EUG XI

Symposium EVO2

Late Quaternary Floodplains: Sedimentary Records of Environmental Change

Convenor

Phil Collins

Tuesday AM Session

EVO2 : TUam04 : F5
Neogene and Early Quaternary Tectonic Phases in Central Hungary. Relations of Sedimentary Record and Morphology

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In the Central Pannonian basin, the Late Neogene-Quaternary sediments are well known from basin analysis. Between the Mecsek Mts and the lake Balaton (SW Hungary), the geomorphology reveals an immature fluviatile net, with captures, mostly tilting southwards. The actual relief is incised in an Upper Miocene delta with marshy paleosoils. Fine fluviatile sands outcrop in the valleys above a perched (30 m) abrasion surface existing south of the lake, cut into Late Miocene and tilted towards the North. These white-grey sands lay unconformably over the Miocene and are believed to be a post- or syn-uplift early infilling of the late Miocene river net. These sands are deposited against a normal fault on the edge of a late Miocene hill (SW of Balatonfoldvar), before late re-adjustment sealed by large calcium carbonate precipitation. This Formation of Latrany is truncated by early Quaternary deposits, reworking Permian sands from the Northern side of the lake Balaton. It is folded in a synsedimentary way towards the Balaton lake. It corresponds probably to the Middle Pliocene aggradational unit described in adjacent deep basins by Juhasz et al., (1999) (third order 3.6,3.7). A complementary outcrop has been found in a Duna terrace at Kerepes (230 m). Also incised into a Miocene hill (Hungaroring) , this high terrace records several aggradational bodies of quartzeous fluviatile sands reworking already weathered crystalline rocks. These sands are truncated by at least 2 periglacial fluviatile bodies (early Quaternary), very similar to those of the Rhine graben and of Western Europe. The oldest one ends with a calciustol palaeosol, laterally interconnected with a pedogenic calcrete, described by M.Pecsi as early Quaternary. In Europe , these 2 bodies, usually provide a dating of 2.4 and 1.4 Ma corresponding respectively to the Prae-tiglian and Waalian regressions (third order 3.8 & 3.9). Moreover, the upper one is disturbed by evidences of 2 separated large coseismic events (tension faults, localised large loading). The lower body may correspond to the Piacenzian (third order 3.6,3.7) equalling the Latrany Fm. The interpretation of both records is a depostional sequence during a post-orogenic event, the Messinian uplift. After this compressive event, large diachronic alluvial fans developed, mostly during the Piacenzian, in subsiding position: the Balaton basin and the subsiding Duna valley. The Balaton lake is confined towards the south by a flexure probably related to the inversion of Pannonian strata during the Messinian, the early Quaternary (circa 1 Ma) and a recent event (OIS 9?).The proposed sketch is very similar to these recorded west of the Alps for the Valensole plateau or for the northern edge of the Variscan front in Northern France and England.

EVO2 : TUam05 : F5
Morphotectonic Evolution of the Gulf of Izmit, NW Turkey

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The Gulf of Izmit is a neotectonic feature located on the Intra-Pontide suture separating the Pontide and the Sakarya continental fragments. The Gulf and its eastern continuation is a narrow depression filled by Late Pliocene and younger deposits. Anoxic, brackish marine, brackish marine-deltaic and marine sediments have been deposited within the Gulf during the Late Pliocene, Early-Middle Pleistocene, Late Pleistocene and Late Pleistocene-Holocene periods respectively. In the eastern part of the depression thick alluvial fan deposits have been deposited at the same time. The depression started to form under the control of NE-SW and NW-SE trending faults having dominantly normal component since Late Pliocene. This period can be characterized by a series of pull-apart basins developed in the North Anatolian Fault system. Since Late Pleistocene E-W trending right-lateral faults developed and cut the older pull-apart structures.

EVO2 : TUam06 : F5
Dating the Death of a Fault by Stratigraphic and U/Th Methods: The Xylokastro-Loutro Fault, Rift of Corinth (Greece). Kinematics Implications

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The rift of Corinth, located between continental Greece and the Peloponnese, is a 130-km-long dissymetric graben, trending N110°. Active since about 1 Myr, the rift is controlled to the south by normal faults dipping 40-50° to the north and which connect at depth with a low angle N-dipping brittle detachment. Structural and sedimentological data show that these normal faults have migrated from the south to the north during the evolution of the rift. The presently active normal faults are located near the southern shore of the gulf. It controls the subsidence of the gulf and the uplift of the northern Peloponnese. Because of its young age and its fast rate of extension (10-15 mm/yr) this rift allows to combine an accurate stratigraphic study and a radiometric dating method suitable during the last 700 kyr. Several U/Th dating are in process, either on syn-tectonic calcite of the normal fault planes or on post-tectonic calcite of a karstic origin. A first age is presented in this study. The Xylokastro-Loutro fault is one of the most recently active of the rift. It limits mesozoic limestones in its footwall from a middle pleistocene detritic formation in its hanging wall. Discordant on this formations lie remnants of three stepped marine terraces. These terraces can be correlated with those outcropping east of Xylokastro, which have been correlated with the 5.5, 5.3 and 5.1 peaks of the oxygen-isotope curve. The limestones of the Xylokastro-Loutro fault scarp are notched and covered by shoreline conglomerates of the highest terrace 5.5 (125 kyr). Locking of the fault is also proved by an U/Th age of 112 ±0.4 kyr obtained on calcite of karstic origin which crosses through the Xylokastro-Loutro fault plane seals its activity. Some authors consider that this Xylokastro-Loutro fault is still active. These new data demonstrate that the fault's activity has ceased before 110-120 kyr. The younger extension of the Corinth rift is accommodated more to the north by an offshore fault, likely the eastern continuation of the onshore Helike fault. This explains also the uplift of the three marine terraces north of the Xylokastro-Loutro fault.

EVO2 : TUam09 : F5
The Clay-With-Flints of the North Western Europe: Typology, Chronology and Weathering Balance

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In the north western Europe, the clay with flints (CWF) known in France as argiles & silex (or formations résiduelles & silex) cover generally the Upper Cretaceous Chalk. These formations derive by weathering processes from flint bearing chalk.

A compared study between the recent studies of Laignel (1997), Laignel et al. (1999), Quesnel (1997), Quesnel et al. (2000) based on the digital cartography and lithological analyses of CWF and the european bibliography is made. This comparison allow to identify 5 CWF families. The study of the geometric and stratigraphic relations between the CWF and the remnants of overlying Cenozoic deposits allow to define the periods of chalk weathering. We distinguish: the CWF post-erosion of the Ypresian clay in the Talou-est Pays de Caux, north of France and the London and Hampshire basins; the CWF post-deposition of Pliocene sands in the Pays de Caux; the Quaternary CWF under the alluvial terraces of the Seine, Eure, Meuse and Tamise rivers; the CWF post-deposition of the Oligocene sands of Drouais, Limbourg and Rhinland; the Paleogene and Cenozoic CWF of the Eure-Eure et Loir-Perche and east Devon.

