Late Pleistocene Palaeo-Sedimentary Sequence Near Kursk, Russia: Refining Chronostratigraphy And Palaeoecological Reconstructions For The Eastern European Loess Area

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Aleksandrov quarry is located 10 km south of the Kursk city on the levied watershed of Seim and Mlodat rivers in the west-center of European Russia. In its exposures one of the most detailed and complete palaeosol-sedimentary record for the Late Pleistocene on the Eastern European loess area is exposed. At present it is provided with a chronological scale based on a set of instrumental datings (C14 and OSL) and vast variety of research results (physical, chemical and mineralogical characteristics of palaeosols and sediments, micromorphological observations, phytoliths and pollen assemblages). Palaeosols of Aleksandrov quarry are under monitoring since the early 1990 s. The paleoalka with interlacial Rysklovo palaeo on its slopes and in the bottom was discovered. This soil is correlated with Silvan soil of Mikulino interglacial of the upper east-European basins according to Velichko et al. (1997). New OSL dates of the sediments below and above paleolim profile confirm that development period of Rysklovo palaeo is restricted to MIS5e and its paleoalka is filled by Valdai colluvial-infillation and loessic sediments and palaeosols. According to the C14 dating and OSL dates, the two lower interstadial Kukiev and Streiteck soils belong to the early Valdai – MIS 5c and MIS5e respectively, while the two upper palaeosols (Aleksandrov and Brysikiv) belong to the Middle Valdai – MIS3. Pedogenic features are specific for each palaeo. In particular Rysklovo palaeo is presented by Albeluvisol with typical morphological and analytical indicators of leaching, stagnic processes, clay illuviation typical for humid forest pedogenesis. It presents a sharp differences to the Holocene Chernozem typical for steppe ecosystems. These differences point to more humid climate during the Last Interglacial. Kukiev palaeo still presents signs of clay illuviation whereas overlying streiteck and Aleksandrov palaeosols have chernozem-type profiles and Brysikiv soil is a Cambisol partly formed by posterior cryogenic processes. Late Valdai loess deposition was rather modest, so the top of Brysikiv palaeo often corresponds to the base of the Holocene Chernozem profile. The sequence of Aleksandrovsky quarry provides more complete record of Late Pleistocene geologic events, than standard Russian loess stratigraphy (Velichko 2003) and better possibilities for correlation with the global climate proxies.

Lessons from the AMS 14C and OSL/IRSL-dating of the Dunaszeksző loess record, Hungary

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Reliable chronologies are prerequisites of appropriate proxy interpretations from terrestrial archives of Quaternary climate and environmental change. Loess records may provide a wealth of palaeoenvironmental information, yet they are usually poorly dated. This mostly means low resolution dating of loess profiles and also imprecise chronologies, i.e. age-depth models that have uncertainties of millennial magnitude. This prevents us from addressing issues like synchronicity of abrupt climatic/environmental events on millennial time scales. Two different means of dating are commonly applied for loess sequences: luminescence and radiocarbon dating. Major problems are low precision of luminescence ages and the general lack of organic macrofossils (e.g. charcoal) in loess that can reliably be dated using 14C. Other datable phases in loess are molluscs shells, rhizoliths and organic matter. Evidences are growing that rhizoliths are unreliable phases for 14C dating and organic matter 14C ages are often seriously compromised by reequilibration in loess sequences. Also molluscs shells are often regarded as unreliable material for 14C-dating, as they may incorporate 14C-deficient (or dead) carbon from the local carbonate-rich substrate during shell formation, thereby producing anomalously old ages by up to 30%, while the post-IR RSL 225 years overestimate.

In this study an attempt has been made to address some of the dating issues and problems mentioned above by triple-dating (AMS 14C and OSL/IRSL) of the Dunaszeksző loess-palaeo sequence (South-Hungary). While the OSL/IRSL techniques directly date the sediment (quartz and K-feldspar grains) and provide burial ages, radiocarbon yield ages from phases like organic matter, molluscs shells and rhizoliths and determines the time elapsed since the living system was last in equilibrium with atmospheric 14C and became closed after burial.

