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GROUND TRUTHING MAGNETOMETER DATA USING SOIL CORING: INITIAL RESULTS FROM CORNEŞTI-IARCURI, TIMIŞ COUNTY, ROMANIA

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(Abstract)

This study uses soil augering to explore a sample of the range of geomagnetic anomalies from magnetometer surveys at the massive fortified site of Corneşti-Iarcuri. The cores focus on the south end of the interior of Enclosure II and a limited area to the east between Enclosures II and III. These areas were studied during the 2010 campaign when the international team used different techniques to verify the age and type of occupations in this portion of the site. The coring results are presented in standardized descriptions and 1 m section photographs. The cores sample both high contrast anomalies from suspected burned deposits and low contrast areas where archaeological deposits are thought to be absent. These field data suggest that the local calcareous Chernozem soils vary by depth and thickness of calcitic horizons due to slope, erosion, or impact due to possible use of the slopes for borrow. The low magnetic susceptibility of the carbonates can affect the results of the Cesium Magnetometer, in some cases identifying high contrast anomalies due to the close proximity to $CaCO_3$ horizons and other material. In other cases archaeological deposits result in low contrast areas on the magnetogram due to the absence of burning. The initial auger results suggest that while the geomagnetic data clearly maps the enclosures and other burned features, there is the potential that other types of deposits may go unrecognized in this calcareous soil landscape.

Introduction

This paper provides the results of the initial soil auger tests from Corneşti-Iarcuri, a massive fortified site primarily dating to the Late Bronze Age, approximately 15 km north of Timişoara[1]. These data provide preliminary information on the soil landscape and demonstrate an effective way to “ground truth” geophysical survey results[2]. Rather than excavating large labor intensive test units to test magnetic anomalies, augering or coring[3] can provide relatively non-invasive, timely and more cost-effective results. Subsequent knowledge of the range of the magnetic anomalies can then be used to inform excavation strategies and ultimately contribute to the understanding of the site. The range of high contrast features at Corneşti-Iarcuri is of particular interest – are they archaeological and if so what type of feature do they represent – hearth, building, etc.[4])? And finally, while the sample is small, artifacts can be collected from known depths that may be diagnostic or at least provide information on preservation conditions.

Two conditions are essential to the success of this auger testing approach. First a highly accurate mapping survey and some system to correlate the geophysical survey points to known locations on the ground (e.g. GIS, AutoCAD) must be in use to be able to return to stake-out the exact locations of the original geophysical reading. Second, the person describing the cores must be trained in soils and have a working knowledge of standardized terms to create comparable field data. Following a brief review of augering in archaeology and the technique applied at Corneşti-Iarcuri, data tables and images are discussed and interpreted clearly demonstrating the utility of this approach while

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[1] Szentmiklosi *et alii* 2011; Heeb *et alii* 2008.

[2] “Ground truthing” refers to the testing of specific signatures produced by various geophysical techniques in different types of depositional environments to see what specific signals are measuring thus providing independent evidence. See for example Hargrave 2006.

[3] The terms augering and coring are used interchangeably in this paper, however the auger is the tool, and the process can be called augering or coring, and the byproduct is a core or auger test.

[4] For example, if the signal is thought to represent a house or near a house then burned floors or daub (fired mud) is expected, and in the case of a pit (used for daub manufacture, borrow, or storage) there is the possibility there are no artifacts present but an abrupt boundary indicating the base of the pit, etc.

providing insights into the variability observed in the magnetometer data.

Corneşti-Iarcuri

Corneşti-Iarcuri lies in the northern reaches of Timiş County, in the southeastern Pannonian Plain of western Romania. This region is known for its highly fertile calcareous chernozems and millennia of intensive agriculture, primarily cereals. The area encompassing Corneşti-Iarcuri is currently under heavy commercial cultivation for crops such as corn and sunflower. With these conditions in mind we anticipated calcareous loess soils with evidence for localized erosion and accumulation, both natural and cultural.

While historically documented in various forms since the 16th century, Corneşti-Iarcuri's significance has only recently become the focus of a long-term international interdisciplinary archaeological investigation[5]. The site, which includes an area of approximately 1722 ha, encompasses four enclosing rings of ramparts, the majority of which appear to date to the Late Bronze Age, ca. 1200–1450 BC, making this fortified settlement the largest known for this period in Europe (**Pl. 1**)[6]. Even in the age of high precision satellite photography and geophysical instrumentation it is immensely challenging to document the extent and variation of such a large site. In order to begin to record the site layout, extensive high resolution magnetic prospection (using a cesium magnetometer by Becker Archaeological Prospection), topographic mapping and surface collections are underway[7]. Since much of the enclosures appear to be constructed of ditches with wood and packed earth ramparts that were subsequently burned, the magnetogram results show a high magnetic contrast signature for the enclosure rings or ramparts[8]. These data combined with LiDAR, will provide an unprecedented scale and resolution of site mapping for this part of the world. With minimal effort and impact, soil augering provides a glimpse beyond the obvious enclosures to explore other subsurface features mapped by these techniques.

Methodological Background

The simple technique of coring evolved along with the development of new questions and technological advancements in archaeological field methods. The earliest equipment typically consisted of hand augers with extensions and, less often, commercial drilling rigs. In 1986, Stein[9] offered a detailed look at the history of coring in archaeology and a description of the types of techniques available. She distinguishes two periods, beginning with the late 1930s to 1950s, when coring was used prior to radiometric techniques to build relative chronologies in the Mississippi Delta region of the US. During the latter period of the mid-1960s, cores and augers began to play a key role in the exploration of subsurface deposits for environmental and site reconstruction and the collection of controlled samples for chemical, biological and 14C analyses[10]. At this time truck-mounted hydraulic soil sampling rigs also began to appear in archaeological research programs. By the early 1980s, cores and augers were used to assess site structure or the depth and nature of cultural deposits in a growing number of intersite applications[11]. By the late 1990's, others[12] proposed several ways in which coring can assist archaeologists, including delineating a site, mapping paleotopography, confirming geophysical results, and the systematic collection of paleoenvironmental samples on- and off-site.

