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Oral communications

Poster sessions

RADIOCARBON AND ARCHAEOLOGY – 5TH INTERNATIONAL SYMPOSIUM

Nearly 60 years after the publication of the first radiocarbon ages, the radiocarbon dating method has become the key dating tool in archaeology. Recent years have brought new developments in radiocarbon dating, which are of great interest to archaeologists. Moreover, the growing number of archaeological excavations and the new research into landscape change has resulted in a significant increase of measured radiocarbon ages.
This dynamic development requires a much closer communication and collaboration between radiocarbon and archaeology communities. In an exchange of knowledge the new techniques and tools available in radiocarbon dating can be introduced to the archaeologists and the problematic behind archaeological chronologies can be illustrated for the radiocarbon community.
The series of '^{14}C and archaeology' conferences support communication between the two communities and focuses on questions that are of common interest. The previous four conferences, including the last two in Lyon (1998) and Oxford (2002), have established a tradition of such interdisciplinary discussions.
The conference will focus on the new developments and problems associated with radiocarbon methods as well as their application in archaeological studies.

1. Towards a calendar time scale for the Palaeolithic – extension of the radiocarbon calibration curve beyond 10000 BC
Extension of the calibration curve beyond the present limit of 26 kyrs is of great interest to the whole paleo community. Recently published new data sets provide a baseline for the INTCAL04 update, which has been recently announced. This session will discuss the chronological and archaeological aspects of this development.

2. ^{14}C chronologies, dendrochronology, wiggle matching and calibration tools
Precision of radiocarbon ages is often lost due to calibration. Calibration tools such as wiggle matching or Bayesian based models available in calibration programs (e.g. OxCal) allow for more precise calendar chronologies. Presentations showing examples of improved chronologies of the last 12500 years based on dendrochronology and/or application of ^{14}C wiggle matching or are invited to this session.

3. Radiocarbon, archaeology and landscape change
Radiocarbon dating of artefacts and/or organic residues in natural or human-influenced soils and sediments is a widely used technique to decipher past human activities and, in combination with additional methods, to help reconstructing landscape and climate history. It allows not only the creation of chronological registries of human activity or of geomorphological settings, but also to unravel the nature of these activities and landscape changes thereby induced. This session explores the interface between archaeology and landscape research (as perceived by archaeology and earth science). Its purpose is to create an interdisciplinary platform in order to discuss the various investigative approaches.
The session will address existing and new techniques and their applications in various environmental settings. We welcome case studies of dating, the interpretation of landscape features and related archaeological finds and hope to encourage discussions on the limitations of the methods used. The calibration issues, the conservation of dateable materials, the sampling techniques and the estimation of the in-situ character of the dated objects are some of the problems which have to be taken into consideration when reconstructing landscape changes.

4. How good are ^{14}C ages of bones? Problems and methods applied
Numerous archaeological sites have been dated using bone material. Various preparation techniques have been developed in order to minimize the effects of contamination of bone material. This session is dedicated to preparation techniques and to discussion of chronologies based on bone ages, comparison with other independent ages (or ages on different type of material).

5. Radiocarbon chronologies of the Neolithic and Metal ages
During the last 10 years, extensive radiocarbon dating has substantially modified our perception of prehistoric time and gives us the opportunity to refine the regional chronological frameworks and to reconsider some of the traditional, established models.
Starting from some current researches about the absolute chronology, it should be considered to which extent this "flood of information" has led to certain changes of archeological questions. This session will also give the opportunity to point out the problematic fields, for example the time periods and the regions, in which the chronological problems continue despite an improved data basis.

6. How to improve chronologies of archaeological sites
POSTER SESSION
Papers presenting new innovative method, improvements, studies complementary to the radiocarbon dating method are invited.

PROGRAMM

ORAL COMMUNICATIONS

Conference Location: ETH Zurich Main Building HG (Raemistrasse 101)

Oral Sessions: HG Lecture Hall E3 (ground floor)

Posters & Coffee breaks: HG Main Hall (ground floor)

Wednesday 26.03.2008		
08:00-09:00	**Registration**	
Opening Lectures		
09:00-09:05	**Welcome note**	
09:05-09:35	**M. Suter,** G. Bonani, I Hajdas, M. Ruff, T. Schulze-König, H.-A. Synal, S. Szidat, L. Wacker	Recent developments in accelerator mass spectrometry and its impact to archaeology
09:35-10:05	**Ph. Della Casa**	Radiocarbon Dates and the Earliest Colonization of East Polynesia: More than a Case Study
10:05-10:30	**Coffee break**	
Session 1. Towards a calendar time scale for the Palaeolithic – extension of the radiocarbon calibration curve beyond 10000 BC		
10:30-11:00	**N. Conard (Invited)**	Dating the late Middle Paleolithic and the early Upper Paleolithic in Europe
11:00-11:30	**K. Hughen** and INTCAL Extension Working Group **(Invited)**	Update and extension of the IntCal04 ^{14}C calibration back to 55 ka
11:30-11:50	**B. Kromer,** M. Friedrich, F. Guibal, F. Kaiser, C. Miramont, R. Muscheler and S. Talamo	Tree-ring based ^{14}C calibration in the Late Glacial – Status and perspective
11:50-12:10	**M.-J. Nadeau**, P.M. Grootes, C.M. Hüls, M. Sarnthein	Radiocarbon Calibration beyond 10 000 BC: Limited Data from a variable system
12:10-12:30	**A.A. Sinitsyn**	Towards a calendar time scale for the East European Upper Palaeolithic: evidences of radiocarbon, OSL dating and events of high chronological resolution.
12:30-12:50	**P. Haesaerts,** I. Borziac, V. Chirica, F. Damblon, N. Drozdov, S. Pirson and J. van der Plicht	Climatic signature and radiocarbon chronology of middle and late pleniglacial loess from Eurasia: comparison with marine and Greenland data
12:50-14:30	**Lunch**	
Session 2. ^{14}C chronologies, dendrochronology, wiggle matching and calibration tools		
14:30-15:00	**St. W. Manning (Invited)**	History, Potential and Complications of Radiocarbon Wiggle-Matching
15:00-15:20	**C. Bronk Ramsey (Invited)**	Dealing with multiple radiocarbon dates: methods for integration of chronological information.
15:20-15:40	**C. E. Buck**, G. Boden, J. A. Christen and G. N. James	BCal: a phoenix rises
15:40-16:00	**Ph. Lanos** and Ph. Dufresne	Bayesian Archaeomagnetic and Radiocarbon dating: the RenDate software
16:00-16:30	**Coffee break**	
16:30-16:50	L. J. McColl, **A. R. Millard,** C. E. Buck, P. G. Blackwell and D. G. Froese	Wiggle matching for "blocked" tree-ring samples using the IntCal04 calibration curve model
16:50-17:10	**H. J. Bruins,** J. van der Plicht and J. A. MacGillivray	The Minoan Santorini Eruption and Tsunami Deposits in Crete (Palaikastro): Geological, Archaeological and Radiocarbon Dating
17:10-17:30	**M. Dee**, F. Brock, S. Harris, C. Bronk Ramsey, T. Higham, J. Rowland and A. Shortland[c]	Investigating the Possibility of a Reservoir Effect in Egypt by Utilising Plateaus in the Calibration Curve
17:30-18:30	**Poster Session**	
19:00-	**Visit to the AMS facility &Dendrochronology Lab**	

Thursday 27.03.2008		
Session 3. Radiocarbon, archaeology and landscape change		
08:00-08:30	**E. Eckmeier (Invited)**	Charred organic matter in soils as an indicator for the change of natural to cultural landscapes
08:30-09:00	**M. Bednarz (Invited)**	Digging coal on the slope. The interpretative potential of charcoal samples from colluvial sites
09:00-09:20	**M. A. Kulkova** and S. B. Krasnienko	The impact of Holocene climate on the development of prehistoric societies
09:20-09:40	**F. Favilli,** M. Egli, P. Cherubini, G. Sartori, E. Delbos, W. Haeberli	Comparison of different methods for radiocarbon dating of organic matter fractions in Alpine soils
09:40-10:00	**I. Unkel,** B.Kromer, M. Reindel, L. Wacker, I. Hajdas, K. Lambers, H. Otten, P. Siegle and A. Wetter	A chronology of the pre-Columbian Paracas- and Nasca-culture in South Peru based on AMS-^{14}C-dating
10:00-10:30	**Coffee break**	
10:30-10:50	**A. Michczyński,** O. Gabelmann, A. Pazdur and J. Pawlyta	Radiocarbon Chronology of Santa Lucía, Bolivia
10:50-11:10	**S. Ozainne,** L. Lespez, Y. Le Drezen and B. Eichhorn	Developing a chronology integrating archaeological and environmental data from different contexts: the Late Holocene sequence of Ounjougou (Mali)
11:10-11:30	**P. Szwarczewski**	Sedimentological record of human impact and climate change on selected examples from Mazovian Lowland (Central Poland, Europe)
11:30-11:50	N. Shishlina, **E. Zazovskaya**, S. Sevastyanov', J. van der Plicht, R. Hedges, O.Chichagova	Paleoecology, Subsistence and ^{14}C Chronology of the Eurasian Caspian Steppe Bronze Age
12:00-13:30	**Lunch**	
Session 4. How good are ^{14}C ages of bones? Problems and methods applied		
13:30-14:00	**T. Higham (Invited)**	Radiocarbon dating of ancient bone collagen and its application in archaeology
14:00-14:30	**G. De Mulder**, M. Van Strydonck and M. Boudin **(Invited)**	^{14}C-dating of cremated bones: the issue of sample contamination
14:30-14:50	**A. Motschi**, G. Bonani and I. Hajdas	Teeth, coffins and an impost: Questions concerning the dating of the early phases of the Wasserkirche in Zurich (10-12th century)
14:50-15:10	**A. Denaire**	“Old wood” and “young bone”-effects in the western European Neolithic
15:10-15:30	**E. Boaretto,** E. Mintz, N. Rebollo, and S. Weiner	Bone preservation in relation to charcoal preservation: field and lab observation
15:30-16:00	**Coffee break**	
16:00-16:20	**C. M. Hüls,** P. M. Grootes and M.-J. Nadeau	Ultrafiltration: Boon or Bane?
16:20-16:40	**A. Zazzo,** J.-F. Saliège and A. Person.	Radiocarbon dating of cremated bones: where does the carbon come from?
16:40-17:00	**M. Van Strydonck**, A. Ervynck, M. Vandenbruaene and M. Boudin	Anthropology and ^{14}C analysis of skeletal remains from relic shrines: an unexpected source of information for medieval archaeology
17:00-17:20	**A. Cherkinsky**	Can we get a good radiocarbon age from "bad bone"? Determining the reliability of radiocarbon age of bioapatite.
17:30-18:30	**Poster Session**	
19:00-20:30	**Visit to the Swiss National Museum with Apéro**	

Friday 28.03.2008		
Session 5. Radiocarbon chronologies of the Neolithic and Metal ages		
08:00-08:30	**W.E. Stöckli (Invited)**	Contradictions in the relative chronology: archaeological dating and radiocarbon dating
08:30-09:00	**A. Baylis and A. Whittle (Invited)**	Timing, tempo and temporalities in the early Neolithic of southern Britain
09:00-09:30	**J. Müller (Invited)**	High resolution chronologies and the changing pattern of neolithic societies
09:30-09:50	**P. M. Dolukhanov, N. P.** Gerasimenko, G. A. Pashkevich, N. N. Kovalyukh, V. V. Skripkin and G. I. Zaitseva	The Spread of Neolithic in the South East European Plain: Radiocarbon Chronology, Subsistence and Environment
09:50-10:10	Y. V. Kuzmin, **A. J. T. Jull** and G.S. Burr	Major patterns in the Neolithic chronology of East Asia: issues of the origin of pottery, agriculture, and civilization
10:10-10:30	**M. Piguet** and M. Besse	Chronology and Bell Beaker common ware
10:30-11:00	**Coffee break**	
11:00-11:20	**P. Włodarczak**	Archaeological interpretation of dendrochronological and radiocarbon dates. An example of Corded Ware culture
11:20-11:50	**C. E. Buck,** P. G. Blackwell, M. Charles. and G. Jones.	New tools for modelling the movement of past peoples and cultures
11:50-12:10	**A. Reingruber** and L. Thissen	Depending on ^{14}C-data: chronological frameworks in the Neolithic and Chalcolithic of South-Eastern Europe
12:10-12:30	**G. I. Zaitseva,** V. Skripkin, N.Kovaliukh, G.Possnert, P.Dolukhanov and A.Vybornov	Radiocarbon Dating of Neolithic pottery
12:30-12:50	**I. Passariello,** C. Lubritto, C. Albore Livadie, P. Talamo, A. D'Onofrio and F. Terrasi.	Is it possible to chronologically define the "Avellino Pumices" eruption? And…how long did the human resumption take after the eruption?
12:50-13:15	**Final discussion**	

PROGRAMM

POSTER SESSIONS

POSTERS Session 2. ^{14}C chronologies, dendrochronology, wiggle matching and calibration tools		
2.1	**H. Ozaki**, M. Sakamoto, M. Imamura, H. Matsuzaki, T. Nakamura, K. Kobayashi, E. Niu, S. Itoh and T. Mitsutani	Improvement of radiocarbon dating using local calibration curve for Japan
2.2	**P. J. Reimer,** G. J. McClean, D. W. Beilman and S. E. Crow	Marine reservoir effects in modern mollusc shell and flesh from the Irish coast
2.3	**N. Martinelli**	Radiocarbon and dendro-dating of monoxylous boats from Northern Italy
2.4	**A. Walanus** and D. Nalepka	Calendar age of boundaries arbitrarily determined as radiocarbon age
2.5	**A. Walanus**	The probability imbalance in calibrated radiocarbon age
2.6	**G. I. Zaitseva,** S. Pankova, A. A. Sementsov, S. S. Vasiiev, V. A. Dergachev, H. Jungner, E. Soonninen, E. M. Scott and L. M. Lebedeva	Dating of the Oglakhty Burial Ground of the Tashtyk Culture (Siberia)
2.7	C. Tyers**, J. Sidell,** J. van der Plicht, P. Marshall, G. Cook, C. Bronk Ramsey and A. Bayliss	Wiggle-matching using known-age pine from Jermyn Street, London UK
2.8	**J. Meadows,** A. Bayliss, L. Ladle and R. Scaife	Muddy Fields Forever?
POSTERS Session 3. Radiocarbon, archaeology and landscape change		
3.1	**B. Sekar** and A. K. Pokharia	Application of ^{14}C dating towards solving archaeological problems- A case study - Antiquity of custard-apple in India
3.2	M. Giersz, P. Prządka-Giersz, **A. Michczyński** and A. Pazdur	A View from the Andes: Prehispanic Settlement Patterns and Absolute Chronology of the Culebras Valley, North Coast of Peru
3.3	**K. Klimek** and E. Zygmunt	Prehistoric and Early Medieval landscape changes in the light of radiocarbon dates:the north-eastern foreland of the Sudetes Mts, Poland
3.4	**J. Mazeika**, M. Stancikaite, D. Kisieliene and P. Blazevicius	Radiocarbon dating and palaeobotanical investigations in the territory of Vilnius Lower Castle, Lithuania
3.5	M. Błonski and **P. Szwarczewski**	Nasielna River Valley in Nasielsk - a Study of Anthropogenic Changes (IXth Century - XXIst Century)
3.6	A.M. Wyrwa, T. Goslar and **J. Czernik**	AMS ^{14}C dating of romanesque rotunda and stone buildings of medieval monastery in Ł,ekno, Poland
3.7	**P. Szwarczewski**	The formation of deluvial sediments and alluvial cones as the Response to Human Settlement on a Loess Plateau – an example from the Chroberz Area (Nida Basin, Little Poland Upland)
3.8	**A. Zhou** and F. Chen	Radiocarbon reservoir effect in dating lake sediment: based on Varve chronology of Sugan Lake
3.9	**Z. Wang** and D. Ji	The origin of agriculture in northern China – A case study: Dadiwan, Gansu province
POSTERS Session 4. How good are ^{14}C ages of bones? Problems and methods applied		
4.1	**E. I. Alexandrovskaya,** M.G. Zhilin, J. van der Plicht and A. L. Alexandrovskiy	Radiocarbon and Anthropochemical Studies of Mesolithic Human Bones From the Upper Volga
4.2	**A. L. Alexandrovskiy,** E. I. Alexandrovskaya, J. van der Plicht, N.N. Kovalyukh, V.V. Skripkin	Radiocarbon and Anthropochemical Studies in the Andronikov Monastery
4.3	**K. Arslanov**	A reliable method for extraction and purification of collagen from fossil bones
4.4	I. Hajdas, **A. Michczynski**, G. Bonani and L. Wacker	Dating Bones near the limit of the radiocarbon dating method: Study case Mammoth from Niederweningen
4.5	**C.M. Hüls,** P.M. Grootes, M.-J. Nadeau	Dating bones without collagen
4.6	M. Van Strydonck, M. Boudin, **G. De Mulder**	^{14}C-dating of cremated bones: the issue of sample contamination
POSTERS Session 5. Radiocarbon chronologies of the Neolithic and Metal ages		
5.1	**K. Davison**, P.M. Dolukhanov, G.R. Sarson, R. Shiel, A Shukurov and M. Y. Videiko	Agriculture and settlement patterns of the Cucuteni-Tripolye culture
5.2	**I. Krajcar Bronić** and K. Minichreiter	New ^{14}C dates of the oldest Early Neolithic settlements in Croatia

5.3	R. F. Mazurowski, **D. J. Michczyńska**, A. Pazdur and N. Piotrowska	Chronology of the early pre-pottery Neolithic settlement Tell Qaramel, Northern Syria, in the light of radiocarbon dating
5.4	**A.Z. Rakowski,** G. McIntosh, G. Catanzariti, M. L. Osete and T Nakamura	A comparison of radiocarbon and archaeomagnetic dating
5.5	**E. Valzolgher**	Radiocarbon Dating of the Copper Age Megalithic Site of Velturno/Feldthurns-Tanzgasse, South Tyrol, Italy.
5.6	**E. Valzolgher**	AMS Dates from the Copper Age/Early Bronze Age Rockshelter of Peri, Northern Italy.
5.7	**M. Wuttmann,** M. Mahran and N. Sabri	The datation of the palace of the governors at Balat (Dakhla Oasis, Egypt): a contribution to the Egyptian Old Kingdom and First Intermediate chronology.
5.8	**G.I. Zaitseva,** P.M. Dolukhanov, G. Possnert, M.M. Cheryavski and I.N. Yezepenko	New data on radiocarbon chronology of the Neolithic sites of Byelorussia and neighbouring territories based on the food residual of pottery.
5.9	**A. I. Zagorska**, B. L. Lõugas, C. K. Mannermaa and D. H. Jungner	Radiocarbon ages of bones from Zvejnieki burial ground, Latvia
5.10	**A. Engovatova** and I. Saprykina	New dates of Neolithic radiocarbon chronology in the central part of Eastern Europe
5.11	**S. van Willigen**, I. Hajdas and G. Bonani	New radiocarbon dates for the early Neolithic of western Mediterranean
POSTERS Session 6. How to improve chronologies of archaeological sites		
6.1	**F. Brock**, T. Higham, M. Peresani and A. Broglio	AMS radiocarbon of Palaeolithic-aged charcoal using ABOX-SC
6.2	**K. Douka,** R.E.M. Hedges and T. Higham.	Improving the radiocarbon dating of shell carbonates from Palaeolithic archaeological sites in the Mediterranean Rim
6.3	**D. Nawrocka**, J. Czernik, J. Michniewicz and T. Goslar	Verification of ^{14}C dating of carbonate mortar
6.4	**M. Oinonen**, G. Haggren, A. Kaskela, M. Lavento, V. Palonen and P. Tikkanen	Radiocarbon dating of iron – a northern contribution.
6.5	**G. Pesce,** P. Cavaciocchi and C. Lastrico	Radiocarbon dating of aerial lime mortars: considerations on the applicability of method and on the limitations of using data. The study case of S. Nicolò of Capodimonte church (Camogli – Genoa)
6.6	**N. Rebollo**, I. Cohen-Ofri, O. Bar-Yosef, L. Meignen, P. Goldberg, S. Weiner and E. Boaretto	Microstructural effects of low and high pH on fossil charcoal: implications for Radiocarbon Dating
6.7	**F.J. Santos,** I. Gómez-Martínez and M. García-León	Radiocarbon measurement programme at the Centro Nacional de Aceleradores (CNA).
6.8	**M. Senn,** I. Hajdas, L. Eschenlohr, C. Deslex, S. Schreyer and L. Wacker	Also ancient iron artifacts can be dated by radiocarbon
6.9	**R. E. Wood** and T. Higham	The chronology of the Middle to Upper Palaeolithic transition in Iberia: the problems and a way forward
6.10	**E.M. Wild**, K. Rumpelmayr, P. Steier, M. Teschler-Nicola, F. Novotny, M. Spannagl and H. Friesinger	First ^{14}C and stable isotope results of the Early Medieval site at Gars-Thunau, Lower Austria
6.11	**E.M. Wild**, C. Neugebauer-Maresch, Th. Einwögerer, M. Haendel, U. Simon, P. Steier and M. Teschler-Nicola	^{14}C Dating of the Upper Paleolithic Site at Krems-Wachtberg, Austria
6.12	**A.M. Monge Soares**, A. F. Carvalho and J. M. Matos Martins	Human Skeletons from the Mesolithic Shell Middens of Muge (Tagus Estuary, Portugal) – Isotope Composition, Reservoir Effect, and Radiocarbon Dating
6.13	Y.Y. Li, **L.P. Zhou** and X.S. Sun	AMS ^{14}C dating of plant remains from archaeological sites in the Western Liaohe River Basin, northeastern China
6.14	**M.-J. Nadeau**, C.M. Hüls and P.M. Grootes	Attention Fraud: modern fabrics made to date old
6.15	**M. Ruff**, I. Hajdas, T. Jenk, H.-A. Synal, S. Szidat and L. Wacker	Radiocarbon dating of small samples

OPENING LECTURES

Recent developments in accelerator mass spectrometry and its impact to archaeology

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The invention of accelerator mass spectrometry (AMS) 30 years ago had a large impact on carbon dating and also for its application in archaeology. The new method allowed analyzing samples of milligram size which opened the possibility of the dating valuable object almost non-destructive. Today AMS is a well established method which has replaced decay counting to a large extent.
Originally, relatively large and complex accelerators were used for AMS, which were initially designed for nuclear research. Significant advances have been made during the last 10 years with the development of new generations of very compact AMS facilities, which are especially suited for radiocarbon measurements. The most advanced instruments have footprints of about 2.5 x 3 m^2 and are operated a voltages of about 200 kV. They fit into a regular size laboratory, are much simpler in operation and provide high performance at much lower cost.
At the same time significant progress has been made in the ion source performance of these instruments. Higher beam currents help reducing measuring time and are the basis for high precision work. Ion sources providing a direct gas feed for operation with CO_2 are eliminating the graphitization step in sample preparation and thus reducing contamination especially for small samples in the range of 20-100 μg. Gas ion sources have the potential for being connected to various chromatographic systems for on-line chemistry.
An overview of the recent instrumental developments made at ETH is given and implications to radiocarbon dating in archaeology are discussed.

Radiocarbon Dates and the Earliest Colonization of East Polynesia: More than a Case Study

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Over the last 30 years, there has been an ongoing debate on the dates and modes of the earliest colonization of east Polynesia, namely the Cook islands, the five archipelagos of French Polynesia, the Hawaii islands, Easter island and New Zealand. At least three alternative models have been proposed by Sinoto, Anderson, Kirch, and more recently Conte, but interestingly all these models basically rely on the same set of roughly 150 radiocarbon dates on various organic materials from archaeological excavations as far back as the 1950s. Some of the models differ by 500-1000 years – for a proposed initial colonization around the turn of BC/AD eras.
By comparing the different approaches to this chronological issue, it becomes evident that almost all known problems in dealing with radiocarbon dates from archaeological excavations are involved: stratigraphy and exact location of samples, sample material and quality, lab errors in ancient dates, etc. More recently, researches into landscape and vegetation history have produced alternative radiocarbon dating for early human impact, adding to the confusion about the initial stages of island colonization.
As it appears, the Polynesian case is more than just a case study, it's a lesson on radiocarbon-based archaeological chronology. The present lecture does not pretend to solve the problems of early Polynesian colonization, but intends to open up the debate on how radiocarbon specialists and archaeologists might cooperate in future.

