Electron Microscopy Workshop Announcment

When: Tuesday, 29 March 2005 10:00 am – 4:00 pm (One day before the 2005 SAA meetings in Salt Lake City)

Where: Brigham Young University Microscopy Laboratory (A shuttle will be provided to transport participants from and to their Salt Lake Hotels and the Workshop).

Who: All researchers interested in electron microscopy of phytoliths. Enrollment will be limited to the first 12 participants to register. A minimum of 5 participants will be needed to conduct the workshop.

Cost. $100.00 per person. Includes registration fee and transportation to and from Salt Lake Hotels to the workshop location.

Instructors: Michael Standing and John Gardner BYU Microscopy Lab

Objective: After completing the workshop participants should have an increased understanding of Electron Microcopy theory and practice, what kinds of data EM can provide, how to recognize and obtain good EM results, particular applications of EM to phytolith analysis, etc.

Workshop Content:
10:00-12:00—Class room instruction: Basic Theory (SEM, ESEM, High and Low Vac EM, EDS, Backscattered and *in situ* imaging, etc.) and Laboratory Procedures (Sample Prep, Sputter Coating, etc.).

12:00-1:00---Lunch: We will walk to a nearby Pizzeria. Lunch is at individual participants costs.

1:00-2:00---Demonstrations on the microscope for all techniques addressed in the class room instruction.

2:00-4:00---Hands-on Lab Work and Demonstrations. Sample Prep, SEM, ESEM, EDS, Backscattered and *in situ* imaging, etc. Participants who bring their own samples will have the opportunity to work with them.

If you are interested in registering, please contact:

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Report on the 5th International Meeting for Phytolith Research

The 5th International Meeting for Phytolith Research was held October 13-16, 2005 at the Russian Academy of Science in Moscow, Russia. We extend our thanks to the sponsors for providing a wonderful meeting venue, and a great cultural experience. Special thanks to Alexandra Golyeva for chairing the organizing committee, and making most of the arrangements. Sponsors for the meetings included: The Institute of Geography Russian Academy of Science, Institute of Soil Science Moscow State University, Soil Science Department of Moscow State University, and The Society for Phytolith Research. Contributors from a wide variety of disciplines and approximately a dozen countries participated. Abstracts of the papers and posters presented are found below.

Abstracts of the 5IMPR

Editor's note: I have chosen to include the abstracts as submitted with no editing.

First report on morphometric analysis of phytolith deriving from *Musa Accuminata* and *M. balbisiana*.

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Banana is one of the major tropical food resources. It is one of the oldest crops domesticated by man (De Langhe 1995), apparently first domesticated in Papua New Guinea and the surrounding areas. Domesticated varieties were subsequently introduced into other tropical areas (Simmonds 1962).

Phytolith analysis has proven to be an efficient tool to document banana history (Wilson 1988, Bowdery, Mbida et al 2000 and 2001; Lentfer 2001; Denham et al. 2003). Research suggests that the question of the identification of archaeological banana phytoliths is made difficult by the fact that in some instances wild, semi-domesticated and domesticates varieties may coexist (Vrydaghs et De Langhe 2003). In other cases an area devoid of wild banana species may present unique varieties and/or diversity (De Langhe et al. 1996). As *Musa accuminata* and *M. balbisiana* are the two species basic to banana domestication, the description of their phytoliths constitutes a first step towards the elaboration of an identification key for archaeological banana phytoliths.

This contribution reports a first attempt to discriminate phytoliths extracted from *Musa accuminata* and *M. balbisiana* based on their morphometries (measurements of size and/or shape). The phytoliths extracted from both species are the classical volcano-shape common to banana (Mbida *et al* 2001). In this study, morphological differences between the phytoliths produced by the two species are noted, and descriptive statistics for three morphmetries, the crater width, the total width and the aspect ratio for phytoliths produced by the taxa are calculated. Statistical analysis of the data indicate that morphometric differences between the phytoliths produced by the two species are significant.

References

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Phytolith analysis of buried soils in kurgans of Hungary: first results and perspectives.

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Kurgans is one of the oldest culture historical sites in Hungary. Therefore, they preserves great amount of and very interesting information about paleoecological conditions of the ancient period.

Archeology is not the sole science that may be enriched by observations of kurgans, but our knowledge of botany, paleoecological and soils, too. Our research team planned the paleoecological, paleobotanical and soil scientific observations of the kurgan called Csipő-halom situated in the Hortobágy steppe area of the Great Hungarian Plain.

We planned this in the interest of getting to know the strata of the kurgan and gain data for the paleoecological knowledge on its broader environment. Based on the data gained we can state that this kurgan was built in the Copper Age, onto an existing hill. Its surface is currently covered by Chernozem soil, and the buried soil feature below the kurgan preserved a soil with chernozem features, too. Therefore, this kurgan was once surrounded not by closed forest vegetation (as former theories say), but rather warm dry steppe and half-shaded tall grass steppe environment, that surrounded mosaic wetlands and salt-affected areas. No evidence referring to the generation of Luvisol was found.

Phytolith complexes from the middle parts of the [A] and [B] horizons of paleosol and from the overlying material of burial mound are analyzed. The [B] horizon does not contain phytoliths, and this is typical for studied paleosol and allows us to conclude that it had never been buried under some other material before the creation of the burial mound. The phytolith complexes in the [A] horizon and material of the mound have identical composition, which implies that the mound was made of the humus layer stripped from surrounding soils. The phytolith assemblages are characterized by the predominance of forms indicative of relatively warm and humid climate and meadow phytocenoses. The proportion of phytolith forms indicative of drier steppe conditions is lower. Hence it can be concluded that at the time of the mound creation the study area was occupied by not dry steppe, but meadow–steppe communities. The presence of single phytoliths indicative of forest vegetation confirms our hypothesis that rare small areas of woods also occurred in the vegetation cover.

Identification of Phytoliths from Human Tooth: first results and discussion

A.A.Bobrov[1], N.I.Shishlma[2]

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Phytolith analysis play a very important role in the investigation of the diet system of ancient population. Results of the identification of the vessel residue as well as "stomach content" allowed us to forward a proposal, according to which nomads of the Bronze Age consumed a lot of plants growing in the steppe zone. It is possible that people consumed vegetarian food every day. Such food could be unprocessed, or even non-cooked. Therefore , plant remains could have penetrated into the space between human teeth and into the tooth stones during the chewing process and remained there.