Today, archaeologists actively use hydraulic-powered direct-push devices[13]. The direct-push machines use hydraulic pressure in conjunction with a rotary hammer to push a sampler below the ground surface to a desired depth. The devices are self-contained and either mounted to four-wheel-drive truck beds or track-mounted for rough terrain. Such hydraulic rigs are ideal in alluvial, colluvial, and urban environments where deposits are often greater than two meters in depth. They have the added benefit (depending on the equipment) of producing intact, encased cores that can be taken back to the lab for sampling and storage. In urban settings hydraulic coring can be especially important when thick modern fill layers overlay potentially significant earlier historic layers or soil surfaces[14]. In many instances, especially in areas where safety and/or sensitivity to ecological and/or viewscape is a concern, any type of coring is preferred over deep excavation because coring avoids deep, potentially unstable trenching, and it

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[5] Szentmiklosi *et alii* 2011.

[6] *Ibidem*, 819, 827.

[7] *Ibidem.*

[8] Becker 1999; Szentmiklosi *et alii* 2011, 832.

[9] Stein 1986.

[10] *Ibidem*, 509.

[11] Hoffman 1993; Whitacker – Stein 1991.

[12] Canti 1998; Entwistle *et alii* 2000.

[13] Typically hydraulic-powered direct-push devices are contracted through drilling, environmental or geotechnical companies operating throughout Europe and the US.

[14] Schuldenrein 1991.

has minimal surface impact and creates almost no visual disturbance to the landscape (e.g. mounded dirt, damaged vegetation)[15].

When conditions are such that hydraulic coring is not readily available, practical or affordable, then hand augering is a reliable and efficient technique. Hand augers can be operated by one person or two and can provide a view of the subsurface soil to whatever depth is desired depending on the substrate and the extensions available. A hand auger, shown in use in **Pl. 2**, can vary in design but typically includes a "bucket" mounted on a simple "T" bar (handle for turning) where the end of the bucket has a curved bit designed so that turning the handle will cause it to cut downward into the soil, pulling soil into the bucket. Hand augers can vary in form (e.g. Bucket, Edelman or Dutch, Screw, etc.) and width (e.g. the Oakfield or split spoon is usually 1 cm wide and buckets typically up to 10 cm wide). The size and design of the auger used typically depends on the texture and saturation of the soil or sediment[16].

Augering Method used at Corneşti-Iarcuri

Core locations were selected in order to test different geomagnetic anomalies (suggesting presence or absence of archaeological deposits), and different topographic positions to reveal the range of soil variation. During the 2010 campaign we focused in the interior of Enclosure II and a relatively narrow area in the eastern portion between Enclosure II and III (**Pl. 3**). While the signature for the burned walls is obvious in the magnetograms there are many other types of features in the data that are unknown. The cesium-magnetometer used at Corneşti-Iarcuri can detect especially faint magnetic anomalies caused by various iron oxides, biogenic magnetization and from features at greater depths[17]. With this sensitivity it is essential to have the ability to efficiently ground truth the observed variation in the data.

At Corneşti-Iarcuri, a 7.5 cm closed or "Riverside" bucket auger was used with up to 4 m in extensions. Extensions can be added at the completion of each 1 m section. Various auger designs exist but most include either thread connection (typically requiring two pipe-wrenches to detach), or easier designs such as a pin lock or quick connect. We successfully used the latter at Corneşti-Iarcuri and other sites in the Banat region[18]. When the bucket was pulled (the number of turns that constitute a full bucket is usually determined quickly by the operators and depends largely on the density and texture of the sediment), the sediment is emptied into core trays – 1 m long sections of PVC gutter that have been cut and painted to indicate 20 cm intervals for scale in photographs and to facilitate sampling (**Pl. 2b**). Extended rulers or weighted pull tapes are used to check depth between buckets to assure the depth and the consistency of sampling. All depths are given as cm below surface (cmbs). Each tray is photographed and described using standardized soil terminology, and then sampled.

Photographs of the cores that appear in the plates are taken under natural light. The nature of the light varies depending on the conditions and time of day so the color varies between core photographs and sometimes between sections[19]. The purpose of these images is to illustrate the general variability between the soils revealed in the auger tests. Using standardized soil terminology is important in the communication of the horizons present and in the understanding of the evolution of the landscape. Field descriptions include texture[20], color[21], structure[22], lower boundary[23] [24]and "notes" with

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[15] Sherwood 2006.

[16] For more on auger types see http://pkd.eijkelkamp.com/Portals/2/Eijkelkamp/Files/P1–01e.pdf.

[17] Szentmiklosi *et alii* 2011, 832.

[18] For example, archaeological investigations at Pecica "Şanţul Mare" using the same hand auger system, successfully documented the extent of cultural deposits both vertically and horizontally. O'Shea*, et alii* 2004, O'Shea*, et alii* 2006.

[19] We only had two of the sectioned trays (1 m long) on site so only two meters could be sampled and photographed at a time. This is why the photographs for the cores >2m are spliced together.

[20] Textures are based on the amount of sand (S), silt (SI), and clay (C) determined by hand in the field. Abbreviations include Silt Loam (SIL); Silty Clay Loam (SICL); Loam (L); Clay Loam (CL).

[21] Munsell Color 1992.

[22] Soil structure is defined by the way individual particles in the soil aggregate into different shapes. Structure can indicate many things including parent material, degree of weathering, age of the soil, and the amount of water that can circulate in the soil. Structure Grade (where it was possible to determine): Structureless (0); Weak (1); Moderate (2); Strong (3). Structure Type: granular (gr); crumb (cr), subangular blocky (sbk); angular blocky (abk), massive (m); single grain (sg).

[23] The boundary between the horizons is usually described considering the distinctness and topography when observed in profile. Using an auger it is impossible to identify topography but a general assessment of the distinctness can describe the degree of contrast between adjoining horizons which can reveal the degree of weathering within the soil profile and perhaps most importantly in archaeology, cross-cutting relationships and intrusions suggested with abrupt boundaries. The standardized terms used include Abrupt (a) – < 2 m; Clear (c) – 2–5 cm; Gradual (g) – 5–15 cm; Diffuse (d) – > 15.