Conte, E. (2000) L'archéologie en Polynésie française. Esquisse d'un bilan critique (Tahiti: Aux vent des îles).
Spriggs, M. & Anderson, A. (1993) Late colonization of East Polynesia. Antiquity 67-255, 200–217.

SESSION 1

TOWARDS A CALENDAR TIME SCALE FOR THE PALAEOLITHIC – EXTENSION OF THE RADIOCARBON CALIBRATION CURVE BEYOND 10000 BC

Dating the late Middle Paleolithic and the early Upper Paleolithic in Europe

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The transition from the Middle to the Upper Paleolithic in Europe dates between roughly 30,000 and 40,000 years ago. This is the period in which modern humans arrived in Europe and replaced the indigenous Neanderthals. This transition is also associated with a wide array of cultural developments including diverse technological innovations, the widespread use of personal ornaments, and the earliest evidence for figurative art and musical instruments.
Reliable data on the spatio-temporal patterning of these important events in prehistory and paleoanthropology is a prerequisite for building and testing models to explain why these events took place. At present the poor temporal resolution of this period in prehistory is one of the greatest problems facing Paleolithic archaeologists. This paper will address why researchers have thus far been unable to establish high resolution chronologies for this period. Using data from excavations in the Swabian Jura including the sites of Geißenklösterle and Hohle Fels, this paper will illustrate some of the persistent problems and some potential solutions for dating the late Middle and the early Upper Paleolithic. The paper will also address the implications the available dates for testing mono- and polycentric models for cultural innovations at this critical threshold in human evolution.

Update and extension of the IntCal04 ^{14}C calibration back to 55 ka

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During construction of the IntCal04 radiocarbon calibration curve, absolutely-dated tree ring data extended back to ~12.4 ka. Beyond that date, high-resolution marine ^{14}C data from annually varved Cariaco basin sediments and U/Th-dated corals were used to extend calibration to ~14.7 ka, and corals alone anchored the calibration curve back into the Glacial period. Beyond about 26 ka, coral data were less frequent and other available data sets showed large discrepancies. As a result no calibration curve was provided for the interval from 26 to 55 ka. Following completion of IntCal04 however, new data sets were published providing calibration information for this period, including U/Th dated corals, and marine sediments linked to calendar chronologies through high-resolution paleoclimate records. These ^{14}C data show generally good agreement back to 55 ka, and have been combined using the methods of IntCal04 to produce an updated curve anchoring radiocarbon calibration over the full radiocarbon time span. A significant change from IntCal04 is the incorporation of new evidence for abrupt changes in marine reservoir ages. A floating tree ring sequence covering part of the last deglaciation suggests that reservoir age in the subtropical North Atlantic decreased dramatically near the onset of the Younger Dryas cold period. Data from this interval from varved Cariaco basin sediments and Barbados corals were therefore removed from the updated data set prior to running the random-walk model to construct the curve. The resulting curve shifts the rapid ^{14}C change associated with the Younger Dryas toward younger ages by nearly 300 calendar years. Overall, this new calibration curve eliminates known errors associated with marine reservoir variability and provides a significant extension beyond IntCal04, effectively doubling the time span covered.

Tree-ring based ^{14}C calibration in the Late Glacial – Status and perspective

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Radiocarbon calibration of terrestrial samples, e.g. in archaeological studies, is best done based on tree-ring chronologies, because the underlying time-scale is accurate to one year and the ^{14}C content of tree-ring cellulose reflects most directly the atmospheric ^{14}C level. Presently the absolutely dated Central European oak and pine chronologies range back to 12.594 calendar years BP (Schaub et al. 2007), i.e. covering already most of the Younger Dryas (YD). For the Late Glacial two long pine floating pine chronologies exist, built independently in the Hohenheim and Zurich tree-ring laboratories, but cross-matched recently into one chronology. ^{14}C ages range between 12.200 and 10.600 ^{14}C BP. In addition, from the French Pre-Alps we have pine chronologies from three sites, with ^{14}C ages in the same range and extending into the second half of YD.
Previously we used the strong ^{14}C signal at the onset of YD to anchor the floating tree-ring chronologies to the Cariaco marine ^{14}C data set (Kromer et al. 2004), and concluded that changes in marine reservoir age were required at the Cariaco site to match the ^{14}C sequence of the floating tree-ring chronologies to the Cariaco data, with consequences for the calibration curve IntCal04 in the Allerød/Bølling interval.
An alternative solution was recently proposed. It uses the coeval production signal of ^{10}Be in ice core and ^{14}C in tree-rings to link the floating tree-rings to the Greenland ice core time scale GICC05 (Muscheler et al. 2007). This link results in a younger absolute age of the tree-ring chronology, compared to the match to Cariaco, and would even suggest an overlap between the floating and the absolutely dated chronologies. In the contribution the ongoing work of our collaboration is presented, and the consequences for ^{14}C calibration in the Late Glacial is discussed.

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Radiocarbon Calibration beyond 10 000 BC: Limited Data from a variable system

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Constructing a calendar time scale for the Paleolithic via radiocarbon dating is highly desired, but has turned out to be also highly problematic. Apparent conflicts between radiocarbon dates and stratigraphic context have been blamed both on bad dates and on disturbed stratigraphy. Although both undoubtedly occur, recent results suggest whims of Nature, in this case large variations in the atmospheric ^{14}C concentration, may be equally to blame. This is particularly important for the current efforts to extend the radiocarbon calibration curve beyond 10 000 BC, the range of tree ring calibration data.

^{14}C concentrations observed in corals and planktic foraminifera from carefully chosen locations are translated for IntCal04 into atmospheric values assuming a constant local reservoir age, and a calibration curve has been constructed statistically back to 26 cal kyr BP. Several long ^{14}C records back to the limit of ^{14}C dating show in general a similar trend, but also large and sometimes apparently inconsistent variations. Whether size and shape of the fluctuations in ^{14}C concentration and apparent inconsistencies reflect ^{14}C production, changes in the carbon cycle, local oceanography or hydrology, or low resolution sampling artifacts of a highly variable record needs to be discussed. Plateau tuning of several high resolution ^{14}C records of the glacial-interglacial transition in ocean sediments already has demonstrated major changes in meridional overturning circulation (MOC) and local reservoir ages. Opposite trends in paleoreservoir ages indicate a shortlasting phase - 17.5 to less than 14.6 cal. ka - of deep and intermediate-water formation in the North Pacific coeval with a brief northward reversal of Denmark Strait Overflow waters in the North Atlantic.

Towards a calendar time scale for the East European Upper Palaeolithic: evidences of radiocarbon, OSL datings and events of high chronological resolution

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Despite of increasing amount of radiocarbon dates and analytic studies related to chronological problems, multilayer sites remain to be the most reliable base for the chronological correlations. Principal meaning for East European Upper Palaeolithic have two cultural-stratigraphic sequences: Molodovo and Kostenki.
The Molodovo model constructed during 1950-60s in classical works by A.P. Chernysh and I.K. Ivanova and recently updated in by P. Haesaerts (Belgium), represents a unilinear model of evolution covering a large time span from Middle Palaeolithic up to Mesolithic.
The Kostenki model has been under construction untill now and remains to be incomplete, because it bases on number of sites, sections of which are used as a compliment one another. In its classical form the Kostenki model was first developed in 1950-60s by A.N. Rogachev in cooperation with G.I. Lazukov and A.A. Velichko. It was a tripartite sequence based on the triple subdivision of the sedimentary formation. Sites of the late (III) chronological group were related to the loess-like silts of the colluvial mantle on the II and Ist river terraces. The middle (II) and ancient (I) groups were associated with two humic beds separated by volcanic ash. Their chronological brackets were established as 36-33 kyr for ancient; 32-27 kyr for middle, and 26-20 kyr for the recent groups according to the series of radiocarbon dates provided in 1980s by joint efforts of N.D. Praslov and L.D. Sulerzhitsky. Sites of the Last Glacial Maximum according to this model were absent at Kostenki due to the lack of a sedimentary record for that time.
Due to excavation of 1998-2007 at Kostenki 14 (Markina Gora), the site became to be a key section both for geological and cultural sequences of the region with the complete series of 9 cultural layers relating to the late MIS 3 - early MIS 2, or in geochronometric terms – to 44(?)-22 kyr interval. The section appears to be one of the best equipped by analytic data: there are 2 pollen diagrams plus a series of more than 60 radiocarbon and 40 OSL-IRSL dates counted in different laboratories. Of particular significance are the chronologic markers of high temporal resolution. These are layer of the volcanic ash connected with Campanian Ignimbrite (CI) eruption at the Phlegraean Fields Caldera in southern Italy dated to 39-41 calendar kyr, and paleaeomagnetic excursion Lachamp-Kargopolovo (~42 kyr) related to the sediments of a fossil soil beneath the tephra layer. Cultural layer of Aurignacian attribution with radiocarbon dates of 32 kyr (~37 cal) in the volcanic ash, and cultural layer provided a new before unknown cultural tradition with radiocarbon series of 36-37 kyr (41-42 cal) in the sediments under the fossil soil with paleaeomagnetic excursion are the base for the formation of two time scales. New OSL series made by J-I.Svendsen and J.Mangerud (Bergen) in Aarhus (A.Murray) provided en evidences in favor of "long" scale.
The problem of calendar time of Palaeolithic cultural layers appears to be more complex than direct calibration of radiocarbon dates but has to have a correlation with all available chronological evidences for theirs mutual corrections.

Climatic signature and radiocarbon chronology of middle and late pleniglacial loess from Eurasia : comparison with marine and Greenland data

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During the last decade, investigations devoted to complementary long lœss records with pluristratified Palaeolithic settlements rich in charcoal, from the East Carpathian Area allow a new insight on the palaeoenvironmental background and chronology of the middle and late pleniglacial successions. This approach centred on the Palaeolithic settlements of Molodova V and Cosautsi along the Dniestre and Mitoc-Malu Galben along the Romanian bank of the Prut (Haesaerts *et al*., 2003), has provided a high resolution climatic sequence with a strong chronological framework back to ± 33 ka uncal BP set up on large series of radiocarbon dates. The degree of resolution of the middle pleniglacial succession was further improved with the loess sequence of Kurtak (Central Siberia), which provided a remarkable climatic record well dated from 26 ka to 42,5 ka BP on wood remains and charcoal (Haesaerts *et al*., 2005). These complementary sequences give way for the first time to an almost semi-continuous reproducible palaeoclimatic sequence for the period between ± 45 ka and 10 ka BP encompassing about twenty-three short interstadial events with a degree of resolution close to several centuries. This approach confirms the predominance of highly unstable environmental conditions during OIS 3 and OIS 2 on the scale of the Eurasian Continent and leads to a better understanding, in a global perspective, of the distribution of the loess sedimentation with regard to the maximum extension of the northern ice cap. In this way, the integrated palaeoclimatic loess sequence could be compared by proxy-correlation with the climatic signal recognized in the fluctuations of ^{18}O in the Greenland ice cores, taking into account the distribution of the aeolian components in both records. This correlation allows also the atmospheric radiocarbon ages of the lœss sequence to be compared with the Greenland calendar chronology; it gives further access to the corrected chronology based on paired ^{14}C and U/Th dates, correlated with the Greenland record via the climatic signal of the marine sequence preserved along the Iberian margin.

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SESSION 2

^{14}C CHRONOLOGIES, DENDROCHRONOLOGY, WIGGLE MATCHING AND CALIBRATION TOOLS

History, Potential and Complications of Radiocarbon Wiggle-Matching

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The concept of radiocarbon wiggle-matching is now four decades old. But for some 60% of that time it had little to no real impact in archaeological or environmental chronology, and arguably it has only been in the last dozen or so years that the topic has really taken off. The explanation for this slow development trajectory lies partly in the history of related technological developments (especially the recent availability of higher-precision AMS; and the availability of accessible computer equipment and software) and partly in the time it takes for conceptual changes to become integrated into other fields (e.g. archaeology). After a brief review of the history of radiocarbon wiggle-matching, this overview paper will then consider:

- The potential of the method at present illustrating the ability greatly to enhance chronological precision in archaeology and environmental sciences applications, using a combination of some recent/unpublished case studies and some hypothetical examples looking to sophisticated future applications; and
- Some of the various complicating factors which particularly start to come into play as radiocarbon based chronologies seek to become high-precision. What are the limits to wiggle-matching? What issues need to be addressed as we move forward?

Dealing with multiple radiocarbon dates: methods for integration of chronological information.

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A radiocarbon measurement is on its own only a measurement of isotope ratio. In order to interpret any such measurements as dates other information must be used. For single measurements relating to single events, this is principally the information we have on past radiocarbon concentrations (via the calibration curve) and information on the organism from which the sample came (it's diet and lifecycle). A calibrated date is itself therefore already an amalgam of information from different sources.

With multiple radiocarbon dates, other information can also be included in analysis. This can include, the ordering of events, known age gaps (for example with wood with tree rings), and depth information in sedimentary sequences. In addition to these types of direct information other information is equally important in any statistical analysis – in particular the grouping of events.

The methods available for this sort of analysis are potentially very powerful and can in some circumstances provide chronological resolution almost an order of magnitude better than is available from calibration of single dates. However, the methods also demand a lot in terms of the integrity of the measurements and the other information that goes into the analysis. For this reason it is important to include in such analyses, tests of their sensitivity to underlying assumptions. It is also critical that the underlying data for such analyses are published so that others can either reproduce the results, or interpret the data in a different way.

BCal: a phoenix rises

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A decade ago, the authors of this presentation joined forces to provide the first on-line Bayesian radiocarbon calibration software; known as BCal. Since its launch in 1999 (Buck et al, 1999), BCal has been popular with users in both archaeology and palaeoenvironmental science who have found it to provide a robust framework within which to combine radiocarbon determinations and *a priori* chronological information such as historical dates and stratigraphic sequences. The software is intuitive, but makes no guesses about what the user intends, offering a step-by-step interface to what is otherwise a fairly daunting model-building process. It is also still the only fully Bayesian radiocarbon calibration software available.
The hardware on which the service is hosted (a SUN Ultra 60) has proven durable and the software reliable and BCal has many loyal users around the world. Recently, however, we have been struggling to accommodate all of those wishing to use the service. Given the usual difficulty in obtaining funding for software services in academia, BCal seemed to have reached the end of its life. That was, until we alerted the user community to our dilemma and (as one of them so eloquently put it) the "phoenix began to arise from the ashes".
With monetary donations from some users, hardware gifts from others and the encouragement of colleagues worldwide, a team of volunteer programmers has ported the BCal software from the SUN Ultra to PC hardware and from a single machine to a multi-client network of machines around the world. This port will allow us to continue to provide the high quality, user friendly service that we have provided for almost a decade, but now hosted on hardware that is scalable and software that is more amenable to update by the volunteer group.
This presentation will launch the new service, highlight a range of user features which make BCal unique, explain how others can become involved in the project and invite those with available computing resources to configure their machines to become a part of the BCal network thus spreading the computational load across timezones.

C. E. Buck, J. A. Christen and G. N. James (199) BCal: an on-line Bayesian radiocarbon calibration tool, *Internet Archaeology*, **7**, http://intarch.ac.uk/journal/issue7/buck/.

Bayesian Archaeomagnetic and Radiocarbon dating: the RenDate software

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The Bayesian statistical framework allows us to estimate the calendar dates of undated archaeological features (such as kilns or ceramics) based on one, two or three geomagnetic parameters (inclination, declination and/or intensity). The "RenDate" software now allows the date estimates to be presented in much the same way as those that arise from radiocarbon dating. It is also possible to combine different dating results owning to one or several stratigraphic sequences. In order to illustrate the models and inference methods used, we will present results combining magnetic data with chronometric data (radiocarbon or thermoluminescence dating), relative dating (stratigraphy) and chrono-correlation information (based on chronotypology for instance). The important notion of Bayesian “phase”, or how to define a time distribution for some set of events, will be introduced. In addition, chrono-correlation between phases from different sequences is implemented based on the notion of similarity. The RenDate software will be presented and used to show the models and results we can construct and obtain when it is applied to archaeological data

Wiggle matching for "blocked" tree-ring samples using the IntCal04 calibration curve model

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A variety of methods have been used in the past for wiggle-matching of radiocarbon-dated tree-ring sequences to the calibration curve (Bronk Ramsey *et al.*, 2001). With the advent of IntCal04 and a smoother calibration curve, fears were expressed by some workers that this would inhibit the use of wiggles in the curve to obtain precise matches.
The methods previously used for wiggle-matching have (implicitly) assumed that the radiocarbon values, both from the calibration curve and the sample, can be treated as if they were independent observations related to single years. This was rarely true in either case. The values provided for IntCal04 *are* estimates of the single year values at the given years (though not independent), but in most cases the dates from tree-ring sequences are averages of 5 or 10 year blocks of rings.
This paper proposes the use of a method where the blocks of tree-rings dated for a wiggle-match are compared to the calibration curve using a method similar to that used for construction of the curve (Buck and Blackwell, 2004), which allows for the fact that the observations are averages of the atmospheric radiocarbon content over a known number of years, and for temporally overlapping blocks of tree-rings. It also examines whether the correlation of the uncertainties in the calibration curve points needs to be taken into account in the wiggle-match. It thus removes some of the inherent approximations of earlier methods, removes the limitation of no temporal overlap of blocks, and is self-consistent in using a common model for the origin of the observed data and the calibration data.
Using a series of artificial and real case-studies (notably the dating of the White River Eastern Lobe volcanic eruption in Southern Yukon, Canada), we show that allowing for the blocked nature of the sample to be wiggle-matched can increase the precision of the results, decreasing the span of the 95% posterior density date range by up to 8% in our examples. Accounting for the covariance structure of the calibration curve has a smaller impact on precision, usually increasing posterior ranges only slightly.

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The Minoan Santorini Eruption and Tsunami Deposits in Crete (Palaikastro): Geological, Archaeological and Radiocarbon Dating.

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Deposits from the Minoan Santorini eruption in the eastern Mediterranean region constitute the most important regional stratigraphic anchor in the chronological perplexity of the 2nd millennium BCE. This volcanic upheaval – now classified as 'super-colossal' with a volcanic explosivity index (VEI) of 7 – was the largest eruption in the region during the Holocene. Substantial geoarchaeological tsunami deposits, containing volcanic Santorini ash, were recently discovered – identified – for the first time in Crete, at the Minoan site of Palaikastro in the north-eastern part of the island (Bruins et al., 2008).

Relative geological dating indicates that the tsunami occurred after the deposition of airborne volcanic Santorini ash over eastern Crete. The tsunami was apparently caused by pyroclastic flows and/or caldera collapse in the final stages of the eruption sequence. Archaeological dating of the tsunami deposits based on ceramics relates the event to the Late Minoan IA period along the coastline and also at the main archaeological excavation site about 300 m inland. Radiocarbon dating of cattle bones in the tsunami deposits along the coast and at the inland archaeological site, also here stratigraphically related to volcanic Santorini ash, all give dates in agreement with the average uncalibrated ^{14}C date for the Minoan Santorini eruption (Bronk Ramsey et al., 2004). Radiocarbon dates of a number of *in situ* marine shells in the tsunami deposits along the coast also accommodate the ^{14}C date of the eruption. Therefore, the large Minoan site of Palaikastro in Crete exhibits a unique combination of features that are very important in the study of cultural archaeological links in relation to the Santorini eruption: Airborne volcanic Santorini ash within a detailed archaeological stratigraphy, tsunami deposits that reworked the volcanic ash, all linked to the Late Minoan IA cultural period and ^{14}C dates of different bones from these layers in areas spatially apart by 300 m that are similar with the ^{14}C date of the eruption. The large difference between radiocarbon dating and archaeological dating for the LM IA period and the Santorini eruption (Manning et al., 2006; Bietak and Höflmayer, 2007) is hereby confirmed in detail for the Cretan site of Palaikastro. The reasons for this discrepancy have not yet been resolved. Therefore, it is our opinion, unlike Manning et al. (2006), that a dual dating system should be maintained in parallel: archaeological dating linked culturally with Egyptian historical dates on the one hand and radiocarbon dating on the other. Mixing dates from one system into the other may lead to erroneous archaeological and historical correlations.

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Investigating the Possibility of a Reservoir Effect in Egypt by Utilising Plateaus in the Calibration Curve

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Text: Radiocarbon results for Ancient Egyptian contexts have been marked by their inconsistency with historical records. Furthermore, the discrepancies have not always been satisfactorily explained. One possible cause is an alluvial reservoir effect, intuitively supported by the abundance of limestone along the Nile Valley. Could such an environmental source have created a localised depletion in radiocarbon activity? As part of the Egyptian Chronology project at the University of Oxford, this possibility has been thoroughly investigated. The most suitable samples were identified to be short-lived plants, grown in Egypt and of exact known age. However, due to the construction of the Aswan dams in the 20th Century, the hydrology and growing environment of present-day Egypt is incomparably different from that of the Dynastic period. Accordingly, botanical specimens from the 18th and 19th centuries were obtained from the University of Oxford Herbaria and the Herbaria of the Natural History Museum in London. In all, more than 60 samples spanning nearly 200 years were acquired. The flatness of the calibration curve over this period, usually considered problematic, provided an advantageous platform against which the uncalibrated measurements could be compared for any evidence of a systematic offset.

SESSION 3

RADIOCARBON, ARCHAEOLOGY AND LANDSCAPE CHANGE

Charred organic matter in soils as an indicator for the change of natural to cultural landscapes

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During Late-Neolithic (3500-2200 BC), agricultural practice in the Lower Rhine Basin (NW-Germany) changed from ploughless agriculture to a presumably fire-based livestock farming. These changes were connected to a strong human impact visible in nearly all terrestrial archives (e.g. extensive changes in tree species composition). The natural landscape was transformed into a cultural landscape. To reconstruct such past environmental processes and changes, radiocarbon dating of macroscopically visible charcoal particles (macrocharcoal) taken from soils is commonly used. Dating of chemically isolated microcharcoal, i.e. black carbon, could provide information if macroscopic charcoal is absent.
We acquired ^{14}C AMS ages of macrocharcoal particles and of chemically isolated microcharcoal. Both charcoal fractions were separated from soil samples taken from dark relic Anthrosols in the Lower Rhine Basin. These soil horizons were always connected to anthropogenic pits, which did not contain any artefacts but charred organic matter. Macrocharcoal particles were hand-picked from the soil material, and the proportion of charred material in soil organic matter was examined by isolation and identification of black carbon via UV photo-oxidation and ^{13}C NMR.
Large proportions of the organic matter taken from the dark soils consisted of charred organic matter (19 to 46 % of soil organic carbon). The radiocarbon ages of macrocharcoal and black carbon indicated the presence of fires from 12800-12150 calBP to 1275-1170 calBP. We found that microcharcoal seems to be more resistant to degradation than macrocharcoal and thus yields more conservative radiocarbon dates. Microcharcoal ages could be apparently mixed ages while single charcoal particles would date a single event. Ages of both fractions are therefore not comparable, but chemically separated microcharcoal could nevertheless be used for dating.
Temperate deciduous forests could not be easily ignited by natural causes. Thus, mainly human induced fires are very likely the sources of the detected charred organic matter. We concluded that the investigated dark soils are relics of prehistoric agricultural burning activities in NW-Germany, possibly providing the basis for the change to a cultural landscape in Late-Neolithic.

Digging coal on the slope. The interpretative potential of charcoal samples from colluvial sites.

