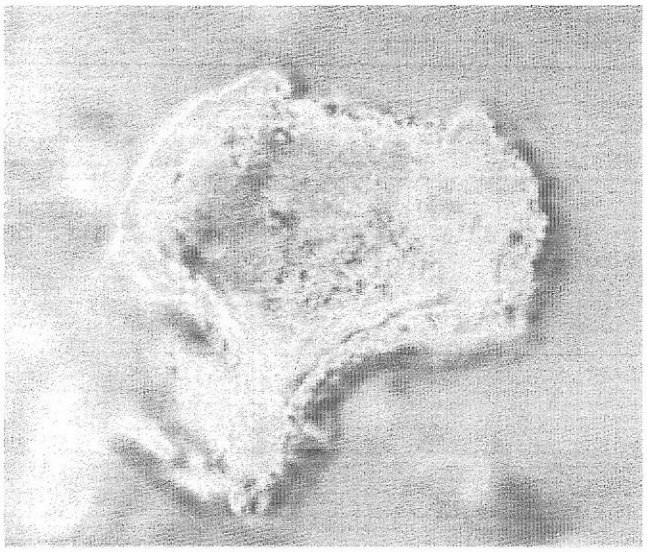
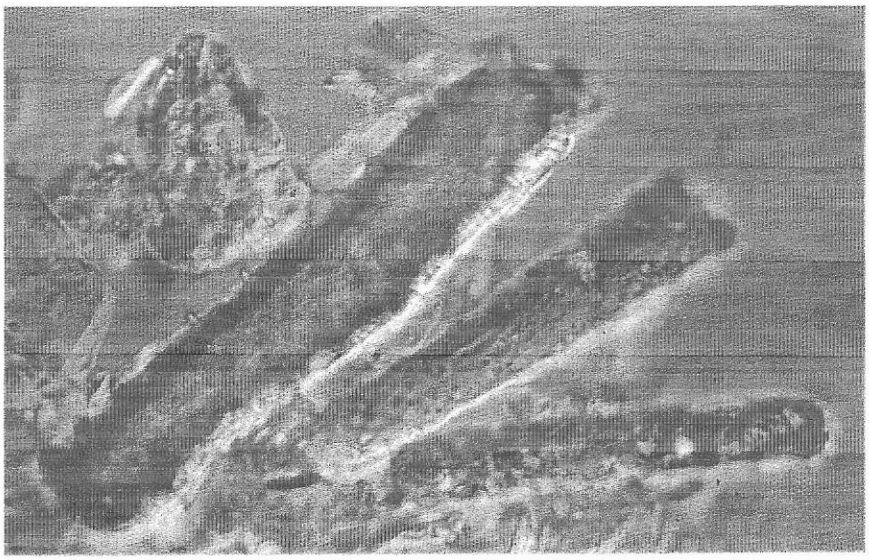
4th INTERNATIONAL MEETING ON PHYTOLITH RESEARCH

Cambridge (UK)
28th - 31st
August 2002





McDonald Institute for Archaeological Research
University of Cambridge

4th INTERNATIONAL MEETING ON PHYTOLITH RESEARCH

New Perspectives in Phytolith Research: Climate, Environment and Archaeology

The McDonald Institute for Archaeological Research
28th - 31st August, 2002

Organizing Committee

Chair: Marco Madella (The McDonald Institute - University of Cambridge, UK)

Members

Martin K Jones (Department of Archaeology - University of Cambridge, UK)

Anne Alexandre (CEREGE-CNR Europole de l'Arbois, France)

Katy Boyle (The McDonald Institute - University of Cambridge, UK)

Glen Fredlund (University of Wisconsin-Milwaukee, President SPR USA)

Charly French (Department of Archaeology - University of Cambridge, UK)

Margarita Osterrieth (Universidad de Mar del Plata, Argentina)

Luc Vrydaghs (Musée Royale de l'Afrique Centrale, Belgium)

Debora Zurro (DURSI, Laboratori d'Arqueologia CSIC, Spain)

SPONSORS

The British Academy
McDonald Institute for Archaeological Research
Department of Archaeology - University of Cambridge

4th International Meeting on Phytolith Research
Cambridge, August 2002

Programme

Wednesday 28th August 2002

9:00 – 10:30 Registration

10:30 – 10:45
Welcome from the Head of the Archaeology Department, University of Cambridge.

10:45 – 11:45
Lecture by G. Fredlund – President of the Society for Phytolith Research

11:45 – 12:45
Lecture by L. Scott-Cummings– President-elected of the Society for Phytolith Research

Lunch

❖ PHYTOLITHS IN ARCHAEOLOGICAL CONTEXTS, ANCIENT AGRICULTURE AND HUNTER-GATHERER SOCIETIES

Chair R.M. Albert

14:30 - 15:10 Schiegl, S, Stockhammer, P & Wadley, L - Mineralogical Studies on MSA Hearths and Sediments from Sibidu Shelter (KwaZulu-Natal), Republic of South Africa.

15:10 - 15:50 Cabanes, D, Allue, E, Vallverdu, J, Caceres, I & Vaquero, M - Hearth Functioning at level Ja (50 Kyr BP) at Abric Romani (Capellades, Spain): Phytoliths, Charcoals, Sediment, Bones and Stone Tools.

15:50 - 16:30 Madella, M - Environment and Plant Exploitation in an Upper Pleistocene Shelter in the Alps: The Riparo Tagliente (Lessini Plateau - Italy).

16:45 – 18:30 *Wine Reception at the Museum of Archaeology & Anthropology*

Thursday 29th August 2002

❖ PHYTOLITHS IN ARCHAEOLOGICAL CONTEXTS, ANCIENT AGRICULTURE AND HUNTER-GATHERER SOCIETIES

Chair L. Vrydaghs

9:30 - 10:10 Shishlina, N & Bobrov, A - Bronze Age Diet System of Ancient Pastoralists: Phytolith Analysis of the Clay Vessel Residue.

10:10 - 10:50 Kajale, MD & Eksambekar, SP - Archaeostratigraphical and Phytolith Analytical Study on a Late Chalcolithic-Early Historical Cultural Sequence from Balathal, South Rajasthan, India.

break 10:50 - 11:00

11:00 - 11:40 Bobrov, A & Shishlina, N - Phytoliths and Biogenic Silica from the West Eurasian Steppe Bronze Age Kurgans: Ecological Interpretations.

11:40 - 12:20 Korstanje, M A & Babot M P - Andean Crop Sphere: Vegetal and Faunal Microfossils Characterisation.

12:20 - 13:00 Scott Cummings, L - Phytoliths as Artifacts: Evidence of Threshing on Silica Bodies.

Lunch

Chair M.A. Korstanje

14:30 - 15:10 Vrydaghs, L, Devos, Y, Fechner, K & Degraeve, A - Contribution of Phytolith Analysis to the Early Medieval Town development of Brussels (Belgium). The Example of the Treurenberg Site.

15:10 - 15:50 Zurro, D & Madella, M - A Theoretical Approach to the Application of Phytolith Research to Archaeology.

15:50 – 16: 30 Serpa, K & Madella M – Use of Plant Resources in Harappa: a Phytolith Perspective.

break 16:30 - 16:45

❖ PHYTOLITHS IN PALAEOCLIMATOLOGY AND PALAEOECOLOGY

Chair M. Madella

16:45 - 17:20 Osterrieth, M & Fernanadez Honaine, M - Micromorphology and Phytoliths Study in Coastal Dunes of Southeastern Pampean Plains, Argentina.

17:20 - 18:00 Bremond, L, Alexandre, A & Guiot, J - Improving vegetation models: the phytolith input

from 19:30 Formal Dinner in Selwyn College

Friday 30th August 2002

❖ PHYTOLITHS IN PALAEOCLIMATOLOGY AND PALAEOECOLOGY

Chair G. Fredlund

9:30 - 10:10 Delhon, C - Phytolith and Pedo-anthracological Analyses of "off-site" Holocene Pedosedimentary Sequences from Mondragon (Middle Rhone Valley, South France)

10:10 - 10:50 Madella, M - Ecological and Climatic Information of Phytolith Assemblage Analogs from Modern Soil of Developed under Herbaceous Vegetation

***break** 10:50 - 11:00*

11:00 - 11:40 Thanheiser, U - Environmental Reconstruction Based on Phytoliths in Dakhleh Oasis, Egypt: Discussion of a Failure

11:40 - 12:20 Bobrov, A - Phytoliths and Micropalaeontological Data in Bogged Soil (Archaeological Monument "Gnezdovo")

12:20 - 13:30 Microscopy workshop

Lunch

Chair A Alexandre

14:30 - 15:10 Thorn, V - A Pilot Study of Phytoliths from Subantartic Campbell Island, New Zealand.

15:10 - 15:50 Stromberg, C A E - Using Phytolith Assemblages to Reconstruct the Origin and Spread of Grass-dominated Habitats in the Great Plains During the Late Eocene to Early Miocene.

15:50 - 16:30 Fredlund, G - Searching for Full-Glacial C4-Dominated Grasslands on the Southern High Plains, USA.

***break** 16:30 - 16:45*

16:45 - 17:25 Gol'eva, A - Various Phytolith Forms as Bearers of Different Kind of Ecological Information.

17:25 - 19:00 Microscopy workshop

(17:25 - 18:25 Society for Phytolith Research Board Meeting - Board Members Only)

from 19:30 Social Event

Saturday 31st August

❖ PHYTOLITHS IN PLANT AND ANIMAL STUDIES

Chair A. Sangster

9:30 - 10:10 Albert, RM & Vila L - Phytolith and Spherulite Study of Herbivores Dung from the African Savannah.

10:10 - 10:50 Ball, T - A Survey of Phytoliths Produced by the Sub-Tropical Coastal Region of Dhofar – Oman.

