<u>**The Körös Regional Archaeological Project Field School, 2002:**</u>
Independent Research Project: Soil Chemistry Survey at Vésztö-20:
The Advantages of the Chemical Perspective

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Abstract

The project described herein is a systematic survey of the soil chemistry at Vésztö-20, an Early Copper Age settlement in the Körös region of the Great Hungarian Plain. Samples were collected at 10-meter intervals across an 80x80 meter grid of the site, at 10-meter intervals along 100-meter transects to the south and east of the site, and at feature and control points used to identify the chemical signatures of the other samples. Analysis and interpretation of the data awaits transportation and laboratory work back in the United States. The results will be forthcoming in a later, more developed research paper to be presented at the 2003 annual Society for American Archaeologists convention in Milwaukee, Wisconsin.

Soil Chemistry and Archaeology

The application of soil chemistry survey in archaeological research provides a useful complement to more traditional survey techniques. While careful excavation and screening may recover artifacts and organic remains as tiny as a square millimeter, soil analysis provides information about the chemical composition of anthropic soils at the microscopic and elemental levels. Residues left over from human activities (e.g., metalworking, pottery production, food preparation, etc.) or as byproducts of human occupation (e.g., waste concentrations, midden deposits, agricultural intensification, etc.) may alter the chemical profile of soils, providing evidence of human influence even when macro-artifacts have been swept away by the daily cleaning routines of the occupants (Custer et al.1986; Griffith 1981; Rapp and Hill 1998; Collins and Shapiro 1987; Middleton and Price 1996; Lambert; Eidt; Entwistle et al. 2000).

As a survey method, soil chemistry analysis may be used to: locate an archaeological site; identify features within that site; define the boundaries of individual features or of the site itself; and to compare the chemical signatures of identified features to unknown anomalies in an attempt to interpret those anomalies (Lambert 1997: 31-33, 41-42; Custer et al.; Collins and Shapiro). Concentrations of elements associated with human activity can be mapped three-dimensionally and compared to maps of artifact concentrations. This process would either support the interpretations already drawn about feature areas from artifactual evidence, or possibly demonstrate the extent of artifact displacement by modern disturbance, like the material recovered from the plow zone at Vésztö-20. Concentrations of anthropic elements may be ranked proportionally and mapped to demonstrate areas with the most intense human activity. These values may be compared for different features within the site and with data from other sites to produce a quantifiable understanding of the intensity of use and occupation of features at Vésztö-20.

Soil chemistry survey is a relatively non-intrusive method of data collection that will not interfere with future excavations. Laboratory analysis of the sediment relies on relatively inexpensive weak acid extraction and spectrometry techniques. No macro-artifacts are needed, and sediment samples as small as 0.2 grams are sufficient for chemical analysis (Middleton & Price 1996). The collection of samples may be easily built into excavation strategies, allowing for each new unit and level to be tested and catalogued for unique chemical signatures. Alternatively, samples may be extracted from unexcavated areas using a coring device. This method also allows for vertical comparison of sediments at a particular location over time, or for testing sediments close to the surface for modern contamination that may interfere with deeper samples. In single component sites that were not intensively occupied, deep coring may not be necessary (Lambert 1997: 36).

Anthrosols at Vésztö-20: What we might expect

Human activities involve the manipulation of a variety of raw materials for different purposes. The types of residues left behind for soil chemists to uncover are dependent upon the chemical compositions of those raw materials and the effects of human processing. For example, the activity of preparing food involves the burning of wood, which releases potassium into the surrounding soil. Aluminum and iron may be associated with areas of pottery production or intense usage (Lambert 1997: 47).

Various elements and combinations of elements may identify human activity areas in general terms, if not by their specific functions. Supplementary information may be provided by prior understanding of the types of activities and features that may be expected in the test area. Given the results of chemical survey and a working knowledge of the culture being studied, the soil chemist may match generalized profiles with specific features like single-family dwellings, communal workplaces or ritual centers, clay source pits, or cattle pens.

In the context of Vésztö-20, valuable information about the culture and the site at hand are readily available. As a single component Early Copper Age site, Vésztö-20 can be presupposed to contain features dating to the Tiszapolgár culture of around 4,500 BC (Parkinson 2001:?). While the presence of intrusive burials or other later disturbances is a proven possibility, the single component nature of Vésztö-20 is important for interpretations of soil survey data because most of the identified features at the site can be tentatively assigned to a common Tiszapolgár cultural horizon. Houses may be expected to be small, about five meters per side, and probably contained single family units as opposed to the multiple family dwellings of the Late Neolithic. These houses were constructed of wattle and daub from local materials, may have had foundation trenches or post holes, and placed the associated family units' ovens outside of the building (Parkinson 2001: 11). Possible domesticates on site would be sheep, goats, pigs, and predominately cattle (Nicodemus 2002). In Block 2 of the site, a possible foundation trench seems to support a building in the near-center of Vésztö-20. Previous excavations uncovered a relatively high density of bone and antler points near this structure, implying the possible function of this structure as a tool production center. Analysis of the soil chemistry inside this feature may reveal high levels of calcium, phosphorus, and other elements that leach from bones and organic tissues into the surrounding environment (Custer et al. 1986: 90-91; Eidt).

