Papers

Pleistocene and long term studies

Chronology of Pleistocene Sedimentary Cycles in the Carmel Coastal Plain of Israel
Manfred Frechen (Hannover, Germany)

The coastal plain of Israel is characterized by development of Pleistocene and Holocene sand dune fields and aeolianite ridges locally termed "kurkar" running parallel to the coast line. Kurkar ridges are built of several sedimentary cycles, which are intercalated by red sandy loam soils locally termed "hamra" (Arabic word for "red"). These kurkar ridges are designated to represent typical longitudinal sand dunes formed synchronously parallel to the coastline by dominant wind direction perpendicular to the coast. Archaeological and geological studies of sections along the Haifa-Tel-Aviv highway indicate that the upper part of exposed Quaternary sediments in the Carmel coastal plain contain two major kurkar units separated by a red palaeosol including Mousterian artifacts. The different facies are related to changes in the environmental setting, including changes in the vegetation cover and distance from the sediment source, the Mediterranean beaches. Owing to the complexity of the numerous exposures of aeolianites and soils in the elongated ridges along the coastal plain, it is difficult to set up a reliable stratigraphy. A systematic luminescence dating study was carried out on loose sand, kurkar and hamra deposits in the coastal plain between Netanya and Haifa. The chronological results are in excellent agreement with the geological estimates. Five periods of sand accumulation and kurkar formation can be distinguished at about, 140 ka, 130 ka, 90 ka, around 60 ka and between 60 and 50 ka. Hamra formation took place between 140 and 130 ka, around 80 ka, 65 ka, around 60 ka and between 20 and 12 ka. The beach rock is correlated with the sea level maximum during OIS 5e. The luminescence dating results indicate that neither kurkar nor hamra formation correlate with glacial and interglacial periods of the Northern Hemisphere.

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Pleistocene Chronostratigraphy and Quarternary Geology in Nadaouiyeh and Hummal (El Kowm, Central Syria)
Jean-Marie Le Tensorer, Reto Jagher, Philippe Rentzel, Thomas Hauck, Kristin Ismail-Meyer, Christine Pümpin, Dorota Wojtczak (Basel, Switzerland)

The El Kowm area in the desert steppe of Central Syria is one of the oldest settlement centers in the Near-East and is unique worldwide for its great density of Paleolithic sites. About 180 sites dating between 750000 and 10000 years ago testify that nomadic people regularly resided at local water springs.
Steady conditions throughout the Quarternary enabled nomadic hunters to stay at the same place over and over again. We can follow the history of a single landscape spanning over a period of time seldom this long. The sites in El Kowm represent a unique archive in which both historic cultural anthropology as well as the development of the landscape can be observed with exceptional detail.
The sites of Nadaouiyeh Aïn Askar and Aïn Hummal are the main focus of our research. At these two springs the history of the region El Kowm can be pursued in an exemplary manner. In Nadaouiyeh, the older period dates between 500000 and 200000 years ago, and in Hummal essentially a time span

between 300000 and 50000 years is represented. Both sites are endowed with a wealth of finds so characteristic for the El Kowm area.
The geological-pedological analyses aim to define the formation of the deposits particularly with the aim to reconstruct the palaeoenvironment. A number of field observations as well as preliminary analyses show that certain palaeosoils are conserved at those sites. Because comparative geological–pedological observations from this geographic area are thus far lacking, these studies are very important from a paleoecological point of view.
Through hydrogeological studies the manner in which the artesian springs function will be investigated for a better understanding of the processes responsible for variations in lake water levels.
The PaleolithicPaleolithic settlement horizons with their excellent conservation contain a high potential of information which can easily be made accessible by micromorphological analyses. Further analyses will provide answers concerning the depositional milieu, the anthropogenic influences, and the post-sedimentary development of the archaeological levels.

Changing patterns of Paleolithic landuse in the Damascus Province, Syria
Nicholas J. Conard (Tübingen, Germany), Andrew W. Kandel (Tübingen, Germany), Andrey Dodonov (Moscow, Russia) and Mohammed al Misri (Damascus, Syria)

Since 1999 four seasons of survey and excavation have been conducted in the Damascus Province of Syria. This research has focused on the region around Ma'aloula with survey covering elevations between Lake Utaibeh at 800 meters and 2350 meters in the Anti-Lebanon Mountains near the border with Lebanon. The conditions for survey in the area are generally favorable, and based on the coordinates for 254 localities with 441 Paleolithic components, we have been able to establish the distribution of sites from all of the major periods of the Paleolithic. The intensity of settlement appears to have been greatest during the Levalloisian Middle Paleolithic, and during the Upper Paleolithic, the spatial distribution of sites expands further into the low and highlands. Compared to more arid regions like El Kowm, sites are less tightly concentrated around water sources, and as one might expect, the visibility of sites appears to correlate with the abundance of high quality lithic raw materials. Other factors affecting the visibility of sites include the stability of the land surface and patterns of erosion. Despite the importance of taphonomic factors, the distribution of sites from the Lower, Middle, Upper and Epi-Paleolithic does reflect changing patterns of landuse.

Parallel to the regional survey, excavations at Baaz Rockshelter have provided a good sequence of Epi-Paleolithic materials that provides better environmental and behavioral data than the survey results. We still, however, lack stratified sequences for all the earlier periods from the immediate region, and it remains to be demonstrated whether or not the important results for earlier excavations at the nearby sites of Yabrud can serve as a baseline for the cultural chronology of the region.

Thermoluminescence dating of heated flint. Examples of its potential and limitations, as demonstrated at the Near Eastern Paleolithic sites of Rosh Ein Mor and Jerf al-Ajla.
Daniel Richter (Leipzig, Germany)

Thermoluminescence dating of heated flint determines the time elapsed since the last firing of a piece of flint. In contrast to many other chronometric dating methods, it is thus possible to directly date the human occupation of a site. Luminescence methods depend to a large degree on the geological nature of a site. Therefore site formation processes and postdepositional disturbances have to be taken into account. The influence of such parameters will be discussed and demonstrated with examples from the Paleolithic sites of Rosh Ein Mor and Jerf al-Ajla.

Hamra and the Old Stone Age on the coastal plain of Southern Levant: from Ruhama to Givat Olga
Stanislav Laukhin (Moscow, Russia)

The formation of dunes on the coastal plain of the Southern Levant (*kurkar*) periodically gave way to a decrease in sedimentation, which resulted in the formation of ancient soils (*hamra*) and the

deposition of swamp, marsh, and lacustrine sediments. The environment in which ancient soil formation took place and swampy, marsh and lacustrine sediments were deposited, was more favourable for Paleolithic man on the coastal plain. That is why many Paleolithic sites on the coastal plain were connected with these geological formations: e.g., Ruhama (ca. 900-850 Ka), Evron (ca. 500-600 Ka), Revadim (ca. 240-400 Ka), Habonim (ca 50-100 Ka), Givat Olga (ca 12-20 Ka). Practically all these Paleolithic sites need more precise geological and chronological definition. Paleolithic finds are well known in swamp and coastal-lacustrine sediments, overlying the *hamra* (e.g. Ruhama), in the *hamra* or, partly, in marsh sediments which replace the *hamra* (e.g., Habonim). One of the main tasks of the Coastal Plain Paleolithic Geoarchaeology Project is the study of the stratigraphic position of Paleolithic sites in different genetic types and sediment facies, that have a connection with the *hamra* and which divide *kurkar* units. The author thanks Prof. Avraham Ronen for organizing the fieldwork on the coastal plain and numerous valuable scientific consultations.