[24] More descriptive information on these terms can be found in Foth 1984; Scheffer 1989.

general observations (artifact content, $CaCO_3$, etc.). Due to the exploratory nature of these cores the horizon designations should be considered an estimate and an effort to correlate the soils across the landscape. Note that the auger tests are labeled S1 through S11; there is no S9. Sampling protocol included small (~50 g) bulk samples for geochemistry, and large (200+ g) bulk samples for macro and microartifacts[25], which were bagged by depth, air dried and stored for analysis. The most immediate benefit to the use of coring in contexts like Corneşti-Iarcuri, is to provide quick, basic descriptive documentation of the local soil and sediment and link it to the magnetometer results.

Results and Discussion

The map in **Pl. 3** shows the locations of the cores in relation to a portion of the site magnetogram and topography. **Table 1** lists the cores, their maximum depth and the reason for their placement. **Tables 2–11** offer descriptions of each core which are illustrated in various plates of single or combined cores positioned in the 1 m sectioned trays by depth.

The auger test results can be grouped into two overlapping areas of inquiry. The first is the range of features observed on the top of the terrace, where archaeological features appear to concentrate in several areas within the southern half of Enclosure II and a narrow area between eastern sections of Enclosures II and III (**Pl. 3**). This includes cores S1, S3 S4, S6, S7, S8, S10 and targeted areas of both contrasting high susceptibility (anomalies indicating suspected archaeological features) and low susceptibility (suspected undisturbed areas for comparison). The second area of inquiry provided preliminary data on the soil landscape in order to understand the natural variation and how it differs according to topography, in particular in relation to slope (slope aspect or slope direction, likely also plays a role in the variation but it is not addressed here). These cores include S2, S5, S8, and S11. In addition to looking at the soil by topographic variation this second group also sought to provide initial data on the presence of colluvium. In the terrace and valley topography of Corneşti-Iarcuri, distinguishing colluvium will ultimately be important in the interpretation of both local climatic and anthropogenic landscape modification and erosion.

On the plain or terrace surface, above 145m amsl, areas of low susceptibility, and assumed absence of archaeological features reveal aspects of the "natural" soil profile. Core S6 (**Table 7**; **Pl. 4**) has a general horizon sequence of Ap – AB – Bk1 – Bk2 – Bkt. This profile is typical for calcareous Chernozems (mollosols) and is estimated to be Pleistocene in age. The greatest variability in the terrace soils appears to relate to the calcic horizons (Bk) and the amount and form of $CaCO_3$. These horizons develop when carbonate precipitates due to some combination of decreasing CO_2 pressure, increase in pH, increase in soil water temperature, and an increase in ion concentration where saturation is reached or evapotranspiration of the soil moisture[26]. Several of the cores (S7, S10, S11) revealed petrocalcic horizons, indurated layers cemented with $CaCO_3$. Understanding the development of these horizons is key in reconstructing paleoclimate and also how changes in these horizons may impact the magnetometer data.

The overall auger results from the terrace soils suggest there is likely a paleosol that may be the result of ancient fluvial-loess processes based on the presence of fine quartz sand observed in the base of Core S1 and S10 (**Tables 2**, **10**). These cores are, however, quite different, likely due to their position on the slope. The observation of clay coatings and relatively strong structure in these brief glimpses into the buried soil suggests a Pleistocene age. This distinction and attributes of this soil will likely become important as the studies of paleoclimate and hydrologic controls at the site progress.

The auger tests provide a limited sample of the slope variability (Cores S2, S8, and S11). The sample is too small to tell if aspect (slope exposure) plays a role. Using Cores S7, S2 and S5 as a catena, the lateral variability represented on a hill slope is broadly illustrated (**Pl. 3**, **5**). The valley floor contains sedges and crayfish (Decapoda) chimneys, along with gleyed soils, typical of wetland environments (**Table 6**). Core S5 represents the toe of the slope in this wetland with a southwest flowing stream fed by seasonal springs entering from upslope tributaries. The upper 80–110 cmbs of the core is likely composed of colluvium, however, the water table and the type of auger impeded a deeper test. Based on the amount of local land disturbance

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[25] Microartifacts (also called micro-vestiges) are artifacts that typically measure less than 2 mm that can be highly informative at different scales in archaeology (e.g. Sherwood 2001; Kontogiorgos 2012). Ideally, coring samples can be systematically collected at 20 cm intervals and easily processed in nylon paint strainer bags that have a mesh size less than 0.02 mm. Once the clay, silt and fine sand have been washed from the samples, coarse sand-size microartifacts and macroartifacts can be identified and quantified with a low-power microscope.

[26] Birkland 1999, 128.

through the millennia, the steep slopes adjacent to the wetlands, and the low energy stream, one should anticipate thicker colluvial deposits.

Moving to the mid-slope, Core S2 was placed approximately 5 m higher and produced a thin upper horizon over a thin B horizon grading into thick calcic horizons suggesting an active erosive slope (**Table 3**; **Pl 5**). Similarly positioned, Core S11 (**Table 11**; **Pl. 6**) is in an area of low susceptibility and reveals an abrupt contact with a Bk or K horizon which may represent a disconformity. This difference is primarily the degree of erosion (likely related to slope) and the accumulation of colluvium.

Core S7 (**Table 8**; **Pl. 5**), resting on the upper edge of the terrace, completing the catena above Cores S5 and S2, contains a thickened A horizon similar to cores placed in areas of high susceptibility (e.g. Core 10; **Pl. 7**). The "Shadow" that appears here in the magnetogram may be due to filling of the upper slope, possibly in the Late Bronze Age.

The effect of the slope on soils, and therefore the magnetometer results as well, can also be seen in the west-southwest facing slope in the upper northeast portion of the 2010 project area depicted in **Pl. 3**. Just above the 140 m contour line a strip of low susceptibility (white) appears to have intermittent perpendicular darker bands trending in a northeast-southwest direction. Based on observations made in the field and on a preliminary understanding of the soils landscape, these are likely infilled erosional gullies cross-cutting carbonate rich horizons close to the surface on the erosional slope.

The auger tests on the top of the terrace ground truth a sample of the relatively high contrast magnetic anomalies where archaeological features are inferred (Cores S1, S3, and S7 – discussed above). Core S3 (**Table 4**; **Pl. 8**) contained cultural material (primarily abundant daub fragments as well as mammal bone fragments) extending to a depth of 80 cmbs. The auger did not allow the identification of an abrupt pit contact so these deposits may either be a cumulative surface or a pit intruding into the local calcareous soils. Core S1 was placed over a similar anomaly located in the probable Copper Age enclosure (**Pl. 3**). This core revealed a similar cumulic Ap-A/C sequence in the upper 80 cm that contained concentrated daub (**Table 2; Pl. 9**) suggesting that burning is responsible for the high contrast signal from these features.