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Colluvial sites, typical for areas with rugged relief, are not much prized by archaeologists. Their clay and silty deposits are ungrateful in digging, structures are badly readable, very often strongly transformed or even destroyed by various post-depositional processes, artifacts are eroded and dispersed in secondary position on the whole length of the slope.
Large-scale rescue excavations connected with programs of motorways and dams building induced archaeologists to enter on these quasi virgin domains, where the scarcity of "neat" finds forced them to turn to natural sciences, which in this time considerably extended their analytical abilities.
Of course, since several decades the concept of "context" took a very important place in the archaeological paradigm, but now it happens, that in some extreme cases we have (from the traditional archaeology point of view) "only the context and almost nothing inside".
It may turn out that the idea of "poor site" is relative, even if coal (as charcoal samples) remains the main resource of the explored area. It may also turn out that even the small amount of structures and archaeological material, when set on a solid frame of stratigraphy, interdisciplinary analyses and radiocarbon dating, allows us to accomplish reconstructions comparable with settlements known from cave and wetland multilayer deposits. Continuing the mining analogy, we can venture on the

assumption that adequately directed investigation would have changed the dispersed charcoal resources into the real gold mine.
The aim of this presentation will be to discuss : a) the interpretative potential of long sequences of ^{14}C dates obtained from colluvial context and their importance for the reconstruction of environmental changes and interactions between human communities and the environment; b) methodological approaches, mainly the role of proper sampling and combinating of various research methods for solving particular problems; c) examples of analyses in the scale of a simple structure, a whole site or a microregion; d) interpretative limits of this category of sources. Examples will be taken mainly from excavations lead by the *Service Cantonal d'Archéologie de Neuchâtel* on the site of Bevaix - Les Pâquiers.

The impact of Holocene climate on the development of prehistoric societies in the Southern Siberia

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The reconstruction of climate during Holocene in the Southern Siberia and Central Asia is the difficult task. It is a region with strong climatic differences, especially concerning effective moisture. The Tibetan Plateau, north-western and north-central China, Mongolia and the Southern Siberia is situated in the triangle of the Indian Monsoon, the SE Asian Monsoon and the Westerlies. The Southern Siberia region is an inner area with continental climatic conditions and one is divided into some hollows by mountain ridges. Such kind geographical features of this territory had an influence on the people settling and the social and economic structure. The people appearance and occupation in the hollows was different. It depended on the local climate and landscape conditions. The radiocarbon analysis was used as the instrument for correlation of archaeological and environmental events for the different areas of this region.
The largest hollow among intermountain hollows is Southern Minusinsk depression. The intensive people occupation of the Southern Minusinsk hollow about 6000-5000 cal BP corresponds with climatic changes to more humid conditions. It was the Afanasievo culture which was the first barrow culture of region and the most Eastern in the system of Indo-European nomadic groups. In this time the intermountain hollows of Tuva located in more Southern region were thinly populated. In Tuva region the climate was very warm and dry (Dirksen et al., 2007). In Nazarovo depression which is located in Northern part of Minusinsk hollow the increasing of humidity are recorded at 6300-5500 cal BP. The Holocene optimum was recorded in Western Siberia at 6300 cal BP (Orlova L.A. et al., 2007). The archaeological finds of Afanasievo culture from these regions have dates about 6300-5000 cal BP.
The next humid period in Nazarovo depression is recorded at 4300-3250 cal BP. In this time the humid and relatively warm conditions were registered. Such kind conditions were in the Western Siberia area around 3900-3700 cal BP. In contrast to Northern regions in Southern Minusinsk hollow and Tuva area at 4300 cal BP the climate was very arid. The some monuments of Andronovo culture of Middle Bronze epoch were found just in Northern part of Southern Minusinsk hollow. They were dated by 3750-3350 cal BP. In Tuva region the monuments of this type are absent. While the first finds of Andronovo culture were excavated in the Nazarovo hollow. The numerous Andronovo monuments were found in this area. Probably it can be connected with more favorable geographical conditions in Nazarovo hollow in contrast to conditions of Southern hollows.
The synchronous increase of humidity in the steppe zone of Southern Siberia hollows around 2800 cal BP was cause of vast pasturable development. These changes resulted in the appearance of numerous tribes of Scythian culture over the whole territory.
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Comparison of different methods for radiocarbon dating of organic matter fractions in Alpine soils

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The retreat of the main valley glaciers after the last glaciation was progressed already at 16000 ^{14}C cal years BP and pronounced readvances occurred until about 10000 ^{14}C cal years BP. The general pattern of the glacial deposits in Alpine valleys can be associated with distinct re-advance phases of the retreating ice-stream systems after the LGM (Last Glacial Maximum; 25'000 – 20'000 ^{14}C cal yBP). Soil organic matter, as it is the first soil component to be formed after the glaciers' retreat, may give precious information about the age of soil landscapes and, thus, can contribute to decipher geomorphic surface dynamics. Soil organic carbon is known to contain a stable fraction with an old radiocarbon age, even if the size and the stabilisation processes leading to the formation of this old soil carbon pool are still unclear. We tested five methods to isolate the oldest possible stable organic matter of 2 soil profiles developed on a Pleistocene morainic paragneiss substratum in an Alpine environment in northern Italy. Before and after the individual treatments, the organic fraction was dated with ^{14}C. We compared, furthermore, the obtained radiocarbon ages with the age of charcoal fragments found in one of the studied soils. The age of charcoal fragments varied between 3300 y calBP in the upper horizon to 10300 y calBP in the lower one. The extraction methods for soil organic matter (SOM) were based on the oxidation of "fresh" OM and, depending on the method, on the dissolution of the minerals. The first two methods perform an oxidation of organic matter with NaOCl, followed by a dissolution of minerals with HF or Aqua Regia (Method 1 and 2 respectively). Method 3 and 4 were similar to the first two but with a changed order of the treatments (chemical oxidation as the last step). The fifth method included only a treatment with H_2O_2 for 7 days. Dating of SOM with ^{14}C could give, in theory, a minimum age of soil formation. The lowest ages for each soil were obtained with method 1 and 2 (5176 and 8835 y cal. BP). Higher ages were obtained with method 4 (Aqua Regia and NaOCl). In general, methods 1-4 showed increasing ages with increasing soil depth. The H_2O_2 treatment, however, left behind an organic fraction with the highest ages (up to 17000 y calBP) in the topsoil and decreasing ages with soil depth, which would be the theoretical expectance as the weathering of a surface starts from the top of it. In general, the ^{14}C ages of the treatment-resistant fraction increased in the order: untreated samples < method 3 (HF + NaOCl) ≤ method 1 (NaOCl + HF) ≈ method 2 (NaOCl + Aqua Regia) < method 4 (Aqua Regia + NaOCl) < method 5 (H_2O_2). The obtained ages with H_2O_2 corresponded well with the maximum age of charcoal fragments and the geomorphological settings - in particular the end of the Egesen-equivalent glacial state and the oldest Dryas. Our results indicate that the treatment with H_2O_2 can probably be used to date Holocene-aged Alpine soils. This has, however, to be confirmed with additional numerical dating techniques such as exposure dating of rock surfaces with ^{10}Be, ^{26}Al or comparison with moraines of known age.
The presented results are part of a study focusing at dating selected Alpine sites of distinct landform surfaces using numeric and relative dating techniques with the aim to establish an absolute chronology of surfaces and to correlate and improve several dating techniques.

A chronology of the pre-Columbian Paracas- and Nasca-culture in South Peru based on AMS-^{14}C-dating

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The people of the Paracas and Nasca culture, the creators of the famous geoglyphs, lived in the desert of the south coast of Peru approximately between 800 BC and 650 AD. The archaeological chronology of these cultures was based almost exclusively on a sequence of seriated ceramic styles. The absolute dating of some of the style phases was supported by a few radiocarbon dates (Rowe 1967). Here we present the first absolute chronology of the Paracas and Nasca culture based on ^{14}C-dating of more than 130 organic samples from settlement and tomb relics, as well as on material derived from geoglyph sites in the Nasca/Palpa region (South Peru). The main focus has been on the Nasca-period settlement centers near Palpa, Los Molinos und La Muña, the Paracas-period site of Jauranga and the Initial period site of Pernil Alto. Most of the ^{14}C-samples have been dated at the AMS facilities at the ETH Zurich (Switzerland) and at the Lund University (Sweden). The targets were produced in the newly built graphitisation line at the Heidelberg ^{14}C-laboratory (Germany). Clay bricks (adobes), which are quite a common building material in Peru, were successfully tested to be used for AMS ^{14}C-dating of adobe architecture in Peruvian archaeology. This ^{14}C-chronology so far is the largest for Pre-Columbian times in all South America.

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Radiocarbon Chronology of Santa Lucía, Bolivia

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Santa Lucia is a huge formative site located in the center of the *Valle Alto*, it is the largest of the five Cochabamba valleys between the villages of Aranjuez and Santa Lucía, Cliza. The most characteristic structures found on the surface consist of circular to oval spots of deep red burned clay fragments, which cover a burned clay platform. These structures are “ovens” for the firing of ceramic vessels. We counted about 250 platforms on the surface in a more or less eroded state. All of them are distributed homogenously throughout the area of the site. No special craft sector for ceramic production could be recognized. On the contrary, the firing platforms were located near circular house structures of 4,50 – 5,50 m of diameter, which could be detected by their wall foundations of stones. The house foundations were also found, in a lesser amount, evenly distributed over the whole surface. This data links the ceramic production clearly with household activities. We therefore assume, that a household or domestic complex consists of a circular habitation structure of about 5 m of diameter, one or more smaller circular or oval structures of about 2 – 2,50 m of diameter and one or two firing platforms. There is only one area that shows other than domestic activities. A small line of almost eroded mounds follows the site limit from South to North in a semi-circle. These mounds consist of very soft dark soil containing a high percentage of ashes and yielded some human bones.

The dated samples were taken from three places: Trench 5 in the domestic sector, Trench 6 in the burial sector in one of the ashy mounds and the waste pit H21 from Trench 9. All samples were dated at Gliwice Radiocarbon Laboratory using liquid scintillation and gas-proportional counting technique. Radiocarbon dates from Trench 5 were combined with stratigraphic information in order to precise the results and to estimate time-span of the activity period. The dates from the different sectors (trenches) of the site show clear relations with each other and the results for all trenches give consistent view of a chronology of whole investigated part of Santa Lucia. They show, that the site was occupied at least from 1000BC to 50BC. Moreover basing on the dates of samples SL-C20 and SL-C41 we may suppose that about 750 BC- 600 BC a huge restructuration of the surface of the center of site took place. We can also draw a conclusion, that the most of the ash layers were produced during the use of the domestic hearth from Trench 5 and redeposited in Trench 6 about 200 years later.

Developing a chronology integrating archaeological and environmental data from different contexts: the Late Holocene sequence of Ounjougou (Mali)

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At Ounjougou, a site complex situated on the Bandiagara Plateau (Dogon country, Mali), the multidisciplinary research conducted since several years by the program « Peuplement humain et évolution paléoclimatique en Afrique de l'Ouest » has revealed a rich archaeological and palaeoenvironmental sequence for the Late Holocene (3500-500 BC) (Huysecom *et al.* 2004 a, b; Huysecom 2007; Rasse *et al.*, 2006 a, b; Ozainne *et al.*, in press; Le Drezen *et al.*, submitted; Eichhorn & Neumann, in press). Developing a global model for the history of cultural and environmental changes at Ounjougou is connected with several methodological questions. Indeed, the archaeological layers are in some cases interstratified in the complex fluvio-lacustrine sedimentation of the Yame River, but are also often found in a less precise stratigraphic context, disrupted by many pedological features. With regard to the large numbers of carbonized organic remains, we have decided to apply conventional and AMS radiocarbon dating. Since the charcoals are not always *in situ* and may have been reworked along the stream or in the soil profile, getting a large amount of chronological information was essential to assess the correct stratigraphic context. Fifty nine radiocarbon dates have been obtained so far, which confirm a short turn-over of the charcoal along the fluvial system. Moreover, typology and decoration of ceramic vessels allow us to set up some accurate links between the different stratigraphic sequences. The combination of archaeological data and radiocarbon dating, using the bayesian analysis to constraint the chronology (Oxcal Program V4.0.5., Bronk Ramsey 1995, 2001; Reimer et al. 2004), permit us to reconstitute a very precise chronostratigraphy for the Late Holocene. The cultural and environmental sequence has been defined from the archaeological assemblages of several well-dated sites, and from geomorphological, micromorphological and archaeobotanical studies (Huysecom *et al.* 2004b; Ozainne 2006; Rasse *et al.* 2006b). Furthermore, the direct dating of two domesticated pearl millet *(Pennisetum glaucum* ssp. *glaucum)* caryopses indicates the onset of agriculture during the second millennium BC, contemporary to other early evidence of farming in West Africa (Huysecom 2007, Eichhorn & Neumann, in press). From a methodological point of view, the research conducted at Ounjougou reveals the importance of combining stratigraphic and palaeoenvironmental analyses, and the necessity to use a high number of radiocarbon dates in order to establish a precise chronology integrating archaeological and environmental data coming from several contexts.

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Sedimentological record of human impact and climate change on selected examples from Mazovian Lowland (Central Poland)

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The Holocene environmental changes are more difficult to explain than all the former ones – it is due to the complicated interference of geomorphological (and other) processes originating both from the natural and anthropogenic factors (Starkel 1977, 1999). This interference is very diversified in time and space and is especially strong since the Neolith. From the geographical point of view the climate change was a general cause giving the similar i.e. regional responses and consequences while the human impact depended on the local preferences of the settlers (different for breeders and farmers communities or industrial ones). At the very beginning of the Holocene when the gathering and hunting were common in the Mazovian Lowland there were almost no changes in the natural environment due to human activity. Most of the changes were connected with the improvement of the climate conditions and natural succession. In the late Atlantic period (Neolith) southern communities were attracted by the natural conditions to move towards north and settle down in Central Poland. There occurred farmers and breeders what has resulted in the increase of population density and

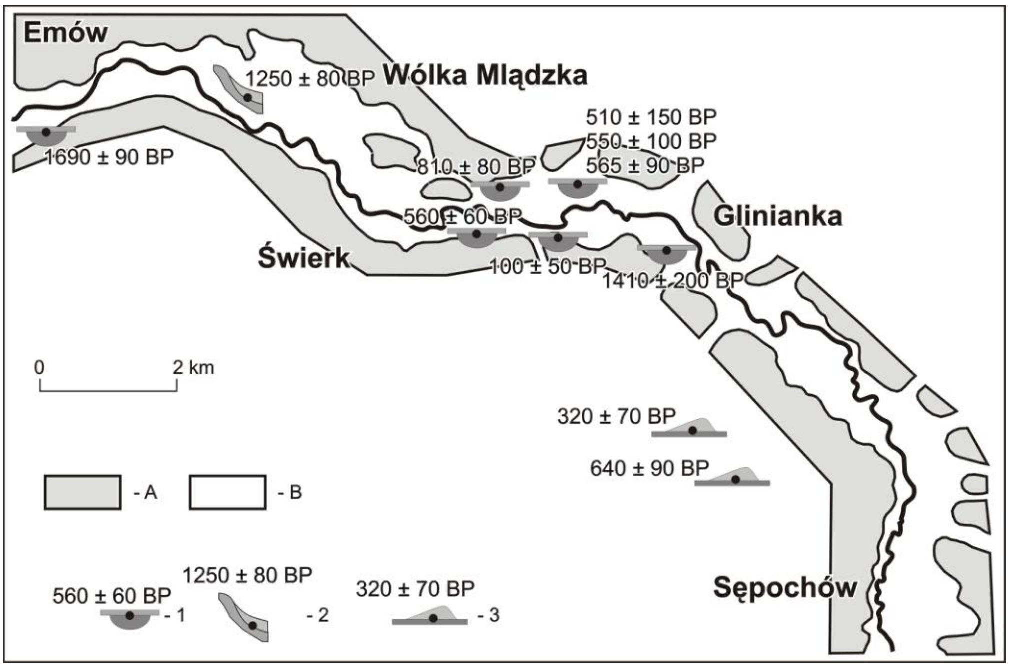

Figure 1. Radiocarbon age of sedimentation type (facial) changes – shift in:
1 – fluvial, 2 – slope, 3 –aeolian environment. Radiocarbon dates uncalibrated
A – glacial plateau, B – Świder river valley.

progress of deforestation. From this very moment there have been started a long period of environmental changes giving repeating cycles of selective deforestation and vegetation succession coming one after another. All these environmental changes resulted either in acceleration or in stopping geomorphological processes such as erosion, transportation and accumulation. Land use change caused the acceleration of soil erosion, development of aeolian processes and aggradation processes in river valley bottoms. All these geomorphological (and climate) changes have been recorded in the shifts of the type of sedimentation (mineral – organic, organic – mineral). These shifts can be found in the outcrops or deposits from the boreholes and can be easily radiocarbon dated (peat or humus horizons). Land use change is also recorded in the slope base by the formation of soils with complex morphology – soils consisting of some separate humus horizons covered by the mineral deposits (Starkel 1977, 1999, 2001, Maruszczak 1999, Tyszkiewicz 2003).

The main aim of the study in the Mazovian Lowland area was to determine the age of the fossil humus horizons and their relation to the human activity in the past. To solve the problem there have been used standard geomorphological methods supported by archaeological and historical ones. The age of the organic matter (some 30 samples) was determine using radiocarbon dating in Minsk (Belarus) and Kiev (Ukraine) Laboratories.

Field studies together with radiocarbon dating allowed for the statement that human impact in the Mazovian Lowland area was present and had medium and low intensity during the Neolite and Iron Age. It was extremely high since Middle Ages. Geomorphological results and radiocarbon dating were confirmed by the great number of archaeological and historical data. The results of the investigation for Świder river valley (eastern part of Mazowian Lowland) has been presented on Figure 1.

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Paleoecology, Subsistence and ^{14}C Chronology of the Eurasian Caspian Steppe Bronze Age

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Paleoecology: The Caspian Steppe is characterized by a variety of environmental niches, i.e. small steppe rivers, lakes, large valleys of the Lower Don and Volga rivers, large watershed plateaus, desert areas of the Black Lands, Caspian Sea coastline steppe areas. The study of regional paleoclimate has revealed frequent and sometimes very sharp climatic changes, alternation of relatively humid and dry periods that could have lasted for several centuries. Even slight variances in the ground-water level may have caused changes in main landscape components; vegetation, soil, fauna and numerous environmental niches of the Caspian Steppes were exploited by different cultures, and nomadic economy developed starting from the end of 5000 calBC. We discuss environment changes of the Caspian Steppes in the time interval of 4300-2000 BC. The environmental disaster of the 2400-2300 calBC has been identified. Time limits of the intervals are based on calibrated ^{14}C data of samples obtained from kurgan graves.

Subsistence: Soil samples have been taken from the content of pots, from the area of the human stomach, and from between the teeth of human skeletons buried in Bronze Age graves. The paleozoological collection has been also analyzed. We have also examined stable isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) in human and animal bones taken from the same graves. Data show that the Caspian Steppe Bronze Age population consumed a lot of C3 plants, gramineous wild plants, North Caucasus honey, fresh water fish and mollusks, domesticated and wild animal meat, wild bird eggs. No domesticated cereals or C4 plants have been found. The stable isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) in human bones clearly show that all individuals apparently had a diet based largely on river and lake food.

^{14}C Chronology: A series of ^{14}C age measurements on human bones, wood and plant remains (more that 160 samples) has been developed in order to reconstruct an age range for Bronze Age Caspian Steppe cultures. For many years human bone samples were considered to be the most appropriate. But comparison of ^{14}C dates reveals several problems. Wood and human bone samples from the same grave show that the bones have older ^{14}C dates than the contemporaneous wood. Domesticated animal and human bone samples from the same grave show that the human bones have older ^{14}C dates than the contemporaneous animal bones as well. Parallel dating of different materials reveals the offset from 85 до 1084 radiocarbon age.

Conclusions: Human bone data show an “apparent age” due to a ^{14}C reservoir effect. Most ^{14}C dates of human bones of the Bronze Age cultures are older than expected. Stable isotope ratios of the human bone collagen reflect the fresh-water resources diet. Such diet could be problematic due the severe aridization of 2400-2300 BC. The steppe population began to develop long-distance seasonal migration routes. All food resources of the steppe had been used by that time. The high value of $\delta^{15}N$ has been identified in domesticated animal bones dating to that period as well. It is possible that the most severe droughts led to changes of annual precipitation, resulting in local vegetation, and water resources available. Differences in domesticated animal samples may be caused by use of pastures with different vegetation. The predominance of halophytes on the natural vegetation pastures (some of them could be C4 plants) could cause the unusually high $\delta^{15}N$ value range for domesticated animals dating to the environmental disaster period. Samples which are not subject to various effects should be dated in order to verify the proposed ^{14}C chronology of Bronze Age cultures of the Caspian Steppes. Additional dietary study of the ancient and contemporary steppe population should be conducted. Local pasture vegetation should be reconstructed and analyzed.

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Session 4

How good are ^{14}C ages of bones? Problems and methods applied

Radiocarbon dating of ancient bone collagen and its application in archaeology

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AMS radiocarbon dating of bone is particularly challenging when the material is poorly preserved and yields of extractable collagen are low (<1% wt.). Problems are further increased when the age of the material approaches the background limit of the method (*c*. 0.2-0.1 pMC; 50-55 ka). Research in Oxford has focussed on developing more effective pre-treatment protocols for extracting and characterising Type 1 bone collagen, tripeptides or purified amino acids, and validating AMS measurements obtained using a suite of analytical parameters. These latter include carbon to nitrogen atomic ratios (CN), % weight collagen, % carbon and stable isotope analyses of C and N.
Our current method comprises the gelatinisation of the bone using well-established techniques, with the additional ultrafiltration of the soluble gelatin. This technique enables collagen of a demonstrably improved quality to be extracted, as shown by CN ratios and other analytical parameters. It also enables poor quality collagen samples to identified and excluded from analysis. Redating of several key Middle and Upper Palaeolithic sites using this technique shows significant differences between ages obtained using older techniques and those obtained using ultrafiltration. Examples will be given. Ultrafiltration is routinely used on collagen extraction of all bone samples submitted to our facility. Care must be taken, however, to remove humectants used to moisten the filters prior to their use.
New developments in Oxford over the last 3 years have focussed upon the isolation and dating of single amino acids. This approach may help in the dating of bone where there are questions regarding the reservoir effect in humans and the degree to which one can be confident in the ages of bulk extracted collagen. Further applications made possible by this technical advance will be outlined.

The impact of cremated bone dating on the archaeological chronology of the Low Countries

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Since the publication of the first article by Lanting and van der Plicht about the possibilities of dating cremated bones, the number of dated cremation remains has grown exponentially. The validity of this method has been tested. The success of this dating technique lies in the fact that an absolute date now can be attributed to archaeological phenomena that previously were only datable indirectly.
When archaeological artefacts where present, the cremation burials were dated based on the typology of ceramics and metals. An absolute date could be attributed if charcoal from the pyre were present. Unfortunately these items were not omnipresent on the burial sites. Consequently a complete site was dated by means of the few datable burials present. This implies that the internal chronology of the site could not be studied. Furthermore the typochronology of the ceramics and the metals remains questionable.
A series of dating projects on urnfield cemeteries in the Low Countries (North-France, Belgium and the Netherlands) have shown that the classical chronology of these sites must be revised.
-The supposed chronology of the occupation phases of some cemeteries needs correction. It has been shown that some of these sites start earlier then previously thought, placing them already in, what is traditionally called, the Middle Bronze Age instead of the Late Bronze Age. The same phenomenon occurs at sites situated at the transition of the Early Iron Age – Late Iron Age.
- The radiocarbon dates have shown that the internal chronology of the cremation sites is much more complex then previously thought. This has important consequences for the interpretation of the internal organisation of the site.
- The question should be raised if burial sites should be chronologically relocated from one period to another or that the boundaries between the chronological phases should be adapted according to the new data.

Teeth, coffins and an impost: Questions concerning the dating of the early phases of the Wasserkirche in Zurich (10-12th century)

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According to the legend the Wasserkirche in Zürich on the island on the Limmat River had been built to mark the place where martyr of Saint Regula and Felix took place. The rock that was the place of martyr ("Märtyrerstein") is located under the choir and for centuries has been an important object of religious devotion.
The present church built in late gothic style was consecrated in 1486 (building phase Bau III). Archaeological excavations, which took place in 1940/41 and 2004 , resulted in discovery of two previous church buildings (Bau I and Bau II). The oldest building (Bau I) had been a subject to two reconstructions (Bau IA and Bau IB). The building of second phase (Bau II) is known to be consecrated in 1288 AD but a reliable chronology of the oldest church is not established.
Until recently the dating was based on the estimated age of 'around 1000 AD' based on rather vague stylistic comparison of imposts in the lower part of the church. In order to improve the time frame of this building phase samples organic material were collected and submitted to AMS ^{14}C dating at ETH Zurich. These included wood fragments from coffins and teeth found in three graves dated to middle age and stratigraphicaly belong to the Phase IA (11th -early 13thcentury). Results of radiocarbon dating confirms this correlation however the corresponding calendar ages (results of calibration) cover ca. 200 years and do not allow for more precise dating of the building phase.
In this paper we will report on new ongoing measurements that can help to improve the chronology.