As revealed in this study all loess rhizoliths sampled at three different depths (4.00 m: 5774 10156 2σ age range 500 yr BP, 5.50 m: 5813-8167 cal BP and 6.00 m: 5935-9686 cal BP) yield Holocene ages, so absolute ages cannot be gained this way for loess deposition.

As charcoal are widely accepted as phases yielding very reliable 14C ages, molluscs shell 14C ages were tested against charcoal ages. Here we focused on molluscs with smaller (10 mm) shells as some evidence exists that some species do not incorporate dead carbon into their shells or at least in low amounts. Our results demonstrated that Suvitala obovata and Vitrea crystallinella yield statistically indistinguishable ages (2σ age range: 29990-30830 and 29600-30530 cal yr BP) when compared with the charcoal 14C age (29960-30790 cal yr BP, depth 6.50 m), and others like Clauvia sp. and Chondrula tridens give slightly older ages than the charcoal and show larger age anomalies (500-900 14C yr). Compared to the charcoal ages at 8.20-8.25 m depth, the post-IR RSL 225 age of 28520±1120 yr (2σ age range: 26280-30760 yr) from a depth of 7.75 m match quite well the charcoal ages (Dsz-Ch1, 2σ: 29960-30780 cal yr BP and Dsz-Ch2, 2σ: 29350-30150 cal yr BP). At the same time, the post-IR OSL approach seems to slightly underestimate (2σ: 20640-23070 yr) the post-IR RSL 225 age (2σ: 30260-37100 yr) the expected/true age of deposition at the respective depth (7.75 m). At a depth of 4.00 m, slight underestimation of molluscs AMS 14C ages (Trocchulus hispidus, 2σ: 32370-32740 cal yr BP, Arianta ornata) to 24470-25120 cal yr BP) by post-IR OSL (2σ: 17140-21980 yr) and a moderate to significant overestimation by OSL (2σ: 26760-33880 yr and post-IR RSL290 (2σ: 27660-35740 yr) has been recognized. Again, the post-IR RSL 225 age (2σ: 23180-26900 yr) lies the closest to the AMS 14C ages.

To decide which technique, AMS 14C or OSL/IRSL yields more accurate ages is not possible without independent absolute chronological data based on another method. Yet, we think that the consistent 14C ages of charcoal and small molluscs (two phases having very different origin and genesis) suggest that these ages are reliable and may reflect the real age of sedimentation. Clearly, the precision of 14C ages are an order of magnitude better for a post-IR age of 500-800 yr than the luminescence ages (2σ age range: 3700-7900 yr) and this may be another reason for creating age-depth models based purely on 14C ages, if high precision is needed. The use of the mixture of ages (AMS 14C and OSL/IRSL) allows for a counterproductive in this respect and we suggest to separate the results of the two techniques in modelling. OSL/IRSL-based age models are useful in checking the accuracy of 14C-based chronologies, but in paleoecology and proxy interpretations should be tested against both 14C and OSL/IRSL age models independently.

Abrupt climate changes during the last two glacial-interglacial cycles as recorded in Chinese loess

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Thick loess deposits in the northern Loess Plateau are valuable archives of climatic-scale climate variability. In order to construct a comprehensive climatic record of millennial-scale variability for northern China, grain size was measured for 12,330 samples from eight thick loess sections. Between section correlation of these grain size records shows that, although small depositional hiatuses may be present in places within a single section, most parts of the sections display continuous dust deposition throughout the past two glacial cycles. By correlating the eight records with the precisely dated Chinese stalagmite 6O° record, a stacked 249-kyr-long grain size time series was constructed, termed the "CHILOMOS" (Chinese Loess Millennial-Scale Oscillation Stack) record, which is the first high-resolution stack documenting millennial-scale variability in northern China. The CHILOMOS record shows millennial-climate events superimposed on a prominent cooling trend during the last and penultimate glaciations, consistent with the pattern of increasing global ice volume. However, this cooling trend is damped in the stalagmite record and totally suppressed in the low-latitude ocean record. It follows that the Loess Plateau, far from the low-latitude ocean, is largely influenced by the northern high-latitude ice sheets, while the proximal stalagmites of southern China primarily document signals from the low-latitude ocean. In contrast to the Greenland ice core and stalagmite 6O° records, the CHILOMOS record exhibits relatively small-amplitude oscillations for the two interglacials, probably as a result of