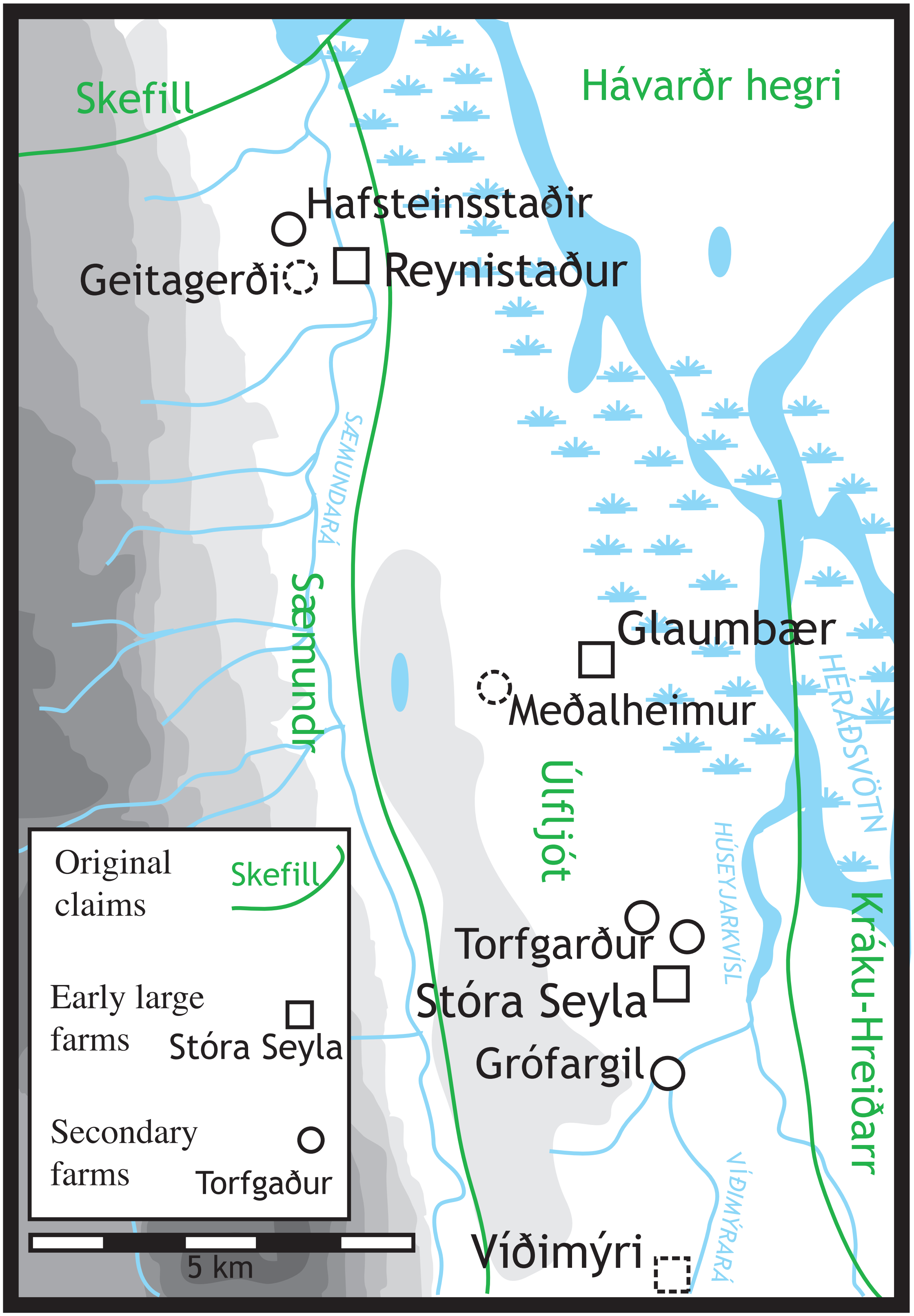


Figure 4: Langholt showing locations of farms mentioned in text.

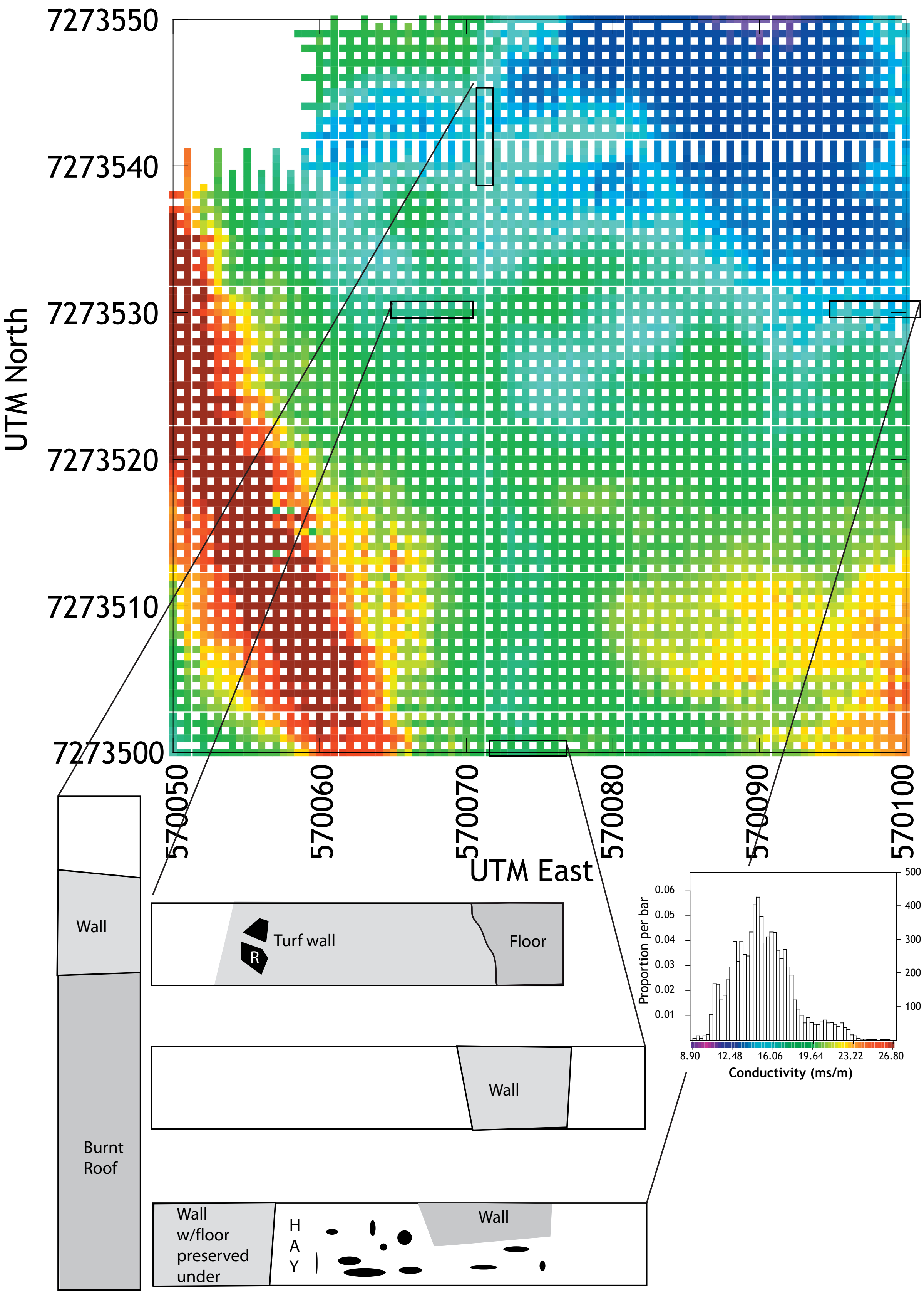


Figure 5: Stóra Seylla composite map. Combines EM-31 conductivity map and test trenches

established. Our survey also indicates that on the order of 25% and as many as 50% of sites established before 1000 AD may not be visible from the surface. Contrary to our expatiations, all but one of the small later farmsteads were marked by farm mounds. Conversely, half of the large early farmsteads had their earliest components well away from the largest farm mounds. These large sites had not been previously identified and the preservation was outstanding. If these results are representative of other parts of Skagafjörður and Iceland, it would imply that a substantial percentage of the earliest sites can only be found with sub-surface survey.

According to the *Landnámabók*, first settlers each claimed large areas (Figure 1). Three, chieftains, who gained their status outside Iceland, are specifically mentioned as settling in Skagafjörður. Their supposed land claims are highlighted in Figure 3. Their territories are not much larger than the average land claim but they are distributed in such a way as to be as far apart from each other as possible (Figure 1). That is, one of the primary determinants of settlement location of a chief may be the distance to other chiefs. That same evenly spaced pattern is mirrored in the distribution of the early large farms actually identified on Langholt (Figure 4).

At three farms on Langholt we identified occupations before 1000: Stóra Seyla, Reynistaður, and Glaumbær. At Víðimýri early occupation is indicated but no structure has been identified. The largest documented early occupation of these sites is at Stóra Seyla. The early site is about 140 m to the east of the visible farm mound just above the fjord bottom. Only 5 test trenches have been excavated, all on the perimeter of the settlement area which seems to be 3,200 m^2. The site is bisected by an drainage ditch that runs right through the site and has eroded a substantial area. This lower site is complex and no obvious long-house can be identified from the remote sensing, coring, augering and excavation (Figure 5). Three of the test trenches indicate substantial occupation before 1000. All of the trenches indicate that this location was abandoned about 1100. Stream cuts through the midden of the visible upper farm mound indicate that occupation began there immediately after 1100.

Our test pits and test trenches at Víðimýri and Reynistaður indicate that these farmsteads were probably established before 1000. Little is preserved at Viðimýri because of extensive landscape alteration from the Víðimýará. Two 1 x 1 m test trenches indicate that there was occupation well before 1100. Although the 1000 layer was not present in either of the trenches, cultural material recovered in cores indicates that Víðimýri was occupied before that time. Reynistaður has two farm mounds, possibly both established before 1000. The earliest definite occupation at Reynistaður, sometime before 1000, was of Langhúshóll—a small oval mound 300 meters east of the large farm mound where most of the settlements seem to have been located. Whether these two occupations are contemporaneous or indicate a shift from Langhusehóll to the later site remains unclear.

Of the early large sites identified, Glaumbær, is particularly interesting. We identified a series of turf walls and a thin, but extensive, peat ash midden, 150 meters to the east of the old turf manner house that now houses the Glaumbær Folk Museum. The walls and midden were under an in place 1104 tephra layer. Less than 10% of the identified area has been excavated so little is known about the structure. However, the extensive remote sensing, excavation and coring suggests a long-house and farm buildings extending approximately 30 meters, surrounded by a midden that extends over 3,500 m^2 (Figure 2). we have identified two parallel 2 meter thick turf walls, and two parallel 1.8 meter benches lining each side of a 1.8 meter wide tramped earth floor. Interestingly, there is one turf wall that seems to have been built before 1000 AD but that early wall's relationship to the main structure is unclear. It would appear that most of the occupation was after 1000 and the structure was abandoned before the 1104 AD Hekla fell. Bog iron working seems to have been a major activity at the site.

Local tradition had it that the turf house museum is located where all previous domestic structures had been. A test trench into the ash midden outside the back door of the turf manor house, indicates that the area around the turf museum was inhabited after the newly discovered long-house was abandoned. We found an ash midden immediately on top of an in-place 1104 tephra which lay on sterile soil. This would imply that sometime around 1100 AD the farm moved, just as at Stóra Seyla. No other structures occupied before 1300 AD were identified on the other hay fields of Glaumbær.

According to the *Saga of the Greenlanders*, the land at Glaumbær was bought by Þorfinnur karlsefni Þórðarson and his family after their return from a failed attempt to colonize Vínland. The other version of the Vínland story, the *Saga of Erik the Red*, implies, though does not explicitly state, that karlsefni lived at his father's farm, Reynistaður. According to both versions, karlsefni's wife, Guðríður Þorbjarnardóttir, accompanied Eiríк rauða Þorvaldsson to Greenland, where she met karlsefni and went to Vínland with karlsefni. While in Vínland, Guðríður gave birth to a son, Snorri Þorfinnsson, who if existed, would be the first European born in the New World. After the family returned to Iceland, via Greenland and Norway, the *Saga of the Greenlanders* goes on to say that Guðríður went south (to Rome) on a pilgrimage and when she returned to Glaumbær, Snorri had built a church for her.

Many scholars believe that the last section of the *Saga of the Greenlanders*, which concerns Glaumbær, is unhistorical and anachronistic (e.g., Hermannsson 1966 [1936]; Ingstad & Ingstad 2001 Þorláksson 2001). While our research indicates that there was a turf wall built before 1000, the main long-house occupation appears to be consistent with the timing indicated in the Vínland sagas for the return of Guðríður and her family to Iceland. It seems to us that it is best to follow Wallace's (2000) approach and combine as many elements as possible from the two stories and make them consistent with the archaeological record. This is especially pragmatic in Iceland, where it would be odd for sagas to differ on the location of family farmsteads. If the stories are true, it would imply that, the family spent the first winter at Reynistaður and then moved to Glaumbær. Then both Reynistaður and Glaumbær would have been in the possession of karlsefni's family.

We may never be able to establish any connection between between this possible long-house and the Vínland stories—although a piece of maple [Mosurr] found in further excavations might help. Nonetheless, the discovery is illuminating. It demonstrates how strong the bias is towards attributing the location of past structures to ruins viable today (*cf*. Friðriksson 1994). Most importantly, the long-house at Glaumbær seems to fit into a broader pattern, where in about 1100 AD large farms seem to shift locations.

The patterning of these large early farms is suggestive. It would appear that large sites seem to be established before 1000 and move locations about 1100. The placement and spacing of these large early farmsteads indicate little differential access to resources, each location was probably self sufficient. Much of the pattern comes from the spacing between the farms, and the negative evidence for the lack of farmsteads between identified sites is good, but many more farms and areas still need to be surveyed.

We expected that with this protocol we would find mostly early small farmsteads. However, we have only identified one early small farmsteads away from a farm mound (Torfgarður [SK-106-100] Table 2 and Figure 4). All of the other early small farms we have identified have been near on part of visible farm mounds. Furthermore, all of the smaller farms we have identified and have good chronological control on, were first occupied sometime between 1000 and 1100 AD. The distribution and timing of these small farmsteads suggests that they were split off from the early large farms that they seem to surround. Again, the negative evidence, which could be more complete, is nonetheless suggestive. Many of the smaller farms are historically identified as either tenant or subtenant farms of the larger farms they surround. If most early farms are initially large, and smaller farms are split off later, then it implies that lower status individuals established farms on the land of their patron. The archaeology of the large and small farmsteads suggest that the sharecropper or hjaleiga system may have been established as early as the mid-11th century.

To summarize our very preliminary results. If historical sources such as Landnámabók are reliable, initial land claims were quickly divided into widely dispersed, large farms. Sometime between 1000 and 1100 AD, these large farm properties were subdivided with the addition of smaller farms, possibly of lower status (Figure 4). Sometime around 1100, many of the larger farms are reorganized and shift locations. This relatively rapid sequence of changes suggests that social structure was quite dynamic during the Commonwealth. The lack of a two-tiered settlement hierarchy until after 1000 AD argues for Gilman's (1995) suggestion, that social stratification was initially based on exploitation and later became institutionalized.

Farmhouse location appears to quite stable after 1100 AD and the distribution of present day farm mounds may be broadly representative of the medieval settlement pattern. Before 1100 AD, the settlement pattern seems to be very dynamic and sub-surface survey is necessary for an unbiased survey because a substantial portion of these sites are not visible on the surface. Excavations of large farmsteads and the surrounding later smaller ones will be necessary to more fully understanding the sequence and relationship.

Appendix

UTM Grid

The National Imagery and Mapping Agency (NIMA, formerly the Defense Mapping Agency) adopted a special grid for military use throughout the world called the Universal Transverse Mercator (UTM) grid. In this grid, the world is divided into 60 north-south zones, each covering a strip 6° wide in longitude. These zones are numbered consecutively beginning with Zone 1, between 180° and 174° west longitude, and progressing eastward to Zone 60, between 174° and 180° east longitude. In each zone, coordinates are measured north and east in meters. The northing values are measured continuously from zero at the Equator, in a northerly direction. A central meridian through the middle of each 6° zone is assigned an easting value of 500,000 meters; grid values to the west of this central meridian are less than 500,000; to the east, more than 500,000.

Our work employed the UTM grid system as augmented by Steinberg (1997). The primary units of analysis are 50 x 50 m survey "blocks." These blocks are assigned UTM coordinates based on their southwest corner, for example 0463855 East, 6305350 North (500000-463855 = 36145 m from the Meridian). As in a normal UTM system (Cole 1992), the measurements in our nested UTM system are based on metric Cartesian coordinates (UTM grid zone 27). All units for collection and analysis of data and artifacts are provenienced at their southwestern corner. As the analytical units become larger, the number of digits in their provenience becomes smaller. For example, the coordinates of the block, have 6 digits (e.g., E 046750, N 710450). The provenience of the excavation unit is calculated to 7 digits (e.g., 0467567, 7104567). Soil samples and features are calculated to the decimeter (04675678, 71045678), and point provenienced artifacts or radiocarbon samples are calculated to the centimeter (046756789, 710456789). While excavating, a level, elevation or depth is added to the Nested UTM coordinate, so that no two units have the same designation (e.g., 0467567, 7104567, 10).

The advantages of adopting the nested UTM System are threefold. First, the recording system is immediately compatible with many other recording systems (Hansen 1992). It has the potential to be a worldwide standardized system of recording artifactual data. Second, the system allows for comparisons across different data sets simply by removing digits to the place of the appropriate analytical unit of analysis. For example, point provenienced artifacts can be analyzed with their appropriate excavation unit simply by removing the last two digits. Finally, nested UTM squares are easy to computerize. The simplicity and universal nature of the nested UTM System makes it easily adaptable on excavation and survey projects of all scales.

All sites investigated in the were first grided by scanning the basic quad map and superimposing a block grid of hectare and 50x50 lines. Datums were set where identifiable landscape makers intersected grid lines. A color system of flags (orange for ha, yellow for 50x50, white for 10x10, and red for 2) was placed at the southwest corner of each nested unit. All units are aligned UTM grid north, which in Mosfell is 0º 47' west of true north.

Remote Prospection

EM-31

The EM 31- MK2 is an updated version of the standard EM 31, with which we had great success in 1999. The MK2 incorporates the data logger into the control console, which can be removed for easy data handling, or hand carried during the survey. Real-time logging is available by connecting a computer directly to the RS-232 output port on the front panel. The EM 31-MK2 maps any subsurface feature associated with changes in the ground conductivity using a patented electromagnetic inductive technique that makes the measurements without electrodes or ground contact. With this inductive method, surveys are readily carried out in all regions including those of high surface resistivity such as sand, gravel, and asphalt. The effective depth of exploration is about six meters, making it ideal for archaeology.

Following Bevan (1983) we used a grid spacing of 2 m. While it is possible to do both EM and magnetic prospection with the same machine (e.g., the EM-38, Tabbagh 1984, 1986:580), the ability to measure conductivity at a greater depth argued for the EM-31 in Iceland (*cf*. Rapp and Hill 1998:188). Clark (1990) does not recommend The EM-31 for archaeological investigations because the long (4m) boom, theoretically makes for a relatively coarse (0.8m) resolution, but excellent depth (about 3 m, depending on conditions). However, we have found that the at depths of 1 m, the EM-31 is sensitive to changes over distances of less than 50 cm.

All readings are of apparent ground conductivity using the quadrature component. Negative numbers in the survey data are due to the height and surrounding conductivity at which the instrument was calibrated. While the readings (including negative numbers) are not absolute conductivity readings, the distance between any two numbers is consistent (i.e., a conductivity change of 3 millisiemens is a constant difference, even between sites).

The goal of the survey was to identify buried turf walls, which are slightly resistive linear targets. As it turns out, natural conductivity changes in most fields in Iceland are as strong or stronger than most human-induced changes; but the natural changes typically take place over greater distances. The range of readings used in displaying remote sensing data can be a determinant in the identification of anomalies (Zhurbin and Malyugin 1998). All scales for magnetic gradient and conductivity were created with a basic box-and-whisker algorithm in which the display range does not extend to the extreme readings. That is, the scales cover the box-and-whisker portions of the range (Table 1). The upper end of the display scale was set to the median plus the sum of quartile 3 and 1.5 times the interquartile range. The lower end of the scales ranges from the median down to the sum of quartile 2 and 1.5 times the interquartile range. Colors or shades of gray for the scales were determined by:

$$x - lw / wr = c \qquad (1)$$

where *x* is reading, *lw* is the lower whisker, *wr* is the whisker range and *c* is the color or shade of gray. The spectrum for each graph is the total length of the interquartile range plus the two whiskers. This range is spread over 60 different colors or shades of gray. It should be noted that because of the dramatic differences between the base readings at different sites, colors or shades of gray from one site to the next are not comparable.

The Graphs were created in SYSTAT 5.0 for the Macintosh. The colors on the maps use a wavelength scale (nanometers) from 400 (purple) to 700 (red), in which each increment is an increase of 5. The lower whisker is 400 and the upper whisker is 700. Gray scale maps use a corresponding scale of 0-100% with 60 increments of gray, with each stop increasing by 1.66%. Magnetic gradient, raw conductivity scores and the maximum difference in conductivity were converted using the following equation:

$$\left(\frac{(c - lw)}{wr} * 300\right) + 400 \qquad (2)$$

Where *c* is the conductivity (or the maximum difference in conductivity), *lw* is the lower whisker, and *wr* is the whisker range.[1] Readings smaller than the lower whisker are purple and readings greater than the upper whisker are dark red (for similar shortenings see Ladefoged et al. 1995). In accordance with identifying our turf wall-eolian soil interface, this scale emphasizes variation with the main reading range.

Syscal Kid

The Syscal Kid is especially designed for shallow resistivity imaging. The Switch 24 features an internal switching board supporting 24 electrodes. Two cable strings with 12 electrode take outs each are connected to the back of the meter. The included software automatically performs roll-along surveys, which are quickly completed, even with a single operator.

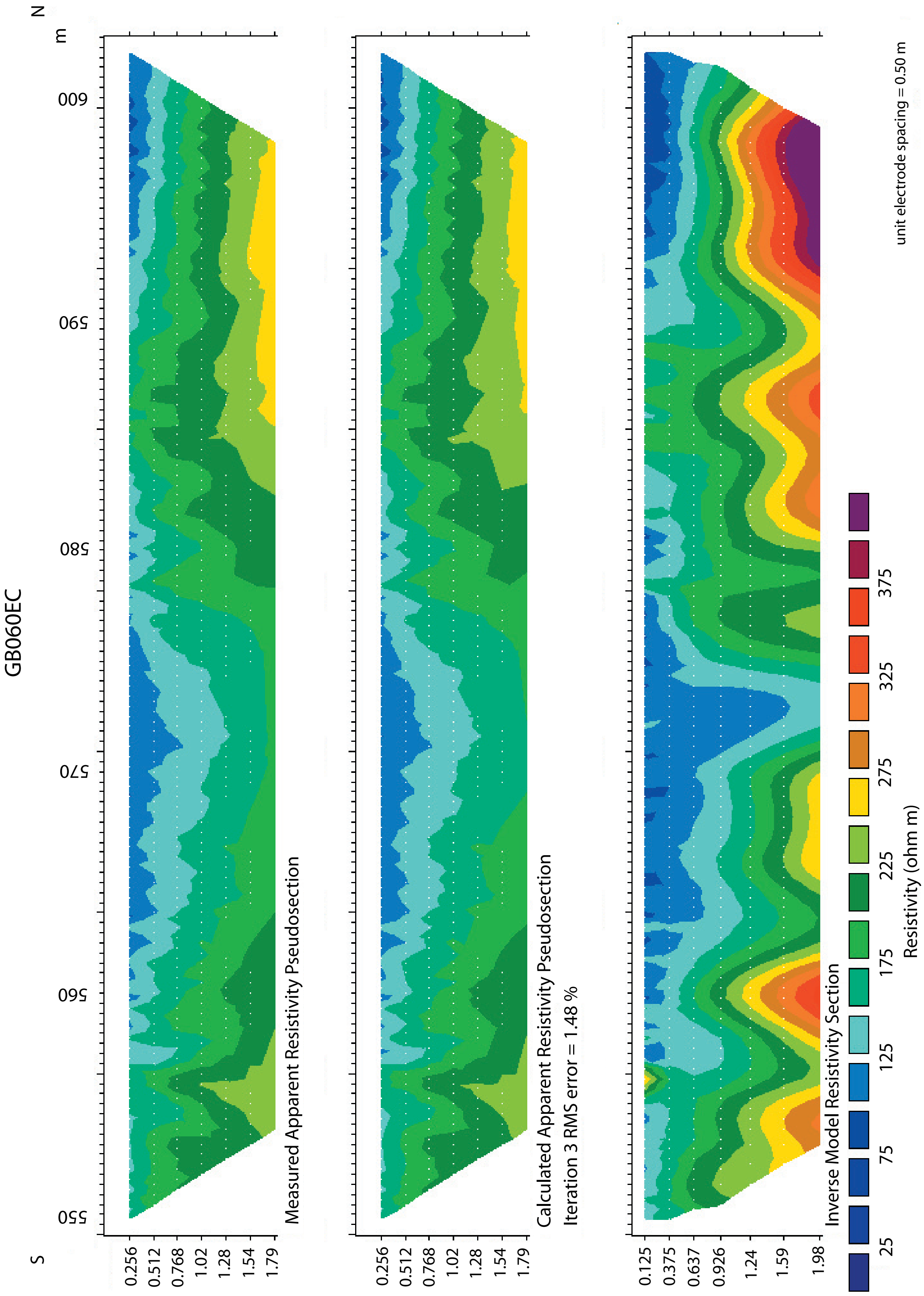
Site	Location	Filename	Date	Direction	Length (m)	Minimum Spacing (m)	"a" Spacings	Number Meas.	1st Electrode	1st Plot Pnt.	Fieldbook
Glaumbaer		GB060E	7/23/02	S-N	53.5	0.50	7	546	060E, 549.25N	550N	I: 67-68
"		GB576N	7/23/02	W-E	59.5	0.50	7	612	023.25E, 576N	024E	I: 69-70
"		GB576NA	7/25/02	W-E	41.5	0.50	7	414	063.25E, 576N	064E	I: 71-72
"		GB582NA	7/25/02	W-E	41.5	0.50	7	414	063.25E, 582N	064E	I: 72-73
"		GB594NA	7/25/02	W-E	53.5	0.50	7	546	053.25E, 594N	054E	I: 73-74
"		GB540N	7/26/02	W-E	71.5	0.50	7	744	-000.75E, 540N	000E	I: 75-76
"		GB540NA	7/26/02	W-E	23.5	0.50	7	216	059.25E, 540N	060E	I: 77
"		GB030E	7/26/02	S-N	41.5	0.50	7	414	030E, 533.25N	540N	I: 77-78
"		GB034E	7/27/02	S-N	47.5	0.50	7	480	034E, 533.25N	540N	I: 79-80
"		GB038E	7/27/02	S-N	53.5	0.50	7	546	038E, 533.25N	540N	I: 80-82
"		CNL15E	7/28/02	W-E	35.5	0.50	7	348	000.75E, 582N to 035.5E, 584N[1]		I: 83-84
	TOTAL			**11**	**522.5**			**5280**			
Gorfargil		GR291N	8/6/02	E-W	65.5	0.50	7	678	306.75E, 291N	306E	I: 89-91
"		GR289E	8/6/02	S-N	53.5	0.50	7	546	289E, 267.25N	268N	I: 91-92
	TOTAL			**2**	**119.0**			**1224**			

Hafsteinstedir		HS157E	8/18/02	S-N	47.5	0.50	7	480	157E, 026.25N	027N	I: 96-97
"		HS046N	8/19/02	W-E	31.0	0.50	7	332	129.25E, 046N	130E	I: 98
"		HS046NA	8/19/02	W-E	29.5	0.50	7	282	153.25E, 046N	154E	I: 99
	TOTAL			**3**	**108.0**			**1094**			
Holar	western field	HO380E	6/28/02	S-N	41.5	0.50	7	414	6380E, 1644N		I: 5-7
"	"	HO384AE	6/29/02	S-N	41.5	0.50	7	414	6384E, 1643.25N	1644N	I: 8-11
"	"	HO388E	7/1/02	S-N	41.5	0.50	7	414	6388E, 1643.25N	1644N	I: 12-13
"	"	HO392E	7/1/02	S-N	41.5	0.50	7	414	6392E, 1643.25N	1644N	I: 13-14
"	"	HO396E	7/1/02	S-N	41.5	0.50	7	414	6396E, 1643.25N	1644N	I: 14-15
"	"	HO400E	7/2/02	S-N	35.5	0.50	7	348	6400E, 1643.25N	1644N	I: 16-17
"	"	HO404E	7/2/02	S-N	35.5	0.50	7	348	6404E, 1643.25N	1644N	I: 17-18
"	"	HO665AN	7/2/02	W-E	41.5	0.50	7	413	6373.25E, 1665N	6374E	I: 18-19
"	"	HO660N	7/3/02	W-E	53.5	0.50	7	546	6373.25E, 1660N	6374E	I: 20-21
	subtotal			**9**	**373.5**			**3725**			
Holar	northern field	HO707N	7/3/02	W-E	29.5	0.50	7	282	6385.25E, 1707N	6386E	I: 21-22
"	"	HO717N	7/3/02	W-E	47.5	0.50	7	480	6374.25E, 1717N	6375E	I: 22-23
"	"	HO726N	7/4/02	W-E	41.5	0.50	7	414	6374.25E, 1726N	6375E	I: 25-26
	subtotal			**3**	**118.5**			**1176**			
	TOTAL			**12**	**492.0**			**4901**			

Stora Seyla	upper field	ST022E	7/8/02	S-N	47.5	0.50	7	480	0022E, 3399.25N	3400N	I: 27-28
"	"	ST020E	7/8/02	S-N	23.5	0.50	7	216	0020E, 3420.25N	3421N	I: 29
"	"	ST016E	7/9/02	S-N	71.0	1.00	7	348	0016E, 3398.5N	3400N	I: 30-31
"	"	ST440N	7/9/02	W-E	41.5	0.50	7	414	-0000.75E,3400N	0000E	I: 31-32
"	"	ST430N	7/10/02	W-E	53.5	0.50	7	546	-0000.75E,3430N	0000E	I: 33-34
"	"	ST044E	7/10/02	S-N	53.5	0.50	7	546	0044E, 3399.25N	3400N	I: 35-36
"	"	ST040E	7/11/02	S-N	53.5	0.50	7	546	0040E, 3999.25N	3400N	I: 37-38
"	"	ST426N	7/11/02	W-E	35.5	0.50	7	348	0016.25E, 3426N	0017E	I: 39-40
	subtotal			**8**	**379.5**			**3444**			
Stora Seyla	lower field	ST530N	7/12/02	W-E	47.5	0.50	7	480	0059.25E, 3530N	0060E	I: 41-42
"	"	ST072E	7/13/02	S-N	47.5	0.50	7	480	0072E, 3499.25N	3500N	I: 43-44
"	"	ST077E	7/15/02	S-N	53.5	0.50	7	546	0077E, 3499.25N	3500N	I: 45-46
"	"	ST080E	7/15/02	S-N	53.5	0.50	7	546	0080E, 3499.25N	3500N	I: 47-48
"	"	ST083E	7/15/02	S-N	53.5	0.50	7	546	0083E, 3499.25N	3500N	I: 48-49
"	"	ST091NW	7/16/02	SE-NW	47.5	0.50	7	480	091E, 508N to 065E, 547N(2)		I: 50-51
"	"	ST096NW	7/16/02	SE-NW	47.5	0.50	7	480	096E, 508N to 070E, 547N(2)		I: 51-52
"	"	ST101NW	7/16/02	SE-NW	53.5	0.50	7	546	101E, 508N to 072E, 552N(2)		I: 52-55
"	"	ST538N	7/17/02	W-E	53.5	0.50	7	546	0050.25E, 3538N	0051E	I: 56-57
"	"	ST541N	7/17/02	W-E	47.5	0.50	7	480	0059.25E, 3541N	0060E	I: 57-58
"	"	ST544N	7/17/02	W-E	41.5	0.50	7	414	0064.25E, 3544N	0065E	I: 58-60
"	"	ST522N	7/18/02	W-E	53.5	0.50	7	546	0049.25E, 3522N	0050E	I: 61-62
"	"	ST516N	7/18/02	W-E	53.5	0.50	7	546	0049.25E, 3516N	0050E	I: 63-64
"	"	ST510N	7/18/02	W-E	53.5	0.50	7	546	0049.25E, 3510N	0050E	I: 64-66
	subtotal			**14**	**707.0**			**7182**			
	TOTAL			**22**	**1086.5**			**10626**			

Torfgardur	house mound	TG814SW	7/29/02	SW-NE	35.0	1.00	7	150	9814E, 3846N to 9833E, 3873N[1]		I: 85
"		TG835NW	7/29/02	SE-NW	47.0	1.00	7	216	9835E, 3821N to 9814E, 3861N[1]		I: 85-86
"		TG874SW	7/30/02	SW-NE	94.0	2.00	7	216	9874E, 3899N to 9800E, 3845N[1]		I: 87-88
	subtotal				**176.0**			**582**			
Torfgardur	northern field	TG747E	8/12/02	S-N	53.5	0.50	7	546	747E, 968.25N	969N	I: 93-94
"		TG748E	8/12/02	S-N	53.5	0.50	7	546	748E, 968.25N	969N	I: 94-95
	subtotal				**107.0**			**1092**			
	TOTAL				**283.0**			**1674**			