Geoarchaeological Perspectives on Prehistoric Settlement of the Wadi el Hasa
Joseph Schuldenrein (New York, USA) and Geoffrey A. Clark (Arizona, USA)

This presentation offers an overview on the prehistoric settlement geography of the Wadi el Hasa. It reflects the results of nearly 20 years of research, synthesizing geomorphic and human ecological information extending from the later Middle Pleistocene to the Holocene. Cultural stratigraphies from the Middle Paleolithic through Neolithic periods are refined. Site placement constructs based on relationships between cultural component, site size, topography, landform, and geomorphic process are proposed. Investigations from the various Wadi Hasa explorations and excavations are updated and summarized in basin wide context and then expanded to the regional (southern Levantine) scales. Models of dynamic landscape change afford comparisons with other projects in Negev, Sinai, and greater Transjordan. Finally, a new evaluation of the Holocene landscape history is presented, centered on alluvial stratigraphy. Dates and soil development profiles facilitate comparisons of Hasa terrace chronology with those of sequences of the western Levant.

Geomorphological Perspectives for Paleolithic Cave and Rockshelter Sites in the Zagros Mountains
Saman Heydari (National Museum, Iran)

Most of the archaeological records of the late Quaternary come from caves and rockshelters. They have been a main source of palaeoenvironmental information in Africa, Europe and Asia. Especially European cave stratigraphies played a major role in demonstrating the antiquity of humans, as did similar settings in Asia and Africa.

Geoarchaeological studies on Paleolithic cave and rockshelter sites in some regions of the Zagros Mountains have shown that geological and geomorphological aspects played an important role in the selection of site locations by ancient people. Furthermore, the geomorphological setting of the sites has a determining role for the formation processes at the site.

The main aim of the following discussion is the geomorphological context of Paleolithic and Neolithic sites and the effect of this setting on the life of ancient people. However, in contrast to Europe where Paleolithic studies are much more advanced and where scientists like W. Farrand and L.G Straus emphasized the geomorphological settings, Paleolithic studies in the Zagros Mountains are still very limited so that it is difficult to provide a coherent theory.

The locations of cave and rockshelter sites in the Zagros Mountains fall into two major groups of geological and geomorphological systems: One is the zone of karstic systems (classic and cave and rockshelters with large amounts of archaeological deposits). The second is the zone of folded rocks (small cave, erosional rockshelters with fewer archaeological deposits). The discussion will show that Paleolithic sites have a clear preference for locations in the karstic systems. Reasons for this may be sought in the availability of water and springs, the availability of raw materials, and the easy communication between mountainous areas and the lowlands.

Remote Sensing

Remote Sensing for Archaeological Sites using Satellite Imagery: The Example of the Settlement and Landscape Development in the Homs Region Project, Syria.
Keith Wilkinson, Anthony Beck and Graham Philip (Winchester, UK)

Satellite imagery has been utilised as a technique for archaeological site prospection since the middle 1990s. Two of the main reasons for this short history are; firstly the recent development of civilian satellite platforms mounting high resolution sensors (e.g. ICONOS) and secondly the declassification by the United States government of spy satellite data from the 1960s and 1970s (e.g. CORONA). Both types of imagery have been employed by the Settlement and Landscape Development in the Homs Region project (SHR) as the primary desk-based means of detecting non-tell archaeological sites, a category which has generally been under-represented in traditional tell-centred surveys. Several factors make satellite imagery especially suitable for site prospection in the marl areas of the Homs region. Firstly, the recent intense agricultural history of the area when combined with a largely erosive landscape history since the Bronze Age, mean that archaeological sites survive as 'lags' in the present soils which are frequently ploughed to the surface. These lags display either highly reflective or (more rarely) highly absorptive signatures in the imagery. Secondly, the area is well served by high quality satellite imagery thanks to US military interest in the Middle East at the time of the 1967 and 1973 Arab-Israeli conflicts. As a result many previously unknown archaeological sites have been detected by the project. Extensive survey of 'blank' areas in the study area suggests that very few settlements are not detected by the satellite imagery. Laboratory analysis carried out of transects of samples taken across four sites detected in the satellite imagery suggests that the reflectance/absorption spectra of the archaeological sites is largely a product of the grain size variations that result from occupation activities; geochemical and magnetic properties play a lesser role. The grain size properties of the site locations are likely to reflect the decomposition of mud-brick, the dominant building material in the area for much of the past.

Marshland of Cities: Deltaic Landscapes at the Dawn of Mesopotamian Civilization
Jennifer Pournelle (New York, USA)

Twentieth century research paradigms have viewed the birth of Mesopotamian civilization as inherently tied to sufficient drying of primordial lands to allow irrigated plow agriculture. Using declassified satellite photography to integrate geomorphologic, paleoclimatic, and excavation evidence within a comprehensive examination of the Tigris-Euphrates delta, I cast serious doubt on the landscape characterization underlying this model. The mid 5th-mid 3rd millennium BCE lower alluvium was not a uniform, arid plain transited by unitary rivers and canals. It consisted in large part of vast wetlands that, rather than inhibiting social complexity, promoted settlement nucleation, facilitated transportation, financed accumulation, buffered climatic extremes, and contributed to political and ideological transformations.

Holocene Near East

Extreme Floods in the Mesopotamian Floodplain
Kris Verhoeven, Ghent University

A brief overview of extreme palaeofloods in the Mesopotamian Alluvial Plain within archaeological contexts will be provided with a possible hypothesis for their recurrence.
The hypothesis presented here is that such floods in the Late Holocene did not occur at random but responded to climatic variability. Solar variability is seen here as a major triggering mechanism for such climatic variations. Solar variability is a planetary phenomenon but its effects in the Near East are amplified due to the unique geographical settings of contrasting large water bodies, semi-desert lowlands and high mountain chains. Changing precipitation patterns and anomalies in snowpack

storage are thought to have an impact in the timing and magnitude of the extreme river discharges for Euphrates and Tigris.

Geoarchaeology of the Surroundings of Qatna: Landuse Versus Environmental Change in a Bronze Age Landscape of Central Syria
Mauro Cremaschi, Trombino, L. and Valsecchi, V. (Milano, Italy)

Since the terminal Pleistocene and for a large part of the Holocene, the "underfit streams" in the region of Qatna were occupied by active rivers and small lakes. Archaeological finds in fluvial deposits allow the correlation of hydrological changes with archaeological phases. These deposits are indicative of higher water availability. Furthermore due to their pollen content they have a great potential for improving our knowledge of long-term vegetation dynamics and human impact on the vegetation in this region. Preliminary results suggest that in contrast to the open vegetation – semiarid environment – of the late Pleistocene, during the Holocene and specifically during the Early Bronze Age a *Quercus* forest was probably present on the terraces, while a treeless vegetation was dominant in the valleys, due to deforestation. Higher availability of water supported a dense occupation of the studied area during the Bronze Age: Qatna was located close to an active river and on the shore of a small lake. Moreover, the observed variations in the nature of the sedimentation are mainly climate dependent, but, on a local scale, can also be connected to the interaction between humans and the landscape: in fact, the construction of the ramparts locally modified the fluvial network and led to the formation of a lake that acted as water reservoir for a long period in the history of the town.