***break** 10:50 - 11:00*

11:00 - 11:40 Bowdery, D - Fine Resolution Phytolith Analysis: Fifty Years of Sheep Dietary Preference from 50 cm at Ambathala Pastoral Station, Queensland – Australia.

11:40 - 12:20 Parr, J - Morphological Characteristics observed in the Bilobate Leaf Phytoliths of Selected Gymnosperms of Eastern Australia.

12:20 - 13:00 Sangster, A & Hodson, MJ - Silicification of Conifers and the Environment

Lunch

14:30 - 15:10 Lentfer, C, Bowdery, D & Daniells J - Bananas in Antiquity: Procedures Used to Identify Musa Phytoliths Recovered from Archaeological Sites in Papua New Guinea.

14:30 - 15:10

15:10 - 16:00 Poster Session

break *16:00 - 16:10*

15:10 - 16:00

16:10 - 17:45 *Report from the International Committee on Phytolith Nomenclature*

17:45 - 18:00 Conference Closing

POSTERS

Eksambekar, SP & Kajale, MD Microstratigraphy of an Early Historic Garbage Pit: Phytolitological Approach.

Kailova, J tba.

Madella M. Environment and Plant Exploitation in an Upper Pleistocene Shelter in the Alps: the Riparo Tagliente (Lessini Plateau - Italy)

Pinilla, A, Martin, A & Sanchez A Phytoliths in Soils and Plants in Wetlands of the River Ciguela (Ciudad Real, Spain).

Pinilla, A, Perez-Gonzales, A & Santonja, MPhytoliths from the Pleistocene Site of Ambrona (Soria, Spain).

Thorn, V Phytolith Analysis - Potential and Limitations for Palaeoclimate Studies in the Antarctic.

Thorn, V Oligocene and Early Miocene Phytoliths from CRP-2/2A and CRP-3.

Zucol, AF, Brea, M & Madden, RH Preliminary Phytolith Analysis of MMZ Profile in the Gran Barranca Sedimentary Sequence (Chubut, Argentina).

Phytolith and Spherulites Study of Herbivores Dung from the African Savannah

R. M. Albert
Equip de Recerca Arqueomètrica de la Universitat de Barcelona (ERAUB) and Seminari d'Estudis i Recercas Prehistòriques de la Universitat de Barcelona (SERP).
email: albert@trivium.gh.ub.es

L. Vilà
Departament de Prehistòria, Història Antita i Arqueología. Facultat de Geografia i Història. Universitat de Barcelona. c/ Baldiri Reixac, s/n. 08028 Barcelona
SPAIN

Faecal spherulites are calcium carbonate crystals formed in the intestines of certain animals. Because of their mineralogical composition they require certain taphonomic conditions for their preservation. Spherulites can be found in more or less number in the dung of some herbivorous, mainly ruminants. Silica phytoliths are also commonly found in the dung of herbivorous animals. Their number and morphology will depend on the vegetal diet of these animals.

This study is centred on the microscopical analyses of both phytolith and spherulites, identified in fresh dung of several wild herbivores collected in the long dry season in the Olduvai Gorge in Tanzania. Phytoliths and spherulites were both identified following a morphological and quantification approach. Phytoliths were then compared to a modern plant reference collection from the same area to evaluate the diet component of each one of the animals analyzed and then the results were related to the spherulites production of the same animals. The purpose of this study consists on evaluating the usefulness of combining both techniques to address questions related to paleovegetation and domestication uses in archaeological sites, taking into account the specific taphonomic conditions needed for the preservation of both type of remains.

A Survey of Phytoliths Produced by the Sub-Tropical Coastal Region of Dhofar Oman

T. Ball
Department of Botany, Brigham Young University, Utah
terry_ball@byu.edu
USA

The Dhofar region of Oman is located at the southwestern tip of the Arabian Peninsula. While most of the peninsula is arid, there is a sub-tropical zone approximately 5 to 20 km wide and 100 to 120 km long located along the southwestern coast. This unique ecosystem is produced by monsoon winds that cause moisture-laden clouds to build up along the coastal bluffs. After dumping moisture along the coastal region, the clouds spill over the bluffs and dissipate out in the arid Arabian Desert. Consequently, the subtropical zone thus produced is ecologically isolated from the rest of the peninsula. It is one of the few areas in which the Frankincense tree, *Boswella sacra* grows, and anciently was the beginning of the Incense Trail that played a major role in the commerce and politics of the Ancient Near East.

Approximately 750 species are found in the area, with nearly 10% being endemic. This study analyzed approximately 500 species collected from the region for phytolith production. A reference collection of the phytoliths extracted from the taxa was made, along with a CD of the phytolith images.

Phytoliths and Micropaleontological Data from a Bog Soil (Archeological Monument "Gnezdovo")

A. Bobrov
Moscow State University
RUSSIA

Subatlantic landscape changes were reconstructed correlating independent results of phytolith and micropaleonthological (diatoms, testate amoebae, sponges) analyses of flood plain soil-sedimentary and sedimentary sections in the Upper Dnieper region within an early medieval pre-urban centre and in its close vicinities.

Every 10 cm of the section was sampled. Assemblage of species, quantity of testate amoebae, density of diatoms and sponge's spi ules were detected in aliquot. Soil samples for phytolith analysis boiled 1 hour in 20% H_2O_2, then added 10% HNO_3 and washed with distilled water. 300 phytoliths were counted for every sample under exaggeration 200 and 400. Scanning electron microscopy was applied to clarify morphology of testate amoebae and phytoliths.

Density of diatoms in samples from the analysed section varied from 0 to 150 thousands exemplars per 1 g of absolutely dry soil. Density of sponges' spicules is relatively low: from 0 to 6752 exemplars per 1 g of absolutely dry soil. There were 87 species, varieties and forms of testate amoebae belonging to 16 genera registered in the samples. Phytolith analysis was constructed on the forms phytoliths which allow reliably to identify an aspect or bunch of plants - sedges and graminoids. Separately were considered phytoliths of a reed (*Phragmites australis*), inhabiting reservoirs and their coast in mid-range of the European terrain of Russia. 62 forms phytoliths in total were determineted.

Analysis of obtained results was carried out in correspondence with zones discriminated for soil-sedimentary section sampled. Thus repeated changes of water regime from hydromorphic to more or less automorphic occurred in this part of floodplain within the period while Garbi-Urbic materials were accumulated. Alternation of "wet" and "dry" phases were interrupted by intensive sedimentation at the depth 100 – 90 cm and, probably, also at the depths 120-110, 140-130 cm. Phases of intensive influx of biogenic silica with spring floods were registered at the depths 70 – 60 and, perhaps, 50 – 40 cm as based on data of rhyzopod analysis. These phases finish a period of relatively dry conditions in the floodplain. Then man-impact ceased, alluvial loam was deposited and surface Distri-Gleyic Fluvisols developed in it. This last period of soil-sedimentary section's formation is characterised by the most dynamic and contrast changes in water regime on the evidence of studies of biogenic silica.

Phytoliths and Biogenic Silica from the West Eurasian Steppe Bronze Age Kurgans: Ecological Interpretation

A. Bobrov
Moscow State University

N. Shishlina
State Historical Museum
RUSSIA

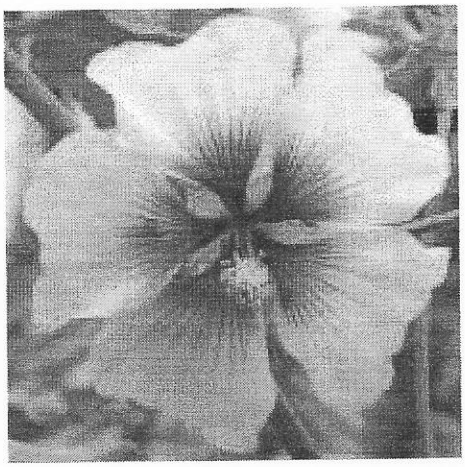
The basic conclusion lead phytolith analysis the following: burial soils of epoch Majkopian and Yamnaya cultures and the modern light chestnut soils are close on their such performance, as complexes of biogenic silicon dioxide. Apparently, they were generated in climatic conditions enough close to modern conditions or much closer modern, than soils of the second bunch. The second bunch of soils distinguished depleted phytoliths of spectrums – Yamnaya-Catacomb, Early-Catacomb of time, most likely, characterizes approach aridization of a climate and more significant broken state of an edaphic integument under barrows (pascual broken, wind erosion and other causes). Being reverted to necessity of correlation of outcomes obtained by different methods.

During time of presence Maykop culture, the diffusions of monuments Yamnaya and Yamnaya-Catacomb such as (5100-4500/4400 of years back) in region dominated light chestnut soils. In a course of their development during these of seven centuries there was an intensification of processes salt and gypsum accumulation in upper two-meter soil-ground more thickly, and the significant place was borrowed aeolian accumulation of chlorides of sodium. In Catacomb time (4500-4000 years back) have taken place a sharp modification of conditions of pedogenesis called catastrophic deflation of the upper edaphic horizons, awake
migration to a surface of carbonates, low-soluble of salts, plaster (Demkin et al., 2002).

Paleoecological reconstruction of natural conditions with use micropaleontological methods and phytolith analysis should be considered in a context of a complex paleoecological methods and outcomes obtained by other methods. In this connection, an obligatory stage of researches should be correlation of outcomes micropaleontological analysis by the data of paleobotanics and archaeological pedology.