During archaeological excavation of the Bronze Age kurgans and graves skull of human skeletons were carefully taken out of the graves, packed and brought to a sealed room of a field laboratory. Then small micro-soil samples were taken from the space between the teeth and from the tooth stones with the help of special dentist instruments. Five samples from humans of the Yamnaya and Early Catacomb cultures from the Pesochnoye burial ground in the Middle Yergenui area of the Eurasian steppe were processed through the phytolith analysis. Many plant remains were identified in these samples.

Phytoliths of cereals, stick-shaped phytolith, dark-brown scrap pieces of vegetarian origin were identified in these samples. The same type of plant remains were identified earlier in the "stomach area" as well as in the vessel residue from the same cultures.

The phytolith study of an Iron Age structure: Was it used for ritual or for economic purposes?

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During the summer of 2003, in the prehistoric site of Balma del Gai (Moià, Barcelona, Spain) it was recovered a structure from the Iron age period (Iberian culture), surrounded by large stone pieces. The excavation of the structure uncovered the remains of a dog skeleton in anatomical connexion together with several ceramic fragments. The structure was interpreted as a possible ritual area. However further studies suggested that the structure could be the bottom part of a storage pit destroyed by diagenetical processes. Phytolith analyses were carried out from different samples collected inside and outside the structure to study its vegetal composition. The results indicated that phytoliths were ubiquitous both inside and outside the structure (with a higher concentration in the inside) and no morphological differences were observed among samples. In this paper we deal with different possible uses for the structure based on the results of the phytolith analyses.

Archaeoclimatic Models, Phytoliths, and Pollen

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Archaeoclimatic models provide a look at climatic conditions over the past 14,000 years at 200 year intervals. Comparison of the results of stratigraphic phytolith and/or pollen analysis provides ground truthing for these models, examining the response of plants to climatic conditions over time. Combining archaeoclimatic models with stratigraphic phytolith and pollen sampling provides valuable interpretation when interpreting the archaeological record or reconstructing the past environment for any other purpose. Modeled climatic conditions have been reflected well phytolith and pollen records examined from the Great Plains and Great Basin of North America.

Zea maize Cob Phytoliths, Genetics, Environment, and Archaeoclimatic Models

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Zea mays cob phytoliths record the growing conditions during the season that maize grew, making this record the ultimate record of environmental conditions during the relatively short growing season for maize. Current research into maize cob phytolith size suggests that either maize received sufficient moisture for good growth and maturation or it did not. In addition, the shape of *Zea mays* cob phytoliths is closely controlled by genetics. Therefore, examination of shape of maize cob phytoliths provides a signature of the genetics and lineage of maize. This signature can be used to identify local races of maize and compare them with races of maize from other areas. Finally, knowing when in the growing cycle water is important to maize, one can examine archaeoclimatic models to identify times in the past when maize could have received sufficient moisture for good growth. This additional tool allows examination of settlement strategies, economic strategies, and potential for exploiting various local habitats for agricultural fields.

Study of phytolith assemblages from modern faeces of sheep-goat and Neolithoc soft-ash from parts of South India.

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The Neolithic site of Budihal is located (Lat. 16.22 N; Long 76.22 E) in Shorapur doab region of Gulberga district in State of Karnataka, South India. The South Indian Neolithic culture was initially discovered in 1880's by colonel Makenzi and Foote. Few sites were excavated later for understanding the origin and nature of the ash mounds. The earlier excavations by scholars like Allchin, and in recent years by Paddayya (where authors participated for scientific studies) suggested that the ash mounds were cattle penning areas of the Neolithic pastoral community.

The aim of the phytolith study here was to understand the origin of peculiar soft ash found in various stratrigaphic sequences of the ash mound. The phytolith assemblages from such soft ash are compared with modern sheep-goat faeces collected from present day Budihal. The phytoliths from soft ash separated into three fractions. All the three fractions of the sample showed slight occlusion of carbon. Here the fine fraction (0- 20 µm) yielded segregated phytoliths such as dumbbells with long shaft and crosses. The Festucoids and Chloridoid types were in minimum while elongates and its sub-types were nearly absent. The medium (20- 50 µm) fraction yielded dumbbells with variations of trilobates and polylobate forms including crosses, bulliform types, bilobate short cells with scooped ends. This fraction had assemblages of flat cells and elongate with serrated edges and short amorphous unicellular types. The coarse fraction (> 50 μm) showed most of the phytolith in their anatomical context along with remnants of woody tissues. Panicoids with subsidiary cells and its sub variations were also noted. The other types included dumbbells, epidermal long cells with small rounded projections, rod shaped and Trichome bases were occasionally noted.

Phytoliths assemblage from modern sheep-goat faeces showed a very high proportion of of panicoid forms as compared to Festucoids , high quantity of Spherulites were also notes in these samples. These results are compared and contrasted to those of phytoliths from soft ash. A scatter diagram analysis suggest that phytoliths from sheep goat and soft ash show a positive correlation. Certain morphotypes of Panicoiod, Festucoid and Chloridoid types were present in the soft ash and relatively rare or absent in the modern sheep-goat faeces. The palatability of plants to grazing animals is an important factor as far as ingestion, digestion and excretion processes are concerned. It can help us getting some insights into the phytolith morpotypes especially from samples of Budihal.

Most grazing animals select leaf over stems and green material over dry material. The spot where a plant gets injured is important, as also the stages of its development and intensity of grazing. In some instances, the animal feeding on different developmental stages of the same plant specimen can differentially affect the plant cover. It is known that sheep graze the grass close to the ground, while cattle do not tear the vegetation below 1.5 cms (Andrzejewska and Gyllenberg 1980). Such processes could be inferred on the basis of the phytolith assemblages of short grass species (Panicoid, Chloridoid and Festucoid) obtained from the Neolithic ash deposit. This helps us appreciating high frequency of phytoliths of Panicoid types from the soft ash may have been product of the ash derived from burning of sheep-goat faeces. Phytoliths from the contemporary faeces were found in articulated state and the assemblage of similar phytoliths were poorly represented in the ash deposits, indicating a biological in situ. transformation from articulated to disarticulated morphotypes initiated by burning and subsequent modifications. The occurrence of Spherulites along with phytoliths is often found in sheep intestine (Brochier <u>*et al*</u>. 1992). Such Spherulites in sheep-goat faeces and Neolithic soft ash strengthen the idea that ancient soft ash may have resulted from burning of sheep- goat faeces. .