The thicknesses of dissolved chalk and the weathering rates are calculated for the CWF of western Paris Basin and the calculate methodology is applied to the totality of NW Europe CWF according to the CWF typology. The thickness of dissolved chalk varies from 5 to 200 meters and the average weathering rate from 1.8 to 14.8 m/Ma. In the detail, the average weathering rates are : for the CWF of Talou-est Pays de Caux, north of France and the London and Hampshire basins, 4.6 to 10 m/Ma; for the CWF of Pays de Caux, 14.8 m/Ma; for the CWF localised under the alluvial terraces of the Seine, Eure, Meuse and Tamise rivers, 12.5 m/Ma; for the CWF of Drouais, Limbourg and Rhinland, 5.5 to 6.9 m/Ma; for the CWF of Eure-Eure et Loir-Perche and east Devon, 1.8 to 2.1 m/Ma.

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EVO2 : TUam10 : F5
Erosion and Tectonics: Why the Drainage Pattern Matters – A Perspective of the Present-Day Situation of the Swiss Alps

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Orogens grow by accretion of upper crustal material until an equilibrium with erosional dispersion is reached. If this steady state situation is established, then a modification of the pattern of erosion potentially results in a reorganization of the exhumation path of rock particles. Specifically, the change of the drainage pattern from a symmetrical (e.g. orogen-normal) to an asymmetrical configuration of dispersion (e.g. orogen-parallel) represents a modification of the pattern of erosion that is likely to result in a reorganization of the pattern of strain in the crust.

The Central Swiss Alps provide such an example where the present-day drainage geometry reveals a strong asymmetry. It is characterized by two large orogen-parallel oriented dispersal systems (Rhone and Rhine rivers) that drain the core of the Alps (area surrounding the Aar massif), and smaller orogen-normal oriented rivers (e.g. Aare, Reuss, Ticino). The asymmetry of the drainage configuration is reflected by differences in discharge between orogen normal and orogen parallel rivers: Average discharge of Rhone and Rhine rivers (150-170 m^3/s) exceeds that of the smaller tributaries (<35 m^3/s) by a factor of between 5 to 10 where they cross the Alpine front. In addition, high erosional potentials of Rhone and Rhine systems might also be controlled by source rocks with low erosional resistance. Specifically, the course of both rivers is trapped by faults that are interpreted as zone of erosional weakness. In contrast, the bedrocks of the orogen-normal oriented rivers predominantly consist of lithologies (granites, gneiss) with high erosional resistance.

It appears that enhanced discharge and bedrocks with low erosional resistance found in the Rhein and Rhone systems potentially result in an asymmetry of the Alpine erosional potential. According to theoretical concepts of landscape development, the long-term evolution of a drainage basin is dictated by fluvial dissection that balances crustal thickening. Provided that the rates of crustal uplift are constant, then rivers adapt steady state slopes (S) that are inversely related to discharge (Q) and to source rock erodibilities (k). Therefore, steady state slopes reflect the ability of a river to compensate crustal uplift (U) by surface erosion. According to these theoretical concepts, enhanced erosional potentials are found for Rhine and Rhone systems. This is the case because the gradients of the courses of these rivers are significantly lower than those of the orogen-normal directed rivers despite higher crustal uplift rates.

It appears that the present-day pattern of crustal uplift rates is partly a response to the asymmetry of the erosional potential in the Alpine drainage basin. Indeed, the nearly symmetrical increase of crustal uplift rates to ca. 1 mm/yr with respect to the foreland is interrupted by the occurrence of maximum rates of crustal uplift of 1.4 mm/yr in Rhine and Rhone valleys.

EVO2 : TUam11 : F5
Fluvial Bedrock Incision Following Typhoon Impact on Taiwan

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Of all the mechanisms of continental denudation, fluvial erosion of uplifting bedrock is thought to be crucial because it sculpts the local relief upon which the mass wasting of hillslopes depends, and creates the conduits for transfer of the erosion products. Despite its importance, the process is poorly understood. Key questions are: what are the principal mechanisms of fluvial bedrock incision, what is the rate of the process, and what controls that rate? These questions are addressed in a field experiment located in the eastern Central Mountains of Taiwan. There, networks of recessed benchmarks were installed, spanning bedrock channels from low flow line to above extreme flood level. Between benchmarks, the channel bed topography is surveyed at regular intervals in order to obtain an accurate measure of fluvial bedrock erosion.

During the wet season of 2000, Taiwan was hit by several major typhoons. A rare supertyphoon, "Bilis", crossed Taiwan on 22 - 23 August, generating very high discharges and concomitant hillslope mass wasting in the study catchment. The ensuing channel bed erosion, and the wear caused by smaller discharge events is captured by the differential of surveys performed in February and December 2000. We will present the erosion measurements for the 2000 wet season, interpret the observed wear in the context of long-term rock uplift and exhumation rates, and discuss the spatial distribution of fluvial incision within the active channel.

EVO2 : TUam12 : F5
The Holocene Lake Mega-Chad: Extension, Dynamic and Palaeoenvironmental Implications since Upper Miocene

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The chadian basin is made up of a southern basin, which corresponds to the present-day hydrological Lake Chad basin (level varying between 275 and 280 m) and a northern basin, which is centered on the chadian Lowlands (saharian area, lowest point at about 210 m). These two sub-basins are connected by the Bahr el Ghazal dry valley which can occasionally be flooded (threshold at 285 m). The presence of lacustrine holocene deposits at the altitude of 300-320 m (diatomites, shelly shoreline bars, longshore sandridges) suggests the existence of a giant Lake Mega-Chad, as wide as the Caspian Sea (about 350000 km^2). The existence of Lake Mega-Chad, defended by Tilho (1925), Schneider (1967) and Servant (1973), was however contested by Durand and Lang (1986) and Durand (1995) arguing that the longshore sandridges have a neotectonic origin rather than a lacustrine origin. At time, no conclusive argument has been proposed against or in agreement with the Lake Mega-Chad hypothesis.

Digital Elevation Models (TOPO6 and GLOBE data sets) were used to reveal, at the scale of the whole basin, a well-defined terrace, locally up to 50 km wide. This terrace is a very striking feature because of (1) its constant elevation at about 305 m above sea level, (2) its amazing flatness and (3) its continuity. Wathever the origin of this terrace, its presence is a convincing argument for Lake Mega-Chad in past time. The formation process should have had a base level rigorously horizontal at the scale of the basin. Only a relation with a standing water-body could explain such an horizontality.The outlines of the terrace precise the extension of the Holocene Lake Mega-Chad.

In the Chad basin, which is a stable intracratonic sag basin, the Holocene Lake Mega-Chad episod is a reliable model that can be used to constrain Pliocene palaeoenvironmental changes. The Mio-Pliocene fossiliferous outcrops are characterized by high fossils concentration areas of various vertebrate fauna, among which Australopithecus bahrelghazali has been discovered (Brunet et al., 1995). The aim of our research is to understand the palaeoecology of the chadian early hominids sites. The sedimentary record is made up of 1-2 m thick sequences. These latter comprise a lacustrine facies associations (diatomites and claystones) in the lower part and an aeolio-fluvial facies association (cross-bedded, well sorted fine sandstones, argilaceous sandstones) in the upper part. Each sequence, indicating an increasing aridity, is the result of a climatic oscillation. Such sequences are represented in Mio-Pliocene stratas as well as in recent deposits of Lake Chad. Several sequences are verticaly stacked, suggesting that several climatic oscillations occured since Upper Miocene. Hence, the palaeoenvironmental successions of Chad basin are more or less unchanged for 7 My.