Some of the most plausible theories about Early Copper Age cultural patterns suggest that animal husbandry, particularly cattle breeding, was an increasingly vital aspect of the economy and lifestyles of humans in this region. Soil survey may be able to locate areas of high phosphorus concentration outside human dwellings, suggesting the presence of animal pens where large quantities of organic waste materials would have collected, leaking phosphates into the soil. Depending on the pH level of the soil at Vésztö-20, these phosphates should have survived for present day analysis in a variety of chemical forms. Neutral soils leach phosphorus slowly, while in acidic or alkaline soils phosphorus bonds with calcium or aluminum and iron, respectively, to form long-lasting phosphate compounds (Thurston).

Exchangeable magnesium levels may also provide information about activity areas. The quantities of shell and fish bone in the Block 2 storage pit (Feature 13) suggest that food was stored in this bell-shaped subterranean feature as if it were a large earthen jar. Exchangeable magnesium has been shown to correspond with fish bones and midden deposits – if a substantial amount of fish was stored in this pit during the site's occupation, then this fact should be reflected in the chemical signature of Feature 13 (Griffith 1981: 29).

Although the interpretations of features at Vésztö-20 may change as new evidence is uncovered, the chemical signatures that remain from this survey can simply be redefined to account for the new interpretations. For example, the chemical signature of

Feature X may be described as a trench signature to match our current understanding of that feature. New anomalies discovered on site may be noted as possible trenches because their chemical signatures match that of Feature X. If future excavation proves that Feature X is actually a posthole, the interpretation of those anomalies can easily be reassigned to note that they are possible postholes. Future excavation and identification of these anomalies and comparison to their soil chemistry signatures will provide a better understanding of the range of values attributed to different activity areas. In the meantime, preliminary interpretations based on soil chemistry alone may at least help to guide the placement of excavation units to maximize the amount of data being collected from research.

Regional Sediment Characteristics: Vertisols

The sediments at Vésztö-20 contain a high proportion of clay, posing a stratigraphic dilemma for soil chemistry and for archaeology in general. The clayey ground surface expands and contracts with the seasons, creating deep cracks in the earth into which modern sediment can fall or drain. In effect, the soils dry out and churn themselves over, ruining the vertical position of sediments and artifacts – thus earning the name vertisols for their vertical dispositional characteristics (Frolking 2002; Rapp and Hill 1998: 32).

If Vésztö-20 were a multi-component site, or if it had been occupied intensely over a long period of time, soil chemistry analysis would be extremely difficult because of the turbation of vertisols. Distinct horizons would be vertically displaced, possibly mixing sediments of different time periods. However, the single component nature of Vésztö-20 implies that most artifacts found beneath the surface are dateable to the Early

Copper Age. Despite the turbation of sediments at the site, cultural layers have been uncovered and identified by artifact distribution. It is the author's hope that chemical residues will be similarly preserved in their original contexts, thus allowing survey and analysis of the prehistoric cultural horizon as planned.

Methodology

Field/Extraction Methods

The goals of my soil chemistry survey project were to establish the boundaries of settlement at Vésztö-20, to identify the chemical signatures of features that have already been excavated and interpreted, and to systematically test the area around the site for chemical anomalies that I may be able to identify using knowledge about the chemical residues of human activities. Logistical restraints limited the number of samples I could analyze to 250 bags. For each point at which I took a sample, I extracted soil from the buried cultural layer (45-50 cm) as well as from a shallower depth (15-20 cm) to test for modern disturbances and to compare with the archaeological sample. Thus, my survey was limited to 125 individual sample points.

In order to survey the area of the site proper, and to establish the boundaries of the site and its features and to look for new undetected features, I laid out an 80 meter by 80 meter grid at a 10-meter interval. The western 72 points of my grid corresponded to existing, staked points established by the total station crew for topographic survey. I also sampled along an additional 80 meter eastern row that extended beyond the limits of the original topographic survey. Current excavation blocks interfered with coring at 4 points. Altogether, my site grid contained 77 individual points of data collection at 2 depths per point, totaling 154 bags of sediment for analysis. Interesting or important details were noted appropriately, for example that points 72 and 81 – the two northeastern-most points – were extracted from recently plowed earth.