[1] From 1st plot point to last electrode
[2] From 1st to last plot points



GB060EC
S
N
m
550
560
570
580
590
600
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Pseudodepth
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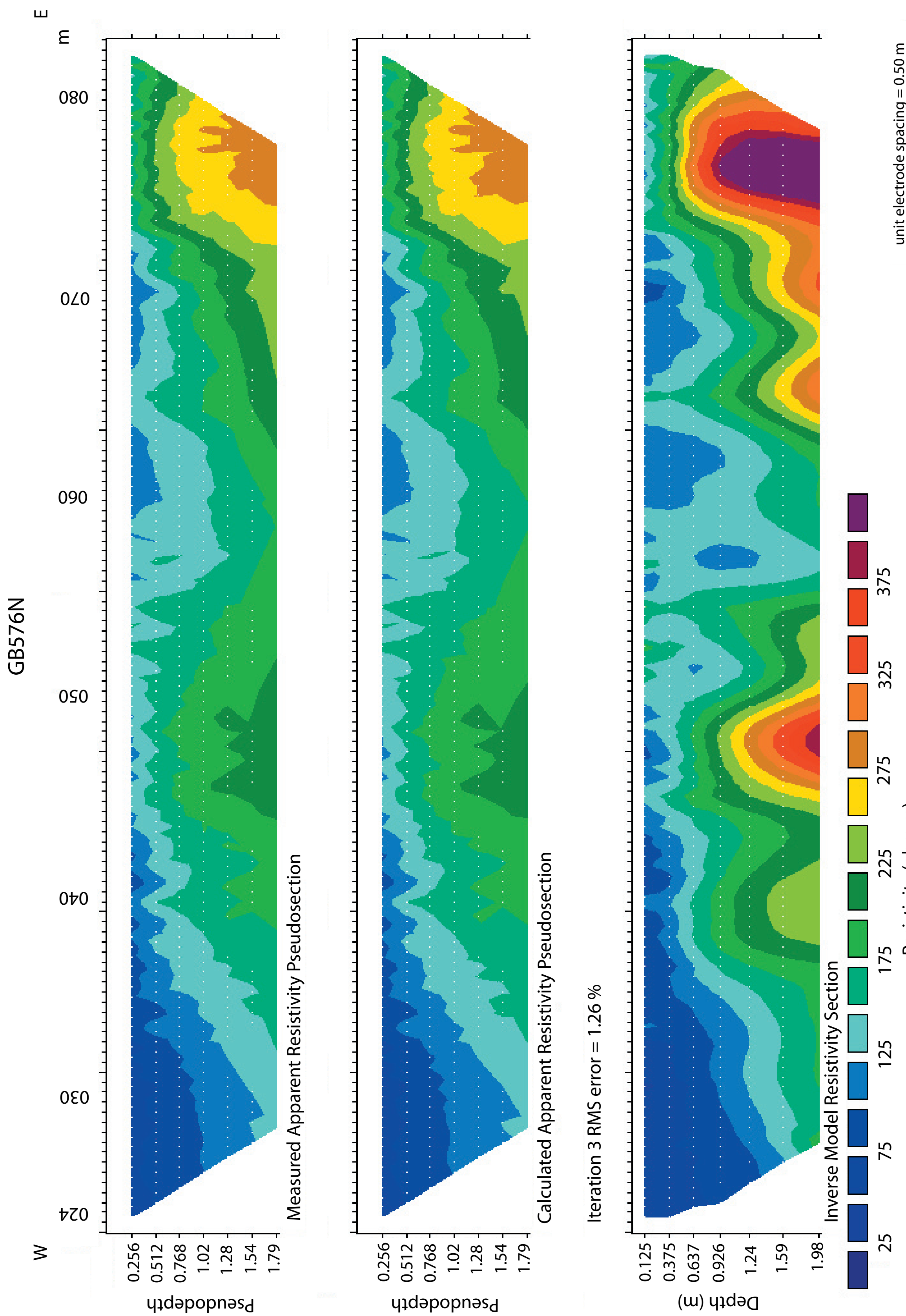
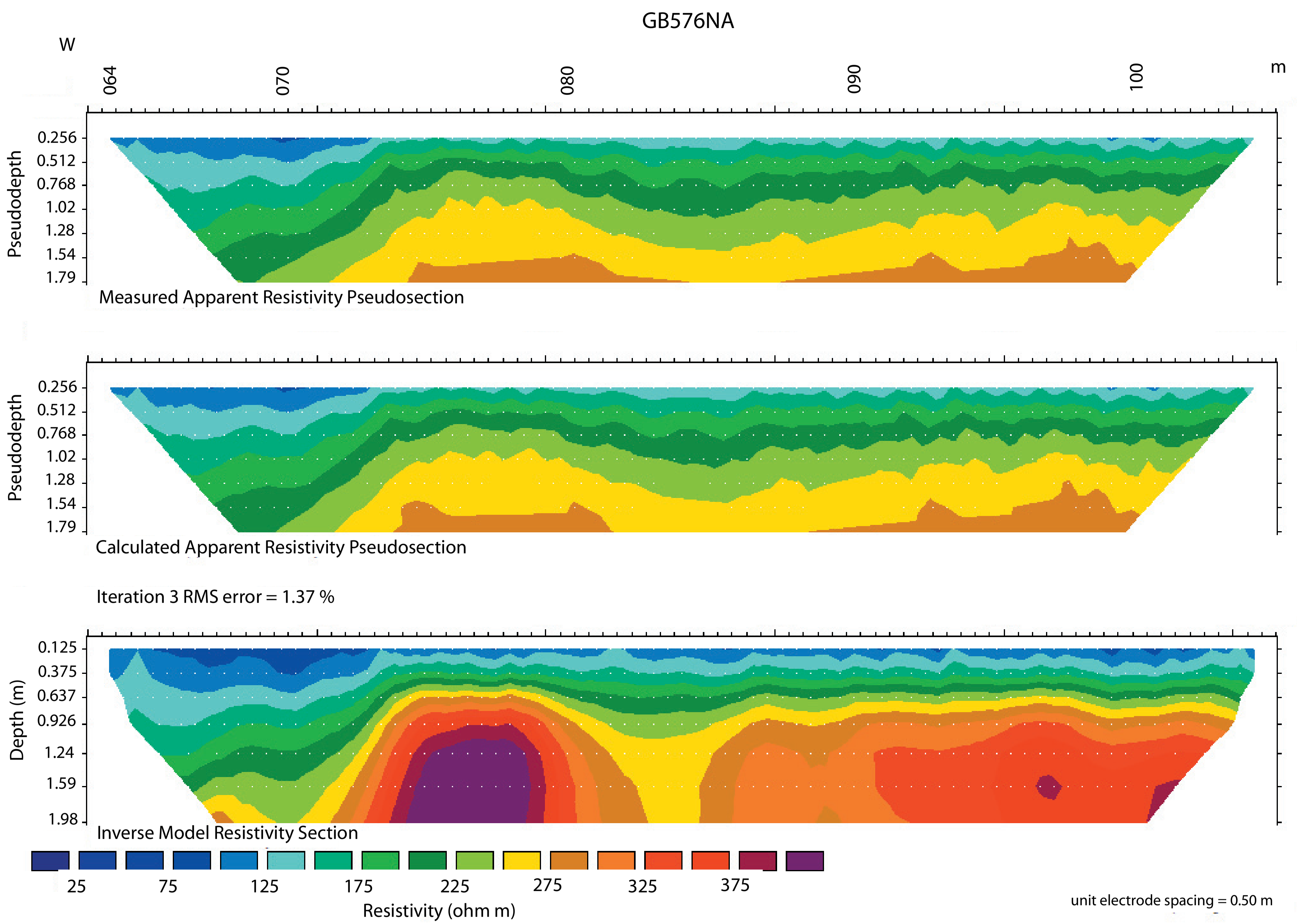
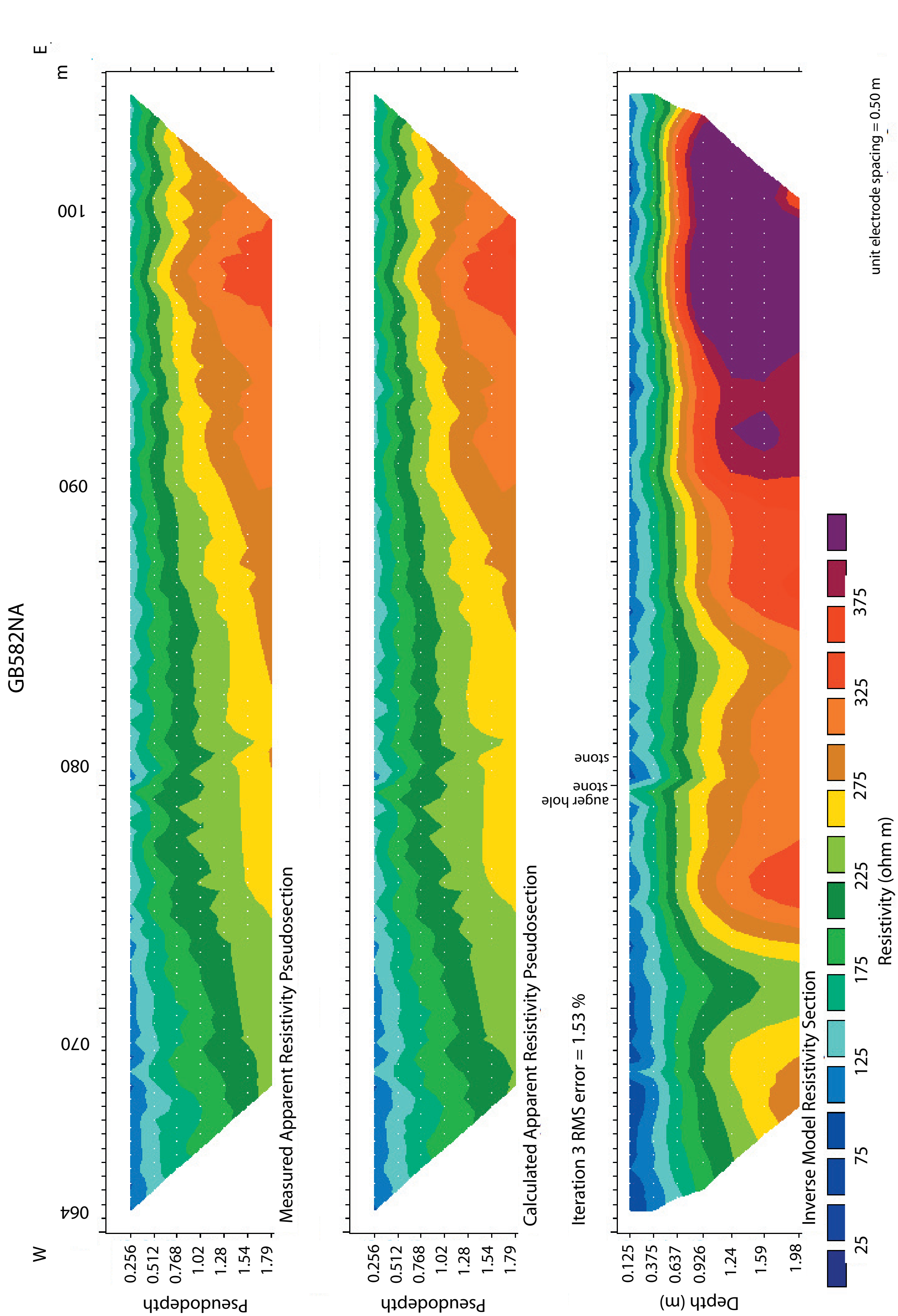
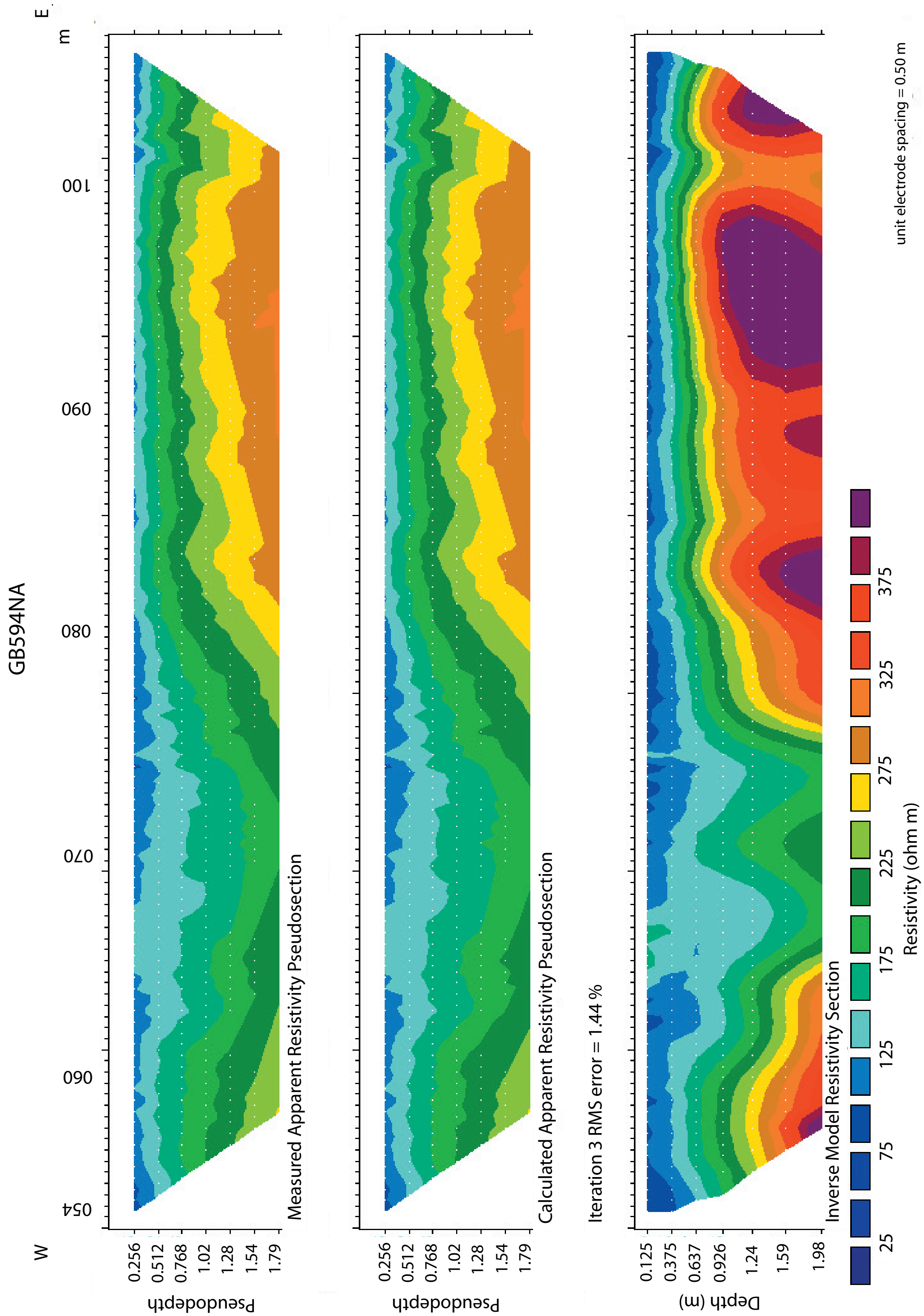
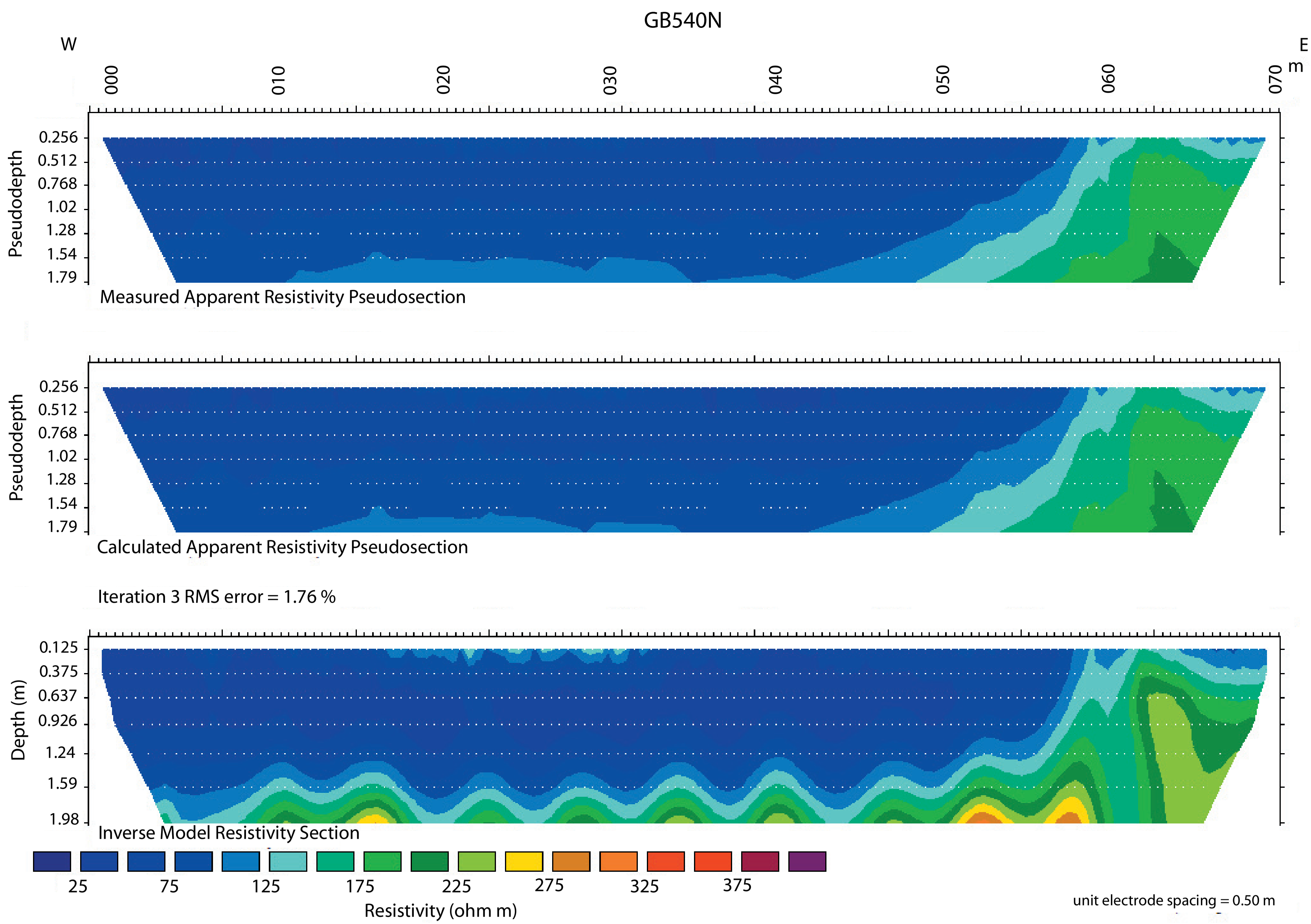
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.48 %
Inverse Model Resistivity Section
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

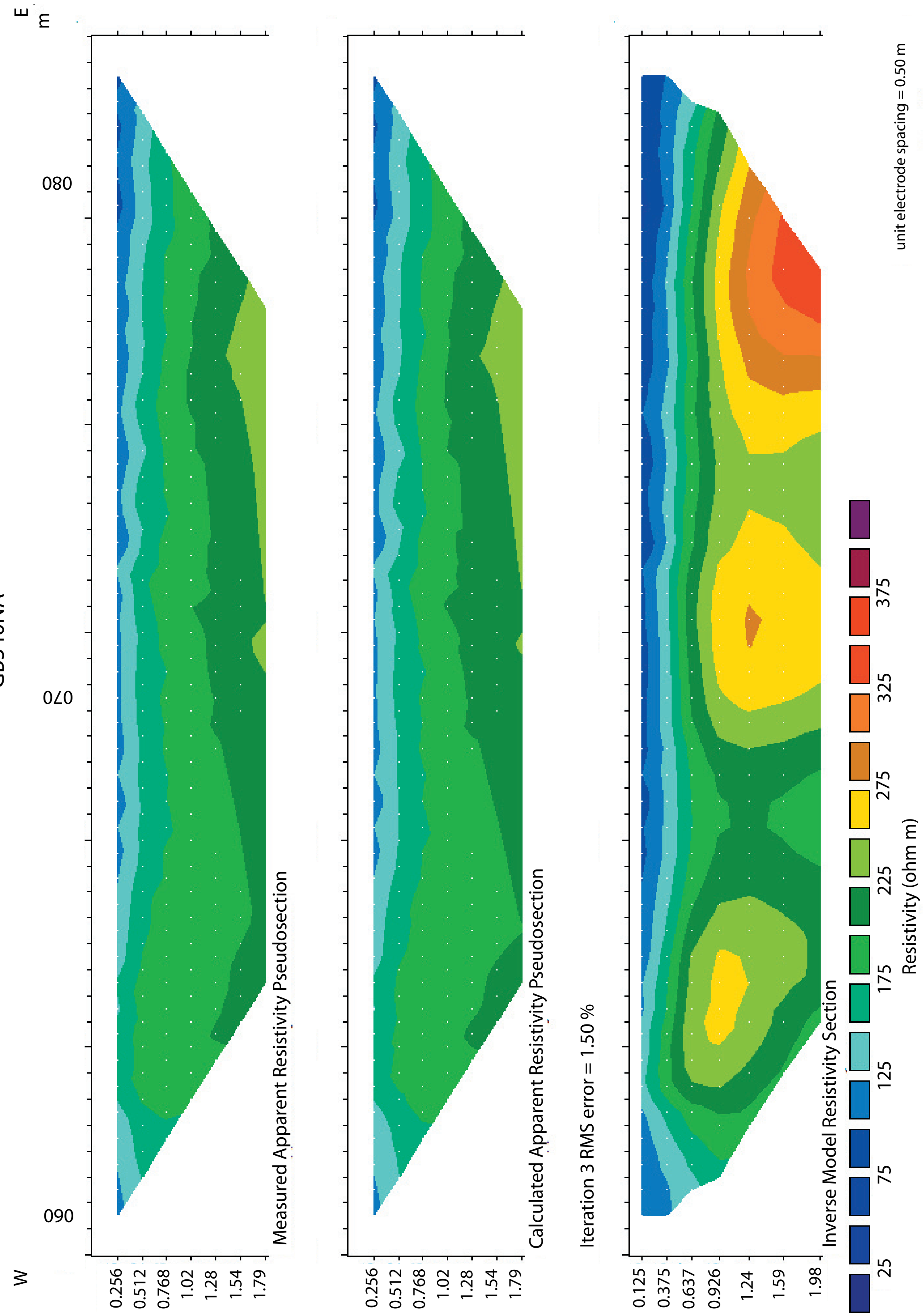

GB576N
W
E
m
024
030
040
050
060
070
080
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.26 %
Inverse Model Resistivity Section
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

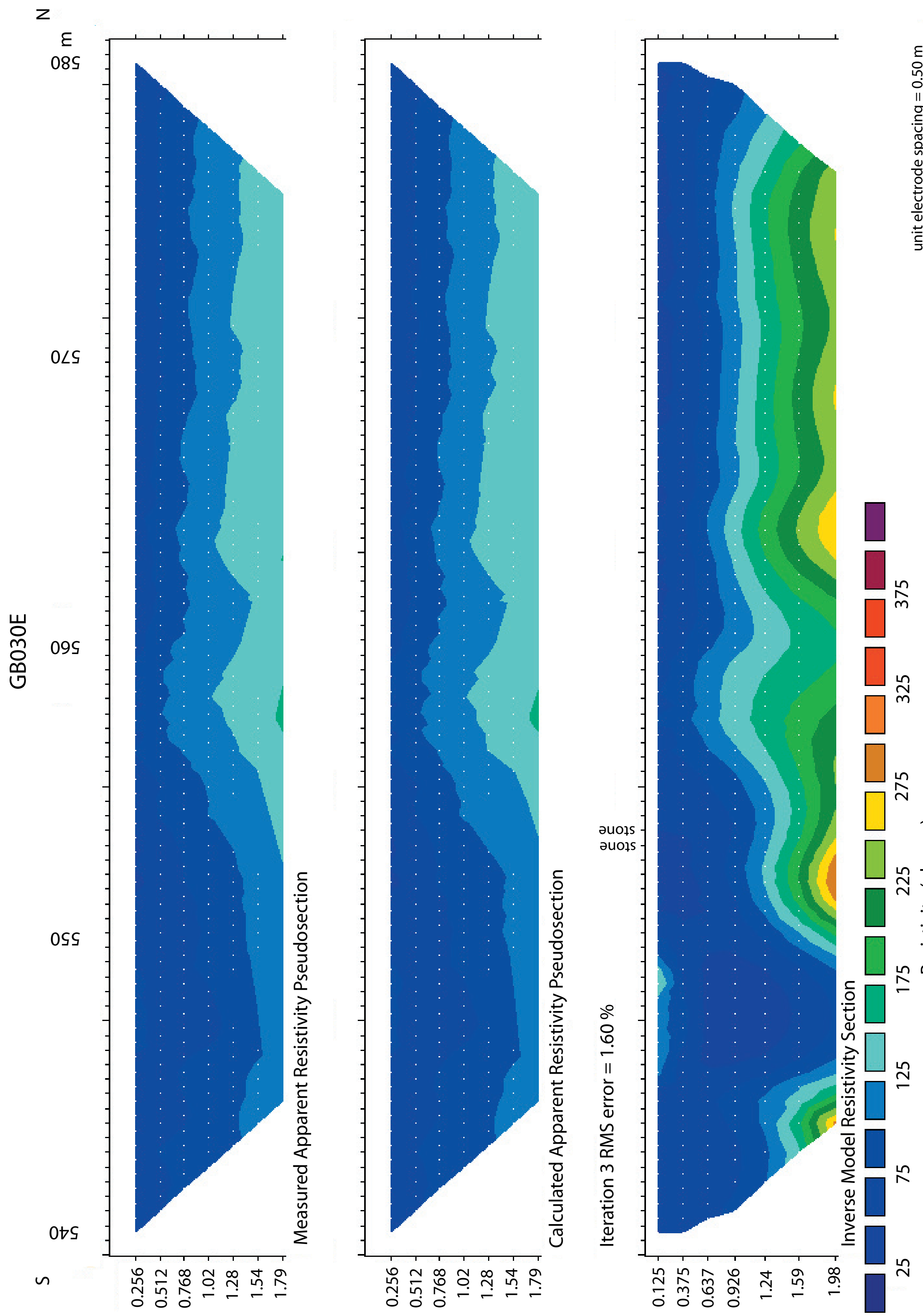

GB576NA
W
E
m
064
070
080
090
100
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.37 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

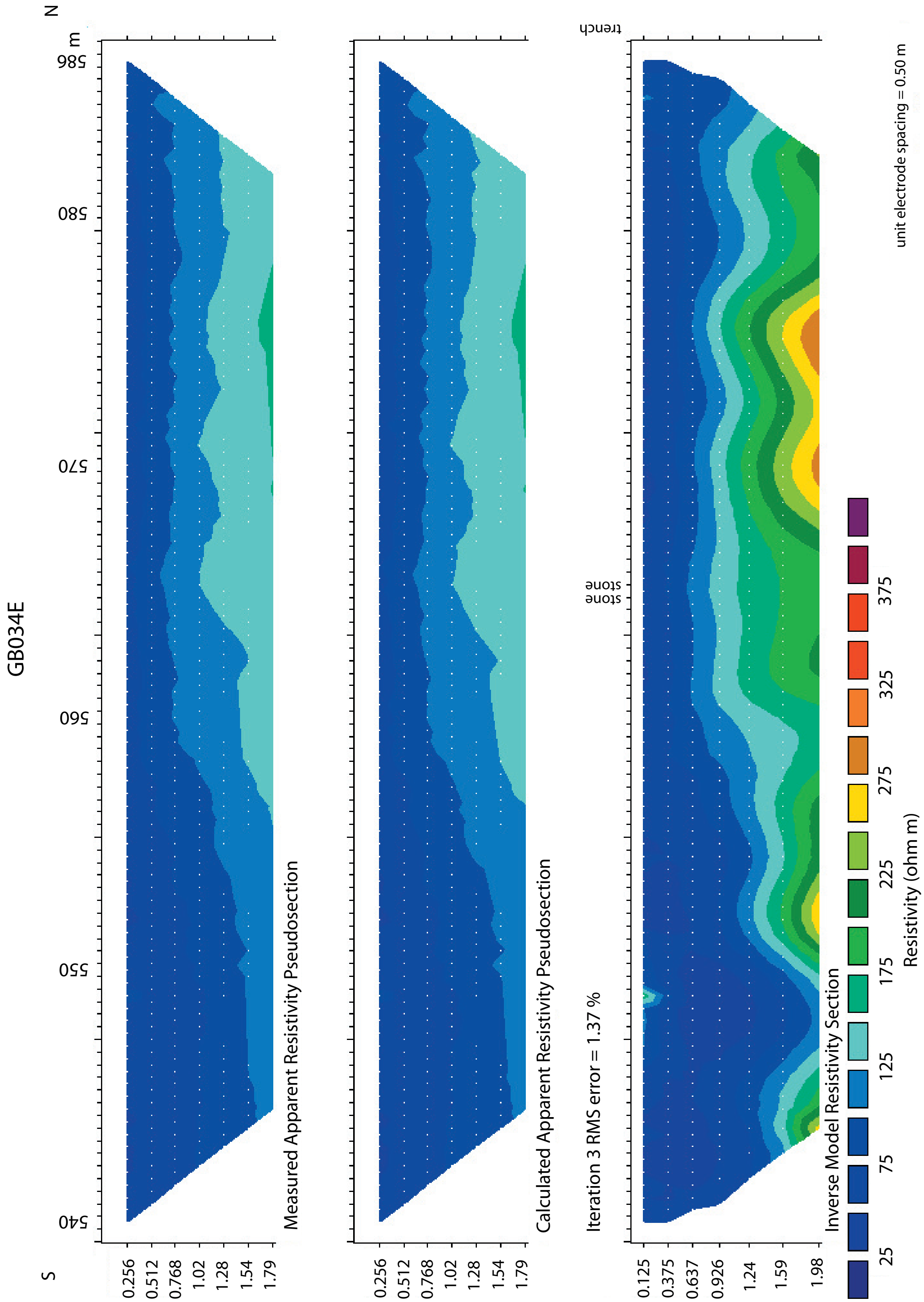

GB582NA
W
E
m
064
070
080
090
100
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.53 %
auger hole
stone
stone
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

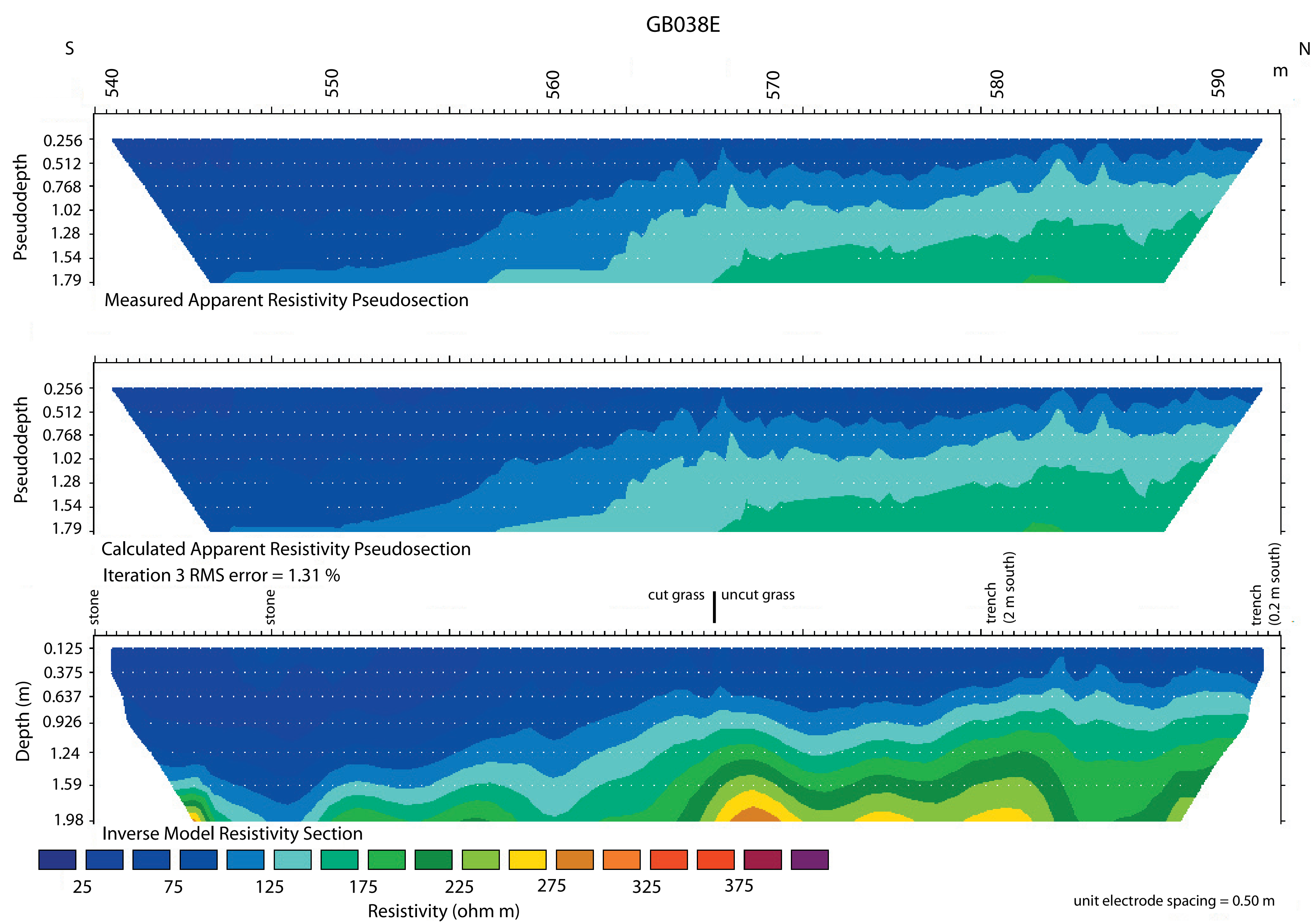

GB594NA
W
E
m
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Iteration 3 RMS error = 1.44 %
Inverse Model Resistivity Section
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m


GB540N
W
E
m
000
010
020
030
040
050
060
070
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.76 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