Archaeological Sites in their Landscape Context in NE Syria. Establishing a Preliminary Fluvial Chronology
Katleen Deckers (Tübingen, Germany)

During the summer of 2002 and 2003, a geoarchaeological survey was undertaken along several small streams of the Upper Khabur watershed in NE Syria in order to investigate archaeological sites in their landscape context and to study the interactions between humans and their environment. A preliminary fluvial chronology has been established through the use of a thermoluminescence screening method on sherds, which will be detailed in this paper. The method applied deviates from conventional TL-dating methods in that simple screening measurements were made from small, heavily abraded sherds, and dose-rates were estimated rather than being measured from each sample. Additional preliminary chronological insight has been gained through geomorphological field observations and sediment analysis (loss-on-ignition, C-content, $CaCO_3$-content and magnetic susceptibility). The geomorphological survey indicated that thick and extensive deposits mostly consisting of fine grained alluvial material covered parts of the plain which has its implications for archaeological survey in the area, especially since there was a strong inclination of settlements towards the river courses. Several old surfaces have been revealed at relatively deep levels under the present plain, indicating that archaeological sites might be buried.

Geoarchaeological and Archaeopedological Investigations Around Tell Chuera, N-Syria - First Report
Heinrich Thiemeyer & Jürgen Wunderlich (Frankfurt, Germany)

Within The Frankfurt Graduate Research Group "Archaeological Analytics" investigations on landscape history around Tell Chuera in N Syria first started in 2003 and focussed on geomorphology, soils and climate history. Remote Sensing is an important tool for mapping the area at several scales and for visual interpretation. Satellite images, aereal photos, and a kite-based camera system have been used for large scale pictures of the entire Tell area. Additionally, soil micromorphology will be undertaken for functional analysis of archaeological strata as well as for investigating former and actual soil development in and around the Tell.

A reconnaissance soil survey around Tell Chuera provided first insight about soils and pedogenetic processes around and below the Tell. Pedogenesis in tell sediments is being investigated in order to

gain insight into soil forming processes after the abandonment of the Tell. The pedological work is closely connected to archaeobotanical investigations of fluvial and oxbow sediments of the Euphrates River and its tributaries Balikh and Habur.

The present Wadi Chuera passes the Tell through a narrow incision, which is probably not the natural river course. Several exposures along the steep slopes show "older gravels" covered with "older flood-plain loam". In the bottom of the Wadi a calcrete appeared at some locations, which has developed on the older gravels. It probably belonged to the calcisol in the "older flood-plain loam". Only a thin layer of "younger gravel/flood-plain loam" occurs as recent sediment in this part of the Wadi. The former natural course to the East of the Tell is completely covered with younger flood-plain loam.

A section through the wall which surrounds the whole Tell shows similar sediments and soil development underneath the wall. Here, as well as under the Tell, we found calcisols which needed time for soil development under terrestrial conditions of yet unknown duration. Further investigations on these soils will be carried out to determine the environmental conditions before the Tell was founded.

The "younger flood-plain loam" has been deposited after the settlement phase of the Tell. Recently, however, a relative age, we found burials which were dug into the "older flood-plain loam" and which were covered later on with the "younger flood-plain loam".

Reconstructing Temperature, Moisture and Seasonality from Equidae Teeth from Tall Mozan, NE Syria

Serge Paulus (Tübingen, Germany)

A lot of climate reconstruction studies take place off site. Therefore, often great problems are encountered in gaining a sufficient chronological resolution. Through the use of oxygen isotope analysis of bones and teeth from archaeological contexts, we have the possibility to gain information about temperature, moisture and seasonality. The palaeoclimatic data collected with this method can therefore immediately be related to the archaeological data. In this paper preliminary results will be presented of oxygen isotope analysis from equidae teeth derived from several strata of Tall Mozan in NE Syria, dating between 2200 and 2000 BC (Early Gazira IV to Middle Bronze Age). Possible interpretations of local climatic change and its impact on human subsistence will be discussed.

Holocene Environmental Changes in Upper Mesopotamia Evidenced by the Stable Isotopic Composition of Pedogenic Carbonate

Konstantin Pustovoytov (Hohenheim, Germany) and H. Taubald (Stuttgart, Germany)

Upper Mesopotamia was of crucial importance for the origin and spread of agriculture in Southwest Asia. In spite of an increasing amount of paleoclimatic data for the Eastern Mediterranean, little is known about the environmental history of Upper Mesopotamia. We examined the stable isotopic composition ($\delta^{13}C$ and $\delta^{18}O$) of pedogenic carbonate at the PPN site Göbekli Tepe (Southeastern Turkey) as an in situ paleoenvironmental record. At this site secondary carbonate accumulated on the undersides of pillars and wall stones as a result of pedogenesis, presumably throughout most of the Holocene. Pedogenic carbonate was collected from a sequence of 25 microlayers with a total thickness of about 5 mm on the underside of a stone from a PPNA enclosure wall. On the assumption of a stable growth rate of the secondary carbonate coating, relatively cool and dry conditions in the Early Holocene are suggested (comparatively positive $\delta^{13}C$ and negative $\delta^{18}O$ values). These gave way to a pronounced, stable amelioration (negative $\delta^{13}C$ and positive $\delta^{18}O$ shifts), which was interrupted as late as in the mid-Holocene by the advent of relatively dry climatic conditions that appear to persist today.

The Geoarchaeology of Holocene Environmental Change in the Southern Levant: Impacts on Landscape, Agricultural Potential and Settlement
Arlene M. Rosen (London, UK)

Studies of ancient landscapes and environments were conducted in central and northern Israel, in order to determine the environmental conditions of the region during the Neolithic through the Byzantine periods, and how these had impact on resources including perennial streams, springs, agricultural land and forests which were available for exploitation by the inhabitants of the region. Preliminary results show that the Holocene configuration of alluvial valleys was established after major downcutting corresponding to the Late Pleistocene Younger Dryas Period. In the early Holocene, valley hydrology was consistent with forested hillslopes and stable alluvial systems, and was characterized by perennial streams and seasonal marshes. These well-watered valleys were undoubtedly an attraction for settlement by Pre-Pottery Neolithic farmers. There is some evidence of very localized small-scale colluviation in the vicinity of some PPNB settlements, perhaps related to near-site exploitation of forest resources. Valley alluviation increased in the Middle Holocene, corresponding to Chalcolithic and Early Bronze age settlement. The lithological character of the valley deposits suggests an increase in stream activity resulting from greater rainfall rather than more intensive deforestation at this time period. This active floodplain development was exploited by Chalcolithic and Early Bronze Age inhabitants for intensive floodwater farming activities. At the end of the third millennium BC, a wide-ranging episode of valley incision ensued, precluding further use of the floodplains for simple floodwater farming. This coincided with widespread abandonments in the southern Levant. In the later Holocene Period, there was an extensive phase of valley alluviation corresponding with the Byzantine and Medieval periods. The lithology of these deposits indicates widespread hillslope erosion which is likely to mark the beginning of intensive deforestation of the region.