"Old wood" and "young bone"-effects in the western European Neolithic

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The purpose of this paper is to wonder about the validity of radiocarbon dates of bones in the western European Neolithic. The starting point of this thought leans on an aspect of a work of thesis dedicated to the cultures of the middle Neolithic of the Rhine (Denaire, 2006). By gathering ^{14}C dates for sequence Hinkelstein-Grossgartach-Roessen-Bischheim, a significant distance appears between the sum probabilities of dates of charcoals and the one obtained with bones. The comparison between these results with the few available dendrochronological dates show that dates of bones are too young, while the sequence based on charcoals fit.
The existence of too young ^{14}C dates of bones is not new: this phenomenon was already dealt in scientific articles. All the advanced explanations talk about contaminations during the sample's burial (Spatz, 2001) or his treatment in laboratory (Bronk Ramsey and al., 2004).
Consequences can be heavy, particularly for the ancient periods of the Prehistory (Higham and al., 2006). Concerning the chronology of Neolithic cultures, many recent studies lean preferentially on short-life samples like bone to the detriment of charcoals, rejected because suspected of being affected by "old wood" effect (Jadin, 1999). In many times, it is obvious that dates of charcoals are really too old. However, in some cases, it is the ^{14}C dates of bones which pose problem, because they are too young compared with results provided by dendrochronoly.
The aim of this communication is to present some examples to define at best this "young bone" effect and to assess consequences which it can have on a chronology built, partly or entirely, on radiocarbon dates of bones.

Bone preservation in relation to charcoal preservation: field and lab observation

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Two of the major materials available for radiocarbon dating are bone collagen and charcoal. Both are often found and collected together in the field although their specific archaeological contexts can differ.
Detailed studies in the field (e.g Obi Rakhmat and Kebara caves) show that charcoal and bone distributions can be anti-correlated. This is not necessarily related to human activities, but sometimes to differential preservation of the two materials. In general bone mineral is stable above pH 7 while charcoal preservation appears to be much more complicated in relation to pH changes and the microenvironment in which it is deposited.
Accuracy and precision of ^{14}C dating of bones depends on the quality of the collagen fraction isolated after the lab pretreatment. Pre-screening in the field can contribute significantly towards identifying the bones that may contain well preserved collagen and infrared spectroscopy of the extracted fraction can provide information on the purity of the collagen. This combined strategy has been used in different age archaeological sites in Israel and in China.
By providing careful quality control of the dated material, unexpected results, often attributed to analytical ^{14}C problems, can be used to improve the understanding of the archaeological context.

Ultrafiltration: Boon or Bane?

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Collagen is the preferred sample fraction for radiocarbon dating of bones. It is usually extracted from the demineralized bone by hydrolization to gelatin dissolved in water and further purified by filtration (at 0.45 μm at the Leibniz Labor). Although non-soluble organic material is removed by this filtration, the filtrate still may contain small foreign carbon molecules which could affect significantly the measured age. Ultrafiltration of the dissolved gelatin (M ~ 100 000 Da) with a cutoff at 30 000 Da will remove smaller fragments of bone protein, but also small contaminants (Brown et al. 1988, Bronk Ramsey et al. 2004, Higham et al 2006) and thus should produce more reliable dates. However, results of comparative dating studies have raised the question whether this cleaning step itself introduces significant contamination with carbon from the filters used (Bronk Ramsey et al., 2004, Brock et al., 2007, Hüls et al. 2007). With rigorous filter cleaning protocols and minimum requirements for the amount of collagen and the collagen yield, filter contamination can be kept at acceptable levels (Brock et al., 2007). We used a series of bones, ranging from modern to very old, dated on both the soluble collagen and the insoluble rest fraction for further tests. We discuss the contamination by ultrafiltration based on evidence of the carbon and ^{14}C content of the filtrate and supernatant as well as SEM and spectroscopic evidence for two filter types with the view to increase the reliability of ultrafiltration cleaning and expand the range of its safe applicability.

Radiocarbon dating of cremated bones: where does the carbon come from?

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Collagen, the organic fraction of bone, is routinely used to date archaeological remains. Under arid or semi-arid setting however, collagen does not survive and ^{14}C-dating of carbonate in bioapatite, the inorganic fraction of bone is the only alternative. The reliability of ^{14}C dates obtained on bone bioapatite has been questioned and very few dates have been published. This is because of the small size of bone crystallites, which makes them unstable and likely to incorporate dissolved carbonates from the environment during recrystallization. Cremated bones are an exception to this rule. During cremation, bioapatite recrystallizes and larger and better structured crystals are formed. These crystals become very similar to enamel crystals and are more densely packed which protects them from further exchange with the diagenetic fluids. This is the reason invoked to explain why cremated bones provide reliable ^{14}C dates at least for the Holocene (Lanting et al. 2001).
Although bone apatite δ^{13}C value remains unchanged for bones burnt at low temperature (Person et al. 1996), anomalously low values have been reported for cremated bones, in association with a significant loss of structural carbonate (Van Strydonck et al. 2005; Olsen et al. in press). This suggests that the mineral fraction of bone is altered during heating and that secondary carbonates could be formed. It is important to identify the source of carbon used to build these carbonates as it might have implications for the validity of ^{14}C dates obtained on cremated bones. A first attempt of experimental heating of modern bone failed to reproduce the low values observed on archaeological samples (Van Strydonck et al. 2005). To this day, no satisfactory mechanism has been validated to explain these values.
Here, we report the results of several experiments aiming at improving our understanding of the fate of mineral and organic carbon during heating. Experimental heating of modern bone was carried at different temperatures, during different times, and under different environments. The evolution of several parameters (weight, colour, %C, δ^{13}C value of the organic and inorganic fraction, crystallinity) was monitored during heating. The result of these experiments should allow us to decipher between an intrinsic (from the bone itself) or extrinsic (from the environment via atmospheric CO_2, or from CO_2 produced during the combustion of wood) origin for carbon in cremated bones.

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Anthropology and ^{14}C analysis of skeletal remains from relic shrines: an unexpected source of information for medieval archaeology

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Since the Middle Ages, relics of Catholic saints played an important role in popular religion in Europe. Despite the rise of Protestantism in the 16th century, the confiscation of religious goods during the Napoleonic period and the secularization of modern society, a lot of these remains are still preserved in shrines kept in churches, abbeys or even museums.
The contents of the shrines are often studied when the restoration of these pieces of art, or the objects kept in them, becomes necessary. However, except for a few isolated cases, the contents of the shrines (especially the textiles, texts, glass, wooden and metal objects) are only studied from an art-historian

perspective. The study of the skeletal remains from the shrines often is restricted to the counting and identification (sometimes even very unscientifically) of the bones.
In this study, a more scientific approach was followed, including physical-anthropological observations, stable isotope analysis and radiocarbon dating. In total, skeletal remains of more than 20 persons were examined. Some of the shrines contained only small parts of a skeleton while others held a quasi complete skeleton. The minimum number of individuals per shrine, and their age at death, sex and size were established. Eventually, traces of injuries or diseases on the skeleton were noted. Collagen extracted from the bones was ^{14}C dated and stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) were measured.
This project focused upon the skeletal remains of so-called 'local' saints. These are saints that have or had only a limited regional impact and that were only worshiped in a geographically very restricted area. Some of the saints represent people whose existence has been attested by reliable historical sources, while others clearly are legendary figures.
Although the attribution of the skeletal remains to a certain historical person is always questionable, it must be noted that in some cases the anthropological information and the radiocarbon dates match the historical data available. The investigation shows that most of the bones date back to the 8th - 9th century AD, which counters the popular belief that most of the bones in the shrines are concoctions made within the context of the popular commerce in relics during the 12th -13th century. Most surprisingly, early medieval dates were also obtained for bones associated with 'legendary saints' without any historical background.
The importance of this project goes much further than a critical evaluation of the authenticity of the relics. Fruitful insights could be gained about the origin and treatment of these parts of our religious heritage, and about the evolution of their significance. Finally, it has been proven that shrines are an important source of early medieval human skeleton material, which is seldom found in archaeological contexts in Belgium.

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Can we get a good radiocarbon age from "bad bone"? Determining the reliability of radiocarbon age from bioapatite.

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Since the early days of radiocarbon dating, the analysis of bone material has been a problem due to frequent dischord between the dates of the bone material and associated charcoal, and/or between different fractions isolated from a single bone. Recent publications show that such problems still exist and suggest that they are caused by both the poor preservation of collagen and the difficulties in removing contaminants from the bone extracts used for dating(see references).
Most methods of bone preparation for ^{14}C dating used today are designed to extract and purify (with varying degrees of success) a fraction of the organic residue. In general, the goal of these methods is to isolate collagen or some individual compounds such as protein or amino acids of collagen. However, for badly preserved bones, the problem becomes acute, as they often do not even have enough collagen for AMS dating.
We discuss alternative techniques for preparation of mineral carbon fraction from bioapatite of bone. We also compare the mineral and organic fractions for bones and teeth of different ages and differing degrees of preservation.
The mineral fraction does not usually undergo microbiological decomposition, but may be exposed to isotopic exchange with environmental carbonates. The problem thus becomes one of separating the diagenetic carbonates without destroying the bioapatite. We offer a technique for removing the secondary diagenetic carbonates by treatment with diluted acetic acid in vacuum.
We demonstrate that relatively well-preserved samples younger than 1,000 years show consistent results between the fractions of collagen and bioapatite. We have also found that if bone is poorly

preserved, yet has been buried in non-carbonate deposits, that bioapatite dates are very reliable.
The dating of the bioapatite fraction can also be used for museum-collected samples that were preserved with natural and synthetic glues. If casein was used for bone preservation, the bone cannot be dated using the collagen fraction, as glue and collagen have almost identical organic structure and it is extremely difficult to distinguish these chronologically different organic phases. In such a case, only the bioapatite fraction can be used for radiocarbon dating.
We demonstrate that that proper pretreatment of bone and tooth samples permits the separation of diagenetic carbonates from bioapatite, as long as the carbon in these samples has not degraded completely. Both bone or tooth tissue can be used for paleodietary studies and radiocarbon dating.

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Session 5

Radiocarbon chronologies of the Neolithic and Metal ages

Contradictions in the relative chronology: archaeological dating and radiocarbon dating

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The topic will discussed on the basis of the following examples:

- Wädenswil-Vorder Au (CH), a Corded Ware settlement
- Tauerbischofsheim (D), a Corded Ware burial ground
- Singen (D), Remseck-Aldingen (D) and Rottenburg (D), early Bronze Age burial grounds.

When contradictions occur, the question is who is right: Archaeological dating or radiocarbon dating. This question can hardly ever be answered conclusively.

1. Archaeological dating is right:

In this case the calibrated 2σ- value is used in order to cancel out the contradiction. This may work for one-off data with a very dubious value. However, in radiocarbon data series with a small variation, all hailing from the same archaeological context, one must look for systematic mistakes in the radiocarbon dating. This must be answered by physicists or chemists. Sometimes mistakes can be found in the readings from different laboratories or between older and newer readings.

2. Radiocarbon dating is right:

a.) The sample must be cross-examined. This is why the sample spots must be exactly documented and published accordingly. Whenever possible, the samples should be taken and published from a context holding objects which can utilized in a typological sense. This is the only way a contradiction can be identified.

This requirement can be easily fulfilled in graves, but the graves in question must contain grave goods. However, one must keep in mind that even in graves a single date is not of much use. Here too, a series of data with as many samples as possible from the same burial ground would be much better. As graves are mainly dated using bones nowadays, one must take the problem of the sample preparation into account and thus hand the sample series to two separate laboratories. This is because the radiocarbon community does not compare the laboratory results of bone data.

Settlement finds also require the extraction of a sample series. This way, contradictions in the interpretation of the archaeological context can be identified. Whenever possible, the samples should be taken on short-lived organic material.

b.) The archaeological relative chronology is wrong, backing the views of many in their rejection of so-called typological methods. Here it must be said that in Switzerland there was never a contradiction between archaeological relative chronology and dendrochronology - alleged contradictions were able to be cleared up. For instance, the stratigraphy in Twann shed important light on the internal chronology of the Cortaillod culture just before the possibility of dendrochronology was able to. Of course, a cross-examination of the archaeological relative chronology is always necessary. In the Bronze and Iron Ages this has been going on for the past 100 years. This is often no longer a cross-examination but a quest for an ever finer periodization. As radiocarbon dating isn't accurate enough, only tree-ring dates can intervene as a corrective measure.

The culture sequence of the following examples: "Corded ware, Bell Beaker, early Bronze Age" has been debated over and over again: As there are no tree-ring dates for the Bell Beaker culture available, it has become a playing field for chronological speculations. For example, chronological parallels between the Corded Ware age and Bell Beaker age or between the Bell Beaker age and early Bronze Age have all been put forward. In the past even between the Corded Ware age and early Bronze age. These parallelizations have been decorated with the idea that bell beakers were prestige objects. I do not think anything of this kind of contemporaneity, but will rather go into the possibilities and limits of radiocarbon dating in order to solve such problems.

Timing, tempo and temporalities in the early Neolithic of southern Britain

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To understand both the flow of life and change in prehistoric societies, we need robust chronologies. From timing come the relationships between events and so the durations of past actions — and from these emerges tempo. Tempo to the level of the single lifetime or even generation opens up the relationship of short-term change to long-term change for examination. Modelling radiocarbon results in a Bayesian statistical framework is presented as the currently best available method for producing explicit, quantifiable, probabilistic, formal estimates of chronology, for those regions which lack dendrochronology. Examples of Bayesian models for the chronology of long barrows and causewayed enclosures from the early Neolithic of southern Britain show the potential of the method for establishing different kinds of temporality, at both short and long timescales, and raise many implications for our understanding of sequences of change.

High resolution chronologies and the changing pattern of Neolithic societies

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The idea of neolithic societies and the identities of neolithic individuals changed rapidly during the last decade. Ideas of neolithic "cultures" are no longer valid, as absolute chronological evidence points to overlapping phenomena of material culture and social developments. High resolution dates of single events and general patterns of ^{14}C dates support the view of paradigmatic changes in the view of neolithic societies.

The Spread of Neolithic in the South East European Plain: Radiocarbon Chronology, Subsistence and Environment

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The expansion of Neolithic in the south East European Plain coincided with a marked increase of the rainfall and the spread of mixed coniferous-deciduous forests in the valley plains. The forest-steppe with isolated stands of oak, elm, lime and maple became dominant on the plateau.
In south-eastern Europe the earliest manifestations of agriculture are acknowledgeable at c. 8.6-7.5 ky cal BC (Franchthi Cave). The next stages of early Neolithic in Central and Northern Greece include Proto-Sesklo (6.5-6.0 ky cal BC) and Sesklo (6.0-5.3 ky cal BC). Further north, in the northern Balkan area and Middle Danube basin, several early farming cultures were recognised, including Karanovo I-II (6.1 – 5.8 ky cal BC); Karanovo III (5.4 – 5,1 ky cal BC), Karanovo IV (5.3 – 4.8 ky cal BC), Starčevo-Körös-Criş (5.9 – 5.5 ky cal BC) and Vinča (5.5 – 4.0 ky cal BC). The expansion of early agriculture in Central and Western Europe took the form of Linear Pottery Culture spreading at c. 5154 ± 62 BC with an average speed of 4-6 km/yr (Dolukhanov et al. 2005).

Recently available radiocarbon dates show, that the early pottery-making communities in the steppe and boreal areas of Eastern Europe started spreading at an early date, comparable and even preceding in age early farming communities in the Near East and South-Eastern Europe. *Yelshanian* sites (Mamonov 2000) in the Middle and Lower Volga basin are radiocarbon dated to 8-7 ky cal BC. *Rakushechnyi Yar*, a clearly stratified Neolithic settlement located on a small island in the lower stretches of the River Don, ca 100 km upstream from the city of Rostov, includes has 23 archaeological layers (Belanovskaya 1995). The radiocarbon dates of the deepest levels (23–6) belonging to the Early Neolithic, lie in an interval of 6.8-5.8 ky cal BC. *Bug-Dniestrian* sites are located on the lower terraces of the River Dniestr (Nistru) and its tributaries, and on the River Pyvdenyi Buh (Danilenko 1969; Markevich 1974). At early sites, about 80% of animal remains belong to wild species, mostly roe deer and red deer. Remarkably, impressions of three varieties of wheat were found on the pottery: emmer, einkorn and spelt. The pottery includes deep bowls with an S-like profile and hemispherical flat-bottomed beakers made of clay tempered with organic matter and crushed shells. Remarkably, several patterns find direct analogies in the 'monochrome' pottery of the Balkan Early Neolithic (Starčevo-Criş Culture). 7 date measurements from the sites on the Pyvdenyi Buh show an average age of c. 6.1 ky cal BC.
The massive spread of farming, as evidenced by Precucuteni-Early Tripolye communities occurred between 4,800-4,500 ky cal BC. Large settlements with stable food-producing economies arose on elevated levels within the Prut, Dniester and Southern Bug catchments. Agricultural settlements of Gumelnitsa-Bolgrad type emerged at that time in hitherto poorly inhabited steppe area of the littoral east of the Danube Delta.

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Major patterns in the Neolithic chronology of East Asia: issues of the origin of pottery, agriculture and civilization

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General chronological frameworks created recently for the Neolithic (i.e. pottery-containing) complexes of China, Japan, Korea, and far eastern Russia, allow us to reveal temporal patterns of several important processes in human prehistory and early history, such as Neolithisation, origin of food production, and the emergence of writing and civilizations.
Pottery (i.e. fired clay vessels) originated in East Asia in the terminal Pleistocene, ca. 13,700-13,300 BP (uncalibrated) (Kuzmin 2006). This development marks the beginning of the Neolithic stage in human prehistory in East Asia. Agriculture in eastern part of Asia emerged only in the Holocene. The earliest trace of millet cultivation in North China can now be dated to ca. 7700 BP (e.g. Lee et al. 2007). Rice domestication in southern China is securely dated to ca. 8000 BP [9000 cal BP] (Liu et al. 2007); however, Fuller et al. (2007) accept the full rice domestication only at ca. 5200 BP. Pottery in East Asia definitely preceded agriculture, and containers made out of burnt clay were used by sedentary hunter-gatherers for storage and processing of different types of food.
The definition of the term "civilization" includes the presence of a state level of social organization and written language (Webster's Universal Encyclopedic Dictionary 2002:328). Recently, an effort

was made to establish the existence of a very early "Yangtze River civilization" in China at ca. 6400-4200 cal BP (Yasuda et al. 2003). The timing of this postulated group is in sharp contrast to the first reliable evidences of writing in China, which are not older than ca. 3900-3000 cal BP (e.g. Oxford Companion to Archaeology 1996; Guo et al. 2000). Hence the "Yangtze River civilization" must have occurred much later and should not be related to the early human history in East Asia.

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Chronology and Bell Beaker common ware

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The present paper is part of a research program initiated several years ago and supervised by one of us (MB). Its purpose is to give a better comprehension of the Bell Beaker phenomenon. The Bell Beaker is a culture of the Final Neolithic which spread across Europe between 2900 and 1800 B.C. It is defined by a decorated bell-shaped pottery, common ware, wristguards, copper Palmela points, copper daggers and bone buttons with V perforation. Whereas the decorated pottery –homogeneous all over Europe– seems to indicate a South-Western European origin, (Salanova 2004, Guilaine 2004), the common ware varies according to the region, putting in evidence a certain dichotomy of the Bell Beaker phenomenon opposing East and West (Besse 2003, 2004). This is also true for the funeral and domestic structures which are quite different from region to region : the numerous individual Eastern European graves can be opposed to the use or reuse of collective graves in Western Europe. Regarding settlements, the Bell Beaker culture also presents a wide range of constructions, on posts or in dry-stone, of circular, oval or rectangular shape, using or not former settlements. Since the origin of the Bell Beaker culture is still widely discussed, we have been focusing our analysis on the transition from the Final Neolithic Pre-Bell Beaker to the Bell Beaker. We thus seek to evaluate the importance of the neolithical base in the setting of the Bell Beaker by studying the common ware and its chronology. Among the 26 main types of common ware defined by Marie Besse (2003), we selected the most relevant ones in order to determine –on the base of their absolute dating– their appearance either in the

Bell Beaker period or in the Pre-Bell Beaker groups. First, we searched for the association between ceramic types and absolute dates by checking the accuracy of each sample. Then we looked for the presence of these ceramics in the Pre-Bell Beaker groups in order to define their origins. We are presently working on a total of 965 sites distributed over 11 countries and 113 radiocarbon datings. This study shows that the neolithical Pre-Bell Beaker substratum played a different role according to the region (Piguet et al. 2007). If there is no doubt about the existence of an important neolithical base in the Eastern Bell Beaker, the situation is however different in Western Europe. Taking into account the appearance of new shapes during the Bell Beaker and other shapes which seem to derive from the neolithical substratum, we can actually talk about a partial renewal of the common ware. The dating of these ceramics allows us to restitute the distribution speed of a shape since its appearance until its expansion into the Bell Beaker interaction sphere. This dating method does however not produce very precise dates because the radiocarbon calibration curve indicates a plateau during the third millenium B.C. We also notice an imbalance in dating availabilities : while the Czech Republic has more than 300 sites presenting Bell Beaker common ware, only 15 radiocarbon dates are available. We are nevertheless able to propose scenarios of appearance and diffusion for the main types of Bell Beaker common ware.

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Archeological interpretation of dendrochronological and radiocarbon dates. An example of Corded Ware Culture

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The radiocarbon dating method is the only way of determining the absolute age of Corded Ware Culture (CWC) in many countries of Europe. The models based on calibrated dating are characterized by considerably differing interpretations. The chief reason behind this are different approaches to the calibration of determinations in particular cases and the results obtained in effect. Checks of sample quality are also an important reason of existing differences. Sample verification draws from the lesser reliability of determinations made years ago, and the unreliable or improper context of the material samples for dating. In effect, the database taken into consideration in determining CWC chronology in particular studies is different. The origins of CWC settlement, defined most often as between 2900 and 2750 BC, falls in the time of an exceptionally vast flattening of the calibration curve (2880-2580 BC). The choice of particular dates in this three-hundred-year range is the effect of an archaeologist's estimate without grounds in radiocarbon dating. The last resort for a much desired précising of the age of the oldest phase of CWC is another method, that is, in modern practice, dendrochronological dating. The duration of CWC settlement in Switzerland, from ca. 2725 to 2420 BC, reconstructed on the grounds of dendrochronological dates, differs substantially from the broader horizon which is often indicated for Central European territories based on radiocarbon datings. The beginning is presented in many areas slightly or evidently earlier (from 3050 to 2750 BC), while the end is either similar (e.g. Netherlands, Lesser Poland) or clearly later, about 2200-2000 BC (e.g. Middle and Southern Germany, Kuiavia, Denmark). Summing up, the main characteristics of the dendrochronological model include: 1. short duration of CWC (ca. 300 years); 2. a disjunctiveness of the said culture from the age of older and younger (Bell Beaker Culture) culture groups; 3. dated ceramic assemblages reveal both an enduring tradition of chosen older ceramic types and a fast pace of stylistic changes. Three clear stylistic phases are in evidence. On the other hand, the CWC chronology based on radiocarbon dates is characterized by: 1. long duration of the culture (most often set at 600-700 years); 2. long spans of contemporaneous existence of CWC settlement and other Late Neolithic and Early Bronze Age cultures; 3. with regard to the ceramic assemblages, a frequently observed "longevity" of examined stylistic types. The scale of the listed differences forces one to consider the possibility of two such separate realities. The quality and accuracy of the data call for greater credibility being granted to the dendrochronological datings and for comparing other areas to it. But such an examination is not always possible.