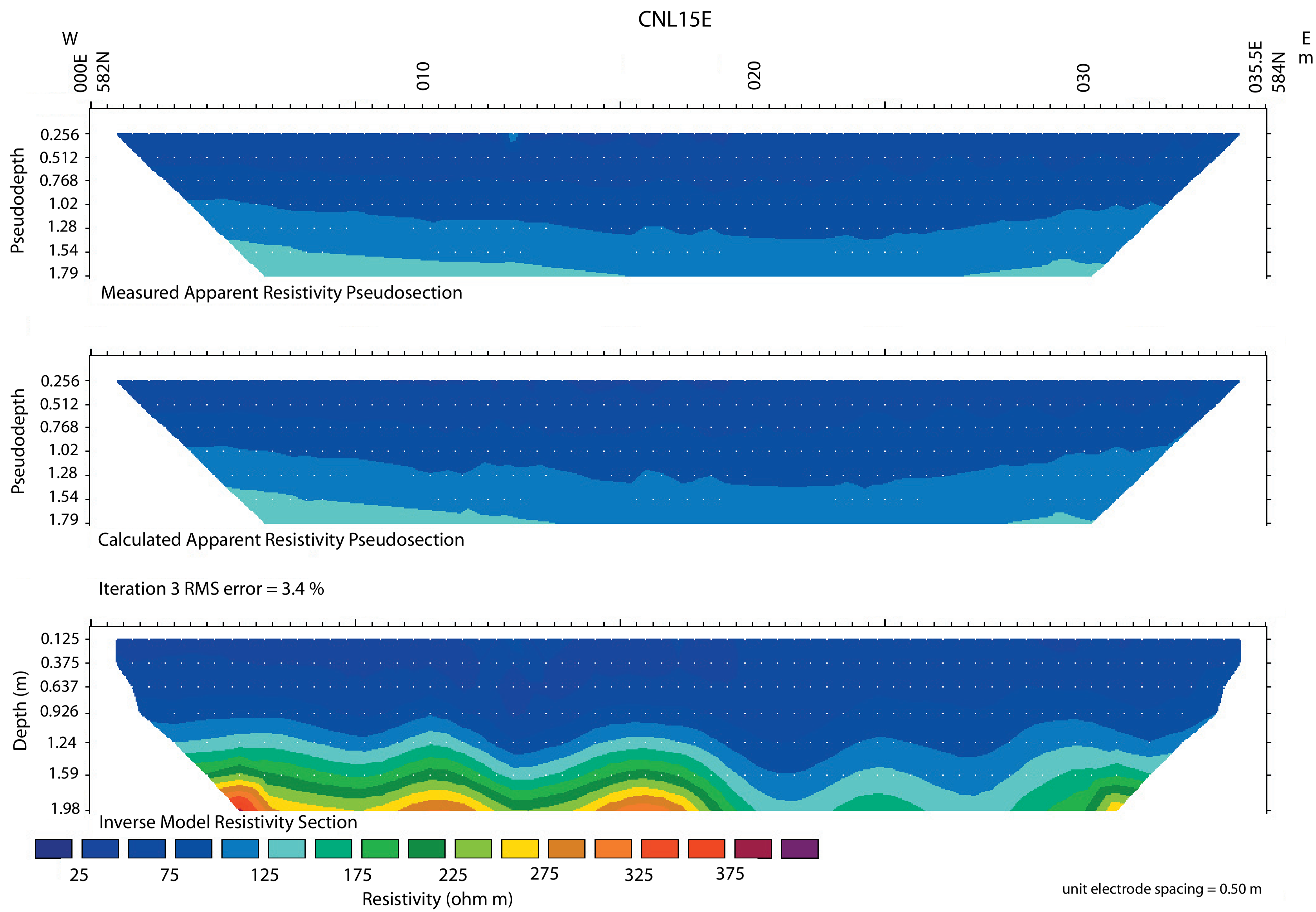

GB540NA
W
E
m
090
070
080
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Iteration 3 RMS error = 1.50 %
Inverse Model Resistivity Section
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

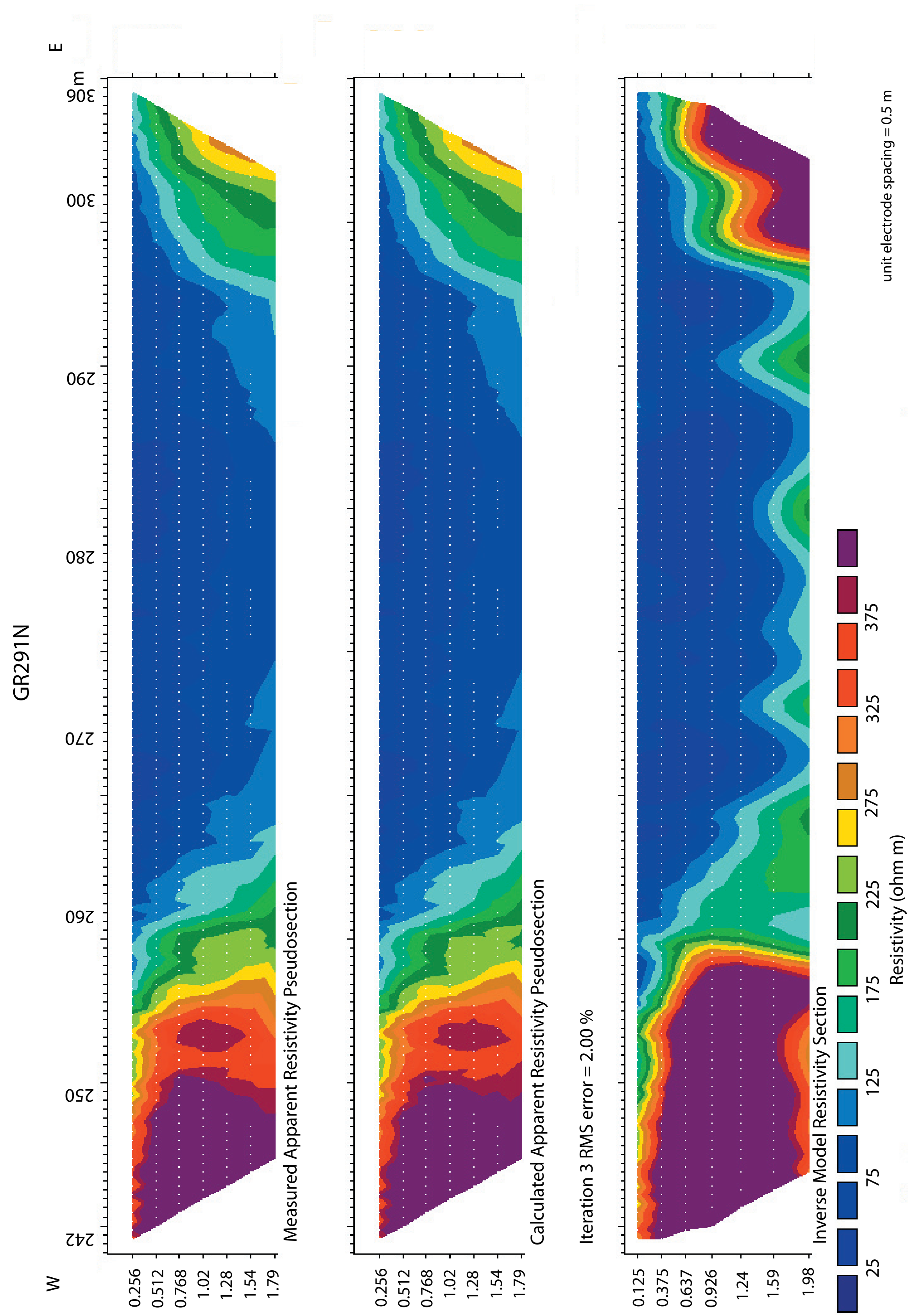

GB030E
S
N
540
550
560
570
580
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.60 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
stone
stone
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m


GB034E
S
N
540
550
560
570
580
586
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.37 %
stone
stone
trench
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

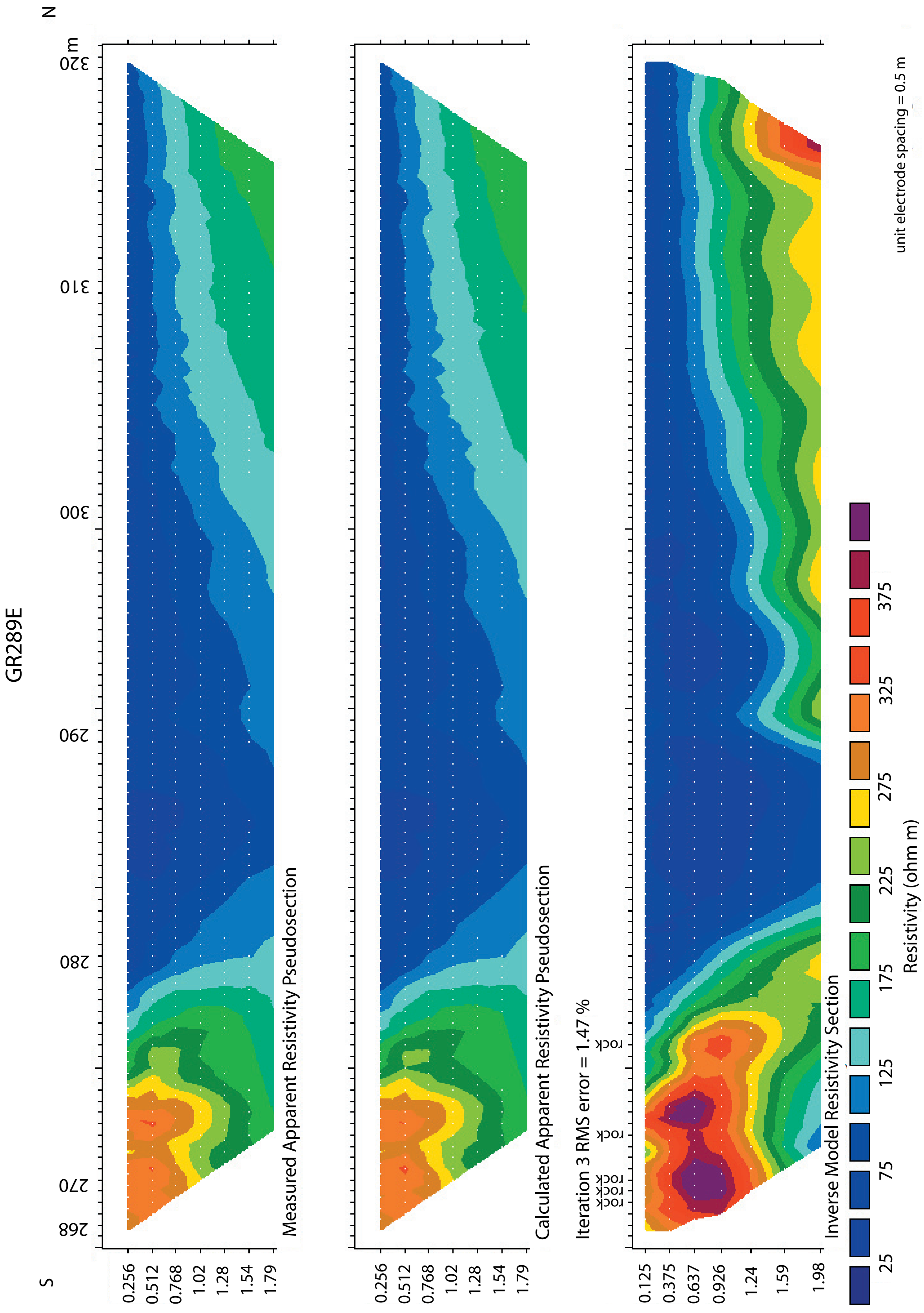


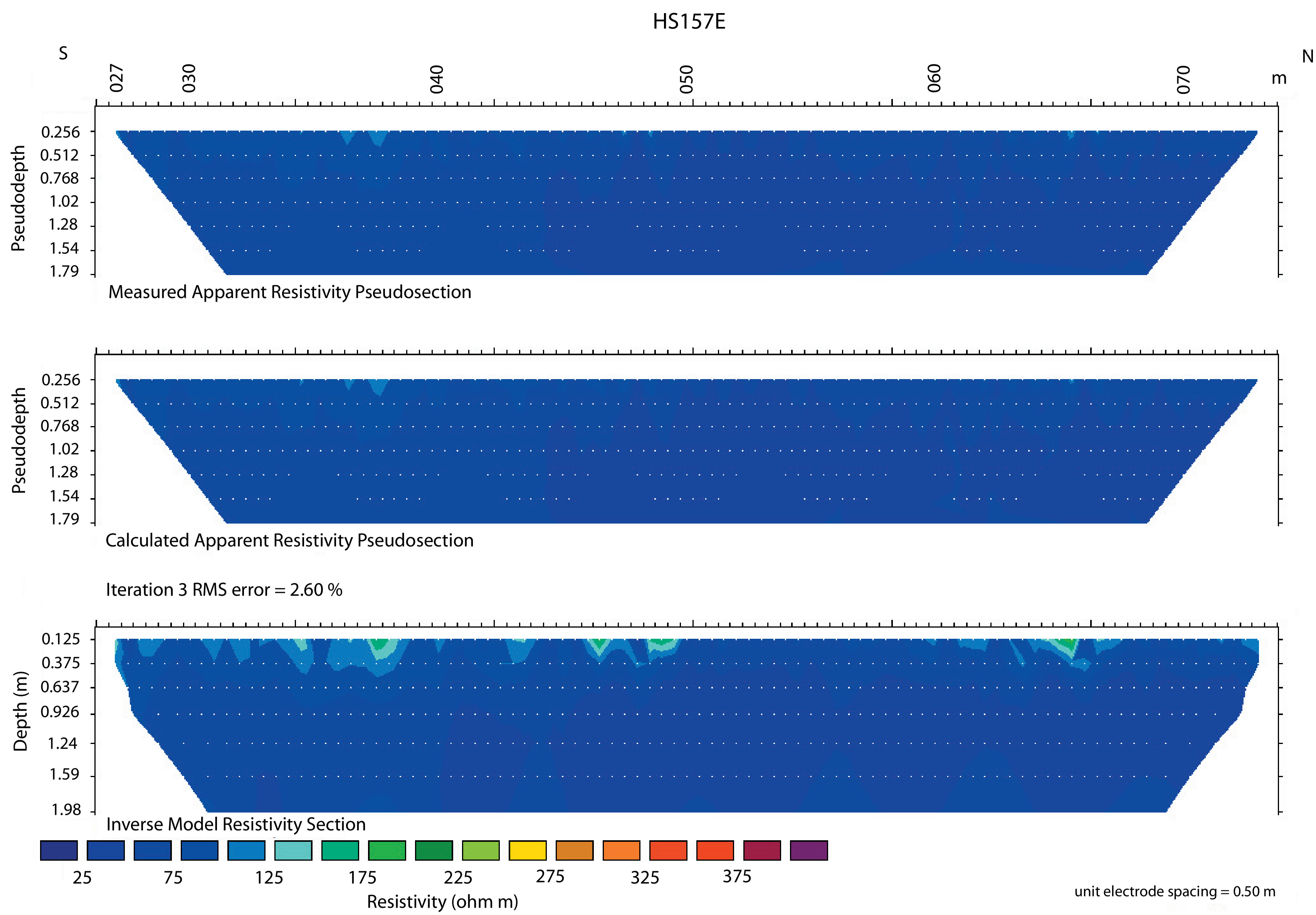
GB038E
S
N
m
540
550
560
570
580
590
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.31 %
stone
stone
cut grass
uncut grass
trench (2 m south)
trench (0.2 m south)
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m


CNL15E
W
000E
582N
010
020
030
035.5E
584N
E
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 3.4 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

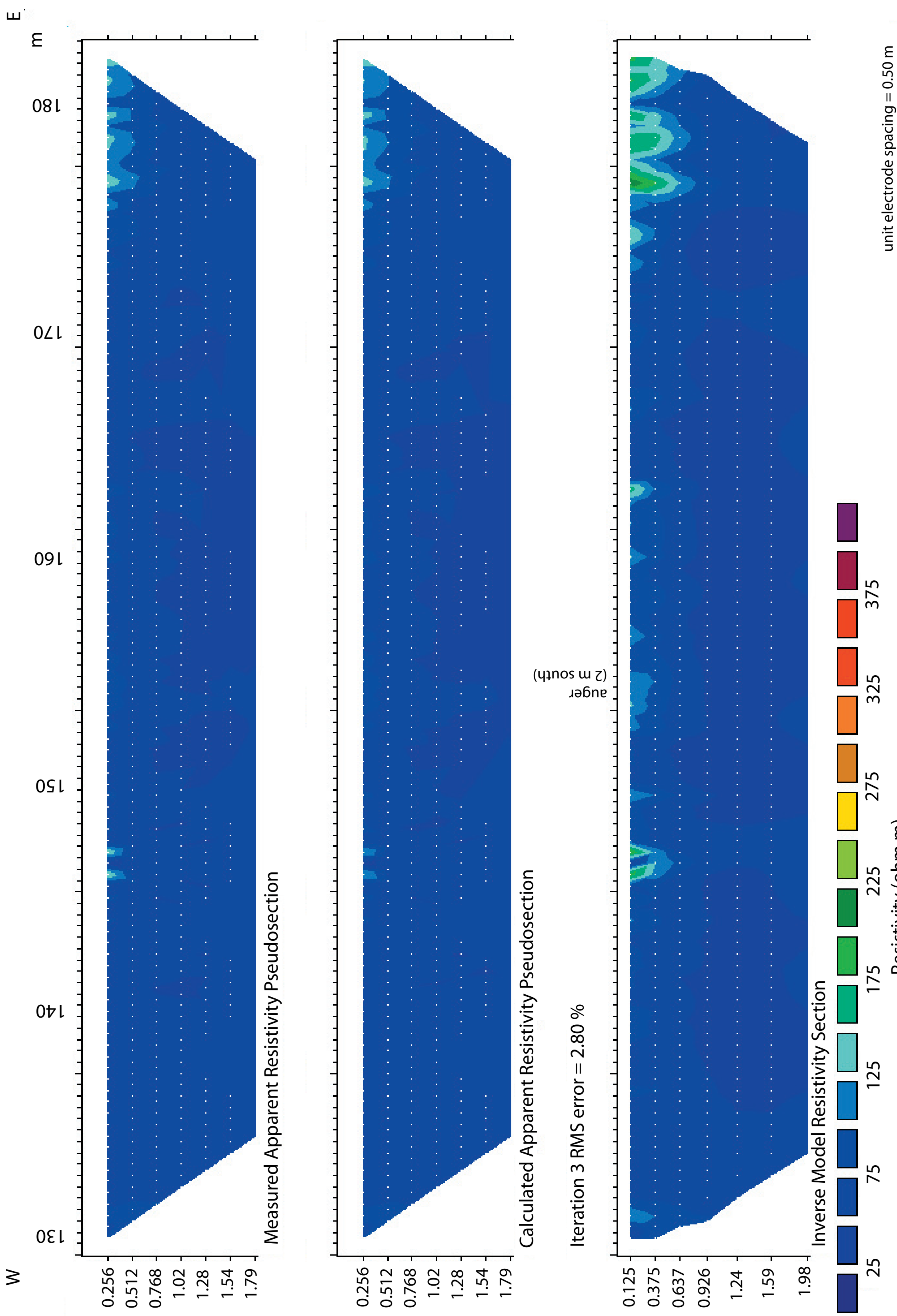


GR291N
W
E
242
250
260
270
280
290
300
306 m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 2.00 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.5 m

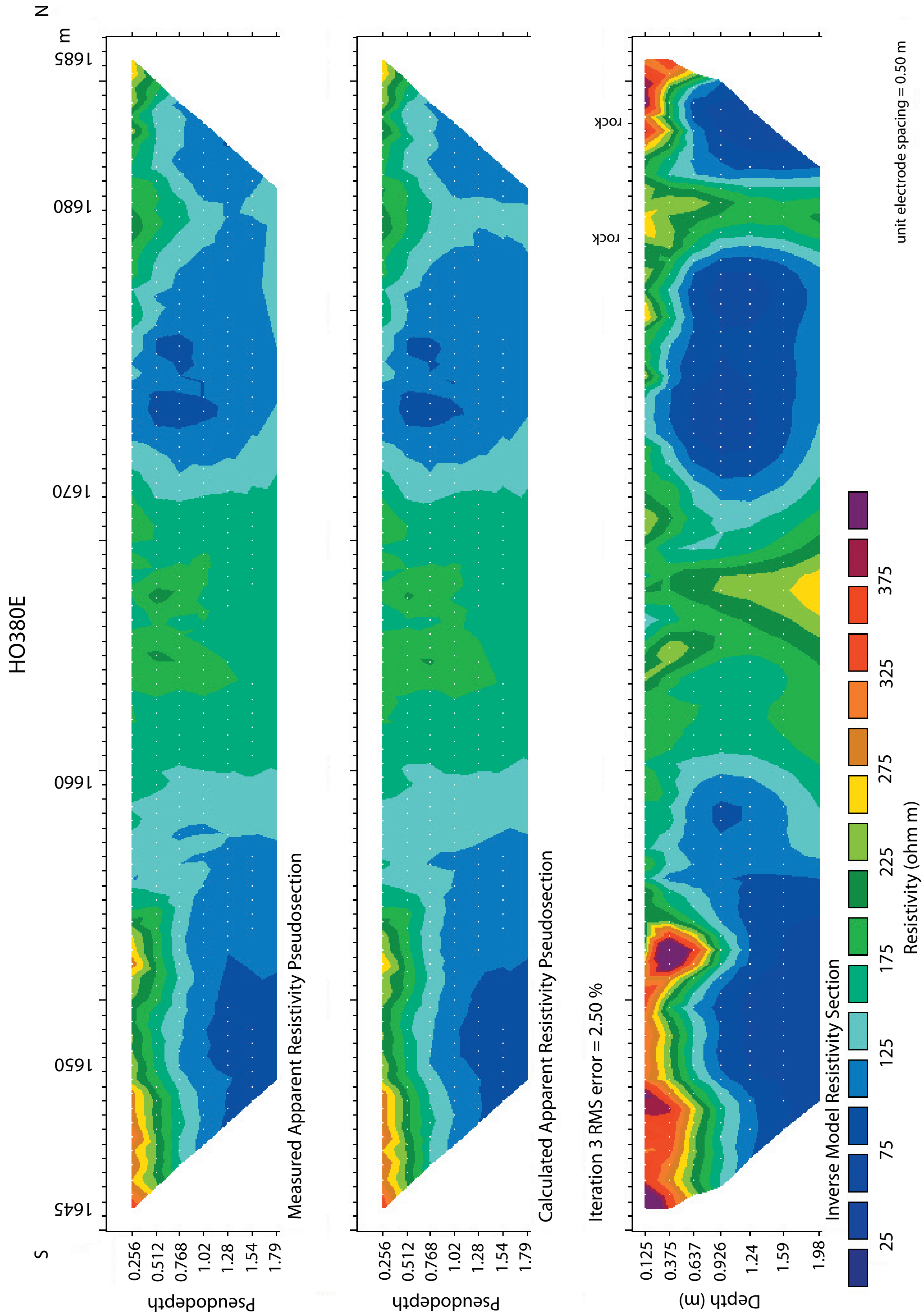

GR289E
S
N
268
270
280
290
300
310
320 m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.47 %
rock
rock
rock
rock
rock
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.5 m

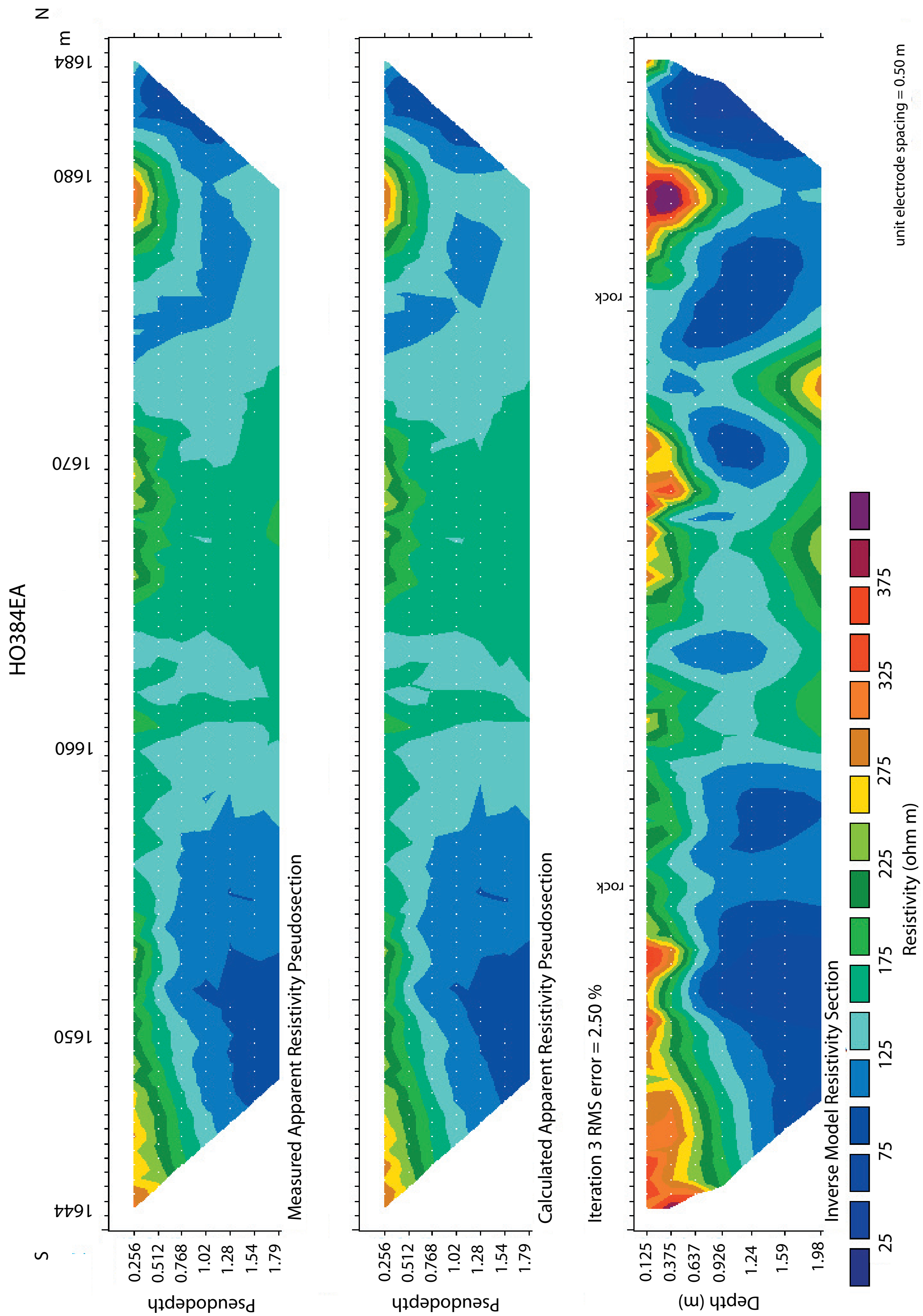


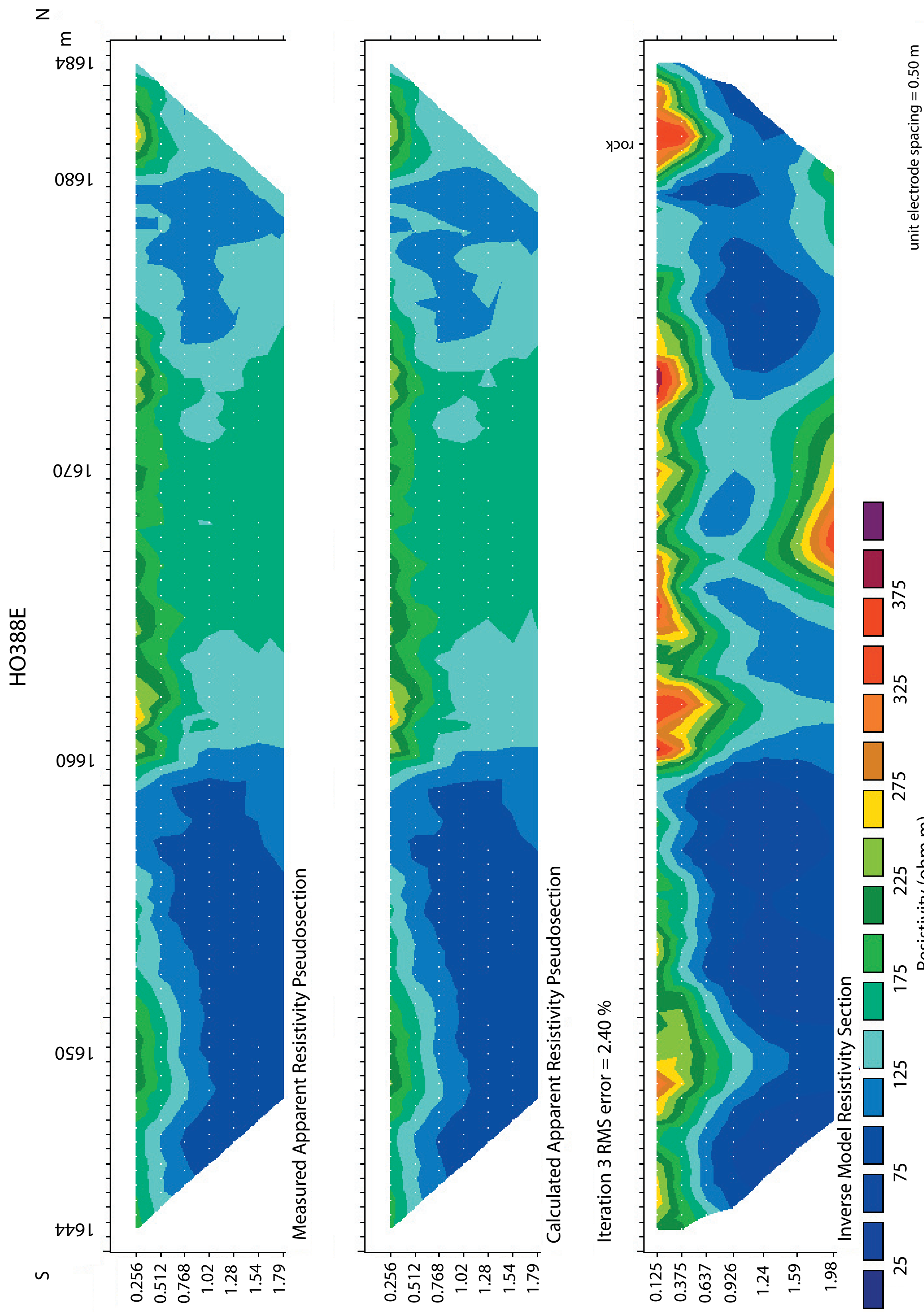
HS157E
S
N
027
030
040
050
060
070
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 2.60 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m



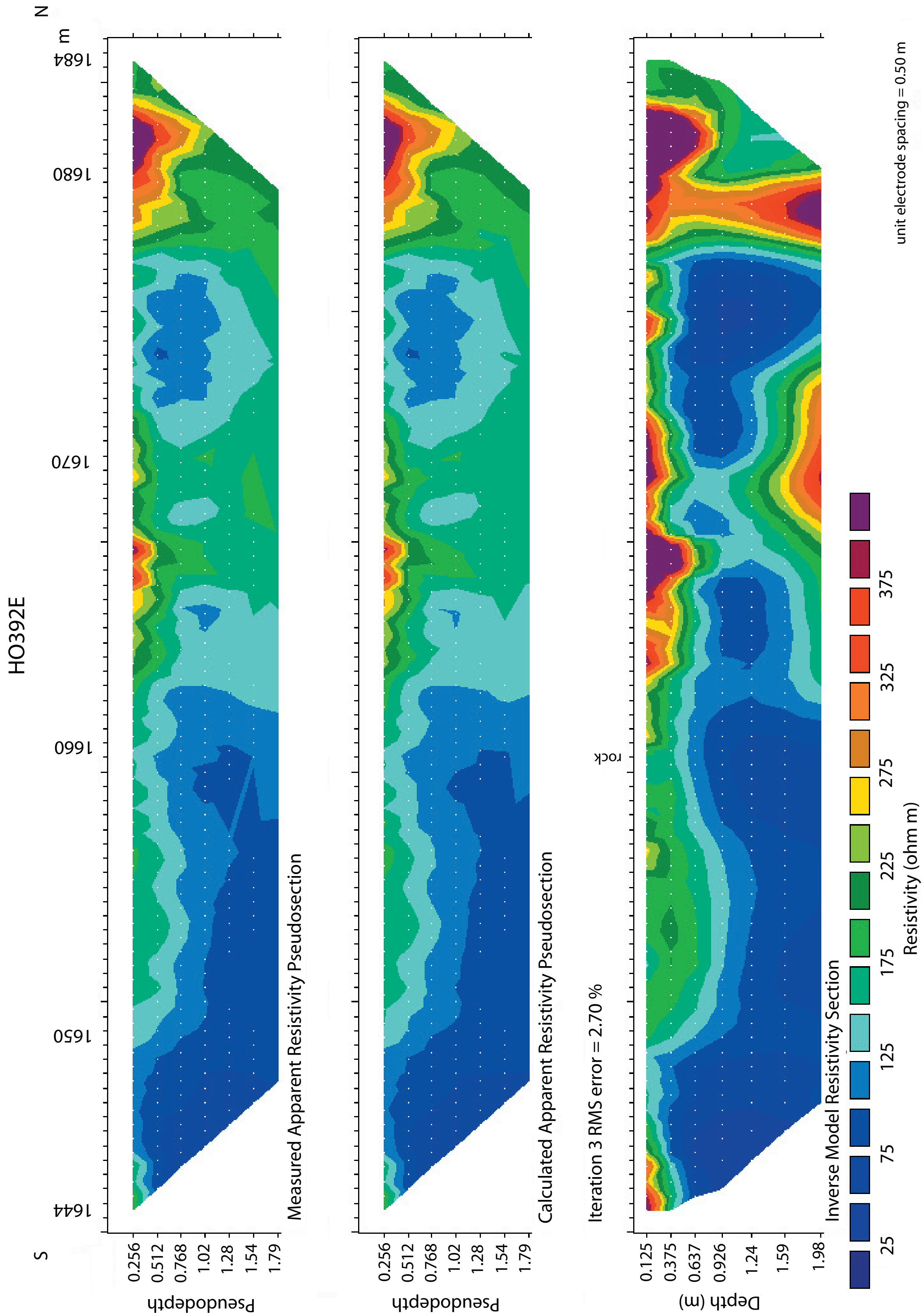
HS046N
W
E
m
130
140
150
160
170
180
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Iteration 3 RMS error = 2.80 %
auger
(2 m south)
Inverse Model Resistivity Section
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m


HO380E
S
N
m
1645
1650
1660
1670
1680
1685
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Pseudodepth
Iteration 3 RMS error = 2.50 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
rock
rock
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