Changes Observed in the Holocene Landscapes of the Jordan Valley, Their Climatic and Cultural Implications
Fouad Hourani (Leiden, The Netherlands)

A series of micro-regional palaeogeographic reconstructions, based on a selection of eight Neolithic and Chalcolithic sites in the Jordan Valley, have recently been performed in order to investigate the impact of climatic events of the Early Holocene on the development of the first farming and agro-pastoral communities in this region. These reconstructions provided an image of the various palaeo-landscapes in which the different human groups lived in the Jordan Valley during the Neolithic and the Chalcolithic Periods. Changes in the ways the inhabitants were settling during these periods appear to have been mainly controlled by major changes in the landscape configuration. The latter bear clear climatic-driven characters and correlate well with the general Early to Mid-Holocene climatic model.

New geoarchaeological investigations will soon be carried out in this region in order to gain a better understanding of the complexities of peoples interaction with dry land environments during the Bronze and Iron Ages. Several methodological aspects, with respect to these coming investigations, will be discussed in this paper as well.

Climate Change and Human Settlement between the Nile Valley and the Central Sahara - Intermediate Archaeological and Geomorphological Results
Heiko Riemer & Olaf Bubenzer (Cologne, Germany)

The talk presents results which were produced within the project A1 at the Cologne Collaborative Research Centre 389 “Arid Climate, Adaptation and Cultural Innovation in Africa (ACACIA)”. Central topic of ACACIA is the historical development of the arid zones of the north-eastern and the south-western African continent and its people during the Holocene in the light of the complex interrelation between man and changing climatic and environmental conditions.

Archaeological explorations show a differentiated spatial and temporal distribution of land use during the Holocene humid optimum. In the time frame between 9,000 and 3,000 years BC, the people in the

recently hyperarid eastern Sahara were able to survive by hunting, gathering and, later on, by pastoralism. Archaeobotanical and geomorphological results point to a former precipitation gradient from approximately 500 mm per year in the Wadi Howar region (Sudan) to approximately 100 mm per year in the Western Desert of Egypt. Outside of the Nile valley and the oasis the archaeological sites are mainly restricted to favourable relief positions with a surplus of water. Therefore relief data, elevation models, and hydrological parameters are fundamental for the reconstruction of former land use potentials.

It can be concluded that the pre-Holocene landscape development (climate and relief history) is a key for the understanding of the possible land use during the Holocene climatic optimum. The results give indications for further possible archaeological sites which have not yet been detected and provide useful data for regional climate models.

Holocene Anatolia and Neighbours

Exposed and Buried Soils at Göbekli Tepe (SE Turkey): a preliminary report
Konstantin Pustovoytov (Hohenheim, Germany)

Göbekli Tepe (southeastern Turkey), as a monumental PPN site, is of paramount importance to Neolithic research in Southwest Asia. Exposed and buried soils at the site can provide evidence for stratigraphy, chronology and paleoenvironments that is archaeologically relevant. A provisional pedological examination of the site over the last two years involved morphological and micromorphological observations, stable isotopic measurements, and radiocarbon dating. Soils at the surface of the mound are chernozems with a pronounced B_k horizon. Within the latter, about 5 mm thick calcite coatings on the undersides of pillars and wall stones represent a typical form of pedogenic carbonate accumulation. Four ^{14}C ages of the oldest microlayers of the coatings strongly suggest that pedogenic carbonate precipitates in isotopic equilibrium with soil CO_2 and thus is promising for the absolute age determination of the site. Carbonate microlayer sequences in the coatings serve as local paleoenvironmental records (micromorphology, stable isotope composition). There are also several weakly developed buried soils in the fill that are of great interest as markers of interruptions in sedimentation. All soils and parent materials are rich in microscopic bone and stone artefact fragments. Soil organic matter in both exposed and buried soils originates primarily from C3 vegetation and shows relatively uniform $\delta^{13}C$ values over the whole sediment sequence.

Holocene Environment and Settlement in the Konya Plain, Turkey: integrating Geoarchaeology and Field Survey
Neil Roberts (Plymouth, UK), Peter Boyer (Plymouth, UK) and Douglas Baird (Liverpool, UK)

A primary objective of systematic multi-season archaeological site survey programmes is to investigate the long-term settlement history and population dynamics within individual regions. Many of the most attractive areas for agriculture and human habitation have been alluvial plains. On the other hand, these are dynamic geomorphic landscapes, with spatial migration of river channels leading to the removal of archaeological sites, and zones of active alluviation progressively burying surficial archaeological evidence. This can lead to the differential preservation of the archaeological record with consequent implications for the interpretation of the results of site surveys.

We have carried out integrated field research on the Çar_amba fan in the Konya basin, Turkey, in order to evaluate the relations between Holocene environmental change and settlement history within a definable alluvial landscape. This has involved on- and off-site study of alluvial sequences via coring, cleaned ditch sections and back-hoe trenching, linked to systematic archaeological site survey and to excavations at the Neolithic/Chalcolithic site of Çatalhöy_k. The majority of archaeological sites surveyed comprise multi-period mudbrick settlement mounds (h_y_k, tell). The present-day alluvial fan, which covers 474 km^2, has formed above Late Pleistocene lake marls to a maximum thickness of >3m. Two principle alluvial units are recognized, and have been characterized using

analysis of particle-size, magnetic susceptibility, organic and carbonate content and colour. Based on a combination of ^{14}C, OSL and archaeological evidence, the lower unit dates primarily to the Neolithic-Chalcolithic, the other from the Early Bronze Age to Byzantine times. Because of river channel avulsion and lateral shifts in depo-centre, these sedimentary units are partly time-transgressive across the alluvial fan. Alluvial landscape changes have, overall, led to the burial – and therefore "loss" - of those archaeological sites that are smaller/shallower, earlier (i.e. prehistoric) and located closer to the fan apex. This geomorphological history of alluviation, pedogenesis and erosion also provides data on changing flood regimes, and soil and water availability, which have affected the suitability of individual areas for human occupation.

Holocene Soil Erosion on the Southeastern Mediterranean Coast of Turkey
Timothy Beach and Sheryl Luzzadder-Beach (George Mason University, USA)

Many studies have documented environmental change and human agency around the Mediterranean world, but few have focused on Turkey's southeastern coasts. Here we report on geoarchaeological field work in the watershed of an archaeological tell, Kinet Höyük. This basin rises in the Amanus Mountains and runs through foothills and fans onto alluvial coastal plains. A legion of little-known environmental dynamics such as seismicity, climatic changes, sea-level changes, and millennia of human impacts complicate these landscapes. To investigate these complications we dated and characterized sediments, soil formation, and alluvial history, and correlated these with the region's other environmental and archaeological records. We studied sediment sequences and paleosols in twenty excavations, cutbank exposures, upland erosion sites, and around archaeological sites across these watersheds' valleys. We found many paleosols that date from the Early Holocene, the Late Bronze Age, the Roman period, and the Ottoman Period. The presence of regional paleosols and their intervening episodes of sedimentation and degradation may suggest possible periods of erosion and sedimentation. Like so many other sites in the Mediterranean, tremendous change occurred in the Roman period. But, despite the long human history of this region, the greatest changes have occurred in modern times. We are also studying the elemental chemistry of regional sediments and soils to provide another source of information for environmental change and past land uses. We conclude by comparing our field studies in this region with previous and concurrent studies in the Eastern Mediterranean to analyze the models of erosion and sedimentation history across this region.

