

The 2022 INQUA LoessFest

20-23 August, 2022



Loess deposits at Luochuan



Chinese Association for Quaternary Research



LOESS AND
PEDOSTRATIGRAPHY
WORKING GROUP

INQUA Loess and Pedostratigraphy Working Group



Institute of Geology and Geophysics,
Chinese Academy of Sciences



Key Laboratory of Cenozoic Geology
and Environment,
Chinese Academy of Sciences



State Key Laboratory of Loess
and Quaternary Geology

The 2022 INQUA LoessFest

Abstract book

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Organized by:

- INQUA Loess and Pedostratigraphy Working Group
- Key Laboratory of Cenozoic Geology and Environment, Chinese Academy of Sciences
- State Key Laboratory of Loess and Quaternary Geology



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20th August, 2022

Chairperson: Shiling Yang

China Time	GMT	Presenter	Affiliation	Title
15:35-15:45	7:35-7:45	Welcome Remarks Shiling Yang, Conference organizer, Institute of Geology and Geophysics, Chinese Academy of Sciences Thijs van Kolfschoten, INQUA President, Leiden University		
15:45-16:10	7:45-8:10	An Zhisheng (<i>Keynote Speaker</i>)	Institute of Earth Environment, Chinese Academy of Sciences	Chinese loess: A key record of global changes
16:10-16:35	8:10-8:35	Fahu Chen (<i>Keynote Speaker</i>)	Institute of Tibetan Plateau Research, Chinese Academy of Sciences	Loess deposits in central Asia and their paleoclimatic implications
16:35-16:45	8:35-8:45	Break		

Chairperson: Huayu Lu

China Time	GMT	Presenter	Affiliation	Title
16:45-17:00	8:45-9:00	Xiaoping Yang	Zhejiang University	Geomorphological, sedimentological and geochemical evidence for the provenances of aeolian sands in the sand seas and sandy lands of northern China
17:00-17:15	9:00-9:15	Zdzisław Jary	University of Wrocław	Last Glacial sudden climate changes recorded in periglacial loess of Poland and western part of Ukraine
17:15-17:30	9:15-9:30	Xiuming Liu	Fujian Normal University	Geological features of Quaternary loess and its significances
17:30-17:45	9:30-9:45	Thomas Stevens	Uppsala University	Loess deposits in central Sweden
17:45-18:00	9:45-10:00	Zhiwei Xu	Nanjing University	Present-day dust emission from northern China associated with climate change and land-use management
18:00-19:30	10:00-11:30	Break		

Chairperson: Zdzisław Jary

China Time	GMT	Presenter	Affiliation	Title
19:30-19:45	11:30-11:45	Chaofeng Fu	Chang'an University	Late Miocene East Asian Summer Monsoon change recorded by Aeolian deposits of Jianzha Basin in the Northeastern margin of the Tibetan Plateau
19:45-20:00	11:45-12:00	Olga Meshcheriakova	Schmidt Institute of Physics of the Earth	Rock-magnetic properties of Late Quaternary loess-paleosol sequence of Tajikistan (Khonako-II section)
20:00-20:15	12:00-12:15	Guoqiang Li	Lanzhou University	The high-resolution luminescence chronology of loess-paleosol records from central-Eastern Asia revealed differential ice volume and orbital modulation of Quaternary moisture patterns between Central and East Asia
20:15-20:30	12:15-12:30	Sándor Gulyás	University of Szeged	Multimillennial paleoenvironmental, temperature variations and aeolian dynamics of the past 1 My inferred from a multiproxy study of the thickest, best resolved independently dated loess/paleosol record from SW Hungary
20:30-20:45	12:30-12:45	Haichao Xie	Institute of Tibetan Plateau Research, Chinese Academy of Sciences	The Climate and Environment Changes in the Northeastern Iran Recorded by Loess-paleosol during the Last Interglacial
20:45-20:55	12:45-12:55	Break		

Chairperson: Thomas Stevens

China Time	GMT	Presenter	Affiliation	Title
20:55-21:10	12:55-13:10	Qiang Wang	Zhejiang Normal University	Holocene moisture variations in western arid central Asia inferred from loess records from NE Iran
21:10-21:25	13:10-13:25	Natalia Taratunina	Lomonosov Moscow State University	Late Pleistocene cryogenesis of the Lower Volga loess-paleosol sequences: structure and chronology
21:25-21:40	13:25-13:40	Yaowu Hu	Fudan University	Loess and Civilization: Integrated Archaeological Evidence to Reveal the Interplay of Millet Agriculture with Chinese Civilization in the Loess Areas
21:40-21:55	13:40-13:55	Jia Jia	Zhejiang Normal University	Temperature dependence of pedogenic magnetic mineral formation in loess deposits
21:55-22:10	13:55-14:10	Olga Tokareva	Institute of Geography of the Russian Academy of Sciences	Late Quaternary pedogenesis in loess-paleosol sequence of Obi-Mazar (Tajikistan)
22:10-22:20	14:10-14:20	Break		

Chairperson: Natalia Taratunina Poster Session I

China Time	GMT	Presenter	Affiliation	Title
22:20-22:26	14:20-14:26	Qingzhen Hao	Institute of Geology and Geophysics, Chinese Academy of Sciences	Clay mineralogy of the Stari Slankamen (Serbia) loess-paleosol sequence during the last glacial cycle — Implications for dust provenance and interglacial climate
22:26-22:32	14:26-14:32	Shuangwen Yi	Nanjing University	Sea-level changes constrained by coastal loess accumulations in northern China over the past 200 ka
22:32-22:38	14:32-14:38	Svetlana Timireva	Institute of Geography of the Russian Academy of Sciences	Reconstruction of the stages of loess sedimentation and paleosol development in the Pekla section (Taman peninsula, Russia)
22:38-22:44	14:38-14:44	Yury Kononov	Institute of Geography of the Russian Academy of Sciences	New data on the structure of the loess-paleosol series of the middle Kuban river valley
22:44-22:50	14:44-14:50	Yongda Wang	Institute of Geology and Geophysics, Chinese Academy of Sciences	Provenance and paleoclimatic implications of loess deposits in Shandong Province, eastern China
22:50-22:56	14:50-14:56	Shiyu Shao	China University of Geosciences, Wuhan	A simulation study on the interdecadal variation of summer precipitation in North China in the Late Ming and Early Qing Dynasties
22:56-23:02	14:56-15:02	Qida Jiang	Institute of Geology and Geophysics, Chinese Academy of Sciences	Modern sand supply of the Tengger Desert and temporal variations in sand provenance driven by northern Hemisphere glaciation
23:02-23:08	15:02-15:08	Zhi Liu	Baoji University of Arts and Sciences	Comparative analysis of the magnetism between Chinese and Serbian loess deposits
23:08-23:14	15:08-15:14	Ju'e Tian	Chang'an University	Reflectance spectra of Late Miocene Sediments from the Jianzha Basin in Northeastern Margin of the Tibetan Plateau and their Paleoclimatic Significance
23:14-23:20	15:14-15:20	Zuzanna Kabacińska	Babes-Bolyai University	Revisiting natural and laboratory electron spin resonance (ESR) dose response curves of quartz from Chinese loess
23:20-23:26	15:20-15:26	Daniela Constantin	Babeş-Bolyai University	An empirical study on the variability of luminescence ages for coeval loess samples

21st August, 2022

Chairperson: Gaojun Li

China Time	GMT	Presenter	Affiliation	Title
15:55-16:10	7:55-8:10	Junsheng Nie	Lanzhou University	Spatial and temporal provenance variations of the Chinese Loess Plateau over the late Miocene to early Pleistocene: a window into the reorganization of the Yellow River and monsoon activity
16:10-16:25	8:10-8:25	Yibo Yang	Institute of Tibetan Plateau Research, Chinese Academy of Sciences	Cenozoic Asian dust provenance changes linked to the Tibetan Plateau uplift
16:25-16:40	8:25-8:40	Hanzhi Zhang	Nanjing Univeristy	Large-number detrital zircon U-Pb ages reveal global cooling caused formation of Chinese Loess Plateau during Late Miocene
16:40-16:50	8:40-8:50	Break		

Chairperson: Junsheng Nie

China Time	GMT	Presenter	Affiliation	Title
16:50-17:05	8:50-9:05	Haobo Zhang	Lanzhou University	Spatially variable provenance of the Chinese Loess Plateau
17:05-17:20	9:05-9:20	Katja Bohm	University of Helsinki	Global climate change and East Asian dust sources: combined rutile geochemistry and zircon U-Pb analysis from Baode, Chinese Loess Plateau
17:20-17:35	9:20-9:35	Yao Gu	Nanjing University	Radiocarbon dating of small snail shells in loess-paleosol sequence at Mangshan, central China
17:35-17:50	9:35-9:50	Fan Lv	Nanjing University	Mineral assemblages in Chinese loess deposits: Implications for past regional weathering intensity
17:50-18:05	9:50-10:05	Jishuai Yang	Lanzhou University	Sustainable intensification of millet-pig agriculture in Neolithic North China
18:05-19:30	10:05-11:30	Break		

Chairperson: Kaja Fenn

China Time	GMT	Presenter	Affiliation	Title
19:30-19:45	11:30-11:45	Xin Wang	Lanzhou University	A new proxy index for wet-dry seasonality of paleoclimate using the range of $\delta^{18}\text{O}$ within single shell of land snails
19:45-20:00	11:45-12:00	Shengqian Chen	Institute of Tibetan Plateau Research, Chinese Academy of Sciences	Holocene dust storm variations over northern China: transition from a natural forcing to an anthropogenic forcing
20:00-20:15	12:00-12:15	Ekaterina Kulakova	Schmidt Institute of Physics of the Earth RAS	On the problem of position of the Matuyama-Brunhes transition in the loess-paleosol series of Tajikistan
20:15-20:30	12:15-12:30	Xinxia Li	China University of Geosciences, Wuhan	Atlantic meridional overturning circulation modulation of late Pleistocene to middle Holocene Asian summer monsoon variability and palaeoanthropological implications
20:30-20:45	12:30-12:45	Zisha Wang	Northwest Institute of Ecology and Environmental Resources, Chinese Academy of Sciences	Microcharcoals witness the Holocene vegetation history across the Loess Plateau and its implications on the plant management
20:45-20:55	12:45-12:55	Break		

Chairperson: Randall Schaetzl

China Time	GMT	Presenter	Affiliation	Title
20:55-21:20	12:55-13:20	Majie Fan (<i>Keynote Speaker</i>)	University of Texas Arlington	Nature and causes of the mid-Cenozoic loess in the western USA
21:20-21:35	13:20-13:35	Jiawei Da	Nanjing University	Reconstructing Pleistocene atmospheric CO ₂ levels using paleosols from the Chinese Loess Plateau
21:35-21:50	13:35-13:50	Zhe Wang	Nanjing University	Evaluation of dichromate oxidation method for extracting black carbon from loess deposits
21:50-22:05	13:50-14:05	Wenjie Yuan	Beijing Normal University	Aeolian-fluvial interaction sequence indicates landforms process in the Paiku Co basin, central Himalayas
22:05-22:15	14:05-14:15	Break		

Chairperson: Xin Wang Poster Session II

China Time	GMT	Presenter	Affiliation	Title
22:15-22:21	14:15-14:21	Randall Schaetzl	Michigan State University	Mapping the Loess Cover of Wisconsin (USA) provides insight into loess depositional and re-depositional systems, post-MIS 2
22:21-22:27	14:21-14:27	Chunxia Zhang	Institute of Geology and Geophysics, Chinese Academy of Sciences	Clay mineralogical and geochemical record from a loess-soil sequence in Chinese Loess Plateau during the past 880 ka and the implication on the East Asian Summer Monsoon
22:27-22:33	14:27-14:33	Shujian Xu	Linyi University	Size-dependent geochemical characteristics of loess sequence from the Central Shandong Mountainous region: Implications for the provenance of eolian deposits in China
22:33-22:39	14:33-14:39	Hao Lu	Institute of Geology and Geophysics, Chinese Academy of Sciences	Insolation and CO ₂ impacts on the spatial differences of the MIS-9 and MIS-11 climate between monsoonal China and central Asia
22:39-22:45	14:39-14:45	Yunkun Shi	Qinghai Normal University	Environmental implications of magnetic susceptibility varied with different altitudes in aeolian loess from the Qinghai Lake area
22:45-22:51	14:45-14:51	Yue Li	Institute of Earth Environment, Chinese Academy of Sciences	Late Pleistocene dynamics of dust emissions related to Westerlies in northern Central Asia: New insights from quantifying loess provenance in the North Tian Shan
22:51-22:57	14:51-14:57	Wubiao Li	Institute of Geology and Geophysics, Chinese Academy of Sciences	Holocene variations of hydroclimate and dust activity as recorded in lake sediments in the northern margin of East Asian summer monsoon
22:57-23:03	14:57-15:03	Lily Pfeifer	University of Oklahoma	Paleo-Loess from the Late Paleozoic of Eastern Equatorial Pangaea

22nd August, 2022

Chairperson: Qingzhen Hao

China Time	GMT	Presenter	Affiliation	Title
15:30-15:55	7:30-7:55	Weijian Zhou (<i>Keynote Speaker</i>)	Institute of Earth Environment, Chinese Academy of Sciences	Geomagnetic tracing studies using Chinese loess ¹⁰ Be
15:55-16:10	7:55-8:10	Leibin Wang	Guangzhou University	Effect of plant roots on radiocarbon dating results in arid central Asia
16:10-16:25	8:10-8:25	Xiaoxu Wang	Beijing Normal University	Cancelled
16:25-16:40	8:25-8:40	Redzhep Kurbanov	Lomonosov Moscow State University	Using luminescence dating for identifying hiatuses in the loess-paleosol series of Russia
16:40-16:50	8:40-8:50			Break