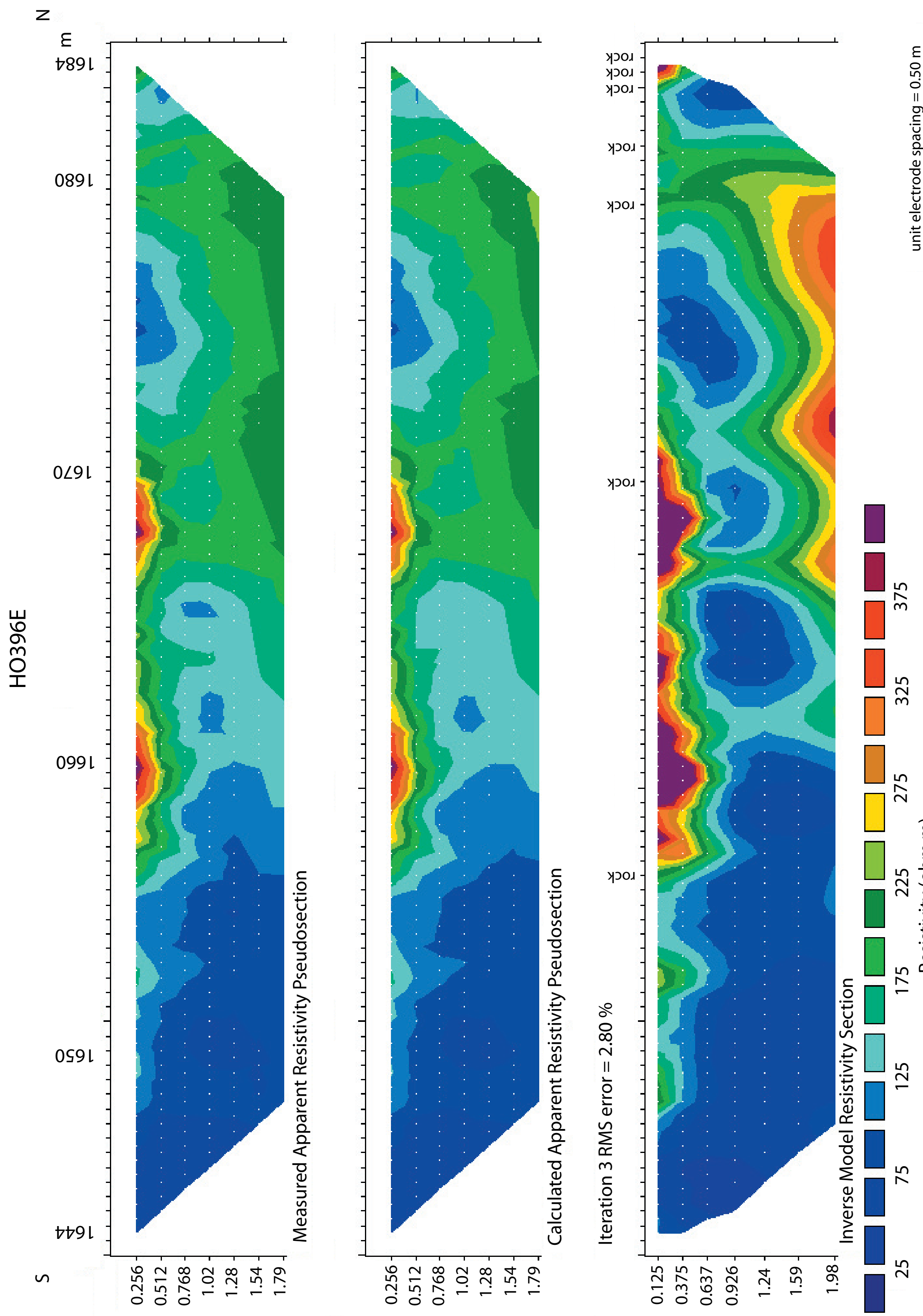

HO384EA
S
N
1644
1650
1660
1670
1680
1684
m
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Iteration 3 RMS error = 2.50 %
rock
rock
Inverse Model Resistivity Section
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

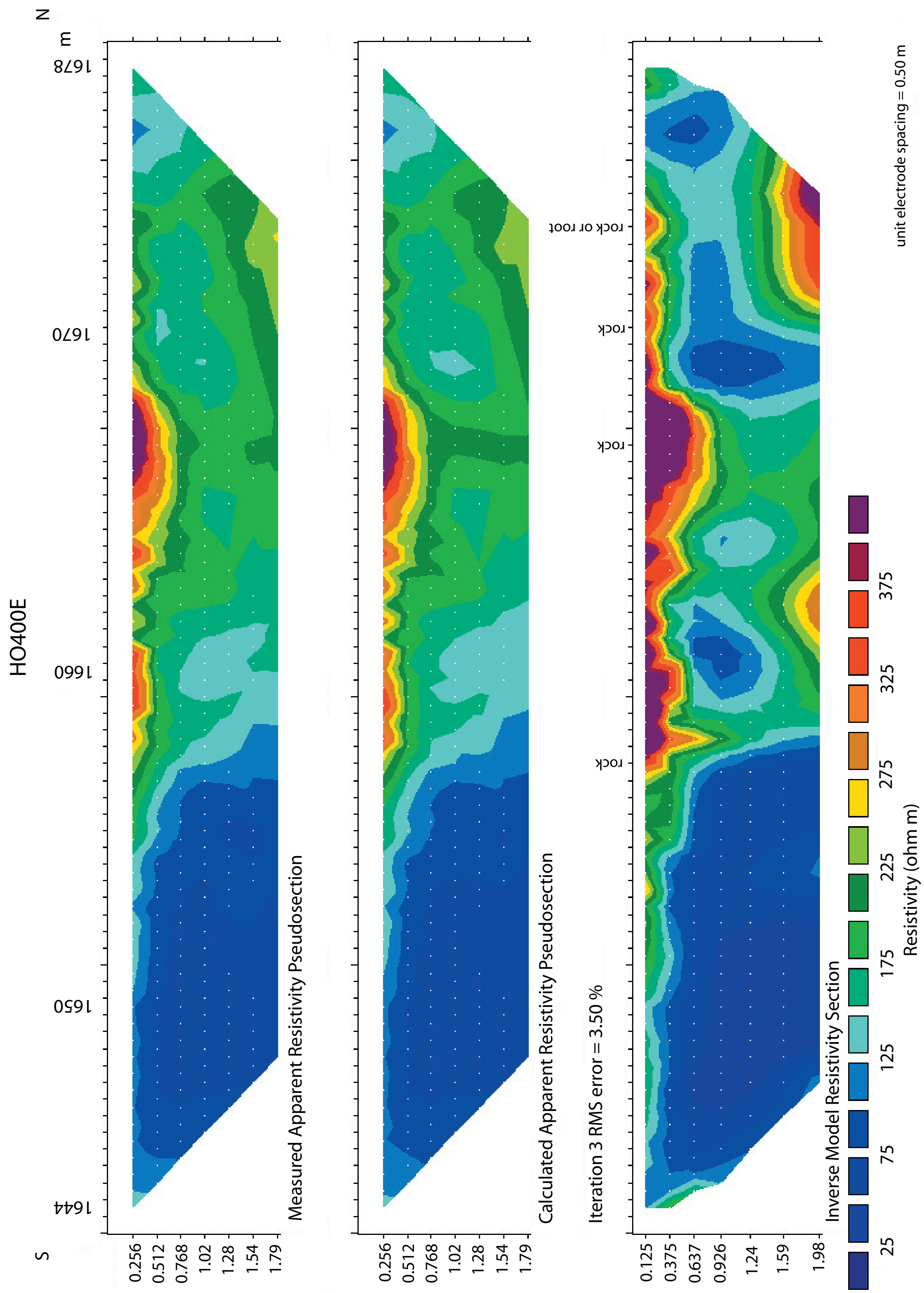


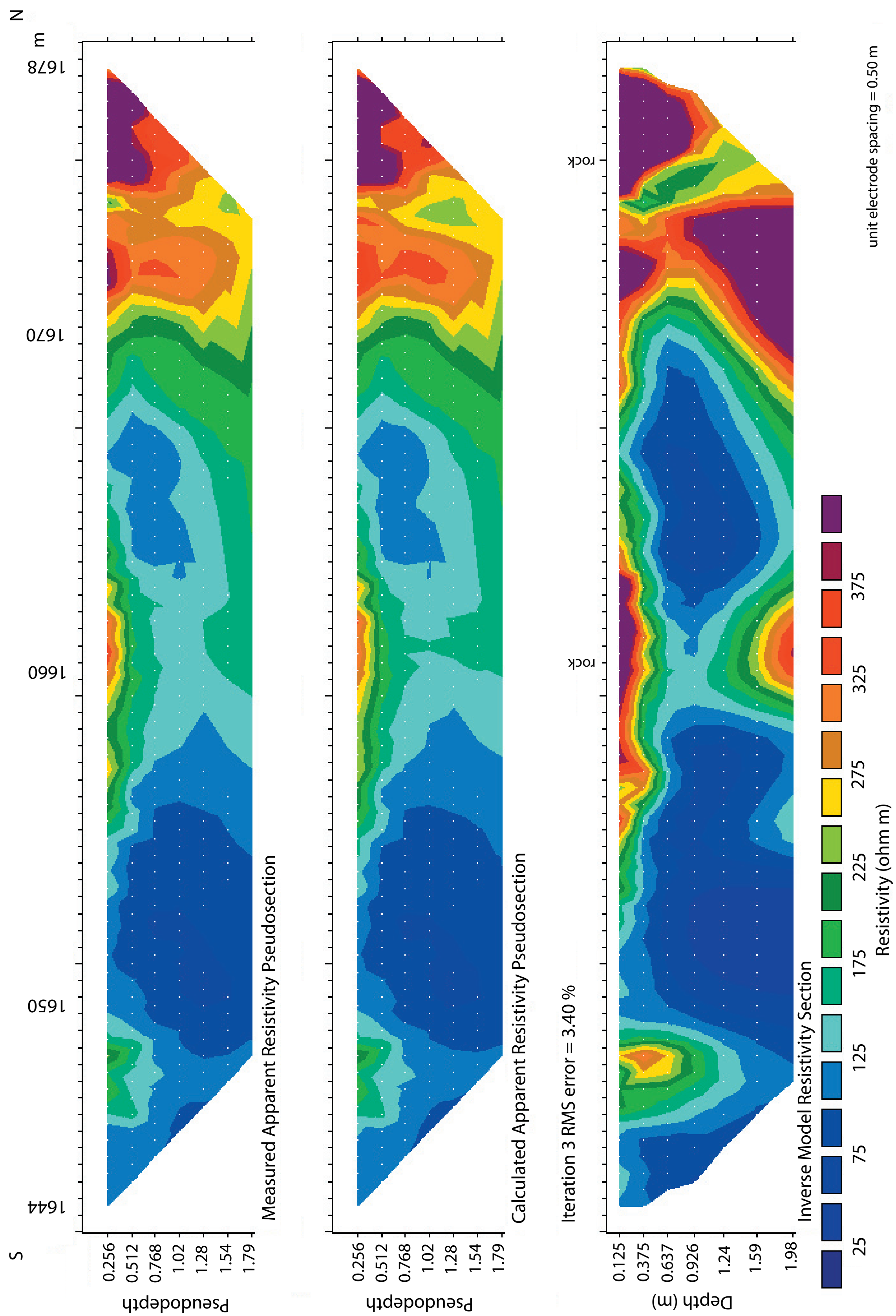
HO388E
S
N
1644
1650
1660
1670
1680
1684
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 2.40 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
rock
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

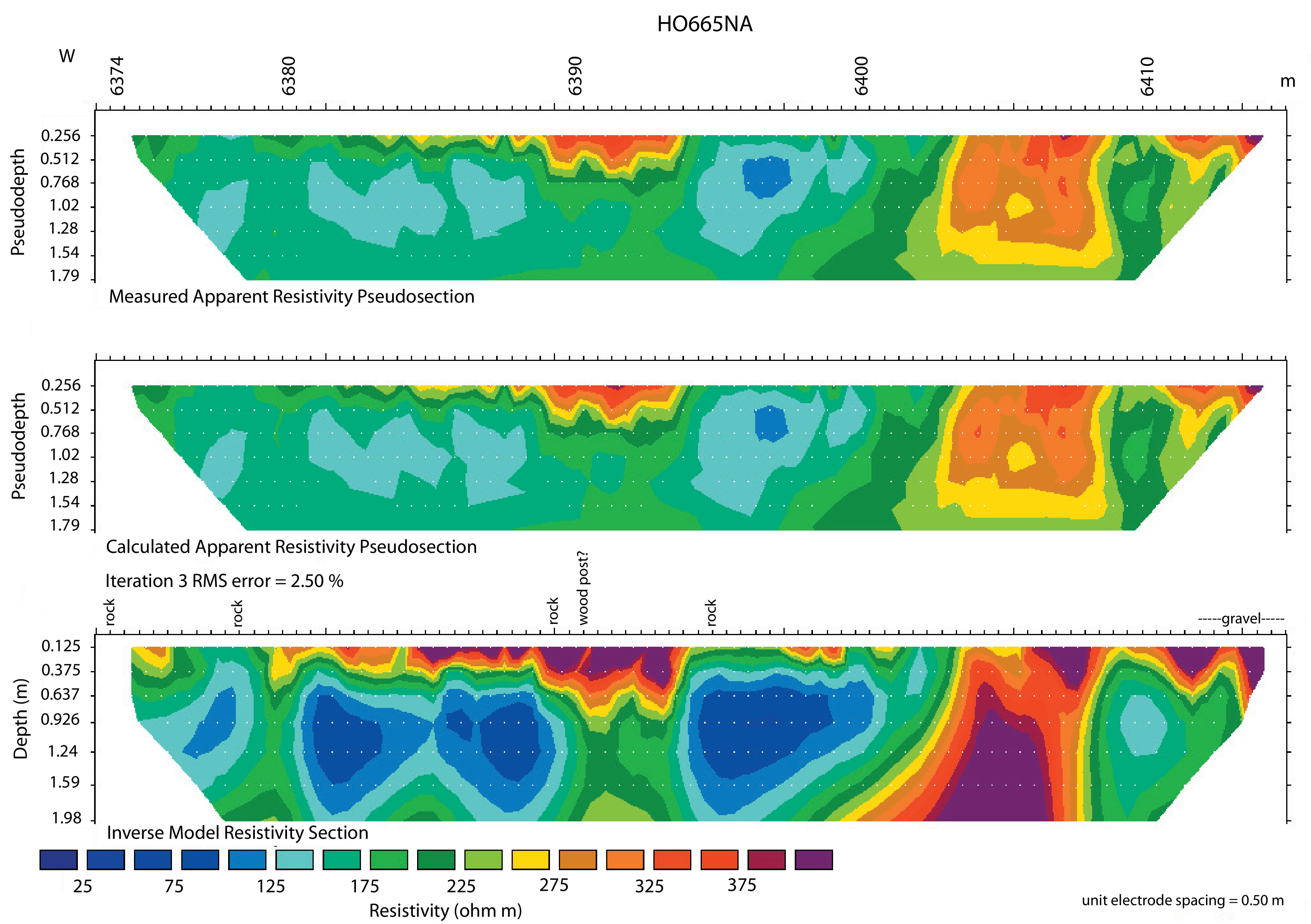


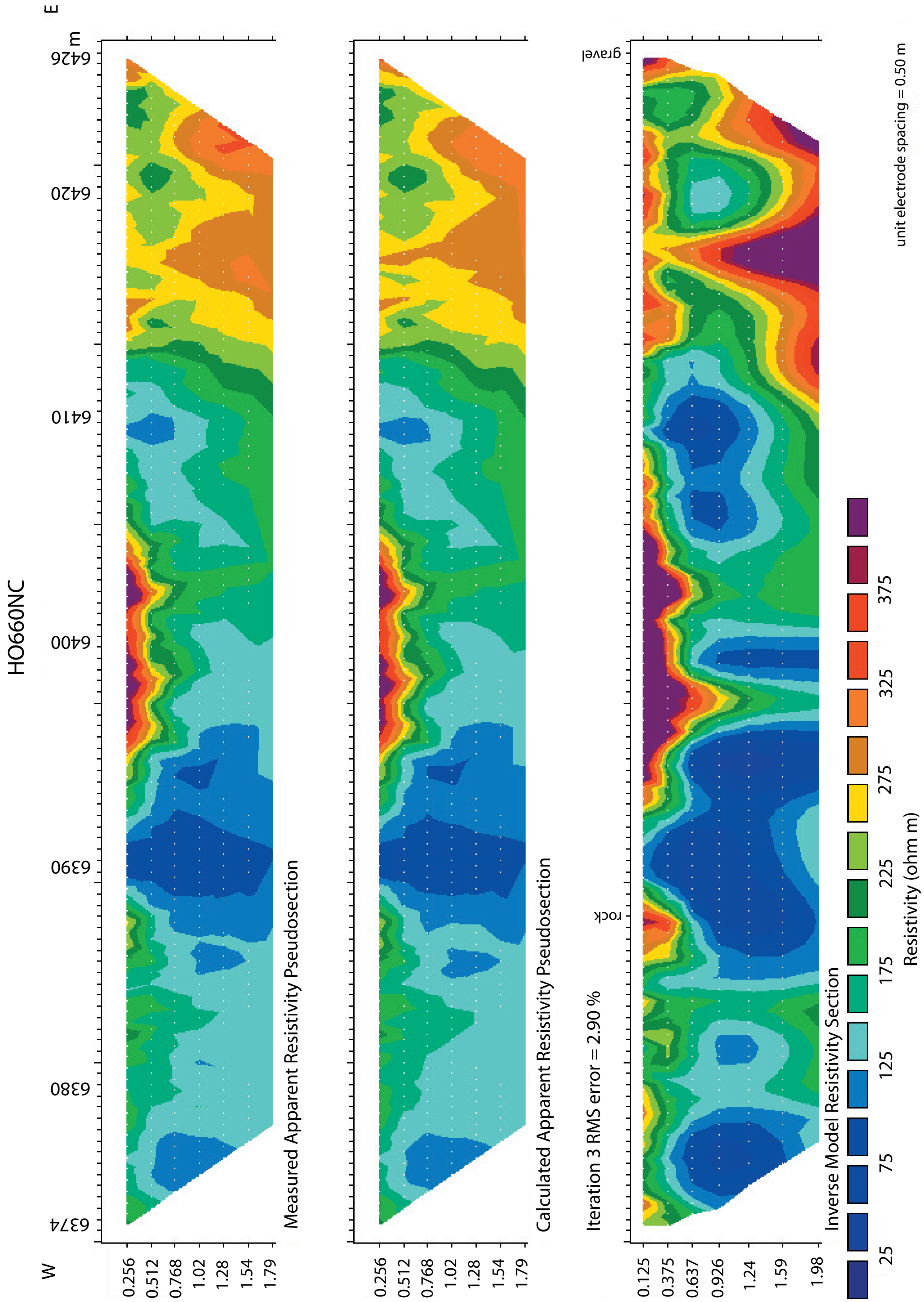
HO392E
S
N
m
1644
1650
1660
1670
1680
1684
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 2.70 %
rock
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

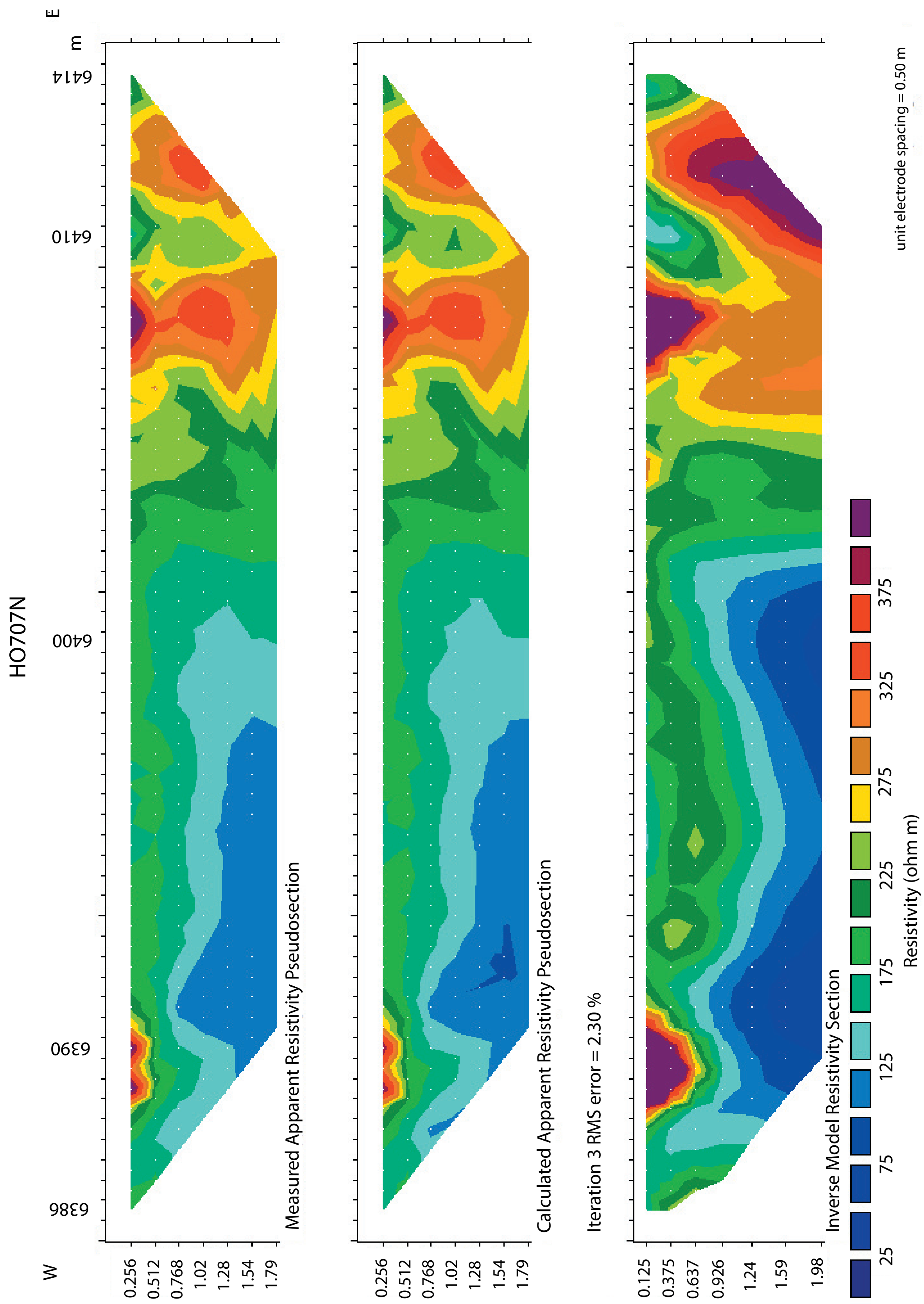

HO396E
S
N
1644
1650
1660
1670
1680
1684
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 2.80 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
rock
rock
rock
rock
rock
rock
rock
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

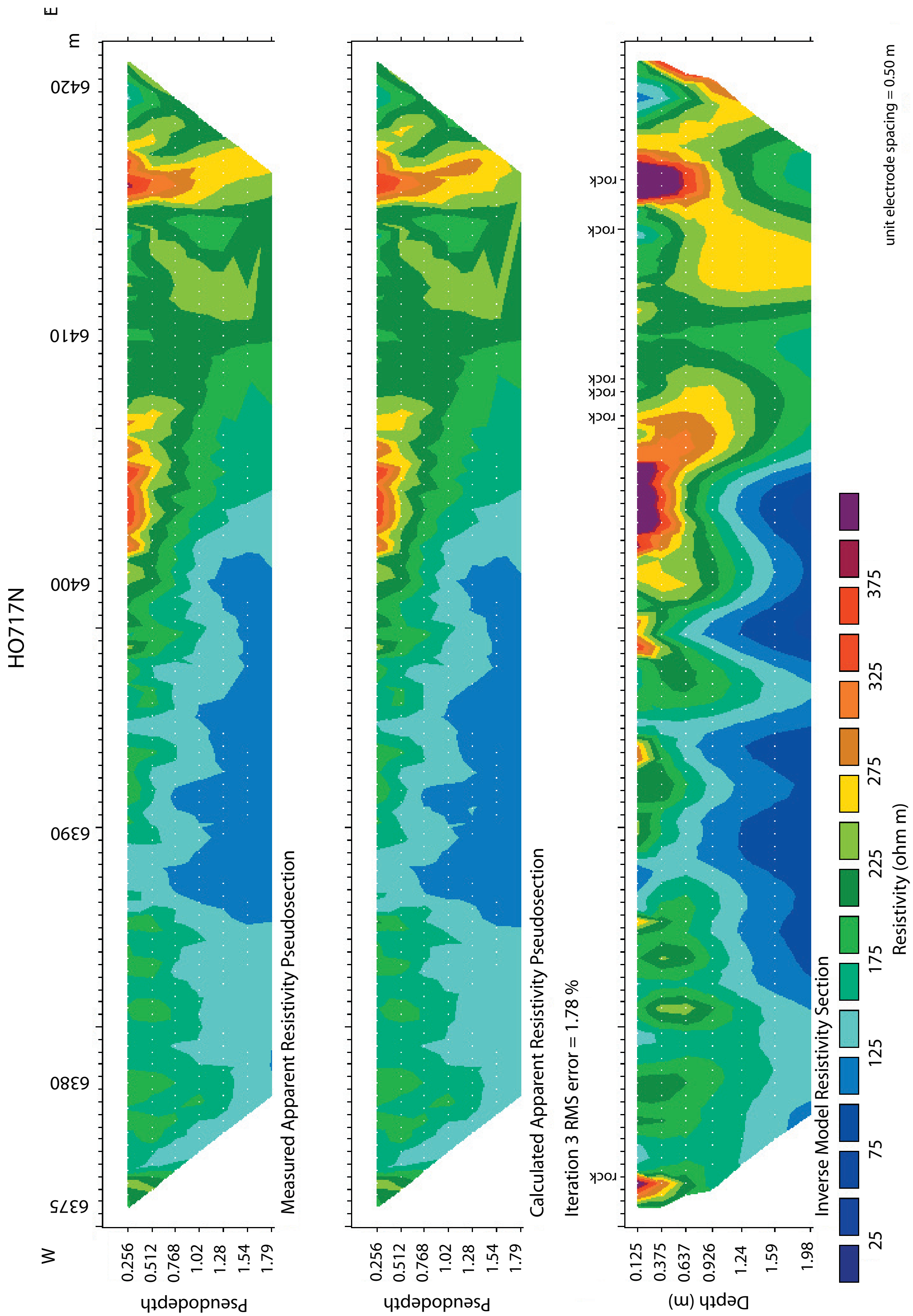

HO400E
S
N
m
1644
1650
1660
1670
1678
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Iteration 3 RMS error = 3.50 %
Inverse Model Resistivity Section
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
rock
rock
rock
rock or root
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

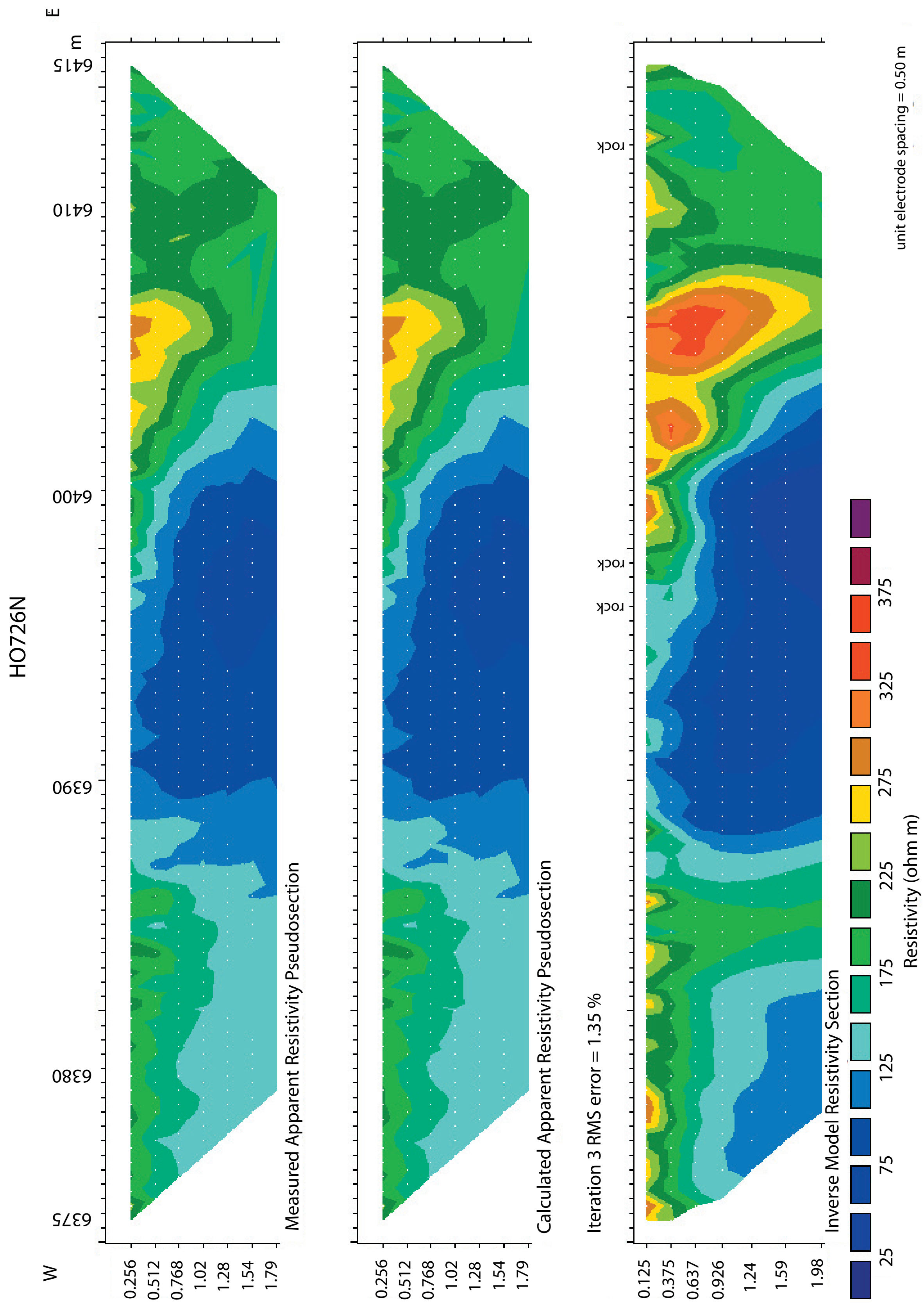

HO404E
S
N
m
1644
1650
1660
1670
1678
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 3.40 %
rock
rock
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

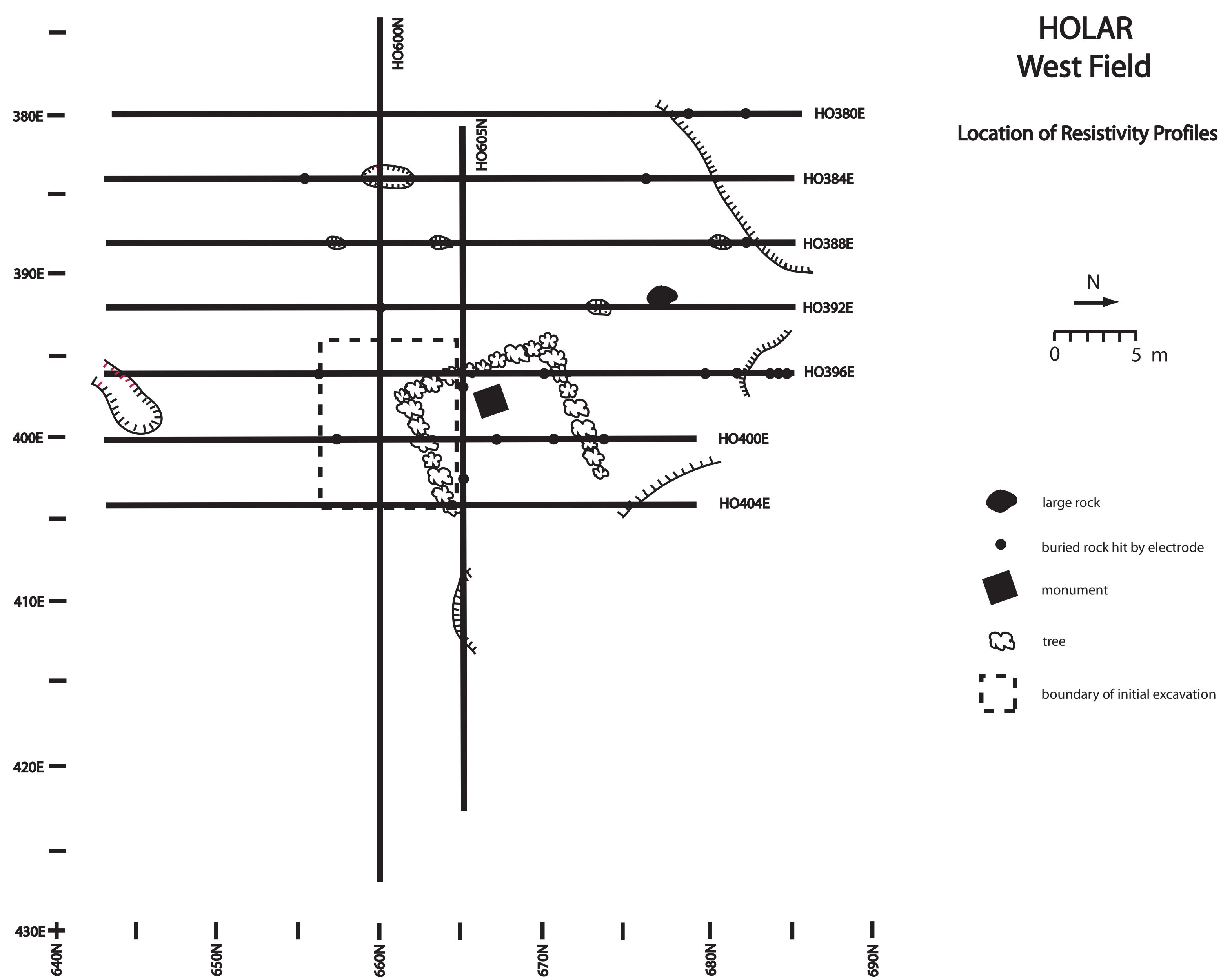

HO665NA
W
E
6374
6380
6390
6400
6410
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 2.50 %
rock
rock
rock
wood post?
rock
-----gravel-----
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