Fine Resolution Phytolith Analysis: Fifty Years of Sheep Dietary Prference from 50 cm at Ambathala Pastoral Station

D. Bowdery
School of Archaeology and Anthropology, Faculties, Australian National University, Canberra , ACT, 0200. Email: Doreen.Bowdery@anu.edu.au
AUSTRALIA



Improving Vegetation Models: The Phytolith Input

L. Bremond,, A. Alexandre. and J. Guiot,
CEREGE
Europole de l'Arbois
13545 Aix en Provence
FRANCE

Global vegetation models provide a way to translate the outputs from climate model into map of potential vegetation distribution for present, past and future climate scenarios. Grass-dominated biomes are widespread and numerous on the continents and this range is hardly reflected by the common proxies such as pollen, charcoal and ^{13}C of organic matter. Global vegetation models, such as BIOME3 (Haxeltine and Prentice, 1996) can be used in inverse mode, using pollen as a proxy of vegetation input (Jolly et al., 1998). As pollen cannot trace grass subfamilies, these models show inaccuracies in modelling the various grassland biomes. For instance, they fail to allocate accurate boundaries between moist and dry savannas.

Phytoliths are helpful to trace various grass-dominated biomes through four phytolith indices mirroring: 1- the tree cover density; 2- the dominant grass subfamily (C_3-Festucoideae; C_4-tall Panicoideae; C_4-short Chloridoideae); and 3- the grass water stress.

The aim of this study is to calibrate the relation between phytolith indices, vegetation physiognomy and climate parameters, in order to integrate phytolith data in vegetation models. For this purpose, surface soil samples were collected in West Africa (Mauritania, Senegal and Cameroon) under various grassland biomes. Phytolith indices are qualitatively compared to vegetation features and bioclimatic data through statistical analysis. Then, multiple regressions are calibrated between vegetation structure variables, climate parameters and phytolith indices. According to these results, phytolith indices will be integrated into a vegetation model (BIOME4), complementary to pollen-based variables.

Hearth Functioning at Level Ja (50Kyr BP) from Abric Romani' (Capellades, Spain): Phytoliths, Charcoal, Sediment, Bones and Stone-Tools

D. Cabanes, E. Allué, J. Vallverdú, I. Cáceres and M. Vaquero
Àrea de Prehistoria (Unidad Asociada al CSIC). Grupo de Quaternari (IEA) Universitat Rovira i Virgili. Plaça Imperial Tarraco 1 43005 Tarragona
Email: dcabanes@prehistoria.urv.es
SPAIN

Fire is the basis of a technology with a huge importance in human evolution. The utilization of fire provides a new system of hominid relationships with the environment and within themselves, which implies a radical change in the behaviour of humankind (Perlès 1977). In the Abric Romaní (Capellades, Spain), a Middle Palaeolithic site, located near Barcelona, hearths are present in all the layers, with special emphasis in the layer Ja (50kyr BP) (Bischoff *et al.* 1988). Since now, charcoal analyses, micromorphology, bone taphonomy and spatial relationships of the hearths have been studied (Vaquero 1999; Vaquero *et al.* 2001; Vaquero and Pastó 2001). The last technique incorporated to our research project has been the phytolith analysis. The aim of this work is to integrate the multidisciplinary works, including the phytolith assemblages present in the hearth, and attempt to describe the hearth functioning through the fuelwood, functionality, diagenesis history, and the state of preservation of this hearths, making an extensive study of these structures from different points of views.

Phytolith and Pedo-Anthracological Analysis of «Off-site» Holocene Pedosedimentary Sequences from Mondragon (Middle Rhone Valley, South France)

C. Delhon
UMR 7041 ArScAn, Maison de l'Archéologie et de l'Ethnologie
21, allée de l'Université, 92023 Nanterre Cedex
FRANCE

Between 1994 and 1997, prior to the construction of the «TGV-Méditerranée» fast railway connecting Paris with the Mediterranean sea, large scale archaeological operations took place in the Rhone valley. From the very beginning, the project focused on palaeoenvironmental issues. With the aim of improving our knowledge of ancient Mediterranean environments, numerous pedosedimentary sequences have been brought into light next to actual archaeological sites.

These sequences contained great quantities of phytoliths and numerous charcoal layers. Because of this «off-site» location, we know that the botanical remains sampled were deposited without any direct human action, and that they had been produced by the surrounding vegetation. Moreover, geoarchaeological studies defined the sedimentary contexts from which charcoal and phytoliths were extracted, in order to enhance our understanding of the spatial and temporal scale of our results.

Mondragon is located in the south of the Tricastin alluvial plain (Drôme, south of France), on the left bank of the river Rhone. The region is characterised throughout the Holocene by important alluviation related to river floods (the Rhone of and its sub-alpine tributaries), so the studied sequences are well-dilated and the time scale reaches great precision. Mediterranean climate and vegetation prevail in the area, but the Rhone valley is a corridor that makes the penetration of more continental or more mountainous influences easier. The vegetation history is closely linked with climate history and cycles of human disturbance.

Phytolith analysis is a good proxy for reconstructing these cycles, as it is a mean of quantification of past vegetation density (ratio of grass phytoliths *vs* tree phytoliths). Charcoal analysis is a way to determine more precisely the ligneous taxa involved in the vegetation, which allows to connect vegetation changes either with human practices or with climatic events, or with a combination of these two factors.

Fire is a natural factor of the Mediterranean ecosystem that has been used by agro-pastoral communities for clearing the vegetation and fertilising soils. Fire layers are easily identifiable and datable, thus a pattern of fire cycles can be proposed for the region. It is often difficult to know whether fire recurrence periods are due to propitious climatic conditions or to agricultural practices. The analysis of micro-charcoal produced by these fires, parallel to the analysis of the phytoliths of the same layers, give information on the burnt vegetation, as well as on the vegetation dynamics before and after the fire, which are clues to understand their origins.

Microstratigraphy of an Early Historic Garbage Pit: Phytolithological Approach

S.P. Eksambekar and M.D. Kajale
Archaeology Department: Deccan College Postgraduate & Research Institute,
PUNE- 411006
Email : mkajale@vsnl.net
INDIA

The paper deals with phytolithological analysis of representative anthropic soil samples from garbage pit dug by ancient inhabitants into layer (3) of the the trench A6 at the site of Balathal, District Udaipur, Rajasthan, India . The trench was laid down during 1997-1998 season's excavations. The contents of the pit are sealed by layer (2) and this layer has yielded cultural materials belonging to Early Historical period. The pit is about 1 m in depth. The general stratigraphy of the pit contents showed three broad divisions such as dumped brownish earth with soft blackish ash at the lower levels overlain by blackish ash and brownish silt and upper portion is represented by brownish earth with whitish fibers. In order to assess the possibility of enhancing the understanding of materials dumped into the pit, the pit contents were further sub-divided, from top to bottom, into twelve microstratigraphic sub-layers for analysis.

The phytolithological analysis of representative samples from bottom, middle and upper levels of the pit contents yielded phytolith morphotypes belonging to different category of classes such as Panicoids, Chloridoids, Fetucoid, Elongate, Rod, Trichome and Bulliform. Thus, a database of varied ancient phytolith morpghotypes from each class has been generated.

The upper portion indicated dominance of Panicoids (long shaft type), Elongates (with thick serrations) while few saddles, squares, plain rods, conical pointed Trichomes and square stony Bulliforms are sparsely noted. The middle portion of the pit yielded abundant varieties of Panicoids including scoop shaped dumbbells in anatomical contexts and Cholridoids, Elongates (thick way serrated) and Bulliforms (square stony, rectangular stony and fan shaped types). The square and rectangular Festucoids, plain surface Rods and conical and solid point Triochomes are relatively less represented. The lower portion of the pit showed high frequency of Panicoids (varieties of crosses, thick shaft and short shaft dumbbells), Chloridoids (saddles,horn tower types, small saddles in clusters), Elongates (mainly fibers), Trichomes (mainly conical pointed solid pointed and prickles) are noted in high frequency while Festucoids (square , rectangles & sphaeroidals), Rods (plain surfaced) and Bulliforms (square & rectangular stony types) are less dominant. The unique feature of the lower portion of pit is Elongates (mainly fibers) and small saddles forming clusters.

Attempts are being made through phytolith analysis to discern the microstratigraphic details as well as sequential acvtivties of the inhabitatnts spanning a few centuries of the early Christian era.

Searching for Full-Glacial C4-Dominated Grasslands on the Southern High Plains U.S.A.

G. Fredlund
Geography UWM, Milwaukee WI 53201
Email: fredlund@uwm.edu

V. T. Holliday
Geography, University of Wisconsin, Madison, WI 53706-1491
USA

Plant physiologist have hypothesized that C4 grasses should have dominated much of the mid- and low-latitudes during the last glacial maximum (21,000 to 14,000 radiocarbon years BP). C4-grass domination is expected in these regions in spite of lower growing season temperatures of the full glacial because of the extreme depression of atmospheric CO2 levels.

To test this hypothesis we analyze an array of late- and full-glacial age samples form the Southern High Plains of Texas and adjacent New Mexico. We were unable to recover pollen or phytoliths from any of the full-glacial paleosols developed in Pleistocene dunes. Analysis of playa-fill sediments samples, however, was generally more successful yielding both pollen and phytoliths. Pollen assemblages confirm that the Southern High Plains were grasslands during the last glacial maximum rather than forested as early pollen analysis predicted. Grass short-cell phytolith assemblages from these samples do not support the hypothesized C4-domination of the region. This discrepancy between model predictions and observed remain perplexing.

Various Phytolith Forms as Bearers of Different Kinds of Ecological Information

Alexandra Golyeva
Institute of Geography RAS, Moscow, e-mail: pedology@igras.geonet.ru
RUSSIA

Phytolith complexes of main modern natural and anthropogenic phytocenoses (bog, tundra, taiga, mixed forest, foliage forest, dry meadow, wet meadow, weed meadow, steppe, dry steppe, and semidesert) of the European part of Russia are described. Phytoliths diagnostic of each phytocenosis are determined. Analysing the diversity of phytolith forms from the specified phytocenoses shows the following:

1)Some forms are common and present in different proportions in almost all phytocenoses.