The phytolith analysis indicates that various sequences of ash deposits at the Neolithic Budihal are not just an outcome of "Cow Dung" depositions but also to some extent that of sheep/goat feces. Such records are known to be the products of cultural depositional and post-depositional natural processes responsible for the formation of ash-mound site at Budihal.

Phytolith transport in sandy sediments: Experimental data

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Analysis of phytoliths in soils is widely used in paleoenvironmental reconstruction. This methodology is based on the postulate, that migration of phytoliths can be ignored, because it is very slow. However, till now there exists no direct evidence that confirms the low mobility of phytoliths in soil. There are only a few indirect hints, as results obtained by phytolith analysis are in coincidence with paleopedological results (Golyeva, 1994).

The long-term aim of the study is to test the postulate of phytolith low mobility in sandy and loamy soils. Here we present the first results on average migration velocities of phytoliths in sandy sediment under moderate and extra-humid water fluxes.

Plastic cylindrical columns of 23-cm height and 11 cm diameter were filled with phytolith-free sandy or loamy sediment. To the upper 1-cm layer of each column we added 4,5 g of reed's ash (*Phragmites australis*). Phytolith concentration, size and shape distribution in ash were determined using polarized light microscopy. Phytolith pictures were made with a scanning electron microscope. The column experiment was carried out under the following simulated environmental conditions: 1) sandy sediment and moderate precipitation of 400 mm (S1), 2) loamy sediment and moderate precipitation of 400 mm (L1), 3) sandy sediment and extra-humid precipitation of 1600 mm (S3), 4) loamy sediment and extra-humid precipitation of 1600 mm (L3). Each treatment was carried out in three replicates. The experiment was run for five months. All columns were irrigated with the same intensity (1L/h) but with different frequencies: Once per 2 weeks to simulate 400 mm/yr and twice per week to simulate 1600 mm/yr. We extrapolate the data of five months experiment for one- year period, as we suppose the water flux to be the main agent controlling the phytolith transport in sands. Before each irrigation step, leachate was collected, filtrated and analyzed for phytoliths. Finally, columns were cut into layers. Phytoliths were extracted from the upper 8 layers. The extraction was done in three steps: 1) disaggregation, 2) separation of the phytolith enriched fraction (5-300 μm), and 3) light mineral (ρ<2,1 g/cm3) extraction (Coil et al., 2003) by sink-float analysis. The absolute number of extracted particles was measured using a particle counter (Coulter Multisizer II). The percentage of phytoliths of the extracted particles was measured by microscope in the same sample. Finally, the absolute number of phytoliths in each layer was calculated. The average depth of phytolith transport was calculated by the following formula:

$D=1/c_{sumi}\ \Sigma c_i d_i$

D : average transport distance (cm)

C_i : phytoliths per cm3 in the *i*-layer (*i* =1-8)

C_{sum} : total sum of phytolith per upper layer volume

Under moderate humid precipitation conditions migration of phytoliths in sand was 0,30 cm/yr. Under extra-humid precipitation, the migration was 0,36 cm/yr. The precipitation rate had only a minor impact on the migration velocity of phytoliths. In future we will measure phytoliths migration velocities in a loamy sediment and model the long-term phytolith migration in investigated sediments.

Investigating early agricultural systems in Northern and Eastern India using phytoliths and macro-botanical remains

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The emergence of agriculture is a fundamental question in archaeobotany. Few studies of this nature have focused on India and many areas within the Indian subcontinent lack empirical data making a synthesis of the emergence of agriculture difficult. This paper focuses on Northern and Eastern India, which both offer the potential to make a significant contribution to our understanding of the early farming systems. These two areas contain many wild progenitors of present crops including rice, wild mung or urd, Horsegram, pigeonpea, and various gourds making the possibility of pristine domestication a real possibility.

Systematic sampling (bulk and phytolith samples) and flotation has been carried out at a number of prehistoric sites in the Belan River Valley, Uttar Pradesh, and highland and lowland areas of Orissa. Both areas contain macro-botanical evidence of rice, small millets (*Bracharia ramosa, Panicum sumatrense, Setaria verticillata*) and pulses (*Cajanus cajan, Macrotyloma uniflorum, Vigna radiata and Vigna mungo*). The North Indian sites also contain evidence of the introduction of a crop package (wheat and barley) later on in their occupation, presumably from the Northwest.

Phytolith analysis has added a new dimension to the studies of these sites. Macro-botanical remains from the majority of sites is poor and only contains the more robust parts of the plant such as the grains therefore much of the evidence is likely to be missing due to preservation problems. So far, the recovery of phytoliths has added to our knowledge of early agriculture by demonstrating the on-site processing of rice at Mahagara in the Belan River Valley and the likelihood that the later introduction of winter crops into this area brought a new method of cultivation or these crops were a traded commodity.

Grass phytoliths analysis from natural grasslands in the SE Pampean region (Argentina): a preliminary study

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In SE of Buenos Aires province, the pampas plains are interrupted by a rocky formation, the Tandilia and Ventana systems. These rocky areas disable the intensive agricultural activities, dominant in surrounding croplands, allowing natural flora growth. At present the "pajonal" of *Paspalum quadrifarium* and the "flechillar" of *Stipa* and *Piptochaetium* spp, represent the main native communities growing on these areas, but their Quaternary distributions are unknown in the region. Phytolith assemblage study of these communities represents a valuable tool for the understanding of the grassland history of pampas plains. In this preliminary study we described the phytolith assemblage of the main grass species for each community, linking them with the systematic groups of the family, and identifying the phytoliths that possess systematic and diagnostic importance. Phytoliths were extracted from leaves of six grasses: *Paspalum quadrifarium* Lam. (Panicoideae), *Bothriochloa laguroides* (D.C.) Pilger (Panicoideae), *Bromus unioloides* Humboldt, Bondpland et Kunth (Pooideae), *Piptochaetium medium* (Speg.) M. A. Torres (Stipoideae), *Stipa papposa* Nees (Stipoideae) y *Vulpia dertonensis* (All.) Gola (Pooideae), following Laboureau calcination methodology. Four hundred phytoliths per slide were counted and identified with a classification system that contemplates isolated and articulate forms. Multivariate analysis (Cluster and PCA) of these species phytolith assemblages were carried out, applying product – moment correlation and average Manhattan distance coefficients. The results showed that isolated and articulated short shank, convex ends panicoid dumbbells, thick crosses and rectangular smooth phytoliths (less than 35 μm long) were the main *Paspalum quadrifarium* phytolith morphologies. Isolated and articulated short shank, straight - concave ends panicoid dumbbells were the most abundant in *Bothriochloa laguroides* phytolith assemblage, while isolated and articulated rectangular crenate phytoliths were the most frequent in *Bromus unioloides.* Short cells phytoliths were very frequent in *Piptochaetium medium* and *Stipa papposa* phytolith assemblages, mainly short shank, convex ends *Stipa* type dumbbells. Rondel shaped (truncated cones) were also very frequent in *Stipa papposa* phytolith assemblage. Cluster analysis results for species data showed three groups conformed by *Bothriochloa – Paspalum*, *Stipa – Piptochaetium* and *Vulpia – Bromus*, which resemble the taxonomy affinities of these species. PCA analysis results showed a strong *Stipa – Piptochaetium* grouping, clearly separated of the other species. *Vulpia dertonensis* was nearer to the *Stipa - Piptochaetium* group than to *Bromus unioloides. Paspalum quadrifarium* and *Bothriochloa laguroides* were the most distant of the groups. The main characters that differentiated the groups were articulated short cells phytoliths, rectangular crenate phytoliths, thick crosses, short shank panicoid dumbbells, *Stipa* type dumbbells and rondel shaped.