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EVO2 : TUam13 : F5
Post-Pleniglacial Evolution of the River Meuse Floodplain in Limburg

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A chorographic analysis is conducted, based on geomorphological mapping and aided by historical data on landuse evolution and changing river pattern. Sedimentology was studied in profiles of gravel quarries, supplemented by borings and geophysical data. A series of quite different types for this post-Pleniglacial gravel river are established.

Tuesday PM Session

EVO2 : TUpm25 : F5
Evolution of the Upper Mississippi Valley's Fluvial Style during the Last Glacial-Interglacial Cycle

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The Upper Mississippi River Valley (UMV) has undergone significant changes in fluvial style during the last 20,000 years. These include changes in channel pattern, location of depocenters, and lithology of sediment stored in the valley. Major changes in style produced by changes in the nature of sediment and water input into the valley occurred during the shift from glacial to interglacial conditions. From 20-11 ka glacial and periglacial conditions were present in the upper basin and a braided stream occupied the UMV. Periodic large glacial-lake-burst floods strongly influenced the valley's geomorphology during this interval. This period was characterized by valley aggradation and a steeper-than-modern down-valley gradient. Fine-grained suspended load was transported through the main valley, sandy alluvium was stored in wide valley reaches, narrow valley reaches were transport dominated, and fine-grained slackwater deposits were stored in the lower reaches of tributary valleys.

This fluvial style changed abruptly to an interglacial style at 10.5 ka as a result of fundamental changes in seasonal water and sediment input accompanying the end of glacial meltwater input into the UMV. The late glacial braidplain became a sequence of terraces as the channel entrenched, and the channel pattern shifted abruptly to island braided as bedload transport rates decreased. The new channel belt was significantly narrower than that of the glacial river and the zone of sediment storage was reduced. The end of the glacial period also brought a shift to net transport of sandy bedload and storage of fine-grained sediment in the UMV. The position of the channel belt stabilized about 7 ka upvalley of the junction with the Missouri Valley, and with the exception of large tributary junction areas, has occupied essentially the same position since that time. New depocenters developed; 1) along the valley margins as alluvial fans and colluvial slopes prograded late glacial and early Holocene surfaces between 8.5 and 2.5 ka, and 2) along the eastern margin of the channel belt where an extensive natural levee developed between 7 and 2.5 ka

Paleobotanical, isotopic, and archaeological studies within the UMV indicate that shifts in atmospheric circulation patterns induced hydrologic and biologic changes that strongly influenced flood frequency and magnitude, and the delivery of sediment to the UMV from tributary basins during the Holocene.

Below the Missouri Valley junction the channel pattern shifted from island braided to meandering about 7.5 ka. From 7.5 to 2.5 ka meander wavelength was large and the channel wide, a response to the large suspended sediment load delivered from the Great Plains via the Missouri River during the middle Holocene. After 2.5 ka channel width narrowed and sinuosity progressively decreased toward the condition of the early historic river.

EVO2 : TUpm26 : F5
Holocene Floodplain Genesis in Southern Ontario Rivers, Canada

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Floodplain accretion processes have been examined in southern Ontario, Canada for rivers that drain into the lower Great Lakes. Drainage areas for these basins range from 500 to 3500 km^2. Evidence is derived from boreholes and geophysical examination of floodplain sediments, along with detailed archaeological investigations. Glacial, glaciofluvial and glaciolacustrine deposits in which these Holocene rivers developed, and isostatic adjustments of base level at the beginning of the Holocene, have greatly influenced river stability and the character of the alluvial

fill. Lateral migration of the channel is severely restricted by glacial terraces in some reaches or by low stream powers in other less-confined zones. Vertical stability is controlled by a combination of armoured gravel beds and erosion resistant substrates of glaciolacustrine clays or carbonate bedrock. Floodplains appear to develop by slow progressive vertical accretion during prolonged overbank flooding episodes that derive from wet conditions in the late spring and/or ice-jams floods in late winter. In the pre-European settlement period, section-averaged vertical accretion rates vary from 0.5 - 3 mm a^{-1} with highest rates observed downstream of zones of flow separation. A post-settlement alluvium (post 1830 AD) is common and it varies in thickness from 0.5 to 1.3 m. In areas upstream of back-water effects from fluctuating lake levels, only one paleosol is present beneath the PSA. Occupations of these surfaces by Late Woodland cultures suggest high vertical stability for at least the last 1300 years (Walker et al., 1997). In downstream floodplain zones, and in particular those influenced by lake level fluctuations, an older paleosol can be documented dating to 3300 years BP. Late Archaic/Early Woodland artifacts are present on this surface but preservation is poorer and concentrations much lower. We propose a model of floodplain development that is based on neither progressive lateral migration nor persistent vertical accretion. Instead, these relatively low-energy rivers transport fine-grained sediments of mostly silt very efficiently. Bank erosion rates are low and large floods have very little geomorphic impact (cf. Gardner, 1977). During periods of low climate variability and lower lake levels, stable floodplain surfaces develop. At least two dominant phases of stability have been noted for the later Holocene but these cannot be tied uniquely tied to other proxy indicators of climate variability in the region during the same period.

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EVO2 : TUpm27 : F5
Floodplain Sedimentology, Stratigraphy, Paleohydrology: Indicators of Monsoon Activity in Northern Australia

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The stream discharge regimes of the large rivers of northern Australia are characterised by high flow events linked to deep tropical depressions and cyclones associated with the northern Australia summer monsoon. Most of the annual precipitation received by areas in northern Australia can be accounted for by the occurrence of as few as one or two of such events. The contribution made by other rainfall generating mechanisms, such as convective thunderstorms, is insignificant. Peak flow events are directly linked to high magnitude precipitation events. Flood discharges with recurrence events of 1:10 can be as high as 20 000 m^3s^{-1}, reaching 40 000 to 50 000 m^3s^{-1} with recurrence intervals of 1:50. The high flow stages, which result lead to extensive inundation of the floodplain and leave a distinctive sediment signature in the floodplain stratigraphy. Although, the details of this differ between basins depending on sediment supply and characteristics.

From the floodplain stratigraphy it is possible to outline the details of paleoflood events and hence monsoon activity in northwestern Australia over late Quaternary time scales. From our findings so far, three major conclusions emerge: (i) the flood regime was active close to the Last Glacial Maximum - a time when monsoon activity should have been suppressed; (ii) the northern Australian monsoon was active during the latest Pleistocene at c. 14 Ka - again a time when climatic boundary conditions should hamper monsoon activity; (iii) there is no clear evidence of major changes in monsoon activity in the Holocene paleoflood record. However, these inferences have to be placed into the context of the limitation which alluvial stratigraphies place on paleohydrological constructions.