Chairperson: Aditi Krishna Dave

China Time	GMT	Presenter	Affiliation	Title
16:50-17:05	8:50-9:05	Gang Hu	Institute of Geology, China Earthquake Administration	Luminescence dating of Malan loess in the Sanmen Gorge: implications for sedimentation rate changes across the Chinese Loess Plateau
17:05-17:20	9:05-9:20	Jiang Wu	Nanjing University	Aeolian dust accumulation process since last interglacial revealed by high resolution dating of loess-paleosol sequence in Mangshan, Central China
17:20-17:35	9:20-9:35	Le Li	Nanjing University	Developing the uranium comminution age and its applications in aeolian system
17:35-17:50	9:35-9:50	Hema Achyuthan	Anna University	Pedogenesis and paleoclimate significance of Late Quaternary loess in Kashmir Valley: Evidence from stratigraphy, chronology and geochemistry
17:50-18:05	9:50-10:05	Shihao Zhang	Institute of Geology and Geophysics, Chinese Academy of Sciences	Wind-blown origin and erodibility of the black soil in Northeast China: evidence from particle size characteristics
18:05-19:30	10:05-11:30			Break

Chairperson: Zihua Tang

China Time	GMT	Presenter	Affiliation	Title
19:30-19:45	11:30-11:45	Yimin Yang	University of Chinese Academy of Sciences	Herding revolution in the Loess plateau
19:45-20:00	11:45-12:00	Shijie Zhao	University of Science and Technology of China	Study of the origins of sacrificial victims from the YinXu Royal Tomb using dietary isoscapes
20:00-20:15	12:00-12:15	Jiao Li	Northwest University, China	Isotopic Analysis on Bone Artefacts of Bone Workshop during the Qin Dynasty in Niejiagou, Xianyang, China
20:15-20:30	12:15-12:30	Péter Cseh	University of Szeged	Kurgans – a special burial site in the loessy region of the Carpathian Basin
20:30-20:45	12:30-12:45	Lanying Shi	Hebei Normal University	Excavation at Jhang Bahatar, Pakistan
20:45-20:55	12:45-12:55			Break

Chairperson: Zhiwei Xu

China Time	GMT	Presenter	Affiliation	Title
20:55-21:20	12:55-13:20	Gerilyn S. Soreghan (<i>Keynote Speaker</i>)	University of Oklahoma	Loess and Dust in Permian Pangaea
21:20-21:35	13:20-13:35	Chengcheng Ye	Shanghai Normal University	Application of new indices of clay minerals in tracing the chemical weathering history of the Loess Plateau in the Late Miocene
21:35-21:50	13:35-13:50	Xinbo Gao	Institute of Geology and Geophysics, Chinese Academy of Sciences	Uplift of the northeastern Tibetan Plateau leads to the extreme desertification in East Asia around 0.9 Ma
21:50-22:05	13:50-14:05	Zihua Tang	Institute of Geology and Geophysics, Chinese Academy of Sciences	Livestock supply to an imperial sacrificial site of the Early Chinese Empires evidenced by strontium isotope ratios
22:05-22:15	14:05-14:15			Break

Chairperson: Lily Pfeifer Poster Session III

China Time	GMT	Presenter	Affiliation	Title
22:15-22:21	14:15-14:21	Xuelian Guo	Lanzhou University	Cancelled
22:21-22:27	14:21-14:27	Sándor Gulyás	University of Szeged	Endemic evolution and Ice age refugia in a thermal lake at the fringe of a loessy landscape during the Late Glacial and the Holocene
22:27-22:33	14:27-14:33	Jie Chen	South China Normal University	Late Quaternary wind erosion of Chinese loess and proximal desert evolution recorded by the accumulation of aeolian deposits on the southeastern margin of the Mu Us dune field
22:33-22:39	14:33-14:39	Yue Du	Beijing Normal University	Holocene biological remains and their environmental significance in the eastern sandy land of Qinghai Lake
22:39-22:45	14:39-14:45	Shengli Yang	Lanzhou University	Environmental changes in the eastern Tibetan Plateau since the last interglacial recorded from the Ganzi loess sequence
22:45-22:51	14:45-14:51	Hongxuan Lu	Institute of Earth Environment, Chinese Academy of Sciences	800-kyr land temperature variations modulated by vegetation changes on Chinese Loess Plateau
22:51-22:57	14:51-14:57	Yanping Sun	Taishan University	Dust accumulation process determined via grain size end-member modelling of Xifeng loess over the last interglacial on the Chinese Loess Plateau
22:57-23:03	14:57-15:03	Tianxiao Wang	Lanzhou University	Holocene temperature variations recorded by the loess-paleosol sequence from the Ganjia Basin in the northeastern Tibetan Plateau
23:03-23:09	15:03-15:09	Mingliang Zhou	Institute of Geology and Geophysics, Chinese Academy of Sciences	Magnetic enhancement mechanism of loess-soil sequence at Qin'an during Middle Miocene and its paleoclimate significance
23:09-23:15	15:09-15:15	Anton Anoykin	Institute of Archaeology and Ethnography RAS	Loess archaeological sites of Final Middle Palaeolithic in the Rubas valley (North-Eastern Caucasus): stratigraphy, chronology and archaeology

23rd August, 2022

Chairperson: Shengwen Qi

China Time	GMT	Presenter	Affiliation	Title
15:30-15:55	7:30-7:55	Slobodan Marković (<i>Keynote Speaker</i>)	University of Novi Sad	Synchronicity between IRD events in Northern Atlantic and grain size variations of the Serbian loess during the last million years
15:55-16:10	7:55-8:10	Zhiqing Li	Institute of Geology and Geophysics, Chinese Academy of Sciences	Microstructural insight into the characteristics and mechanisms of compaction of an intact, compacted and remolded loess for land-creation project from the Loess Plateau
16:10-16:25	8:10-8:25	Zhuolong Jia	Chang'an University	Study on the improvement of guar gum on the anti-erosion properties and soil-water retention capacity of fiber-reinforced loess
16:25-16:40	8:25-8:40	Xiaokun Hou	Institute of Geology and Geophysics, Chinese Academy of Sciences	Water migration characteristics in thick compacted loess due to mega engineering projects
16:40-16:50	8:40-8:50	Break		

Chairperson: Pierre Antoine

China Time	GMT	Presenter	Affiliation	Title
16:50-17:05	8:50-9:05	Lina Ma	Institute of Geology and Geophysics, Chinese Academy of Sciences	Investigation on the deformation and failure patterns of loess cut slope based on the unsaturated triaxial test in Yan'an, China
17:05-17:20	9:05-9:20	Yaguo Zhang	Chang'an University	Settlement prediction of filling compacted loess soil subjected water infiltration
17:20-17:35	9:20-9:35	Ziran Zhang	Chang'an University	Coupled Hydro-mechanical Behavior of Compacted Loess during Isotropic Compression
17:35-17:50	9:35-9:50	Han Bao	Chang'an University	Time-dependency deterioration of two ecological materials in loess cut-slope protecting
17:50-18:05	9:50-10:05	Evgeny Konstantinov	Institute of Geography, Russian Academy of Science	Late Quaternary loess in the Ciscaucasia (South of Russia): distribution, composition, and source of mineral dust
18:05-19:30	10:05-11:30	Break		

Chairperson: Zhongshi Zhang

China Time	GMT	Presenter	Affiliation	Title
19:30-19:55	11:30-11:55	Thomas Stevens (<i>Keynote Speaker</i>)	Uppsala University	Neogene-Quaternary loess sources of Eurasia
19:55-20:10	11:55-12:10	Hong Ao	Institute of Earth Environment, Chinese Academy of Sciences	Orbital and millennial Asian monsoon variations across Northern Hemisphere glaciation
20:10-20:25	12:10-12:25	László Makó	University of Szeged	Pécel: a special Middle and Late Pleistocene loess profile from the Northern part of the Carpathian Basin
20:25-20:40	12:25-12:40	Haozhong Xue	Institute of Geology and Geophysics, Chinese Academy of Sciences	Correlation and discussion of Chinese loess stacked records based on nonlinear time series analysis
20:40-20:55	12:40-12:55	Dongxue Chen	Beijing Normal University	Holocene prehistoric human activities recorded by palynology in the Mu Us Desert, China
20:55-21:10	12:55-13:10	Jian Kang	Institute of Tibetan Plateau Research, Chinese Academy of Sciences	Critical altitudinal shift from detrital to pedogenic origin of the magnetic properties of surface soils in the western Pamir Plateau, Tajikistan
21:10-21:20	13:10-13:20	Break		

Chairperson: Sándor Gulyás Poster Session IV

China Time	GMT	Presenter	Affiliation	Title
21:20-21:26	13:20-13:26	Ruoxiao Gu	China University of Geosciences, Wuhan	Statistical analysis of tropical-cyclone-induced remote precipitation in Henan Province, China during 1961 and 2015
21:26-21:32	13:26-13:32	Peng Jia	Chang'an University	Leachate lithium content records paleoclimate change during the last glacial-interglacial cycle on the Loess Plateau of China
21:32-21:38	13:32-13:38	Tianao Xu	China University of Geosciences, Wuhan	ENSO events during the LIG period under the background of sea level rise
21:38-21:44	13:38-13:44	Ning Liu	Taishan University	High-resolution optically stimulated luminescence ages of monsoon records over the last glacial-interglacial cycles from the loess of the Chinese Loess Plateau
21:44-21:50	13:44-13:50	Zixuan Chen	Lanzhou University	HIRM variation in the Ganzi loess of the eastern Tibetan Plateau since the last interglacial period and its paleotemperature implications for the source region
21:50-21:56	13:50-13:56	Li Liu	Lanzhou university	Chronology and dust mass accumulation history of the Wenchuan loess on eastern Tibetan Plateau since the last glacial

Chairperson: Shiling Yang

21:56-22:30	13:56-14:30	Closing Remarks Zhengtang Guo, Conference President, Institute of Geology and Geophysics, Chinese Academy of Sciences Zdzisław Jary, University of Wrocław		
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Chinese loess: A key record of global changes

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Abstract: Chinese loess is a deposit which results from the interaction of lithosphere, atmosphere, hydrosphere and biosphere. The Chinese loess-paleosol sequence can be well-correlated with the Quaternary glacial-interglacial changes inferred from the $\delta^{18}\text{O}$ of deep-sea sediment (Liu et al., 1985; An and Lu, 1984; Sasajima and Wang, 1984), and the Chinese loess, together with deep-sea sediments and polar ice cores, is one of the three pillars for global climate-changes studies.

The Chinese loess-paleosol sequence is composed of the loess and interbedded paleosols and records the history of climate variation of the alternating cold-dry winter monsoon from high latitudes and warm-humid summer monsoon from low latitudes (An et al., 1991a). The dust flux of Chinese loess, as a direct proxy of the dust emission or aridity in the source area, has reflected the history of aridity and westerlies climate of inland Asia (An et al., 1991b; Fang et al., 2020). The changes of loess grain size reflect the variations of Siberian High and Northern Hemispheric ice volume (Hao et al., 2012). Meanwhile, the grain size provides evidence for abrupt millennial climate events in East Asia and reveals the teleconnection between the East Asian and the high latitudes of the North Atlantic region through AMOC and westerlies (Porter and An, 1995; An, 2000; Sun et al., 2012). In addition, the strengthening of the East Asian winter monsoon can enhance the Australian summer monsoon circulation by the air “pressure push” (An, 2000).

Additionally, the iron containing dust from inland Asia, which is partly deposited on the Chinese loess plateau, can affect glacial-interglacial climate condition through the atmospheric dust deposition to the ocean, stimulating ocean primary productivity and thus drawing down atmospheric CO_2 (Jickells et al., 2005; An et al., 2014; Han et al., 2020). In turn, the lowered atmospheric CO_2 will increase the inland aridity and dust production, which drives the biogeochemical cycle of dust in the Northern Hemisphere. Overall, Chinese loess with its abundant proxies for ice volume, monsoon variability, and more is a key continental record to explore and understand global environmental changes.

Keywords: Chinese loess; Ice volume; Monsoon; Dust cycle; Global changes

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Geomagnetic tracing studies using Chinese loess ^{10}Be

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Abstract: Chinese loess-paleosol sequences are considered to be one of three pillars that comprise the foundation of global change research, along with marine sediments and ice cores. However, paleomagnetic studies of magnetic reversals recorded in Chinese loess were found to be asynchronous with those found in marine sediments. For example, the Brunhes-Matuyama (B-M) reversal boundary was found in loess unit L8, corresponding to marine isotope stage (MIS) 20, but in interglacial MIS 19 in marine sediments. This asynchronicity led to a long-standing debate over the uncertainties of the loess time scale and climatic correlation between terrestrial and marine records. Therefore, it was necessary to reinvestigate geomagnetic reversals in Chinese loess using a new approach, independent of paleomagnetic methods. Meteoric ^{10}Be is produced by cosmic-ray spallation in the Earth's atmosphere and its production rate is inversely proportional to geomagnetic field intensity, allowing us to reconstruct geomagnetic field variations using ^{10}Be records in different sedimentary archives. It is challenging to extract a purely geomagnetic ^{10}Be signal from loess, due to the fact that the geomagnetic and climatic (rainfall and recycled dust) ^{10}Be signals are tightly intertwined. In order to do so, we developed a mathematical method-Residual Trace Approach (RTA) to disentangle the global geomagnetic field and climate signals in Chinese loess ^{10}Be . Based on the RTA method, we first reconstructed high resolution histories of global geomagnetic field intensity record for the last 130 ka from loess ^{10}Be , the specific horizons containing evidence for geomagnetic excursions, such as the Laschamp and Blake events, have been identified. We then reinvestigated the B-M reversal boundary using ^{10}Be from two loess sections. The results revealed that the B-M reversal boundary in Chinese loess was recorded in paleosol unit S7 corresponding to MIS 19, aligning the timing of the B-M reversal recorded in Chinese loess with marine records. In particular, our studies settled the long disputed question of the apparent asynchronicity in the B-M reversal boundary in terrestrial and marine sediments and showed the advantages of using loess ^{10}Be to reconstruct geomagnetic field variations spanning the whole Quaternary.