In the event that my 6400 square-meter grid proved inconclusive at defining the site's boundaries, I also laid two transects using the total station for accurate positioning of sample points. The first transect extended east from the edge of my site grid for 100 meters, containing 10 sample points at 10-meter intervals. Similarly, the south transect extended south of my grid for 100 meters at the same interval, losing one sample point to interrupting by the canal. With the exception of the first two points of the south transect, which were on the site's side of the canal, all of these transect points were taken from recently plowed earth.

In addition to the 81 grid points and 20 transect points, I sampled 9 control points from various locations near the site proper. The purpose of these samples was to establish a quantifiable understanding of the natural chemistry of the environment occupied by humans, yet outside the boundaries of intense interaction, i.e. contamination (Entwistle, et al. 2000). The first 3 were northwest of the site on a slight rise near the excavation crew's lavatory. The next 5 controls were taken alongside the vehicle path, near or inside the underbrush that separated our field from the adjacent northern sunflower field. These points, theoretically, have not been plowed by modern agriculturalists. Point 109 is the exception, intentionally taken from plowed area closer to the vehicle path for comparison. The last control was taken just a couple of meters west of the backshot location tower, near the gravel access road to the site.

My logistical restraints allowed me to take 15-20 more bags for analysis, which suited my purposes for taking feature samples. Rather than attempting to core into the unexcavated portions of features and disturbing ongoing excavations, I took my feature samples from pre-existing collections extracted from flotation samples by Kim, the floral analyst. Since these samples were not cores and depths were ambiguous, I did not take 2 samples per point.

The extraction of sediment samples from my target depths of 15-20 and 45-50 centimeters was accomplished using an Oakfield coring device, which I pounded into the ground at 105 unique locations using a dead-blow hammer. A butter knife proved useful for scooping the cores out of the Oakfield's spoon, and 5-centimeter portions from the desired depths were collected in a plastic dustpan before transferal to sterilized, twist-and-seal Whirlpak bags. All of these tools were swept or shaken clean before each core.

The Whirlpak bags will be arranged on cords in numeric order, packed into sturdy plastic drums with inventory lists, and shipped home. Transportation of the sediment samples back to the laboratory in Jackson will be handled by postal delivery services. Import/Export authorities may require that the samples be radiation-treated to kill potential biohazards. This precaution should not affect the results of analysis, but professional chemists' opinions will be sought upon return to the United States.

Lab/Analysis Methods

The pH level of the samples will be determined and noted, primarily to determine if human activities (prehistoric or modern agriculture, for example) disturbed the natural pH of the surrounding environment. Also, the pH of the soil is a determining factor in the preservation of phosphorus over time and indicates what types of compounds will develop as phosphate vehicles (Thurston).

The exact laboratory procedures for analysis remain to be outlined with experienced chemists and with my project advisor, but the general process will likely be similar to the one outlined by William D. Middleton and T. Douglas Price in an article for the Journal of Archaeological Science (1996). Their method requires the samples to be dried for forty-eight hours at 105 °C, and then pulverized by a mortar device. All sediment clasts larger than 2mm are removed by screening the sample, and 0.2 grams are extracted in 1M hydrochloric acid at room temperature for two weeks. Middleton and Price claim that this slow extraction process is less biased than processes that require stronger acid concentrations. Finally, the resulting extract is analyzed using an Inductively-Coupled Plasma-Atomic Emission Spectrometer to provide values of elemental concentrations per sample unit (Middleton and Price 1996). For my analysis, Millsaps College is able to provide an Atomic Absorption Spectrometer. Any changes required in the laboratory processing procedures will be noted in the final version of this paper.

Forthcoming Research

The analysis and interpretation of soil samples will be conducted at Millsaps College in Jackson, Mississippi, during the spring semester of 2003. Guidance will be provided by Mike Galaty, a professional archaeologist with experience in soil chemistry survey methods, and by faculty members of the Millsaps College Department of Chemistry, as needed. Raw chemical data will be obtained through laboratory methods similar to those described above. Various types of spatial analyses will then be applied to help facilitate the interpretation of the raw data, including but not limited to discriminant analysis, comparison of deviations from a control mean, contour mapping of chemical concentrations, and clustergrams of element correlations (Entwistle, et al. 2000: 293; Thurston). After an understanding of the spatial patterns of chemical concentrations has been established, interpretation of those patterns may begin – possibly defining features and their purposes.

The author’s goal is to present the final results of this project as a formal research paper at the March 2003 convention of the Society of American Archaeologists in Milwaukee, Wisconsin.

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