EVO2 : TUpm28 : F5
Soil Formation and Sedimentation Records during the Last 15,000 yBP in the Oued Medjerda Basin (Northern Tunisia)

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Summary: We want to present the main stratigraphic chronosequences of the Oued Medjerda flood plain within the Ghardimaou basin, which enables us to distinguish incision periods from those of accumulation during the last 15,000 years BP.

Late Pleistocene ends with edaphogenetic conditions as seen in considerable features of rubefaction showing red soils (5 to 7.5 YR 4/6). The Holocene is marked by accumulation of thick fluvial deposits. In these we are able to distinguish different soil horizons from sedimented layer, which points to changes in morphodynamics. ^{14}C-datings, pottery fragments and an intensive field study of the different exposures help us to establish a morphodynamic sequence with at least seven different phases:

1. The transition into Holocene is marked by fine rhythmic accumulation of floodplain sediments mostly composed by silty elements. Some sandy layers are imbedded. Later on the accumulation ends with a fining up sequence.

2. Period of morphodynamic stability permitting soil formation under more humid conditions. The soil shows weak rubefaction beneath a huge humic horizon. This phase is accompanied by river incision. According to results obtained in southern Spain (Faust & Diaz del Olmo, 1997) pointing to soil formation conditions during Neolithic Age, we would suppose this soil to having been formed during the same period of time.

3. Morphodynamic activity is shown by accumulation of flood plain sediments mostly fine silty to clayey. Thick clayey layers with weak humic contents prove slow accumulation conditions which end at about 2,500 years BP.

4. After 2,500 years BP we witness soil forming conditions with humic features along with river incision in Roman times.

5. Following we experience Post-Roman accumulation with great flooding that for the first time takes the river completely out of his meander area. The sediments consist mostly of sandy and silty components.

6. We see morphodynamic stability with soil forming conditions marked by weak humification. Simultaneously the river makes a sharp incision leading the foundations of the Roman bridge near Chemtou to collapse.

7. This phase taking place during the last 400 years BP is characterised by yet another increase in heavy flooding with fine stratification of the sediments all over the flood plain of the Ghardimaou basin. The river bed itself continues meandering and eventually fills with sediments of different sizes. Innerbank positions show younger terracing for the last 250 years BP.

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EVO2 : TUpm29 : F5
Holocene Floodplain Environments in the Pasinler Basin, Eastern Anatolia

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The Pasinler Basin occupies a position of great palaeoclimatic and archaeological significance in the Near East. It lies within the transition zone between areas with Mediterranean-type climates and those with more continental climates. Relief heightens its potential sensitivity to past climatic variations, with high mountains encircling much of the lowland basin floor. The basin itself occurs in the headwaters of the Aras river, which drains east to the Caspian Sea. Immediately to the west are the headwaters of the Euphrates river. The basin's position at the junction of migration and trade routes provided by these major rivers means that it is also of significance in the understanding of the archaeo-historical (the area has been permanently occupied for several thousand years), cultural and political development of the region. Like much of the region, active tectonic processes that have modified surface and subsurface hydrology, as well as producing settings favourable for the preservation of depositional histories have significantly influenced the Pasinler Basin.

Mid-basin floodplain sediments reveal a series of oscillations between mineral and organic-dominated depositional environments through the Early and Middle Holocene. Damp floodplain conditions occur at approximately 7,000 BC, 4,000 BC and 2,000 BC. Generally fine-grained mineral sediments with occasional gravel suggest lower productivity on the floodplain and more variable flows, including higher peak flows. In the late Holocene, some time after the final damp floodplain period, an incision event or phase followed a change in fluvial regime represented by deposition of coarse gravel.

The episodes of damp floodplain conditions in the Early and Middle Holocene are broadly synchronous with similar conditions identified elsewhere in the region. This suggests the Pasinler Basin was sensitive to regional scale climatic events, perhaps associated with variations in the East African Monsoon. Indeed the northeastward penetration of these events can now be better constrained. The degree of correlation declines for the 2000BC event and subsequent conditions. This may in part be due to dating limitations but spatial variability in climate cannot be ruled out. A potentially equal factor is likely to be land use change. Indeed, archaeological investigations in the basin indicate a significant cultural shift at around 2000 BC.

The Pasinler Basin study, although at an early stage, demonstrates the palaeoclimatic use of floodplain depositional sequences in a region where lacustrine sites are rare and, to some extent atypical. They also provide great potential for understanding the impact of varying human activity over long time periods.

EVO2 : TUpm30 : F5
Impact of Historic Land Use Change on Sediment Delivery to and Geomorphic Evolution of a Chesapeake Bay Delta

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Historic land use after European settlement in the Chesapeake Bay drainage basin, eastern USA changed from deforestation to intensive agriculture to urbanization. These land uses induced large fluxes of fluvial sediment to the estuary's tributaries. Stratigraphic and paleoecologic analyses of the deltaic deposits in those tributaries may be used to infer changes on the landscape, but are not sufficient to quantify past sediment supply, which is an important geomorphic variable. When viewed as an inverse boundary-value problem, reconstruction of the sediment supply function may be achieved by combining deltaic sedimentation chronologies with an equation governing delta progradation. We propose that the diffusion equation is appropriate for simulating delta progradation and obtaining the sediment supply function provided a suitable diffusion constant (D) can be determined. Three new methods for estimating D are presented for the case of estuarine deltas. When the inverse boundary-value technique was applied to Otter Point Creek, a tidal freshwater delta at the head of Bush River in upper Chesapeake Bay, D values ranged from 3763 to 6199 m2 per year. Delta growth simulations showed a 1740-1760 initial pulse, a 1760-1780 erosive/re-distributive interval, a 1780-1920 growth period, and a 1920-present erosive/re-distributive era. Coupling of simulated delta elevations with an empirical plant habitat predictive equation allowed for comparison of predicted versus actual relative habitat areas. Also, the model yielded reconstructed watershed erosion rates and stream suspended sediment concentrations that could be useful for development of water quality regulations.

EVO2 : TUpm33 : F5
Timing Floodplain Evolution using Optically Stimulated Luminescence

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The river floodplain is one surface environment mostly sensitive to local and regional perturbations of the climate system, particularly in terms of water and sediment fluxes. Whether or not humans do impact on this environment, and more generally on surface processes equilibrium, remains to be assessed. In order to do so, we have initiated a sedimentological, geomorphological, and chronological investigation of two river drainage basins in Eastern Canada, one of which is draining a zone of relatively intensive wood cutting activities. In both drainage basins, Holocene terrace sediments are found that contain a significant amount of organic material, some of which is peat, thereby indicating local or regional fluctuations of the local base level during the Holocene. Elsewhere, the sedimentary structures and the alluvial lithosome geometry suggest that most sediment has aggraded both as bedload in the channel and at other times, as lateral overflows during flash-flood events.