New tools for modelling the movement of past peoples and cultures

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Thanks to a recently awarded grant from the Natural Environment Research Council, UK, the authors of this presentation are embarked on an ambitious programme of work to develop new statistical tools for modelling the movement of past peoples and cultures. The tools that we are developing are generic, but the motivation of the project is understanding the spread of agriculture in Europe. The nature, speed and timing of thid spread have been debated in the archaeological literature for many years (e.g. Dennell 1983, Zvelebil and Rowley-Conwy 1984, 1986; van Andel and Runnels 1995, Sümegi and Kertész 2001, Whittle et al. 2002, Gkiasta et al. 2003). It is now clear, however, that many such debates simply cannot be resolved with existing data and interpretative tools. There is too much uncertainty in the available radiocarbon data and too little structure in the statistical models.
Consequently, our project has two parts.

- We are investigating the timing and routes of the spread of cereal agriculture by directly radiocarbon dating crop remains, the products of agriculture, rather than indirectly dating archaeological layers associated with Neolithic cultural artefacts. To achieve this we are commissioning 250 new radiocarbon dates from approximately 50 sites and adding these to 57 dates from 13 sites previously obtained as part of a pilot project.
- We are developing a probabilistic approach to modelling movement in space and time, formally accounting both for the uncertainty inherent in radiocarbon dates and for the fact that we are dealing with a spatio-temporal process.

In this presentation, we will explain why our new models are so necessary, demonstrate what can be done with existing models and outline the nature and power of the models that we are currently working on. The talk will focus on concepts methods and practicalities, rather than on statistical technicalities.

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Depending on ^{14}C-data: chronological frameworks in the Neolithic and Chalcolithic of South-Eastern Europe

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Not only did the ^{14}C-method revolutionize chronological frameworks, but absolute data were and still are both a shock and a blessing for Archaeology. In principle every date once published needs to be commented upon, even if it does not fit current theories. What can be often observed is, that theories and models are adjusted to new ^{14}C-sequences or such sequences even lead to the creation of new models. In our paper we want to refer to two major issues which are still heavily debated, although their first absolute dating occurred some 30-40 years ago:
1) the transition from the Mesolithic to the Early Neolithic in the Eastern and Western Aegean: Very high ^{14}C-data for the beginning of the Neolithic in Greece around 7000 BC fuelled debates around the Preceramic period in Thessaly (Argissa, Sesklo) and the Early Neolithic in Macedonia (Nea Nikomedia). A reinterpretation of these data shows, that the Neolithic in Greece did not start prior to 6400/6300 BC.
2) the beginning and the end of the Chalcolithic period: Shifting from relative chronologies which dated the Chalcolithic Period to the 3rd millennium BC to absolute chronology which assigned the Kodzadermen-Gumelnita-Karanovo VI-cultural complex to the 5th millennium BC, the exact beginning and the end of the period are still under research. New data from the cemetery in Varna/Bulgaria and the tellsite "Magura Gorgana" near Pietrele/Romania are leading to new insights.

Radiocarbon Dating of Neolithic pottery.

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The correct association of radiocarbon-dated organic materials with archaeological events or features (the 'placement history') constitutes a major problem in radiocarbon dating of archaeological sites. The possible solution lays in the direct measurement of organic matter included into archaeological artefacts. The pottery being the commonest element in archaeological assemblages seems to be promising in this respect. Routinely archaeologists use the pottery styles as the most important criterion for identifying such entities as 'archaeological cultures'. Pottery together with animal bones are the only datable organic-rich substances detectable in the Yelshanian and other early Neolithic cultural entities in Russia's South. The early dates obtained for the sites of these cultures make them crucial for modelling the early Neolithic dispersal (Davison et al. 2007).
The main hazard associated with the radiocarbon dating of archaeological pottery resides in the identification of the origin of organic matter. Food residues on the pottery sherds that are used for dating are usually found in small quantities which preclude the use of conventional dating, leaving the AMS technique as the only option (Timofeev, Zaitseva & Possnert, 1995).
Recently the Kiev ^{14}C Laboratory has sufficiently improved the dating technique, thus enabling to carry out the direct measurement of organic matter in the pottery paste with the use of conventional methods. Crushed shells, grass and organic substances in lake deposits included into the pottery paste are the sources of measurable organic matter. The discussed dates have been obtained by the Kiev and St. Petersburg laboratories with the use of conventional radiocarbon methods and cross-checked at the Uppsala Laboratory with the use of AMS technique.
The dated pottery sheds were divided into an inner ('the 'terra-cotta' red coloured portion) and an outer parts (the dark one), the both parts were treated by HCl and HF, and the remaining black carbon

fraction mainly originated from the outer part has been measured. It has been suggested that the carbon included into then pottery paste came mostly from the hearths, hence its age may be deemed as a reliable estimate of the site's age. The dates of the same samples obtained in all three laboratories show a satisfactory cohesion. The obtained series of radiocarbon dates have been used for the assessment the age of early stages of the pottery manufacture in the South of Russia.
This research is supported by F6 European Project FEPRE.

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Is it possible to chronologically define the "Avellino Pumices" eruption? And…how long does the human resumption take after this eruption?

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The "Avellino Pumices" eruption was one of the most catastrophic events of Somma-Vesuvius which hit the prehistoric communities during the Early Bronze Age. It always has been intensively studied by geologists, archaeologists, volcanologists, prehistorians and scientists of other fields, due to its close analogy with the famous 79 AD eruption of Somma-Vesuvius, in order to understand when this eruption happened and what happened to the environment and to the prehistoric human settlements after this disastrous event. In the last 25 years, there were many indications about its chronology that are present in several references, including radiocarbon datings, but with poor agreement between them and frequently with large experimental errors. Many ^{14}C datings have been done on humic acids or total organic carbon from paleosols, which are subject to substantial age offsets and/or reservoir effects. Wood, charcoal, bone are usually materials more adapted for radiocarbon dating, especially when they are found in sites covered by eruptions. Many problems can occur also for these materials, e.g. in the choice of samples which must be done from horizons associated with the eruption itself, without redeposition of old material or contamination sources introduced in the laboratory during the sample preparation procedures. New and more accurate radiocarbon dating of this eruption, obtained by a measurement on a bone sample collected in a Early Bronze Age village at Croce del Papa (Nola, Naples) and prepared at the CIRCE AMS laboratory in Caserta (Italy), will be presented in this work. Moreover our data show how the human resumption after the eruption was brief in areas invested by the volcanic products, like Masseria Rossa (Nola, Naples) and S.Paolo Belsito (Nola, Naples), by radiocarbon dating of archaeological samples collected below and above the eruption deposits. All this is done comparing the state of art of this eruption, through summons in references, and the results obtained in this work.

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Central Europe between 2200 and 450 B.C.: some considerations about the chronological frame and problems bound with radiocarbon dates.

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The review of old finds, many new discoveries and the use of absolute dating methods allow a more precise chronology for the Bronze and the first Iron ages in Central Europe. The relative chronology has been developed since the 19th century and constantly refined. This chronological frame is now absolute dated in great part thank tree-ring and radiocarbon methods. The integration of radiocarbon dates in this frame must however be made very carefully and this is not always the case, what can sometimes create contradictions with serious consequences for the coherence of the European chronological system. In this contribution we want to point out three demonstrating cases and we will purpose a chronological frame valid for Central Europe - North-West alpine and Danubian Europe and Northern Italy.

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POSTER SESSIONS

SESSION 2

^{14}C CHRONOLOGIES, DENDROCHRONOLOGY, WIGGLE MATCHING AND CALIBRATION TOOLS

Improvement of radiocarbon dating using local calibration curve for Japan

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Regional offsets, which are represented by differences from the international radiocarbon calibration curve (IntCal), have been frequently argued based on the radiocarbon measurements of tree-ring samples from various regions (eg. Kromer et al., 2001). In the construction of IntCal, radiocarbon contents of contemporaneous tree-ring samples from different regions in the northern hemisphere have been used, because the regional differences were indistinguishable from errors of radiocarbon measurements. Nowadays, high-precision radiocarbon measurements can be carried out much more easily than before, so more attention should be paid to the possible regional offsets.
Most parts of IntCal have been constructed by measuring radiocarbon content of tree-ring samples from woods in high latitudes of Europe and North America, which are farthest from Japan in the northern hemisphere. In order to investigate regional offsets in Japan, we measured radiocarbon contents of tree-ring samples from Japanese wood samples dendrochronologically dated from 11th century BC to 5th century AD (eg. Ozaki et al., 2007 and this work). Although the differences are small in general compared with statistical errors of radiocarbon measurements, significant differences up to more than 50 ^{14}C years from IntCal04 (Reimer et al., 2004) are observed during the period from 1st to 2nd century AD in Japanese tree-ring samples. This is consistent with our previous results of other tree-ring sample (Sakamoto et al., 2003). Such big regional offsets would lead to incorrect calibration. Moreover, invalid calibrated dates of about 100 calendar years could be caused by small regional offsets (eg. Imamura et al. 2007). In practice, calibration results using the series of radiocarbon contents obtained by this work were different by nearly 100 calendar years from the case using Intcal04 for some periods.
During the period from 2nd to 3rd century AD, major cultural transition from prehistoric Yayoi era to protohistoric Kofun era occurred in Japan. Differences of a few ten of years in calibration will give an impact in Japanese archaeology. In this paper, we will report the regional offsets in Japan found by radiocarbon measurements for tree-ring samples ranging from 11th century BC to 5th cetury AD, and a few examples of practical calibration using a local calibration curve tentatively constructed.

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Marine reservoir effects in modern mollusc shell and flesh from the Irish coast

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Our ability to reliably use radiocarbon dates of mollusc shells to estimate calendar ages depends on the feeding preference and habitat of the particular species and the geology of the region (Mangerud, 1972). Gastropods which feed by scraping are particularly prone to incorporation of carbon from the substrate into their shells as evidenced by studies comparing the radiocarbon dates of shells and flesh from different species from the same location and the same species on different substrates (Dye, 1994; Hogg et al., 1998). Limpet shells (*Patella sp*.) are commonly found in prehistoric midden deposits in the British Isles and were presumably part of the palaeodiet, however these shells have been avoided for use in radiocarbon dating in regions of limestone outcrops. Preliminary results from limpets (*Patella vulgata*) collected alive on a limestone substrate on the east coast of Northern Ireland indicate that the shells were formed in equilibrium with the seawater, which has elevated ^{14}C due to the output of Sellafield nuclear fuel reprocessing plant, whereas the flesh was considerably depleted in ^{14}C (McClean, 2007). Further measurements of molluscs collected on limestone and basalt are underway. The results will have an important consequence for radiocarbon dating of midden deposits as well as the bones of humans and animals who fed on the limpets.

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Radiocarbon and dendro-dating of monoxylous boats from Northern Italy

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Over the past fifteen years the author was involved in the study of some Italian monoxylous boats for absolute dating. Because of their conditions on discovery, a chronological indication coming from stratigraphy or associated finds was not possible, therefore both dendrochronology and radiocarbon dating were used for the purpose.

All the monoxylous boats (eleven items) come from Northern Italy; they were discovered during the 19th and the 20th centuries, along the banks of rivers during engineering works, or after periods of severe drought. Only one vessel, that from Lova, comes from the Lagoon of Venice. Almost all the boats are made by a single oak tree trunk. Wooden samples were taken by means of semi-nondestructive methods and borers appropriate for waterlogged wood were used for extracting cores.

The majority of the dates rely on radiocarbon dating, nevertheless tree-ring analysis was carried out on almost all the boats (nine) in order to select the part with the outermost tree-rings on the vessels as specimens, trying to avoid the old-wood effect.

Thanks to the existence of a Venetian oak mean curve, dated by using the ‘wiggle-matching’ method in the period 450-720 cal AD ± 21 y. (2σ), a logboat from Tencarola (near Padua) was dated by dendrochronology, with the last ring dated to the year 727 cal AD. But the absence of millennial long

Italian standard oak chronologies prevents cross-dating all the dendrochronological sequences obtained.
At present nine boats are dated by means of AMS measurements; their ages cover a range from 920 years back to 1435 years BP. Despite their "primitive" shape all the analysed pirogues belong to Medieval age, their calibrate date ranges spanning from the 6th to the 12th centuries AD (1σ). This result confirms that these kind of boats remained in use till recent times in line with research carried out in other regions of Europe.
Some recent studies also suggest that in most of the cases medieval pirogues could have been used both as logboats in rivers, lakes, marshes and lagoons, and as floats for pontoons, boat bridges or floating-mills too.

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Martinelli N., Pignatelli O., 2005. *Datazione assoluta delle piroghe del Museo Archeologico di Padova. Indagini dendrocronologiche e analisi radiocarboniche AMS su quattro imbarcazioni monoxile*, "Bollettino del Museo Civico di Padova", XCIII (2004), pp. 51-59.

Calendar age of boundaries arbitrarily determined as radiocarbon age

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The specific method of smoothing of radiocarbon calibration curve is proposed for recalculation (calibration) of boundaries of the holocene chronozones (Mangerud et al. 1974). The method, which operates for any arbitrarily accepted age horizon, was referred originally on radiocarbon time scale. There is strong need for the "calibration" of some well established "time cuts" which were determined numerically by the large number of radiocarbon dating. The problem is that it is impossible to return to all original dates and especially to their contexts, to calibrate them. Take one strict number, e.g. 5000 BP (conv.), which has no longer sense of radiocarbon determination, into consideration. It is rather absolutely precise (arbitral) number, and in such a case, the application of standard, probabilistic calibration procedure is principally impossible because of well known fact that it is no one-to-one relation between calendar and radiocarbon time scales. Moreover, that relation is imprecise because of measurement errors (not very high, of order of 10yr). There is a point in attaching to the strict number (i.e. with σ=0; ex. 5000±0 conv BP) large error, say σ=200yrs, to apply the calibration technique. The resulting operation is equivalent to the smoothing of the radiocarbon calibration curve. The range 5000±200 conv BP cover most of the significant dates which have had participated in the definition of the given chronozone boundary.
The last step in the procedure is to accept the unique value from the resulting (calibrated) probability distribution. However, it seems that there is no other choice than the median of the distribution i.e. the value dividing total mass of probability into equal halves. That operation would be an analog to accept such a radiocarbon age of chronozone boundary, which divides all dates, which were used historically to determine it, into halves.
However, some specific problem with Mangerud's chronozones boundaries is connected with the fact, that they are given (in conv BP) in highly rounded numbers, in the most cases to thousands. Especially the problem stems from that it is the deep sense in such roundness, because these are arbitral decisions (to some extend). Of course, it is difficult to maintain such a character of numbers after its

"calibration" by given, strict mathematical procedure. However, since the proposed procedure is probabilistic in sense, the obtained values (medians) would be treated loosely, and can be rounded off, to say, hundreds of years.

	conv BP	BC
Subatlantic / Subboreal	2500	600
Subboreal / Atlantic	5000	3800
Atlantic / Boreal	8000	6900
Boreal / Preboreal	9000	8150
Preboreal / Younger Dryas	10000	9600
Younger Dryas / Alleröd	11000	11000

Afarementioned "calibration" ensures, that the samples taken randomly (in some sense) from the closest time horizon will remain distributed in the same proportion, below and above the horizon, also after the calibration.

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The probability imbalance in calibrated radiocarbon age

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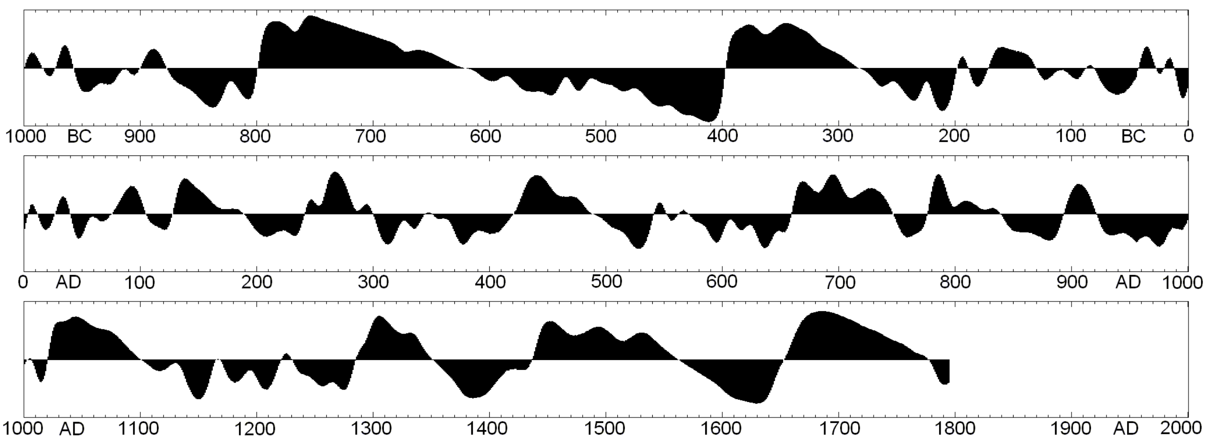
The final result of radiocarbon age determination has the form of probability distribution of well know, complicated shape. From the opposite point of view, any single sample has its own, absolutely precise (however, unknown) true age. The above title states that, in general, the probability is unequally distributed around the true age of a dated object. The difference between the probabilities of younger and older ages, according to the resulting probability distribution, is plotted below as a function of the calendar age of a sample. Such a difference gives some measure of imbalance or, more precisely expected systematic bias of the resulting age as chosen by the archaeologist on the basis of his *a priori* knowledge, as well as the probability distribution.



The last 3 millennia only are presented here, in the abstract. The vertical axis range of plots above is from –1 to 1. The value plotted is a difference of probabilities: $P(t>T)-P(t<T)$, where T is a true sample age, and t is the age "probably" assumed by the end user. Accordingly, positive (upper) values

indicate bias towards younger ages. For example, for T=760BC it is almost sure that the accepted age will be younger than true one (760BC). The curve was obtained assuming measurement error σ=50 yr.

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Dating of the oglakhty burial ground of the TASHTYK culture (Southern siberia)

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The article describes the development of a chronology for one of the key Oglakhty burial grounds. The Oglakhty burials belong to the Iron Age, from the earliest phase of the Tashtyk culture, which followed the Tagar (related to the Scythians) culture. This culture was influenced externally, by contacts with other cultures that apparently penetrated the Minusinsk depression from the southern regions of the Khakasia Republic in Central Asia. There are more than 300 burials of the type investigated, but the great majority of them contain materials that cannot be dated and so are of limited value in chronology development. The only exceptions are several graves at the Oglakhty site, where human mummies with tattoos, clothing, wooden items and textiles have been preserved. However even these fascinating objects appeared to be inadequate for precise dating, so that the previous chronological determination of the Tashtyk burials was quite rough. Since the early 20th century, up to two time variants for the Tashtyk burials were proposed: I century BC- I century AD and I-II centuries AD.
In the 1990's, new data were obtained. Firstly, the Chinese originals for the Oglakhty silk fabrics were attributed to the III-IV centuries AD. Secondly, chemical analyses of beads from tashtyk sites indicated/revealed that some of them could not be dated earlier than the II century AD. On the basis of these findings as well as detailed examination of burial rites, the chronological window was enlarged to the I-IV centuries AD.
Such a significant alteration to the Tashtyk chronology necessitated revision of the dating of linked cultures, therefore it was essential that this change be confirmed with independent data ideally from radiocarbon dating.
One of the best preserved Tashtyk complexes was that of Oglakhty VI, grave 4. Good preservation of the wooden chamber found here provided a rare chance to use the wiggle matching dating method. The chamber, including the ceiling, was made of logs, from Larix sp. (12) and Pinus sylvestris Z. (7). In 2005, two samples were obtained for dating, one of 210 annual rings (sample 1 – Larix sp.) and another of about 180 annual rings (sample 2 – Pinus sylvestris Z). Each of the samples was divided into fragments (layers) of 10 annual rings, used for dating.
According to the data obtained, the grave 4 burial chamber can be dated to the III-IV centuries AD, corresponding to the date of imported objects found in the same grave and thus supporting the revision of the Tashtyk chronology.
This research is supported by the Program of the Presidium of the Russian Academy of Sciences and the INTAS project, No. 03-51-4445.

Wiggle-matching using known-age pine from Jermyn Street, London UK

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Timber used in the construction of an early terrace house on Jermyn Street, in the heart of London's West End, was dated by dendrochronology to AD 1670 and AD 1710. One of the core samples taken for this analysis comprised 303 growth rings, and ended in bark edge. This tree was felled in AD 1670. As part of the quality assurance procedures of the radiocarbon dating programme funded by English Heritage, eighteen samples of decadally separated single rings from this timber were dated by our the radiocarbon laboratories at Groningen, Oxford, and Glasgow. Each laboratory was sent a random selection of six of these samples. This sampling approach was intended to mimic the mix of samples and relative ages incorporated into Bayesian chronological models during routine project research. A sample of Scot's Pine from the period covered by single-year calibration data (Stuiver 1993) was selected for dating, following successful known-age wiggle-matching of decadal samples from earlier oak timbers by the laboratories concerned (Hamilton *et al.* 2007).
This poster presents the results of this experiment.

Hamilton, W D, Bayliss, A, Menuge, A, Bronk Ramsey, C, and Cook, G, 2007 "Rev Thomas Bayes: *Get ReadyTo Wiggle*" – Bayesian Modelling, Radiocarbon Wiggle-matching, and the North Wing of Baguley Hall, *Vernacular Architecture*, **38**, 87–97

Stuiver, M, 1993 A note on single-year calibration of the radiocarbon time scale, AD 1510 – 1954, *Radiocarbon*, **35**, 67–72

Muddy Fields Forever?

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The most recent release of OxCal (v4.0.5; Bronk Ramsey 2008) includes Bayesian age-depth modelling functions which can produce realistic posterior density estimates for the dates of significant ecological changes in off-site pollen records. Such estimates can then be compared to the estimated dates of archaeological events, obtained by Bayesian modelling of on-site scientific dating results. The middle-late Bronze Age village at Bestwall Quarry, Dorset, England, was the subject of an extensive radiocarbon dating programme in 2003-6 (Bayliss *et al*. forthcoming), whose results were modelled using an earlier version of OxCal (v3.10). This poster examines the impact of the new age-depth modelling functions, by comparing the chronologies obtained for the village and a nearby palaeoenvironmental sequence using the two versions of OxCal.

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POSTER SESSIONS

SESSION 3

RADIOCARBON, ARCHAEOLOGY AND LANDSCAPE CHANGE

Application of ^{14}C dating towards solving archaeological problems- A case study - Antiquity of custard-apple in India

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An attempt has been made to solve an archaeological problem, to trace the antiquity of custard-apple in India on the basis of AMS and Ultra Low Level Liquid Scintillation Counting (LSC) radiocarbon dates. Recently associated charcoals and seed remains of custard-apple (Annona squamosa L.) were recovered from a Neolithic settlement at Tokwa on the confluence of Belan and Adwa rivers, Mirzapur Dist. in the Vidhyan plateau regions of North-Central India. The samples were collected and studied by 2nd author. The charcoal sample was dated at ^{14}C laboratory of BSIP, Lucknow by conventional method (LSC) of ^{14}C dating. The sample dated to 1740 Cal BC (BS-2054). A carbonized seed of custard-apple was dated at newly established (2004) AMS ^{14}C laboratory, Institute of Physics, Bhubaneswar, India (3 MV tandem pelletron accelerator). Very interestingly the AMS date was 1520 Cal BC (IOPAMS-10) showing a reasonable agreement with LSC date carried out at BSIP. On botanical ground the custard-apple is native of South America and West Indies and it is supposed to have been introduced by Portuguese in India during 16th century AD. Cultivated for fruits, it grows wild as an escape in parts of Andhra Pradesh, Deccan plateau and Central India. It has also been found in Bharhut and Sanchi Sculptures in M.P. and carvings dug up at Mathura in U.P.(2nd-1st century BC) by General Cunningham in 1879. The finds of fruit coat of custard-apple have been encountered from Kushana Times (1st-3rd century AD) at ancient Sanghol in Punjab. In addition to the above, the seeds of custard-apple are also present in the sample from stratigraphic sequence of iron-using culture at Raja-Nal-Ka-Tila, Sonbhadra District, Uttar Pradesh. Earlier ^{14}C dates from archaeological settlement of Raja-Nal-Ka-Tila, placed its antiquity to 740 Cal BC (pre-Columbian time). The present ^{14}C dates by AMS as well as LSC of the samples pushes back the antiquity of custard-apple on the Indian soil to about 1630 Cal BC, pre-Columbian suggesting Asian-American trans-oceanic contacts, before the discovery of America by Columbus in 1498 AD.