First evidence for phytoliths from ancient mud-plasters (wattle and daub) remains from submerged habitational site(s), offshores of gulf of Cambay (Khambat) in Western India

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The phytoliths are microscopic silica bodies ($SiO2.nH20$) of plant origin found in variety of deposits(fresh-water, brackish, marine, terrestrial) often under pH and Eh condition unsuitable for other microfossils such as pollen, spore, formaminifers, etc. This make it an ideal complimentary fossil system to be employed in conjunction with already established pollen analytical, micropalaeontological, pedological and isotopic studies for reconstruction of ancient vegetation, landscape, climate fluctuations and human interactions with nature.

This paper reports for the first time, initial results of phytoliths retrieved from mineralised and semi-mineralised mutilated plant parts (Bambusoids, Palmoid, etc. morphotypes) and other sub-fossils preserved in mud-plasters(wattle and daub) in zone I, 20-40 km away offshore of Suwali and occurring under water column of 20 to 40 M depth.

A team of scientists from NIOT(National Institute of Ocean Technology, Chennai) during their usual geophysical, marine geological and engineering investigations, hit upon various types of archaeological and geological materials and their reports and papers (Kathiroli et al. 2002& 2003) have been published.

The mud-plaster and other clay structures (kindly entrusted to the author by Dr. S. Kathiroli, Director NIOT) are being studied by me from macrobotanical and microbotanical viewpoints. This paper embodies results of phytolith analysis of sub-fossils and associated ancient Man-made hearth-mud-clods dated by TL , OSL and conventional 14C dating experts from Early to Late Holocene period). The present microbotanical(phytolithological) work has multidisciplinary implications for Prehistoric and Environmental Archaeology, Sea-Level vis a vis climate fluctuations, Neo-Tectonics, palaeolandscape and human adaptation studies on western coast of India. Moreover, the macrobotanical and phytolith studies on these offshore mud-plasters are possibly leading us towards emergence of new sub-discipline-"Marine Archaeobotany" in Asian context.

Phytolithological study of ancient coprolites

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ABSTRACT : The paper deals with the results of analysis of extremely well preserved ancient bovine coprolites recovered from the Protohistoric-Early Historic site of Balathal in Udaipur district of southern Rajasthan, north-west India. The site lies in transitional zone of semi-humid-semi-arid climatic zone with monsoonal annual rainfall of about 700-900 cm and hence significant from the viewpoint of understanding palaeoenvironment and ancient human-animal adaptation.

The analysis brings to light macroscopic and microscopic plant remains in the form of variety of phytoliths which are being utilized for understanding nature of local vegetation, Man favoured vegetal assemblage in the form animal feeds, crop assemblage residue ,local environment and history of human intervention in general. The paper also attempts to visualize holistically phytololithogical data in light of archaeobotanical and archaeozoological and environmental researches carried out earlier.

Paleopedological and biomorph analyses: potentialities at joint use by the example study of paleosols buried under kurgans in the Northen Caucasus, Russia[1]

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Paleosols buried under kurgans of the Early Alan Culture (the IInd – the VIIth centures AD) in the Northern Caucasus (the Northern Osetia-Alania Republic, Russia) have been studied using traditional paleopedological (morphogenetic) approach and biomorph analysis. The study site is located in the first flat terrace of the Kambileevka river (the tributary of the Terek river) within the Sunzha (or Chechen) depression surrounded by the Caucasus Mountains. The morphogenetic analysis of paleosols in the chronosequence showed that the soil evolution for the period since end of the IInd till the middle of the Vth centuries AD developed to the side of the humid soils' features strengthening. The humus content and biogenic features (coprolites' structure and humus-filled channels in the lower horizons) was growing, the carbonate and gypsum contents were decreasing in the profiles of soils during that period. Whereas since the second half of the Vth till the VIIth centures AD the soil evolution developed to the side of the arid soils' features strengthening. The tongue-like lower boundary of the humus horizon appeared and the massiveness of carbonate accumulation increased at that time. On the whole, the soil evolution of the first centuries

[1] This work has been supported by the RFBR, grant №04-06-80044

AD in the Northern Caucasus characterized by cyclicity and wide range of contrast. The regularities of the soil evolution revealed allowed us to reconstruct the paleoclimatic conditions for the period of the Early Alan Culture development in the region. Before the Early Alans appearance in this region the paleoclimatic conditions was rather dry and hot and the paleosols buried at the end of the IInd century AD demonstrate the most xeromorphic pedofeatures among other paleosols of the chronosequence. At the end of the IInd or at the border between the IInd and IIIrd centuries AD the paleoclimatic conditions became more humid and remained the same till the middle of the Vth century AD when the new cycle of dry and warm climate began.