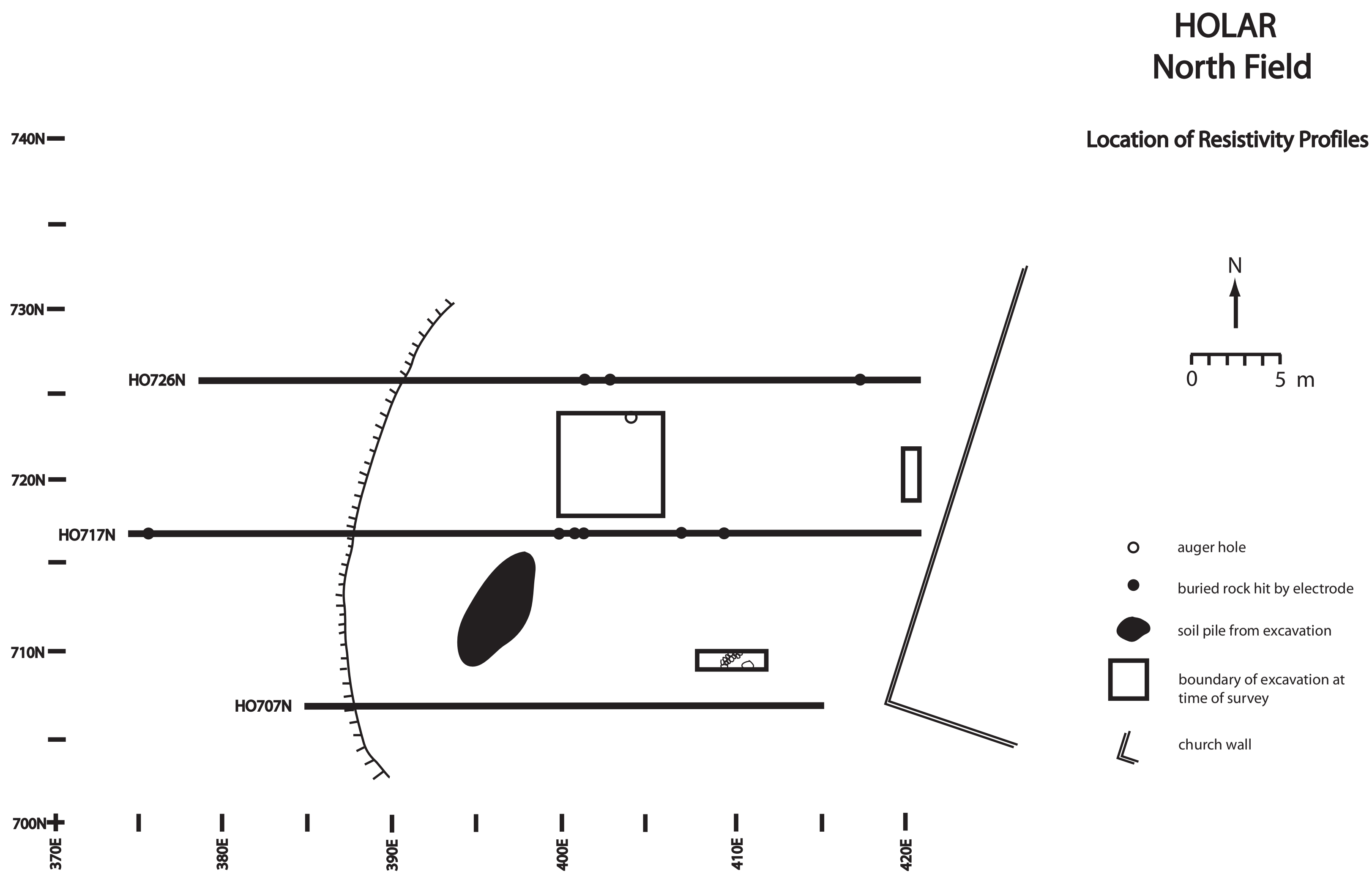

HO660NC
W
E
m
6374
6380
6390
6400
6410
6420
6426
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 2.90 %
rock
gravel
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

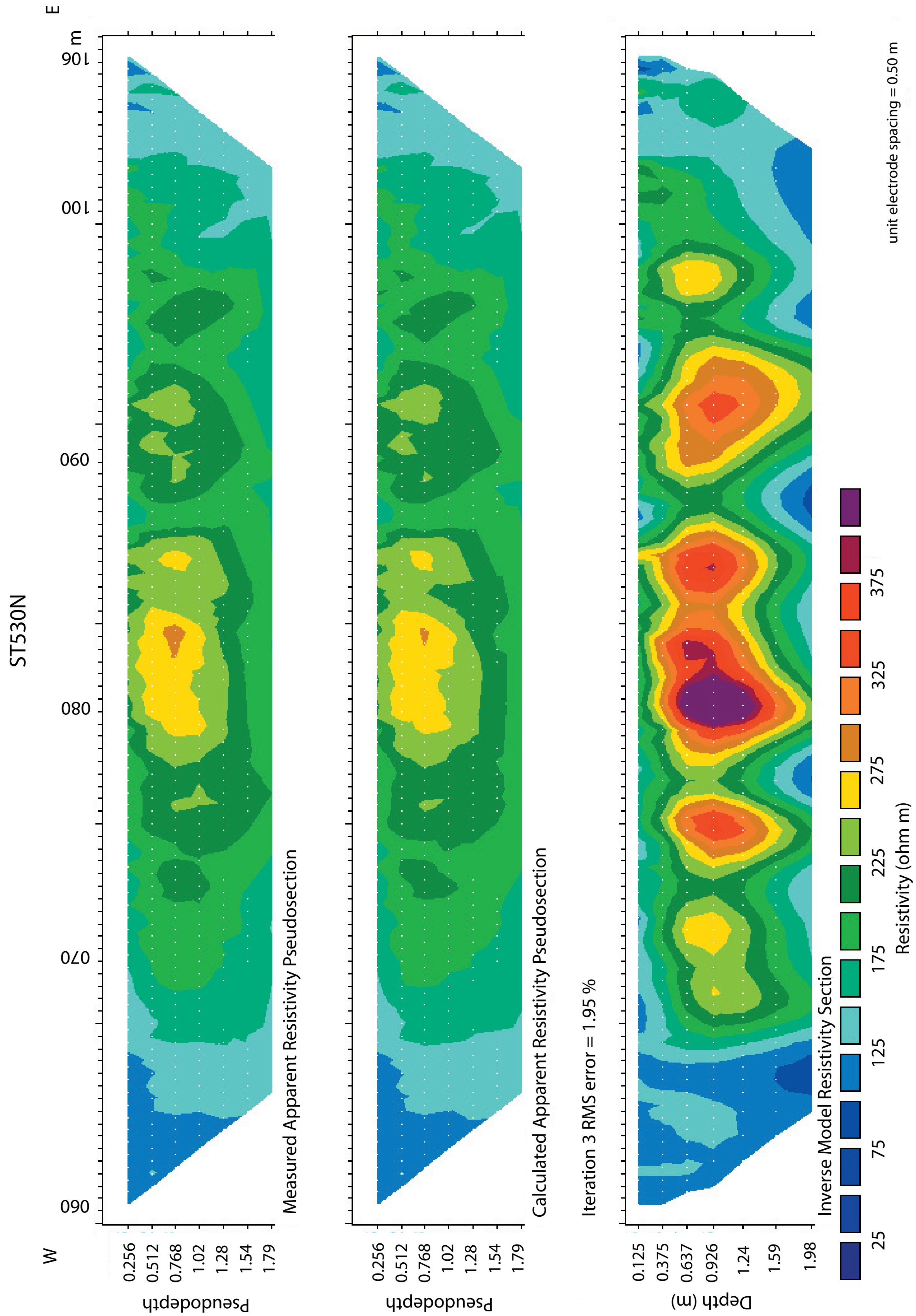

HO707N
W
E
6386
6390
6400
6410
6414
m
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Iteration 3 RMS error = 2.30 %
Inverse Model Resistivity Section
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

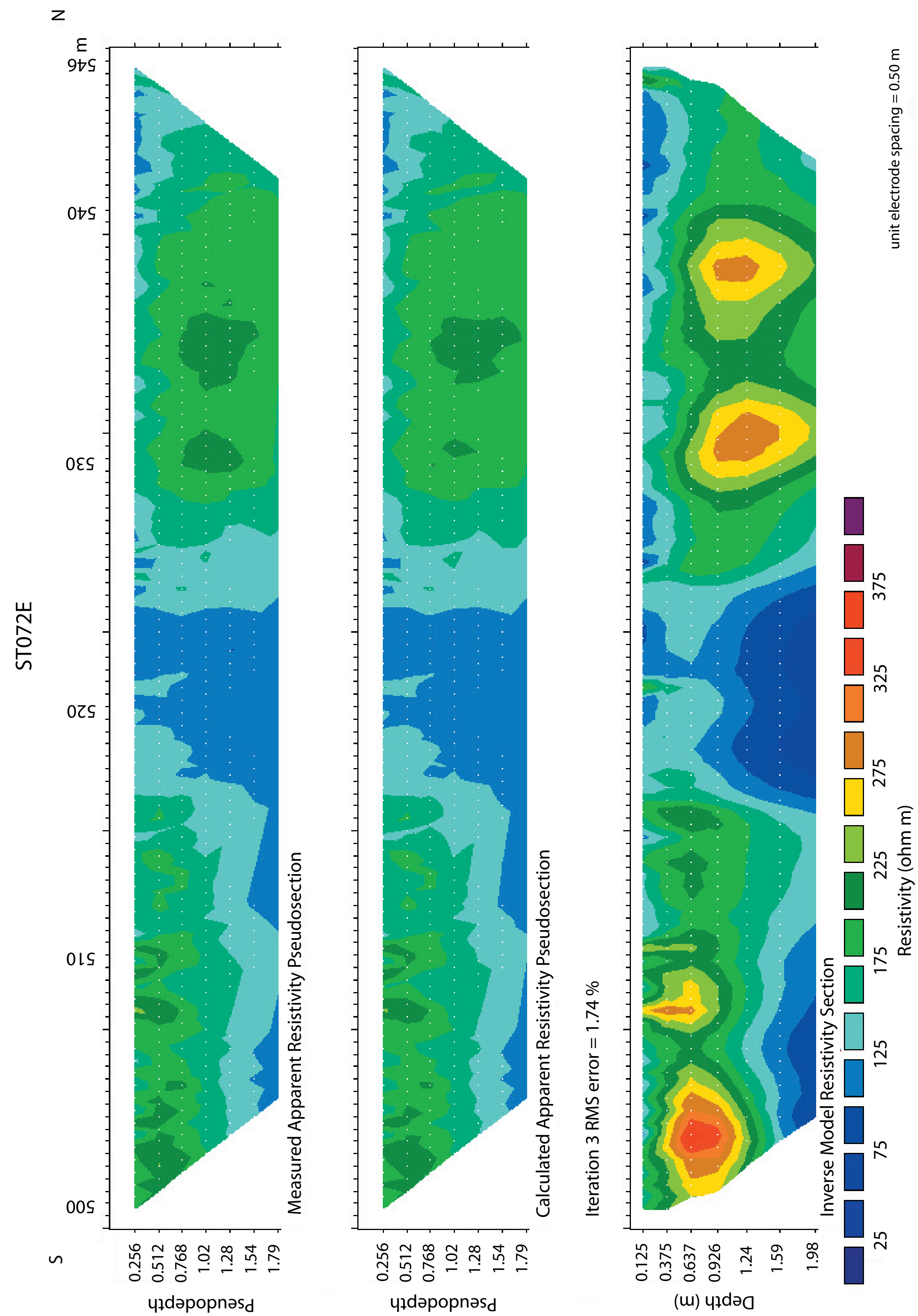

HO717N
W
E
m
6375
6380
6390
6400
6410
6420
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.78 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
rock
rock
rock
rock
rock
rock
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

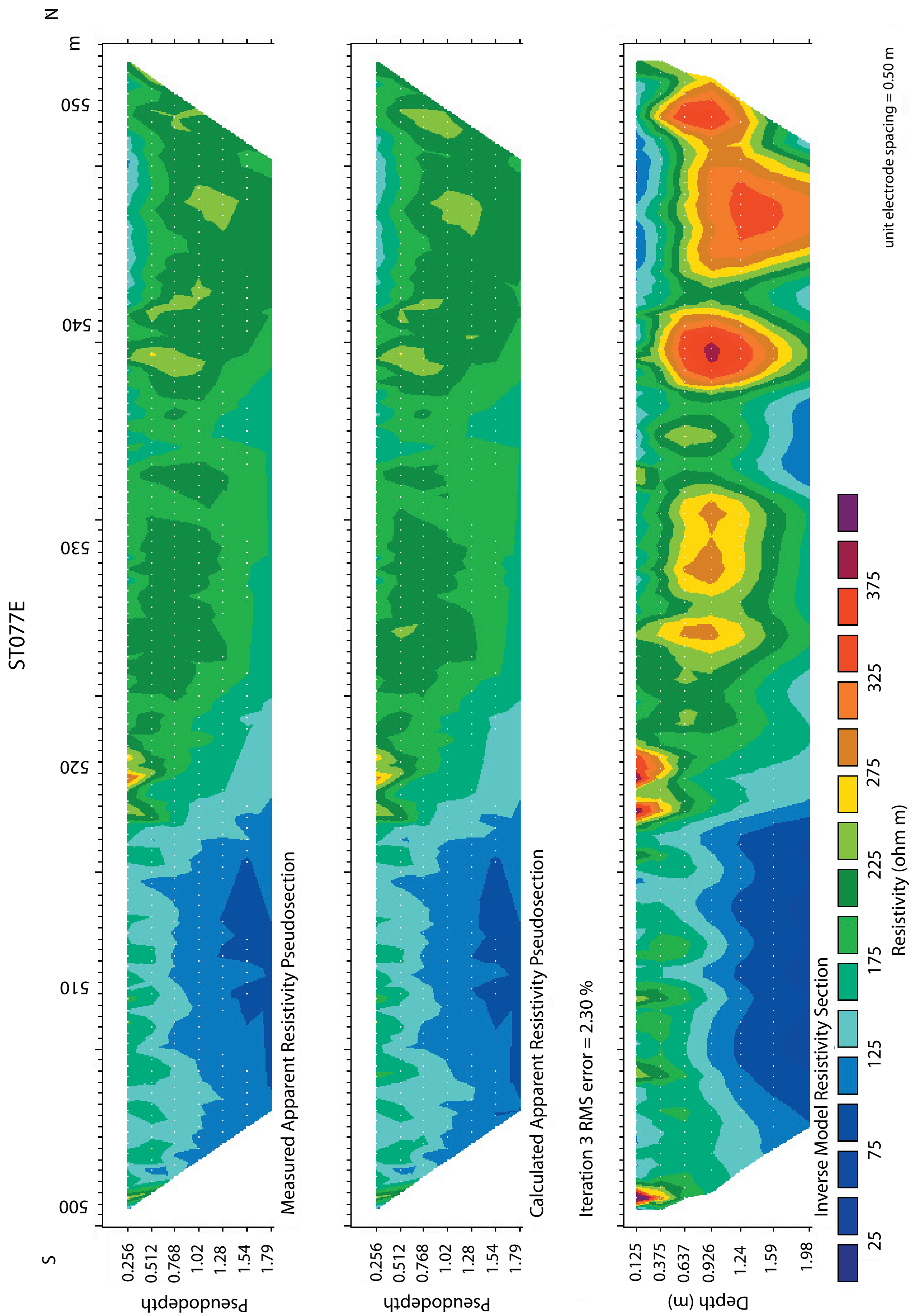

HO726N
W
E
6375
6380
6390
6400
6410
6415
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.35 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
rock
rock
rock
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

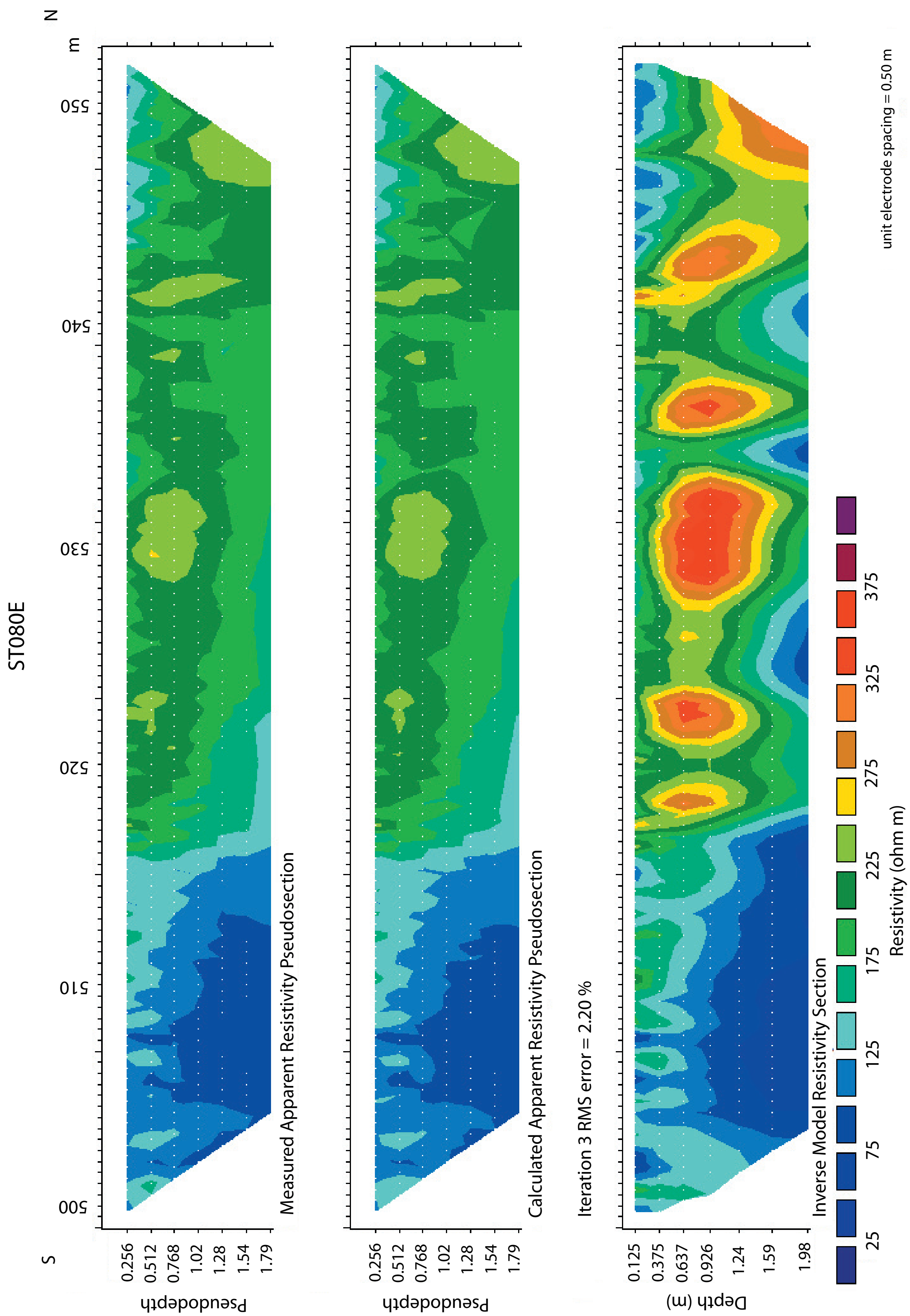

HOLAR
West Field
Location of Resistivity Profiles
N
0
5 m
large rock
buried rock hit by electrode
monument
tree
boundary of initial excavation
HO600N
HO605N
HO380E
HO384E
HO388E
HO392E
HO396E
HO400E
HO404E
380E
390E
400E
410E
420E
430E
640N
650N
660N
670N
680N
690N

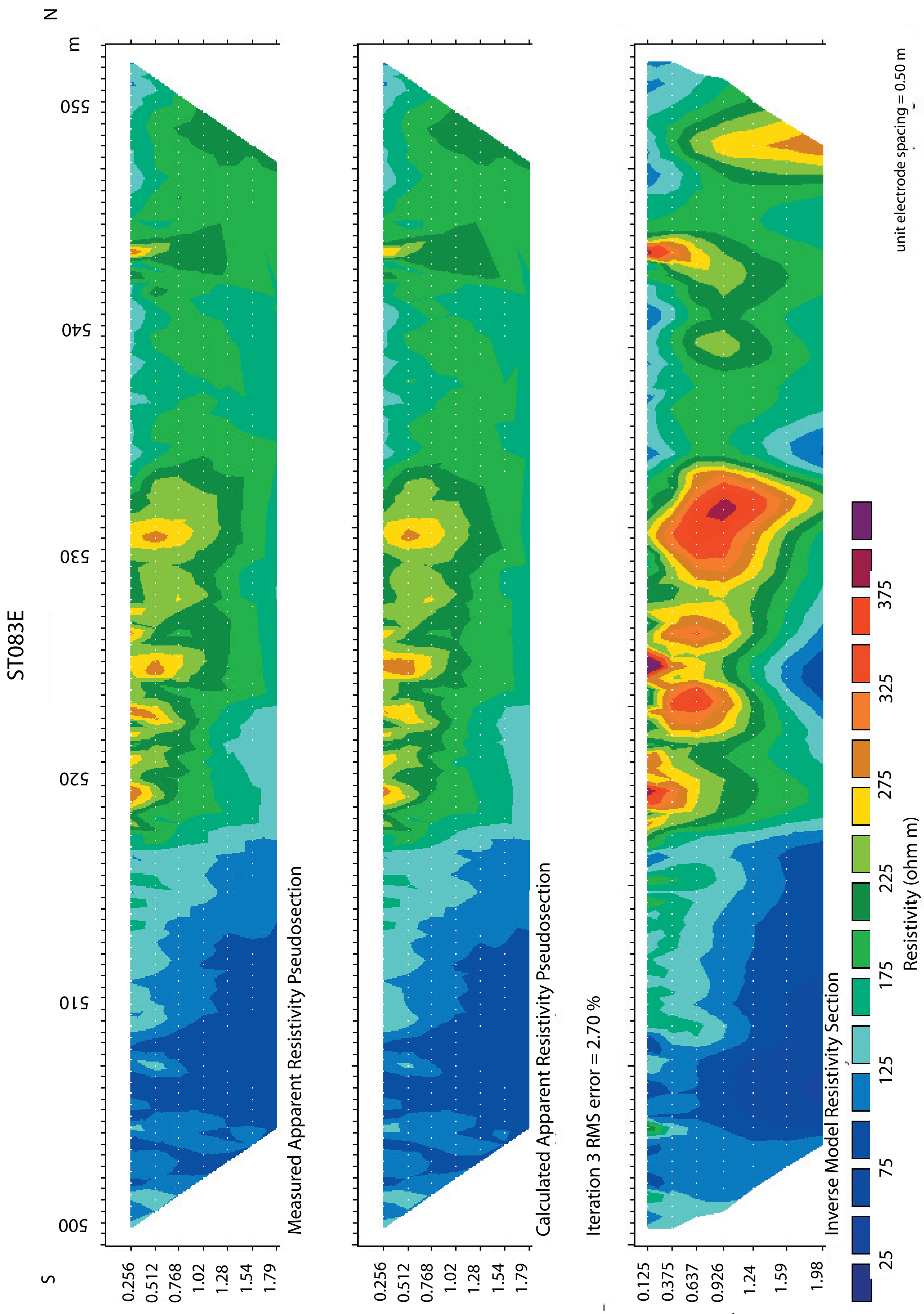

HOLAR
North Field
Location of Resistivity Profiles
N
0
5 m
auger hole
buried rock hit by electrode
soil pile from excavation
boundary of excavation at time of survey
church wall
740N
730N
720N
710N
700N
HO726N
HO717N
HO707N
370E
380E
390E
400E
410E
420E


ST530N
W
E
060
070
080
090
100
106
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.95 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

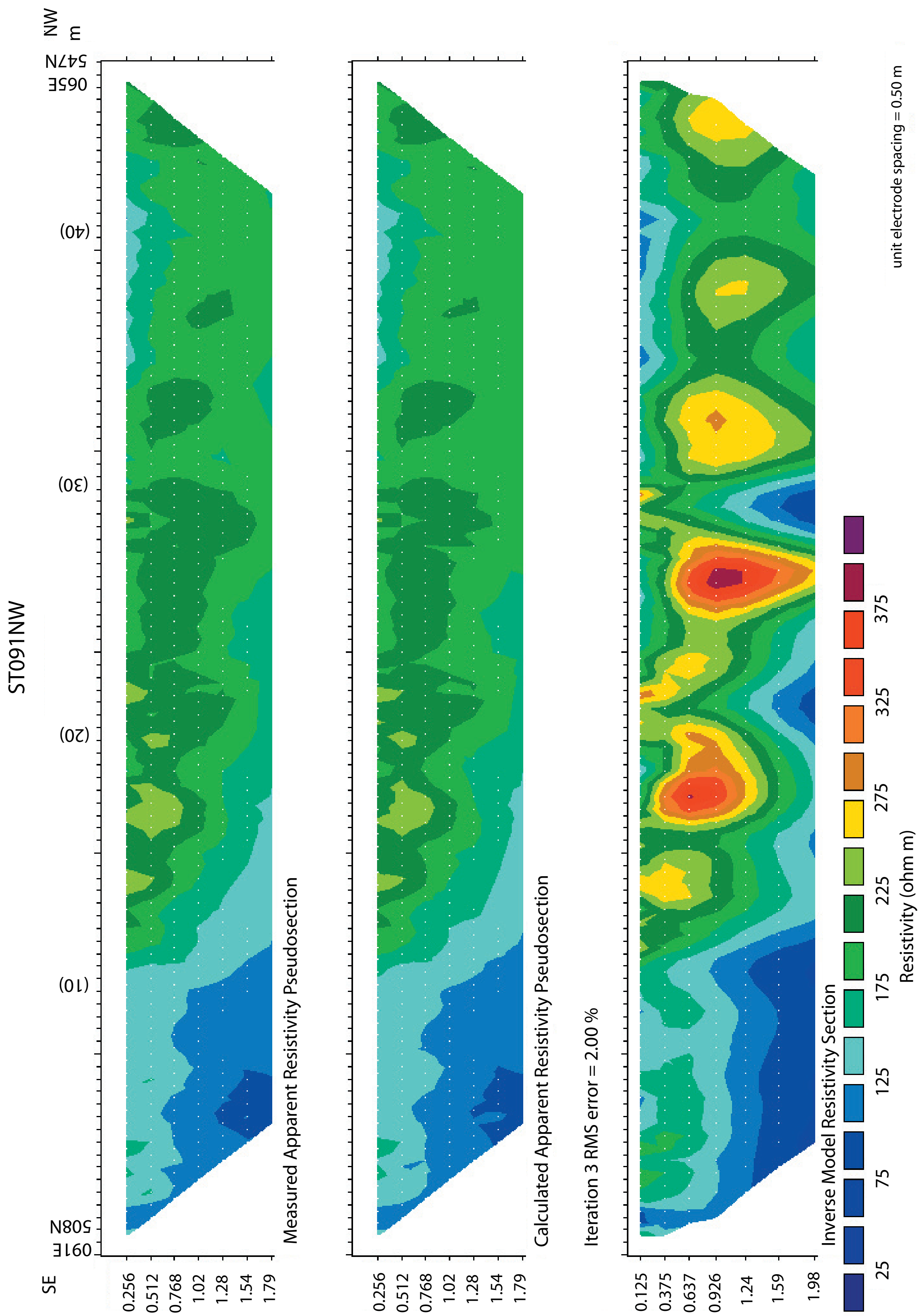

ST072E
S
N
500
510
520
530
540
546 m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.74 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

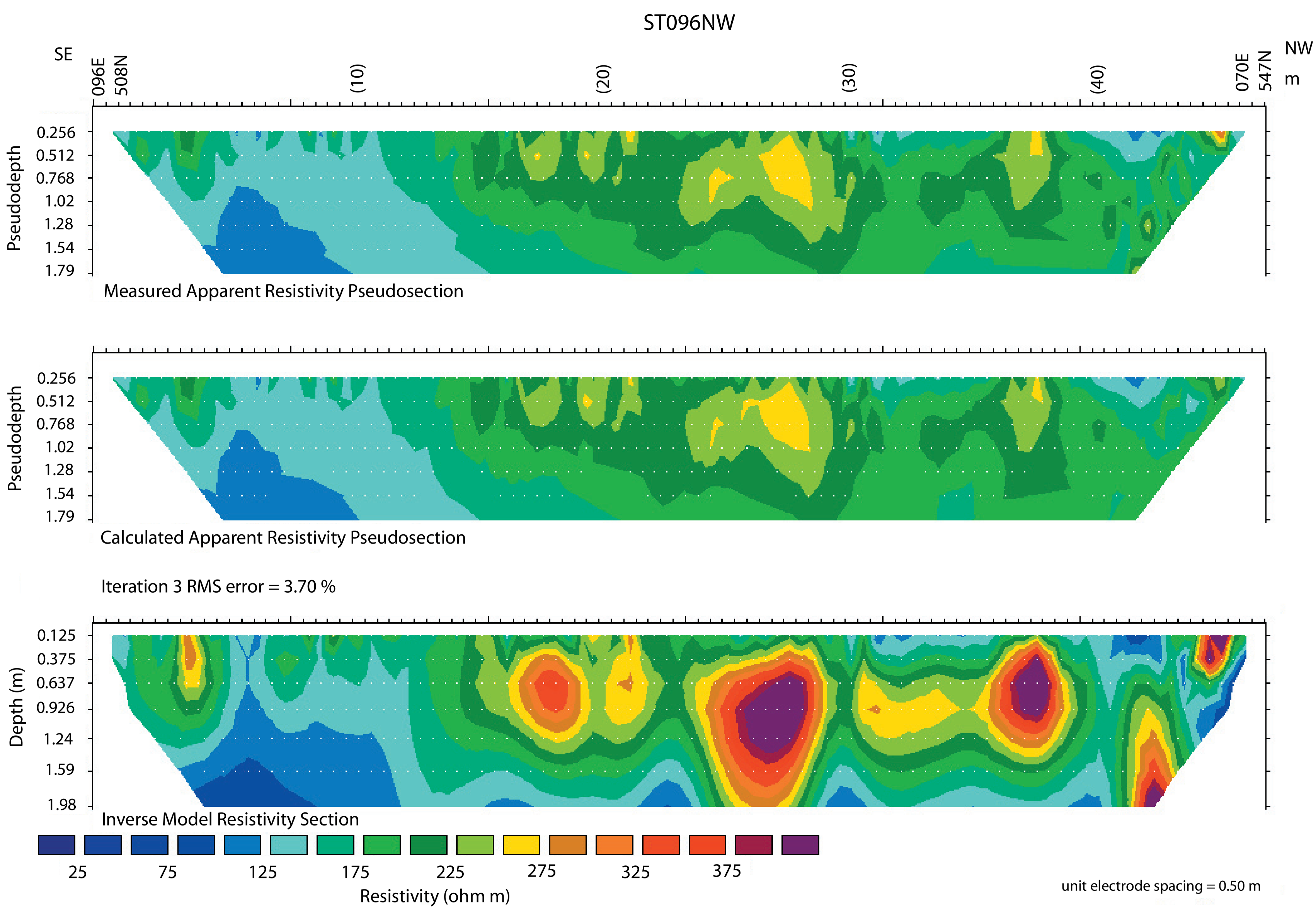

ST077E
S
N
m
500
510
520
530
540
550
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 2.30 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

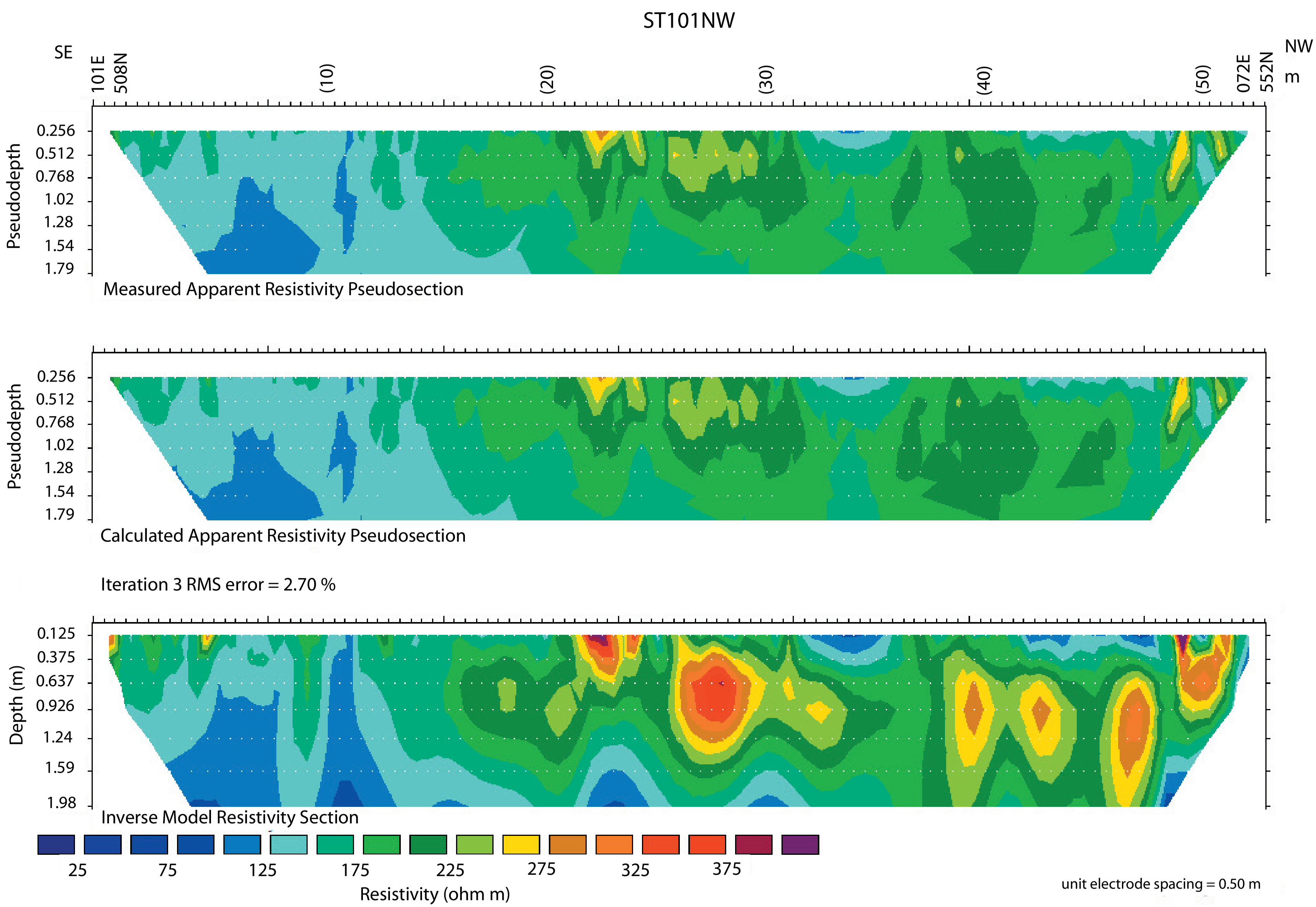

ST080E
S
N
m
500
510
520
530
540
550
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 2.20 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