Coastal and Environmental Changes in Central Western Anatolia – Results from Geoarchaeological Research and Modeling
Helmut Brückner, Roland Gehrels, Mathias Handl, Marc Müllenhoff, Karl-Heinz Müller, Klaas van der Borg & Andreas Vött (Marburg, Germany)

The progradation of the Büyük Menderes (in Antiquity: Maiandros) delta and floodplain during the last 6,000 years led to the total silting up of the former Latmian Gulf. By geoarchaeological means this delta growth is reconstructed in space and time, and the results then cross-checked with information from archaeological and (pre-) historical sciences. As synthesis, a totally new scenario for the landscape evolution during the last five millennia is presented. The data set is also suitable for the extraction of information about the changes of the natural factors throughout the past millennia and for the evaluation of the human impact.

The impact of the shifts in the shoreline on the former harbour cities Myous, Priene and Miletos are especially of interest since they lost their economic and strategic basis due to the siltation process. By geoarchaeologic means, potential Archaic to Classical Greek harbour sites were identified in the embayments west of the Myousian peninsula, i.e. between Castle hill and Settlement hill, and south of Settlement hill. In the vicinity of Myous, the transiton from marine to lacustrine facies must have occurred already in Hellenistic times. Lagoonal conditions prevailed in Hellenistic-Roman times. In the southwest, the lacustrine environment started in the 1st or 2nd century AD and partially prevailed until Modern times. In the east, the brackish and shallow Lake Azap is what remains of the former marine embayment.

Priene was founded anew in Late Classical time around 350 BC. From a palaeogeographical perspective the most interesting question is that of the harbour site(s). Potential areas are the eastern and western embayments at the foot of the promontory of Priene. Ceramic and ^{14}C stratigraphies of drill cores led to the following conclusions: In the eastern embayment, marine conditions prevailed at least until the 13th/12th century BC. Thereafter, a slight regression can be proven by a peat dating to the second half of the 2nd millennium BC. In the mid-4th century B.C, this embayment already had turned into a freshwater lake. At that time, a potential harbour site can be ascertained in the western embayment where water depth was still several metres and a lagoonal environment existed until the beginning of the Roman Imperial era. A freshwater milieu definitely did not exist before the 3rd century AD. This western embayment was filled with sediments slower than its eastern counterpart since it was sheltered from alluviation by its leeward position behind the promontory of the Priene rock.

During the peak of the Holocene transgression, the area of the later city of Miletos was composed of islands. One of them hosted the earliest settlement in the area of the later Athena Temple dating from the second half of the 4th millennium BC. When the Minoan settlers arrived around 1900 BC this island topography is likely to have persisted; however, hints of an already existing connection with the adjacent mainland by a sandbar (tombolo) cannot be neglected. The palaeogeographic setting changed to a peninsula during the Minoan-Mycenaean occupation phase. The sediments were mobilized by coastal longshore drift and human-induced denudation from the adjacent slopes. At the latest from the Archaic period onwards the Milesian peninsula extended until the Latmian Gulf as is known from literary sources and archaeological evidence (city wall). The Roman period - and especially the Roman Imperial era - witnessed strong siltation processes around Miletos. It was then that the southeastern part of the Latmian Gulf was cut off, thereby creating the Milesian lake out of which the still brackish Bafa Gölü developed.

Climate and Archaeology: An Example from the Aral Sea (INTAS Project Aral 00-1030 "CLIMAN")

Nikolaus Boroffka (Potsdam, Germany), Gaziz Akhatov (Almaty, Kazakhstan), Kamildzhan Alimov (Samarkand, Uzbekistan), Karl Bajpakov (Almaty, Kazakhstan), Sergej Baratov (Samarkand, Uzbekistan), Judith Bölscher (Berlin, Germany), Albina Erzhanova (Almaty, Kazakhstan), Anna Hörnig (Berlin, Germany), Sergej Krivonogov (Novosibirsk, Russia), Denis Lobas (Almaty, Khazakhstan), Hedwig Obernhänsli(Potsdam, Germany), Kamildzhan Rakhimov (Samarkand, Uzbekistan), Christian Reinhardt (Berlin, Germany), Nasbirgen Saparov (Samarkand, Uzbekistan), Tamara Savel´eva (Almaty, Khazakhstan), Timur Shirinov (Samarkand, Uzbekistan), Philippe Sorrel (Potsdam, Germany), Bernd Wünnemann (Berlin, Germany)

The main purpose of the CLIMAN project is to trace climate changes over the last 15ky in the Aral Sea Basin as recorded in shorelines and lake sediments. Human activities as reaction to environmental changes are evaluated. First results are presented from the archaeological-geomorphological expeditions during the spring of 2002 and summer of 2003, and their interpretation concerning climate and water level changes are presented. The new research on the Aral Sea contradicts some previous assumptions, while others are confirmed. The oldest archaeological traces are from the Paleolithic (50-35 ky BP) lying at heights of around 57-60 m a.s.l. or higher. Later prehistoric periods (Neolithic to Bronze Age, 9-3.5ky BP) are represented by many settlements at various heights from 46/47 m upwards. The previously assumed highest water-levels of 72/73 and 57/58 m a.s.l. for these periods can not be correct, and probably such a high level was never attained at any time after ca. 50 ky BP. A wetter climate, with the forest-steppe vegetation zone reaching further south up to the northern shores of the Aral Sea is indicated by the archaeological tool-kits for the period 6-4 ky BP. A settlement from the 15th-16th century AD confirms a major medieval regression. This also confirms historic reports about changes in river courses.

Holocene Greece

Landscape and Early Farming Settlement Dynamics in Central Greece

John Bintliff, Emeri Farinetti, Kallipe Sarri, Kostas Sbonias and R. Sebastiani (Leiden, The Netherlands)

Till recently, the early farming landscape of Neolithic Greece was believed to be almost exclusively one of dense tell villages concentrated in the large alluvial plains of North-Central and Northern Greece (Perlès, 2001). More recently, large flat sites have been discovered and excavated in those same areas (Halstead, 1999). The types of microlocation favoured and the exact form of landuse have now become disputed topics for both site types, but unanimity prevails that in Southern Greece early farming sites are extremely rare, isolated and confined to exceptional micro-locations favourable to natural or artificial irrigation. Current hyper-intensive surface survey in the Tanagra district of Boeotia, Central Greece (Bintliff et al., 2002), together with a recent re-analysis of survey results from the Thespiae district (Bintliff, Howard and Snodgrass, 1999), have led to a radical rethinking of how and where early farmers exploited the Greek landscape between earliest Neolithic and Early Bronze Age times. This new work will be described and its significance for the wider debates about the Greek landscape in this period further discussed.