Keywords: Chinese loess; meteoric ^{10}Be ; geomagnetic field; B-M reversal

Loess deposits in central Asia and their paleoclimatic implications

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Abstract: Loess of central Asia is developed as a belt along the foothills of mountains located in the downwind regions of deserts. The dominance of coarse dust components suggests that the main component of the loess sediments in central Asia is transported by near-surface winds from proximal source regions. Therefore, loess deposits provide important sedimentary archives for reconstructing the history of paleoclimate changes in the Asian interior and their relationship with Monsoonal Asia on various time scales.

The oldest deposition of eolian sand and sandy loess-like deposits commenced in the northeast Tajik Basin between ~37 and 25 Ma, and gradually transitioned to fluvial facies after ~25 Ma, suggesting a change in climate towards wetter conditions to the west of the Pamir–Tian Shan mountains during the Late Oligocene. This trend contrasts with the broad accumulation of loess and enhanced aridification to the east of the orogen, suggesting that the interactions between the westerlies and the Pamir–Tian Shan mountains played an important role in shaping the arid climate regime in central Asia since the Late Oligocene.

Typical loess-paleosol sequences accumulated in northern Iran and the Tajik Basin since at least ~2.4 Ma, but a more extensive distribution of loess sediments in central Asia developed since the middle Pleistocene. The loess-paleosol sequences in central Asia are characterized by paleosol development during interglacial periods and loess accumulation during glacial periods, suggesting a consistent temporal pattern of wet-dry climate shifts between central Asia and Monsoonal Asia on orbital timescales during the glacial-interglacial cycles.

The Holocene loess from central Asia consists of loess in the lower part and a paleosol layer in the upper part. Multi-proxy records suggest a drier early Holocene and a wetter late Holocene climatic regime in central Asia, yielding an out-of-phase or anti-phase relationship with monsoonal Asia on the sub-orbital time scale during the present interglacial period. Increasing evidence suggests that this out-of-phase or anti-phase phenomenon may also exist in older interglacial periods, such as the last interglacial period.

Keywords: Central Asia; Loess; Paleoclimate; westerlies-dominated climatic regime.

Synchronicity between IRD events in Northern Atlantic and grain size variations of the Serbian loess during the last million years

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Abstract: Loess covers huge parts of the continents, especially in the middle latitudes of the Northern Hemisphere. However, except in the case of formation of the Chinese Loess Plateau, which is linked with the East Asian Monsoon, we do not know the potential relationship between loess formation and responsible air circulation type(s) in any other region. Comparison between Serbian and Chinese loess-paleosol sequences magnetic and grain size records provide general similarities especially in the case of magnetic records matching. This transcontinental correlation reveals also that there are significant similarities between the magnetic records of northern Serbia and the central Chinese loess plateau. The general multi-millennial variations of presented magnetic proxies are almost identical in these distant major loess regions. This correspondence appears to be also similar with the globally integrated marine records, potentially suggesting accordance in soil formation processes on Eurasian scale. However, median grain size and other parameters of textural variations indicate significant differences in variations of median grain size between Serbian and Chinese loess records. These textural differences point that Serbian loess is formed as a consequence of completely different air circulation than in the case of Chinese loess plateau.

Robust evidence of grain size variations recorded in the Serbian loess indicates significant synchronicity with the appearance of Ice Rafted Debris (IRD) events identified from deep sea cores in the North Atlantic during the last one million years. Additionally, higher contribution of coarse grains, the thickness of loess layers, sedimentation rates and increase of U-ratio is observed in Serbian loess-paleosol sequences is associated with a more pronounced decrease of sea surface temperatures in the Western than in Eastern Mediterranean. These differences in the sea surface temperatures in the Western and Eastern Mediterranean illustrate more polar front fluctuations between the Pyrenees and Alps influencing the more frequent cyclone genesis in Genova gulf, as an important regional climatic anomaly. Modern regional synoptical atmospheric circulation patterns as well as studies in the North Atlantic area support our hypothesis that the observed grain size variations reflect the long-term migration, seasonal

duration and permanency of the polar front on a multi glacial-interglacial scale.

Keywords: Loess; Grain size; North Atlantic; Paleoclimate; Serbia

Loess and Dust in Permian Pangaea

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Abstract: Dust (including loess) deposits are well known as both an archive of climate and an agent of climate change for Earth's recent (mostly Plio-Pleistocene) record. Loess deposits of pre-Cenozoic age are less known, but a growing body of evidence indicates that both loess and dust deposits were widespread across relatively low-latitude regions of the supercontinent of Pangaea during the late Paleozoic, potentially beginning as early as the latest Devonian, but with especially prominent accumulations in the Permian.

We interpret paleo-loess deposits to consist of siliciclastic mudstone or siltstone in structureless units, with common pedogenic horizons, but lacking evidence for fluvial delivery of the siliciclastic material. Individual beds can be several meters thick, but internally massive, and laterally extensive, with minimal basal erosion or channeling. Wet surfaces enhance dust trapping, thus monotonous sections of mudstone and siltstone exhibiting water-influenced structures such as ripple cross-lamination and desiccation features can also record eolian delivery where other means of sediment transport can be eliminated. Eolian-transported dust is also preserved in marine systems, and can be recognized in cases where other modes of siliciclastic transport can be ruled out. For example, in carbonate reef systems and other epeiric-sea strata formed in regions isolated from fluvio-deltaic influx.

Inferred paleo-loess (or "loessite") deposits reach thicknesses exceeding 1000 m (>1500 m) in the Permian of paleo-equatorial regions of Pangea, such as the western- midcontinent U.S. and France, recording extraordinarily large volumes of silt production and deposition. Indeed, Permian loess deposits documented from paleoequatorial Pangaea are the thickest known from any time in Earth history. Provenance (detrital zircon) data indicate derivation from the (broadly speaking) Central Pangean Mountains, after inferred transport in fluvial systems draining these mountains. Sources included crystalline basement rocks with crystal sizes exceeding silt size, indicating the need for processes to manufacture the silt.

Major loess deposits of the late Cenozoic commonly occur in mid- to high-latitude regions and bear some link to glaciation, owing to the well-known capacity for glaciers to produce, via grinding, large volumes of silt. However, thin loess deposits are also documented in warm desert environments, unassociated with a glacial origin. The Carboniferous-Permian interval was a well-known icehouse with widespread glaciation in the southern polar region, but little evidence for glaciation outside the southern high latitudes. The equatorial setting of the vast Permian loess deposits is remarkably unusual relative to the mid-high latitude setting for voluminous loess deposits of the Cenozoic. Widespread glaciation in tectonically active mountains represents one scenario capable of replicating the conditions necessary for voluminous silt generation and mobilization from the Central Pangean Mountains, but this

idea remains controversial. Notably, the voluminous atmospheric dust was iron rich, presumably stimulating productivity in the marine and terrestrial biosphere, thus affecting biogeochemical (including carbon-) cycling and paleoproductivity.

A proposed project (termed “Deep Dust”) to core Permian deposits of the Anadarko Basin specifically targets the vast paleoloess preserved here, owing to the well-known capacity of loess as a high-resolution archive of paleoclimate. We hope to reconstruct the most highly resolved record of the continental Permian yet attempted, with loess and dust.

Keywords: Silt; Eolian; Paleozoic; Pangaea; Paleoclimate

Neogene-Quaternary loess sources of Eurasia

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Abstract: One of the most fundamental topics in loess research concerns the sediment sources of loess deposits themselves. Understanding loess source links to questions over particle production mechanisms for loess, the importance of dust emitting regions, transport pathways, and wider connections to (for example) ice core or marine dust. Constraining loess sources has implications as far reaching as understanding of sediment cycling generally, dust-climate interaction, landscape evolution, and interpretation of loess climate proxy records. In many regions, understanding of loess sources has improved significantly over the last decades, although debates and uncertainties are still common.

A range of methods have been used to constrain the sources of loess over the Neogene-Quaternary, ranging from purely theoretical models, to bulk geochemical, isotopic and magnetic methods, and through to analysis of the chemistry or age of individual mineral grains. In recent years, the focus has shifted more towards the use of single grain methods, and especially detrital zircon U-Pb dating. The advantage of single grain approaches is that multiple sources can be more easily resolved than with bulk data, and the increasing use of single grain methods has led to new insight into loess provenance in multiple parts of Eurasia. However, every provenance proxy has strengths and weaknesses, and ideally multiple, complementary methods should be used in provenance questions. Here, case studies using multi-proxy approaches on Neogene-Quaternary loess will be presented in order to illustrate how the use of multiple techniques can refine insight into dust sources, beyond the use of one technique alone. The focus will be on U-Pb dating of detrital zircons combined with other complementary techniques, and will use examples from China and Europe (e.g., Baykal et al., 2021; Bohm et al., 2022; Fenn et al., 2022). The results from these studies reveal considerable complexity in sediment production, transport and mixing, prior to loess deposition, yet also allow greatly refined and fundamental understanding of landscape dynamics and forcing. They enable the tracking of loess-forming particles from their origins through to final deposition.

Keywords: Provenance; U-Pb; zircon; single-grain; dust; Cenozoic

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Reconstructing Pleistocene atmospheric CO₂ levels using paleosols from the Chinese Loess Plateau

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Abstract: As a typical terrestrial archive, pedogenic carbonate is rich in paleoenvironmental information. In particular, the carbon isotopic composition of pedogenic carbonate (¹³C_c) records the ¹³C of soil CO₂ and has been widely used to reconstruct atmospheric CO₂ levels throughout geologic history. The paleosol-CO₂ proxy relies on the steady-state diffusion behavior of soil CO₂, which is composed of two endmembers with distinct ¹³C: the atmospheric CO₂ penetrating the soil-air interface through diffusion and the biogenic CO₂ sourced from soil respiration. However, due to the lack of constraint on an input parameter - the concentration of soil-respired CO₂ at depth *z* where pedogenic carbonate precipitates (*S*(*z*)), this method bears significant uncertainty compared to other CO₂ proxies.

Pedogenic carbonates are extensively distributed in the eolian deposits on the Chinese Loess Plateau (CLP), owing to the seasonal wet-dry cycles controlled by the East Asian summer monsoon. Previous studies consider the ¹³C_c as an indicator of regional vegetation types (i.e. C₃/C₄ plants), assuming that *S*(*z*) overwhelms atmospheric CO₂ in the soil system. However, recent works based on modern soil observations suggest that *S*(*z*) approaches atmospheric CO₂ during the formation time of pedogenic carbonates, especially in arid regions such as the CLP.

To quantitatively examine the effect of atmospheric CO₂ on the ¹³C_c from the CLP, we collected pedogenic carbonates from multiple sections including both the Quaternary loess-paleosol sequences and the Pliocene red clay formation. Through paired analyses of the ¹³C_c and the ¹³C of paleosol organic matter, we show that atmospheric CO₂ constitutes a significant portion of soil CO₂ (up to 60%) during the time of pedogenic carbonate growth. Our results support the ¹³C_c in arid regions as an indicator of regional aridity, with higher values under increased water deficiency as a result of diminished soil respiration.

After confirming the role of atmospheric CO₂ in setting the ¹³C_c, we next resolved *S*(*z*) and reconstructed Pleistocene interglacial CO₂ levels, using fine-grained calcites disseminated in bulk paleosols from the CLP. Based on paleosols over the past 800,000 yr., we found a significant correlation between bulk soil magnetic susceptibility – a traditional summer monsoon proxy, and the back-calculated *S*(*z*) using the ice-core CO₂ record. This relationship is consistent with previous studies which highlight the effect of rainfall on soil respiration rate. Applying the empirical model relating *S*(*z*) to magnetic susceptibility, we were able to assign

S(z) estimates to individual samples, and reconstruct atmospheric CO₂ levels with high precision. Our results show overall low CO₂ levels (<300 ppm) across the Pleistocene Epoch, indicating that the Earth system has operated under late-Pleistocene CO₂ levels for an extended period.

Keywords: Pedogenic carbonate; Carbon isotope; Atmospheric CO₂; Paleosols; Chinese Loess Plateau

800-kyr land temperature variations modulated by vegetation changes on Chinese Loess Plateau

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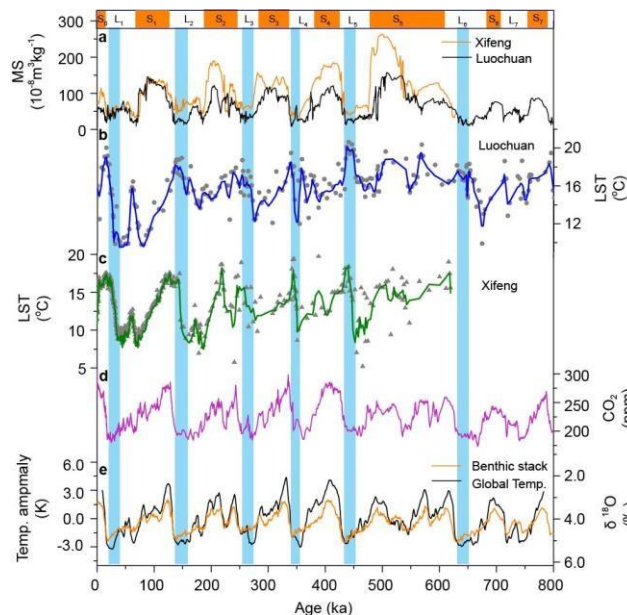
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Abstract: The complicity of long-term land surface temperature (LST) changes has been under investigated and less understood, hindering our understanding of the history and mechanism of terrestrial climate change. Here, we report the longest (800 thousand years) LSTs based on distributions of soil fossil bacterial glycerol dialkyl glycerol tetraethers preserved in well-dated loess-paleosol sequences at the center of the Chinese Loess Plateau. We have found a previously-unrecognized increasing early and prolonged warming pattern toward the northwestern plateau at the onset of the past seven deglaciations, corresponding to the decrease in vegetation coverage, suggesting underlying surface vegetation or lack of has played an important role in regulating LSTs, superimposed on the fundamental global glacial-interglacial changes. Our results support that LSTs in semi-humid and semi-arid regions with little vegetation will be more sensitive to the anticipated global temperature rise, while improving vegetation coverage would reduce LSTs and thus ecological impacts.

underlying surface vegetation or lack of has played an important role in regulating LSTs, superimposed on the fundamental global glacial-interglacial changes. Our results support that LSTs in semi-humid and semi-arid regions with little vegetation will be more sensitive to the anticipated global temperature rise, while improving vegetation coverage would reduce LSTs and thus ecological impacts.