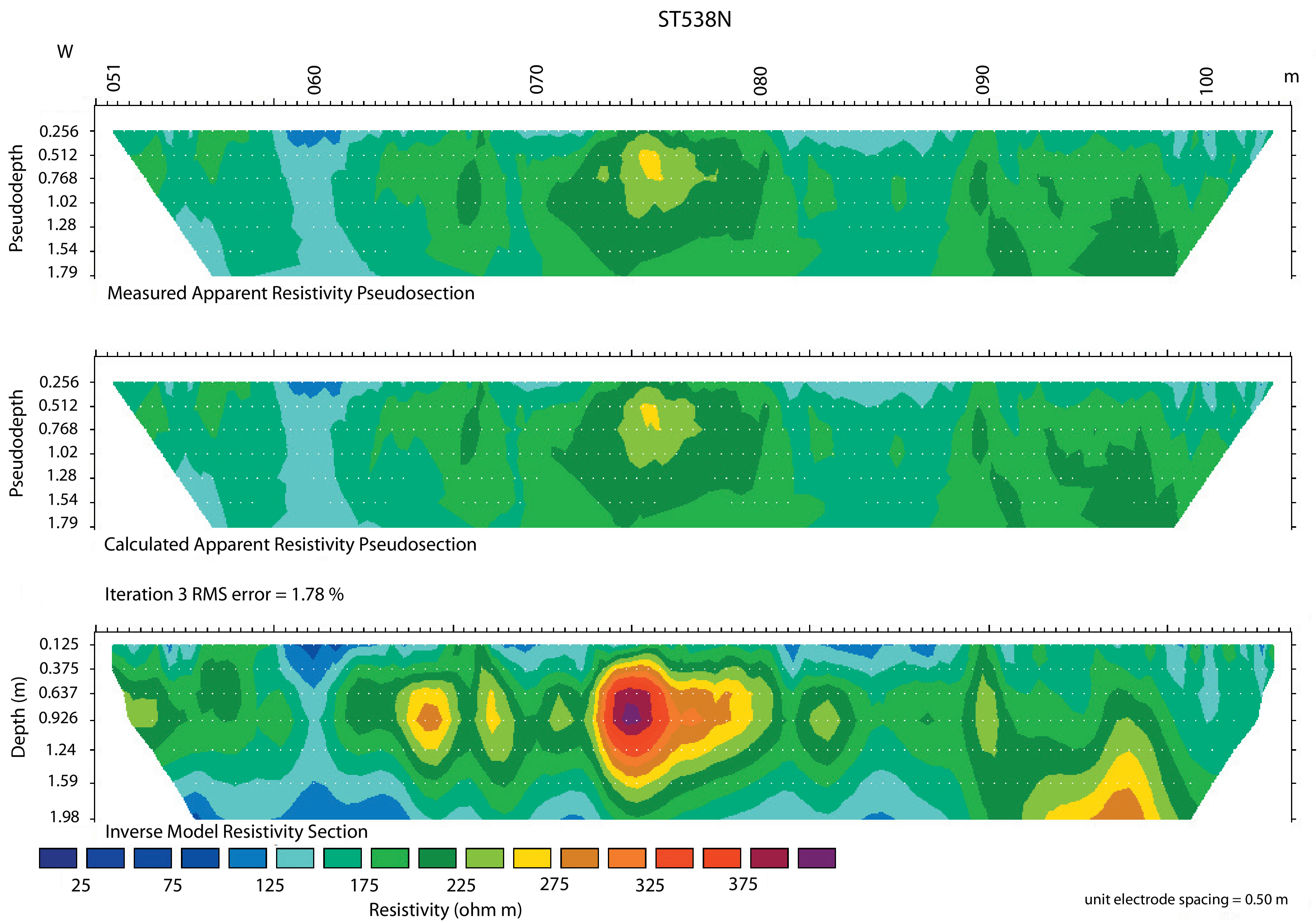


ST083E
S
N
m
500
510
520
530
540
550
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 2.70 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

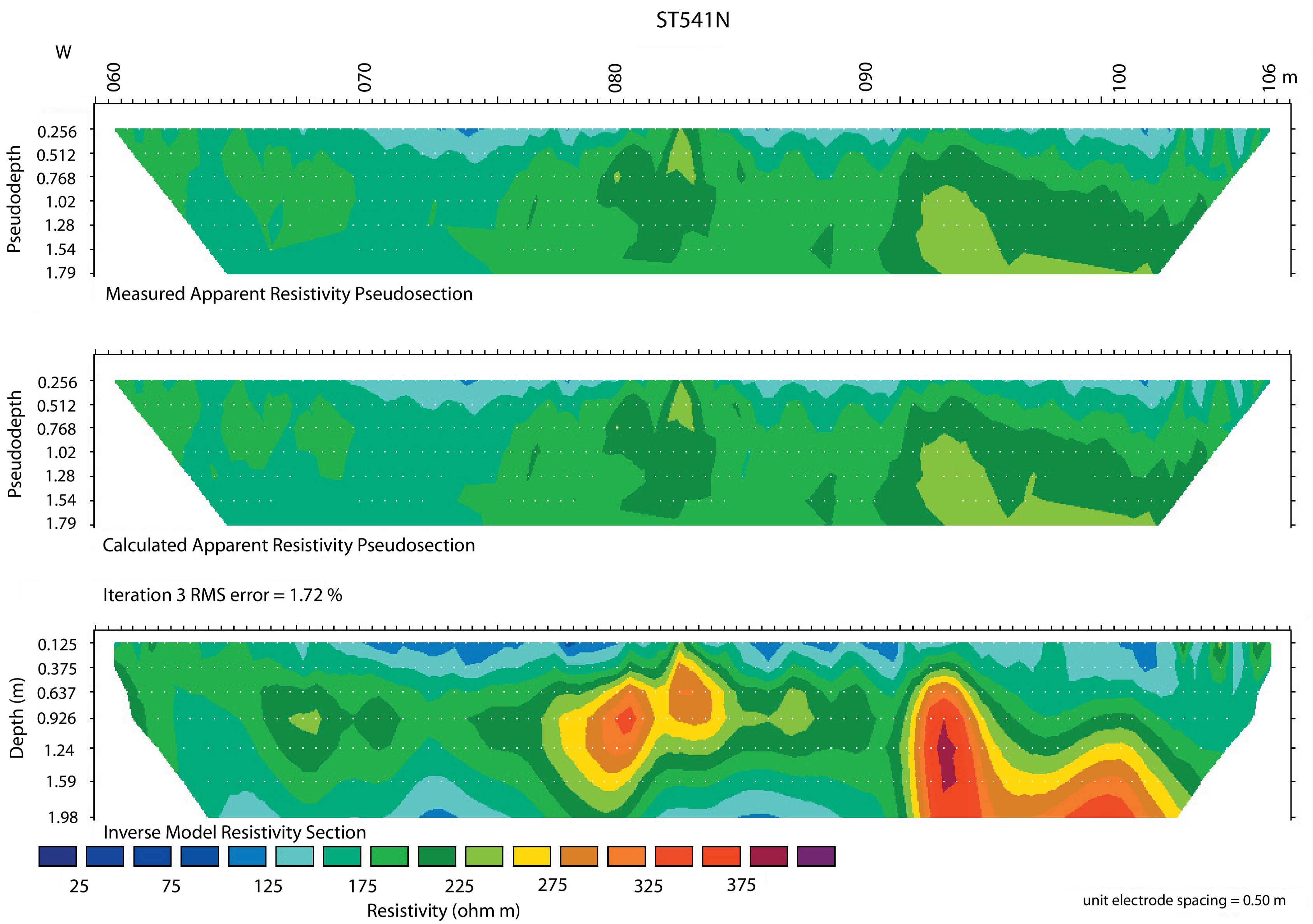

ST091NW
SE
NW
091E 508N
065E 547N
m
(10)
(20)
(30)
(40)
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 2.00 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

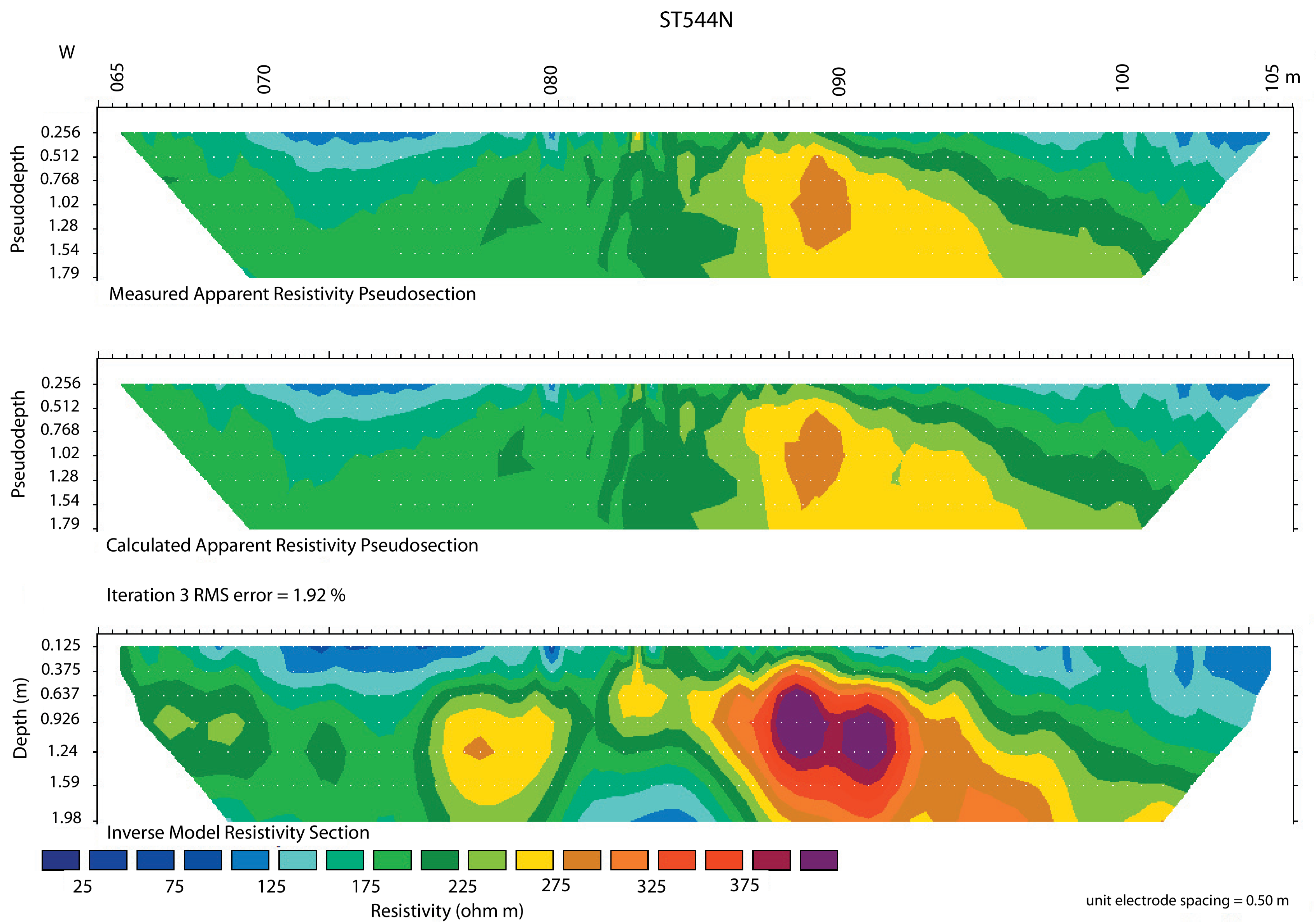

ST096NW
SE
096E 508N
(10)
(20)
(30)
(40)
070E 547N
NW
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 3.70 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

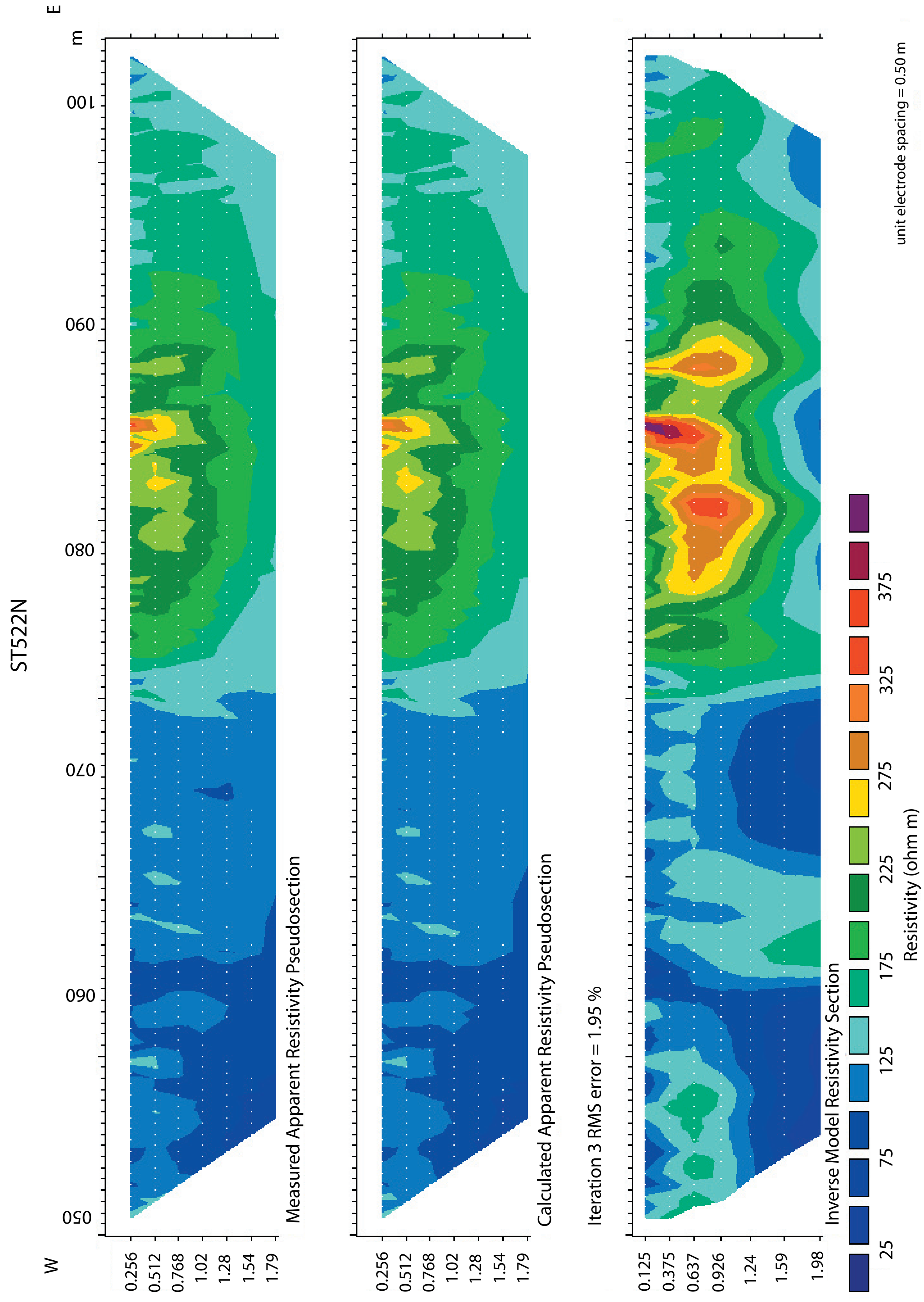

ST101NW
SE
101E 508N
(10)
(20)
(30)
(40)
(50)
072E 552N
NW
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 2.70 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

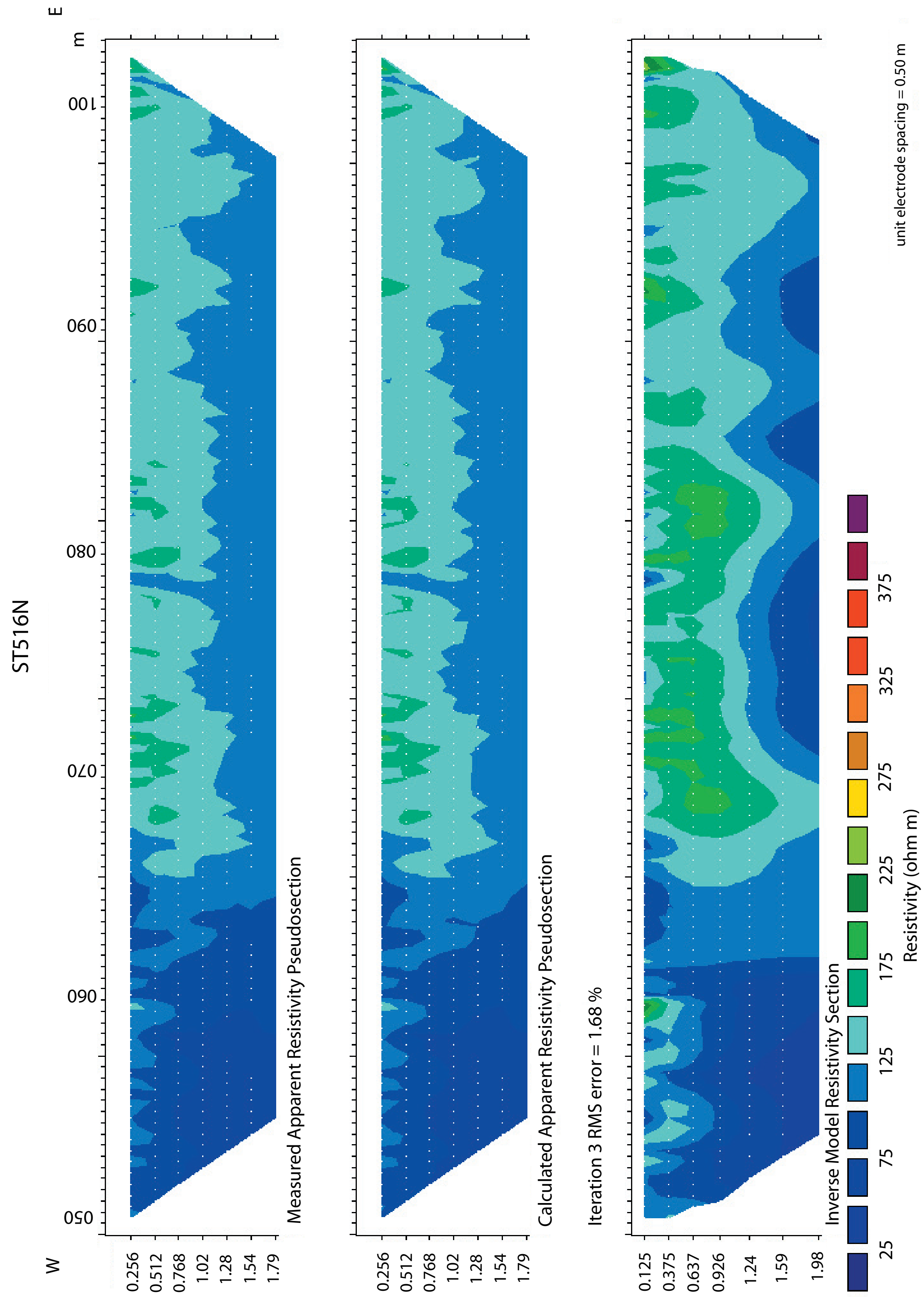


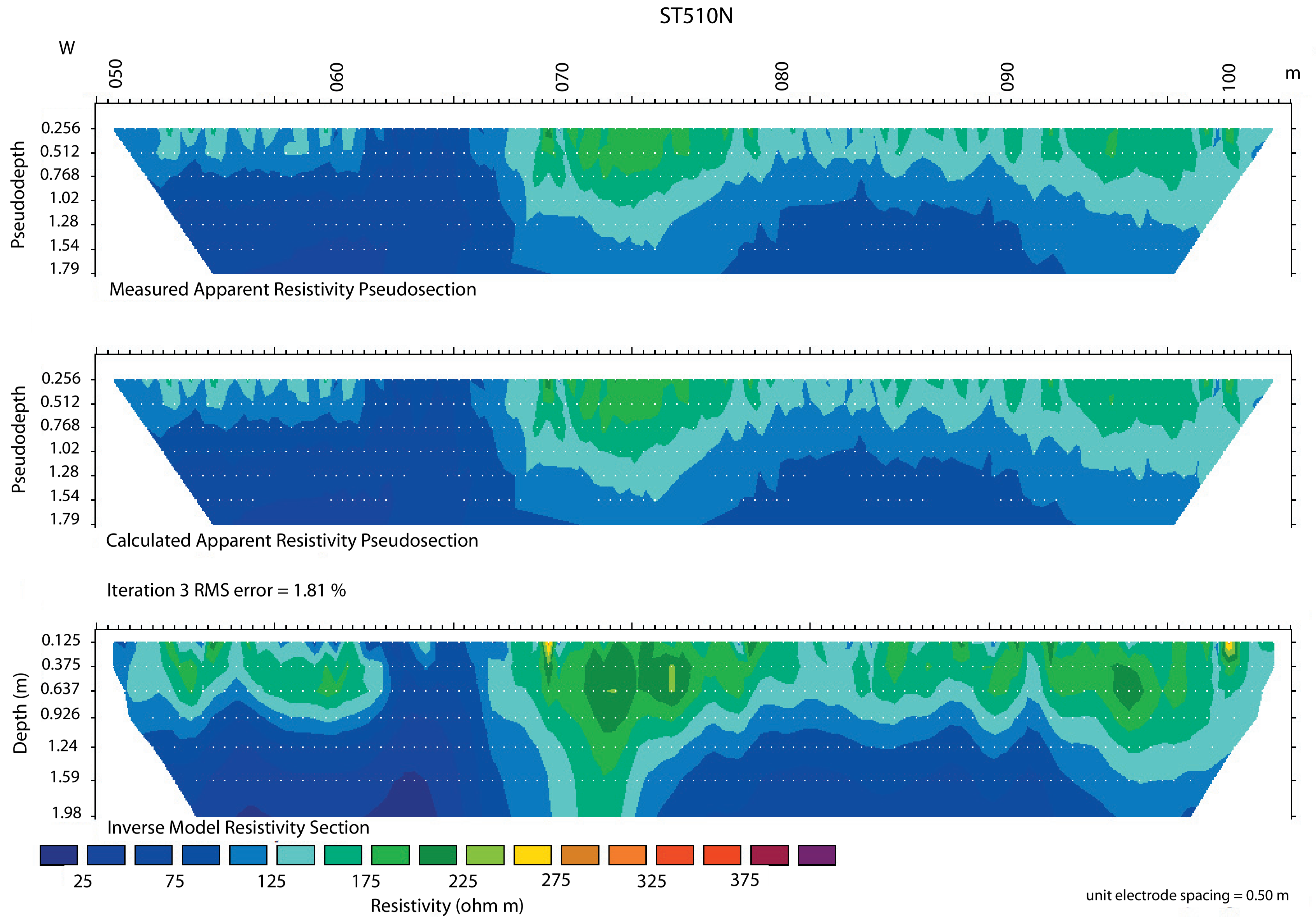
ST538N
W
E
m
051
060
070
080
090
100
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.78 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m


ST541N
W
E
060
070
080
090
100
106 m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.72 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

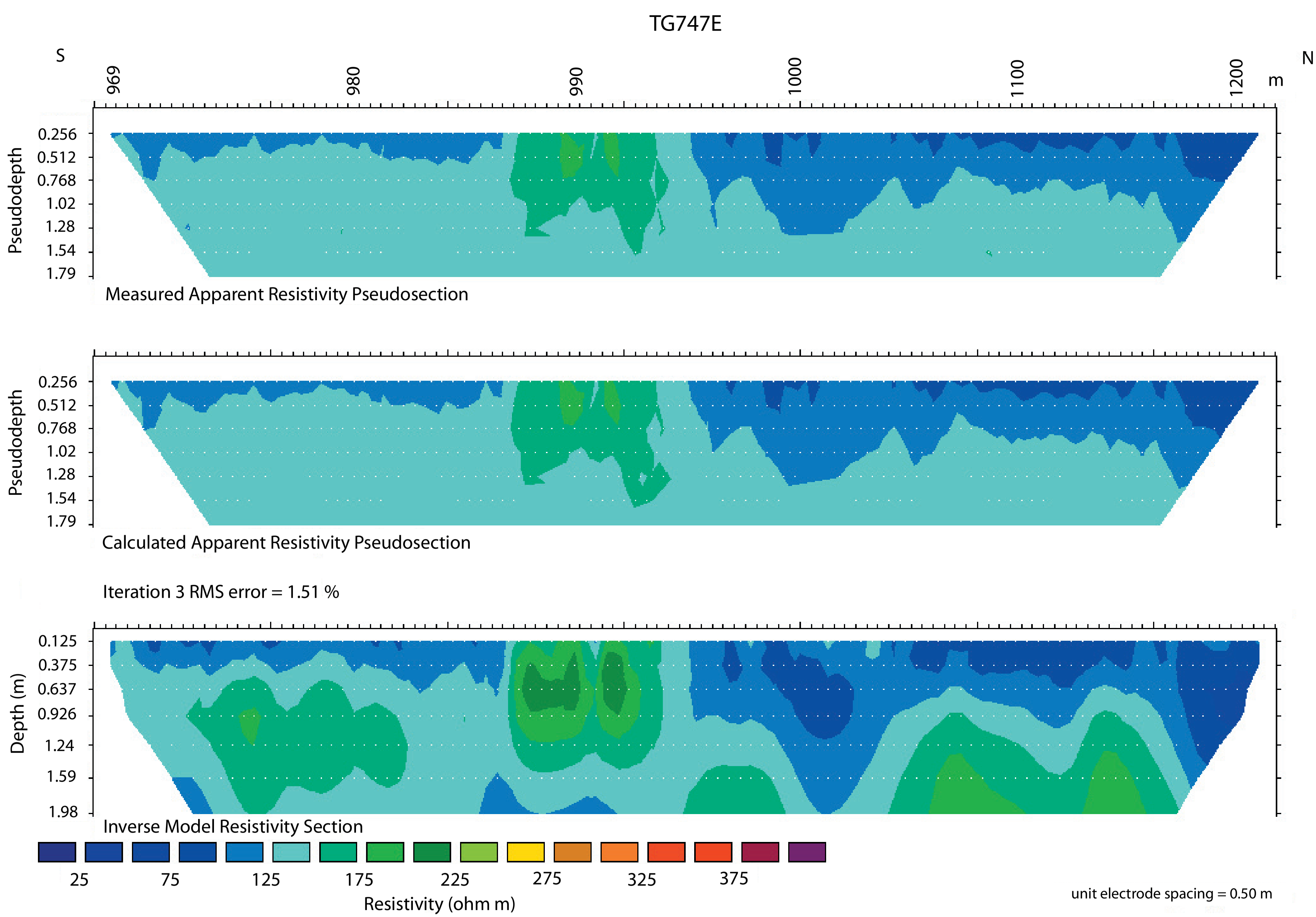

ST544N
W
E
065
070
080
090
100
105 m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.92 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

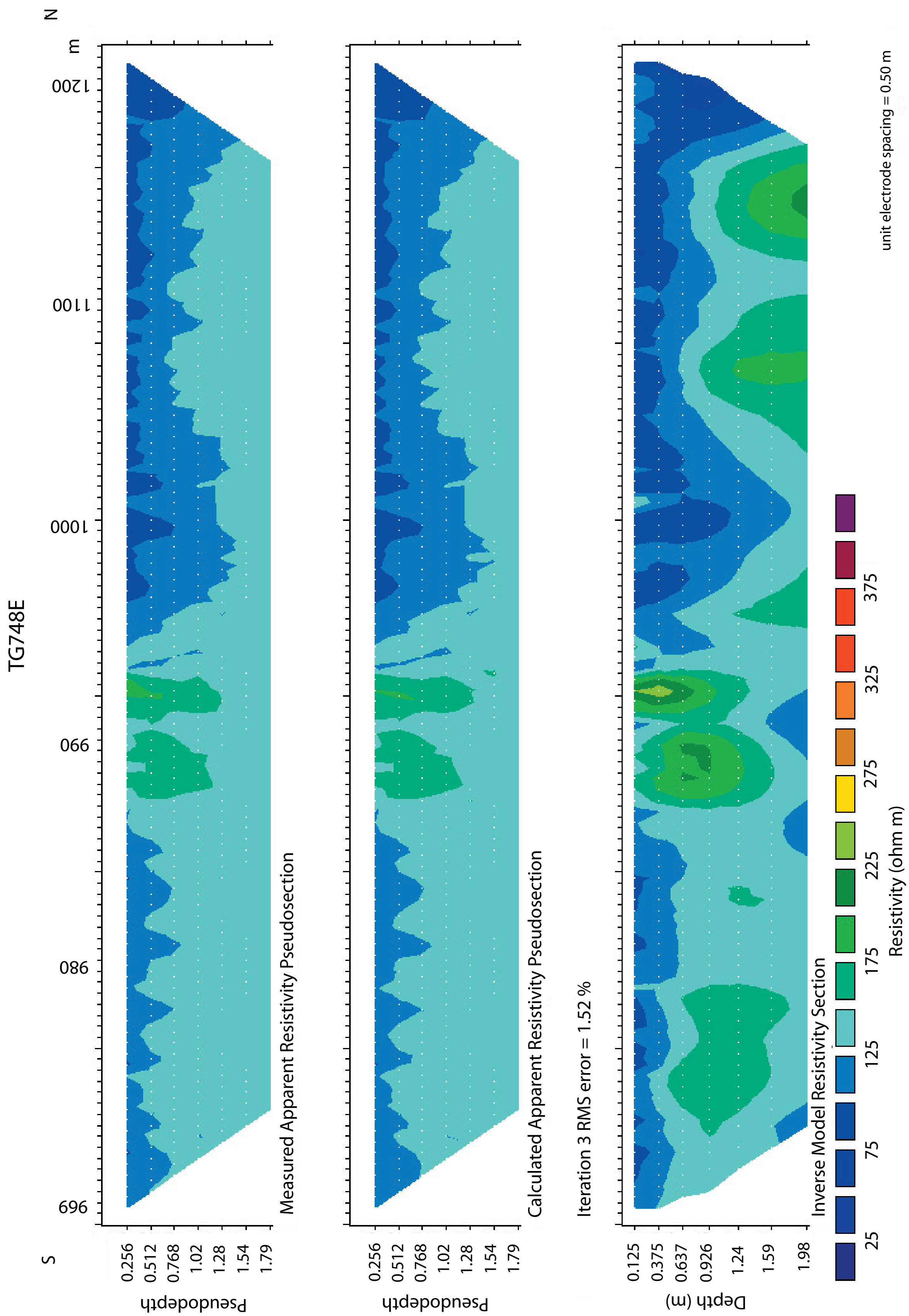

ST522N
W
E
m
050
060
070
080
090
100
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.95 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m


ST516N
W
E
m
050
060
070
080
090
100
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.68 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m



ST510N
W
E
050
060
070
080
090
100
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.81 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m


TG747E
S
N
969
980
990
1000
1100
1200
m
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.51 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m


TG748E
S
N
m
696
086
066
1000
1100
1200
Pseudodepth
0.256
0.512
0.768
1.02
1.28
1.54
1.79
Measured Apparent Resistivity Pseudosection
Calculated Apparent Resistivity Pseudosection
Iteration 3 RMS error = 1.52 %
Depth (m)
0.125
0.375
0.637
0.926
1.24
1.59
1.98
Inverse Model Resistivity Section
25
75
125
175
225
275
325
375
Resistivity (ohm m)
unit electrode spacing = 0.50 m

Excavations

Glaumbær

Initial excavations of 2001 established the existence of a substantial peat ash deposits, well preserved turf walls, and tramped earth floors. Initial excavations failed to reveal any stone foundations to the turf walls but did uncover a few curb stones at floor edges.

The goals of the 2002 season was to confirm the layout of the structure and establish that it was a dwelling. Intensive remote sensing was conducted over the entire area with both the EM-31 and the Syscal Kid. Before excavation commenced. The excavation consisted of re excavating the 2001 trenches and the excavation of two trenches through the structure.

With the assistance of Guðmundur Ólafsson, we were able to select an off grid angle that cross-cut the structure (Figure 7) This revealed two well preserved 1.8 m wide turf walls, Inside of the walls were poorly compacted layers of mixed midden and turf that dropped down at some small rocks that seem to have bordered the tramped earth floor. The overall interpretation of the profile is that of very think turf walls outside of 1.8 m benches that lined the sides of a 1.85 m 10 cm thick floor (highlighted in Figure 8). This floor, bench, wall sequence seems to be overlaid with turf fall, very thin layer of aeolian soil and then the H1 tephra layer. There is a second wall, east of the east wall of the structure. The turf of this wall has a different appearance and Magnus A. Sigurdsson has identified the H 1000 layer on top of the lower portion of the most eastern turf wall, suggesting that the bottom portion of the wall was constructed before 1000, which has implications for an archaeological interpretation if the Saga of the Greenlanders. The 1000 layer has only been identified in soil cores well away from the identified structure. It has not been found in or on top of any of the turfs that make up the other walls. Therefore, both tephra and AMS dating point to a main occupation of the structure between 1000 and 1100 AD. However there may well be an earlier occupation. No part of the structure could have been used after 1104.