Core S4 (**Table 5 Pl. 8**), placed in an area of low contrast near Core S3, interestingly revealed a similar soil profile to S3, lacking the obvious macroartifact content. The microartifact data may be key in determining why both areas reveal cumulic A-AC horizons yet they produce very different magnetometer readings. This suggests that both areas may be archaeological but the depositional processes or types of activities (absence of high temperature burning in particular) do not create geomagnetic signatures that produce strong contrast against the background soils. These observations have important implications for the interior of Enclosure I where the magnetometer data has thus far revealed no evidence of settlement features.

Core S10 (**Table 10**; **Pl. 7**) and S8 (**Table 9**; **Pl. 10**) were placed to explore what appear to be large pits or pit clusters on the upper slopes. Test excavations in 2010 explored one of these anomalies between S7 and S8 and revealed no detectable archaeological deposits (**Pl. 3**). The core results from S8 (low susceptibility) was located outside these anomalies while a series of similar anomalies between Enclosures II and III were explored with Core S10 in the northeastern part of the project area (**Pl. 3**). In both cores a thick series of calcitic horizons were encountered ca. 50 cmbs and no obvious archaeological deposits were observed in either core. If these results are considered within the context of the magnetogram alone, then an absence of rich archaeological deposits in S10 seems surprising. However, if one considers the relation of the sampling grids, the nature of the local soils and the low susceptibility of $CaCO_3$, then the potential source of these linear "pits" begins to become clearer. These large pit or pit clusters may be the result of either borrow areas for the construction of the embankments or other earthworks (beyond the soil material derived from the ditches), or "mining" of the carbonate nodules for use in plaster manufacture. The relatively shallow depth of the concentrated carbonate nodule Bk horizon could be the result of natural erosion or where the upper soil profile has been removed for borrow or access to the carbonate nodules for use in plaster manufacture. The latter could be prehistoric or historic in age, since these practices can be observed today[27]. Another or combined possibility is simply where erosion has left calcitic horizons relatively close to the surface at specific elevations producing an area of high contrast to the magnetometer.

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[27] Modern river banks along the Mureş River have been observed by the author as active "mines" or digging areas for local villagers who are collecting carbonate to process into plaster for interior and exterior house walls.

Conclusions

The site of Corneşti-Iarcuri spans an area so large that it is difficult to conceptualize and study the cultural and natural landscape without the aid of geophysical and topographic survey techniques. The most obvious cultural features that make up the site, both on the ground and in the magnetometer data, are the four enclosures that include ditches and ramparts[28]. In addition to these significant earthworks are a variety of other features revealed in the magnetometer survey data whose interpretation is not as straightforward. The results of this brief study suggest that some of the strong magnetic anomalies are resulting from burning, however others show no evidence for burning or other obvious archaeological activities. This study suggests that the survey results of the Cesium Magnetometer are clearly affected by the proximity of dense $CaCo_3$ horizons which have a low magnetic susceptibility and therefore can produce a significant contrast with the surrounding materials, resulting in a high contrast anomaly that may or may not relate to archaeological deposition. In other cases, cumulic surface soils that do not contain evidence of burned materials produce a low magnetic reading or an absence of an anomaly.

Future directions of study include assessing the types of archaeological deposits that make up seemingly "blank" areas on the upper terrace in the magnetogram that may relate to specific types of activities or middens that go undetected by the magnetometer. The signals from these areas may be further "muted" by the use of calcareous soil material or proximity of carbonate rich soil horizons. Additional auger testing, microartifact and chemical analyses from the existing core samples, or perhaps other geophysical techniques such as soil resistivity or ground-penetrating radar, could be employed to further assess these areas, ultimately contributing to future excavation plans and a more comprehensive understanding of the complex archaeological remains that make up this unusually large fortified site.

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Table 1. Core depth and area/reason for placement.

Core	Total Depth (cm below surface)	Location and Reason for Placement
S1	400	Upper terrace inside Enclosure II. Magnetogram and surface collection suggests this location represents a Copper Age Period enclosure (Szentmiklosi *et alii* 2011, 831). The auger test was placed on an area of high susceptibility suggestive of a pit or burned structure. Daub visible on surface.
S2	240	North facing slope of upper terrace at ~135 m amsl; mid-slope; ~30° slope.
S3	300	Upper terrace; magnetogram indicates a subsurface pit in this area of probable Bronze Age occupation.
S4	190	Upper terrace; area of low susceptibility in area of a probable Late Bronze Age settlement.
S5	128	Base of slope in valley floor. Crayfish (Decapoda) chimneys and wetland vegetation in vicinity.
S6	300	Upper terrace north of the concentrated features. Low susceptibility on Magnetogram suggests "clear" area with no archaeological features.
S7	400	Upper terrace. Magnetogram data indicates an area of high susceptibility bounded by a "wall or terrace feature not visible on the surface.
S8	290	Southwest facing mid slope, ~15° slope, near 2010 excavation block.
S10	375	Upper south-southwest facing slope between enclosures II and III. Testing one of several large anomalies that magnetometer data suggests are a series of large pits. Specifically trying to detect evidence for burning to see if this contributes to the anomaly.
S11	340	North facing upper slope; ~30° slope.

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[28] Szentmiklosi *et alii* 2011.

Table 2. Core S1 description. Auger test placed on area of high susceptibility, suggesting a cultural feature according to the magnetometer data.

Depth	Horizon	Munsell Color	Texture	Structure	Boundary	Notes
0–40	Ap	5YR 3/1	SICL	g/c	c	Common med to fine roots, concentrated daub (5YR 5/6).
40–80	A/C	7.5YR 3/2	SICL	2 sbk	c	Highly mottled cultural fill with course sand-size daub.
80–120	Bk1	7.5YR 5/6	SIL	2 sbk	c	Carbonate filaments, no nodules noted; dark root casts (7.5YR 3/2) likely bioturbated from above.
120–160	Bk2	7.5YR 4/4	SIL	1 sbk	g	Loose, few $CaCO_3$ weakly cemented nodules, increasingly red in color.
160–260	Btk	7.5YR 3/3 – 4/4	SIL	1 sbk	c	Loose, more structure than above, few localized clay coatings (darker in color).
260–360	2Btk1 (possible paleosol)	10YR 4/6	SIL	2 abk	c	Increasing clay with depth, common thin clay coatings, yellow variable Mn/Fe concentrations and rounded nodules, redoximorphic domains associated with concentrations, fine S quartz grains visible in hand lens.
360–390	2Btk2 (possible paleosol)	10YR 4/4	SICL	2 abk	g	Slight shift in color from above, increase in clay coatings.
390–400	–	10YR 4/6	SICL	2 sbk	–	Increase in clay. Out of auger extensions at 4 m

Table 3. Core S2 description. Auger test place on steep north facing slope.