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Man´s Role in the History of Soil Erosion. The Phlious Basin, NE-Peloponnese, Greece
M. Fuchs (Bayreuth, Germany)

The NE–Peleponnese, Greece, is known for its long history of human activity and its early settlements. Within the Basin of Phlious, close to the famous site of Mycenae, agriculture already started during the 7th millennium BC. This was first indirectly indicated by OSL age data of colluvia and is also evidenced by archaeological finds (M. Maran, personal communication). The consequence of the early human impact is the current absence of any soil cover on the slopes, due to intensive soil erosion in the past. The corresponding sediments of soil erosion can be found today as colluvia and alluvia along the footslopes and within the basin. These sediments represent an excellent natural archive for reconstructing soil erosion if their age can be decoded.
Optical Stimulated Luminescence (OSL) dating techniques are favourable for sediment dating, where the last exposure of the mineral grains to daylight can be dated, and thus the last reworking of the sediment. Various studies on sediments from different environmental settings have shown the broad and successful application of luminescence dating techniques. Nevertheless, sediments like colluvia and alluvia are often not well bleached, which would result in an age overestimation. Thus, the detection of insufficiently bleached sediments is a necessary requirement in luminescence dating. This requirement can be fulfilled with coarse-grain single aliquot (SA) dating techniques, where the variation of small aliquots is used to check for an insufficient bleaching.

To reconstruct the history of soil erosion, the stratigraphy of the basin was investigated. Therefore, 19 boreholes were drilled down to a depth of 15 m, and 5 pits were excavated along a 2 km transect through the basin. Forty-three samples for OSL dating were retrieved to establish a high resolution chronology which is correlated with cultural periods of the study area. Results of the investigation show a high variability of erosion rates corresponding with known cultural activities; distinct soil erosion starts already in the Neolithic period.

Holocene Evolution of the Acheloos Alluvial Plain – Geoarchaeological Aspects of the Environs of the Ancient Seaport Oiniadai (Akarnania, NW Greece)
Vött, A.(Marburg, Germany), Brückner, H.(Marburg, Germany) Schriever, A,(Marburg,Germany) Handl, M. (Marburg, Germany), Besonen, M.(Amherst, USA) & K. van der Borg (Utrecht, The Netherlands)

Ancient Oiniadai lies in the midst of the modern Acheloos alluvial plain, which is one of the largest deltaic areas all around Greece and the eastern Mediterranean. The region shows a degree of high tectonic activity due to the nearby subduction of the Adriatic beneath the Aegean microplate. Our geomorphological-palaeogeographical studies aim at new information about Holocene landscape evolution and its different causes; these are, among others, neotectonic, climatic, and anthropogenic factors. From a geoarchaeological point of view, the ancient seaport Oiniadai with its famous shipsheds from the 5th century BC is one of the most fascinating proofs for historical coastal changes. The site is located on the former island of Trikardo. Trikardo itself once belonged to the Echinades islands, most of which were caught by the sediments of the Acheloos river during the last 6,000 years. Nowadays, distance between Oiniadai and the open sea is approx. 9 km.

Data in the literature reveal a wide discussion about the question how ancient Oiniadai was connected to the sea. Most of the existing studies are based on the analysis of written sources, maps, or remote sensing data. Only few data about sedimentary structures exist (Piper & Panagos 1981, Villas 1984). Generally, there are two different interpretations of Oiniadai's situation. Some scientists argue the shipsheds must have had a direct connection to the sea (Freitag 1994, Fouache 1999), others assume that either the river Acheloos itself or an ancient lake, called Lake Melite, were of decisive importance for the shipsheds (e.g. Philippson 1958). Our study is the first based on systematic geomorphological-geological investigations. We carried out vibracorings along selected transects; deposits were described sedimentologically and numerous samples were taken for geochemical and microfaunal analyses. Lateral and vertical changes in sedimentary facies could be used to decipher Holocene landscape changes. Geochronological information was achieved by ^{14}C AMS dating.

In the area of the former swamps of Lesini – north of Trikardo – our cores clearly show regressive sequences. Sediments of a marine embayment are followed by lagoonal deposits. Later, the environment changed into a marsh milieu. In the uppermost parts of the profiles swamp-like flood plain sediments, as well as levee deposits evidence fluvial dynamics. We conclude that the shipsheds of Oiniadai were connected to the Ionian Sea via a large lagoonal system. At the time the shipsheds were used, the profile data show a narrow lagoonal embayment running from W to E. It seems to be the former prolongation of the modern bay north of Kounovina. We assume that it was kept free by karstic freshwater springs. The rest of the former lagoon has already been silted up by coastal and fluvial sediments. Moreover, the architectural remains of the shipsheds refer to a former water level which seems to be identical with our lagoonal system (Vött et al. 2003). Furthermore, there are sedimentological features which might be interpreted as sediments from a fluvial channel delivering freshwater from the Acheloos along the northern flank of Trikardo. Maybe, this additional channel was of artificial nature and was supposed to prevent the northern harbour from further silting up.

Vibracore profiles from the area south of Trikardo are characterized by direct influences of the Acheloos delta prograding from NE to SW. Before the delta front reached the area, the sediments show a marine environment with quiet sedimentary conditions. Later, prodeltaic sediments and fluviodeltaic river channel deposits testify to the time span when the Acheloos delta was passing through. Subsequently, these deposits are followed by shallow marine and lagoonal sediments. In contrast to the opinion found in literature (e.g. Murray 1984), it is questionable if the southern flank of Trikardo could be reached directly via the Acheloos river. We found relics of a lagoonal system which might have been active during the time of Oiniadai.

Based on the results of numerous ^{14}C AMS datings we are able to establish detailed palaeogeographical scenarios. The lagoon of Oiniadai, for instance, which once spread eastwards far beyond the ancient site, was definitely silted up and turned into marshy environments around two thousand years ago. At about this time, Oiniadai – released by its strategic importance as seaport – seems to be already given up.

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Landscape Changes of the Palairos Coastal Plain (Akarnania, NW Greece) During the Holocene

Vött, A.,Brückner, H., Schriever, A., Luther, J., Handl, M. (Marburg, Germany) & K. van der Borg (Utrecht, The Netherlands)

The coastal plain of Palairos is located at the outermost northwestern part of Akarnania, NW Greece, between the Plagia peninsula to the west and the Akarnanian Mountains to theeast. Our detailed palaeogeographical study intends to reveal landscape evolution during the Holocene. This research has to be seen in close context to recent archaeological investigations in the area – the Plagia peninsula survey project by F. Lang (Berlin), P. Funke (Münster) and E.-L. Schwandner (Berlin) – and, therefore, is part of a multidisciplinary approach to landscape reconstruction. From a geomorphological point of view, only few literary sources exist. We carried out several vibracore transects in order to check the widely spread assumption that the coastal plain of Palairos has always been used as an agricultural area as this is the case for modern times.