Biomorph analysis of the uppermost part of humus horizon of the paleosols in the chronosequence allowed getting an additional information characterizing for the soil evolution of this region. Biomorph analysis is the study of the macro- and microremains of biota (biomorphs) in the context of their origin. The phytolith study is a component part of this analysis. The paleosols buried under all Early Alan kurgans contained more biomorphs in the subsurface 2 cm thick layer than in the surface one. The composition of phytoliths in the subsurface horizons was more complex than that in the surface ones. If in the surface horizons the phytoliths of dicotyledonous grasses and steppe cereals were only observed, the subsurface ones contained the phytoliths of meadow and forest grasses in addition. It means that before a soil burial its surface was recovered by an allochthonous material (colluvium). The thickness of colluvium was no more than 1-2 cm. We were not able to determine this layer by the morphogenetic analysis of the paleosols due to spatial variability of the thickness of the soil horizons and small thickness of the colluvium. There are discussed no other hypothesis of this material origin (e.g., its aeolian displacement) because the study site is located in the intermontane depression without strong wind all the year round. The soil development in time-span studied was synchronous with lithogenic process (colluvium deposition) that was revealed by biomorph analysis. In our early study of a large soil chronosequence in the adjacent area within the Sunzha (Chechen) depression it was made a conclusion about synlithogenic soil evolution during last 5000 years in this depression (Khokhlova et al., 2001).

In addition, in the most xeromorphic paleosols buried at the end of the IInd century AD all phytoliths in the surface and subsurface horizons were charring. It means that before redeposition of colluvium the plant cover on the soil surface in the place of the kurgan construction and surrounding area was destroyed by fire. It is likely to suggest that this fire destruction of vegetation in the area was favour for the redeposition of some material from the heights to the plain at that time. This conclusion let us to get an additional information about the local environmental conditions of the chronointerval under the study.

Holocene phytolith assemblages of zoogenic dung deposits for reconstruction of the pasture ecosystem dynamics in the arid zone.

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In mountain areas of arid zone many caves, niches and grottos serve as shelters, places of recreation and habitats for wild and domestic ungulates during many centuries. Dung accumulates in such places while many generations of animals utilize them. These zoogenic deposits are an extremely valuable source of palaeoecological information due to preservation of macrofossil plant remains, pollen and phytolith in them. We employed phytolith analysis of zoogenic deposits for reconstruction of pasture ecosystems dynamic in North Caucasus, Mongolia and Negev desert in Israel.

Two dung deposits were investigated in North Caucasus. First of them was located in mountain range Arau-Khokh at 2400 m a. s. l. and represented by stratified thickness of ash and burned dung of domestic sheep's. This deposit was 194 cm deep and dated back to 4200 years BP. The phytolith assemblages of investigated deposits are mainly composed of the silica bodies of festucoid class with insignificant participation of the panicoid forms. At the initial stages of the deposit formation the cone forms of sedges played significant role in phytolith assemblages. Later they drop out of a dagestanian tur forage.

The second one was found in grotto at river Ardon bank in ravine Kasarskoe. It was 54 cm deep and consisted of dagestanian tur dung. According to radiocarbon dating this deposit began to form 4000 years BP and occurred with interruptions.
The taxons forming the phytoliths of rounded forms of festucoid class prevailed in animals fodder at the first stages of the deposit formation (4200 – 3700 years BP). Grasses producing chloridoid and panicoid forms played a lesser role in animals diet. In the subsequent period grasses dropped out of a goat fodder. They again appeared in phytolith assemblages about 1000 years BP. Grasses producing panicoid forms dominate the goat fodder since 960 till 370 years BP. This testifies that pasture ecosystems were still highly arid in this period. In the last 400 years the role of rounded forms of the festucoid class in phytolith assemblages increased while number of phytoliths of panicoid forms decreased.
Three deposits of siberian ibex dung were investigated in Mongolia. First of them was located in dry steppe zone in ravine Khovtsgait at northern slope of Gurvan-Saykhan mountain range of Gobiyskiy Altay. It was 91 cm deep and formed since 2700 till 100 years BP. The rounded forms of the festucoid class prevail in the phytolith assemblages of the deposit along with constant participation of the panicoid and chloridoid forms. This testifies stable conditions of pasture ecosystems of this region during last 4000 years. Only the role of a panicoid class in phytolith spectra decreased in last centuries indicating slight increase of humidity.
Two other dung deposits were found in Tsagan-Bogdo mountain range of Gobiyskiy Tian-Shan. Deposit of Bayan-Sayr cave was located in the steppe – desert zone of the northern macro slope. It began to form 6700 years BP.
The rounded forms of the festucoid class prevail in the phytolith assemblages of the deposit along with constant participation of the panicoid and chloridoid forms. This testifies stable conditions of pasture ecosystems of this region during last 4000 years. Only the role of a panicoid class in phytolith spectra decreased in last centuries indicating slight increase of humidity.
The third cave deposit was found in true desert zone. It was forming in Late Glacial time since 27500 till 20100 years BP and then in Holocene after a long interruption since 7550 till 1850 years BP. Phytolith spectra of the Late Glacial time are variable. They are characterized by dominance of different forms of festucoid class along with insignificant participation of the panicoid and cloridoid forms. In the Holocene some grasses producing rounded forms were replaced by other kinds producing oblong or rectangular forms of the festucoid class. In the Holocene the grass composition of the animal diet was constant. Only in the last period of deposit formation the role of grasses producing oblong or rectangular forms was sharply reduced while number of rounded forms in phytolith assemblages increased.
Domestic sheep dung deposit was investigated in Negev desert in Israel. It was found in cave located in the upper part of Makhtesh-Ramon precipice close to town Mizpe-Ramon. It began to form 5000 years BP.
Phytolith spectra of dominant grass species of investigated areas were analyzed first. Changes of the phytolith assemblages of the deposit allow to mark out the stages of its formation. Grasses were not included into the animals diet since 4873 till 3500 years BP. Their phytoliths appeared in the phytolith assemblages about 3500 years ago. Presence of chloridoid and panicoid forms in the phytolith assemblages testifies high aridity. In the subsequent 1500 years the role of grasses producing forms of the festucoid and, to a lesser degree, chloridoid classes increased. At the end of this period phytoliths of the chloridoid class dropped out from the phytolith assemblages. About 2000 years ago and later on the role of grasses in animals diet reached its maximum. At the same period of time the participation of the chloridoid class in phytolith assemblages was significant. Only in the last 150-200 years the share of forbs and shrubs in animals diet increased. The fan-shaped silica body produced by reed are present in the phytolith assemblages of all investigated layers. This testifies existence of constant water sources.