Keywords: Paleotemperature; Loess; GDGTs; Vegetation effect

Reference

Hongxuan Lu, Weiguo Liu*, Hong Yang*, Huanye Wang, Zhonghui Liu, Qin Leng, Youbin Sun, Weijian Zhou, Zhisheng An. 800-kyr land temperature variations modulated by vegetation changes on Chinese Loess Plateau. Nature Communications, 2019, 10, 1958 and references therein.

Anti-phase change in the South Asian summer and winter monsoons during Marine Isotope Stage 5, revealed by loess-paleosol sequences in southern Tibetan Plateau

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Abstract: The variation pattern of South Asian Summer and Winter Monsoon (SASM and SAWM) during Marine Isotope Stage (MIS) 5 in the southern Tibetan Plateau (TP) and the associated driving mechanism are still controversial. In this study, we present the analysis of a 4.3-m aeolian sedimentary sequence from the Yarlung Tsangpo valley in the southern TP which is influenced by the SASM and SAWM. A total of 21 samples were dated using K-feldspar luminescence techniques to establish the chronology for the sequence, and the magnetic susceptibility and sorting coefficient of grain size were used to reconstruct the SASM and SAWM during MIS 5. The results indicated that a general anti-phased relationship between SASM and SAWM during MIS 5, namely, the SASM (SAWM) intensity presented a long-term weakening (strengthening) trend from MIS 5e to MIS 5c to MIS 5a, consistent with Northern Hemisphere summer insolation (NHSI). Due to low sensitivity of magnetic susceptibility during cold stadial, the SASM intensity reflected by magnetic susceptibility during MIS 5d was near to that during MIS 5b; while the SAWM intensity reflected by sorting coefficient during MIS 5d was stronger than that during MIS 5b, corresponding to lower NHSI during MIS 5d than that during MIS 5b. We assumed that inverse monsoonal behaviour during MIS 5 could be led by the migration of the mean latitudinal position of the Intertropical Convergence Zone, induced by varying solar energy distribution between the Northern and Southern hemispheres due to Earth's precessional cycle.

Keywords: Nyingchi loess; South Asian summer monsoon; South Asian winter monsoon; Marine Isotope Stage 5; Intertropical Convergence Zone.

A new proxy index for wet-dry seasonality of paleoclimate using the range of $\delta^{18}\text{O}$ within single shell of land snails

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Abstract: Seasonality is one of the key parameters that determine climate characters and dynamics. However, most of the available paleoclimate records derived from loess-paleosol sequences are averaged signals of year to thousands of years and lack seasonal resolution, hindering reconstruction of a full-field view of past climate and for deeper understand the dynamics of long-term climate changes. Here, we develop a novel proxy index for paleo-precipitation seasonality using the range of stable oxygen isotope compositions within single shell of land snails ($\delta^{18}\text{O}_{\text{shell}}$ range). Modern datasets reveal that smaller ranges (ca. 2.9‰) indicate temperature climate with winter precipitation maxima, and larger ranges (ca. 10.2‰) indicate monsoonal climate with summer precipitation maxima. $\delta^{18}\text{O}_{\text{shell}}$ ranges of fossil samples provide unique evidence that the late Quaternary precipitations were concentrated in winter seasons in West Arid Central Asia and in summer seasons in North Monsoonal Asia, respectively. In addition, $\delta^{18}\text{O}_{\text{shell}}$ range records suggest longer and drier winters during glacial periods than interglacial periods in North Monsoonal Asia since the middle Pleistocene. Integrating with modelling evidence suggest distinct seasonal characteristics of interactions between the westerlies and Asian monsoon during the late Quaternary period, which had synergistic impact on glacial-interglacial climate changes over Arid central Asia and North Monsoonal Asia.

Keywords: Paleo-seasonality; Land snail; Proxy index; Glacial-interglacial climate changes; Westerlies-Asian monsoon interactions.

Environmental changes in the eastern Tibetan Plateau since the last interglacial recorded from the Ganzi loess sequence

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Abstract: Loess sequences in the eastern Tibetan Plateau (TP) are valuable paleoenvironmental archives for reconstructing the environmental history related to the Indian summer monsoon (ISM). However, limited detailed information is known about these loess sequences. In this study, we conducted optical stimulated luminescence (OSL) dating and environmental magnetism analysis of the Ganzi loess sequence that developed since the Last Interglacial. Our results are as follows: (a) OSL dating can provide good age constrain for the Ganzi loess since the last interglacial. (b) The pedogenic ferrimagnetic particles dominated the magnetic enhancement, and magnetic parameters can be used to reconstruct precipitation history. (c) The reconstructed precipitation shows that rainfall in the eastern TP has varied dramatically, and the wettest periods over the last glacial cycle were the LIG and the Holocene. The ISM and precipitation in the eastern TP were mainly driven by the combined effect of orbital changes, global ice volume, atmospheric CO₂ concentration, and internal climate forcing on the glacial-interglacial timescale.

Keywords: Ganzi loess; OSL dating; Tibetan Plateau; environmental magnetism; Indian summer monsoon

Loess deposits in the middle reaches of Yarlung Zangbo River valley, Tibetan Plateau: magnetic properties and the enhancement mechanism of magnetic susceptibility

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Abstract: Aeolian loess is one of the most widespread sediments on the land and yield abundant information of paleoclimate changes. At present, the paleoclimate studies of loess in the Yarlung Zangbo River valley are limited, and the researches on the mechanism of magnetic susceptibility variation are still unavailable. Here, we present the results of rock magnetic measurements of the XTM loess including magnetic susceptibility, high-temperature dependence of magnetic susceptibility, low-temperature thermal demagnetization of saturation isothermal remanent magnetization, saturation isothermal remanent magnetization, anhysteretic remanent magnetization, hysteresis loops and first-order reversal curve. Combined with the result of grain size, we analyze the magnetic properties and discuss the possible magnetic susceptibility enhancement mechanism of XTM loess. The results show that the ferrimagnetic mineral assemblage of the loess units is dominated by multidomain and pseudo-singledomain magnetites. Loess samples have higher concentration magnetite than paleosol samples, while more iron hydroxides and iron sulphides appear in the paleosol samples. The enhancement mechanism of magnetic susceptibility for the XTM loess is complicated and superimposes both the “wind vigor” model and the “in situ gleization” model. The higher magnetic susceptibility of loess is attributed to stronger and more frequent wind during the glacial period. The decrease of magnetic susceptibility is resulted from the transformation from magnetites to iron hydroxides and iron sulphides. The enhancement mechanism of magnetic susceptibility in this region is first proposed in this study, which will tremendously promote the application of rock magnetic proxies in Yarlung Zangbo River valley.

Key words : Loess; Magnetic susceptibility; Magnetic properties; The Tibetan Plateau; Paleoclimate significance

Chronology and dust mass accumulation history of the Wenchuan loess on eastern Tibetan Plateau since the last glacial

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Abstract: Loess deposits are spread widely over the eastern Tibetan Plateau (ETP), and constitute key terrestrial archives for reconstructing the paleoenvironments of the late Quaternary, which are still poorly understood. This study creates a detailed chronology of the Wenchuan loess sequence in the ETP through the quartz optically stimulated luminescence dating and radiocarbon dating. The results show that loess has accumulated in the area since at least ~57.7 ka. We show that the variation in the history of the mass accumulation rate (MAR) spanned 4.8–108.0 gcm⁻²ka⁻¹, with a mean value of 43.9 gcm⁻²ka⁻¹ since the last glacial. The MAR of MIS 3 was the highest over the last glacial, with two peaks at 48–44 ka and 35–32 ka; whereas the MAR of MIS 2 was slightly lower and its peak appears at 21–18 ka. The MAR during the Holocene was generally low. Moreover, four enhanced dust events were superimposed on changes in the long-term MAR and correlated with the corresponding Heinrich events. The variation in the MAR of Wenchuan loess since the last glacial period has been similar to that in the eastern Chinese Loess Plateau (CLP) but differing from those of the western CLP. Our results reveal the spatial difference of MAR since last glacial, and can contribute to a better understanding of the link between the evolution of dust deposition and environmental changes in the ETP.

Keywords: Loess; OSL dating; Grain size; MAR; Bulk density

HIRM variation in the Ganzi loess of the eastern Tibetan Plateau since the last interglacial period and its paleotemperature implications for the source region

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Abstract: Reconstruction of paleotemperatures in loess sequences plays a crucial role in paleoclimate research. Depositional-origin hematite is considered a major contributor to high-field isothermal remanence (HIRM), which is closely related to temperature. However, there is limited knowledge regarding hematite of various origins that contributes to the HIRM in Tibetan Plateau (TP) loess deposits. Here, the variation in and contributions of hematites of various origins to HIRM in the Ganzi loess of the eastern Tibetan Plateau (ETP) and their paleoclimatic significance are investigated in detail. We find that depositional hematite is the main contributor to HIRM in the ETP loess and HIRM can be used as an indicator of temperature variation on the TP. During the interglacial period, the TP dust source became more arid, which was conducive to production of more hematite. During the glacial period, the TP dust source region became colder and drier, which was not conducive to the formation of hematite. The HIRM record shows that the TP temperature has varied with orbital-scale glacial-interglacial changes since the last interglacial period. This was mainly in response to Northern Hemisphere summer insolation. The loess source region in the interior of the TP was warmest during the last interglacial period (MIS 5) and the Holocene. Its coldest period occurred during MIS 2. The climate was relatively mild during MIS 3. This study provides further understanding of environmental changes in the TP.

Keywords: Ganzi loess; HIRM; Hematite; Dust source area; Chuanxi Plateau; Paleotemperature

Holocene biological remains and their environmental significance in the eastern sandy land of Qinghai Lake

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Abstract: As an effective sedimentary record reflecting climate change, biological remains are an important index for the reconstruction of paleo-environment and palaeo-climate. Based on the results of AMS¹⁴C and Optically Stimulated Luminescence (OSL) dating methods, biological remains in three sedimentary profiles, CGL (36°46'46.03"N, 100°51'33.72"E; 3407 m a.s.l.; ca. 751 cm in thickness), SDT (36°47'46.18"N, 100°52'31.65"E; 3482 m a.s.l.; ca. 328 cm in thickness) and SQG (36°48'14.47"N, 100°53'24.71"E; 3621 m a.s.l.; ca. 272 cm in thickness), in the eastern boundary of the eastern sandy land (36°37'~37°5'N, 100°25'~100°55'E) were identified and analyzed. Combined with environmental proxies such as lithology, grain size and organic matter, the environmental significance of biological remains was clarified. The biological remains in the eastern sandy land mainly include tree residues and cones of *Picea crassifolia*, charcoal and four kinds of snail fossils. The four snail fossils were *Pupilla* cf. *turcmenica*, *Vallonia tenera*, *Gastrocopta coreana* and *Pupilla cryptodon*, among which, *Pupilla* cf. *turcmenica* and *Vallonia tenera* were the dominant assemblages of snail fossils in this study. The residues of *Picea crassifolia* indicate humid climate, while charcoal reflects a relatively dry environment under overall humid conditions. The combination of dominant species of snail fossils indicates the cold and dry climate. The stratigraphic and age results show that the profiles of CGL and SDT are both the fluvio-lacustrine-aolian sedimentary sections; The age of CGL profile is 9.6±0.2~0 ka B.P. and the age of SDT profile is 6.3±0.1~0 ka B.P., and the profile of SQG is the aeolian sedimentary section with the age of 9.5±0.5~0 ka B.P. The tree residues and cones of *Picea crassifolia* were mainly distributed in fluvio-lacustrine-aolian sediments (610~751 cm) of CGL profile and fluvio-lacustrine-aolian sediments (148~328 cm) of SDT profile, and mainly appeared in the period of 9.6~4.2 ka B.P.; The charcoal is mainly distributed in the sandy loess and paleo-sol sediments of SQG profile, and mainly appeared in the period of 9.5~7.8 ka B.P.; The dominant species of fossil snails were distributed at different depths in SQG section and flourished at 8.4~8.0 ka B.P..

Based on the vertical variation characteristics of lithology, chronological sequence, biological remains, grain size, organic matter in CGL, SDT and SQG profiles, combined with northern hemisphere 35°N summer solar radiation, the changes in pollen concentration and changes in percentage of pollen in arbor in lake sediments of Qinghai Lake, the climate and environmental change processes in eastern sandy land during the Holocene can be divided into five stages: (1) Before 9.6 ka B.P., a small amount of *Picea crassifolia* residues and charcoal were retained.