2)Some forms are found in only several phytocenoses in different quantities. Their quantity in this case is a very important index. For example, the prevalence of "meadow trichomes" over "forest trichomes" is indicative of the phytolith spectrum of meadow (the presence of a forest is questionable and requires analysing specimens from the horizons above and below). If "meadow trichomes" are less abundant than "forest trichomes", then the specimen is characteristic of a forest with a thick grass cover. The higher is the portion of "forest trichomes" in a specimen, the sparser grass cover and the thicker tree stand it represents. A total absence of "meadow trichomes" points to an absence of the grass tire in the forest. The prevalence of "meadow trichomes" over "saddle-shaped trichomes" is indicative of dry meadow; an opposite proportion of the phytoliths is typical for steppe. The higher is the portion of "saddle-shaped" forms, the more xeromorphic is steppe. Vegetation of dry steppe does not produce phytoliths in form of "meadow trichomes".

3)Some forms of phytoliths, "signal forms", are specific for only one phytocenosis. There are not many: cubic or slightly elongated forms with regularly-shaped cavities on the surface are diagnostic of coniferous forest; fan-shaped large phytoliths are diagnostic of a bog or a lake overgrown with reed; "forest trichomes" are indicators of foliage forest; finger-shaped phytoliths with rugged saw-like sides and branched ends are indicators of arid conditions. If a specimen contains only one or very few signal forms, then, most probably, these are aliens brought from other phytocenoses or relicts remained from earlier stages of the development of parent rocks. However, the predominance of signal forms in a sample is not necessary. For example, the presence of, at least, 3 or 4 fan-shaped phytoliths is enough for concluding about very wet soil-forming conditions or about the addition of reed (*Phragmites*) to the cultural layer by men. If the proportion of forms originated from conifers amounts to 3-4% of the total number of phytoliths, then the presence of conifers in the tree stand is undoubted. But a mere presence of "forest trichomes" is insufficient for concluding about the growth of foliage forest in a given place; these trichomes should significantly outnumber "meadow trichomes". The content of rugged finger-shaped phytoliths of 3-4% is enough to indicate that plant growth conditions are arid. And the higher is the proportion of finger-shaped phytoliths, the more arid are paleoclimatic conditions (up to semidesert). Sometimes, the absence of one or another form can serve a diagnostic feature, e.g., very few finger-shaped phytoliths plus prevailing plate-shaped forms indicate extra arid or extra humid phytocenoses: bog, tundra, and semidesert. It should be emphasized that it is necessary to count all phytolith forms regardless of their diagnostic significance. To interpret the results obtained, one should consider firstly a whole complex of phytoliths and then signal forms, their number, and their distribution. The results of different phytocenosis phytoliths's characteristics are useful for palaeoecology and palaeoclimatology reconstruction from natural and anthropogenic sites.

Archaeo-stratigraphical and Phytolith Analytical Study on a Late Chalcolithic-Early Historical Cultural Sequence from Balathal, South Rajasthan, India

M.D. Kajale. & S.P. Eksambekar
Archaeology Department: Deccan College, Postgraduate & Research Institute
PUNE- 411006 (INDIA)
Email: mkajale@vsnl.net

The Chalcolithic-Early Historical site of Balathal (District Udaipur, Rajasthan, India) has been subject of archaeological and multidisciplinary scientific studies during the last nearly eight years. Various archaeological, archaeobotanical, archaeozoological and soil chemical analytical and initial phytolithological results have been published. The pollen analysis of the deposits proved unsuccessful because of terrestrial aerobic conditions during earlier years. Hence phytolithological analysis of an interesting stratigraphic profile , especially the one ranging from Late Chalcolithic to Early Historic sequence (Tr. D2 - layers 3, 4 and 5 dug in the central portion of the site during 1997-1998 season's excavations) was selected for study. Detailed phytolithologicval results obtained during last two years are being reported herewith for appreciating the broad based local environment, anthrosol formation and general vegetation-landscape conditions which ultimately gave rise to a stratigraphic profile assignable to c.1500 B.C. to 200 A.D.

The excavations carried out during seven season had yielded Early Historic sequence represented by anthrosol layers 1, 2 and 3. The layer 4 stood out distinctly as a whitish band in the central portion of the site and it petered off towards the margins. It yielded only a few potsherds of Early Historical period and considered to be archaeologically sterile as compared to layer 3. The underlying layers 5 has been found to be culturally sterile and was supposed to have been formed after desertion of the habitation of Late Chalcolithic occupants. The discontinuity of habitation between latest phase of Chalcolithic and Early phase of Historical occupation has been noted in different excavated parts of the site and in south Rajasthan in general. The reasons and results of this cultural discontinuity have been one of the prime considerations for initiating phytolithological study.

The superficial whitish and ashy nature of the layer 4 had lead us to hypothesise in terms of protracted burning of natural vegetation and ash accumulation over the abandoned land surface represented by layer 5. However, the apparently sharp physical contrast between brownish layer 5 and whitish layer 4 in the field also prompted consideration in terms of natural pedogensis of layer 5 resulting in upward accumulation and encrustation of salts in the form of whitish horizon occurring as layer 4 before the subsequent Early Historic habitation (represented by layer 3) came into being. And question naturally arose whether the change in stratigraphy from layers 5 to 4 represent real pedogenetic change or the burning of natural vegetation over a land-surface abandoned by late Chalcolithic occupants or the result of both the processes or

any other unknown palaeoenvironmental problem waiting to be tackled in the laboratory.

Hence it was deemed worthwhile to broach the problem of nature of the formation of layers 5, 4, 3 through phytolith analysis, routine chemical analysis and micromorphology. Of these, the results of phytolith analysis are available at the moment and attempts are being made to broadly infer about the nature of local landscape-vegetation environment during formation of stratigraphic record of layers 5, 4 and 3 in a warm tropical monsoon terrain of south Rajasthan, where pollen-spores preservation in archaeological deposit has been rather poor.

The layer 5 (subdivided from bottom to top as 5 A, B & C), layer 4 (subdivided as 4A & 4B) and the layer 3 were selected for phytolithological sampling and detailed analysis in the laboratory, in an attempt to understand changes of vegetal cover, landform nature (whether stable or disturbed).

The processed samples were differentiated into 3 sub fractions-small , medium and coarse (upto 20, 20-50 and more than 50 microns) and phytoliths from each of these sub-fractions of above mentioned layers were studied in details for preparing a local database . It has been subjected to morphometric analysis and dendrogram has been prepared for more accurate zonation of the stratigraphic sequence .

The layer 5 is dominated by high frequency of occurrence of Panicoids and Trichomes (solid pointed types). The layer 4 is showing predominance of Panicoids (half dumbell, uneven lobes, dumbells with concave lobes and various types of Choloridoid forms. The layer 3 shows high frequency of Panicoids (crosses with concave lobes), various Chloridoids (except horn tower type) and Bulliforms (faceted stony, narrow arch, blunt with concavity). A detailed summary of phytolith morphotypes (belonging to eight classes and their various subtypes) and their distribution at Trench D2, layers 3, 4 and 5 has been prepared. The dendrogram possibly suggests similarity between layers 5A and 4A (large sized phytoliths); layers 5B, 5C and 4B (medium sized phytoliths) whereas the layer 3 stands out separately because of its smallest sized phytoliths.

Pending comparative reference collection of phytoliths from modern plants, it is difficult to assign the phytolith assemblages to the specific genus or species with high degress of certainty. However, the database does suggest that large sized phytoliths are conspicuously found in 5A and 4A, perhaps emanating from matured plants. The phytolith size decreases in layers 5B, 5C and 4B. The smallest sized phytoliths are noted in layer 3 perhaps emanating from immature plants. Does it suggest that while the layer 5 was being formed, fully matured plants (mainy arboreal, few herbs &/ shrubs on natural stable land surface) could have been supported by the deserted portion of the landscape which was getting pedogenised under warm tropical monsoon environment. The early phase of burning of the natural undisturbed vegetation seem to have resulted into whitish ashy stratum, i.e. layer 4. The layer 3 with abundant Bulliforms, Panicoids (crosses with concave lobes) could have resulted predominantly from Man-made disturbed vegetation with immature plant cover (less arboreals, mainly herbs & shrubs on a disturbed landscape) subsequently occupied by Early Historic people. The present approach, methodology and initial interpretation are subject to modification in light of our ongoing study and complimentary scientific studies like micromorphology, AMS radiocarbon dating, etc. by other colleagues. We do believe science as learning.

Andean Crop Sphere: Vegetal and Faunal Microfossil Characterisation

M. A. Korstanje & M. P. Babot
Instituto de Arqueología y Museo, Universidad Nacional de Tucumán
e-mails: alek@unt.edu.ar and shypb@arnet.com.ar

The use of phytoliths for agricultural studies is successfully spreading around the world. In contrast, the archaeological studies incorporating phytoliths in the southern Andes are scarce. One of the reasons may be there are not many staples or economic taxa that produce non-redundant phytoliths and are possible to grow in the arid Andes environment (Puna and Sierra).

Since food production in the Andes involves mixed farming and herding systems and a strong reliance on the gathering of wild resources, we propose to study the whole microfossils assemblage when opal phytoliths record is not enough, as in this case.
We present here, as a way to encourage more work in the southern Andes, a comprehensive and critic characterization of the opal phytolith, starch and faunal spherulites record for that region, both from literature and our own research.