In order to devise a chronological framework for the Holocene alluvial history of this area, a luminescence dating project has been initiated. It focuses on the dating of single feldspar grains extracted from the sediments as the alluvial environment is not one in which the whole population of sedimentary grains can be confidently thought to have been fully zeroed at time of burial. Indeed, modern river sediments, collected at the surface of meter scale sand bars, are composed of a significant proportion of unbleached grains. Those modern-day sediments yield apparent optical ages of ca. 3 to 6 ka, an unsurprising fact since they can be sourced to a nearby Quaternary section where are exposed sediments older than 30 ka. In the Holocene terrace, organic material was retrieved from a sandy alluvial layer, and dated at ca. 700 years BP. Single grain dating of feldspar grains from this same unit revealed an age structure rather similar to the one displayed by the analogue modern environment. This reflects the heterogeneity of luminescence residual levels at time of deposition. Several lines of investigations are being tested in order to find a protocol that would yield the expected age (e.g. changing preheat conditions, optical stimulation sources, luminescence emission windows...). One way to overcome age overestimation is to suppress preheating mineral grains all together before measurement of the luminescence signals, since an unwanted source of luminescence is released upon thermal pretreatments, that significantly affects the dating of young sediments. This new protocol is being tested at other late Holocene floodplain sites.

EVO2 : TUpm34 : F5
Variations in Long-Term River Incision Rates Associated with Terrace-Forming Glacial Events and Post-Glacial Return to Equilibrium of a Longitudinal Ice-Dammed Bedrock River Profile: Cosmogenic Isotope Data from the French Alps

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The French Alps were extensively glaciated during late Cenozoic glaciations. Glacial erosion and the associated periglacial climate induced severe disturbances in river behaviour and rate of incision. Different drainage basins display various patterns and degrees of ice occupation. Along the border of the glaciated region, damming of ice-free tributary valleys by glacier tongues resulted in massive storage of fluvial and lacustrine deposits high in the fluvial system. Reequilibration of river longitudinal profiles accounts for most of the observed post-glacial incision. Downstream of the glacier fronts, and in ice-free catchments, valley bottoms widenedd under periglacial climates and were subsequently incised during interglacial periods. The inactivated floodplains remain as well-preserved strath terrace treads.

In situ cosmogenic ^{10}Be dating of these terraces provides the first absolute age determinations on terraces whose ages have been strongly debated previously. In the periglacial zone, older terraces exhibit cosmogenic ages that span several glacial-interglacial cycles. They provide good estimates for the integrated, long-term incision rate. Younger terraces reveal variations in incision rates that may be linked to terrace-forming events and/or post-glacial isostatic rebound. Within the glaciated area, the Drac river valley is characterised by periodic glacial damming of its outlet. This results in 800 m variations in the river base level. Complex, imbricated buried drainages bear witness of successive glacial storage followed by interglacial reworking of river sediments and epigenic incision of the bedrock. Cosmogenic dating of post-glacial valley terraces reveals the headward propagation of a well-defined knickpoint over more than 50 km since the inception of incision, soon after final glacier retreat. This knickpoint is still active and visible in the headwaters. Incision rates in glacial sediments and bedrock are extremely high. Sediments evacuated contributed to the infilling of a large trough lake downstream and to the building of a huge holocene alluvial fan, allowing the settlement of the biggest town of the French Alps. The data also help to constrain the timing of deglaciation on local glaciers and evaluate the synchronism of alpine glacier retreat.

EVO2 : TUpm35 : F5
Erosion Timescales Derived from U-Decay Series Measurements in Rivers

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Continental erosion processes are responsible for the production of soils and for the transfer of dissolved elements and sediments to the oceans. Silicate weathering is also a major process in the pumping of atmospheric CO_2. Nevertheless, the timescales of rock and soil weathering are still poorly constrained.

U-series disequilibria measured in rivers can be a powerful tool for constraining the age of chemical erosion at the scale of a watershed. Indeed, by contrast with other tracers, the initial conditions are well known: all fresh rocks older than 1 Ma can be assumed in secular equilibrium (activity ratios = 1). During chemical erosion, the preferential leaching of radium and uranium relative to thorium, coupled with α-recoil effects, induce radioactive disequilibria in waters and in weathered products which are complementary relative to 1. TIMS and MC-ICPMS now allow the precise analyses of (^{234}U/^{238}U), (^{230}Th/^{238}U) and (^{226}Ra/^{230}Th) in both phases, which permit to constrain the age of the fractionation.

Two regions have been studied: (1) the Mackenzie basin (Canada), which was under an ice sheet until about 10 ka, and (2) the tropical rivers draining the Deccan traps basalts (India).

In order to explain the U-series fractionations, we have developed a model of continuous leaching of particles. This model considers that particles have resided during a non negligible time in the watershed before being sampled, whereas the activity ratios of dissolved loads reflect the present-day leaching of rocks and soils. The Mackenzie basin rivers yield chemical erosion times of 9 - 28 ka, whereas the Deccan traps rivers yield longer times (55 ka - 85 ka).

The ages estimated for the Mackenzie region are recent and are lower than the estimated residence time of soils (about 70 ka). Moreover, these ages are significantly lower than those estimated for the Deccan traps region, which was under tropical climate during the last glacial period. These results strongly suggest that chemical erosion was significantly inhibited on the canadian shield during the last glaciation.

A comparison of measured denudation and denudation calculated with U-series nuclides show that erosion processes in the Deccan traps are not in a steady-state: mechanical erosion rates are higher than predicted by a simple mass balance between pristine rocks at secular equilibrium and river carried weathering products. This region is deeply affected by human activity: intensive deforestation and agriculture have occurred these last hundred years. This parameter is probably responsible for the transient state of Deccan soils.

EVO2 : TUpm36 : F5
Meander Traces and Late Quaternary Subsidence in the Great Hungarian Plain

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The present watercourse and the relict meander system of the Tisza, the main river of the Great Hungarian Plain, were analyzed to draw conclusions about the vertical movements in the late Quaternary. Since the relief of the study area is extremely low (20 m in 200 km) river meander geometry bears geological information about the relative uplift and subsidence along the rivercourse (Burnett and Schumm, 1983), in addition to the climate influence (Vandenberghe et al.; 1994, Gábris, 1995). The present riverline is mostly a result of the river regulation works carried out in the second part of the 19th century. The last-original, pre-regulation rivercourse was reconstructed by transforming the content of the historical maps to the modern coordinate systems. Sinuosity (Schumm, 1963) sequence with different window lengths was calculated along the original riverline and compared to the Quaternary sediment thickness, to the results of repeated precise levelling (Jo-, 1992) and to the known structural features. Four subsiding zones were indicated by high sinuosity river sections. The relative subsidence can be attributed to neotectonic activity, sediment compaction and anthropogenic factors (e.g. hydrocarbon exploitation). High resolution digital elevation model (DEM) of a part of the study area was also analyzed to get indications about one of the recognized subsidence zone. The results were also compared to the flood-defense experiences on the Tisza river. The relatively subsiding zones are found to correlate well the most flood-endangered river sections.