The climate was warming but there were wet and dry fluctuations. (2) From 9.6 ka B.P. to 8.0 ka B.P., the remains of *Picea crassifolia* were abundant. The climate was generally warm and wet. From 8.4 ka B.P. to 8.0 ka B.P., charcoal was concentrated with the highest value, and the dominant species of snail fossils were abundant. The climate was relatively dry. (3) From 8.0 ka B.P. to 4.0 ka B.P., the remains of *Picea crassifolia* were concentrated and the number of dominant species of charcoal and snail fossils remained low. The climate was warm and wet, a suitable period of the Holocene. (4) From 4.0 ka B.P. to 2.3 ka B.P., the remains of *Picea crassifolia* and the number of dominant species of snail fossils increased. The climate changed from warm and wet to cold and dry. (5) Since 2.3 ka B.P., the residues of *Picea crassifolia* and charcoal have not been found in the profiles and the number of dominant snail fossils has maintained a high value. The climate is cold and dry.

Key words: eastern sandy land of Qinghai Lake; Holocene; biological remains; environmental indicators

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Modern sand supply of the Tengger Desert and temporal variations in sand provenance driven by northern Hemisphere glaciation

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Abstract: Knowledge of surface processes in source-to-sink system of sand is important for the development and utilization of natural resources in desert. However, the surface processes within Chinese deserts, especially their response to long-term global cooling since the Late Pliocene, are still poorly understood. In this study, thirty samples from a drill core in the central Tengger Desert of China spanning the past ~3.5 Ma, together with sixty-eight widely-distributed surface samples, were collected. We analyzed the trace element data of their aeolian sand (63–500 μm) to elucidate the present and past surface processes. The principal findings are as follows: (1) The main sand provenances for the southwestern and northeastern parts of the Tengger Desert are the northeastern Tibetan Plateau and the Alxa Block, respectively. (2) After the inception of Northern Hemisphere glaciation at ~2.7 Ma, the expansion of ice sheets in high northern latitudes was the major trigger of an increased sand supply from the Alxa Block to the desert hinterland, via the strengthening of the Siberian High. After the Mid-Pleistocene Transition (MPT), during ~1.2–0.8 Ma, the development of mountain glaciers in the Tibetan Plateau was the major trigger of an enhanced fluvial sand supply from the northeastern Tibetan Plateau to the hinterland. (3) Further, we propose that these two triggers may subsequently have caused substantial variations in the sand supply to most of the deserts surrounding the northern Tibetan Plateau rather than only the Tengger, due to the similarity of their sand supply mechanisms. And the enhanced fluvial sand supply from the northern Tibetan Plateau may be of significance to the continuous existence of a sand sea landscape in the surrounding basins during the post-MPT interval. Overall, our study suggests that glaciation in the high latitudes and the high mountains of the Northern Hemisphere have a significant impact on the two sand supply agents, i.e., wind and water, of Chinese deserts respectively.

Keywords: Source; Sediment transport; Geomorphology; Tibetan Plateau; Mid-Pleistocene transition

Uplift of the northeastern Tibetan Plateau leads to the extreme desertification in East Asia around 0.9 Ma

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Abstract: The first sandy loess L9 in Chinese loess represents aeolian deposits under conditions of extreme aridification, but the forcing mechanism remains unclear. Substantial paleomagnetic studies on loess sections from the eastern Chinese Loess Plateau (CLP) proved that the coarsest part of L9 is remagnetized, and shows a normal polarity. However, our high-resolution paleomagnetic studies on a new loess section from the western CLP reveal that the coarsest part of L9 records a primary reverse polarity. Similar results were also observed in other loess sections from the western CLP. The contrast paleomagnetic behaviors mainly originate from the different magnetic carriers of the characteristic remnant magnetization, hematite for the western CLP and magnetite for the eastern CLP. We further proposed that the increased hematite content specifically in the western CLP results from episodes uplift of the northeastern Tibetan Plateau, which finally leads to the extremely enhanced aridification around 0.9 Ma.

Keywords: Loess; L9; Remagnetization; Hematite; Desertification

Last Glacial sudden climate changes recorded in periglacial loess of Poland and western part of Ukraine

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Abstract: Loess – simply defined as terrestrial silt sediment of aeolian genesis is an exceptional source of palaeoclimate data, because its lithological and structural features constitute an indirect record of changing environmental and climatic conditions prevailing during loess deposition and early diagenesis. The northern European loess belt was shaped in cold climate conditions on the foreground of the great Pleistocene Scandinavian ice sheets. Loess-paleosol sequences (LPS) in this region were formed in relatively short but locally intense sedimentation phases being strongly influenced by dynamic periglacial processes in periglacial environments. LPS in Poland and western part of Ukraine have a great potential for reconstruction of the former periglacial conditions due to they contain a rich inventory of deformation structures associated with changing climatic conditions in the periglacial zone of the Pleistocene glaciations. These structures usually form well-distinguishable marker horizons within LPS and their stratigraphical positions are not random which suggests relationship with global or at least regional climate changes. We assume that at least some of these horizons were formed as a result of sudden, short-term coolings followed by equally sudden warmings of the climate, when ice wedges and permafrost were decay. The number of periglacial horizons within LPS and their morphological features are diverse, which depend on their geographical settings (E-W and N-S directions). Periglacial phenomena in the research area indicates the occurrence of four main cold phases during the Last Glacial period well correlated with the cold marine isotopic stages (MIS 5d, 5b, 4, 2). Taking into account a spatial distribution of Last Glacial ice-wedge pseudomorphs and other periglacial phenomena in research area it can be stated that in the central and eastern part the permafrost had developed twice. The distribution and morphological features of the older (MIS 4) generation of ice-wedge pseudomorphs indicate their development in conditions between continuous and discontinuous permafrost. In the western part of Poland the clear evidences of permafrost were found only in its northern part. The common occurrence and large size of the younger generation of ice-wedge pseudomorphs (MIS 2) indicate continuous permafrost in the central and eastern parts of the research area. However, ice-wedge pseudomorphs in the western part of Polish loess area were probably developed within both continuous (northern part) and discontinuous permafrost (southern part). Periglacial records in the LPS confirm the general instability of the last glacial climate and indicate considerable climatic gradient between western and eastern part of the investigated area as well as meridional changes of periglacial climate conditions during the Last Glacial period. Hence, the special importance of the Polish and Ukrainian loess areas for the recognition of heterogeneity of the Late Pleistocene periglacial zone seems to be unequivocal.

Keywords: Last Glacial; Loess-paleosol sequences; Climate changes; Periglacial structures

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New insights into climate change during the Holocene in middle and North Xinjiang: A synthesis of records of moisture, temperature and near-surface wind strength

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Abstract: A large number of Holocene temperatures, moisture/precipitation and near-surface winds geological records and simulation results have been reported in Middle and North Xinjiang. However, the controversy of moisture/precipitation evolution, the internal relationship between temperature, moisture/precipitation and near-surface winds, and the driving mechanism of climate change during the Holocene in the region need to be further clarified. Here, we reveal the pattern of Holocene climate change based on the previous studies of moisture/precipitation, temperature, near-surface winds and recent studies of the Holocene evolution of the winter mid-latitude Westerlies and the Siberian high-pressure system. We propose an early to middle Holocene relatively cold and dry interval, with strong near-surface winds; and a warmer, wetter interval with weaker near-surface winds in the middle to late Holocene. An increasing number of geological records and climate simulation results highlight the significant contribution of winter temperature to the climatic evolution of the region. Based on this, we established a conceptual model to better explain the Holocene climate change in the region. That is, from the early to the late Holocene, the increasing atmospheric CO₂ content and winter insolation, and the shrinking of high-latitude continental ice-sheets, resulted in increasing winter temperatures in middle to high latitudes in the Northern Hemisphere. The increased winter temperature further strengthened the winter mid-latitude Westerlies and weakened the Siberian high-pressure system, causing increased precipitation and decreased near-surface wind strength. This scenario is strongly supported by evidence from geological records, climate simulation results, and modern reanalysis data. Based on the conceptual model, we suggested that regional precipitation and near-surface winds response to changes in winter temperature and the winter temperature is dominated by atmospheric CO₂ content, winter insolation and the high-latitude continental ice-sheets.

Keywords: Holocene; Siberian high-pressure system; mid-latitude Westerlies; Arid Central Asia

Evaluation of dichromate oxidation method for extracting black carbon from loess deposits

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Abstract: Black carbon (BC) has long been considered as a potential carbon pool for “the missing CO₂”. Though, as black carbon is a combustion continuum composed of a wide range of materials from slightly charred biomass to highly condensed graphite and soot, the isolation and quantification of it in different geological records inevitably have biases and artifacts. Under such circumstances, we should evaluate and optimize methods used for each specific research objective. Here, we first evaluate the effects of oxidation time on extracting BC from loess deposits using the dichromate oxidation method. Unlike previous researches, we ascertain that the decay curves of C abundance don't reach the plateau at the oxidation time of 60h. Conversely, the C abundance of reaction residues still decreases markedly from oxidation time of 60 to 80h (>50% relative to 60h-oxidation residue). However, increasing the oxidation time from 80 h to 120h results in only a relatively small loss of C abundance (~1%) in all the samples. The stable carbon isotope compositions of residues also have relatively little variation through the oxidation reaction from 80 to 120h (<±1‰). Besides, we analyze the composition of reaction residues by Raman spectroscopy. The spectrum of the 100h-oxidation reaction residue of the loess sample (from layer of L9) presents a single sharp peak at 1576 cm⁻¹, which indicates its highly graphitic structure as black carbon has. The results demonstrate that the oxidation time of 80-100h for loess samples through weak pedogenesis which have low total organic carbon concentration is enough. Nevertheless, for paleosol samples through strong pedogenesis which have high magnetic susceptibility and total organic carbon concentration, we should adopt longer oxidation process to exclude the contamination of non-pyrogenic organic carbon. Therefore, to precisely quantify the black carbon long-term preserved in loess deposits, we propose the optimized oxidation time of 120h. Moreover, this study highlights that evaluation of BC extraction methods used for specific samples and research objectives is necessary for follow-up research.

Keywords: Black carbon; Dichromate oxidation; Loess deposits, Raman spectroscopy; Element analysis

On the problem of position of the Matuyama-Brunhes transition in the loess-paleosol series of Tajikistan

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Abstract: Loess-paleosol sequences are widespread in southern Tajikistan, covering vast areas of the Pamir piedmont and having an age up to 2 million years. Many well-studied reference loess-paleosol sections of Tajikistan contain a record of the last geomagnetic reversal, the Matuyama-Brunhes (M/B) polarity transition, which is found in the loess layer between pedocomplexes 10 and 9 (corresponding to the marine isotopostages 21 and 19, respectively). This is in contradiction with the M/B boundary position in marine sediments, where it is localized within the interglacial stage 19. Such a discrepancy was also established for the loesses of the Eastern Europe and the Chinese Loess Plateau, therefore being an issue of interregional significance, requiring further study.

We have sampled a 5 m loess-paleosol interval at the Kuldara section, southern Tajikistan, covering the stratigraphy of pedocomplex PC9, loess L10, and pedocomplex PC10, to study the record of the M/B polarity transition. From this interval, oriented blocks (each 10-20 cm high) were taken and then were cut into ~2 cm thick horizontal slices using a sawing machine. In the laboratory. A total of 230 stratigraphic levels are represented in our collection. Every level was cut further into cubes, and 4-5 cube specimens from each level were obtained. The first 3 blocks (19 levels, depth 74.53 – 75.19 m) correspond to PC9. Next 50 cm of section below the PC9 is a petrocalcic horizon (75.19 – 75.73 m), from which no sampling was carried out. Blocks 4 – 26 correspond to L10 (149 levels, 75.73 – 78.64), and blocks 27 – 34 correspond to PC10 (62 levels, 78.64 – 80 m). All specimens were subjected to alternating field step demagnetization up to 130 mT, natural remanent magnetization was measured using a 2G Enterprises cryogenic SQUID-magnetometer.

The first results have showed that the M/B polarity transition itself encompasses 3 m thick zone and includes both polarity flips and anomalous directions (i.e. those corresponding to virtual geomagnetic pole (VGP) with latitudes equal 45° or less). According to the features of the paleomagnetic record, the studied 5 m interval can be subdivided from top to bottom into the following segments:

- (1) 74.53–75.07 m – only normal polarity directions corresponding to high northern VGP latitudes are presented;
- (2) 75.07–75.19 m - the same but with the sporadic appearance of anomalous directions;
- (3) 75.74–76.95 m – noisy record, containing only anomalous directions;

- (4) 76.95–77.50 m – reverse polarity directions (corresponding to southern high VGP latitudes) alternating with anomalous directions;
 - (5) 77.5–77.8 m – predominance of normal polarity directions with the presence of anomalous and single reverse polarity directions at some levels;
 - (6) 77.80–78.66 m – predominance of reverse polarity directions with the presence of anomalous ones;
 - (7) 78.66–80.0 m – only reverse polarity directions (high southern VGP latitudes).
- Therefore, the paleomagnetic record of M/B transition in the Kuldara section contains 3 polarity flips. The similar record of the M/B transition (but with varying number of polarity flips) has been also evidenced from the high-resolution loess records of China, lava flows, and marine and lacustrine sediments (Hyodo et al., 2020, and references inside). The true nature of these slips remains unclear and may be either a real record of the geomagnetic reversal or the result of distortion of the paleomagnetic record due, for example, to lock-in, pedogenic, illuvial or bioturbation processes.

Therefore, a deeper study of the lithological features of each horizon is necessary to better constrain the nature of the paleomagnetic record.

Keywords: Brunhes-Matuyama reversal; Paleomagnetism; Loess-paleosol series; Tajikistan.