Bananas in Antiquity: Procedures Used to Identify *Musa* Phytoliths Recovered from Archaeological Sites in Papua New Guinea

C. Lentfer
Center for Geoarchaeology and Palaeoenvironmental Research, Southern Cross University, Lismore, NSW, 2480. Email:clentfer@scu.edu.au
D. Bowdery
School of Archaeology and Anthropology, Faculties, Australian National University, Canberra , ACT, 0200. Email: Doreen.Bowdery@anu.edu.au
J. Daniells
Department of Primary Industries, Centre for Wet Tropics Agriculture, South Johnstone, Queensland, 4859. Email: jeff.daniells@dpi.qld.gov.au
AUSTRALIA

Phytolith research at a number of archaeological sites in Papua New Guinea, including the early agricultural site of Kuk in the highlands and the Watom site in East New Britain, reveals a strong banana presence in phytolith assemblages. With this evidence comes the potential for tracing prehistoric banana distribution as well as early agricultural developments and patterns of domestication. In 1985 Samuel Wilson published a paper showing the potential for using statistical procedures to classify banana phytoliths into their various sections, but until now very little work has been done to expand on this. This paper re-examines Wilson's methodology and discusses new developments in Musaceae phytolith research and their application to the classification of fossil phytoliths found in archaeological deposits.

Environment and Plant Exploitation in an Upper Pleistocene Shelter in the Alps: The Riparo Tagliente (Lessini Plateau - Italy)

M. Madella
McDonald Institute for Archaeological Research
University of Cambridge
Email: mm10018@cam.ac.uk
UNITED KINGDOM

The Tagliente Shelter is located in Val Pantena (250 m asl), Lessini Plateau, in northeast Italy (Regione Veneto). In the Lessini limestone plateau, during the late Middle Pleistocene, due to the deepening of the canyons which characterise this mountain group, several shelters and caves appeared along the slopes. Their entrances were inhabitated by Mousterian and Epigravettian hunter-gatherers and also acted as sedimentary traps for the wind blown material deposited as loess.

The archaeological evidence is in the form of a very large amount of flint artifacts, hearths, living floors, chipping areas, waste deposits and faunal remains. The Mousterian sequence may be attributed to the first Pleniglacial of the Würmian age, about 60,000 – 40,000 years ago, while the upper part of the Aurignacian level has been correlated, on the basis of the industries, with the Arcy interstadial period. For the Epigravettian layers some radiocarbon dates are available.

The samples from Riparo Tagliente are characterised by a low frequency of phytoliths which resulted in very long time being taken to count 250 phytoliths (in one case up to 18 hours). Despite the paucity of phytoliths, it was decided to proceed with full 250 phytolith counts rather than take the option of using the more efficient time-catchment approach on account of the intrinsic interest of these samples.

The phytolith suites are, in general, rather homogeneous and dominated by long cells and secondary typologies. Secondary typologies tend to increase with depth and they are more frequent in the Mousterian levels. In the Tagliente samples there is indication of post-depositional destruction of phytoliths due to colluviation, bioturbation, human action, and pH values, and phytolith assemblages give evidence of impoverishment and enrichment in morphotypes in contiguous layers by downwards infiltration and leaching of phytoliths.

Epigravettian and Mousterian levels tend to separate out in the correspondence analysis display, showing a certain differentiation on the basis of their phytolith content. Phytoliths also demonstrated to be sensitive to climatic influence as shown but the frequencies of grass short cells and schlereids from broad-leaved arboreal plants.

Ecological and Climatic Information of Phytolith Assemblage Analogues from Modern Soil Developed under Herbaceous Vegetation

M. Madella
McDonald Institute for Archaeological Research
University of Cambridge
Email: mm10018@cam.ac.uk
UNITED KINGDOM

The sites investigated for modern soil sediments represent two examples of grassland vegetation from the high latitudes of the northern hemisphere: the mountain meadows and pastures, and the steppe. Val Fredda di Bazena is located in the Central Alps, at the southern fringe of the Adamello Regional Park in Lombardy (North Italy). The vegetation of the valley is represented by alpine pastures, shrubby pastures and meadows. A vegetational study for the area has shown that some of these Alpine grassland stands are still retaining, in their floristic composition, clear steppe elements. Darai Kalon, Darai Kalon II, Obi Dara and Chashmanigar are soils developed under steppe vegetation in the loess-desert zone of South Tadjikistan.

All the samples from Val Fredda represent A_0 horizons. They have been chosen as representative examples of different Alpine vegetations. Some of these stands have been used over time as pastures while for others human action should be considered minimal. Sampling also took into account differential soil water availability. Soil parental material varies from the very alkaline limestones and diorites to more acidic granites. The samples from DRK, D-II, OBD and CSG sections are from complete soil profiles developed on loess deposits.

The preservation of phytoliths in the modern soil sediments seems to be independent of pH values and the production of secondary morphotypes in relation to depth/time of burial, according to the proposed hypothesis, is confirmed for grassland communities soils of these sites. Topmost assemblages (A_0) are markedly better preserved than those from B or C horizons.

Ratios of long *versus* short cells may be successfully utilised as an index to highlight indirect water content in soils from similar vegetal formations, and genetic and environmental controls of cell silicification may be considered as dependant when anthropogenic action is thought to be absent.

Also, the differences observed in the phytolith suites reflect the original floristic composition of the phytocoenoses. This composition is in turn an expression of adaptation to the environment.

Phytolith Deposition and Taphonomy in a Loess-Palaeosol Sequence of the Italian Pre-Alps: the Val Sorda (Veneto Region)

M. Madella
McDonald Institute for Archaeological Research
University of Cambridge
Email: mm10018@cam.ac.uk
UNITED KINGDOM

The Val Sorda is a deep cut in the fluvio-glacial deposits on the SW slope of Mt. Moscal, operated by the Progno Stream. It is part of the Rivoli moraine system, situated where the Adige River flows out of its pre-Alpine valley and into the plain of the Po River in north-east Italy, Veneto Region. This area was surrounded by Alpine Quaternary glaciers and many of the sediments are of fluvio-glacial origin. The most important feature of these sediments is the presence of the so-called Alpine loess which is a silty deposit transported and accumulated by wind. The loess sedimentation in northern Italy is a sedimentary process which recurred at least from the early Middle Pleistocene.

A series of 27 samples, covering the loess, the moraines and the palaeosol, were collected. Phytoliths were extracted from all 27 samples. Primary typologies have generally very low frequencies apart from the palaeosol samples and they are completely absent from the moraine samples.

The analysis of the sediments from the loess-palaeosol-moraine sequence of Val Sorda elucidated the formation of phytolith assemblages for a periglacial environment. The samples from the different sedimentological realities are clearly separate when correspondence analysis is applied to the data set, and they divide on the basis of the composition of their phytolith assemblages. These differences between phytolith suites seem to be related to pre and post-depositional processes and, when vegetation was present on the sediments, to the floristic composition of the original plant communities.

Micromorphology and Phytoliths Study in Coastal Dunes of Southeastern Pampas Plains, Argentina

M. Osterrieth
Centro de Geología de Costas y del Cuaternario. Facultad de Ciencias Exactas y Naturales-Universidad Nacional de Mar del Plata.

M. Fernández Honaine
Comisión Investigaciones Científicas de la provincial de Buenos Aires – Centro de Geología de Costas y del Cuaternario Universidad Nacional de Mar del Plata.
ARGENTINA

The evolution of the coastal dunes during the late Holocene (1000 to 500 years BP) in the pampean plains of Buenos Aires province, involves the combination of: marine erosion, aeolian action, dynamics of vegetation cover, soil development and human activities.

Results of phytoliths, micromorphological and mineralochemical analysis are presented. The inter-relation between biomineralization, weathering rate of non-biogenic and biogenic silica and soil profile development are performed.

The amorphous silica fraction of the disturbed samples was concentrated with sodium polytungstate at a density of 2,3. The undisturbed samples were impregnated in synthetic resin for the thin section description. The semi-quantitative studies of the elementary components were made by means of EDAX, and X-ray diffraction.
The dominant soils are typical Quarzipsaments and Entic Hapludolls which present scarce development (C - 2AC-2C); alkaline pH (8-9, 2), and low content of organic matter (0, 4 to 4%). Under SEM, many phytoliths exhibited weathering features like dissolution micro-cavities

These soils present a single grain structure to a bridge grain structure, and the related distribution pattern of coarse and material is Monic to Gefuric. The skeleton grains are similar in size (fine sand) shape, and mineralogy. No cutan or subcutan were observed, but a little plasma separation existed around some skeleton grains. Cements constitute small adhesive bridges at grains points in a skeleton matrix. Allophane was detected in the AC horizon. The material coating and bridging the framework grains is enriched in silica, and also contains calcium, iron, sodium and chlorine. The alteration levels in the silico-bioliths are not related with temporary events, but rather they are related with the biogeochemical of the means, and with the organic components. These interactions allow the formation of organo-mineral complexes starting from biogenic silica, like part of the matrix of the soils. It favors the development and persistence of structure peds, and also the resistance to the erosion of these soils located in highly unstable coastal environmental.

Morphological Characteristics Observed in the Bilobate Leaf Phytoliths of Select Gymnosperms of Eastern Australia

J. Parr
Centre for Geoarchaeology and Palaeoenvironmental Research
School of Environmental Science and Management - Southern Cross University
PO Box 157 Lismore, NSW 2470.
OFFICE 66203789 LAB 66203357 Email: jparr@scu.edu.au
AUSTRALIA

Often described as a living fossil, the Wollemi Pine (*Wollemia nobilis*), has induced some debate as to its specific taxonomic relationship to other Australian Gymnosperms. Morphological comparisons of some leaf features, microsporophyll and pollen indicate a relationship between *Wollemia nobilis* and *Araucaria* spp.. Recent phylogenetic studies using the *rbc*L chloroplast gene have resulted in conflicting genetic evidence. The lack of pollen in the fossil record after two million years ago had led a number of palynologists to believe this species to be extinct in Australia. However, it is now clear that the reduction in *Wollemia nobilis* pollen may simply reflect the receding of this species to select pockets of protected habitat as a result of climatic change and/or the lack of ideal preservation conditions for this particular pollen. Recent research in Papua New Guinea has demonstrated that fossil phytoliths often survive in sediments where pollen is found to be scant thus providing a potentially useful proxy for more contemporary evidence of *Wollemia nobilis.* With this possibility in mind, the phytoliths extracted from herbarium specimens of *Wollemia nobilis* and those species believed to be most closely related are currently being examined. This paper presents initial results of the current study depicting the morphological characteristics observed in the bilobate leaf phytoliths of select *Agathis* spp., *Araucaria* spp., *Podocarpus* spp. and those of *Wollemia nobilis*.