Depth	Horizon	Munsell Color	Texture	Structure	Boundary	Notes
0–55	AC	5YR 3/2	SIL	g/c	c	Few to common to medium roots, few cemented $CaCO_3$ nodules derived from colluvium (decrease with depth). Plowed but nature of the colluvium makes it difficult to identify.
55–120	Bk1	10YR 5/6	SIL	1 sbk	c	Increasing clay with depth, concentrated $CaCO_3$ at 100–120 (sizes and degrees of cementation highly variable 2–50%, 10YR 8/3).
120–150	Bk2	10YR 4/4	SIL	1 sbk	g	Few to common $CaCO_3$ nodules.
150–205	Bkt1	7.5YR 4/3	SIC	2 sbk	c	Clay coatings, Mn/Fe concentrations and rounded nodules
205–240 (not pictured)	Bkt2	7.5YR 4/3	CL	–	–	"Stringers" of $CaCO_3$. Water at 210 cmbs

Table 4. Core S3 description. Upper Terrace in area of high susceptibility, i.e. Cultural feature suggested by the magnetometer data.

Depth	Horizon	Munsell Color	Texture	Structure	Boundary	Notes
0–35	Ap	2.5YR 2.5/1	SIL	g/c	c	Common to medium roots.
35–65	AC	2.5YR 3/2	SIL	1 sbk to 3 g	c	Artifacts including large mammal bone fragment, red mottles (daub?), large frag of grinding stone (broken by auger).
65–95	2AC	7.5YR 2.5/3	SICL	1 sbk	c	
95–140	2Bw	7.5YR 4/4	SIL	g to c	g	Highly friable, mottled.
140–195	2Btk1	5YR 4/4	CL	1 sbk	g	Variable $CaCO_3$ filaments and nodules, few clay coatings.
195–260	2Btk2	5YR 3/3	CL	1 sbk	g	$CaCO_3$ filaments, the color is darker.
260–290	3Btk1 (?)	5YR 3/3	CL	1 sbk	g	$CaCO_3$ filaments and nodules, with domains of carbonate accumulation, darker color and more massive; decrease in structure from above.
290–300	3Btk2 (?)	7.5YR 5/6	CL	m	–	$CaCO_3$ nodules, sediment becoming more cemented; increase in clay.

Table 5. Core S4 description. Upper Terrace in area of low susceptibility, i.e. No cultural features indicated by the magnetometer data.

Depth	Horizon	Munsell Color	Texture	Structure	Boundary	Notes
0–30	Ap	2.5YR 2.5/1	SIL	g to c	c	Common to medium roots.
30–60	A/C	2.5YR 4/2	SIL	1 sbk – 3 g	c	Sediment friable, increase in SI.
60–95	2BCw	2.5YR 3/3	SICL	1 sbk	g	Slight increase in structure.
95–120	3AB	7.5YR 4/4	SIL	1 sbk	g	Weak clay coatings, transition, mottled.
120–140	3Bt	7.5YR 4/4	SI	1 sbk	g	$CaCO_3$ filaments.
140–200	3Btk	7.5YR 3/4	SICL	1 sbk	–	$CaCO_3$ filaments and nodules (up to gravel size), decreasing with depth.

Table 6. Core S5 description. North facing slope, directly downhill from Auger S2, near the base of the slope. Wetland vegetation, and crayfish (Decapoda) chimneys in vicinity.

Depth	Horizon	Munsell Color	Texture	Structure	Boundary	Notes
0–30	A	10YR 10/1	CL	g	c	Few to common to medium roots,
30–80	AB	mottled 10YR 3/1 & 10YR4/6	CL	1 sbk	g	Transitional, bioturbated.
80–110	Bg (?) or 2Bgk1	10YR 4/4	CL	1 sbk	g	Large (~1 cm) redox mottles, weakly cemented Mn/Fe concentrations, angular cemented $CaCO_3$ nodules (possible colluvium).
110–128	2Bgk2	2.5YR 5/4	SICL	–	–	Significant increase in carbonate nodules 10YR 7/2 (angular granules), water at 125 cmbs.

Table 7. Core S6 description. Upper terrace. Area of low susceptibility reading suggesting no archaeological deposits in this area to the north of concentrated Late Bronze Age surface debris.

Depth	Horizon	Munsell Color	Texture	Structure	Boundary	Notes
0–40	Ap	7.5YR 3/1	SIL	g	c	Common fine roots.
40–70	AB	7.5YR 3/2	SIL	1 sbk	c	Mottled.
70–140	Bk1	7.5YR 4/4	SICL	2 sbk	g	Yellow-brown, mottled, few fine $CaCO_3$ filaments
140–220	Bk2	7.5YR 4/6	SICL	2 sbk	d	Common to many uncemented CaCO3 filaments and fine masses, few cemented nodules (1 collected).
220–240	Bkt1	75YR 4/6	SICL	1 sbk	A	Weak orange mottles (5YR 4/6), few common $CaCO_3$ filaments. Few clay coatings.
240–280	Bkt2/K1?	10YR 5/4	SIL	1 sbk	c	Transition of the dark matrix and dense carbonate to the cleaner silt; common to many $CaCO_3$ weakly cemented nodules.
280–300	Bkt3/K2?	2.5YR 6/4	CL	–	–	$CaCO_3$ nodules 2.5YR 8/2.

Table 8. Core S7 description. Upper terrace. Magnetometer data indicates an area of high susceptibility; behind a "wall or terrace" feature not visible on the surface.