Funding: This work is supported by the Russian Science Foundation under grant 22-18-00568.

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Anthracological and malacological remains from the loess region of South Hungary

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Abstract: Anthracological, sedimentological, radiocarbon and malacological analysis of a typical and an infusion loess section from SE Hungary revealed the geologic and geomorphologic evolution of the area. Aeolian (typical) loess accumulated on sand dunes that formed during MIS3, while in the interdune depressions infusion loess developed. At the end of MIS3 and during MIS 2, between 33,000 and 13,000 cal BP, a temperate steppe-forest steppe environment characterized the loess surface of the SE Great Hungarian Plain. During the first interstadial phase of MIS2 a *Pinus sylvestris* charcoal rich paleosol layer developed on the loess covered surface of a wind-blown sand hummock, while in the interdune depressions a pond phase developed. After the formation of the paleosol layer, during the Heinrich 2 event, *Vertigo modesta*-*Valloniatenuilabris* mollusc species indicate a cold steppe, forest steppe environment and a deeper and colder lake phase in the interdune depressions. After that, a short microinterstadial phase developed and a *Pupilla triplicata*-*Chondrula tridens* dominated temperate steppe-forest steppe environment evolved on the terrestrial surface between 23,000 and 21,000 cal BP. During the Last Glacial Maximum (LGM) the environment completely changed. The average dust accumulation accelerated and coarse silt became dominant. As a result, the lake stage transformed to a marshy environment, while on the land area shade loving, including closed forest environment-preferring mollusc taxa appeared. Humidity increased during the LGM horizon, forestation started and a boreal forest-steppe evolved at the study site. During the post LGM, the interdune depressions filled and aeolian loess layers developed.

Keywords: Anthracology; Malacology; Aeolian loess; Infusion loess

Late Quaternary pedogenesis in loess-paleosol sequence of Obi-Mazar (Tajikistan)

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Abstract: Loess-paleosol series are the most significant paleogeographic archive containing information on landscape and climatic changes during glacial and interglacial epochs of Quaternary. Loess-paleosol sections of Central Asia contain more than 40 pedocomplexes covering the period for the last 2-2,5 million years. The most complete and detailed loess-paleosol series are located in Chinese Loess Plateau and in Afghan-Tajik depression, which is surrounded by mountain systems of Hindukush, Pamir and Hissaro-Alay. In Tajikistan the reference sections are situated in Khovaling Loess Plateau. They were actively studied over the past 40 years by V.A. Ranov, A.E. Dodonov, I. Shaefer and other. These studies were principally dedicated to description of general regional stratigraphy and palaeolithic archeology. There is an urgent shortage of data on the structure and mode of formation of major stratigraphic pinpoints – pedocomplexes (PC), with which the main findings of stone tools are connected. Therefore, to introduce clarity into the paleogeographic formation conditions of the loess-paleosols sequences it is very important to obtain more detailed characteristics of the structure and properties of loess and paleosol units of different age.

This research is dedicated to study of structure and features of loess and paleosols in upper part of the Obi-Mazar section that formed during the last glacial-interglacial cycle and to detailed characteristic of pedogenic processes. Studied section is located on the right bank of the Obi-Mazar river just opposite the Lakhuti village in Khovaling region of Tajikistan. The Obi-Mazar section includes 7 pedocomplexes and 7 loess units. The thick layer of alluvium pebbles is expressed in the bottom of the section. There are a number of unique palaeolithic sites with abundant collection of stone tools in PC4-PC6 in this outcrop (Ranov, 1996).

To study features of PC1 and loess unit embedded above (L1), the stratigraphic and field soil description were performed. The micromorphology analysis, grain size and geochemical analysis were carried out for every horizon of PC1 and L1. The detailed stratigraphic chart and main properties of studied Late Pleistocene horizons will be reported in our presentation.

Keywords: Loess-paleosol sequences; Last Pleistocene; Micromorphology; Tajikistan

This study was supported by of RSF (project № 22-18-00568).

The detrital zircon U-Pb ages reveal change of the dust provenances of the Mangshan loess-paleosol deposit (Zhengzhou, central China) during the last glacial-interglacial alternations

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Abstract: The Mangshan loess deposits located at central China Plain, to the southeastern Chinese Loess Plateau (CLP), preserve high-resolution records of paleoclimatic and paleoenvironmental changes at glacial-interglacial scale due to its large thickness and rapid accumulation rate. In this study, Sixteen samples for detrital zircon U-Pb data analysis from the Mangshan loess-paleosol sequence of the last glacial-interglacial cycle reveal that the main age spectrum peaked at 240 Ma, 440 Ma, 800-1000 Ma, 1800-2000 Ma and 2500 Ma, which indicates that the Mangshan loess provenances were mainly located at the northeastern Qinghai-Tibet Plateau and North China Craton. During the last glacial period, denudation materials from the northeastern Tibetan Plateau to the upper reaches of the Yellow River were increased, which were carried by fluvial processes to the lower reaches; while during the interglacial period, the influence of the nearest source materials were intensified and their contribution increased by 10%. Investigation of Mangshan loess provenance can help better understand the late Quaternary sedimentary environment changes in central China, the coupling processes between tectonics and climate as well as the Yellow River evolution during the Pleistocene.

Key Word: Mangshan loess; Detrital zircon; U-Pb age; Glacial-interglacial; Provenance of Chinese Loess

Luminescence Dating of Loess from Luochuan Section on the Chinese Loess Plateau

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Abstract: It was about 46 years ago when the ages from luminescence dating in Luochuan section were firstly reported. The section has been studied comprehensively and continuously in different aspects including the chronology. Although luminescence dating, from thermoluminescence dating earlier to optically stimulated luminescence dating later, was developed considerably, absolute chronologies for loess-paleosol sequences older than ~130 ka on the Chinese Loess Plateau are still scarce. We conducted the first high-resolution luminescence dating, extending back to 350 ka, of the classical Luochuan loess section. Bacon age-depth modelling of the luminescence ages was used to obtain an age framework. The results indicate that on orbital timescales, loess accumulation at Luochuan was continuous over the last three glacial-interglacial cycles. The new age framework resolves discrepancies between orbitally-tuned age models at several boundaries and provides new evidence supporting the reassignment of the MIS 8/9 boundary age from 300 ka to ~280 ka. The potentials and challenges of luminescence dating applied to even older samples are discussed.

Keywords: Luochuan section; Luminescence dating; back to 350ka; continuous accumulation; MIS8/9 age

Distribution, provenance, and onset of the Xiashu Loess in Southeast China with paleoclimatic implications

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Abstract: Loess deposits are important archives of past climate change in subtropical China, where long-term terrestrial records are scarce. However, only a few long-term records with reliable dating were reported in Jiangsu Province, where loess deposits in southeastern China were first discovered and designated as the Xiashu Loess. Moreover, the provenance of the Xiashu Loess is still controversial. This study presents the magnetostratigraphy and detrital zircon U–Pb age results of loess deposits at Zhoujiashan in Nanjing, Jiangsu Province. To date, this section (with basal age of approximately 0.88 Ma) may be the oldest loess deposits discovered in southeastern China. Based on the detrital zircon U–Pb ages of the Zhoujiashan section, together with published results of geochemistry, geomorphology, sedimentology, and meteorology, we propose that the Xiashu Loess has two mixed sources. Local materials derived from the Yangtze River Basin (including exposed river/lake beds, floodplains, and mountains) served as a major contributor. The distal eolian dust that originated from the arid areas of North China (including deserts, piedmont alluvial fans, and drylands) played a minor role in the formation process of the Xiashu Loess. The nearly synchronous onset age (approximately 0.88 Ma to 0.85 Ma) of the Xiashu Loess was attributed to a regional environmental event during the middle Pleistocene transition.

Keywords: Southeast China; Xiashu Loess; Provenance; Magnetostratigraphy; Loess chronology

Radiocarbon dating of small snail shells in loess-paleosol sequence at Mangshan, central China

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Abstract: Radiocarbon age obtained on small snail shells show that the limestone effect is smaller than for the large shells, providing great potential to constrain accurate ages of late Quaternary loess deposits by dating small snail shells. In the Chinese Loess Plateau (CLP), snail shells are often the only radiocarbon dating material available for building chronology. However, the reliability of different small snail shells for radiocarbon dating remains an open question. Here, we collected different small snail shells from a loess-paleosol sequence located at south-east CLP to test the availability of dating snail shells. Both solid graphite target AMS measurement and gas AMS measurement were performed to evaluate the reliability and possible contamination of different sizes of small shells for radiocarbon dating. ¹⁴C ages of graphitized samples are generally consistent with corresponding OSL ages, indicating the reliability of small snails ¹⁴C dating at CLP. Ages of the surface fraction of small snails are close to the ages of the interior part and the contamination after chemical treatment is limited, indicating fossil snail shells behave as a close system during burial. In addition, gas measurement results further demonstrate the different degrees of reliability among various snail species. For minute taxa, such as *Vallonia* and *Pupilla*, their shells can mainly reveal reliable ¹⁴C ages. While for larger taxa, such as *Cathaica* and *Metodontia*, much attention should be paid to selecting the appropriate shells. Large individuals and snail hatchlings may contain considerable old carbon and only small shells larger than newly incubation (<10 mm and > 2 mg) can provide reliable ¹⁴C ages.

Keywords: Land snail; radiocarbon dating; loess; limestone effect

Mineral assemblages in Chinese loess deposits: Implications for past regional weathering intensity

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Abstract: Thirty-four loess-paleosol samples from Lochuan site, spanning the last 2.6Ma, are examined using Quantitative Evaluation of Minerals by Scanning Electron Microscopy (QEMSCAN). More than 40 000 mineral particles were recognized for each sample. The mineral assemblages in loess and paleosol show that, the provenance of eolian deposits in the Luochuan site is stable over the last 2.6 Ma. The content of unstable minerals (e.g. hornblende, feldspar) are mainly affected by regional weathering. By analyzing the grain size of hornblende, plagioclase and other minerals, we conclude that: (i) the plagioclase/(plagioclase + K-feldspar) value (PKi) is a good indicator of the intensity of regional weathering, and records the characteristics of synchronous changes in weathering intensity with global cooling in the Loess Plateau region since Pleistocene. (ii) Actinolite/tourmaline value (Ac/T) is consistent with the record of magnetic susceptibility, which not only documenting a progressive global cooling trend since the Late Pliocene, but also documenting increasing differences between glacial and interglacial climates since the Mid-brunhes event. (iii) The content of < 10 μm hornblende may also correlate with weathering intensity. This may be caused by fragmentation of easily weathered minerals during weathering process. Our research indicated that, the mineral assemblage is a promising tool for long time weathering intensity record of the terrestrial sediments.

Key words: QEMSCAN; Mineral assemblages; Lochuan loess; Weathering intensity

Magnetic enhancement mechanism of loess-soil sequence at Qin'an during Middle Miocene and its paleoclimate significance

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Abstract: Magnetic susceptibility of loess-soil sequence increased significantly during Mid-Miocene, which has been used as a regional marker for stratigraphic correlation on the Loess Plateau. However, the mechanism of magnetic enhancement is still unclear. In order to reveal the magnetic enhancement mechanism of Miocene's Red clay during the Mid-Miocene and its paleoclimatic significance, 347 samples during 14 to 17.1 Ma are collected from QA-I loess-soil sequence in the Qin'an Area. In this paper, environmental parameters, and rock magnetic measurements (thermomagnetic properties, hysteresis properties etc.) and color parameters of all samples are systematically analysed. Our results show that magnetic minerals of loess-soil sequence are pseudo-single domain (PSD) magnetite, superparamagnetic/single domain (SP/SD) maghemite and hematite. More SP/SD maghemite presents in soil than in upper and lower loess layers. Magnetic characters of loess-soil samples before and after CBD (Citrate-Bicarbonate-Dithionite) treatment show that concentrations of detrital PSD magnetite of the loess-soil sequence are almost stable. The increase of pedogenic fine particle (SP/SD) maghemite concentrations is the main reason for the magnetic susceptibility enhancement of loess-soil sequence during ~14.5-16.0 Ma. However, the redness of the loess-soil sequence correlated with pedogenic degree did not increase significantly during this period. This inconsistency indicates that these SP/SD maghemite minerals removed by CBD treatment may not be formed by local pedogenic weathering. Low-temperature magnetic properties of samples before and after CBD treatment during ~14.5-16.0 Ma show that SP/SD maghemite may be the weathering crust of detrital magnetite particles, and their variations are consistent with median grain size of samples during ~14.5-16.0 Ma. These phenomena reveal that these magnetic particles with SP/SD maghemite possible formed in source area, and their contents in loess-soil are mainly controlled by the strength of wind. Although magnetic susceptibility of Miocene soil samples can reflect the pedogenic degree compared with the upper and lower loess layers, the variations of SP/SD maghemite contents possible are controlled by the local pedogenic degree and the input of source area, resulting in a complex relationship between magnetic susceptibility and the local pedogenic degree. Therefore, the long-scale variation in magnetic susceptibility of Miocene loess-soil sequence cannot reflect the evolution of East Asian Summer Monsoon.