Phytolith Analysis of Buried Soils of the Trakian Telle «Flat Grave»

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Cultural sediments of multi-layered monuments are complex objects for paleocological studies. This is determined by the genesis of thicknesses, which were mainly formed as a result of intensive human activities (Sycheva, 1994). Hence, the composition of phytoliths in the cultural layer of settlements may not be in conformity with the natural vegetation of the environment. They could have been brought in the course of construction and economic activity.

For the above reasons, biomorphs are studied rarely for the tell profiles. The most promising in this respect are the soils buried in the thickness of cultural layers. The present study presents the first results of the investigation of the phytolith spectra of buried soils of the tell «Yunacite», where we attempted to reveal the properties of the formation of their phytolith assemblages. On the basis of the above data, possibilities of paleoecological reconstructions are discussed. A series of samples of heterotemporal soils produces a conventional column: 1) the soil buried under the tell; 2) the soil separating the interlayers of Eneolithic and Early Bronze Age (EBA); 3) the recent soil in the vicinity of the monument. All the samples were collected in the course of soil studies of the tell, which revealed the specificity of the formation of the profiles of two buried soils. A well-defined genetic profile of the soil separating the layers of Eneolithic and EBA indicates a long and sustainable development of the processes of soil formation, which is only possible in case of a protracted interval in the functioning of the settlement.

Serving as a soil-forming rock was the thickness of the Eneolith cultural layer. Its accumulation was importantly contributed to by the remains of destroyed structures. The soil concerned started developing under conditions of the dry steppe. Gradually, the climate became cooler and considerably moister. As a result of increasing moisture, the carbonates were washed off the soil, and there accumulated three times as much humus compared with the lower paleosoil. The upper layer of the soil must have been cut off by human-caused processes of the EBA. The obtained 14C data indicate that the soil concerned was formed over 800 years (Chichagova at al., 2004).

The samples under study are dominated by phytoliths produced by grasses. The silicon bodies produced by plants of other families occurred in small numbers and did not affect the composition of phytolith spectra.

In the humic horzizons of the buried soil underlying the tell, there is an accumulative profile of the distribution of phytoliths, in which their content sharply declines with depth from 13 to 2.5%. In the soil profile separating the layers of the enolithic and EBA, the phytolith content ranges from 1.28 до 3.41%. There are three peaks reflecting their augmented content. The upper peak corresponds to the humic horizon of the soil (A), another peak coincides with the transition soil horizon (AB) and the third peak, with a carbonate (B). That horizon is the least modified by soil formation processes, and, in addition, it contains artifacts. In the surface horizon of the recent soil, 11.1% phytoliths were revealed.

The phytolith spectra (FS) of the three soils under study include 10 classes of silicon forms produced by grasses. The spectra obtained reflect the dynamics of the content of the forms of different classes in three heterotemporal soils. However, these data do not permit diagnosing the taxonomic category of the producers of silicon bodies. Some more informative ecological phytolith assemblages (EPA) for the estimation of which the found forms of phytoliths were merged into three major groups – festucoids, panicoids and chloridoids (Twiss et al., 1969; Twiss, 2001). The relationship between such groups indicates the relative contribution of wild grasses of different ecological taxa in the production of silicon bodies. In addition, the calculations of phytolith assemblages included the forms of phytoliths produced by cultivated cereals and reeds.

The phytolith assemblages of both buried soils (that underlying the tell and separating the interlayers of Eneolithic and EBA) are dominated by festucoids and sub-dominated by the silicon forms of cultivated cereals, and to less extent by the panicoid group. The content of chloridoid forms is considerably lower. It ranges within 3-6% and it is only in the humic soil horizon, the underlying tell reaches 11% . The EPA of the recent soil is dominated by the festucoid and panicoid forms, the content of phytoliths of cultivated cereals declines and the content of chloroid forms produced in that region only by wild-growing taxa of arid habitats to some extent reflects the dynamics of the latter in the plant cover and its vicinity. In the soil profile separating the sediments of Eneolithic and EBA, the soil horizon A is characterized by the least values of aridity coefficient, and below, in the AB horizon it increases threefold. The latter reflects a increase in the aridity of the given area during the formation of the soil complex. The above conclusion regarding an increase in the aridity the territory during the formation of buried soil coincides with the results of the spore-pollen studfies on the monument (Balabina et al., 2000; Aleksandrovsky et al., , 2003). The high ardidity coefficient is registered also for the soil under the tell at a depth of -9.00 – 9.10 cm. The phytolith assemblages of settlements are formed under the effect of human economic activity. The soils formed on lithological components of the cultural layer inherit the phytoliths brought in. It is only protracted assemblages development on such parent rocks that may promote development of phytolith reflecting the natural biocenosis of the locality.

The phytolith spectra under study have revealed that the desolation of the monument of the Eneolithic epoch and formation on it of a horizon well-defined in terms of the content of biogenic silica in the course of the hiatus between Eneolith and the Early Bronze Age coincided with the aridization of habitat conditions, which was replaced by increased moistening

Pastoralism, Seasonality and Fire: The Ashmound Neolithic Tradition of South India

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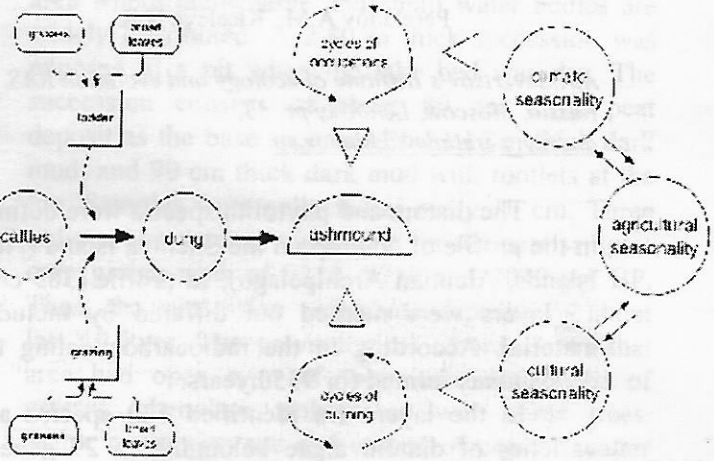
The Southern Neolithic has long provided evidence for the earliest pastoralism in Peninsular India. The ashmounds of Deccan are probably the most striking and unique component of the southern Indian Neolithic. They have been formed by the heaped accumulation of large quantities of cattle dung, episodically burned at high temperatures, sometimes to an ashy consistency and sometimes to a scoriaceous state. The sites have been plausibly linked to Neolithic rituals and the symbolic importance of cow, dung and ash in the Indian society, starting from the Neolithic period. The present paper discusses the results of the analysis of phytoliths from several ashmounds of the Deccan in the light of the human occupation of the sites (temporary vs permanent). Phytoliths, can be used to identified the time of death of the plants were they have formed and on this basis they have been used in this research to identify the time of dung deposition. This illustrates seasonal moment of deposition, which seems to be connected with the pastoralist annual cycle.