Depth	Horizon	Munsell Color	Texture	Structure	Boundary	Notes
0–15	Ap	7.5YR 2.5/3	SICL	g/c	c	Common fine roots.
15–55	A2	7.5YR 3/3	SICL	2 sbk	c	Few $CaCO_3$ mottles.
55–110	Bk1	7.5YR 3/3	SICL	2 sbk	c	$CaCO_3$ coatings on ped faces and along veins, uncemented. Increase red color but very dark.
110–150	Bk2	10YR 4/4	SIL	1 sbk	c	Increase in $CaCO_3$ nodules, cemented, difficult to auger through.
150–300	Bk3	10YR 6/4	SI	1 sbk	c	Concentrated $CaCO_3$ filaments, consistent and homogeneous horizon.
300–325	Bk4	10YR 4/6	CL	1 sbk	c	Increase in clay and structure.
325–375	2Btk1	5YR 4/4	CL	1 sbk	g	Mn/Fe concentrations, weak structure; appears deeper compared to other exposure of probable red Paleosol (e.g. S10). Few fine clay coatings increasing with depth. Localized $CaCO_3$ nodules (some appear hollow).
375–400	2Btk2	5YR 3/4	CL	1 sbk	--	Slight increase in clay coatings and $CaCO_3$ nodules (10YR 8/4) and concentrations variably cemented.

Table 9. Core 8 description. Southwest facing mid (~15o) slope near 2010 excavation block.

Depth	Horizon	Munsell Color	Texture	Structure	Boundary	Notes
0–15	Ap	7.5YR 3/1	SIL	g	a	Common fine roots.
15–50	Bk or BC	7.5YR 5/6	SIL	1 sbk	c	Soil appears mixed based on observations from other cores.
50–78	BC2	7.5YR 5/6	SICL	2 sbk	g	Slightly darker with >50% mixed $CaCO_3$ uncemented concentrations, cemented nodules (2.5YR 7/3), and filaments.
78–180	2Bk	7.5YR 4/6	SICL	2 sbk	d	Significant decrease in $CaCO_3$ to 2% nodules; generally very heterogeneous.
180–215	2Btk	75YR 4/6	SICL	2 sbk	c	Common $CaCO_3$ nodules (variably cemented), few clay coatings.
215–240	3Bk1	10YR 5/6	SICL	2 sbk	g	Common $CaCO_3$ nodules, including cemented angular gravel-size.
240–290+	3Bk2	10YR 5/6	SIL	–	–	>50%, large gravel-size $CaCO_3$ nodules (2.5YR 7/2), at 290 cm too hard to auger.

Table 10. Core S10 description. Upper terrace slope where the magnetogram indicates high susceptibility in the shape of large pits of clusters of pits.

Depth	Horizon	Munsell Color	Texture	Structure	Boundary	Notes
0–30	Ap1	7.5YR 2.5/1	SICL	g to c	c	Common fine roots.
30–40	Ap2	7.5YR 3/3	SICL	1 sbk	c	Mottled orange sediment, possibly anthropogenic, could be colluvium as it resembles the $CaCO_3$ from deeper horizons.
40–50	AB	7.5YR 3/3	SIL	2 sbk	c	Transition to clear boundary of calcitic horizon below.
50–140	Bk1	10YR 5/4	SIL	1 sbk	g	Loose, $CaCO_3$ nodules (10YR 8/4) and concentrations variably cemented nodules up to cobble size. Difficult to get auger through.
140–180	Bk2	7.5YR 5/6	SIL	1 sbk	c	Mottled red and brown with few $CaCO_3$ nodules; increase in structure.
180–240	2Bt	5YR 4/5	CL	2 sbk	c	Common sand size Mn/Fe concentrations, few clay coatings.
240–300	2Btk1	5YR 4/5	CL	m with abundant nodules	g	Variably cemented $CaCO_3$ nodules (10YR 8/4), increasingly difficult to auger through. Gradual transition to increasing red and fewer fine nodules into large gravel-size that had to break with the auger to continue.
300–375	2Btk2	5YR 3/4	CL	m with abundant nodules	–	Common clay coatings and $CaCO_3$ nodules (10YR 8/4) and concentrations variably cemented. Increasingly difficult to auger through, could not auger after 375 cmbs.

Table 11. Core S11 description. North facing upper third of slope (~30o). No magnetic anomalies.

Depth	Horizon	Munsell Color	Texture	Structure	Boundary	Notes
0–15	Ap	5YR 3/1	SIL	c/g	a/c	Common fine roots.
15–60	Bk1	5YR 3/4	SICL	2 sbk	a	$CaCO_3$ filaments.
60–70	Bk2	7.5YR 7/4	SICL	1–2 sbk	c	Cemented $CaCO_3$ layer.
70–110	Bk3	7.5YR 4/6	SICL	1–2 sbk	g	$CaCO_3$ non to weakly cemented.
110–170	Bk4	7.5YR 5/6	SIL	1–2 sbk	c	$CaCO_3$ non to weakly cemented common; increase in silt with depth.
170–240	Bk4	2.5YR 7/4	SI	1 sbk	c	~50% $CaCO_3$ nodules, cemented, uncemented, and filaments (5YR 7/4); decrease in $CaCO_3$ at base.
240–340 (not pictured)	2Bk1	10YR 5/4	SIL	1 sbk	c	Few $CaCO_3$ concentrations or filaments, no nodules, increase in clay and red color with depth.
340–390 (not pictured)	2Bk2	7.5YR 4/4	CL	1sbk	--	Increase in clay coatings, common Mn/Fe concretions (rounded, sand-size). Too wet to auger at 390 cm.