In an effort to determine if the turf manner house that is now part of the Glaumbær museum was occupied contemporaneously, a multiple profile excavation trench was excavated into the south side of the ash mound near the kitchen door of the manner house. The ash pile is over two meters tall and extends 70 cm below the modern ground surface. The non-stratified ash midden is underlain by the H1 tephra layer which at that sport is found on top of sterile aeolian soil (Figure 11). If the chronology of this mound can be extended to the rest of the upper settlement, it would imply that the recently discovered long-house is not contemporaneous with the settlement at the manor house.

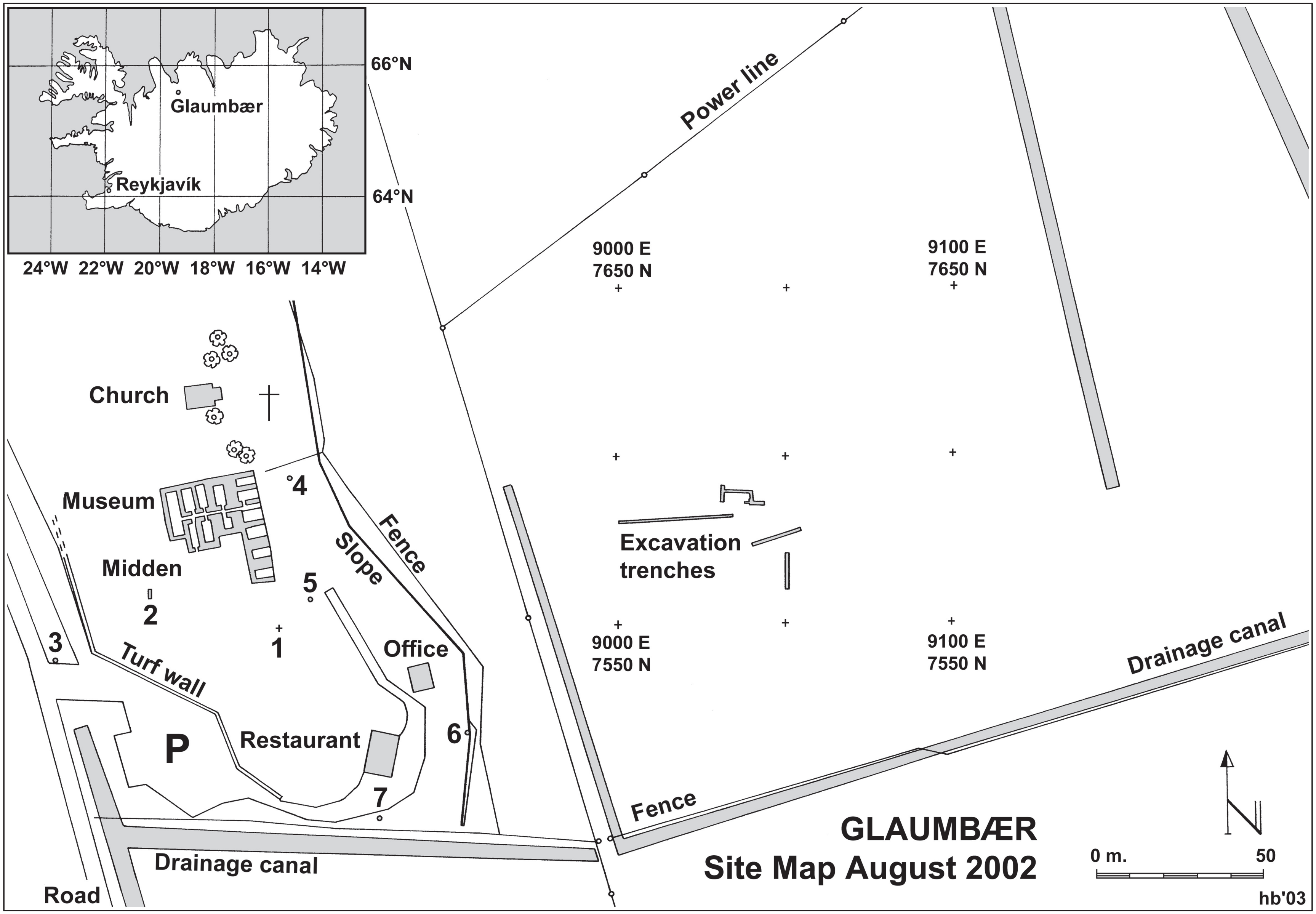


Figure 6. Layout of Glaumbær

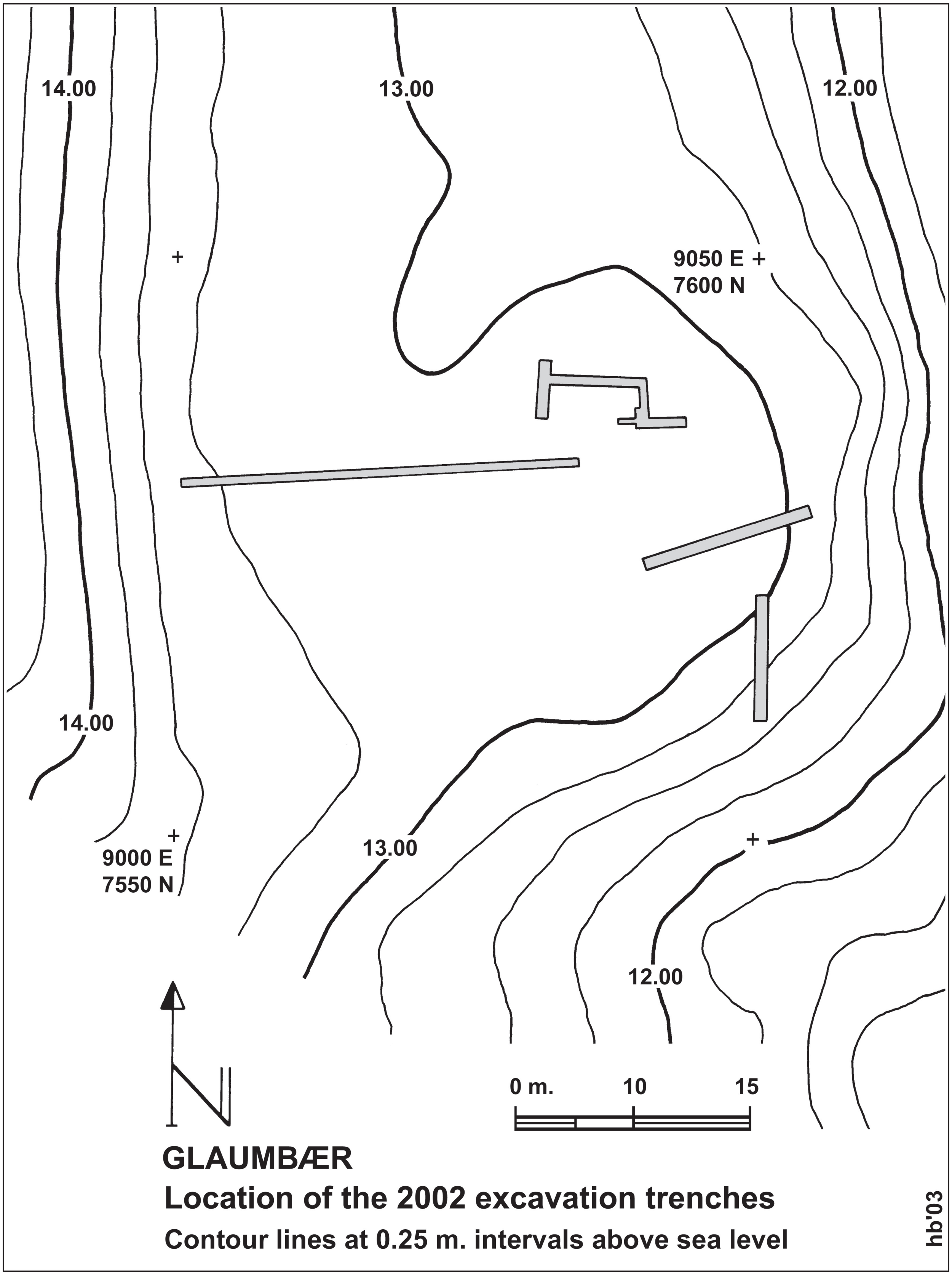


Figure 7. Glaumbær trenches

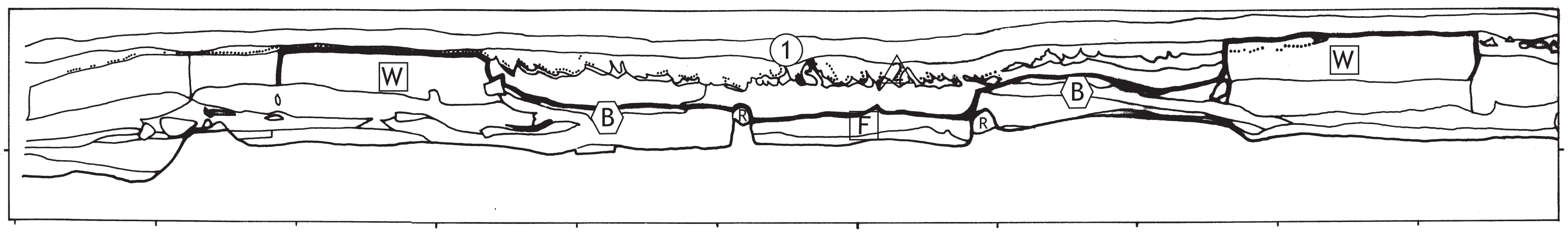


Figure 8 South profile of off Grid trench through long access of house.

SASS Profile Key

① Soils
- Brown
- Gray
- Gravel
- Sand
- Sterile

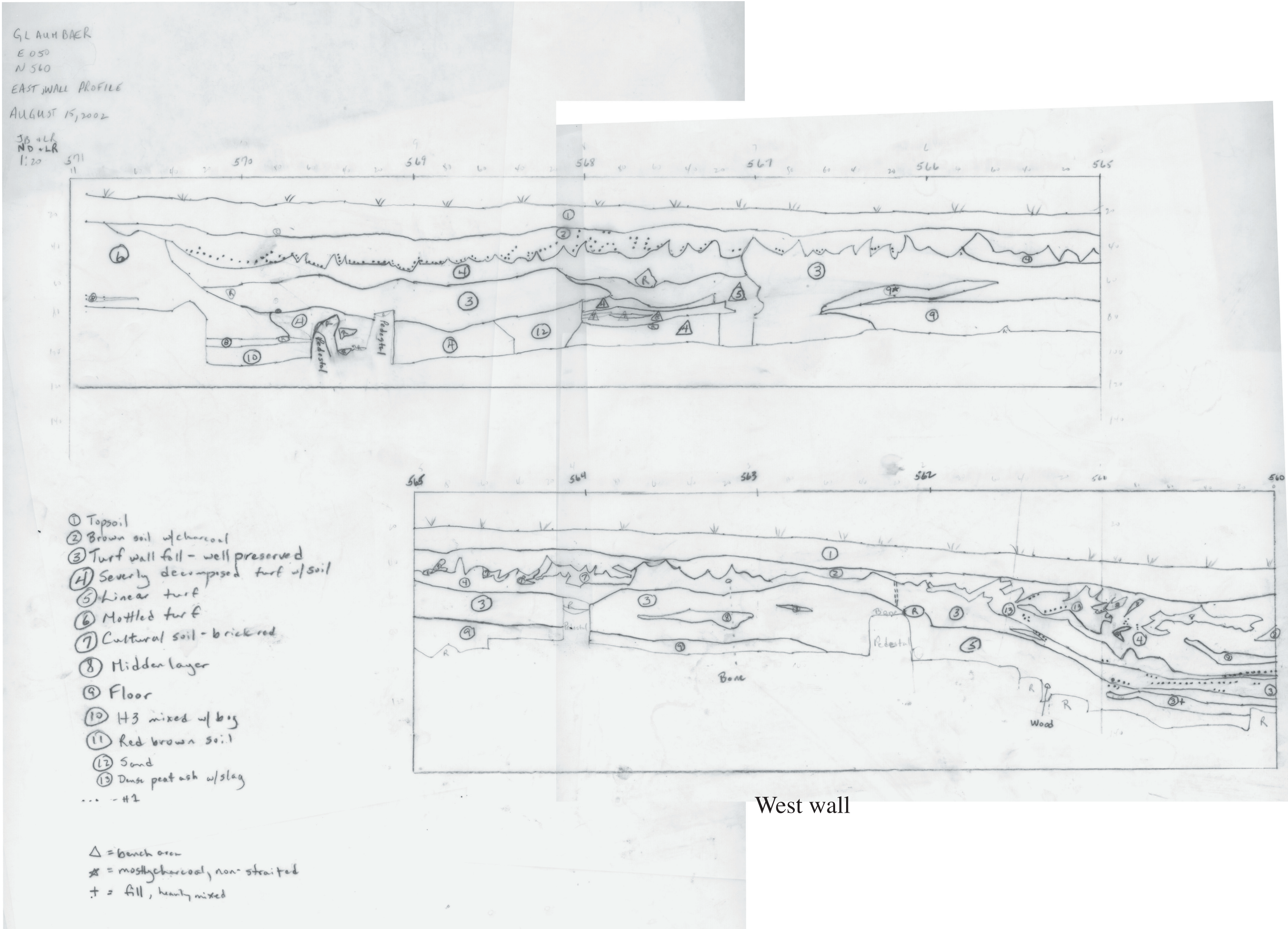
△2 Tephra or
- 1766
- 1300
- 1104
- 1000
- LNL

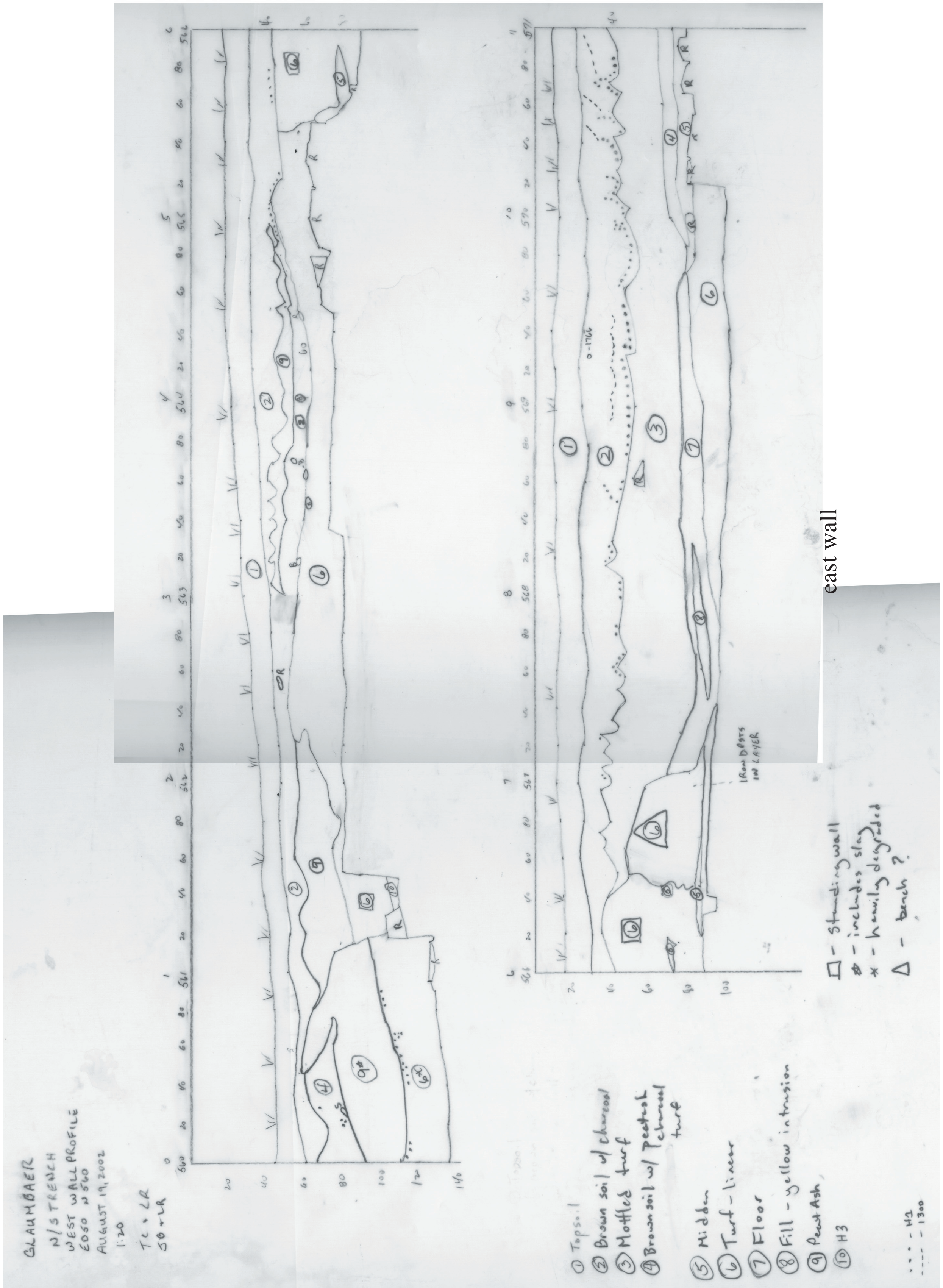
[5] Turf & Floor and other Direct cultural deposits
- Wall
- Wall Fall
- Tramped earth
- Hay

⟨8⟩ Midden
- Peat Ash
- Wood Ash
- Mixed

* Sample

R Rock
W Wood
C Charcoal


GLAUMBAER
E 050
N 560
EAST WALL PROFILE
AUGUST 15, 2002
JB + LR
ND + LR
1:20
① Topsoil
② Brown soil w/charcoal
③ Turf wall fall - well preserved
④ Severly decomposed turf w/soil
⑤ Linear turf
⑥ Mottled turf
⑦ Cultural soil - brick red
⑧ Midden layer
⑨ Floor
⑩ H3 mixed w/ bog
⑪ Red brown soil
⑫ Sand
⑬ Dense peat ash w/slag
... - #1
△ = bench area
✲ = mostly charcoal, non-straited
+ = fill, heavily mixed
Pedestal
Bone
Wood
West wall


GLAUMBAER
N/S TRENCH
WEST WALL PROFILE
E060 N560
AUGUST 19, 2002
1:20
TC + LR
JB + LR
① Topsoil
② Brown soil w/ charcoal
③ Mottled turf
④ Brown soil w/ peat & charcoal turf
⑤ Midden
⑥ Turf - liner
⑦ Floor
⑧ Fill - yellow intrusion
⑨ Peat Ash
⑩ H3
□ - standing wall
ø - includes slag
* - heavily degraded
Δ - bench ?
IRON BITS IN LAYER

east wall

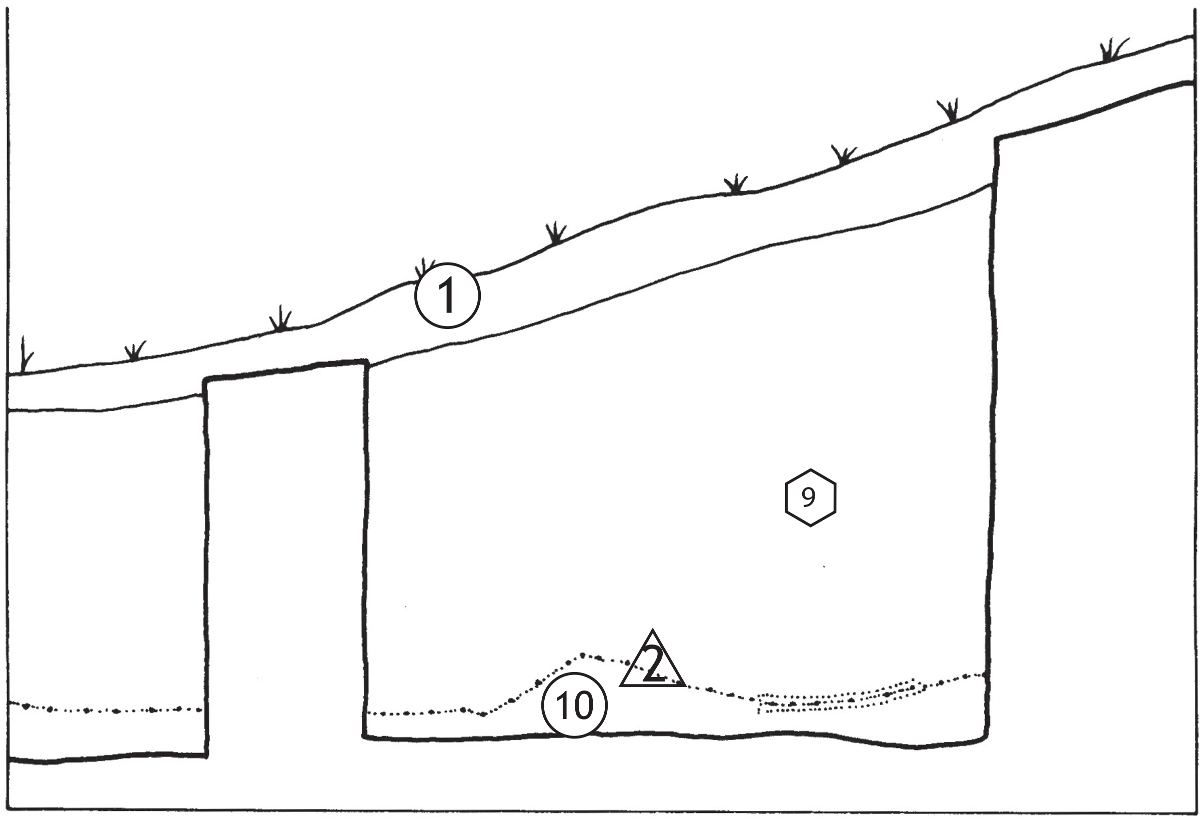


Figure 11. Peat-ash midden outside mannor house at Glaumbær

Stóra-Seyla

Besides the excavations based on the remote sensing, we also excavated a 1x1 m test trench into the location traditionally thought to be that of the chapel and later meeting house. This test trench shows no signs of any turf structure (Figure 14). Today it is the location of a garbage dump and the majority of the cultural material is peat-ash, indicating continuity.

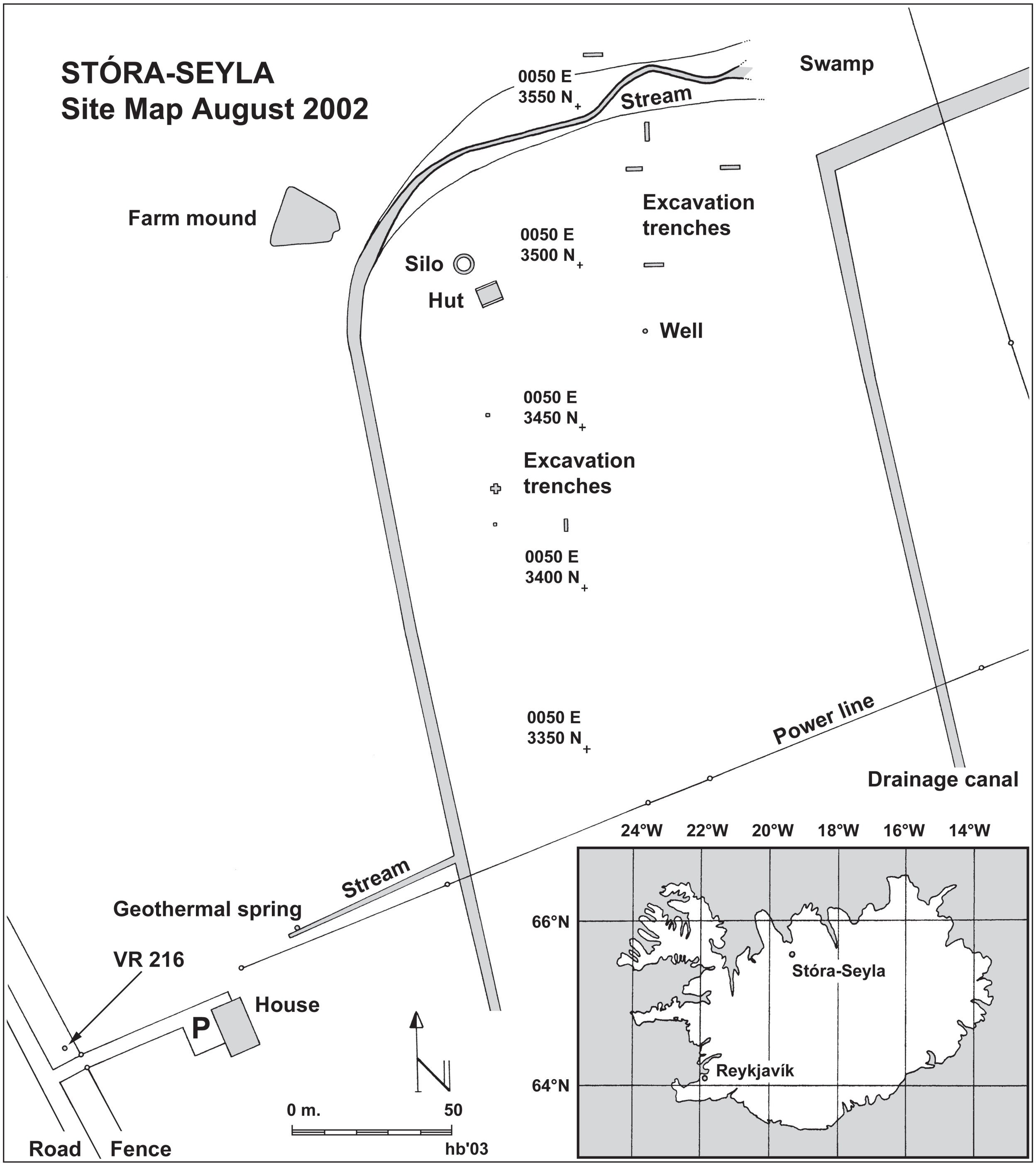


Figure 12 Stóra-Seyla excavation location.

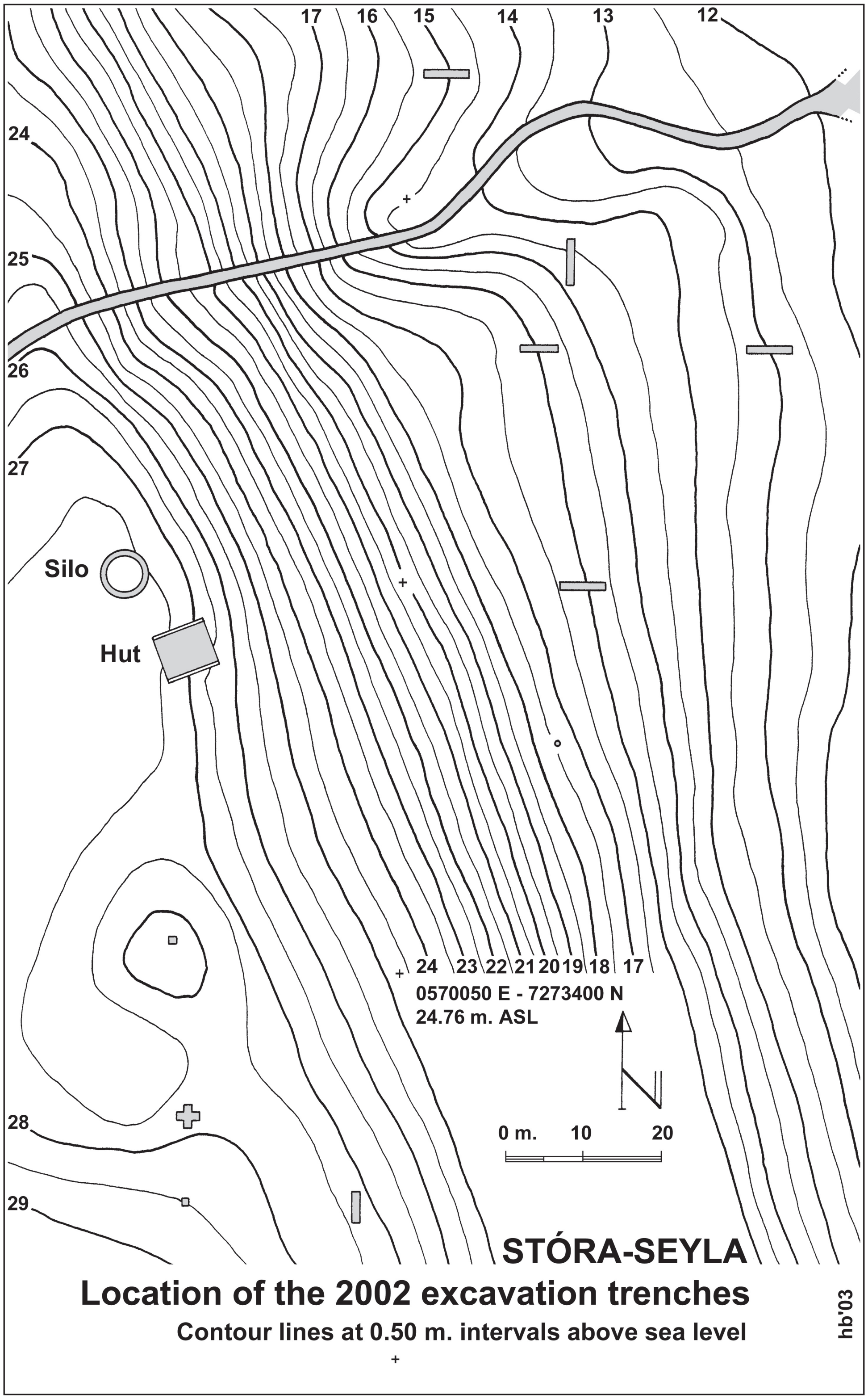


Figure 13. Stóra-Seyla contor map

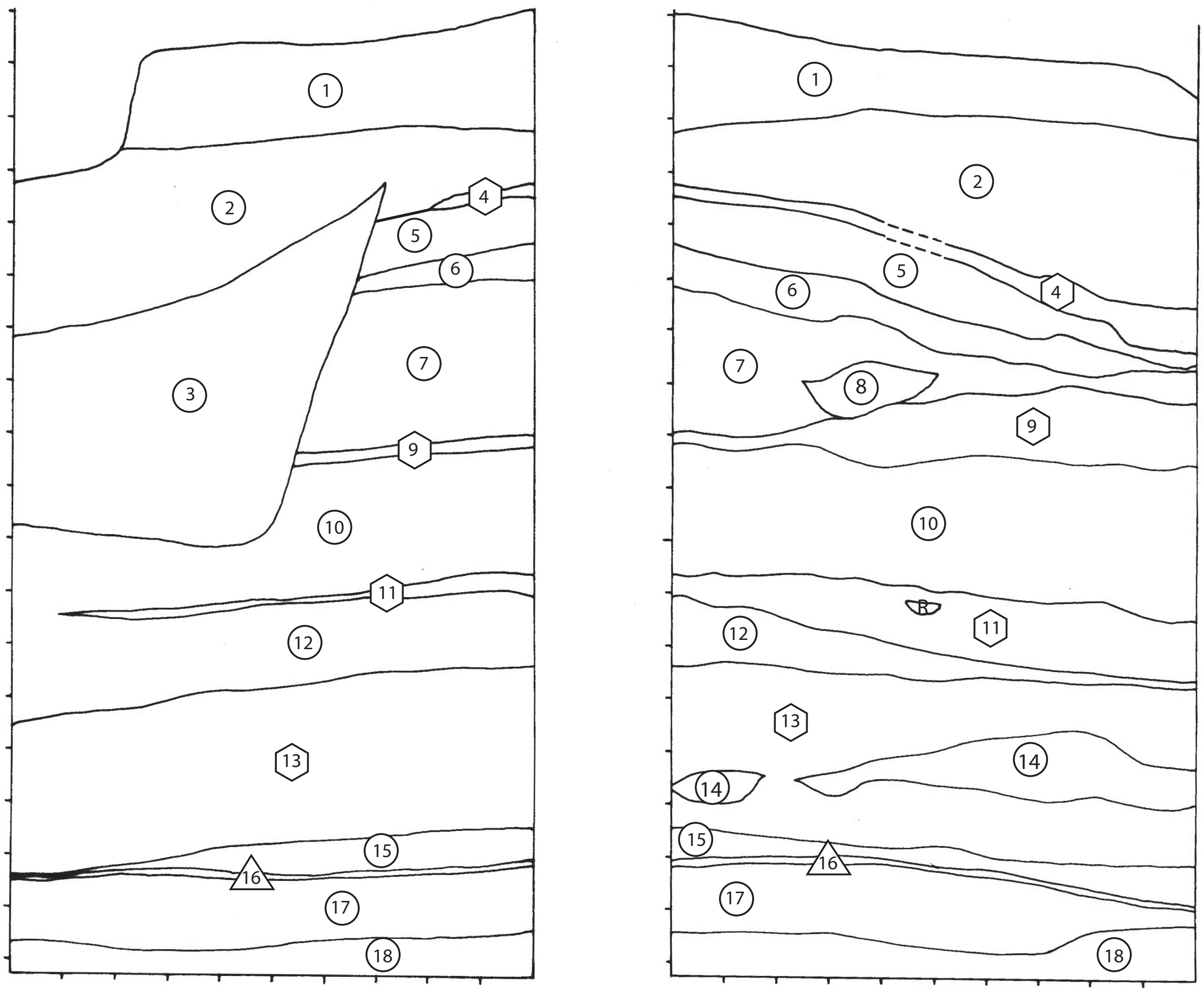
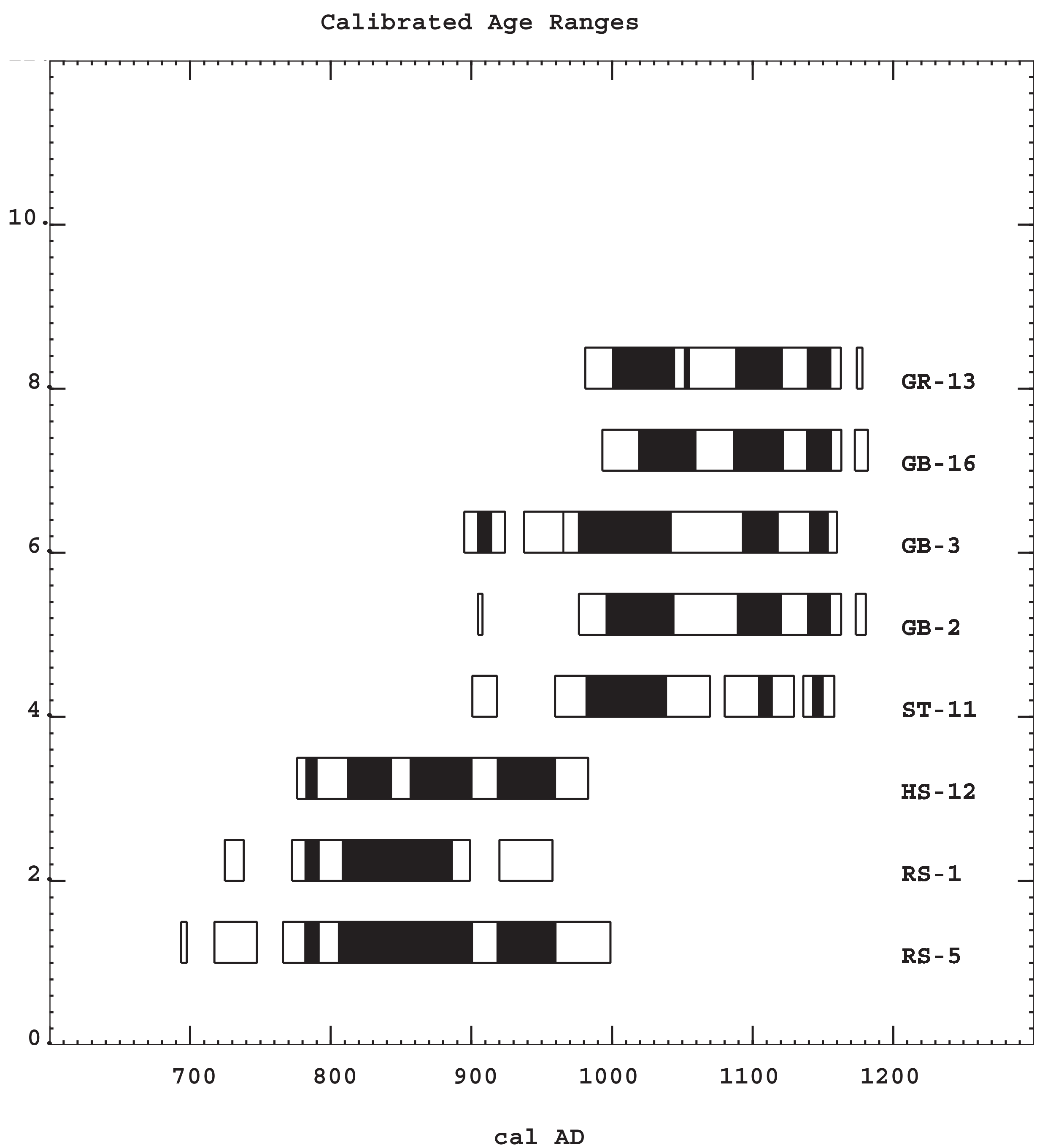


Figure 14. Stóra-Seyla test trench into location taditionally held as that of the chapel.