Phytoliths in Soils and Plants in Wetlands of the River Cigüela (Ciudad Real, Spain)

A. Pinilla, A. Martín and A. Sánchez
Departamento de Suelos, Centro de Ciencias Medioambientales, CSIC, Serrano 115 bis, 28006 Madrid. E-mail; ebvpn90@ccma.csic.es
SPAIN

In this work, we studied wetlands in the basin of the river Cigüela, which is part of a wider area known as the "Mancha Húmeda" that also encompasses the Tablas de Daimiel. The lagoons examined, known as "El Molino del Abogado" and "El Masegar", were both man-made. In fact, they were established for hunting purposes around 1970 and later drained; however, both might be recovered. At present, the two lagoons are semi-arid ecosystems on alluvial sediments with high gypsum and calcium carbonate contents.

"El Masegar" samples were collected from the lagoon bed, the flood lagoon -currently dry- and the river channel, whereas "El Molino del Abogado" samples were collected from the latter two locations. Analyses were conducted on the > 200, 200-50, 50-20, 20-8 and 8-2 m fractions. The materials found in the soils included siliceous biomineralizations (*viz.* phytoliths, diatomaceae, chrysophyceae and spiculae). This communication reports the results obtained from the phytoliths, which proved useful with a view to establishing the functional analysis of the lagoons.

We studied phytoliths from herbaceous vegetation in the two wetlands in terms of the water regime of each season and their degree of disruption. The materials collected in the less disturbed locations, where water was available semi-permanently, included *Phragmites australis*, *Cynodon dactylon, Puccinellia fasciculata* and *Elymus curvifolius* among gramineae; and *Cladium mariscus*, *Scirpus lacustris* and *Carex acuta* among cyperaceae. *Equisetum* sp and *Typha domingensis* were also collected. On the other hand, the materials collected from moderately disturbed locations that were submerged during the winter included *Agrostis stolonifera*, *Juncus articulatus, Juncus maritimus* and *Juncus inflexus* Finally, the plants from highly disturbed locations that remained flooded until May or June belonged to the *Carex acuta* and *Phalaris arundinacea* species; also *Salix purpurea , Salix alba and Tamarix canariensis* among bushes.

The phytoliths studied in soils differed among areas. Thus, virtually all specimens collected from the lagoon bed -whether from the surface or from deeper layers- were of herbaceous origin. Cyperaceae and gramineae were the two most abundant families; the latter were of the C_4 and, especially, the C_3 type. Biominerals in the samples from the flood lagoon were scantier, particularly in "El Molino del Abogado"; phytoliths were similar to the previous ones but gramineae (particularly of the C_4 type) were more abundant. Finally, the samples from the river channel contained many more phytoliths, especially in "El Masegar". Herbaceous phytoliths were again the most abundant; those from gramineae were found in similar numbers for C_3 and C_4.

Phytoliths from the Pleistocene Site of Ambrona (Soria, Spain)

A. Pinilla
Departamento de Suelos, Centro de Ciencias Medioambientales, CSIC, Serrano 115 bis, 28006 Madrid. E-mail: ebvpn90@ccma.csic.es
A. Pérez González
Departamento de Geodinámica, Facultad de Ciencias Geológicas, UCM, 28040 Madrid, E-mail: alfredog@geo.ucm.es
M. Santonja
Museo de Salamanca, Junta de Castilla y León, Patio de Escuelas 2, 37007 Salamanca. SPAIN

Over the last few years, the authors have conducted a research project on the Achelense site of Ambrona with a view to delimiting the natural framework for human activity in the area. This is a multidisciplinary study including the analysis of minerals and biominerals. This communication reports the results obtained for phytoliths from the lower stratigraphic complex of Ambrona. The siliceous biomineralizations found also included diatomaceae, chrysophyceous stomatocysts and spiculae. All these microfossils were encountered in very small numbers, silicophytoliths being the most abundant. Analyses were conducted on the 62-50, 50-20, 20-8 and 8-2 μm fractions (the same used to examine the minerals).

Marked changes across the stratigraphic column, particularly as regards contents, were observed. Thus, phytoliths were scant in the AS1/2 unit (*i.e.* at the bottom of the column) and increased gradually in number in the following unit sequence: AS3 > AS4 < AS5. Samples 12a and 12b, from the bottom of the AS6 unit, exhibited the highest phytolith contents. However, not only phytoliths, but also other biominerals (particularly diatomaceae) increased in number and variety in the previous sequence. This suggests that the environmental conditions prevailing at that level must have been highly favourable for the development of vegetation. The contents in phytoliths and other biominerals decreased above it, so much so that these materials were virtually absent from the top of the AS6 unit -which represented the final portion of the Lower Complex.

Based on phytolith morphology, two well-defined groups of phytoliths were observed across the section, namely: (*a*) gramineae (Panicoideae and, especially, Pooideae), and (*b*) trees and bushes. The proportions of the two groups varied from unit to unit. Gramineae were of the C_3 type and the tree phytoliths were mainly from pines. These phytoliths are typical of cold, wet climates. On the other hand, the phytoliths found near the top of the column were virtually exclusively from gramineae. There was thus a regression to the tree stratum, which suggests a change in the vegetation of the Ambrona area. That growing at present consists primarily of grassland (*Festuca* and *Poa*), but also includes bushes and, to a much lesser extent, *Pinus laricio*.

More Phytolith Evidence for Large-scale Mid-Holocene Climatic Change in Small-scale Hunter-Gatherer Sites of the Pre-ceramic Archaic Period, Eastern USA

I. Rovner
North Carolina State University, Raleigh, NC, 28608 - 8107, USA
Irovner@earthlink.net

At the 2nd IMPR, Aix-en-Province, France,(1998) phytolith evidence from two mid-Holocene archaeological sites supported Carbone's phytolith (1976) evidence for a warming period in the Eastern United States. Such a mid-Holocene warm (and dry) period was well documented in the Great Plains of the Central United States -- west of the Appalachian Mountain Range and east of the Rocky Mountains. Evidence for a similar climate shift on the Atlantic Ocean side of the Appalachian Mountains in the Eastern Forest Zone was poorly documented in the absence of effective fossil proxy data in much of the eastern region. This is being changed by the widespread presence of well-preserved phytoliths in archaeological sites of the region. At the 3rd IMPR, Brussels, Belgium, (2000) phytolith evidence was presented suggesting that the mid-Holocene warming period of this region was, in fact, not drier, but warmer and wetter. Phytolith data is demonstrating tremendous success in the investigation of the previously poorly known climatic history of the region.

Recent phytolith studies of regional archaeological sites continue to confirm the warm period as well as a shift in the next period to a cooler, more "normal" climate in the region. Independent, multiple lines of evidence are also confirming the results of phytolith studies. Archaeological studies of site distributions clearly indicate an abnormal pattern during the warm period that is consistent with increased wetness, not dryness. Detailed studies of alluvial and colluvial soil deposits likewise indicate increased wetness during the mid-Holocene.

Results of phytolith studies in the context of multiple lines of evidence are demonstrating that large scale (e.g. continental) climate change, such as the mid-Holocene warm period, does NOT provide homogeneous effects everywhere. Data presented here indicates that while one major region of the continent was experiencing warmer and drier conditions, a neighbouring major region was experiencing warmer and wetter conditions. This has enormous implications for the study of regional and continental climate history everywhere.

Silicification of Conifers and the Environment

A. G. Sangster
Division of Natural Sciences, Glendon College, York University, Toronto, ON, M4N 3M6 E-mail: sangster@yorku.ca
CANADA

M.J. Hodson
School of Biological and Molecular Sciences, Oxford Brooks University, Gipsy Lane, Headington, Oxford OX3 0BP E-mail: mjhodson@brookes.ac.uk
UK

Biomineralization of the cell walls of the root, stem and leaf tissues of conifers was measured by gravimetric analysis or by EDX-microanalysis. silicon predominates, but calcium and aluminium are also present. Quantitative comparisons indicate that silica deposition lacks homogeneity, varying widely between taxa and between individual root and leaf tissues. Silicon accumulation increases with needle age and may reach maximum values in the tip region. While internal factors, especially cell type and tissue maturation, may be limiting to Si deposition, external factors including site (soil) characteristics also moderate deposition patterns within taxa.

At the individual plant level, abiotic criteria (e.g. pH), by influencing the release of adsorbed Si into the soil solution, can determine the quantity of soluble Si available for uptake, transport and ultimately tissue biomineralization. Abiotic factors operating at the atmospheric interface with the aboveground biomass including temperature, light, humidity, wind velocity and others, affect Si transport by modification of the rate of transpiration. However, more experimental evidence of the impact of these environmental stresses on phytolith formation *per se* is required. Biotic factors including competition, herbivory and pathogens can severely restrict Si deposition by defoliation.

At the ecosystem level, conifer forest communities can be severely reduced or even eliminated by climatic impacts, representing the most severe limitation to phytolith formation. These abiotic stresses include hurricanes, ice storms, fire, drought and others, while biotic stresses include insect/pathogen outbreaks. Often these impacts are localized; whereas, widespread atmospheric trends such as El Niño/Southern Oscillation variations and global warming may affect the silica biocycle, including phytolith formation, over entire biomes.