KEYWORDS: Late Quaternary, subsidence, river meanders, sinuosity, Tisza river, Great Hungarian Plain, riverline reconstruction, flood defense

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EVO2 : TUpm37 : F5
A Graphical Estimation of Heavy Metal Enrichment in Floodplain Sediments in the River Severn Catchment, UK

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Since mining activities were historically operated on the upper reaches of rivers, heavy metals have been intensely released to river systems and have given rise to river pollution issues around the world. Heavy metals associated with the suspension load within fluvial system are transported downstream from the source, deposited and stored in floodplain sediments. In the River Severn catchment, UK, metalliferous mining activities started in the 12th century and ended at the beginning of the 20th century. Heavy metals are widely distributed on floodplains throughout the catchment. Samples from three floodplains along the Severn were collected and analyzed for Pb and Zn contents. Results show a clear enrichment of Pb and Zn in the upper part of the soil profiles. A sharp decrease of heavy metal content at a certain depth indicates accumulation of Pb and Zn in floodplain deposits. The % cumulative frequency of Pb and Zn content for each area was plotted separately and the lower portion of each curve is identified and separated.

This is interpreted as a representation of the natural level from uncontaminated pristine material at depth. The identification of heavy metal enrichment in the upper part of the profile in the lower reaches indicates that heavy metals are transported for a long distance from the source in the Severn system. Further detailed information is needed to determine the suitability of using the sediment profile to interprete the natural level of heavy metals. Human influences on a river system can alter the nature of floodplain deposits.

Tuesday PO Session

EVO2 : TUpo01 : PO
The Recent Sediment Geochemical History of the Spoakne River Basin, Washington, USA

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The Spokane River Basin (SRB), in eastern Washington, extends from the northern outlet of Lake Coeur d'Alene (CDA) to the Columbia river. It is 110 km downstream of the CDA mining district. The SRB is heavily regulated by dams to control floods and to generate hydropower. One of the major goals of this study was to evaluate downstream sediment-associated trace element concentrations to determine if the enrichments observed in the CDA Basin extended into the SRB and to try to determine a recent geochemical history of the basin from just before the inception of upstream mining and ore-processing activities in the CDA Basin, through to the present (a period of about 120 years).

Surface and subsurface sediments in the SRB are enriched in Pb, Zn, As, Cd, Sb and Hg relative to local background levels. On average, for the bulk sediments, the enrichment ranges from factors as low as about 1.25 for Hg to as high as about 10 for Pb, whereas for the <63-µm fraction, it ranges from 1.2 for Ag and Sb to about 10 for Pb, Zn, Cd, and Hg. Not surprisingly, these are the same elements enriched throughout the CDA River and Lake CDA (Horowitz, et al., 1993; 1995). Maximum enrichment occurs in the upper part of the basin in close proximity to Lake CDA; and then decreases downstream. This enrichment is sufficiently high to represent both a potential aquatic as well as a human health problem (Sheldrake, U.S. EPA, written comm., 1999).

Subsurface geochemical patterns were similar in all the cores. About one third of the way upcore, the concentrations of the enriched trace elements rise rapidly, and then remain nearly constant over the last third of their lengths. Near the tops of the cores, there is a small but significant concentration decline; however, the levels never return to the background concentrations observed in the basal sediments of these cores. The enrichment began between 1900 and 1920 in the middle of the basin; this is contemporaneous with similar findings in Lake CDA (Horowitz, et al., 1995) as well as the completion of Long Lake Dam (1913). In the most downstream part of the basin, enrichment began between 1930 and 1940. This temporal shift may reflect the latter's greater distance from the CDA Basin, but is more likely the result of the completion of Grand Coulee Dam (1934-1941). The decline in trace element enrichment noted in the upper third of all the subsurface sediments appears to have begun around 1970. This is contemporaneous with, and may be the result of the installation of tailings ponds in the CDA Basin, which were designed to limit the downstream dispersion of mine and ore-processing waste.

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EVO2 : TUpo02 : PO
Historical and Contemporary Dynamics Near the Head of the Sacramento Delta, California, USA: A Multi-Disciplinary Approach to Restoration

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The McCormack-Williamson Tract is a large island situated in the Sacramento Delta, California, USA. This leveed 1,600-acre parcel of land is slated for restoration by The Nature Conservancy, with the goal of reverting the island from intensive agriculture to a historical tidal freshwater wetland. To design a sustainable wetland, it is necessary to determine the past and present biogeomorphic processes that have operated at the study site over different time scales. Of particular concern are the interactions between the drainage basin and the delta, especially since the drainage basin is subject to increasing pressure through urbanisation. The approach is to combine data from contemporary vegetation and hydrogeomorphic investigations with shallow reflection seismic and paleoenvironmental research. The on-going investigation is divided into 3 general components: 1) calibration of the contemporary pollen and spore spectra and calibration of the concentration of pollen, suspended sediment, and charcoal in river water; 2) determination of the subsurface geomorphic architecture by shallow seismic reflection profiling using a 48-channel seismograph; and 3) reconstruction of paleoenvironmental history using 10-15 m sediment cores collected by the recently developed Geoprobe direct-push coring rig. The calibration data is used to more accurately interpret fossil pollen and spore assemblages, to identify the over- and underrepresentation of arboreal types, to develop transfer functions of climate (temperature and precipitation), and to create discharge-by-pollen concentration regression equations. The seismic data documents the distribution of past processes in the study area, such as migration of paleochannels and the transitions between deltaic, floodplain, and fluvial-ripiarian sequences. Lithostratigraphic facies are identified using the cores collected for paleoenvironmental reconstruction. Pollen, spores, and charcoal are extracted to reconstruct the paleovegetation and fire disturbance history of the site. Combined, these data will provide a measurement of the richness of biodiversity in the recent past. Sedimentation chronologies are estimated using radiocarbon-14 and ^{210}Pb methods, coupled with known historical geochemical and non-native vegetation markers. Core data is also used to reveal past processes through grain size, bulk density, loss-on-ignition, and magnetic susceptibility profiles. Preliminary results suggest several unique depositional environments have characterised the site in the recent past including Pleistocene glaciofluvial outwash and Holocene floodplain and channel deposits, *Scirpus* marshes and associated mudflats, and riparian oak woodlands.