Keywords: The Mid-Miocene; environmental magnetism; CBD; color parameters; pedogenic degree

Luminescence dating of Malan loess in the Sanmen Gorge: implications for sedimentation rate changes across the Chinese Loess Plateau

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Abstract: The Chinese Loess Plateau (CLP) is the world's largest loess plateau. Due to its complex depositional environment, there remains some debate about the continuous nature of its sedimentary loess sequence. In this study, we dated a 9.8 m- long Malan loess core extracted from the Sanmen Gorge on the southern CLP using an optically stimulated luminescence (OSL) technique. The OSL dates suggest that loess accumulated continuously between 52.4 and 11.3 ka, and that the sedimentation rate (SR) of the core could be divided into six episodes, namely, with SRs of ~18.1, ~26.0, ~14.9, ~31.9, ~13.7 and ~49.9 cm/ka between 50.7-47.4, 47.4-39.7, 39.7-26.2, 26.2-19.8, 19.8-16.1 and 16.1-10.7 ka. In order to discuss the possible mechanisms causing loess SR changes, we also reviewed 613 OSL ages from 18 sections at 14 sites across the CLP. These OSL ages suggest that loess deposition was continuous over a millennial timescale at most sites during the past 60 ka, except for two sites located on the margins of the Mu Us Desert, indicating those hiatuses only exist within a few loess sections. The SRs for different sections show several high and low SR episodes within the past 60 ka. The high SR episodes that occurred during the Marine Isotope Stage (MIS) 3 across the CLP were driven by increased dust emissions from the Plateau's aeolian dust sources, as well as an enhanced dust deposition efficiency. MIS 2 deposits were driven by an intensified East Asian Winter Monsoon (EAWM). Most sites experienced low SR episodes during MIS 1, most likely related to reduced atmospheric transportation capabilities and pedogenesis. After comparing the spatial distribution of SRs for loess sections across the CLP, we took the view that the western and northern CLP were the optimal areas for researching millennial climate change, that the southern CLP would be our second choice, and that the central CLP provided the least good option. Temporally heterogeneous characteristics also indicated that changes in local depositional environments might also play a key role in driving changes in the SR.

Environmental implications of magnetic susceptibility varied with different altitudes in aeolian loess from the Qinghai Lake area

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Abstract: The loess deposits in the Qinghai-Tibet Plateau record abundant information regarding climate evolution. The Qinghai Lake is an essential chronicler of paleoclimate in the northeastern of the Qinghai-Tibet Plateau. The environmental significance of the grain size (GS) is clear but that of the magnetic susceptibility (MS) is equivocal in aeolian loess of the Qinghai Lake area (QLA). In this study, we explored the environmental significance of the MS in aeolian loess from QLA by analyzing the relationship between MS and GS. The results show that MS shows different characteristics varied with different altitudes in the aeolian loess of QLA. In QLA, if the altitude is lower than 3300 m, the MS and GS of aeolian loess are favourable indicators to indicate the intensity pedogenesis under different climatic conditions. Under warm and humid climate conditions, the pedogenesis is strong with the clay particles increasing and strongly magnetic minerals augmenting, which results in more fine particles being carried by wind power, thus, MS increases. Under cold and dry climatic conditions, the wind carries more coarse particles, sand content increases, and the clay content decreases, moreover, the pedogenesis is restricted, and the addition of magnetic minerals is limited, thus, MS decreases. At the altitude of higher than 3400 m in the QLA, GS is still able to indicate environmental changes but MS becomes an invalid environmental indicator due to the soil environment varied. With increased precipitation, lower temperature, reduced evaporation, higher soil moisture content and longer freeze-thaw time, the strongly magnetic minerals are likely to be dissolved and become weakly magnetic minerals in aeolian loess at high altitudes of QLA. To sum up, the MS may regard as an "altitude effect" in the aeolian loess of QLA. We should carefully use the MS index to reconstruct the paleoclimate in this region.

Keywords: Qinghai Lake; Aeolian loess; Magnetic susceptibility; Grain size; Altitude effect.

Vegetation variations recorded by sedimentary *n*-alkane ratios since the last 850kyr in the central Chinese Loess Plateau

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Abstract: Vegetation is the principal part of the terrestrial ecosystem, which is very sensitive to climate change and strongly affects the global carbon cycle and water cycle. The Loess Plateau is located in the semi-arid and semi-humid region of China, and its climate is mainly affected by the East Asian monsoon. The study of vegetation variations in this region has practical significance in terms of the global carbon cycle and regional eco-environment construction. However, pollen records for vegetation reconstruction in loess sequence are limited and low-resolved due to its poor preservation in oxidative environment, and the stable carbon isotopic composition of total organic carbon ($\delta^{13}\text{C}_{\text{TOC}}$) cannot accurately distinguish vegetation types as well. These unfavorable factors have restricted the understanding of the long-sequence vegetation variations in the Loess Plateau. Long-chain *n*-alkanes are mostly produced by terrestrial higher plants, and are stable after depositional and burial process. Ratios of *n*-alkanes content are closely related to vegetation types, and have great potential in the study of vegetation in the Loess Plateau. This paper analyzed the long-chain *n*-alkane contents (simplified as *n*-alkanes) of Lingtai section in the central Chinese Loess Plateau since 850 ka to reconstruct the regional vegetation history and explored the driving factors of vegetation variations. Based on previous studies on the characteristics of *n*-alkanes from modern plants in this area, this paper selected the sum of *n*-alkanes $\Sigma(\text{C}_{27}+\text{C}_{29}+\text{C}_{31}+\text{C}_{33})$ to indicate the biomass change of terrestrial higher plants, and used the *n*-alkanes ratio of $\text{C}_{31}/(\text{C}_{27}+\text{C}_{29}+\text{C}_{31})$, $\text{C}_{33}/(\text{C}_{29}+\text{C}_{33})$ and $\text{C}_{33}/(\text{C}_{27}+\text{C}_{33})$ to indicate variations in the relative proportion of herbs, herbs/trees and herbs/shrubs ratios, respectively.

The results showed that the vegetation types in the central Loess Plain has changed in three stages since 850 ka: 850-420 ka (S8-L5 period), 420-240 ka (S4-L3 period) and 240-0 ka (S2-S0 period). $\Sigma(\text{C}_{27}+\text{C}_{29}+\text{C}_{31}+\text{C}_{33})$ indicated that the biomass of terrestrial higher vegetation was at a relatively low level in the first two stages, and has fluctuated and increased since 240 ka in the last stage, and finally has accelerated to increase since 100 ka. The *n*-alkanes ratios almost showed consistent variations, indicating that the relative proportion of herbs, herbs/trees and herbs/shrubs ratios were at the lowest level during 420-240 ka (S4-L3 period), and gradually increased during 240-0 ka (S2-S0 period). Among the *n*-alkane ratios, $\text{C}_{31}/(\text{C}_{27}+\text{C}_{29}+\text{C}_{31})$ fitted best with the glacial- interglacial cycle, with lower abundance of herbaceous vegetation during the glacial period and with relatively higher proportion of shrubs during the last glacial period under cold and dry climate, and with the relative abundance of herbaceous vegetation increasing during the interglacial period under warm and humid climate. During the glacial-interglacial cycle from MIS12 (L5 period, about 480-420 ka) to MIS11 (S4 period, about 420-360 ka),

the vegetation pattern was special, with the relative abundance of herb vegetation and herbs/shrubs decreasing sharply, and an increase in shrubs due to the stable ratio herbs/trees at the MIS11. The *n*-alkane ratios reflected the vegetation variations on orbital scales and special periods in the central Chinese Loess Plateau were generally consistent with the limited pollen records from the adjacent Pingliang and Chaona sections. From the results of frequency spectrum analysis, the periodicity of the *n*-alkane ratios since 850 ka in the Lingtai section included the eccentricity cycle of 114 kyr, the obliquity cycle of 43 kyr and precession cycle of 19 kyr, indicating that the expanding and contracting of ice sheets at high latitudes and the enhancement and weakening of the summer monsoon at low latitudes both had an impact on the vegetation variations in the central Loess Plateau.

Keywords: Chinese Loess Plateau; *n*-Alkane; Plant types; Periodicity; Climate driven

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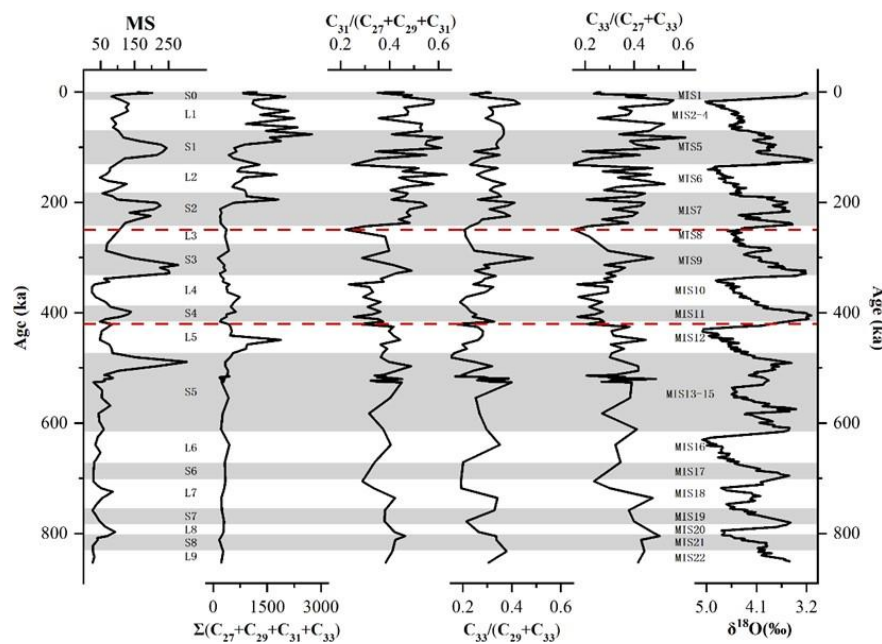


Figure 1. The index parameters of 850-kyr *n*-alkanes in the Lingtai section of Chinese Loess Plateau and their comparison with magnetic susceptibility and benthic $\delta^{18}\text{O}$ stacks. The red line represents 420 ka and 240 ka. The grey bars highlight palaeosol layers (S8-S0), corresponding to the odd-numbered oxygen isotope periods (MIS21-MIS1); the white bars highlight the loess layers (L9-L1), corresponding to the even-numbered oxygen isotope stages (MIS22-MIS2).

Loess deposits from the southeast Chinese Loess Plateau and their paleoclimatic implications during the last interglacial-glacial cycle

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Abstract: Loess-paleosol sequences are important terrestrial paleoclimatic archives in the semi-arid region of north-central China. Compared with the numerous studies on the loess of the southeast Chinese Loess Plateau (CLP), the eolian deposits have not been well studied. The Sanmenxia loess section in the southeast CLP provides an opportunity for reconstructing paleoenvironmental changes in this region. An optically stimulated luminescence chronology demonstrates that the loess deposits accumulated during the last interglacial-glacial cycle. High-resolution climatic proxies, including clay minerals, color-index, particle size and magnetic parameters, reveal orbital-scale climatic cycles, corresponding to marine oxygen isotope stages (MIS) 5 to 2. In contrast to the loess deposits of the central Loess Plateau, loess in southeast CLP is a mixture of distal dust materials from gobi and sand deserts in the arid part of north-western China and proximal, local alluvial sediments. Climatic change in southeast CLP during the last interglacial-glacial cycle was controlled primarily by the changing strength of the East Asian monsoon. Paleosols developed during the last interglacial complex and the interstadial of the last glaciation, being associated with an enhanced summer monsoon in response to increased low-latitude insolation and a weakened Siberia High. Loess accumulation occurred during cold-dry stages of the last glaciation, in response to the intensified winter monsoon driven by the strengthened Siberia High and its longer residence time.

Keywords: Loess; Clay minerals; Paleoclimate; The East Asian Monsoon; The Chinese Loess Plateau.

The establishment and comparative study of quantitative model between modern pollen assemblage and vegetation cover on the Chinese Loess Plateau

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Abstract: The Chinese Loess Plateau (CLP) is an ecologically sensitive area in China, with relatively low vegetation coverage and fragile ecological environment. Therefore, it is of great significance to scientifically and accurately understand the temporal and spatial distribution of vegetation coverage for the sustainable development of the CLP. Based on a set of 443 modern surface pollen assemblages and Normalized Difference Vegetation Index (NDVI, MOD13Q1) during the period of 2000-2015, this study used the modern analogy technique (MAT), stepwise regression (Stepwise), weighted average partial least squares regression (WA-PLS), local weighted weighted average method (LWWA), and boosted regression trees (BRT) to establish quantitative models between modern surface pollen assemblage and vegetation cover on the CLP by using the R software. The model performance was evaluated according to the root mean square error (RMSE), coefficient of determination (R^2) and maximum bias (Max-bias) of the model's correlation test. Then, above five methods are evaluated by leave-one-out cross-test. The results show that the MAT (RMSE=0.18, R^2 =0.6277, Max-bias=0.15) and LWWA_Inv (RMSE=0.18, R^2 =0.5847, Max-bias=0.20) models have better performance than the WA-PLS (RMSE=0.21, R^2 =0.4605, Max-bias=0.22), LWWA_Cla (RMSE=0.24, R^2 =0.4397, Max-bias=0.15), BRT (RMSE=0.22, R^2 =0.5746, Max-bias=0.17), and Stepwise (RMSE=0.19, R^2 =0.4673, Max-bias=0.66). Therefore, the MAT and LWWA_Inv models are suitable to reconstruct the past vegetation cover of the CLP.

Keywords: Modern pollen assemblage; Vegetation cover; Quantitative model; The Chinese Loess Plateau

Siberian High modulated suborbital-scale dust accumulation changes over the past 30 ka in the eastern Yili Basin, Central Asia

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Abstract: Loess contributes considerably to understanding the interactions between dust cycles and climate change. However, systematic and regional-scale reconstructions of variations in the dust mass accumulation rate (MAR) using Central Asian loess are lacking. Based on the high-resolution luminescence dating of 10 loess sections, we present a stacked suborbital-scale (multi-millennial-scale herein) dust MAR record over the past 30 ka in the eastern Yili Basin, Central Asia, which shows obvious advantages at representing basin-scale dust accumulation changes when compared with that based on individual sites. The stacked results in the eastern Yili Basin indicate that the MAR level remained high during the Last Glacial Maximum, followed by a dramatically decreasing trend throughout the last deglaciation, and exhibited a slight decrease during the early Holocene and early middle Holocene, followed by a clear increasing trend toward the late Holocene. We propose that changes in the Siberian High intensity dominantly modulated the aforementioned MAR variations. These results effectively link dust accumulation to the Siberian High, imply a possibly weakened dust activity in the Yili Basin at a long-term scale under future global warming scenarios, and also provide a significant reference for dust accumulation reconstruction in other basins in Central Asia.