Radiocarbon Samples

Six samples were submitted for AMS dateing from the 2002 season. The forms and calabration curves are presented below.



NSF ARIZONA AMS FACILITY
The University of Arizona

SAMPLE INFORMATION SHEET

Physics Building 81
Tucson, Arizona 85721
USA.

Tel. (520) 621-6810
Fax. (520) 621-9619
Electronic mail:
AMS@physics.arizona.edu

Please read the attached supplemental information and agreement

AA -
Sample target no.

User sample no. SASS HS 12

Date received at AMS lab:

Submitted by: John M. Steinberg
Affiliation and address: UCLA, Inst. Archaeology
A-210 Fowler
LA CA 90095-1510
Telephone: (310)794-9485
FAX: (310)206-4723
E-mail: jmstein@ucla.edu

Collected by: John Steinberg
Affiliation and address:
UCLA, Archaeology
A-210 Fowler
LA CA 90095-1510

Supported by NSF Division: Archaeology
Grant no: BCS 0107413
Other agency:

SITE INFORMATION

Name Hafsteinstadir
Region Skjafjordur
County
State/Province
Country Iceland
Map reference
Latitude UTME 0565117
Longitude UTMN 7282972

Date submitted: 5/25/03
Date collected: 8/02/02
Sample material: Bone
Weight (mg): 0.5 g
Identified by:
Cultural or time range of the site: AD 800-1700
Previous dates from the site: N/A

Expected age and on what basis.
Cite any previous ^{14}C dates and relevant cultural, paleoenviromental information
Sample was pulled from peat ash midden matrix below 7 cm below AD 1104 tephra layer
Just above AD 1000 tephra layer. Both tephra layers are probably in situ.

Associated cultural, paleontological, paleobotanical or other material:
Burned wood charcoal, and burned peat ash.

Stratigraphic position, including depth in core.
Attach a diagram if necessary
277 cm below ground surface

Sample pre-treatment:
None

Special instructions:

Note: Samples of soil and sediment must be submitted wrapped in Al foil, and contained in a sealed container. This is also a good way to submit any type of sample.

Accelerator Laboratory Use Only

Pricing: Commercial____ Academic ____ NSF ____ Student ____ Gas ____ Graphite ___ Other ____

d^{13}C required ____ **Deadline** ____________

We request that users acknowledge the University of Arizona and the National Science Foundation when the results are published. We also request that a copy of any published material be sent to the laboratory.

NSF ARIZONA AMS FACILITY
The University of Arizona

SAMPLE INFORMATION SHEET

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USA.

Tel. (520) 621-6810
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Electronic mail:
AMS@physics.arizona.edu

Please read the attached supplemental information and agreement

AA -
Sample target no.

User sample no. SASS GR 13

Date received at AMS lab:

Submitted by: John M. Steinberg
Affiliation and address: UCLA, Inst. Archaeology
A-210 Fowler
LA CA 90095-1510
Telephone: (310)794-9485
FAX: (310)206-4723
E-mail: jmstein@ucla.edu

Collected by: John Steinberg
Affiliation and address:
UCLA, Archaeology
A-210 Fowler
LA CA 90095-1510

Supported by NSF Division: Archaeology
Grant no: BCS 0107413
Other agency:

SITE INFORMATION

Name Grofergil
Region Skjafjordur
County
State/Province
Country Iceland
Map reference
Latitude UTME 0570050
Longitude UTMN 7272520

Date submitted: 5/25/03
Date collected: 8/02/02
Sample material: mature bovine crainium
Weight (mg): 1.3 g
Identified by: Tom Wake
Cultural or time range of the site: AD 800-1700
Previous dates from the site: N/A

Expected age and on what basis.
Cite any previous ^{14}C dates and relevant cultural, paleoenviromental information
Sample was pulled from trampled earth floor with turf wall fall
and peat ash midden matrix. Associated with AD 1104 Tephra Layer.

Associated cultural, paleontological, paleobotanical or other material:
Burned wood charcoal, and burned peat ash, unburnt turf.

Stratigraphic position, including depth in core.
Attach a diagram if necessary
83 cm below ground surface

Sample pre-treatment:
None

Special instructions:

Note: Samples of soil and sediment must be submitted wrapped in Al foil, and contained in a sealed container. This is also a good way to submit any type of sample.

Accelerator Laboratory Use Only

Pricing: Commercial____ Academic ____ NSF ____ Student ____ Gas ____ Graphite ___ Other ____

d^{13}C required ____ **Deadline** ____________

We request that users acknowledge the University of Arizona and the National Science Foundation when the results are published. We also request that a copy of any published material be sent to the laboratory.

NSF ARIZONA AMS FACILITY
The University of Arizona

SAMPLE INFORMATION SHEET

Physics Building 81
Tucson, Arizona 85721
USA.

Tel. (520) 621-6810
Fax. (520) 621-9619
Electronic mail:
AMS@physics.arizona.edu

Please read the attached supplemental information and agreement

AA -
Sample target no.

User sample no. SASS MD 14

Date received at AMS lab:

Submitted by: John M. Steinberg
Affiliation and address: UCLA, Inst. Archaeology
A-210 Fowler
LA CA 90095-1510
Telephone: (310)794-9485
FAX: (310)206-4723
E-mail: jmstein@ucla.edu

Collected by: Steve Martin
Affiliation and address:
UCLA, Archaeology
A-210 Fowler
LA CA 90095-1510

Supported by NSF Division: Archaeology
Grant no: BCS 0107413
Other agency:

SITE INFORMATION

Name Medalheimer
Region Skjafjordur
County
State/Province
Country Iceland
Map reference
Latitude UTME 0567691
Longitude UTMN 7277004

Date submitted: 5/25/03
Date collected: 8/02/02
Sample material: Wood, Brich: Betula Sp.
Weight (mg): 0.6 g
Identified by: Steve Martin
Cultural or time range of the site: AD 800-1700
Previous dates from the site: N/A

Expected age and on what basis.
Cite any previous ^{14}C dates and relevant cultural, paleoenviromental information
Sample was pulled from float sample.

Associated cultural, paleontological, paleobotanical or other material:
Burned wood charcoal, and burned peat ash, unburnt turf.

Stratigraphic position, including depth in core.
Attach a diagram if necessary
142 cm below ground surface

Sample pre-treatment:
None

Special instructions:

Note: Samples of soil and sediment must be submitted wrapped in Al foil, and contained in a sealed container. This is also a good way to submit any type of sample.

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d^{13}C required ____ **Deadline** ____________

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AA -
Sample target no.

User sample no. SASS MD 15

Date received at AMS lab:

Submitted by: John M. Steinberg
Affiliation and address: UCLA, Inst. Archaeology
A-210 Fowler
LA CA 90095-1510
Telephone: (310)794-9485
FAX: (310)206-4723
E-mail: jmstein@ucla.edu

Collected by: Doug Bolender
Affiliation and address:
UCLA, Archaeology
A-210 Fowler
LA CA 90095-1510

Supported by NSF Division: Archaeology
Grant no: BCS 0107413
Other agency:

SITE INFORMATION

Name Medalheimer
Region Skjafjordur
County
State/Province
Country Iceland
Map reference
Latitude UTME 0567691
Longitude UTMN 7277004

Date submitted: 5/25/03
Date collected: 8/02/02
Sample material: Burnt bone
Weight (mg): 0.4 g
Identified by: n/a
Cultural or time range of the site: AD 800-1700
Previous dates from the site: N/A

Expected age and on what basis.
Cite any previous ^{14}C dates and relevant cultural, paleoenviromental information
Sample was pulled from South east corner of profile. No tephra associated.

Associated cultural, paleontological, paleobotanical or other material:
Burned wood charcoal, burned peat ash, and unburnt turf.

Stratigraphic position, including depth in core.
Attach a diagram if necessary
160 cm below ground surface

Sample pre-treatment:
None

Special instructions:

Note: Samples of soil and sediment must be submitted wrapped in Al foil, and contained in a sealed container. This is also a good way to submit any type of sample.

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d^{13}C required ____ **Deadline** ____________

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AA -
Sample target no.

User sample no. SASS GB 16

Date received at AMS lab:

Submitted by: John M. Steinberg
Affiliation and address: UCLA, Inst. Archaeology
A-210 Fowler
LA CA 90095-1510
Telephone: (310)794-9485
FAX: (310)206-4723
E-mail: jmstein@ucla.edu

Collected by: Elizabeth Ward
Affiliation and address:
UCLA, Archaeology
A-210 Fowler
LA CA 90095-1510

Supported by NSF Division: Archaeology
Grant no: BCS 0107413
Other agency:

SITE INFORMATION

Name Glaumbaer
Region Skjafjordur
County
State/Province
Country Iceland
Map reference
Latitude UTME 0569050.39
Longitude UTMN 7277560.35

Date submitted: 5/25/03
Date collected: 8/02/02
Sample material: bone
Weight (mg): 1.3 g
Identified by: n/a
Cultural or time range of the site: AD 800-1700
Previous dates from the site: N/A

Expected age and on what basis.
Cite any previous ^{14}C dates and relevant cultural, paleoenviromental information
Sample was taken from 'butter bone' in floor of trench.
Associated with AD 1104 Tephra Layer.

Associated cultural, paleontological, paleobotanical or other material:
Burned wood charcoal, burned peat ash, burnt turf and un burnt turf.

Stratigraphic position, including depth in core.
Attach a diagram if necessary
90 cm below ground surface

Sample pre-treatment:
None

Special instructions:

Note: Samples of soil and sediment must be submitted wrapped in Al foil, and contained in a sealed container. This is also a good way to submit any type of sample.

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d^{13}C required ____ **Deadline** ____________

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Tucson, Arizona 85721
USA.

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Fax. (520) 621-9619
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Please read the attached supplemental information and agreement

AA -
Sample target no.

User sample no. SASS ST 11

Date received at AMS lab:

Submitted by: John M. Steinberg
Affiliation and address: UCLA, Inst. Archaeology
A-210 Fowler
LA CA 90095-1510
Telephone: (310)794-9485
FAX: (310)206-4723
E-mail: jmstein@ucla.edu

Collected by: Nilka Dabare
Affiliation and address:
UCLA, Archaeology
A-210 Fowler
LA CA 90095-1510

Supported by NSF Division: Archaeology
Grant no: BCS 0107413
Other agency:

SITE INFORMATION

Name Stora Seyla
Region Skjafjordur
County
State/Province
Country Iceland
Map reference
Latitude UTME 0569043.5
Longitude UTMN 7277584.5

Date submitted: 5/25/03
Date collected: 8/02/02
Sample material: Mature 1st rib from sheep (or goat) with cut marks
Weight (mg): 3.9 g
Identified by: Tom Wake
Cultural or time range of the site: AD 800-1700
Previous dates from the site: N/A

Expected age and on what basis.
Cite any previous ^{14}C dates and relevant cultural, paleoenviromental information
Sample was pulled from peat ash midden matrix possibly above AD 1104 tephra layer

Associated cultural, paleontological, paleobotanical or other material:
Burned wood charcoal, and burned peat ash.

Stratigraphic position, including depth in core.
Attach a diagram if necessary
99 cm below ground surface

Sample pre-treatment:
None

Special instructions:

Note: Samples of soil and sediment must be submitted wrapped in Al foil, and contained in a sealed container. This is also a good way to submit any type of sample.

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d^{13}C required ____ **Deadline** ____________

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Organic content of Turf Walls

Turf, from the upper levels of peat bogs, provided the farmers and pastoralists of Viking Age and Late Norse (874-1500 AD) Scandinavia with an ideal building material (contributions to Myhre, Stoklund and Gjærder; 1982 Urbanczyk 1999. Turf procurement and construction methods in Medieval Iceland are well understood (e.g., Berson 2002; Sigurðardóttir 1998; Smith 1995). The volcanic tephra layers incorporated into turf walls have been routinely used for dating (Vésteinsson 2000) and therefore changes in construction techniques, especially for the earliest phases, are well understood. However, the post-depositional behavior of buried turf in archaeological contexts is not well understood. The tests described below were performed to see if it were possible, practical, and productive to quantify the organic content of turf walls in buried archaeological contexts.

These tests were run as part of the work of the Skagafjörður Archaeological Settlement Survey (SASS). The SASS project developed and implemented a protocol of surface survey, coring, augering, remote sensing (conductivity and resistivity), and test trenches to identify and explore archaeological remains without any surface sign (Steinberg and Bolender in press). The successful identification of anomalies associated with archaeological sites depends on the preserved remains having distinguishing characteristics. The main component of turf, and an important attribute that distinguishes the walls from the surrounding soil, is turf's high organic content (Crowther 2002). Therefore, an understanding of the post-depositional behavior of turf might be important for the identification of biases in site identification using remote sensing.

Turf is primarily composed of *Sphagnum* (the peat mosses). *Sphagnum* is the only genus in the class Sphagnopsida but it consists of more than 300 species. *Sphagnum* has two special properties: through selective ion absorption, the pH in the center of a tuft of peat moss is often lower (pH=4.4) than surrounding soil and water (pH=6.0) and, due to a unique and unusual arrangement of two different kinds of cells in the leaves, it is highly absorptive. Therefore, areas inhabited by Sphagnum are extremely acidic. This prevents the dead *Sphagnum* and other organic material from decaying, creating peat deposits or bogs. Turf comes from the upper layers of partially compressed peat that has been cut and dried. When dry, the turf is light and has a consistency similar to cork, which, along with its good insulation properties, make it an excellent building material.

Once a turf house is abandoned, the strips and blocks of turf erode and fall in various directions, usually leaving only the bottom of the wall intact, but surrounded by a substantial area of turf fall. It is likely that in the coastal and fjord areas of Skagafjörður, turf structures abandoned during the Viking Age would have been buried rapidly, preventing their destruction by the wind and weather. Soil deposition studies (Guðbergsson 1975, 1994) indicate that most of the 30 to 90 cm of aeolian soil that has accumulated in lowland Skagafjörður over the last 1100 years from eroding highland areas (e.g., Dugmore and Buckland 1991), was deposited during the first 250 years of settlement (from 874-1100 AD, see also Thorarinsson 1961).

However, good conditions for preservation of turf structures do not necessarily imply that the identification of the early sites with substantial turf architecture is unbiased. Once buried, the small air pockets in turf that make up most of its volume, are compressed, substantially reducing the volume. Turf does contain inorganic matter, most of it deposited in bogs by the wind, (Johannesson 1960), caused by highland erosion (Låg 1955). The lower the inorganic content, the better the turf for house building (Gestsson 1982). Increased inorganic material in the turf blocks would have made them heavier; reduced their ability to insulate; and may have decreased their resistance to wind and weather. The combination of the reduction in turf volume and the deposition of substantial aeolian soils means that well-preserved compressed turf structures can be completely buried, with little sign of their existence on the ground surface. If leaching causes a substantial reduction in organic content (e.g., Kortelainen and Saukkonen 1998) of a particular class of structures (e.g., small and very early farmsteads) then the identification of these structures using any type of remote sensing could be impossible or at least biased.

On the other hand, it may be that some proportion of the organic content of turf walls are consistently preserved. If that is true, then measurements of the organic content of buried turf walls may yield information on a number of different issues ranging from dating to economic wherewithal. Unfortunately, the data collected and processed so far only hints at some of the possible applications of measures of the organic content of turf walls.

If eluviation causes slow and regular leaching of the organic content of buried turf walls then the organic content may correlate positively with the age of the turf structure. That is, organic content could vary with age because once removed from their aseptic environment, the organic content of turfs will begin to reduce. Under this scenario, lower organic content would indicate an older wall. Conversely, if organic content does not leach very rapidly and the bog where the turf is removed receives ever-increasing inorganic content from highland erosion (e.g., Guðbergsson 1996), then organic content may be inversely correlated with age. That would mean that the earliest walls would have very high organic contents because they were built with turf that had not yet received inorganic matter from the human induced erosion associated with the settlement.

Organic content could also indicate the quality of the building or be a proxy for the wealth of the builders. While bogs are ubiquitous in Iceland, it may be that good turf is scarce. Turf cutting and house building are a labor intensive activities best done during the summer, when that activity would compete with the grass harvest. It may be that the better the turf, the less often it needs to be replaced or repaired. Using the sturdiest, warmest turf would increase the overall efficiency of a farmstead. It could be that only the wealthy could obtain the best turf. If good turf is only somewhat scarce, then it may be that only the most important buildings were constructed out of the best turf. Therefore, depending on the relative abundance of good turf, organic content may be positively correlated with wealth.

Organic content could also become more variable with structure occupation length. Turf houses that are occupied for a long time (several generations) are usually rebuilt piecemeal over the life of the house. If the organic content of bogs varies from year to year or from bog to bog, then the overall variation in organic content within a single structure could yield some relative measure of the length of time a structure was used or the number of times it was rebuilt.

Finally, and least desirable, the organic content of turf in buried archaeological contexts could be so complex or could be so sensitive to local environmental differences that measurements of organic content are not helpful at all. If leaching is not substantial but predictable, then the organic content of turf walls could be useful for looking into a number of different archaeological problems.

Methods

In order to assess organic content, a series of 80 loss-on-ignition (LoI) tests were conducted. LoI is a fast, cheap, and effective method for analyzing soils with high organic contents. In general, LoI is preferred over the Walkley-Black method for soils where samples are expected to be over 10% organic. Turf deposits could be over 90% organic (*cf.* Caft, Seneca and Broome 1991). The procedure for the archaeological soil samples followed the guidelines for general LoI samples (e.g., Oliver, Lotter and Lemcke 2001) in which volumetric sub-samples were place in weighed crucibles and weighed. Weight loss was measured after heating at 100° C overnight to remove water, and then after two hours at 550° C in a muffle furnace which removed organic matter. After burning, the weighted crucible was weighed again and the percentage of the sample weight lost due to burning was defined as the organic content of the sample (LoI % in Figures 16-18).

In Skagafjörður, sample sequences were taken at 2 archaeological sites (Glaumbær & Stóra Seyla) in and one bog deposit (Grófargil). An additional sequence was taken and analyzed from Hvanneyri (not discussed herein, see Carter 2003 for a description). At the site of Glaumbær, sequences were taken from 4 different locations and at Stóra Seyla 3 locations were sampled. Depths and LoI's for these sites are presented in Figure 16. At each of these locations a sequence of samples was taken through an exposed profile to assess change in organic content with depth. A series of double samples were also run to make sure that, within a sample, there was little LoI variation. In those 8 cases, samples from the

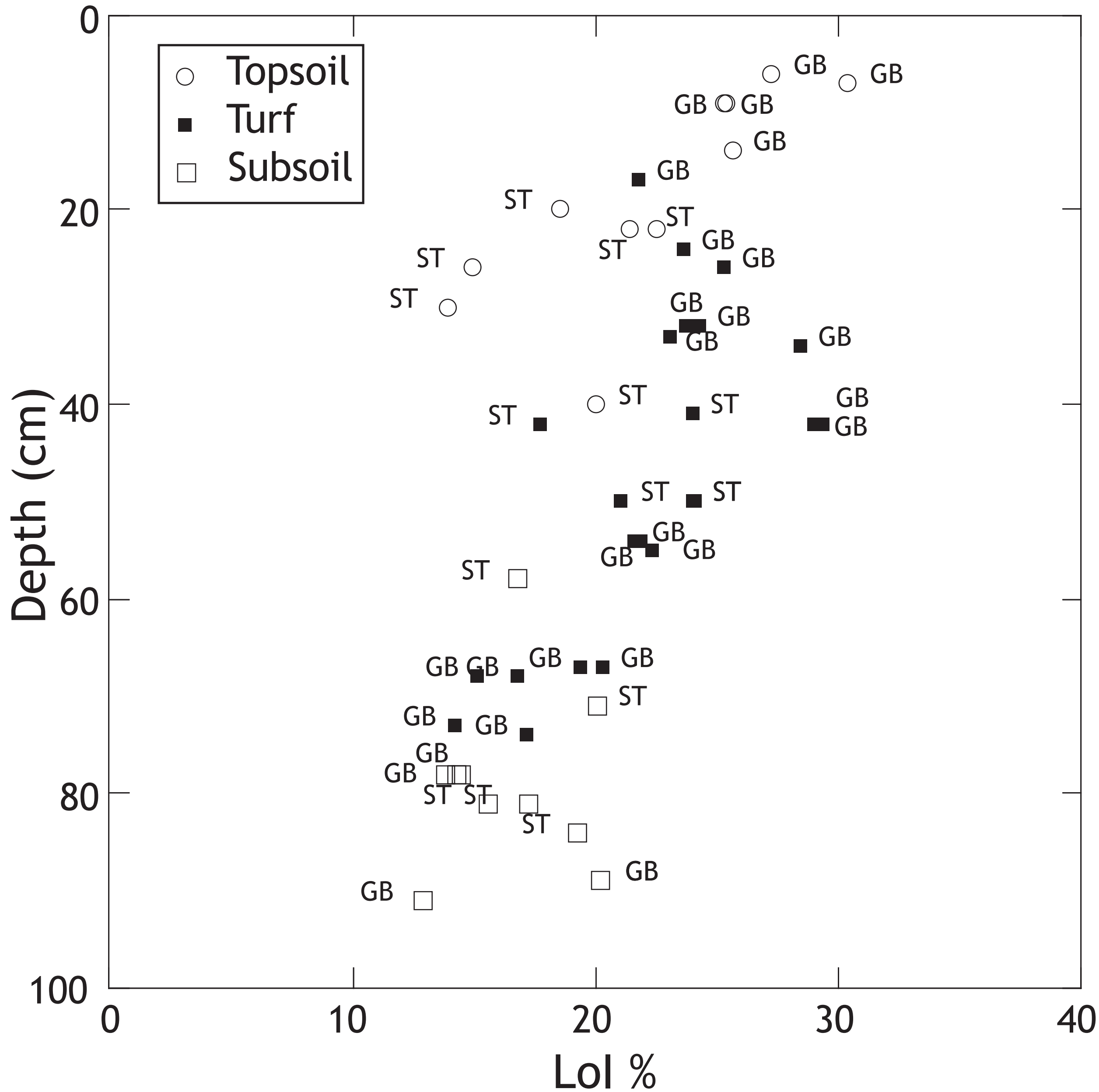

Figure 16. Sample depth against LoI percentage at Stóra Seyla (ST) and Glaumbær (GB). Deposits of topsoil, turf and subsoil are distinguished.

same bag were burned twice to assess consistency. In those samples LoI's ranged from 3.3 to 24%, the maximum difference was 1.9%, and the average difference was 0.15% (SD = 1.17%). There was no trend in LoI differences.

Results

The examination of a profile of a buried peat bog at the farm of Grófargil yields some idea of the basic patterns of organic leaching (Figure 17). The bog is capped by a prehistoric tephra layer, either Hekla 3 (2900 BP) or Hekla 4 (4500 BP). Two layers of diatomaceous earth divide the bog layers. The amount of soil below the prehistoric Hekla layer would indicate that this bog was dry for some time before the settlement of Iceland. Bogs forming today can have up to 70% LoI (Johannesson 1960) and so the high of just under 50 % may indicate some leaching. It would appear that the lowest layer of bog has had a substantial percentage of organic content leached out (just over 20% LoI) while the subsoil under the bog shows enrichment in its upper layers.

The turf wall at Glaumbær (Figure 18) shows a similar pattern but with much lower LoI numbers. All of the samples from this profile were run twice and both data points are presented. The turf wall is just under the Hekla 1 tephra layer (1104 AD). The turf wall below has an organic content that is about the same as the topsoil. Peatash contains almost no organic material. The thin older wall overlain by the second peatash layer would appear to be severely leached while the subsoil immediately below is enriched.

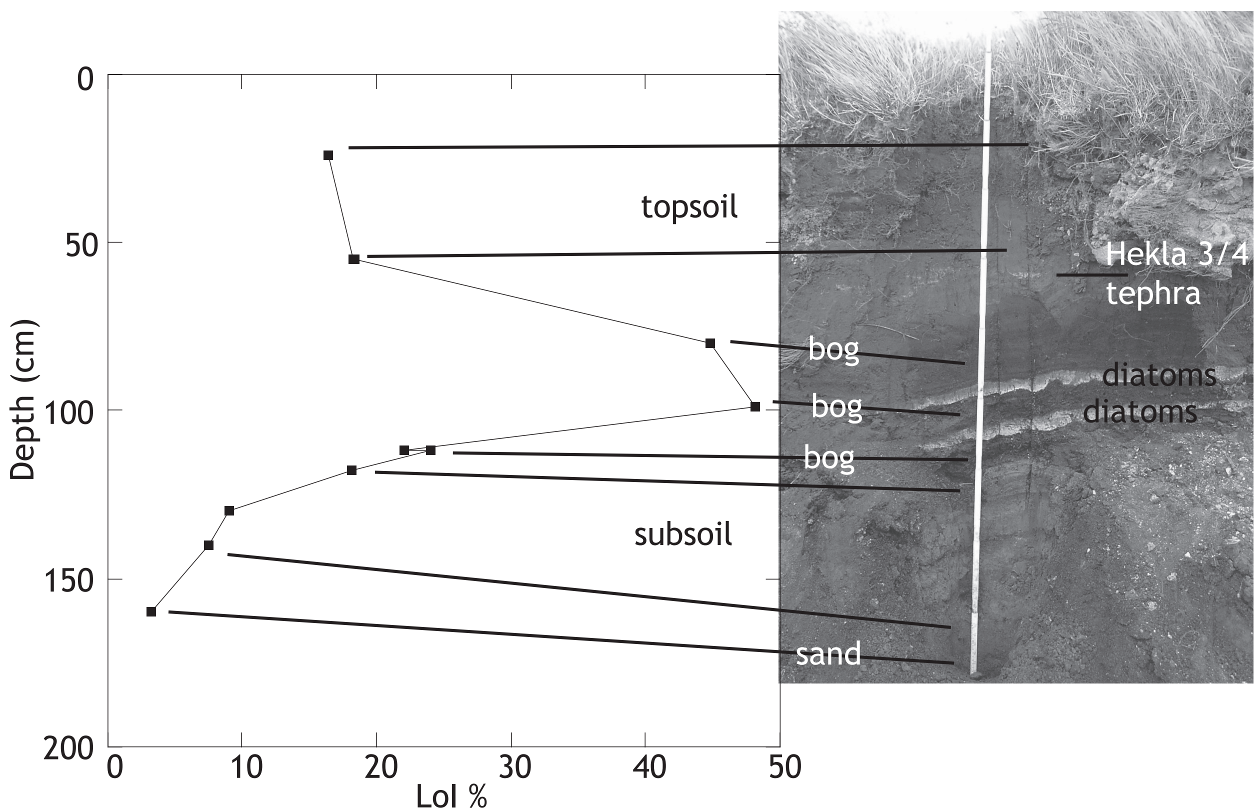

Figure 17. Sample depth against LoI percentage at Grófargil

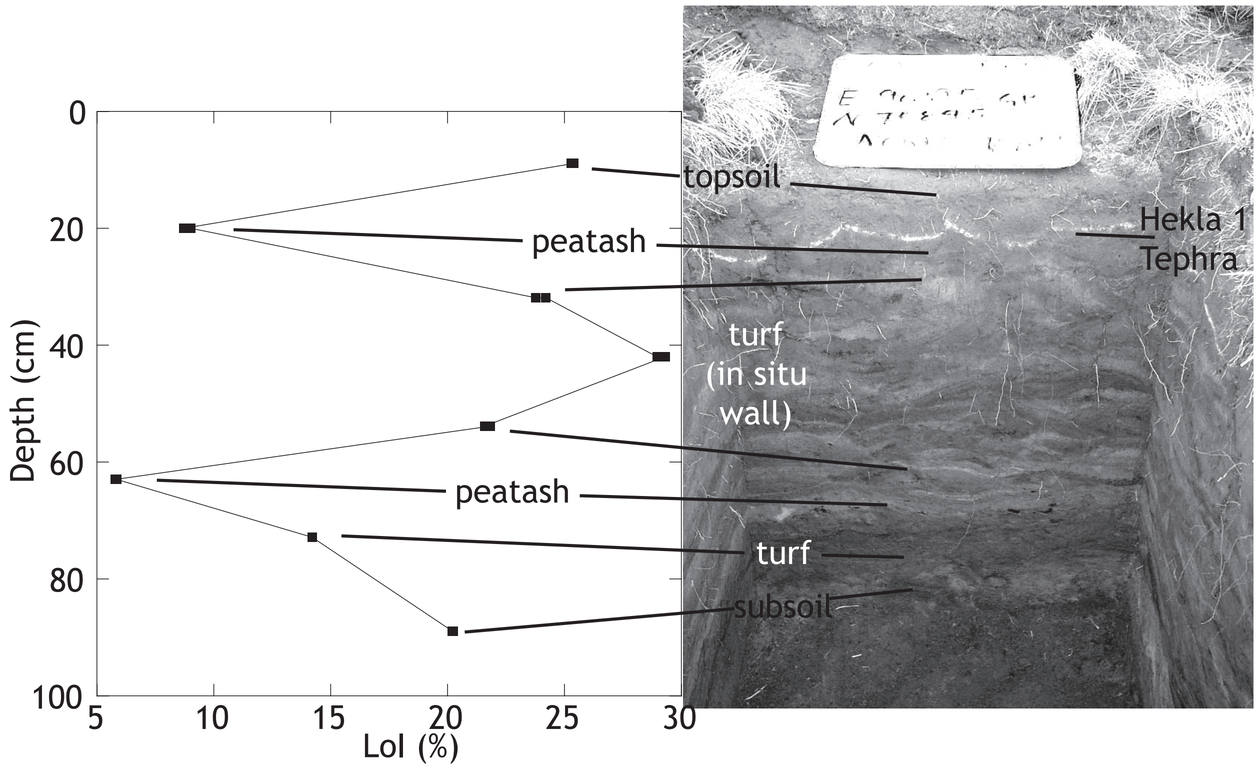

Figure 18. Sample depth against LoI percentage at location 1 of Glaumbær.

Overall, (see Figure 16) turf has a lower LoI then the topsoil. The topsoil has an average of 25 % LoI (SD = 4.6), while turf has an average of 21.7% (SD = 4.2). However the upper portions of large turf walls have higher LoI percentages. Conversely, lower portions of turf walls, close to the subsoil, have probably experienced a substantial loss of organic content while the subsoil has received the organic material.

Conclusion

Leaching of organic material from turf walls in buried contexts is substantial. The leaching appears to occur rapidly after burial but then may fall into equilibrium (Wagenet 1990). Leaching probably affects the lower parts of turf walls to a much greater degree than the upper parts of turf walls. Differential lower leaching is probably due to the proximity the subsoil and the subsoil's ability to absorb organic material (e.g., Tipping et al. 1999). The results of this little study suggest that there may be a bias for subsurface survey. Buried turf walls without a surface sign, that have a preserved height of less than 25 cm, and have their base close to the subsurface may leach so much of their organic content as to be indistinguishable from the surrounding soil as measured by LoI. It would seem that LoI tests on small walls would not provide useful data.

The results suggest that LoI does not decrease with age and therefore the quantification of leaching would not be a good candidate for a dating technique. It is interesting to note that the walls at Stóra Seyla, which are probably on the order of 100 years older than those at Glaumbær, have a slightly higher LoI than Glaumbær (averages of 22.2% vs. 21.5%) hinting that the parent material may have less inorganic material and that LoI may be inversely correlated with age. This needs to be investigated further.

The results do point to a consistent preservation of some proportion of an elevated organic content in larger walls that are completely buried. Buried walls preserved to a height of more than 25 cm can probably be reliably identified with the remote sensing techniques used by SASS. In those cases, LoI testing could provide information about relative economic importance and add to our knowledge of Medieval building techniques.

Needless to say, this is a small and incomplete study. The conclusions reached are at best tentative, although suggestive. LoI may provide useful data but much more work on Icelandic archaeological remains and natural deposits needs to be done.