EVO2 : TUpo03 : PO
Composition of Modern Stream Sands from Sedimentary Source Rocks in a Temperate Climate (Northern Apennines, Italy)

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The northwestern sector of the Italian Apennines is mostly made by sedimentary units; these basically are carbonate Cretaceous-Paleogene flysch (Ligurian Flysch) with minor ophiolite slices representing the remnants of a pre-collisional accretionary wedge, Oligocene-Miocene clastic sequences accumulated into sin-collisional epi-Ligurian piggy-back basins and Oligocene-Miocene foredeep clastic units cropping out in the Val Trebbia tectonic window. Nowadays, this tectonic pile constitutes a medium relief belt (maximum elevation less than 2000 m above s.l.) into a temperate climate, drained by quite short transversal streams flowing northward into the Po River. In order to evaluate if and in which amounts the different sedimentary source rocks are represented in the modern stream sediments, the geology of six contiguous Po tributaries watersheds, covering an overall eroded area of 3100 km^2, was studied and compared with the composition of the resulting river sand-size sediments. As a result, the amount of carbonate rocks cropping out in the drainage basins is quite well reflected in the sediment; the fit becomes even better if the studied area and sediments are considered collectively (49.5 and 47.0 per cent of carbonate rocks in the eroded area and sediment respectively). This means that in a temperate climate, the Apennines relief energy is enough to prevent significant carbonate rock dissolution. By contrast, the amount of siliciclastic source rocks occurring in the basins generally is strongly under-represented in the corresponding sediments; an average of 28.4% in the basins exhibits only 14.8% in the sediments. The only exception occurs in the Trebbia River, where the amount of eroded siliciclastic rocks is perfectly recorded by the sediment (20.5 and 20.8 per cent respectively). This contrasting behavior reflects the difference of sisliciclastic rocks eroded by the Trebbia River with respect to the others; the former eroding well lithified foredeep turbidites from the deepest part of the belt, the others eroding poorly lithified piggy-back sediments from the uppermost part of the belt. Ophiolite rocks are fairly well represented in the sediments,

but they occur as minor constituents even in the detritus shed by streams having ophiolite-lacking drainage basins, due to the recycling of ophiolite-bearing piggy-back deposits. These data provide the base for a quantitative provenance approach to the study of Quaternary Po River Plain alluvial sediments as a tool for unraveling the evolution of the Northern Apennines drainage patterns in response to neo-tectonics and climate changes and, more in general, to the study of ancient sediments fed by recycled sedimentary rock involved into orogenic belts.

EVO2 : TUpo04 : PO
Catastrophic Flooding of the Namib Desert, Namibia- Implications for Hazard Assessments and Reservoir Characterisation

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The northern Namib erg consists of simple and compound transverse and barchanoid dunes, 20-50 m high which forms a 6-20 km wide belt parallel to the Namibian coastline. West ward draining ephemeral rivers traverse the erg only rarely, during exceptional flooding events, following disturbance of the intertropical convergence zone. The April 2000 flood exposed river bank profiles in the Uniab area, enabling detailed facies description and sampling in an older complex fluvio-aeolian setting.

The mechanism for fluvio-aeolian interaction is related to sporadically dune damming of the Uniab River east of the erg. Past dune dams probably formed a huge flood basin behind the dune field. When the water level in the flood basin reached the lowermost point of the threshold dune, the dam collapsed, creating a catastrophic flooding within the erg. As the flood flow incorporated masses of aeolian sand, the flow changed into a hyperconcentrated flow, and in rare cases where enormous reworking of the dunes occurred, flow properties changed into those of a debris flow.

The sediments from these catastrophic floods are almost free of mud (less than 1%), as the majority of the material is reworked aeolian sand. This study is believed to be the first detailed description of these facies and the mechanism for catastrophic floods, which form an important feature in modern and ancient ergs.

The Uniab fluvial sand is derived from the basalt dominated catchment area, east of the erg. The prevailing wind direction in this coastal area is from south-west (land ward), producing a net transport of aeolian sand from an area south and west of the erg. Due to its coastal position, the majority of the aeolian sand is derived from the beach zone, thus feeding the erg with mature quartz sand. The quartz rich aeolian sands mix with less mature sand derived from local source rocks thus diluting their source signal. The differences in composition of the two sand types can be discriminated using whole rock geochemistry, allowing a model for fluvio-aeolian interaction to be proposed.

The Northern Namib erg, is a coastal erg within the 30-degree belts and with fluctuating river and wind directions, represents a typical desert setting. Consequently, results and models proposed in this study are applicable to modern and ancient erg system. The results are therefore important both in modern hazard assessments regarding flood flows and in predictions of reservoir architecture in hydrocarbon reservoir description.

EVO2 : TUpo05 : PO
Impact of Climatic Change on Fluvial Incision in North Tian Shan (Northwestern China)

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We focus on rivers that flow on the northern flank of eastern Tian Shan (NW China). As the rivers exit the high range into the Junggar foreland basin, they deeply embed themselves in large alluvial fans. Topographic analyses of several levels of strath terraces inferred to be of Holocene age yields longitudinal paleoprofiles for two rivers along 10 to 20 km-long alluvial reaches. Amplitude of incision in the fans (more than 1 cm/yr) is regionally much greater than the tectonic deformation, which indicates a state of disequilibrium. Furthermore, terrace slopes decrease from upper levels to actual profiles (from 2% to 1%), so channel gradients decrease with time. We use a classical transport-limited erosion law to model the incision of these types of alluvial channels. Computed profiles show the same trend in slopes, with aggradation of new fans downstream while older material is removed from the upper reaches. This dynamic feature demonstrates the transient behavior of a hydrological system in relaxation, which is likely a function of climatic change.

EVO2 : TUpo06 : PO
An Ancient Volcanic Debris Avalanche Initiated the River Loop? The Mystery of the Danube Bend, Hungary

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Origin of the peculiar, curved shape of the Danube river north of Budapest - traditionally called the Danube Bend - has been debated since the end of the 19th century. Well seen even in small-scale maps or satellite images, the bend, which is apparently a rocky gorge, is located between coeval, Mid-Miocene calc-alkaline volcanic areas: the Börzsöny and Visegrád Mountains. Due to the high position of Quaternary terrace levels of the Danube (identified up to 300-350 m elevations, 200-250 m higher than the present level of the river) as well as the unevenly elevated position of overlying, Mid-Miocene reef limestone, the tectonic uplift of the mountains and the synchronous downcut of the river have long been accepted. However, as for the origin of the Danube Bend, the only proposal was that it may have been a “heritage” of a preceding strait of the Pannonian Sea, the latter having diminished by the end of the Pliocene. No explanation has been put forward for the original negative landform in relation to the initial course of the Danube. Our recent volcanological research in the area started from an early hypothesis (Cholnoky 1937) that in the southern, Visegrád side of the river, there are two U-shaped half-calderas, open toward the Danube Bend. In the area of the proposed inner caldera, widespread dome collapse breccias (made up of monolithological amphibole±biotite andesite) have been found; however, no ignimbrite or other caldera-collapse related deposits have been identified yet. Instead, on the way out of the caldera, and on both sides of the Danube Bend, large volcanic debris avalanche and lahar deposits have been revealed whose volume can equal the missing one-third of the caldera. Therefore, we propose that it is a giant (and/or multiple) volcanic flank failure(s) that should have created a negative topography for a contemporaneous strait, and determined the path of the post-collapse fluvial systems of the Danube in the Quaternary. The evolution of the latter Danube Bend has been strongly controlled by subsequent uplift and tectonic faulting.

Cholnoky J, *Bull. Geogr. Soc. Hung*, **LXV/1**, 1-27, (1937).

EVO2 : TUpo07 : PO
The Effects of Deforestation on Soil Erosion in Tropical Highlands (Sri Lanka) as Quantified by Cosmogenic Nuclides

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Removal of tropical forest is known to result in severe soil erosion, but the actual quantification of this effect has remained difficult. Here we present a combined approach of quantifying both the natural, pre-human rate of erosion (using cosmogenic nuclides), and also the present-day rate of soil erosion (from river suspended matter).