As for the northern part of the area, we could show that there never was a connection between the shallow Limni Vulkaria and the marine bay between Pogonia and Palairos, which is situated south of the plain. This confirms the information from Grüger (Göttingen) and Jahns (Wünsdorf) who carried out palynological coring in the lake of Vulkaria in 1997. Limni Vulkaria seems to belong to a tectonically induced karst polje. Our sedimentological profiles reveal that the lake once extended further south. Its southern margin was characterized by extended swamps which were, from time to time, covered by a shallow freshwater lake. The southermost part of the plain shows an asymmetric evolution. To the west, near Pogonia, there are signs of a temporary marine influence; at approx. 5,800 cal BC the coastline was even situated some 900 m further north (Vött et al. 2002). Later, the area changed into a backbeach swamp environment. The eastern part is mostly dominated by sediments of a lacustrine milieu. Focussing to the central and southern parts of the plain, we see clear signs of massive sedimentation by a huge system of alluvial debris fans coming from the east; they can be traced back to the Slavena revma.

Generally, vibracore profiles next to the modern coast reveal a rather stable coastline. This is also proved by the existence of an old stone bridge from Byzantine/Turkish time. At least for centuries, the beach seems to have been the only reliable and the shortest connection between the mountainous areas east and west of the plain. Therefore, we assume that in ancient times it was of enormous importance for traffic purposes and military strategy. We conclude that the coastal plain has received its agricultural importance only when first ameliorative measurements were undertaken within the last two centuries.

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Site formation processes

The Identification of Degraded Features in Open-air Ephemeral Pastoral Settlements: a geo-ethno-archaeological approach

Ruth Shahack-Gross, Fiona Marshal, Steve Weiner (Rehovot, Israel)

Ethnoarchaeological studies on the accumulation processes in contemporary settlements have long been recognized for their contribution to the understanding of site formation processes. Studies on degrading settlements, however, are fewer and rarely deal with the aspect of sediments. Moreover, studies on the degradation of settlements of highly mobile groups, such as hunter-gatherers and pastoralists, emphasize the "archaeological invisibility" of such groups which results from the fact that these societies do not invest much in permanent architecture and tend to leave very few material remains in their sites. A method for identifying degraded features in open-air pastoral settlements was developed in southern Kenya through geo-ethno-archaeological study of abandoned pastoral Maasai settlements. The method employs the combination of three lines of geo-archaeological evidence, namely micromorphology, mineralogy and quantitative phytolith analyses, in order to characterize the sediments of all degraded features present in Maasai settlements. The study focused on the identification of organic-poor livestock enclosure sediments as means of differentiating between pastoral and hunter-gatherer societies that co-existed in the Pastoral Neolithic period in East Africa. The potential for "archaeological visibility" of house floors, cooking hearths, trash pits, gates and fences was also studied using the same methodology. The method is successful in identifying degraded sediments of livestock enclosures, trash pits, cooking hearths and possibly gates. Degraded house floors and fences could not have been detected using this method. The method is currently applied to archaeological sites in Africa and the Near East, where in the latter case livestock penning was identified in an Iron Age monumental building in the site of Tel Dor, Israel, probably indicating a phase of secondary use of this building after its abandonment.

Posters

Solubility and Re-crystallization of Bone Carbonated Apatite: implications for site formation processes

Francesco Berna (Rehovot, Israel), Alan Matthews (Jerusalem, Israel) and Stephen Weiner (Rehovot, Israel)

Bone is a major component of the archaeological and paleontological records. Its mineral and macromolecular components may contain much information about the animal itself and the environment in which it lived. Extracting this information, however, depends upon an understanding of the stability of the components of bone within the different sediments. Here we focus on the stability of the mineral phase of bone, which is carbonated apatite [$(Ca, Na, Mg)_5(HPO_4, PO_4, CO_3)_3(OH, CO_3)$] also referred to as dahllite.

Field observations in archaeological sites show that bones are generally preserved when they co-exist with calcite and authigenic carbonated apatite, but are absent -presumably due to dissolution- when more insoluble authigenic calcium aluminum phosphate minerals are present. Even when bones do not dissolve, their mineral phase changes. In fact, after deposition bone dahllite generally undergoes re-crystallization and its crystals become larger. These crystallinity changes can be monitored by the sharpening of two absorption peaks in the infrared spectrum; the so called splitting factor (IRSF).
Not much is known about the specific conditions under which bone dahllite re-crystallizes. Useful information can be obtained by measuring the solubilities of fossil bones at different stages of re-

crystallization. In fact, the solubility of a fine-grained solid such as bone dahllite reflects the nature of its crystal structure and its surface characteristics. Measuring the relative solubility of recent and re-crystallized fossil bones can thus provide insights into the driving mechanisms behind bone diagenesis. Therefore, we measured the solubility of synthetic hydroxyl apatite (the ideal end-product of bone re-crystallization), re-crystallized fossil bone and recent bone. In order to have measurement conditions relevant to the natural system, we performed the experiments in CO_2-open systems with unbuffered and buffered alkaline solutions.

We identified a "recrystallization window" between pH 7.6 and 8.1, which defines the condition under which bone crystals dissolve and reprecipitate as a more insoluble form of carbonated apatite. We also found that re-crystallized fossil bones were less soluble than recent bones and that in the presence of small amounts of calcite bone did not dissolve at all. Thus a small pH shift of the pore solution dictates the rules of bone preservation: Bone is likely to be best preserved only in sediments in which the pH is above 8.1, such as those saturated with respect to calcite. In alkaline to neutral conditions bone mineral will be preserved, but its mineral component will undergo re-crystallization and the original crystals will be replaced by more stable forms of carbonated apatite. The recrystallization process together with the precipitation of additional apatite will result in a general increase in crystallinity of the bone mineral phase. This process will be more intense as the sediment pH approaches neutrality. We predict that, below pH 7.5, the original bone mineral will be totally replaced by authigenc apatite. When the pH of the sediment solutions drops below 7, bone mineral will rapidly dissolve.

These findings provide a better mechanistic understanding of the re-crystallization process of bone mineral and therefore have fundamental geoarcheological implications. In fact, by examining the IRSF of a bone specimen, we can determine the extent of its re-crystallization and extrapolate the chemical environment in which it was buried. These are fundamental information when trying to reconstruct the formation processes in an archeological site.

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High resolution Alluvial Record of Late Holocene Morphodynamic Change in Northern Tunisia: Climatic or Human Impact?
Christoph Zielhofer, Dominik Faust (Dresden, Germany)

In Northern Tunisia the late Holocene alluvial record of Medjerda flood plain sediments indicates morphodynamic changes due to fluctuations of past climate, superimposed by human activity. Geomorphic activity arises several times with interruptions of geomorphic stable conditions. Enhanced fluvial dynamics occurred around 4.7, 3.0, 1.7, 1.0 and 0.7 ka cal BP. A peak of activity took place about 0.4 ka cal BP. Some periods of fluvial activity show event-like phenomena, particularly when an anthropogenic impact intensified climatic aridification. This has been the case around 1.7, 1.0, 0.7 and 0.4 ka cal BP with partly catastrophic deluges in the Medjerda valley. During antiquity as well as around 1.3 ka, 0.8 ka and 0.5 ka cal BP slight alluvial soils have developed, the first one being the most distinct.