Experience in the interpretation of archeological objects on the basis of results of biomorph analysis in the west of Russia.

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Archaeological complex "Genezdovo" located in the west of Russia is one of the largest monuments remained from the time of establishing the Ancient Russian State (late 9th- early 11th centuries). The floodplain sector of an ancient settlement within this complex was studied. The dry cultural layer within the most part of the settlement does not contain plant residues, primarily, wood. Buildings are represented only by fragments of their foundations, which makes their interpretation almost impossible. The application of biomorph analysis made it possible to offer the reconstruction of some buildings and to account for discrepancies that appear in the course of analyzing archeological data.

Diatom And Phytolith Spectra Of Shemya Island (Aleutian Islands) Peatbog In Holocene [2]

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The diatom and phytolith spectra were defined in the profile of outcrop on the Shemya Island (Near Islands, Aleutian Archipelago). In profile (385 cm), 15 layers were marked out differed by included material. According to the radiocarbon dating the deposit was formed for 9550 years.

In the layers we identified 120 species and varieties of diatom algae belonging to 29 genera: *Centrophyceae* (5 gen.), *Pennatophyceae* (24 gen.), and phytolith forms of dominant species of grasses - *Calamagrostis nutkaensis, Festuca rubra, Poa eminens, Deschampsia beringensis and Phleum commutatum.*

The quantity of diatoms in the different layers of peatbog changed from 200 to 10280000 valves/g. According to the spectra we distinguished six zones.

The most ancient zone (interval 369-385 cm) was formed 9550 to 9400 years ago. Diatom analysis showed that in this period the peatbog was developed in conditions of oligotrophic bog at boreal--north-alpine climate (*Eunotia bigibba* Kutz.. *Eunotia praerupta* Ehr., *Navicula cf. subtilissima* Cl., *Pinnularia borealis* Ehr.). *Phleum* was the most abundant among grasses at this period.

The next zone (interval 335-369 cm) was formed from 9400 to 7300 years ago. Diatom complex of this zone was developed in oligotrophic-xenotrophic bog at cold boreal climate (*Eunotia praerupta* Ehr., *Pinnularia lata* (Breb.)W.Sm., *Pinnularia borealis* Ehr.). Phytholiths of *Calamagrostis* and *Festuca* dominate in this horizon.

During the next period (7300 to 4000 years ago) (270-335 cm) the peatbog functioned as shallow oligotrophic pond at boreal--north-alpine climate (*Fragilaria construens var. venter* (Ehr.)Grun., *Fragilaria construens var. subsalina* Hust., *Melosira cf. distans* (Ehr.)Kutz.). Among phytholiths plate forms of *Phleum* and, possibly, *Deschampsia* dominated in this spectrum and above layer formed 4000-3250 years ago.

In the period 4000 to 1200 years ago (110-270 cm) it was a β – mesosaprobic bog at boreal climate (*Pinnularia viridis (*Nitzsch) Ehr., *Pinnularia viridis var. fallax* Cl., *Pinnularia obscura* Krasske). This zone marks the most long and stable stage of formation of outcrop. The bad safety of diatoms valves allows us to suppose that they were redeposited by water flow. Well-developed trapezoid forms of *Festuca* and *Calamagrostis* dominated in the layers belonged to 3250-1200 years ago period.

The next zone (interval 85-110 cm) was formed 1200 to 870 years ago. This layer was very sandy, there were no phytoliths and only few diatoms that allow to suppose the eolian genesis of it.

The most upper zone (interval 0-85 cm) was formed during the last 870 years. The diatom spectrum shows the mesotrophic-oligotrophic bog developed at boreal climate (*Diploneis elliptica* (Kutz.) Cl., *Diploneis ovalis* (Hilse) Cl., *Hantzschia amphioxys* (Ehr.) Grun., *Pinnularia viridis* (Nitzsch)Ehr., *P. borealis et.var.* Ehr.). About 300-100 years ago there was a change among dominant grasses from *Calamagrostis* to *Phleum*.

Analysis showed a very high diatom diversity in the Aleutian peatbog. It demonstrates the dynamics of the peatbog from oligotrophic to meso-oligotrophic and the dynamics of climate from boreal—north-alpine to boreal conditions.

[2] The research was support by RFFI grant № 03-04-49323 and the Program «Origin and evolution of biosphere».

Plant uses and food processing through the study of grinding stones during the Iron Age in the Catalonian coast (NE Spain): The results of phytolith analyses

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Grinding stones of different morphologies and type of materials are common along the Catalonian Coast of the Iberian Peninsula during the Iron Age. In order get a deeper knowledge on plant uses and food processing in these sites we have carried out a combined study of querns typology, raw material and phytolith analyses. The results obtained indicated that grasses represented the major part of plant material identified in all the querns independently of their morphology. Grass inflorescences were especially abundant in the samples with an average close to 21%. The mechanical degradation of an important amount of the phytoliths noted as well as the absence of silica skeletons should be related to the same grounding process. The same phenomenon has also been observed in other grinding stones from other geographical areas. These results are complemented with other paleobotanical analyses carried out in the same area during the Iron age and discussed here.