Cosmogenic ^{10}Be was measured in pure quartz from river sediments of six small tributaries of the Upper Mahaweli catchment, Sri Lanka. The rivers are draining a mountain range of 600-2400 m altitude which is underlain by crystalline rocks. The catchments have been covered by thick rain forest up to 200 years ago. Now they are being used extensively for agriculture. In the technique employed, use is made of the fact that cosmogenic nuclides are generated in minerals at the earth’s surface, their concentration decreases exponentially with depth, and they are accumulating steadily with time. Therefore, the measured concentration of ^{10}Be in river sediment is a function of the rate of surface erosion. Our study revealed that rate of erosion for the six Sri Lankan catchments ranges from 10 mm/ky to 30 mm/ky. Moreover, measured erosion rates for both forested and agricultural experimental sites (located in the same Upper Mahaweli catchment) together with a numerical erosion model suggest that the cosmogenic technique is insensitive to recent human effects. Therefore, this novel technique can be used as an effective tool to quantify natural erosion and weathering rates.

The present day soil erosion rates for the same six catchments of Upper Mahaweli were calculated from river load gauging data for the past ten years. It was determined that the present-day soil erosion ranges from 100 mm/ky to 500 mm/ky.

The difference between two methods suggests that deforestation and agriculture has increased the present-day soil erosion by a factor of 10 to 20 over the island’s natural erosion.

EVO2 : TUpo08 : PO
Neogene-Quaternary Tectonics and Morphological Evolution in the Ortles-Cevedale Massif (Italian Alps)

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The Neogene-Quaternary tectonics and the morphological evolution of a large sector of the Ortles-Cevedale Massif (central-eastern Alps) have been analysed within a national project for the new Geological Map of Italy at 1:50.000 scale. The aims of this study are: a) reconstruction of the Neogene-Quaternary tectonics; b) analysis of the relationships between morphological features (such as deep seated gravitational deformations, trenches, etc.) and brittle structures; c) finding evidence of the neotectonic activity. This research is based on remote sensing techniques (satellite images and aerial photographs), field data, calculations of the stress distributions and seismological analysis. We have reconstructed a compressive stress field oriented from NNW-SSE to N-S activating the NE-SW to NNE-SSW faults as sinistral transpressive lineaments and the NW-SE faults as dextral distensive or transtensive lineaments. Several deep seated gravitational deformations, trenches and uphill facing scarps were found along the major tectonic lineaments. Since they are related to a gentle morphology and/or low topographic stress, at least in some cases these geomorphic features are surely due to neotectonics. Distribution, depth and magnitude of earthquakes give a further evidence for activity of some tectonic struc-

tures. In conclusion, new tectonic structures have been recognized allowing a reconstruction of the Neogene-Quaternary brittle tectonics. In spite of the absence of Quaternary deposits or landforms displaced by faults, the morphotectonic structures and earthquakes support the neotectonic activity of this alpine area.

EVO2 : TUpo09 : PO
Major Hydrodynamic Events in Ancient Harbour of Alexandria during the Late Antiquity. Tsunami Deposit or Storm Surges?

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In 1998 and 1999, two borehole projects were organised in the region of Alexandria, Egypt. Stratigraphical, sedimentological and biological studies have allowed us to distinguish several different marine environments during the recent Holocene. The C I core records the infilling of a harbour operational from the Augustean period to late antiquity. The C II core shows stages of accretion of the tombolo which has linked the island of Pharos to the continent for the last 8000 years. The development of the tombolo, at first in the infralittoral zone, and followed by its emersion, has brought about two different morpho-sedimentary evolutions. The eastern bay is characterised by the deposition of fine sediments whereas the western bay is exposed to the dominant swell from the north-west bringing much coarser material. Since the late Antiquity period, the tombolo appears to no longer protect the eastern port, which is exposed to marine influences. Some hypotheses are proposed. Macrofaunistic determinations and quartz exoscopic analyses of the coarse unit, inside the ancient harbour, suggest tsunami deposition. Quartz shows high hydrodynamic features impacts (crush areas, microfracturation lines, desquamation sectors, large cusp impacts) and macrofaunistic determinations present various reworked stocks. These proxies attest for important marine hydrodynamic events in ancient Alexandria.

EVO2 : TUpo10 : PO
Deca-Meter-Scale Holocene Sedimentation on the Vietnamese Shelf

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Shallow seismic survey data aquired during a cruise with the German RV Sonne (Südmeer III) in April 1999 (Wiesner et al., 1999) shows a thick sediment cover on the shelf along the Vietnamese coast. Four sediment cores (18414-3, 18415-2, 18416-2 and 18417-3) from water-depths ranging between 21 and 97 m along a transect have been investigated by component analysis of the coarse fraction (250-500 µm) considering planctonic foraminifers, benthic foraminifers, shell fragments, lithoclasts and plant fragments. The deepest core (18417-3, 97 m waterdepth) shows a general trend from a high percentage of plant fragments in the deeper parts of the core. This indicates a strong influence of terrigenous material, probably due to lower sea level, whereas in the shallower part of the core the amount of shell fragments prevails, indicating a strong marine influence. Core 18416-2 (66 m waterdepth) has been dated by AMS ^{14}C yielding an age of 9820 ^{14}C years BP of *in situ* bivalve shells in his deepest portion, and an age of 9195 ^{14}C years BP one meter below the top. Above, the sediment composition changes from the dominance of shell fragments in the deeper part towards an increasing amount of lithoclasts in the upper part, corresponding to the coarse fraction in core 18415-2 (38 m waterdepth). The age control indicates a high sedimentation rate of 4 meters within less than 700 years. The two shallowest cores show a high amount of shell fragments in their deeper parts passing into a high percentage of lithoclasts indicating a more nearshore position. Core 18414-3 (21 m waterdepth) has an age of 6005 ^{14}C years BP from *in situ* bivalve shells in the lower middle part. Benthic foraminifers of this core have been investigated for their oxygen isotopic composition. The isotope curves of *Nonion subturgitum* and *Elphidium advenum* show a trend from heavier to lighter oxygen isotopes in the range of 0.5 ‰ from the deeper to the shallower parts in the core. This trend in the shallowest core could be the result of an increasing influence of riverine waters due to shoreline progradation following the slight sea level lowering after the last highstand at approx. 5500 years BP and/or due to more humid climatic conditions. Component analysis as well as the seismic record suggests, together with high precision AMS ^{14}C age control, the possibility of teleskoping the cores to an extended section of more than 10 m of Holocene sediments. Future investigations will aim at high resolution stratigraphy and paleoceanographic reconstruction of the Holocene in the coastal, tropical, siliciclastic environment of the Vietnamese shelf.

Wiesner, MG; Stattegger, K; Kuhnt, Wetal, *Cruise Report SONNE 140 SUEDMEER III, Ber. -Rep. Inst. fuer Geowiss. , Universitaet Kiel*, **7**, 157, (1999).