Bond events

The comparison of Medjerda sedimentation rates with the Haematite curve of Bond *et al*. (2001) reveals a parallel progression of late Holocene North Atlantic coolings and increased alluviation in Mediterranean Tunisia. Short-term periods of geomorphic activity in Northern Tunisia match well with North Atlantic Bond events. The findings indicate a late Holocene climatic link between the North Atlantic region and the Mediterranean basin.

Man or climate?

In central European river systems, short-term oscillations of Holocene flood plain deposits have been attributed to human impact in many cases (e.g. Kalis et al., 2003). Thus, differences in the stratigraphical history of various river systems are due to regional settlement patterns rather than climate. In addition, many findings from palaeoclimatic archives in the central Mediterranean exhibit the dominant influence of man on geomorphic processes during the late Holocene (e.g. Oldfield et al., 2003). However, the late Holocene Medjerda alluvial history clearly shows that fluvial dynamics in Northern Tunisia were predominantly climatically-driven. Anthropogenic impact only intensified or weakened these processes.

Mineralogy, micromorphology, phytolith analysis and organic petrology of Middle Paleolithic and MSA Cave sites: comparison between Sibudu (South Africa) and the Levant
Solveig Schiegl, Bertrand Ligouis, Nicholas J. Conard (Tübingen, Germany) and Paul Goldberg (Tübingen, Germany/Boston, USA)

Fossil hearths show complex textures and sediment compositions. Their original features have been altered to a greater or lesser extent by dissolution, mineral transformations and reworking. FT-IR spectroscopy, micromorphology, SEM-EDAX analysis, phytolith analysis, and microscopic techniques from organic petrology have been used to characterize several of the numerous hearths at the MSA-site Sibudu.

Establishing the mineralogy of the ash sheds light on diagenetic processes and site formation. The mineralogy and the micromorphology of the hearth samples indicate a relatively dry sediment milieu, lacking water percolation, but bearing a moisture content which had been sufficient for the formation of several authigenic minerals, such as gypsum, apatite, as well as traces of the phosphate minerals taranakite and leucophosphite. The mineral assemblages of hearths and the sediments in which the hearths are enclosed suggest a comparatively good bone preservation at this site.

Apart from gypsum formation the diagenesis reveals common traits with Middle Paleolithic cave sites in the eastern Mediterranean area, such as Theopetra (Greece), Kebara and Hayonim (Israel). Severe morphological changes of the majority of phytoliths from the hearth ash could be attributed to intensive heating. The prominent white ash lenses are presumably the remnants of either intense fires or repeatedly used fire places. A major organic component of the hearths consists of charcoal from herbaceous plants.

Reflectivity measurements on the charcoal (fusinite) and the char (see below) fragments resulted in similar reflectance distributions within subsequent charcoal-rich sub-layers indicating equivalent burning conditions. Thus an inventory of the lateral and vertical variations in reflectance distributions of the numerous interfingering charcoal-rich layers can help to determine occupation surfaces and spatial organization. Other organic residues with porous spherical char morphology are the products from burning fat or meat. Furthermore traces of burnt and unburnt resins are present. These resins possibly testify that hafting activities were carried out at Sibudu.

This multidisciplinary study of hearths stands in the tradition of earlier comprehensive investigations carried out on several cave sites in the Mediterranean and the Levant and provides a deeper understanding of the use of fire, which was very likely an indispensable tool during human dispersal within and out of Africa.

Reading Sediments from Prehistoric Caves in Israel
Paul Goldberg (Boston University/Uni-Tübingen); Liliane Meignen (CNRS, Valbonne)

Prehistoric cave sits in Israel are not numerous. Yet they have furnished important information along a variety of themes. These include human evolution (the Neanderthal/anatomically modern human

conundrum: Kebara, Qafzeh), the development of lithic industries (e.g., Tabun, Hayonim); human exploitation of fauna and the latter's role in palaeoclimatic reconstruction (e.g., Tabun, Kebara), Bates' famous *Dama/Gazella* ratios; palaeobotanical remains and phytoliths (Tabun, Kebara, Hayonim, Amud); and lastly, the sediments themselves. The deposits not only furnish the context for the archaeological record, but are also a part of it in that they contain abundant anthropogenic deposits – particularly combustion features – that provide indications of Neanderthal activities and lifeways (e.g., Kebara, Hayonim, Tabun, Amud); even some hints of climatic change are registered in these accumulations (e.g., Hayonim). This poster will highlight various aspects of the sediments as seen from recent excavations at Kebara and Hayonim caves as a means to encourage similar types of research in other caves, either within or beyond the Mediterranean zone.

Remote Sensing and GIS as Base for the Reconstruction of Holocene Land Use Potential in Arid Regions
Andreas Bolten, Olaf Bubenzer & Frank Darius (Cologne, Germany)

The poster presents results of the project "GIS-based atlas of Holocene land use potential for selected research areas" as part of the Cologne Collaborative Research Centre 389 "Arid Climate, Adaptation and Cultural Innovation in Africa (ACACIA)". The central topic of ACACIA is the historical development of the arid zones of the north-eastern and the south-western African continent and its people during the Holocene in the light of the complex interrelation between Man and changing climatic and environmental conditions.

Generally a lack of area-wide topographic information in arid regions exists. Stereoscopic Remote sensing data (ASTER-Sensor, Terra-Satellite) built a sound base for a digital terrain analysis within a Geographical Information System. Secondary parameters derived from the digital elevation model include altitude, aspect, inclination and actual drainage pattern. Additionally, a flow accumulation index and a topographic index are ascertainable.
Moreover, high resolution Quickbird-Sensor data allow a detailed mapping of geomorphological as well as archaeological structures.

The results open a further interdisciplinary discussion about the Holocene man-environment relation.

Climate and Archaeology: An Example from the Aral Sea (INTAS Project Aral 00-1030 "CLIMAN")
Nikolaus Boroffka (Potsdam, Germany), Gaziz Akhatov (Almaty, Kazakhstan), Kamildzhan Alimov (Samarkand, Uzbekistan), Karl Bajpakov (Almaty, Kazakhstan), Sergej Baratov (Samarkand, Uzbekistan), Judith Bölscher (Berlin, Germany), Albina Erzhanova (Almaty, Kazakhstan), Anna Hörnig (Berlin, Germany), Sergej Krivonogov (Novosibirsk, Russia), Denis Lobas (Almaty, Khazakhstan), Hedwig Obernhänsli(Potsdam, Germany), Kamildzhan Rakhimov (Samarkand, Uzbekistan), Christian Reinhardt (Berlin, Germany), Nasbirgen Saparov (Samarkand, Uzbekistan), Tamara Savel'eva (Almaty, Khazakhstan), Timur Shirinov (Samarkand, Uzbekistan), Philippe Sorrel (Potsdam, Germany), Bernd Wünnemann (Berlin, Germany)

Geoecological Investigations to the Change of Ancient Landscapes in Northwestern Greece
Martin Sauerwein (Halle, Germany)

Geoarchaeological and Palaeoecological Studies in the Provinces of Sanliurfa and Adyaman, SE-Turkey. A Study Proposal
Annette Kadereit, Dominik Faust, Harald Hauptmann and Günther A. Wagner (Heidelberg, Germany)