Phytoliths as Artifacts: Evidence of threshing on Silica Bodies

Linda Scott Cummings
Paleo Research Institute, 2675 Youngfield St., Golden, CO 80401
USA

Phytoliths of cereal grain stems and chaff have been recovered from a variety of archaeological deposits. Within these populations of archaeological cereal grain phytoliths, some are whole and others are fragmented. The fragmented long cell sheet phytoliths exhibit either regular or irregular breaks. Anderson (1998) conducted experiments that studied formation processes resulting in various breaks such as straight cuts, curved cuts, stepped cuts, and irregular cuts. She demonstrated that threshing sledges produce straight cuts, curved cuts, and stepped cuts and that a variety of other tools including scythes, hand-held knives, and scissors do not. Therefore, examination of the type of cuts on cereal grain long cell sheet phytoliths can provide valuable evidence for use of threshing sledges in the past. Recovery of cut phytoliths from Neolithic sites in the Near East provides evidence of use of threshing sledges at a variety of locations. These cut phytoliths indicate the presence of cultivated cereals and the use of a threshing sledge. In a more surprising application, recovery of cut phytoliths from the Santa Inez Mission, California in the western United States provides evidence that the Spanish introduced threshing sledges into the New World when they introduced cultivation of cereal grains. Since phytoliths recovered at a variety of archaeological sites were cut using tools employed by people processing the plant remains, they provide artifactual evidence of the use of threshing sledges.

Bronze Age Diet System of Ancient Pastoralists: Phytoliths Analysis of a Clay Vessel Residue

N. Shishlina
State Historical Museum

A. Bobrov
Moscow State University
RUSSIA

The correlation of the phytolith analysis outcomes with outcomes obtained by other methods is the important part of the scientific research. This is especially relevant for the investigation of the diet system of the ancient population. The North-West Caspian maritime steppe was the area of the origin and development of a new type of the economy – pastoralism. The earliest Yamnaya culture bearers (cal.3000-2500 BC) can be characterised as herders of sheep/goat and cattle. They have developed the seasonal cycle of the pastures but were not very mobile. The next Catacomb culture (cal. 2500-2000 BC) represents a far more complex adaptation to the steppe and the further development of the seasonal cycle. The diet system of these two cultures was linked with ecological and spatial-dynamic conditions, technological level, relationships with sedentary populations etc. In our research we use the samples taken from the burials of the Yamnaya and Catacomb cultures and try to identify the contents of vessels. The contents of vessels found in graves are major source of a diet system reconstruction. We suppose that such vessels felled with food and drinks were placed into the grave. Therefore such food and drinks could have been consumed not only as regular meals but could have performed a ritual function. Four independent methods were used - pollen analysis, definition of a content of phosphorus, phytolith analysis, method of chemical biomarkers (fatty acids etc.). The research conducted has allowed us to obtain the new data on a diet of ancient nomads of the Northwest Caspian See region steppe, and also to compare outcomes obtained by different methods.

Fifty-five clay vessels were analysed, 20 samples were processed by two independent methods, 13 – by three, 3 – by four methods. We should note that results are correlated. 1) phytholiths found in small quantities correlate with pollen also present in small quantity, the content of phosphorus indicate that there was water in such pots; 2) other pots had a lot of pollen such as Chenopodiaceae, Plumbaginaceae etc as well as high content of phosphorus; 3) low phosphor contents of 5 pots indicate that there was water there, but presence of microciliac gramineous (*Hordeum, Helictotrichon*) is the evidence of cereals (boiled cereals) rather than just water; 4) the method of biomarkers has allowed to separate clay vessels on a content of meat and vegetative nutrition into the moment of a burial place. The content of vessels indicate that the diet of the Bronze Age nomads was composed of – 1) clear meat soup; 2) boiled wild cereals; 3) herd infusions including narcotic infusions such as hard drugs as *Cannabis* and soft as *Artemisia*; 4) some pots contained only water. It is very important to correlate different data obtained through methods when we investigate the diet system. The phytholith analyses does not only refine results of other methods but is actually a major tool in this kind of research.

Mineralogical Studies on MSA Hearths and Sediments from Sibudu Shelter (KwaZulu-Natal) Republic of South Africa

P. S. Solveig Schieg,
Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters, Burgsteige 11,
72074 Tübingen
GERMANY

L. Wadley
Archaeology Dept., University of the Witwatersrand, Private Bag 3, WITS 2050
SOUTH AFRICA

Sibudu Shelter is situated 10 km inward from the coast, north of Tongaat, South African Republic. This wide shelter was formed within an erosionally weaker sandstone-bed of the Natal Group.

The shelter deposits contain Iron Age and MSA horizons. The upper MSA layers were carbon dated to 25ka and 41ka B.P. (uncorrected). Since 2001 layers dating 200 ka – 130 ka (OIS 6) has been excavated.

Large parts of the MSA-strata were apparently well protected from humidity. This is reflected by the excellent stratification of the sediment record and numerous well-preserved plant ash deposits.
The latter play an important role in the interpretation of occupation phases and the use of space. Their distribution and function therefore reflect behavioral and social aspects of the anatomical modern humans. (Wadley 1999).

Mineralogical analysis of the ash deposits prove the use of wood fuel. Phytoliths were separated by means of heavy liquid. The good preservational shape of the phytoliths makes them an appropriate tool to clarify the following aspects, which are associated with hearths.

1. The kind of plant resources, which were used as fuel.
2. Lateral and vertical separation of adjacent ash deposits which is macroscopically hardly attainable.
3. Establishing the intra- and interstratal difference in the degree of alteration of the plant ash in individual hearths reflects important aspects of site formation processes.

Applied analytical methods are FT-IR (Fourier transform-infrared spectroscopy) for the mineral identification and transmitted light microscopy for the phytoliths analysis. These analysis are supplemented by electron microscopy studies of polished thin sections.

Using Phytolith Assemblages To Reconstruct the Origin and Spread of Grass-dominated Habitats in the Great Plains During the Late Eocene to Early Miocene

C. Stromberg
Dept. of Integrative Biology & Museum of Paleontology, Univ. of California, Berkeley
CA 94720, cstrom@socrates.berkeley.edu
USA

Assemblage analysis of phytoliths is widely used for reconstructing vegetation types in Pleistocene-Holocene paleoecology and archaeology but is less commonly employed in pre-Pleistocene paleobotany and paleoecology. Studies of sub-modern assemblages with well-known modern analogs commonly rely on system-specific methods of inference; for very ancient phytolith assemblages whose modern analogs are largely unknown a more general analytical approach is necessary. This approach includes using all size fractions (0-250 μm), employing a classification scheme based on all available literature and a comprehensive modern phytolith reference collection, and analyzing relative frequencies through time of all diagnostic phytoliths in order to document and interpret vegetation changes.

This more general analytic method was applied to late Eocene to early Miocene sediment samples from northwestern Nebraska. The results were compared to a previous study of the same samples using a more specific technique (Strömberg et al. 2001). In both studies phytoliths were extracted using heavy liquid separation from the following lithostratigraphic units: 1) the late Eocene Big Cottonwood Creek Member of the Chadron Formation, the early Oligocene Orella Member, the early or middle Oligocene Whitney Member and middle Oligocene brown siltstone beds of the Brule Formation (White River Group); 2) the late Oligocene-early Miocene Monroe Creek Formation, the early Miocene Harrison Formation, and the early Miocene Upper Harrison beds (Arikaree Group); 3) the early Miocene Runningwater Formation, and the Dawes Clay Member of the Box Butte Formation (Hemingford Group). The two techniques (general vs. specific) produced results that differ markedly. These differences are principally due to inclusion of phytoliths in the >50 μm size fraction in the more general approach, as well as refinement of the identification of phytolith morphotypes.

Results from the study employing the more specific technique suggest open grasslands were established in northwestern Nebraska by late Eocene. In contrast, data obtained using the more general approach indicate the presence of relatively closed habitats in late Eocene to early Oligocene, typified by the presence of bambusoid phytolith morphotypes and abundant forest indicator phytoliths (phytolith from woody and herbaceous dicotyledons and palms). Moreover, the introduction and spread of modern, open-habitat grasses (pooids, panicoids) seems to have occurred between the late Oligocene and early Miocene, resulting in a savanna type habitat by the early Miocene. These results point to the importance of methodological choices in phytolith analysis and emphasize the usefulness of phytoliths as paleoecological indicators in the fossil record.

Environmental Reconstruction Based on Phytoliths in Dakhleh Oasis, Egypt: Discussion of a Failure

U. Thanheiser
VIAS – Archaeobotany, Vienna University
AUSTRIA

The Dakhleh Oasis is the largest of the oases of the Western Egyptian Desert. It lies half-way between Luxor and the Libyan frontier and is centred at Mut, the capital, on 25°30′N at 29°07′E. The modern oasis is some 80 km long and about 25 km wide. It sits beneath a 300 m limestone escarpment and is surrounded by the sand and stone wastes of the eastern Sahara. The climate today is hyperarid.

The oasis has been inhabited since the mid-Pleistocene but continuously only since about 3500 B.C. Of special interest here are two cultural units, Masara and Bashendi, extant in the present oasis and beyond in the early and middle Holocene. While subsistence was footed in a broad-based hunting/gathering strategy during the earlier Masara unit, plant macro-remains show a heavy reliance on grass fruits in the later Bashendi unit. To investigate environmental changes which might have accompanied and/or triggered off this change in subsistence strategy, wood charcoal and phytolith analysis were employed.

The phytolith samples were treated in the conventional way. Unfortunately none of the c. 200 samples yielded any number of phytoliths worth mentioning. Reference samples were analysed by A. Miller Rosen and D. Pearsall with the same negative results. The reasons for the obvious lack of phytoliths in soil samples from Dakhleh Oasis are discussed.