Record of oryzacae phytoliths in a Holocene lake deposit of Ganga plain, India

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The Ganga Plain has a large number of lakes and ponds, formed during Late Pleistocene-Holocene.These lakes represent oxbow lakes, segments of abandoned channels of earlier drainage system. The lakes are mostly few km^2 in area and have a limited catchment area of several km^2 adjacent to the lakes. These lakes mostly show few meter thick sediment fill essentially of Holocene age. Many archaeological sites dated 3-7 kyrs are located adjacent to these lakes. Hence, such lake deposits may provide proxy information on the palaeoclimate, palaeovegetation, vegetation dynamics and human activity.
The Lahuradewa lake (Lat. 26° 46′ N, Long. 82° 57′) is located adjacent to Lahuradewa archaeological site where archaeological deposits of about 9 kyrs have been documented. The lake is located in Sant Kabir Nagar, Uttar Pradesh, in an area where many large and small water bodies are widely distributed. A 2.80 m thick succession was exposed in a pit when the lake bed was dry. The succession consists of about 80 cm thick peat deposit as the base succeeded by 1.10 m thick dark mud; and 90 cm thick dark mud with rootlets at the top. Samples were collected at every 10 cm. Three radiocarbon dates are available for the peat samples only giving ages of 9210, 8710 and 7010 yrs BP. Thus, the succession represents deposits of about last 10 kyrs. The palynological record shows that area had open type of vegetation constituted of grasses, chenolam, polygonum with some trees. Stable carbon isotope and carbon of organic matter in the sediments shows dominant of C-4 vegetation during deposition of peat followed by C-3 dominant vegetation. Samples prepared for the study of diatoms contain good amount of phytoliths, which are present in all the samples, and they show some variation in shapes and sizes. Bull-shaped phytoliths are most common and exhibit variation in their shape and size in the succession. They seem to be of Poacae family, and may be from submerged variety of rice. Work is in progress to distinguish wild and cultivated rice phytolith. However presence of oryzacae family phytoliths in Lahuradewa lake deposits suggests that throughout the Holocene, lake supported submerged plants, possibly submerged wild rice. This is the first documentation of phytoliths from lake deposits of the Ganga Plain. Integrated study of multiple proxy data on palaeovegetation, palaeoenvironment may be helpful in interpreting the nature of phytoliths and rice growth and cultivation in the area.

Plant economy at Harappa: a phytolith perspective.

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Archaeological interest in South Asia began i n the nineteenth century with the discovery of the massive sites of Harappa and Mohenjo-daro. Further interest in the Indus Valley revealed that cities along the floodplain and foothills were well planned, with complex drainage systems, bastions, stone sculptures and bronze tools.

Paleoethnobotanical research in South Asian archaeological sites has generally been limited to noting the presence of plant remains at particular time periods (Fuller and Madella, 2001:318; Weber, 1991:1). As a repercussion, there is little known about the early food economy of the Indus Civilisation, and how it changed through time (Vishnu-Mittre and Savithri, 1982:205). During the various excavation seasons at Harappa, a body of soil samples for pollen and phytolith analysis was collected. In this research a small sub-sample of this body is examined to try to add information on plan t economy at Harappa and more generally on the Indus Civilisation at large.

Taxonomic regularities in the opal phytolith distribution.

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Since 1971, several phytolith reference collections have been published (e.g. Geis 1975; Runge 1996; Piperno 1989; Bozarth 1992; Ball 2002). In view of the amount of data available, an extensive review was called for. Carried out for the foliage leaf phytoliths of the Gymnosperms, Monocotyledons (to the exception of grass phytoliths) and Dicotyledons of the Old and New World, this enterprise had two aims:

- to enlighten genus and family regularities in the opal phytolith distribution within leafs;
- to discuss their taxonomic significance.

Leaving out grass phytoliths, the reviewed literature reports data concerning more than 700 genera and 1100 species. While for some taxa data are clearly insufficient, regularities are suggested for others at the genus and family level. They are of two types: the systematic occurrence of one or several morphotypes and the recurrent absence of any morphotype. In some case, intraspecific variations in the phytolith presence are aslo noted.

In order to discuss these observations, data collected for leaf phytolith were compared to those available for the woody tissues. It is concluded that the distributions of woody tissues and foliage leaf opal phytolith share the same characteristics. For both organs, redundancy, multiplicity and morphological differences are reported. At each taxonomic level considered, diverse regularities and variability can be observed. As the taxonomic significance of the distribution of wood opal phytolith is admitted, one should accept it for leaf phytoliths. As with consequences that the published reference collections may be arranged in an Atlas in order to help scholars to select reference material for specific identifications.

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A space of exchanges. Phytolith analysis of ceramic thin sections. The case study of ed-Dur (Um al-Quaiwan, U.A.E.)

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Located on the coast between Qatar and Hormuz, the site of ed-Dur was occupied from the 5th/4th millennium till the first century AD. The unearthed ceramic collection is subsumed under two broad categories, the local (LP) and non local (NLP) production. Petrographic, chemical and phytolith analysis of the pottery were conducted to define their respective provenance. The results of the study of the NLP were published elsewhere (De Paepe *et al.* 2003) and the present contribution deals with the LP group and more specifically, with its phytolith analysis.

Phytoliths were recorded in thin section of sherds. Their presence, distribution and spectra vary from one ware to the other. Most of the phytoliths observed in the Local Production derives from a grass (*Sporobolus* sp.) and the date palm tree (*Phoenix dactyliphera*). *Sporobolus* phytoliths are distributed in the pores while most of the Palmae phytoliths are embedded in the paste.

The present contribution addresses two questions: (a) to which extend does these phytolith analysis contribute to the identification of the precise pottery provenance within the LP area and thus to the archaeology of ed-Dur; (b) how can such analysis contribute to paleoenvironmental studies?

Petrographic and chemical analysis point the Oman Mountains as source area for some sherds. Phytolith analysis proposes that several sources areas are located within the Semail complex. It also establishes that plant temper was been collected along abandoned irrigations canals. It is concluded that phytolith analysis of ceramic thin sections may successfully contributes to environmental archaeology.

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A methodological approach for the application of phytolith analysis in hunter- gatherer studies

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In this paper we present some results of phytolith analysis carried out on samples coming from the archaeological site of Túnel VII, located in Tierra del Fuego (Argentina). The site corresponds to the inside of a hut of Yamana hunter-gatherer society, which inhabited the Beagle Channel area until its extinction in the first third of the XXth century.

One of the aims of this research was to check the validity of our laboratory protocol (MADELLA, POWER-JONES & JONES, 1998) for this kind of samples, considering that the site is a shell-midden and that sediments are impregnated with different kinds of animal oils.

A total of 10 samples corresponding to different subgrids were analyzed. Results clearly show that phytolith distribution in archaeological layers have a clear anthropogenic origin and that the sampling strategy determines the quality of information we acquire when using phytolith analysis in archaeological research. Results at both quantitative and qualitative levels are different between the samples, clearly showing a possible space task distribution inside the hut.

Finally, it is interesting to see that the creation of a small reference collection of fuegian vegetable species made possible the identification of fern phytoliths (*Penna marina*) in two of the samples, suggesting use of the plant as a hut accommodation.

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