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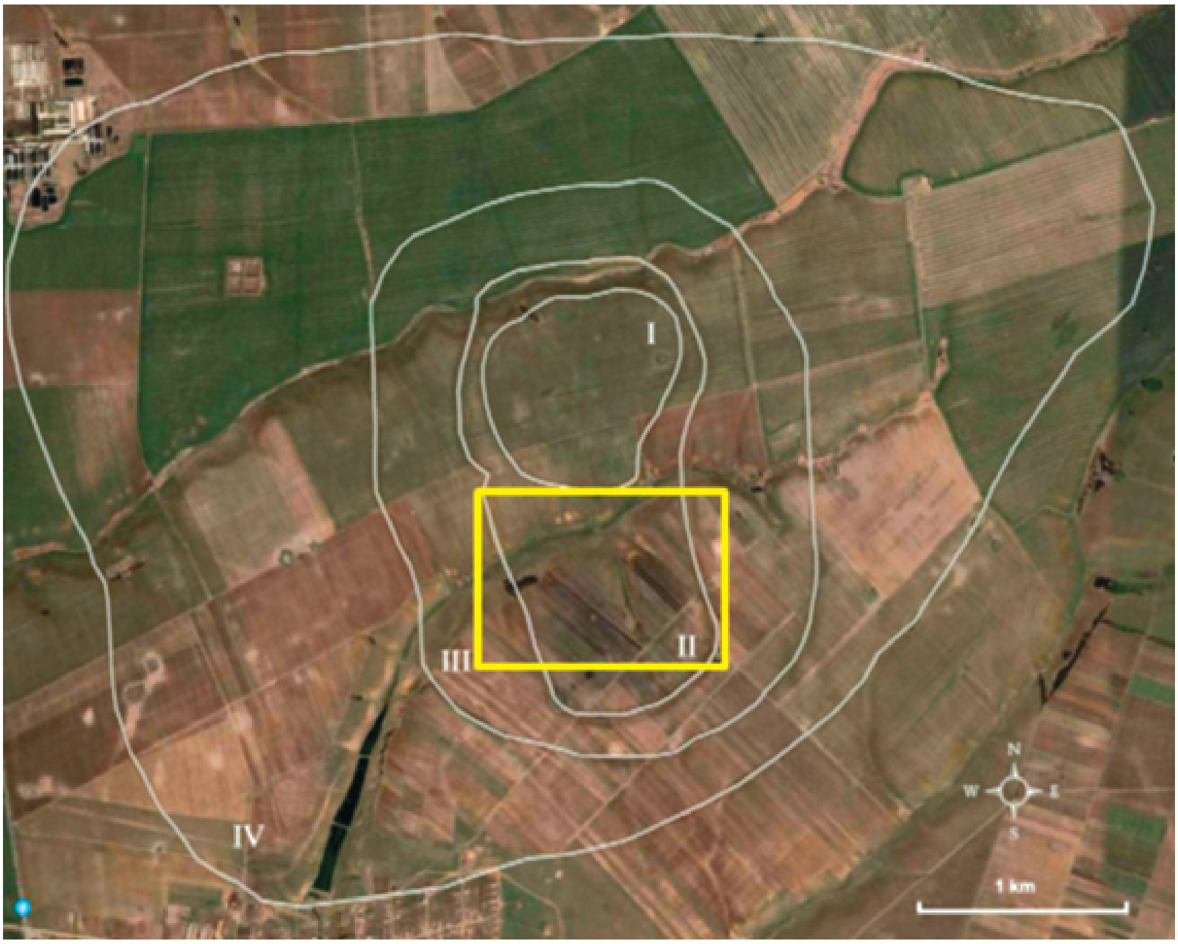
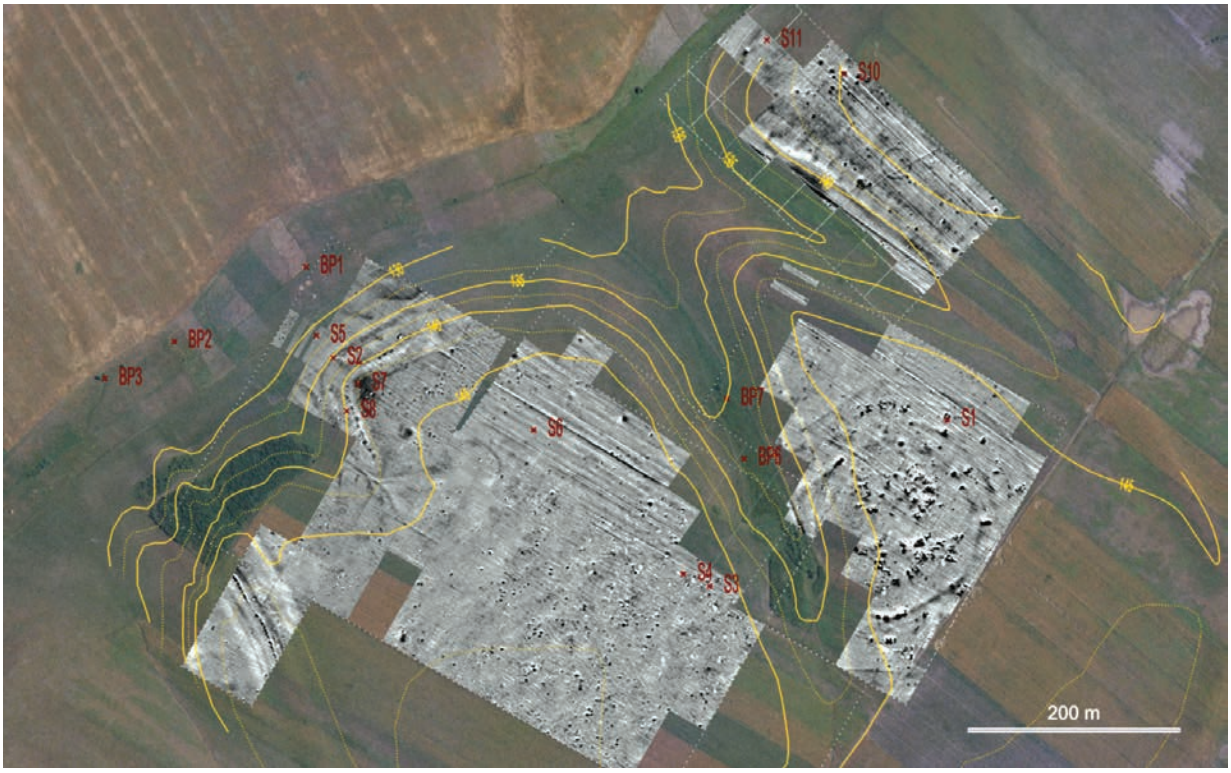