A pilot study of phytoliths from subantarctic Campbell Island, New Zealand

Vanessa Thorn
Victoria University of Wellington, PO Box 600, Wellington
Email: vanessa.thorn@vuw.ac.nz
NEW ZEALAND

A pilot study on phytolith production by the flora of subantarctic Campbell Island, *c.*600 km SSE of New Zealand, has revealed both redundant and genera-specific forms in addition to non-productive species. This study includes forming a modern phytolith reference collection for the high southern latitudes so more detailed palaeoecological comparisons can be made with fossil phytolith assemblages in Antarctic Tertiary sediments. Campbell Island and its flora provide a modern analogue for climatic conditions modelled for the Ross Sea margin during ice-sheet development in the Oligocene (34-24 mya). Seventeen leaf and twig samples, most from plant species known to be abundant on Campbell Island, have been wet-ashed. Species analysed include a grass (*Poa* sp.), creeping perennial herbs (*Acaena* spp., *Anaphalioides bellioides*), a fern (*Polystichum vestitum*), dicotyledonous shrubs (*Dracophyllum* spp., *Coprosma* spp., *Myrsine divaricata*) and seven species of the unusual macrophyllous forbs or 'megaherbs' (*Anisotome* spp., *Bulbinella rossii*, *Pleurophyllum* spp., *Stilbocarpa polaris*). Preliminary results indicate *Acaena* spp. produce epidermal silicified cell-linings and hair cell phytoliths that could well be genera-specific. *Polystichum vestitum* and *Coprosma rugosa* produce distinctive spinulose spherical forms. The macrophyllous forb samples are either non-productive or deposit redundant long cell phytoliths. Leaf litter samples collected with the Campbell Island plant samples are being processed to assess the soil surface phytolith assemblage of the local vegetation. Interpretation of both high latitude fossil phytolith and terrestrial palynomorph assemblages provides data for "ground truthing" climate models used to provide scenarios for global warming.

Oligocene and Early Miocene phytoliths from seafloor cores off Cape Roberts, Victoria Land Basin, Antarctica

Vanessa Thorn
Victoria University of Wellington, PO Box 600, Wellington
Email: vanessa.thorn@vuw.ac.nz
NEW ZEALAND

Phytoliths have been recovered from Cenozoic sediments in the CRP-2/2A (*c.*29-19 Ma) and CRP-3 (*c.*34-31 Ma) cores recovered from the seafloor *c.*15km off Cape Roberts, Victoria Land Basin, Antarctica. Phytolith abundances were low but well preserved throughout with dominantly spherical forms, many not previously described. Some spherical forms observed have been compared to phytoliths extracted from modern *Libocedrus*, *Nothofagus*, Palmae and Proteaceae. Rare forms comparable to modern grass phytoliths were also observed. Phytoliths were extracted from a total of 48 fine-grained sediment samples using standard oxidation, filtration, sedimentation and heavy-liquid flotation techniques. Subsequent interpretations made were necessarily tentative due to low phytolith abundances. A cool climate is interpreted to have prevailed throughout the deposition of both cores. Predominantly woody vegetation, including *Nothofagus* and *Libocedrus*, and local areas of grass is interpreted for CRP-2/2A and the upper *c.*250m of CRP-3. Below this level, phytoliths comparable to Palmae, Proteaceae and 'warm' climate grasses were observed. This latter association suggests the occurrence of sheltered, moist sites – possibly north-facing mid-slopes or the coastal fringe. It may also represent remnant vegetation that grew in moist, temperate conditions during the Middle to Late Eocene, previously interpreted from other Cenozoic sediments in the Ross Sea region. The phytolith analysis for the Cape Roberts cores both complements and supplements the terrestrial palynomorph record.

Contribution of phytolith analysis to the early medieval town development of Brussels (Belgium). The example of the Treurenberg site

L. Vrydaghs[1, 2], Y. Devos[1], K. Fechner[1] and A. Degraeve[3]

1. Groupe interdisciplinaire d'Etudes du Paléoenvironnement (GIEP) – Université Libre de Bruxelles Rue de Bruxelles, 37, 1400 Nivelles
2. Laboratory of Palaeontology, Vakgroep Bodemkunde and Geologie University of Ghent, Krijgslaan 281/S8, B - 9000 Ghent
3. Royal Museums of Art and History – Brussels Capital Region - Archaeology in Brussels. Place Masui, 29. B-1000 Brussels
BELGIUM

Since 1995 a systematic archaeological follow up is conducted in Brussels. One of the emerging research topics is the first city wall (13th century AD). During excavations conducted at the Treurenberg, one of the seven city-gates, its construction level was found on top of a layer presenting the external characters a ploughed land. If potsherds have been recovered from these strata, the archaeological material is too poor to document the oldest periods. A multiproxy study in natural sciences becomes the only way to gain archaeological data.

During the fieldwork, the first results of the archaeopedological research indicated that the surface beneath the first city-wall building phase might have been a ploughed land. If demonstrated, this evidence of agricultural practice could be among the first clear evidence of an early medieval Brussels settlement. The site sampling was partly designed to demonstrate this former hypothesis.

Phytolith analysis, as a tool to gain direct evidence of crop cultivation, is part of the multiproxy approach, which also involves micromorphology, chemical and physical analysis and charcoal identification. Phytolith analyses were conducted on soil thin sections and some sediment samples. The first results seem to confirm the archaeopedological interpretation.

Since several years, the GIEP -ULB has adopted micromorphology of archaeological deposits as routine analysis. The description in terms of presence/absence of the phytolith fabric is part of it. This approach already provided important archaeological contributions. This contribution intends also to take the opportunity of the multiproxy approach to test the accuracy of such a description of the phytolith fabric.

Preliminary Phytolith Analysis of MMZ Profile in the Gran Barranca Sedimentary Sequence (Chubut – Argentina)

A. F. Zucol,, M. Brea
Laboratorio de Paleobotánica CICYTTP-Diamante, Materi y España sn, Diamante (3105), Entre Ríos, Argentina – email: cidzucol@infoshopdte.com.ar
ARGENTINA

R. H. Madden
Department of Biological Anthropology and Anatomy, Duke University, Durham, NC 27710
USA

The sedimentary sequence at Gran Barranca, the escarpment south of lake Colhué Huapi (Chubut province, Argentina), is composed mainly of pyroclastic silts of the Sarmiento Formation (165m thick), with majority tabular strata of predominantly tabular-bedded intraformational clay-pebble conglomerates, reworked glass-rich tuffs, fine ash and bentonitic ash deposits. In the MMZ profile (45°42'49" S - 68°44'16" W), the Sarmiento Formation comprises three successive units, which from the base to the top are: Gran Barranca Member -76m thick- (Late Eocene – Early Oligocene, with vertebrate fossil remains of Barrancan and Mustersan SALMA (South American Land Mammals Age)); Puesto Almendra Member -60m thick- (Early Oligocene - Late Oligocene, with vertebrate fossil remains of Deseadan SALMA) and Colhué Huapi Member -28m thick- (Late Oligocene - Early Miocene -, with vertebrate fossil remains of Colhuehuapian SALMA). The present contribution is the phytoliths analysis preliminary result of this Formation in the MMZ profile, wherein the phytolith assemblages from the sequence are described.

The phytolith assemblage throughout the entire sedimentary sequence is characterized by an elevated abundance of the following morphotypes phytoliths:

Gran Barranca Member: in the lower and middle section, spherical to aspherical spinulose phytolith are dominant, in association with elongate, point-shaped and *incertis sedis* phytoliths. In the upper section and the transitional levels with Puesto Almendra Member, fall the spherical spinulose phytolith frequency, and increased dumbbell, point-shaped and fan-shaped phytoliths.

Puesto Almendra Member: in the phytolith assemblage of the lower section the panicoid short cells are less frequent, and the pooid (festucoid) and chloridoid phytoliths are more abundant to the top. In the upper section assemblage, also appear spherical smooth, elongate, point-shaped and fan-shaped phytoliths.

Colhué Huapi Member: the phytolith distribution along the whole section becomes heterogeneous. With levels dominated by spherical to aspherical spinulose, panicoid, festucoid or chloridoid phytoliths. And some levels with spongy spicules and diatoms.

Sarmiento Formation phytolith analysis show a phytolith assemblages are dominated by palm phytoliths during the Late Eocene (Gran Barranca Member), that are replaced up-section by assemblages with more abundant graminoid phytoliths, with panicoid components dominant in the upper section of Gran Barranca Member and chloridoid–pooid components dominant in the Puesto Almendra Member (Oligocene). The upper section of profile (the Colhué Huapi Member) shows the presence of previously described floristic components although present in relatively smaller frequencies and oscillations or alternating abundances of the megatermic and meso-microtermic grass components

A theoretical approach to the application of phytolith research in archaeology

D. Zurro
Departament d'Universitats, Recerca I Societat de la Informació
Laboratori d'Arqueologia (I.M.F.) – Consejo Superior de Investigaciones Científicas
C./Egipcíaques, 15 – 08001 Barcelona
Email: debora@bicat.csic.es
SPAIN

M. Madella
McDonald Institute for Archaeological Research
University of Cambridge
Email: mm10018@cam.ac.uk
UNITED KINGDOM

The application of phytolith analysis in archaeology has now been carried on for many years by specialists coming from a wide range of disciplines. This has represented an enormous thrust in the progressing of the study of phytoliths. However, this variety of backgrounds, and sometimes an over-technical approach to the discipline, meant that there has not been a more specific focus on the theoretical foundations for the application of phytolith analysis to archaeological questions.

In this paper we explore the advantages of the phytolith analysis in comparison to other archaeobotanical techniques and the necessity of developing a specific sampling strategy at the "pre-excavation" stage. We hope that this work will help in setting the agenda for the development of a theoretical framework for the analysis of phytolith in archaeology.

We would like that the ideas put forward in here will awake an awareness for seeing phytolith as part of the archaeological record and provoke discussion on their potential for understanding social processes in the past.