A View from the Andes: Prehispanic Settlement Patterns and Absolute Chronology of the Culebras Valley, North Coast of Peru

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Since 2002 the Culebras Valley has been the focus of an extensive archaeological surface survey and limited excavations in selected sites carried out by Polish and Peruvian scholars. So far, over one hundred previously unknown archaeological sites have been recorded, and tentative interpretations of their chronology, functions and settlement patterns have been suggested. In this paper we will present how the application of radiocarbon measurements, widely correlated with archaeological data and new research into paleoclimatic change, helps to reveal over 4000 years of Andean prehistory. The research is promising for achieving significant advances in the current understanding of local pre-Hispanic societies.

Prehistoric and Early Medieval landscape changes in the light of radiocarbon dates: the north-eastern foreland of the Sudetes Mts, Poland.

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In the NE foreland of the Eastern Sudetes and partly of the Western Carpathians, there is a zone of loess plateaus (Głubczyce Plateau and Rybnik Plateau) approximately 110 km long and 30 km wide, extending from NW to SE. The undulated summits of the plateaus reach 350m a.s.l. at the foot of the Eastern Sudetes and descend gradually to 210-130m a.s.l. along their NW margin. The largest rivers dissecting the loess plateau have their source areas in the Sudetes (Odra, Osobłoga) while the smaller ones (Psina, Troja) drain the loess area only.

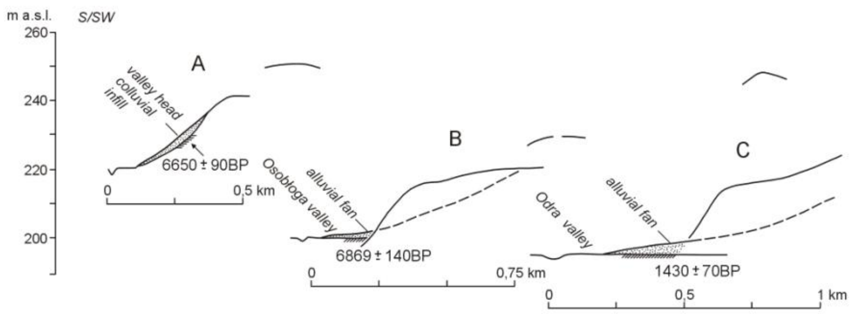
Major relief features of the loess plateaus were shaped in severe, periglacial climatic conditions of the Pleistocene. The loess "mantle" deposited at that time smoothed the older relief. During the Holocene warming, fertile soils were developed in these areas, mostly under deciduous forests communities.

These loess plateaus are situated in Central Europe between 50^0 and 50^0 30'N latitude and between 17^0 20' and 18^0 55'E longitude. The mean annual temperature is between 7.5 and 8°C, ranging from -2°C to -3°C in January, to +17-18°C in July. Annual precipitation amounts to 650-700 mm. Arable agriculture prevails in the region, with forest cover accounting for only a small proportion of the area.

Offering moderate climatic conditions, abundant in surface waters, and producing biomass during 9-10 months per year, these plateaus were already settled in the Neolithic age by Linear Band Pottery Culture communities, which migrated from the Carpathian/Pannonian Basin to the north via the Moravian Gateway. The development of agriculture and herding as well as the establishment of permanent settlements led to the deforestation of large areas, initiating soil erosion.

In the interior part of the Głubczyce Plateau, Holocene fossil soils of 6650±90 years BP (cal. 2σ 5640 -5320 BC) in the headwaters of main rivers dissecting the plateau, were covered by colluvia, attributed with high probability to settlements, which started in the Neolithic Age and continued through the Bronze Age (Fig.).

In the transit Osobloga valley, 2-metre thick alluvial fan deposits at the mouth of a small tributary covered the valley floor with organic matter, mostly peat. It interrupted the peat increment whose uppermost part was dated back to 6895 years BP (cal. 2σ 5919-5543 BC). The SW slope of the Rybnik Plateau was settled markedly later, in 6th-7th centuries, by Slavic tribes. The period of gully formation and alluvial fan progradation in the Odra valley floor is well-documented. The most recent radiocarbon dates of organic matter covered by alluvial fan deposits are here recorded at 1430±70 BP (cal.2σ 540-670 BC) and 1390±80 years BP (cal.2σ 540-700AD),(Fig.).



Radiocarbon dating and palaeobotanical investigations in the territory of Vilnius Lower Castle, Lithuania

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^{14}C dating and palaeobotanical (plant macrofossils and pollen) investigations carried out in the territory of the Vilnius Lower Castle. Multiple sediment sequences (up to 315 cm in depth) for the ^{14}C dating and palaeobotanical investigations (plant macrofossil and pollen survey) were taken from a cleaned wall of the archaeological ditch. Sediments were sampled at 2 cm intervals for pollen analyses and ^{14}C dating. A parallel sequence was sub–sampled for plant macrofossil analyses (every 5 cm). Paleobotanical data indicate that continuous agricultural activities confirmed by presence of cereals and weeds, together with exploitation of natural resources, supported the survival of the local community during the A.D. 5th–6th. Flourishing of well-developed forest with the wet grasslands predominated in the local landscape confirming some climatic instability recorded in the vast territories of Europe during the Migration period (Zolitschka et al. 2003). The onset of 14th century coincided with a period of intensive human activity at the territory of Vilnius Lower Castle and surrounding areas. Opening of the vegetation cover was accompanied by increasing importance of agriculture activities indicated by the high representation of *Cerealia* undiff. and *Cannabis sativa* pollen, occurrence of *Panicum miliaceum* and *Secale sereale* specimens in archaeobotanical material. Occurrence of *Linum* and *Fagopyrum* pollen grains suggests an introduction of these plants into the local vegetation. The vegetation structure shows reduction of human interference at about A.D. 1331–1330 when forest gains more ground in area. Nevertheless, the open habitats, including agricultural fields and pastures, still existed, possibly on a regional scale. Palaeobotanical and historical records indicates sudden rise of the human activity and remarkable environmental changes starting in the second half of the 14th century that could be related with Christening of Lithuania state in 1387 (Zabiela, 2001). General opening of the vegetation structure was accompanied by intensive development of the Vilnius territory and progressive agriculture around ancient town. Presence of *Fagopyrum* sp. seeds confirms the local cultivation of this plant. Formation of drier environmental conditions may have played a positive role in this process as well. Presence of exotic plant remains e.g. fig (*Ficus carica*) in archaeobotanical material indicates increasing foreign trade. Intensive exploitation of the area continued during the first half of the 15th century indicated as a period of as economic and cultural expansion in area under investigation. High number of cultivated plants e.g. *Panicum miliaceum*, *Fagopyrum* sp., *Brasssica rapa* and *Cannabis sativa*, weeds and ruderals were transported to the territory, confirming intensive pressure on the local landscape, where development of the urban territories, together with intensive land use in suburbs, affected the vegetation cover along with the entire environment.

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Zabiela G (2001). Viduramziu archeologija Lietuvoje [Medieval Archaeology in Lithuania]. Lituanistica, 3 (47): 20–30.

Nasielna River Valley in Nasielsk - a Study of Anthropogenic Changes (IXth Century - XXIst Century)

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The interdisciplinary study dealing with human impact and climate change during last fourteen hundreds years was carried out in Nasielna river valley in the town of Nasielsk (east-central Poland, some 50 km north of Warsaw). The main aim was to recognize the morphology, geology in the vicinity of the medieval stronghold located in the northern part of the Nasielna river valley (Photo 1). There has been also examined whether the origin of the sediments filling researched part of the valley bottom is connected more with natural processes (i.e. climate change etc.) or with the former human activity in this area.

Fig. 1. An aerial photograph for the town of Nasielsk. A well-visible circle-type shape of the early Medieval stronghold is located in the very damp part of the river valley. (Photo by M. Tyc).

There have been done a detailed geomorphological and geological mapping for the stronghold environs. Some 50 shallow (up to 2 m) drillings let to identify facial differenciation of the valley bottom geology. Direct observations and sedimentological analyses (such as loss on ignition or calcium carbonate contents) allowed to distinct such facies as (1) peats, (2) sandy peats and (3) gythias which were connected with organic accumulation in the damp valley with or without vast deforestation and agriculture (types 1 and 2) and lacustrine sedimentation in the mill ponds (type 3). The absolute age of the sediments deposited in the top part of the valley bottom or some objects and cultural levels in the stronghold were determined using radiocarbon, dendrochronological and palynological methods respectively. The stronghold was first excavated in 1967 (Górska 1976). A detailed archaeological studies in the stronghold and its vicinity were carried out in 2001-2006 (Błoński, Milo, Misiewicz 2003; Błoński, Szwarczewski 2007; Błoński 2008a, 2008b). According to the results of the dendrochronological examinations of the wood samples from the oldest and the youngest phases of the rampart, the date of use of the stronghold can be defined as between the mid of the 9th and second half of 13th centuries. Stronghold in Nasielsk was preceded by an open settlement located in the vicinity of the stronghold.

Facial differentiation of the organic sediments in the Nasielna valley bottom points out for repeating operation of mill ponds in this area. Geological drillings and sedimentological analyses proved functioning of at least five chronologically independent artificial ponds – two of the well expressed gythia levels has been radiocarbon dated giving the dates as follows 860±105 BP (990-1310 cal AD, 1360-1380 cal AD, IGSB-1264) and 1010±90 (822-838 cal AD, 868-1244 cal AD, IGSB-1263).). The written sources indicate for the water mill ponds in this part of the river valley from the XIV century. Archival topographic map also document the presence of few water mill ponds from XVIII to XX century. The palynological data prove human presence since the beginning of organic matter formation (Bińka 2005); it has started accordingly to recived date some 1470±75 BP (822-838 cal AD, 868-1244 cal AD, IGSB-1262).

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AMS ^{14}C dating of romanesque rotunda and stone buildings of medieval monastery in Łekno, Poland

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Archaeological excavations performed for many years in Łekno, central Poland, has disclosured relicts of wooden fortified settlements in 3 phases of development between 7th-10th century, and in its enclosure, also basements of stone buildings, consisting of romanesque rotunda, and cistersian monastery, including oratorio, church, and abbot’s house. Earlier archaeological, spatial-structural and stratigraphical studies have shown that these buidlings were constructed in a sequence, and represented several phases of development.
In this paper we present results of ^{14}C dating of stone buildings of the rotunda and the monastery. For ^{14}C dating, we used tiny pieces of charcoal retrieved from calcareous and gypsum mortar binding stone elements of buildings. These pieces were incorporated in mortar during firing process, where the fuel for firing was wood. Most of the obtained ^{14}C dates formed clear groups, confirming that individual buildings were constructed in separate periods. Calibrated ^{14}C dates of these phases, agree well with the constraints provided by historical sources, and enable us to set their ages with accuracy better than available before. In particular, we have learned that the oldest rotunda was built at the boundary of X/XIth centuries (in 1020 AD at the latest), and the church and the abbot’s house – before 1250 AD.
However, some samples gave much too old ^{14}C ages, clearly reflecting use of old wood for firing. These problems were revealed only for samples from the rotunda, and also from the gypsum stone ornamental details.

The formation of deluvial sediments and alluvial cones as the Response to Human Settlement on a Loess Plateau – an example from the Chroberz Area (Nida Basin, Little Poland Upland)

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Holocene, and in particular its younger period distinguishes itself from other periods in the Earth's history by economic activity of the man. Man's activity in the natural environment became a new, exceptional morphogenetic factor whose force affecting on animated and unanimated nature is dependent upon the development level and type of dominating economy. Widely conceived pressure caused by human activity interferes with natural transformations (e.g. climatic ones) and therefore the record indicating the existence of these two groups of factors in the natural environment has a hybrid character, and is troublesome and difficult to separate. The existence of these interrelations is deduced on the basis of results of numerous studies based both on an analysis of direct measurements (the last 200–300 years) and on indirect analyses based on a signal recorded e.g. in lake and deep sea sediments, corals, calcareous tufa or ice cores projecting changes taking place in the entire Quaternary or solely Late Glacial and the Holocene periods (e.g. Starkel 1999, 2001, Boryczka 1993, Ralska-Jasiewiczowa 1993, Alley 2000, Wagner, Melles 2002, Gerdes *et al.* 2003, Vlag *et al.* 2004).
The research in the area of Chroberz (a site was located on the border zone between the Wodzisław Hummock and Nida River basin, Southern Poland) had an interdisciplinary character and comprised geomorphologic, sedimentation and archaeological-historical problems. The main aim of the study was to identify geomorphologic response to changes in natural environment that took place in the area of the loess plateau (and its close vicinity) as a result of its settlement by man and of climate change.

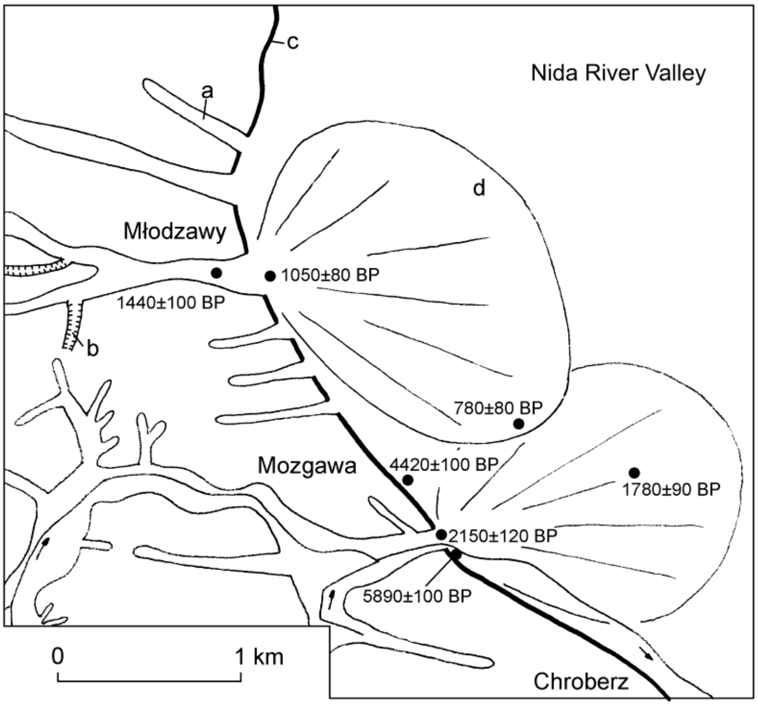

Fig. 1. Alluvial fans in the vicinity of Młodzawy and Mozgawa. Radiocarbon age pointing for the stages of fans progradation and the beginning of coluvia accumulation. a – valleys, b – gullies, c – loess plateau edge, d – aluvial/deluvial cones

At the outlet of eroded form coming down the Wodzisław Hummock to the Nida river valley alluvial (alluvial-deluvial) cones were formed. Two of them are situated close to each other and the area of each exceeds 1 sq km. The first one (the northern one) located near the locality of Młodzawy, is formed at the outlet of a dry, large flat-bottomed valley. The other (the southern one) situated near the village of Mozgawa is connected with Nida's small right tributary, the Mozgawka (Fig. 1). The alluvial cones-building material volume is many times smaller than the size of eroded forms which allows to conclude that the valleys are older than the cones. Probably, at their initial formation stages part of the material may have been transported directly to the Nida river bed. In a later period – i.e. late Holocen – the tiniest fractions may have been transported in suspended matter at considerable distances and may have accumulated away from the cone.

Slopefoot and alluvial cone areas were identified by a dense network of shallow (1–3 m) and deeper (to 11 m) probes and drillings. The age of organic sediments found below deluvia and aluvia, determined by radiocarbon method (datings done in the Kiev Laboratory), enables the determination of primaeval and historic soil erosion and the rate of progradation of alluvial cones. The recived radiocarbon age fits very much to the archaeological data avaliable for this area. The results of radiocarbon datings, at the background of the main elements of surface relief are presented in Fig. 1 while the relations of recived radiocarbon dating to the geomorphic processes and their orgin are presented in fig 2.

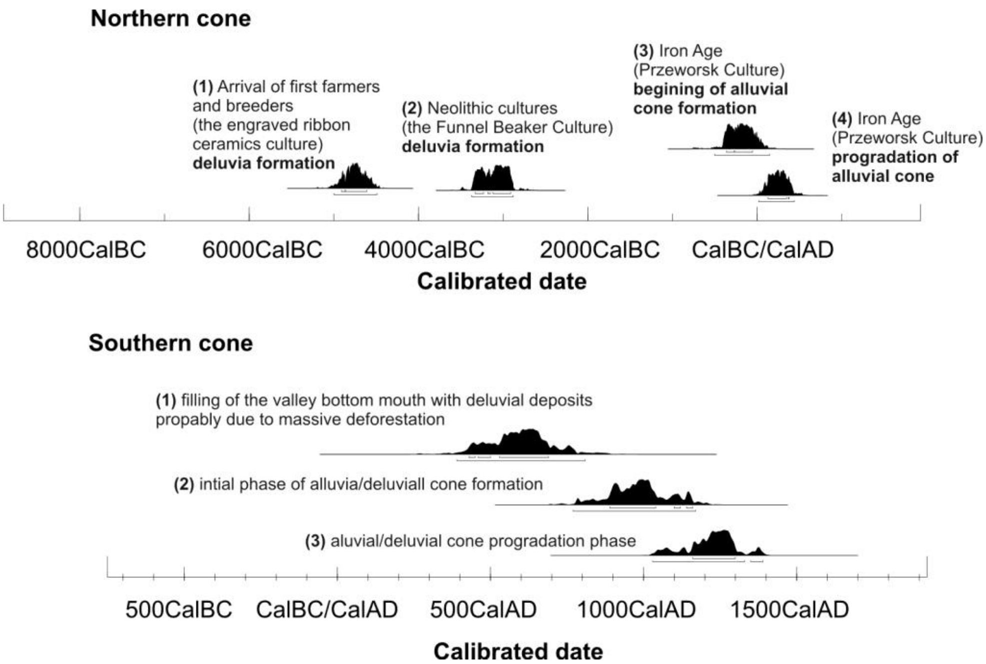

Fig. 2. A calibration of radiocarbon datings from fig. 1 with dominating geomorphic processes and sediments origin (Atmospheric data from Stuiver et al. (1998); OxCal v3.9 Bronk Ramsey (2003); cub r:4 sd:12 prob usp[chron]).

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Radiocarbon reservoir effect in dating lake sediment: based on Varve chronology of Sugan Lake

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Chronology is the basis for using lake sediments to reconstruct the history of environmental change. Because samples are mixed with "dead carbon", the measured ^{14}C age is normally older than the actual age, which is recognized as "reservoir effect".

Detailed examination of sedimentary cores retrieved from Sugan Lake in the northern Qaidam Basin of northwest China's Tibetan Plateau reveal that fine laminated beddings form in the sediments where water depth exceeds 3 m. Seasonal surface sediments trapped at the bottom of the lake suggest that sediments deposited during summer and autumn are mainly light colored monohydrocalcites, while those deposited in winter are dark organic matter, indicating that varve layers form under modern limnological conditions. Continuous varve sediments comprising four types have accumulated in the upper 5.5 m of Core SG03I from the center of the lake. All types exhibit clear seasonality indicative of annual deposition. Varve counts correspondence with 210Pb dates on recent sediments in the upper core suggest the continuous varves of the upper 5.5 m of the core formed in the late Holocene (2670 a BP). The Sugan Lake varve sequence is the first demonstration of annually laminated sediments reported in arid western China.
Five aquatic plant Ruppia maritima fossil Seeds were picked up in Sugan Lake sediment for the radiocarbon dating. Compared with varve dating result, 2630-year radiocarbon reservoir effect age was determined. Although radiocarbon reservoirs vary geographically and temporally, stable reservoir ages in specifically period was shown during Little Ice Age (LIA). According to this result, radiocarbon reservoir age may be driven by climate change.

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The origin of agriculture in northern China – A case study: Dadiwan, Gansu province

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OA (origin of agriculture) research in the world and northern China shows that northern China is the only one where it does not seem to unfold, in situ, from local hunter-gatherers in ten instances known worldwide in which agriculture evolved independently; Agriculture evolution from domesticated seeds is not clear deviod of systematic agriculture survey; the cause of what ever drove the change from the hunter-gathering to agriculture also need to be detected based on the detailed environmental records. So published radiocarbon dates of archaeological sites and archaeological materials in northern China was collected, a large scale survey centered on Hulu River and Xihan River drainage was carried out, and Dadiwan site was excavated scientifically since 2004 in order to answer these questions. Here are some points.
1. 10-8kyr BP, 7.4-6.6kyr BP, 4.8-4.5kyr BP and 3.8-3.5kyr BP are the low value zone based on the cumulative probability of 1364 radiocarbon dates in northern China.10-8kyr BP and 7.4-6.6kyr BP are right on the transition Paleolithic Age to Neolithic Age and Early Neolithic to Late Neolithic Age, and they both witnessed a "culture gap" in northern China. So no continuous archaeological record for origin of agriculture was ever discovered in north China.
2. Agriculture survey indicates that hunter-gathering was dominated by low ubiquity of half-domesticated Panicum miliaceum during 8-7.3 kyr BP, but developed agriculture quite higher ubiquity

of domesticated Panicum miliaceum after 6.4kyr BP. The replacement of hunter-gathering by Agriculture may take place on the transition from Dadiwan Ⅰto Late Banpo, Yangshao Culture.

3. Paleosol-loess section at Dadiwan and δ13C of charred Panicum miliaceum and Setaria italica combine together a continuous environmental record for the research on OA.

a. The first continuous archaeological record exposed at Dadiwan site make it possible to detect the climate change for origin of early agriculture and the transition from Paleolithic to Neolithic age in northern China. Environment proxies reconstructed suggest that 60-25kyr BP and 12-7kyr BP are moister, but 25-12kyr BP and 7.2-6.4kyr BP much drier. 7.2-6.4kyr BP is much important for OA.

b. δ13C of charred Setaria italica goes up from Late Banpo to Changshan culture, and then it goes down until Qiaocun type and Dongzhou. It suggests that the precipitation increased continuously from Late Banpo to Changshan culture, then reduced since Changshan and reached the lowest point during Dongzhou.

4. When, where and why did agriculture originate in northern China?

a. Setaria italica and Panicum miliaceum may originate at different region, central China and transitional zone from grassland to forest, respectively.

b. Agriculture may originate firstly around 8 kyr BP induced by 8.2 kyr BP event, or around 7 kyr BP triggered by 72-6.4 drought event.

c. It has different time, different development stage and different model for the origin of agriculture in northern China.

POSTER SESSIONS

SESSION 4

HOW GOOD ARE ^{14}C AGES OF BONES? PROBLEMS AND METHODS APPLIED

Radiocarbon and Anthropochemical Studies of Mesolithic Human Bones From the Upper Volga

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Six fragments of human bones from three archaeological monuments of the Mesolithic epoch have been studied. The radiocarbon date of a bone from the Stanovoe monument (9310±60 BP, GrA-34084) is an agreement with the radiocarbon age of the layer, in which this bone was found: 9280±240 BP (GIN-10122 I) to 8850±90 BP (GIN-11093). All the three bones from the Ozerki monument have similar radiocarbon ages (7760±50 BP, GrA-34078, 7680±45 BP, GrA-34082, 7755±50 BP, GrA-34083) and are more than 1000 years younger than the radiocarbon age of wood fragments from the layer of habitation deposits (8830±40 BP (GIN-6655), 8840±50 BP (GIN-7474)). Evidently, the bones do not belong to this habitation layer, as the Ozerki site was flooded about 8500 BP and habitation there was impossible until about 7400 BP. It can be supposed that these are the bones of a person eaten (as indicated by the intentional breakage of the bone to get the marrow) somewhere else were intentionally thrown away into the water at some distance upstream from the habitation site. The bone from the Ivanovskoe monument (8410±50 BP (GrA-34112)) is, on the contrary, about 1000 years older than the peat layer, in which it was found: 7530±150 BP (GIN-9361 I) to 7320±190 BP (GIN-9369 I). Between 8500-8000 BP the site was flooded. In this case, it is most probable that the inhabitants of the Ivanovskoe site found somewhere an old human bone and used it in ritual practices. Such examples are known from West Siberian ethnography.
All the three bones from the Ozerki site are marked by sharply increased concentrations of iron and arsenic against the background of normal or somewhat lowered concentrations of other elements. This fact makes it possible to suppose that all these bones belonged to the same person. The extremely high iron content in the bones could be due to poisoning or a disease that provoked dehydration of the organism and a rise in the concentration of red blood cells with iron-containing haemoglobin. A hypothesis of poisoning is supported by the fact of the high concentration of arsenic in bone tissues. A somewhat increased concentration of arsenic is also registered in the bones from the Stanovoe and Ivanovskoe archaeological sites; it could be due to the high portion of mushrooms in the food diet of their inhabitants. However, this increase was fairly small and could produce favourable effect on the health of ancient people via some strengthening of their bones. The concentration of zinc in the bones from the Ozerki and Ivanovskoe monuments is lower than the normal value. It is known that zinc deficiency negatively affects the reproductive function. In both bones from the Stanovoe site, the zinc content is high. Excessive concentration of Zn in the organisms provokes serious diseases, such as quinsy, gastrointestinal malfunctions, sleep disturbances, fatigability, tinnitus, auditory malfunctions, etc. These diseases were really dangerous for people of the Mesolithic epoch.