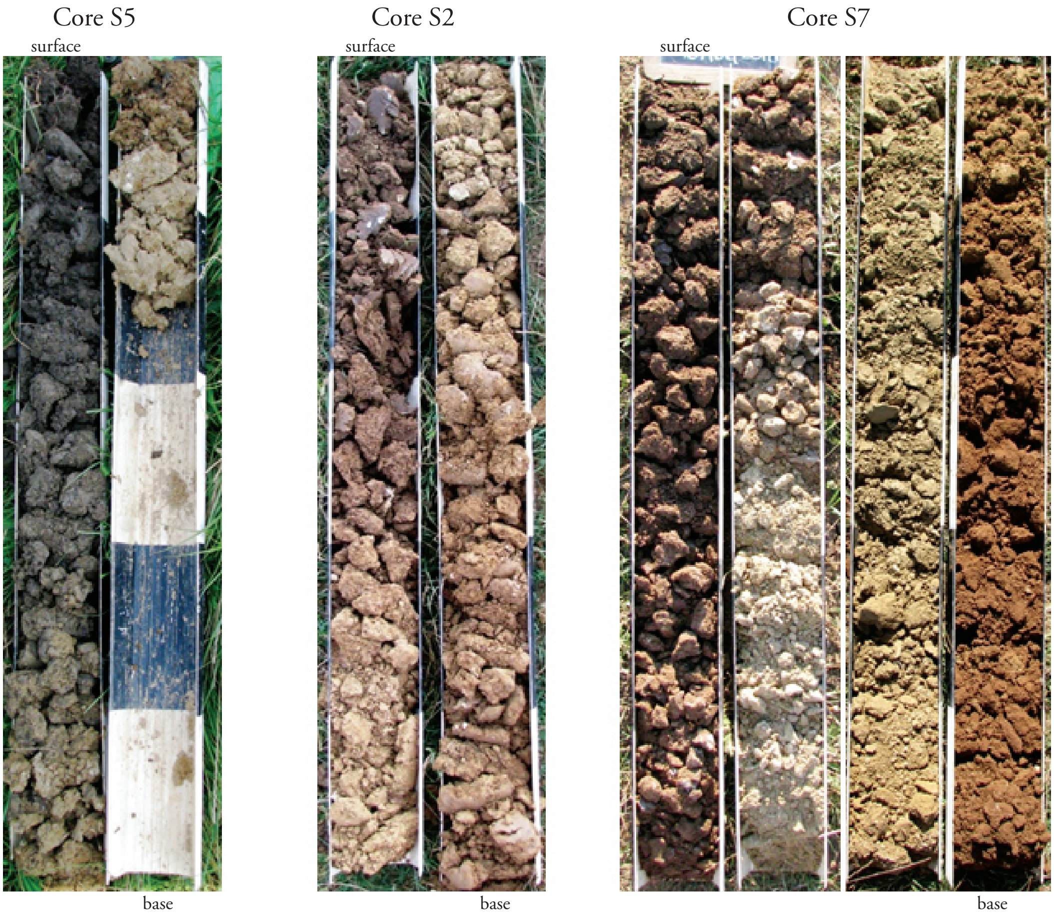
Pl. 1. Map of the Corneşti-Iarcuri site. The highlighted area shows the location of the Pl. 3 detailed map. (Source: Szentmiklosi *et alii* 2011; Figure 11). Note the original figure includes survey magnetograms overlaid on the satellite image from Google Earth. The most recent magnetograms are not included.

Pl. 2. Hand auger in use on site at Corneşti-Iarcuri. a) turning the auger to collect a sample; b) removal of the soil from the bucket and placement in a scaled trough according to depth for documentation and sampling.



Pl. 3. Map showing the locations of the 2010 cores in relation to topography and the magnetograms. S# indicates the author's cores and BP# marks the locations of the exploratory archaeobotanical coring by Dr J. Kalis, Department of Archaeobotany, Institut für Vor- und Frühgeschichte, Universitüt Frankfurtam Main. These samples were described in a technical report by Kalis as 'suboptimal' for preservation of micro and macro plant remains (Szentmiklosi *et alii* 2011, 823).

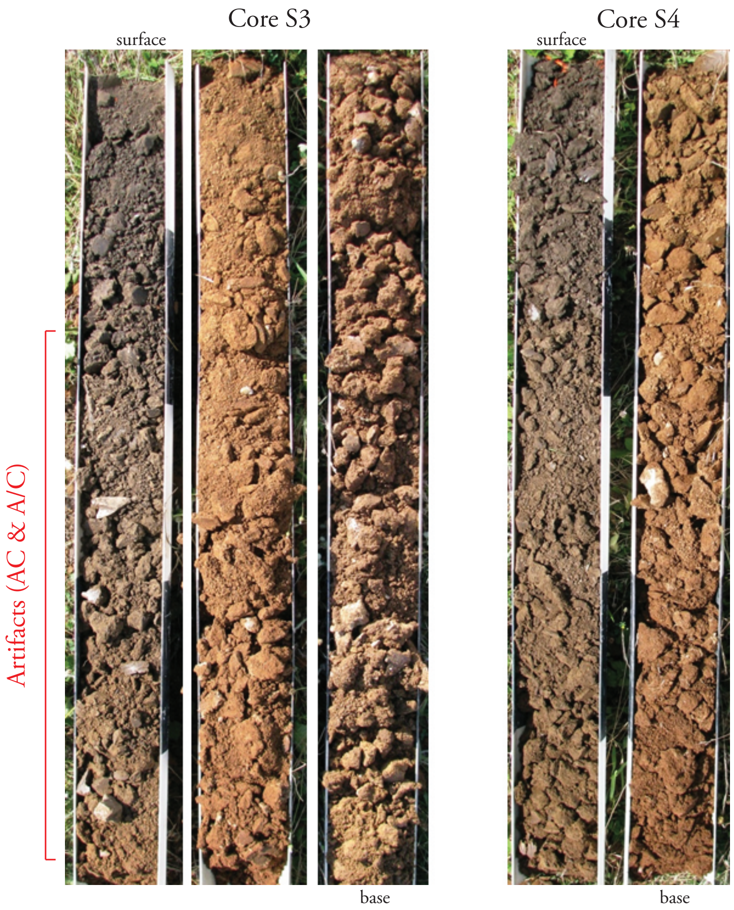
Pl. 4. Core S6.



Pl. 5. Catena with toe slope (left) to the top of the slope (right). Cores S5, S2, S7.

Pl. 6. Core S11.

Pl. 7. Core S10.



Pl. 8. Cores S3 and S4.

Pl. 9. Core S1.

Pl. 10. Core S8.