Radiocarbon and Anthropochemical Studies in the Andronikov Monastery

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Five burial graves were discovered in the Saviour Cathedral (1420-27 AD) of the Andronikov Monastery (founded about 1360 AD, Moscow). The fifth grave is twinned. It is supposed that the first hierarchs of the monastery and icon and frescos painters were among the people buried there.
Radiocarbon dates were obtained from bone tissues of the six buried people by the AMS method in the Centre for Isotope Research in Groningen. The coffin wood from graves 1–4 was also dated in Groningen and in the Radiocarbon Laboratory in Kiev. The anthropochemical investigations included the determination of the chemical composition of bone tissues of all the six buried people. As found earlier, data on element concentrations in the bones are indicative of the food diets; in many cases, they can also be used to judge the professional occupation of people (Alexandrovskaya & Alexandrovskiy, 2003, 2005). Thus, elevated concentrations of Pb, Zn, As and other microelements contained in mineral dyes are contained in the bones of ancient painters.
In the bones from the first four graves, concentrations of most of the determined elements were relatively low. Concentrations of iron, copper, lead, bromine and some other elements in these objects

were less than their normal (average) values. Iron and copper are important elements of haemoglobin and their low concentrations in bone tissues may attest to anaemia. In some of the samples, concentrations of arsenic, mercury, and manganese were somewhat higher than normal values.
The chemical composition of the bones from graves 5 and 6 was different; it was marked by the considerably increased concentrations of lead and zinc and by the slightly increased concentration of copper. This allows us to assume that the people buried in these graves were either metallurgists or painters. At the same time, the concentration of arsenic—a characteristic element of mineral dyes—in these bones was relatively low.
The age of the wood from graves 1 and 3 dated in Kyiv was 645±40 and 645±59 years, from graves 2 and 4 (5 dates) it was from 750±50 to 850±50 BP. The calibrated age (with tree ring age correction) is within the 14th century. According to AMS (Groningen), the age of the wood is from 575±35 to 705±35 BP, while the calibrated age ranges (with the correction as well) within the 14th century – the first half of the 15th century.
The four dates for bones 620±35 – 710±40 BP are close to those for wood. The calibrated age ranges within the 14th century. It agrees with the age range for wood (with tree ring age correction). The date for the bones of the supposed painter (grave 5) is 700±40 BP, the calibrated age range is 1268-1381 AD. This date correlates with the Spassky cathedral construction period.

A reliable method for extraction and purification of collagene from fossil bones

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Organic matter of bones consists mainly (80-90%) of thin collagene fibers. The surface area of bone is rather large, >100 m^2 g^{-1} what make it a favourable medium for sorption of dissolved and colloidal particles of humic substances from modern soils and lacustrine – bog deposits. Earlier the acid-alkali (HCl-NaOH) (Haynes, 1967, Arslanov, Gromova, 1970) and Longin's (1971) methods were developed for extraction and purification of bone collagene. Because part of humic matter in fossil bones might occur as insoluble compounds they might not be extracted from collagene by treatment with 0,1N NaOH at room temperature. On the other hand when we use Longin's method a less polymerised and more soluble portion of humic matter could be dissolved in the hot, slightly acid solution and transferred in solution together with gelatine. Thus, contamination of extracted collagene by humic matter is possible in both cases. Such contamination strongly affects the ^{14}C ages of Pleistocene fossil bones. We assumed that best conditions for humus extraction can be achived by purifying collagene via extraction of soluble humus impurities with 0,1N NaOH at room temperature, then precipitating nearly insoluble impurities from the collagene extraction using Longin's method (Arslanov, Svezhentsev, 1993). The bone samples from Late Pleistocene deposits and Paleolithic sites were cleaned, washed, pulverized and treated at room temperature by 2-3 fresh solutions of 0,5N HCl for a few days. We treated the obtained collagene with 0.1 N NaOH at room temperature for 24h. We then treated the collagene with a week HCl solution (pH=3) at 80-90°C for 6-8 n. Finally, we separated the humic acid residue from the gelatine solution by centrifugation and solution was evaporated. Benzene was synthesized from the dried gelatine (Arslanov, Svezhentsev, 1993). The data obtained show that the oldest measured ^{14}C age is achieved by extracting the collagene by the method that we recommended here. The fractions extracted using acid-alkali and Longin's methods have more younger age. The age discrepancy of those fractions is most likely caused by incomplete removal of younger humic substances.
This research is supported by Russian Foundation of Basic Research (Grant Nr. 06-05-64996)

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Dating Bones near the limit of the radiocarbon dating method: Study case Mammoth from Niederweningen

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Mammoth bones found in a peat section at Niederweningen, near Zurich, provide excellent material for dating using ^{14}C method. The bones contain sufficient amount of collagen and have been found in peat section that is reach in wood fragments which can be dated for comparison. The peat section was dated to 46 ka BP. The first radiocarbon ages were obtained on collagen fraction and showed ages 38-40 ka BP.The following preparations included separation of gelatin and pre-cleaning collagen using the base step (Hajdas et al., 2007) and resulted in age very close to the peat section. In this study we present results of radiocarbon dating of the mammoth bones obtained on gelatin cleaned using Ultar Filtration and Ultra Filtration combined with base treatment. This exercise shows that for the mammoth from Niederweningen, all pre-treatment steps added to cleaning gelatin result in age consistent with the age of the peat section.

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Dating bones without collagen

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Collagen, the major component of the organic bone matrix, is preferred for the radiocarbon dating of bones as it can be purified of contaminants. Yet, diagenetic processes, organic decomposition as well as burning can remove the collagen completely leaving only inorganic carbonate carbon for dating. During cremation, that is prolonged burning at temperatures >650°C, most of the inorganic bound carbon is removed, but a small fraction of CO_3^{2-}, partially substituted in the hydroxylapatite for PO_4^{3-} during the life time of the organism, is preserved. This carbonate is apparently protected against ion exchange with the environment by the larger and better-structured crystals formed during cremation. The feasibility of dating cremated bones, using the carbonate fraction of the hydroxylapatite, has been demonstrated (e.g Lanting et al 2001, Van Strydonck et al. 2005, Naysmith et al. 2007). As burning at lower temperatures does not lead to the protective increase in crystallinity, an objective criterion to establish cremation is needed to support the reliability of radiocarbon dates on bone carbonate. Here we discuss the objective examination of bones for cremation using infra red spectroscopy (IR) and X-ray diffractrometry (XRD) measurements.
Different pretreatment methods for carbonate dating of bones are compared using VIRI cremated bone samples, burnt bones (<650°C), and bleached bones (e.g. bones exposed at or near the surface for example in hot desert environments) to study the suitability of the last two for radiocarbon dating. Burned and bleached bones do not show the large crystallinity of cremated bones and lack enhanced protection against carbonate exchange and are thus more susceptible against contamination.

^{14}C-dating of cremated bones: the issue of sample contamination

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Recent comparative studies have proven the validity of ^{14}C-dates of cremated bones. The issue of sample contamination has however been overlooked in most studies. Analyses of cremated bone samples have shown that in some cases cremated bones are contaminated. This contamination is more outspoken near the surface of the bones and depends on the compactness of the cremated bone as well as on the site conditions. $\delta\ ^{13}C$ is not a good estimator to discriminate between contaminated and not contaminated bones because cremation processes may have an influence on the stable isotope values. The presence of contamination has also been compared with the Crystallinity Index (CI). A high CI is not a proxy for sample integrity. The paper also compares the two pretreatment methods (HCl versus Acetic acid) used to eliminate contamination.

POSTER SESSIONS

SESSION 5

RADIOCARBON CHRONOLOGIES OF THE NEOLITHIC AND METAL AGES

Agriculture and settlement patterns of the Cucuteni-Tripolye culture

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Palaeo-demography of the Mesolithic-Neolithic transition remains one of the dominant topics in recent prehistoric debate. The population dynamics involved in this transition, i.e. the speed and features of the spread of the Neolithic populations have been discussed by many authors (e.g., Ammerman and Cavalli-Sforza, 1973; Davison et al., 2006, 2007; Ackland et al., 2007). In a further development of this trend, here we aim to probe beyond the speed and structure of the propagation front and consider the subsequent evolution of the populations and hence communities behind the front. Radiocarbon evidence is essential for this purpose as it allows us to constrain mathematical models. In our previous work (e.g., Davison et al., 2006, 2007), it has allowed the modification of previous theories of a single 'wave of advance' of the Neolithic in Europe to include the possibility of a second wave of Neolithic advance from the East.

The Chalcolithic Cucuteni–Tripolye culture in Eastern Europe is the subject of our case study. As suggested by the radiocarbon evidence, this culture spread to the north-east through eastern Romania, Moldavia and south-western Ukraine in 4,800–4,500 BC. At the largest scale of a few hundred kilometres, this spread seems to be consistent with the "wave of advance" theory. However, at smaller scales (ca 100 km) and at later stages (4,000–3,200 BC), the farming communities formed relatively small clusters, usually focussed around rivers, and then "proto-cities" emerged and economic trading networks formed. Our aim is to develop mathematical models for these later stages of evolution. This requires reliable and detailed estimates of the carrying capacity of the landscape, among other parameters.

We estimate the productivity (wheat yield) of a landscape using appropriate historical agricultural evidence from proxy sites in the USA (where the climate and soil types are similar to those of the Cucuteni–Tripolye region), which provide appropriate relationships of the yield and the rainfall and cultivation time. This allows us to estimate the amount of people a landscape can support, and then the minimum size a self-sustained farming settlement. Similar techniques can be adopted to estimate the lifetime of a settlement given a particular crop structure and farming strategy.

Careful examination of the existing data on Cucuteni–Tripolye settlements leads to interesting conclusions regarding the settlement structures and sizes. Both deterministic and stochastic methods can then be employed to model these features of the population structure both in terms of the clustering (e.g., Ripley's K-test) and the relative settlement sizes (i.e. via the rank-size relations). Our preliminary results suggest that the Cucuteni–Tripolye settlements obey the Zipf law.

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New ^{14}C dates of the oldest Early Neolithic settlements in Croatia

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According to the stylistic characteristics of pottery, settlements Slavonski Brod – Galovo and Zadubravlje – Dužine in the vicinity of the city of Slavonski Brod, E Croatia, belong to the first/oldest phase of the beginning of Neolithic in the area of East Croatia, i.e. to the Linear A phase of the Starčevo culture. Special attention during last 10 years has been paid to systematic excavation of the larger settlement Galovo that was discovered by chance during excavation for the local brickyard. It is a large complex with completely preserved objects and their inventory that enabled comprehensive and multidisciplinary study of the organization of life and settlement of the first agriculture communities in the south Panonnian plane.
Radiocarbon dating of 18 charcoal samples from Slavonski Brod – Galovo and 8 wood and charcoal samples from Zadubravlje – Dužine has been performed. At the last ^{14}C and Archaeology conference we presented some preliminary dates for both settlements (Krajcar Bronić, Minichreiter, Obelić, Horvatinčić 2004; Krajcar Bronić, Minichreiter 2007) we presented some more results for Galovo. Here we include dating of recently (campaign 2007) excavated pits at Galovo and new dates for Zadubravlje – Dužine. The measurement techniques by gas proportional counter (GPC, 7 samples) and liquid scintillation counter (LSC, 19 samples) were used. After pretreatment by the acid–base–acid method, samples were combusted in a stream of pure oxygen. The obtained and purified CO_2 was then catalytically converted to methane, which is used as the counting gas in GPC. Alternatively, CO_2 is used for benzene synthesis (Horvatinčić, Barešić, Krajcar Bronić, Obelić 2004) and benzene was measured by LSC *Quantulus 1220*. The results were corrected for $\delta^{13}C$ and dendrochronologically calibrated.
The obtained ^{14}C dates correspond to the expected archaeological age. The period between 6070 and 4960 cal BC is the most probable time of existence of the settlement at Slavonski Brod – Galovo. Combination of archaeological findings and ^{14}C dates allowed a reconstruction of at least three phases of the 1000-year-long existence of this settlement and its development. ^{14}C dates indicate a simultaneous existence of a nerby settlement Zadubravlje – Dužine (6000 – 5000 cal BC). The corresponding archaeological finds – pottery, stone tools, kilns, kult-like burials – substantiate such a conclusion, and place both settlements to the Linear A phase of the Starčevo culture, the first Neolithic culture in this area. However, in Zadubravlje – Dužine the areas supposingly devoted to rituals were found within the residential area, while at the settlement Sl. Brod – Galovo a special area for rituals and burials was established separated by arched wooden fences from the residential part. This settlement is among the earliest sites within the Starčevo culture complex with such a separated ritual–burial area.
This work supported by projects 098-0982709-2741 and 197-1970685-0681 by the Ministry of Science, Croatia.

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Chronology of the early pre-pottery Neolithic settlement Tell Qaramel, Northern Syria, in the light of radiocarbon dating

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Polish archaeologists from the Centre of Mediterranean Archaeology of the Warsaw University since 1999 work at a Syrian settlement Tell Qaramel (25 km north of Aleppo and about 65 km south of the Taurus Mountains). Researches are the result of scientific and financial collaboration between the Polish Centre of Mediterranean Archaeology, Warsaw University and the Direction General for Antiquites and Museums of Syria. They are concentrated on remnants of the early stages of the Pre-pottery Neolithic period – a time of transformation from a hunting-gathering economy to a domestication of plants and animals. About 3.5 hectares large settlement has revealed an extremely rich collection of every day use flint, bone and mostly stone objects, such as decorated chlorite or limestone vessels, shaft straighteners used to stretch wooden arrow shafts, richly decorated in geometrical, zoomorphic and anthropomorphic patterns, as well as made of different kinds of stones querns, mortars, pestles, grinders, polishing plates, celts and adzes .
Excavations brought the discovery of five circular towers. 57 charcoal samples were collected during excavations and dated in GADAM Centre in Gliwice. The stratigraphy of the settlement and results of radiocarbon dating testify that these are the oldest such constructions in the World, older than the famous and unique tower in Jericho. They confirm that the Neolithic culture was formed simultaneously in many regions of the Near East, creating a farming culture and establishing settlements with mud and stone architecture and creating the first stages of a proto-urban organism.

A comparison of radiocarbon and archaeomagnetic dating from archaeological sites in Spain

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Recently, a new archaeomagnetic secular variation curve for the Iberian Peninsula has been established. The curve is based on 134 directional data (declination and inclination) from sites in Spain, France and Morocco, obtained from heated archaeological features (kilns, furnaces and burnt horizons). It spans the last 2000 years and can be use for dating of archaeological sites from pre-Roman up to modern times. The principal control on archaeomagnetic dating concerns the age control of the data used to construct the reference curve. At the present time the curve has few data that have been dated physically. In this study, new AMS radiocarbon data will be presented, along with the corresponding archaeomagnetic data. Together they will be used to test the archaeomagnetic reference curve.

Radiocarbon Dating of the Copper Age Megalithic Site of Velturno/Feldthurns-Tanzgasse, South Tyrol, Italy.

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The megalithic site of Velturno/Feldthurns-Tanzgasse, in South Tyrol (Italy), lies 851 metres above sea level on a mid-slope terrace on the western side of the Isarco/Eisack Valley, and is one of the best known Copper Age monuments in the southern Alpine region. This site was excavated on various occasions since 1983 by the *Ufficio Beni Archeologici della Provincia Autonoma di Bolzano - Alto Adige*/*Amt für Bodendenkmäler der Autonomen Provinz Bozen - Südtirol*. The archaeological investigations, which are still in progress, have hitherto revealed the existence of at least three major ceremonial features (Area A, Circles B and C), as well as secondary burials that occurred as small clusters of cremated human bones, possibly belonging to high-ranking individuals. In addition to Late Copper Age pottery, flint tools, and stone beads, a few Beaker sherds were also collected. Furthermore, a statue-stele was recovered from the site. Five charcoal samples from the monumental structures as well as the surrounding associated layers were recently dated by accelerator mass spectrometry (AMS) at the ETH Zurich (Switzerland). Overall, the radiocarbon results fall within an age range of 4040 ± 55 to 3885 ± 55 BP, and appear highly consistent with the two previously published AMS measurements (ETH-12288 [3995 ± 55 BP] and ETH-12287 [3945 ± 55 BP], respectively). These newly obtained AMS dates confirm the archaeological dating of the monument to the Late Copper Age; they suggest that ritual activity at Velturno/Feldthurns-Tanzgasse was restricted mainly to the third quarter of the third millennium BC and covered a relatively short time span.

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AMS Dates from the Copper Age/Early Bronze Age Rockshelter of Peri, Northern Italy.

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The rockshelter of Peri, situated in the southern Adige Valley at the foot of the Lessinian Plateau (Verona, Northern Italy), has been known in the Italian archaeological literature for its burial remains since the late 1880s, when it was discovered by accident. New excavations at the site were undertaken in 2001 by the *Soprintendenza per i Beni Archeologici del Veneto - Nucleo Operativo di Verona*. This fieldwork was preceded by thorough archival research, which allowed us to identify the exact location of the rockshelter, previously forgotten for over one hundred years. The excavations revealed evidence, both inside and immediately outside the rockshelter, of funerary remains that had not been detected and damaged during the nineteenth century investigations, even though the burial deposits of the interior of the shelter appeared severely disturbed *ab antiquo*. Outside the rockshelter, of particular note was an intact small cairn, built above a stone platform and sealing two distinct collective secondary interments. Items that could have been original grave goods included lithic artefacts (bifacial flint daggers and geometric microliths), metal ornaments (a pure copper wire spiral), as well as pottery. On the basis of the typological determination of the finds recovered from the site, the whole context was generically assigned to the Copper Age. In 2005-2006, eleven human bones were strategically sampled from nearly all of the burial layers and submitted to the accelerator mass spectrometry (AMS) facility of the CEDAD, University of Salento, Lecce (Italy). Of these, three had insufficient collagen to produce radiocarbon dates. The eight AMS radiocarbon results from Peri certainly confirm a Copper Age date for at least a part of the human bones deposited inside the shelter. However, they also unexpectedly provided evidence of a later use of the site as a burial place during two clearly distinct phases of the Early Bronze Age, dating respectively to EBA I A/EBA I B and EBA I C/EBA II of the north Italian chronology. This group of measurements also points clearly to a displacement of the burial activity away from the interior to the exterior of the rockshelter in the latter phase, between EBA I C and EBA II (*c.* 1900-1700 cal. BC). A Bayesian statistical analysis of the dates is presented. The burial caves and rockshelters of the southern Prealpine and Alpine region are usually dated purely by archaeological typology or by a very few radiocarbon determinations. However, the results yielded by the AMS dating programme undertaken at the rockshelter of Peri emphasise the need to obtain, routinely, an acceptable number of radiocarbon dates for long-lasting and depositionally complex sites of this type.

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The datation of the palace of the governors at Balat (Dakhla Oasis, Egypt): a contribution to the Egyptian Old Kingdom and First Intermediate chronology.

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The historical egyptian chronology is known in its main lines, in an absolute way, back to 2000BC. A few number of schemes for absolute chronologies of the Third Millenium and more specifically for the Old Kingdom (dynasties 3-6) and the following First Intermediate Period have been proposed by different authors. They may differ by up to two hundred years shifts. The most accepted scheme situates the end of the 6th dynasty around 2200 BC.
The site of 'Ayn-Asil at Balat (Dakhla oasis) is a town settlement enclosed by successive walls, organized around the palace of the governor of the oasis. This palatial complex is one of the best preserved civil monuments belonging to the Old Kingdom as it has been assessed by the inscribed material and the ceramic finds unearthed there. The palace has been arsoned and then destroyed, under or immediately after, the very long (50 to 70 years) reign of Pepi the second, almost the last king of the 6th dynasty (Soukiassian, Wuttmann, Pantalacci 2002).
Fire produced impressive amounts of burned or charred material: wooden construction material (lintels, columns, door-jambs and lintels) or furniture (boxes, canopies), crops, seeds, animal bones and ostrich egg-shells. The extensive destruction which followed arsoning sealed many layers of ashes and charcoals produced by near-by domestic ovens or by the bakeries and masses of dumps piled up during the life span of the palace. We took about forty samples out of this material. They have been dated after relevant pretreatment in the IFAO datation laboratory in Cairo by liquid scintillation counting. Some outliers, may-be intrusions in the stratigraphic sequences, have been discarded. We conducted further a more detailed study by dating separately different components of a stratified dump. We isolated charcoals of beams and main limbs, charred small twigs, crops, seeds, and dung.
We built a bayesian model including these radiocarbon dates, previous thermoluminescence dates, stratigraphy and termini given by the analysis of the artefacts. We noticed an extensive use and most probably re-use of "old wood" as a building material for the erection of columns and roofing.
The study leads to a date for the arsoning of the palace consistent with the dominant or "low" chronology, bringing new elements to the historical debate about the duration of the First Intermediate Period.

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New data on radiocarbon chronology of the Neolithic sites of Byelorussia and neighbouring territories based on the food residual of pottery.

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The radiocarbon dates recently obtained for food residues on the pottery of the Neolithic sites from Byelorussia and the Leningrad oblast of Russia with the use of AMS methodology have considerably clarified the Neolithic chronology in those areas. He dates obtained for the Zatsenye site in North-Eastern Byelorussia show the age: 5895±55 BP (Ua-34616): 4910-4600 cal BC (with 95% probability) and 6425±60 BP (Ua-34617) or 5480-5360 cal BC (with 68%) and 5490-5290 cal BC (with 95% probability). These dates are coeval with the age of early pottery bearing sityes belonging to the Serteya culture in the neighboring Smolensk province of Russia: 5940±130 (4900-4786 BC) Le-2566; 6230±40 (5230-5204 BC), Le-2568.

The sites of Sperrings Culture (or the I:1 Style of the Finnish writers) are located on ancient sea and lake shore-lines in a vast territory encompassing southern and central Finland and Ladoga and Onega Lake basins in Russian Karelia. The pottery corpus consists of large conic vessels with straight rims decorated with impressions of cord, incised lines and pits forming a simple zoned ornament. The lithic industry manufactured from quartz, schist and rarely flint (presumably imported from the Upper Volga) retains a Mesolithic character. Earlier age assessments based on the gradients of the shore-line displacements (*Siiriäinen 1970*) have placed the I:1 Style in Finland into the time range of 4100–3000 BC. One of the sites containing the Sperrings-type pottery, Ust-Rubezhna, on the River Pasha, south of trhe Ladoga Lake, has been dated to 5505±140 BP (Ua-34614), or 4700-3950 cal BC (with 95% probability). Early the charcoal from the hearth of the same site had been dated to: 6380±220 BP (Ле-405) or 5750-4800 cal BC (with 95% probability). The site of Berezye on the River Volkhov in the Southern Ladoga Lake area with the typical Sperrings pottery has been dated 5965±55 BP (Ua-34615): 4990-4710 cal BC (with 95% probability).

The statistical processing of the radiocarbon dated that had been earlier obtained for the early Neolithic in the central and northern parts of East European Plain that belonged to several archaeological cultures: the Upper Volga and Valdai, in Central Russia, Sperrings, Narva (in Latvia, Estonia and north-western Russia), Chernoborskaya in Russia North-East have shown an interval of 7300 – 5600 BC. The newly obtained dates lie within this interval.

The mean radiocarbon dates for early pottery-bearing sites on the entire the entire East European Plain shows the age 5317±30 BC. Significantly this corresponds with the assessment of age of the Holocene Althitermal.

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Radiocarbon ages of bones from Zvejnieki burial ground, Latvia

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Good progress of applying radiocarbon dating in archaeology was observed in Eastern Baltic during the last fifteen years (Girininkas, 1994; Kriiska et al, 2001, 2004; Zagorska, 2003). In Latvia Stone Age grave material from the Zvejnieki burial ground was dated. The favourable preservation conditions of bone, tooth and antler allowed to obtain more then 60 datings. The radiocarbon data generally match very well with the archaeological sequence, based on typological method. Radiocarbon datings also helped to date graves lacking any grave goods. The results confirmed that the cemetery was in use for several millennia – from cal 74890-7290 BC up to cal 2890-2620 BC. Mainly the human bones were used in datings, but later also animal, bird an fish bones were enclosed (determinations by L.Lõugas, K.Mannremaa). Some problems arise, when different bone samples from closed assemblages – separate graves , collective burials – were dated. The radiometric data not always overlap, a matter which deserves further consideration (reservoir effect, depositional history, burial traditions).

New dates of Neolithic radiocarbon chronology in the central part of Eastern Europe

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One of the most important problems in archaeology of the Stone Age of Eastern Europe is the time definition of beginning Late Stone age in separate regions, and accordingly accurate chronological definition of Neolithic cultures, revealing of evolution dynamic. Nowadays there are a lot of special researches devoted this question and the database of the radiocarbon dates of Neolithic epoch is enlarges constantly – now it consists more than 400 dates. The part of dates was received from materials which seems doubtful to the researchers, other part has exact archaeological associating.
Time of the first ceramic appearance in the central part of the forest zone in Eastern Europe is fixed by radiocarbon dates from cites of Early Neolithic cultures (Upper-Volga archaeological culture) which is chronological located between Middle Stone age archaeological culture of Butovo and developed Neolithic's archaeological culture of pit-comb-shaped ceramics (located in this region). Large part of radiocarbon dates of the initial stage of Upper-Volga archaeological culture correlates with dates of the latest Butovo that raise a question of assimilation model in the central part of Eastern Europe between archaeological periods.
During the field archaeological researches there was made an attempt to precise chronological schemes especially of the first stage of Upper-Volga archaeological culture which were worked out before. Comparison of radiocarbon, geological, geomorphological and palinological analysis was the base of this research. During data processing fractional stratigraphical number was received; it's position was defined by radiocarbon dating allowing to operate while processing of large number introductory.
As a results we derived valuable conclusions about climate and vegetation consecutive changes in this region at Atlantic period have compared with archaeological obtained.

New radiocarbon dates for the early Neolithic of western Mediterranean

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The franco-iberian Cardial is at present one of the best documented groups of the early Neolithic in south-western Europe, in respect to both: material culture and absolute chronology. It is therefore of interest to check the chronological framework set up in the 1980's. Our approach included submission of the ensembles that can be attributed to the franco-iberian Cardial of our region of study (eastern Languedoc and western Provence) and considered homogenous, to an automatic seriation of ceramic types defined on the basis of morphological and stylistic criteria. The resulting classification was then subjected to the radiocarbon dating. On this basis, we propose to divide the franco-iberian Cardial in southern France in three successives phases: "old", (5350-5200 cal.BC) "middle" (around 5200 cal.BC) and "recent" Cardial (5200-4800 cal.BC). This hypothesis requires verification by additional analysis of others domains of material culture, improvement of the documentary bases and high-resolution ^{14}C dating.

POSTER SESSIONS

SESSION 6

HOW TO IMPROVE CHRONOLOGIES OF ARCHAEOLOGICAL SITES

AMS radiocarbon of Palaeolithic-aged charcoal using ABOX-SC

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Radiocarbon dating of charcoal remains from archaeological sites has shown that for material >~30 ka BP contamination is the principal challenge to accuracy, once laboratory background is established to an acceptably low and reproducible level. Recent work by Bird and colleagues has shown that the application of an oxidation/stepped combustion treatment produces results that are often older than previously established chronologies determined on the same material from the same archaeological contexts. The samples used initially by these workers were predominantly charcoal from arid environments in Australia[1,4]. Other sites have since been dated in South Africa and Brazil[1,2]. We have previously dated material from Malaysia[5]. Our research question is what effect this treatment might have when it is applied to ancient charcoal from European sites, and those around the Mediterranean Rim. The initial results show that there can be substantial differences between samples dated using routine acid-base-acid (ABA) treatments and those dated using ABOX-SC. We provide examples from Palaeolithic sites in Italy, Egypt, Morrocco, Israel and Gibraltar.

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Improving the radiocarbon dating of shell carbonates from Palaeolithic archaeological sites in the Mediterranean Rim

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AMS radiocarbon dating of marine shell is often characterized as unreliable. The reasons have been identified many years ago, however only very recently have there been suggestions on ways to overcome reliably the problems inherent. In this paper, we review the current efforts at the Oxford Radiocarbon Accelerator Unit (RLAHA, University of Oxford) to develop a new pre-screening and pretreatment method for the dating of molluscan marine shells.
Our aim is to apply these methodological developments to the dating of Aurignacian personal ornaments and shell beads from around the Mediterranean, with an emphasis to the south-eastern areas, where bone is usually poorly preserved, and chronologies are often problematic and based on unreliable material.

The Middle and Upper Palaeolithic periods have generally lacked firm chrono-stratigraphies and single dates offer little to the resolution of important issues, such as the arrival and establishment of the first anatomically modern humans (AMHs) in Europe, during the approximate time range between 40-30 kyr BP (Aurignacian culture/s).
Many Aurignacian levels often contain personal ornaments, many of which have never been directly dated, even when found in abundance (eg. Ksar Akil). The recent assignment of these ornaments to regional typologies and possible ethno-linguistic entities (Vanhaeren & d'Errico 2006) clearly lacks reliable direct dates of the ornaments themselves.
We describe the methods involved in the shell dating and discuss its application to important Palaeolithic sites from around the Mediterranean Rim.
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Verification of ^{14}C dating of carbonate mortar

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The first attempts at ^{14}C dating of carbonate mortars were made in the 1960s (Baxter et al., 1970; Delibrias G., 1964; Folk et al., 1976). Carbonate mortars are often found at archaeological sites and the technique of their production determines the choice of a component used in dating. To be able to estimate the age of a carbonate mortar sample it was necessary to work out a method of sample preparation, the attempts have been made by many authors (Heinemeier et al., 1997; Sonninen et al.,2001;Hale et al., 2003; Nawrocka et al., in print). A good agreement between the ^{14}C dating and the age expected on the basis of other data collected for a given site and historical context, has been shown for the samples coming from Lake Galilee, after the samples were subjected to a special preliminary processing to eliminate the carbonate aggregate (Nawrocka et al., 2005, Nawrocka et al., 2007).
A similar method of preliminary processing of carbonate mortar samples prior to dating was applied to estimate the age of buildings coming from the Middle Ages and localised in Kraków, in south of Poland. The results of the ^{14}C dating showed that in many cases the age estimated differed from the expected calendar age: some buildings were too young while some others too old relative to the are implied by the historical context. Analysis of the reasons for the discrepancy has revealed that the actual site of collection of the components used for production of carbonate mortars may have an important effect. Moreover, the carbonate aggregate can be difficult to separate from the binding material and its presence may lead to overestimated age of the samples. The samples of the carbonate mortars coming from the Middle Ages were found to contain carbonates whose structure differed from the binder. The effect of these fragments on the age estimation has not been determined yet although there are arguments indicating that their presence would lead to underestimation of the age of the samples. The presence of these admixtures may be related to the climatic conditions in a given area. The effect of these factors needs to be verified.

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Radiocarbon dating of iron – a northern contribution

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Local folklore in Finland – collected during 19th century – builds an image of ages when eternal blacksmiths were even capable to forge back the celestial bodies once lost (Lönnrot 1849). These most-respected metal workers left signs to follow. As examples, ancient iron furnaces have been located in the Finnish lake district (Lavento 1999) and detailed study of iron production and blacksmithy in Estonia and the neighboring areas has been recently presented (Peets 2003).
Iron dating by radiocarbon method took initial steps at late 60's (van der Merwe 1969). Within the same years was the Radiocarbon Dating Laboratory established at Helsinki University (Jungner 1968). Now, the decades of radiocarbon dating experience have been harnessed to result in ages of iron artifacts. The methodology is based on the pioneering works (Cook 1999; Hüls 2004) in the field: samples of iron artifacts are combusted in excess of CuO in sealed quartz tubes and successively collected, purified and reduced to graphite targets for AMS measurements.
Well-characterized iron samples produced by coal (Ruukki Ltd) are used to examine the methods and measurement background. Selection of reference-dated iron samples aim to cover the whole history of the charcoal-produced iron smelting in Finland: from c. 300 BC up to the products of a present-day iron blacksmith. The broad time-range allows for studying also the own-age effects present due to charcoal use. This contribution presents the preliminary results of this pilot project aiming to form a solid foundation for more detailed archaeological Iron Age studies in the North.

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Radiocarbon dating of aerial lime mortars: considerations on the applicability of method and on the limitations of using data. The study case of S. Nicolò of Capodimonte church (Camogli – Genoa)

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With this contribution we would like to underline the technical problems and the using limitations of the radiocarbon dating of aerial lime mortars.
The presence inside the aerial lime mortars of lump of lime not completely melted (the so called "calcinelli" or "bottaccioli") and not polluted with external carbon sources like the limestone sand put in the dough during the preparation of mortar, allow to have - for every different piece of masonry of the wall - a concentration of aerial carbon, typical of the carbonation time of mortar, and rich enough to allow the dating through the radiocarbon technique. Thus, this concentration of carbon can be used for dating the different parts of the walls.
This contribution would underline the problems of use of this particular technique that today is studied in many laboratories both in Italy and in the other European country, and above all it would underline the practical problems in the use of this technique (from sampling to the interpretation of data).
The discussion will be based on the archaeological study of the walls of S. Nicolò of Capodimonte church (Camogli – Genoa) where this technique has been applied different time with the aim of dating different parts of the walls otherwise not datable. In this case it has been possible to compare the radiocarbon dating with the history of the church reported in the historical document, and with the stratigraphic lectures of the walls. The considerations about the sampling problems (linked above all to the building technique), about the size of uncertainty of C14 dating (compared with the stratigraphic description), etc. are only few elements that could be underlined in this contribution that involving a new, interesting technique of dating in the field building archaeology.

Microstructural effects of low and high pH on fossil charcoal: implications for Radiocarbon Dating

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The possibility to extend the current limit for radiocarbon dating largely depends on the effectiveness of contamination removal. The separation of contaminants from poorly preserved charcoal is complicated by their similarities on chemical and structural properties. The Acid-Base-Acid (ABA) protocol has proven its applicability on sample purification on well-preserved charcoal. However, when applied on poorly preserved charcoal, the exposure to extreme high or low pH solutions tend to disintegrated and/or dissolve both the contaminants and the dateable material, due to their similar solubilities. It would be therefore advantageous to study the structural changes undergone through the ABA treatment to unveil the underlying basic mechanisms governing the separation and removal of contaminants.
This study examines the structural and chemical changes that the ABA treatment induces on fossil charcoal from the Middle Palaeolithic to Upper Palaeolithic (MP-UP) transition strata in Kebara Cave (Mt. Carmel) in Israel. The issue addressed here is the underlying reasons for the preferential abundance of hearths in the southern portion of the cave linked to the absence of bones, as opposed to the northern part. This issue is not exclusive of this site but is frequently encountered on other places.

The preferential distribution of hearths in this particular case is associated to an acidic Paleo pH environment in the southern area after deposition of charcoal in the sediments. Thus, by characterizing the structural changes of the charcoal from these hearths upon fluctuating pH conditions *in vitro*, insight can be gained both on the applicability of the ABA treatment on these samples and on the possible scenarios that led to the preferential preservation of charcoal in the southern area of the cave.
A combined analysis with Fourier Transform Infra-Red spectrometry (FTIR), Thermo-Gravimetric and Differential Thermal Analysis (TGA and DTA) and Transmission Electron Microscopy (TEM) show that acid treatment disrupts the structure, whereas alkali treatment results in the re-formation of molecular aggregates. The major changes are ascribed to the formation of salt bridges at high pH, and the disruption of graphite-like crystallites at low pH. Weight losses during treatments are consistently greater for older samples implying that they are less well preserved. Here, we propose a possible mechanism for preferential preservation of charcoal in nature, based on the changes observed *in vitro*. The effects of pH fluctuations on the structural stability on poorly preserved fossil charcoal are also discussed. This study raises a series of questions that could be systematically addressed regarding the changes in the ABA protocol that might be advantageous for improving sample purification, with the concomitant benefits on the accuracy of Radiocarbon Dating on poorly preserved charcoal.

Radiocarbon measurement programme at the Centro Nacional de Aceleradores (CNA)

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In September 2005 an AMS system based on a 1MV tandetron accelerator arrived at the CNA (Klein, van Staveren, Mous, Gottdang 2007; Klein, Mous, Gottdang, 2006). One of the main research programmes for this AMS facility was around radiocarbon. At the same time as the AMS facility was installed and tested, the radiocarbon sample preparation laboratory was designed and installed. A Vogel type (Vogel, Southon, Nelson, Brown 1984) graphitisation line which allows preparation of five samples in parallel was designed and built in October 2006.
The first months have been mainly dedicated to check and optimize all the sample processing. For such a task, IAEA reference samples (Rozanski, Stichler, Gonfiantini, Scott, Beukens, Kromer, van der Plicht 1992) and FIRI (Scott et al. 2003) and VIRI samples have been prepared and measured. Since the beginning of year 2007 the laboratory has been fully operational and is currently performing as a service for the scientific community. During 2007 nearly one hundred unknown samples have been prepared and measured in our AMS system. Most of them were for dating purposes, but also bio diesel samples were analyzed in order to check the content in bio-oil.
The performance of the radiocarbon laboratory and dating service will be shown, with some examples as illustration.

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Also ancient iron artifacts can be dated by radiocarbon

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There was substantial progress in the last years in dating iron artifacts by radiocarbon. The quantities of required sample material decreased from 1 kg (500 mg C) in the sixties to 50 mg to 1 g (1 mg C) in our days (Cook 2001). This is due to the accelerator mass spectrometry (AMS). Several publications of the last years show the feasibility of radiocarbon dating of small sample amount from steel and pig iron artifacts dating back from more then thousand years (Cook 2001, Hüls et al. 2004). Also some complications can happen depending on sample preparation (Scharf et. al. 2005). In this study we will show the first results of ^{14}C of iron samples performed at the AMS facility in Zurich. The first samples were chosen from the five well dated steel and pig iron artifacts from Iron Age, roman and early medieval times. The sampling surface was on the counterpiece of artifacts studied by Metallography. The samples were cut into chips ca. 1 mm long using a tool made from cobalt-titan-carbide alloy. The chemical treatment was applied to remove corrosion products and extract fatty residues. The chips were controlled under a lens, weighed and combusted with Cu_xO as an oxygen donor in a sealed and evacuelted quartz tube. The resulting CO_2 was graphitized using hydrogen reduction.
Our first results show that in the future iron hoards and items from collections of unknown age can be dated using AMS radiocarbon dating.
Next we will date of the early medieval smithy from Courtedoux, Creugenat JU. Here worked and not worked smithing waste from steel and pig iron (four artifacts) will be sampled for ^{14}C dating. Another two samples will be ingots type "Spitzbarren" from the hoard from Bellmund BE (von Känel 1981). Artifacts from collections and hoards often are only dated by stylistic arguments. This way of classification is here controlled on a kris from Java (Trüllinger/Zgraggen 2002).

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The chronology of the Middle to Upper Palaeolithic transition in Iberia: the problems and a way forward

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The Palaeolithic of Iberia contains both the earliest dates for the Aurignacian (the industry likely to have been produced by the first modern humans in Europe) and some of the latest dates for the Mousterian (the industry associated with Neanderthals). Taken at face value, these dates suggest that the two species overlapped for more than 10,000 years. As such, the peninsular appears to be of immense importance for understanding the nature of any possible interaction between the species, and reasons for the extinction of Neanderthals. Unfortunately, poor preservation of organic remains alongside problematic sample selection has meant that a large proportion of these dates do not stand up to scrutiny. Thus, in recent years much ink has been spilt attempting to filter the c.500 dates to produce a reliable chronology. How reliable are such chronologies? This poster will present a review of the available data and suggest a way forward.

First ^{14}C and stable isotope results of the Early Medieval site at Gars-Thunau, Lower Austria

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The Early Medieval sites at Gars/Thunau (Lower Austria) are of particular interest in many aspects. The sites comprise two areas, which were archeologically investigated during the last 30 years: On the top of a hill, a fortified settlement with a manor-house and a grave field in close distance as well as several other isolated burials (e.g., along the fortification wall) have been excavated. Moreover, downhill, next to the river Kamp, many other medieval graves were recovered. It is assumed that these graves belong to a settlement which was inhabited by craftsmen, farmers etc., who probably served the inhabitants of the castle/manor house. From an anthropological point of view, there is a high interest in questions concerning social differentiation and the biological consequences.
In a recent project the medieval archaeological finds from Gars/Thunau are examined and the human remains are anthropologically investigated. In the course of this study 9 human bones from individuals buried in graves at different locations were ^{14}C dated at the VERA laboratory. In addition, subsamples of the gelatin extracted for ^{14}C dating were used to determine the $\delta^{15}N$ and $\delta^{13}C$ values. These measurements were performed with a *Micromass-Optima* stable isotope ratio mass spectrometer coupled to an elemental analyser. The variability of the data indicate different nutrition within the population at this region and time. These first results encourage us to pursue palaeodiet studies further. Both the ^{14}C data as well as □ □ values and a tentative interpretation of the data together with an outlook to further work within this project will be presented.

^{14}C Dating of the Upper Paleolithic Site at Krems-Wachtberg, Austria

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In the year 2005 a spectacular discovery was made during a research project of the Prehistoric Commission of the Austrian Academy of Sciences. In the course of excavations at the well known Upper Paleolithic site Krems-Wachtberg in the loess region near Krems, Lower Austria, a double burial of two infants from the Old Stone Age was found. One year later in the nearby area a single grave of one infant was excavated. The way in which these infants were laid down gave valuable information about burial rites in the Upper Paleolithic[1)]. Both graves are in association with a rich well-preserved living floor, which is assumed to comprise the remains of a frequently used Upper Paleolithic hunter-gatherer camp. The excavated cultural horizon was abundant in Gravettian cultural remains such as lithic artifacts and ornaments, but also faunal remains, charcoal, ochre etc. could be recovered from this horizon. In order to verify the time period from which the finds originate, several ^{14}C dates of charcoal samples - mainly from the cultural horizon - were determined at VERA.
The dating results and their relevance for the archaeological site will be discussed.

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Human Skeletons from the Mesolithic Shell Middens of Muge (Tagus Estuary, Portugal) – Isotope Composition, Reservoir Effect, and Radiocarbon Dating

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Several Mesolithic shell middens are known in the Muge region, which is located in the upper estuary of the river Tagus. Moita do Sebastião, Cabeço da Amoreira and Cabeço da Arruda are, among Muge shell middens, the best preserved. They have been subject to archaeological excavations since the middle of the nineteenth century and, consequently, an important and abundant archaeological record has been recovered. It has been observed that Mesolithic people were buried there, usually at the site's lower levels. In effect, more than two hundred and fifty human skeletons have been identified and exhumed during the excavations. The isotope composition of bone collagen determined from some of the skeletons that have been subject to anthropological analyses show enrichment in ^{13}C and ^{15}N compared, for instance, with Neolithic human bone collagen. This fact points out that the Mesolithic diet was a mixture of marine and terrestrial foods (Lubell and Jackes, 1988; Lubell *et al*., 1994). Some of these human skeletons have also been radiocarbon dated (nineteen dates have so far been published). Nevertheless, their conversion into calendar dates has suffered from an error due to the fact that until now the estuarine reservoir effect at the Tagus estuary near Muge was unknown. Given this limitation, the ΔR value (250±25 ^{14}C yr) determined by Soares (1993) for the Portuguese coast that has been used (e.g., Jackes and Meiklejohn, 2004, 2005). However, recent archaeological excavations at Cabeço da Amoreira allowed the determination of an accurate ΔR value for the Muge estuarine region. A pair of closely associated estuarine mollusc shells and bones of terrestrial mammals (not humans) were recovered and radiocarbon dated. A value of 140±40 ^{14}C yr for ΔR was then calculated, which was used to calibrate the radiocarbon dates from the Muge human skeletons. The percentage of marine food in the diet was also calculated using the isotope composition determined for the human bone collagen samples. Accurate calendar dates were therefore determined for the human skeletons recovered taking into account, not only the above-mentioned estuarine ΔR value, but also the calculated percentages of marine food in the diet. This chronological data points out to an occupation period larger than a millennium for the shell middens, starting probably just after the cold event of 8.2 ka cal BP.

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AMS ^{14}C dating of plant remains from archaeological sites in the Western Liaohe River Basin, northeastern China

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A variety of bio-remains from archaeological sites has been used for dating. These materials including macrofossil charcoal, microfossil charcoal, pollen, phytolith and animal bone may have different origins and hence represent different events of the past. Few studies have been undertaken to evaluate the dating results based on different materials in terms of the accuracy required in the archaeological context. Here, we present preliminary results of an on-going systematic comparison of AMS ^{14}C dating results of different materials from a wide range of archaeological sites in Western Liaohe River Basin, northeastern China. This area is known to have witnessed one of the earliest civilizations in China. Numerous archaeological sites have been found and dated by ^{14}C. Our dating results on plant remains from 18 archaeological sites show that the dates of macrofossil charcoal overlap well with culture stages; macrofossil charcoal from different archaeological sites with the same culture character gave the same ages even these macrofossil charcoals were identified to different species under SEM. The advantage of the detailed study of macrofossil charcoal structures is that accurate information about the environment may be obtained. This information is useful not only for paleoenvironmental reconstruction but also for evaluation of age consistency among archaeological sites. The interpretation of the ages based on phytolith, microfossil charcoal and pollen may be more complicated due to the potential variability in their origins. This will be illustrated by some examples of the dating studies at the archaeological sites and some Quaternary sedimentary profiles.

Attention Fraud: modern fabrics made to date old

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In the last few years, we have encountered a few fabric samples that had the correct ^{14}C concentration for the age of the culture they represent, because of an admixture of fossil based synthetic fibres in modern natural fibres. Using two original looking fake samples, one made of silk imitating a 4th century chinese artefact and one of wool imitating a pre-islamic arabian carpet, we will discuss how selective chemical pre-treatments will change the ratio between fossil and modern material, and thus help detect the fraud.

Radiocarbon dating of small samples

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Radiocarbon dating by means of accelerator mass spectrometry (AMS) is a well-established method for samples containing carbon in the milligram range. However, the measurement of small samples containing less than 100 µg carbon often fails. It is difficult to graphitise these samples and the preparation is prone to contamination. A solution can be the direct measurement of carbon dioxide just after the sample combustion avoiding a graphitisation. The MICADA system, the smallest accelerator

for radiocarbon dating, is equipped with a hybrid Cs sputter ion source. It allows the measurement of both graphite targets and gaseous CO_2 samples without any rebuilding.
Samples can be supplied in glass ampoules. A gas inlet system was constructed with an ampoule cracker for releasing the small amounts of CO_2 and mixing it with helium for better handling. This system is now running for more than 15 months in routine operation and we present interesting applications using this technique for measuring small samples containing 10-50 µg carbon.
A second option is an online measurement using an elemental analyser (EA) as combustion unit. The carbon dioxide leaving the EA is collected and injected directly into the gas inlet system of the AMS machine. Measurement and sample combustion can be done in parallel. A first view on the validation data will be presented.
A short outlook will be given for the analyses of small samples with respect to archaeological interests.