Keywords: Central Asia; dust mass accumulation rate; loess; luminescence chronology; Siberian High

Geomorphological, sedimentological and geochemical evidence for the provenances of aeolian sands in the sand seas and sandy lands of northern China

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Abstract: Desert encroachment is a common hazard in the margins of sand seas and sandy lands around the globe. Understanding the provenances of aeolian sands is important not only for establishing sustainable strategies to combat desert encroachments but also for deciphering knowledge about interactions between aeolian, fluvial and lacustrine processes in Earth surface system. Over the years different theories with respect to the sources of sands in the desert regions of northern China have been published both in Chinese and international journals and works on the basis mainly on sedimentological, mineralogical and geochemical characteristics of these sediments. The geomorphological processes which directly transport the sediments are often not given sufficient attention in these studies. Here we aim to synthesize our current understanding about the provenances of aeolian sands in the Taklamakan Sand Sea, the Badan Jaran Sand Sea, the Kubuqi Sand Sea, the Maowusu Sandy Land and the Hunshandake Sandy Land from west to east across the northern China desert belt. We made effort to pay attention to cover potentially every river catchment while collecting surface samples in the study areas. Our geochemical interpretation is based on ratios and concentration patterns of rare and trace elements. In more recent studies we considered also the possibilities of different transport pathways of various grain size fractions in the aeolian sediments, as confirmed by our interpretation of the transport pathways of 2021 mega sand and dust storms. Our results suggest that knowledge about geomorphological background and fluvial processes is crucial to a better understanding of provenances of aeolian sands in northern China and beyond.

Application of new indices of clay minerals in tracing the chemical weathering history of the Loess Plateau in the Late Miocene

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Abstract: Late Miocene-Quaternary continuous aeolian sediments from the Loess Plateau are considered ideal materials for reconstructing the evolutionary history of continental chemical weathering in East Asia. However, previous studies have shown that the effects of grain size and mineral sorting make loess geochemical indicators have multiple interpretations when indicating regional weathering. Clay minerals are important components of aeolian sediments and may provide important clues for understanding regional paleoweathering history by using monomineral mineralogical and geochemical composition changes.

In this study, we present detailed mineralogical analysis of chlorite and illite collected from the Chaona section in the central Loess Plateau and try to reconstruct regional chemical weathering history in the Late Miocene using chlorite chemical composition and authigenic illite content. The chlorite chemical composition variation was revealed by its characteristic diffraction peak ratio and crystallinity; while the authigenic illite content was obtained by polytype determination and peak decomposition. The results of chlorite chemical composition and authigenic illite content collectively show that regional chemical weathering intensity has presented a four-stage evolution trend since 6.2 Ma. The regional chemical weathering intensity remained relatively low during the period of 6.2-3.6 Ma and then became enhanced in 3.6-2.6 Ma; after that regional chemical weathering intensity showed a long-term decreasing trend in ~2.6-0.6 Ma and became increased significantly again in 0.6-0.1 Ma. After excluding the influence of provenance and diagenesis, we believe that the regional chemical weathering evolution of the Loess Plateau mainly reflects the gradual intensification of the East Asian summer monsoon from the Late Miocene to the Pliocene, and the co-evolution of the East Asian winter and summer monsoon during the Quaternary.

Keywords: Chemical weathering; Chlorite; Illite; East Asian Summer Monsoon; Loess Plateau

Late Pleistocene cryogenesis of the Lower Volga loess-paleosol sequences: structure and chronology

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Abstract: Caspian Lowland is one of the most controversial areas of permafrost distribution on the East European Plain in the Late Pleistocene. Complex geological history of this region was dominated by transgressive-regressive events of the Caspian Sea. For many decades Quaternary geology studies were focused on the reconstruction of the parameters of the Pleistocene basins of the Caspian Sea, while the subaerial deposits of the region have not been intensively studied.

In this regard, the structure, genesis and age of the subaerial deposits of the Lower Volga region are still debatable. In a significant number of published studies, there are practically no data on the history of cryogenesis processes and their role in the formation of subaerial deposits in the region.

In 2017-2021 in the Lower Volga region (along the valley of the Volga and Akhtuba rivers) six sections were studied: Srednyaya Akhtuba, Leninsk, Raigorod, Bataevka, Cherny Yar, Kosika. All of them reveal several horizons with cryogenic structures.

Methods. A comprehensive analysis was carried out as part of the study: particle size distribution (Mastersizer 3000), investigation of microstructure and morphology of quartz grains (TM 3000), fractional study of the mineralogical composition (D2Phase) of deposits with the determination of the degree of their cryogenic transformation by calculating the coefficient of cryogenic contrast (Konishchev et al., 1981). Absolute dating was performed using luminescence dating of quartz and feldspars grains in Riso Laboratory, Denmark.

Results. The studied sections are located on the right and left banks of the Volga-Akhtuba Valley. Horizons with cryogenic structures of various shapes were exposed at in different geological units: thin wedge-shaped structures (from 30 cm to 2.0 m vertically), two-layer, with a thinner tail and a pocket-like top, wedge-shaped structures (up to 25 cm).

Six stages of the development of Late Pleistocene cryogenesis were identified in the Lower Volga region:

I stage was from the late MIS 5c to the beginning of MIS 5b (95-90 ka);

II stage was ~85-80 ka and corresponds to the middle of MIS 5a.

III stage occurred at the beginning MIS 4 (~70 ka).

IV stage – corresponds to the middle of MIS 3c (~52-50 ka);

V stage – took place at about end of MIS 3c and the beginning of MIS 3b (~47-45 ka);

VI VI stage – occurred at about end of MIS 3b and the beginning of MIS 3a (40-35 ka). Environmental conditions during the formation of loess were dry and cold. The cryogenesis of that time was reflected in more clayey and water-saturated sediments, i.e. in paleosols, usually occurring under loess layers.

The most severe conditions in the Lower Volga region (permafrost, negative ground temperatures) existed in MIS 5b (cryogenic stage I) and in the beginning of MIS 2 (cryogenic stage VI). They were reflected in the form of regionally widespread thin vertically extended wedge-shaped structures in loess-paleosol series.

The obtained data on the development of the Late Pleistocene cryogenesis in the Lower Volga region clarify the extent of the paleopermafrost distribution in the south of the East European Plain i.e. 250 km south of the currently widely accepted boundary (Velichko, 1973; Vandenberghe et al., 2014).

Keywords: Cryolithology; Luminescence dating; Paleopermafrost; Cryogenic structures

The study was supported by the RFBR (project № 20-55-56046).

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Reconstruction of the stages of loess sedimentation and paleosol development in the Pekla section (Taman peninsula, Russia)

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Abstract: The southern coast of the Sea of Azov (Taman Peninsula) is a region with well-developed loess-paleosol series (LPS). The detailed studies we started in the area of the Cape Pekla are being carried out with the aim of reconstructing the dynamics of landscape evolution and climatic changes of the Taman peninsula during the Quaternary. An important task is clarifying the age of the main loess and paleosol units of the region. In the granulometric composition of the Pekla section, a characteristic feature is the large volume of the sandy fraction, which, in all likelihood, is associated with active eolian processes occurring in the immediate vicinity of the transport sources. This is confirmed by the results of the analysis of morphoscopy of sand grains. Sand grains generally have a low haze index from 7 to 23.5%. The roundness coefficients reach quite high values and range from 39 to 62%.

The study of quartz grains of a 0.5-1.0 mm size on a scanning electron microscope shows a variety of microtextures created under the influence of mechanical and chemical processes. Each level identified in the section has its own textural features of the surface. Thus, in the loess horizons, the number of grains with traces of mechanical impact, characteristic of eolian processing, increases. Grains with traces of the impact of chemical processes appear in the soil horizons - textures formed as a result of soil acids reaction on the surface of the grains. Redeposition processes play a significant role in the formation of LPS in this part of the Taman peninsula coastland. So, on the surface of grains from sandy deposits lying at the base of the section, traces of water treatment are clearly visible. Similar grains with traces of water treatment are present in all identified LPS units. Frosty weathering also left traces in the form of conchoidal chips, cracks, and stepped surfaces. This process manifested itself most clearly in the loess horizons of the upper part of the section.

Detailed paleopedological studies revealed five buried soil. On the basis of a complex lithological data, it was established that the exposed stratum of sediments contains 5 paleosols and loess or sandy horizons separating them. The three lower, older paleosols PS5-PS3 formed under warm, humid conditions. The formation of the upper paleosols PS2 and PS1 proceeded with the participation of synlithogenic cryo-arid soil formation. According to the results of luminescence dating (Timireva et al., 2022), the upper part of the section to a depth of 125 cm was formed in the Holocene. The middle part of the modern soil was formed about 3 ka BP, loess at the base of the soil reflects the rapid accumulation of loess around 9 ka BP. In the loess horizon L1 below the base of the modern soil, there is a sharp jump in ages up to 50-56

ka. Thus, loess in the depth interval of 190–225 cm was formed during MIS 3. From a depth of 2.5 m in horizon L1, another jump in age is noted: in the interval of 265–295 cm, loess accumulation occurred in the period of 160–170 ka BP (MIS 6). An interesting result obtained from luminescence dating was the confirmation of the age of the coastal-marine sands identified between PS3 and PS4. The upper part of this sand unit was dated 255 ± 18 , which is close to the date obtained earlier - 279.4 ± 13.8 . Thus, according to new data, layer 13 was formed in the period of 255–280 ka, which corresponds with the time of Uzunlar transgression of the Black Sea usually dated 220–280 ka years ago (Svitoch et al., 1998).

Keywords: Loess accumulation; Taman peninsula; Paleosol; Azov Sea loess

The reported study was funded by Russian Science Foundation, project №22-17-00265.

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New data on the structure of the loess-paleosol series of the middle Kuban Rivervalley

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Abstract: Loess-paleosol series (LPS) are the most significant paleogeographic archive containing information on landscape and climatic changes during glacial and interglacial epochs. These deposits are widespread in Eurasia and studying them is of great importance for paleoclimatic reconstructions. Currently, one of the urgent tasks in studying is to clarify the stratigraphic position of specific loess-paleosol horizons of the sections according to the existing chronostratigraphic scheme of the East European Plain. Our study area is located in a transit position between Siberian, Central Asian loesses and loesses of Eastern and Western Europe; however, it is still poorly studied. We carried out field work in the south part of the Russian Plain between Tbilisskaya and Kazanskaya villages (N 45°22'54.055" E 40°19'34.961) on the right bank of the Kuban river valley. A 25-meter section named Kropotkinsky was studied in the upper part of the natural outcrop. The field study included: lithological characteristics of deposits, identification of the stratigraphic units, description of the paleosols, detailed sampling for a set of analyzes (magnetic susceptibility, grain size measurements, micromorphology, OSL and paleomagnetic dating, morphoscopy of sandy quartz grains, etc.).

At the moment, the first results have been obtained on the general structure of the units of this section. The upper half of the sequence is represented by subaerial deposits consisting of four intervals which correspond to different structure of paleosols and loess horizons separating them. Thick layers of alluvial sands lie at the base of the section.

The upper interval of the subaerial stratum, formed during the last glacial cycle, is distinguished by a large thickness of loess deposits and the presence of three poorly developed paleosols. In the second interval, three well-developed pedocomplexes (PC) are noted, alternating with thin horizons of loess. The paleosols are brown in color, enriched in carbonates and gypsum accumulations.

The third interval is represented by a thick PC4 consisting of 3 paleosols with characteristic red color. Specific feature of the paleosols of this interval is the presence of slickensides, increased clay content and a platy structure.

The fourth interval is represented by two well-developed brown PC5 and PC6, separated by thick loess horizons (2-3 m), also affected by soil formation processes.

Thus, a thick subaerial stratum is distinguished in the Kropotkinskiy section in the middle part of the Kuban River valley, consisting of 6 pedocomplexes formed during periods of warming

separated by loess horizons accumulated during glacial periods. The alternation of paleosols and loess in the section reflects climate changes over the past 800 ka.

Keywords: Loess-paleosol sequences; East European Plain; Kuban loess; Cis- Caucasus

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Using luminescence dating for identifying hiatuses in the loess-paleosol series of Russia

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Abstract: The incompleteness of the geological record is a significant limitation in the study of Quaternary deposits. For the most detailed characterization of the natural environment evolution stages expressed in the alternation of horizons of various genetic types of deposits it is customary to identify sections with the maximum completeness of the record. The geological incompleteness is usually clearly expressed in the form of erosional boundaries, reflecting the change in sedimentation condition and the destruction of the upper part of the unit formed in the previous period. Such boundaries make it possible to determine the presence of breaks in sedimentation already in the field. Unfortunately, in sediments represented by homogeneous material detection of possible traces of erosion is a difficult task, which is usually can't be solved in the field. It is traditionally believed that such horizons were formed without erosional breaks. First of all, this applies to the loess-soil series.

In recent years, with the widespread introduction of absolute geochronology methods, in particular, high-resolution dating, more data have been obtained and published on the loess-soil series of various regions of the world, indicating the presence of significant breaks in sedimentation - hiatuses. Detection of the erosional breaks in sedimentation was made possible from performing high resolution OSL dating (Stevens et al, 2018). The method is widely used in geochronological studies of Quaternary deposits, and loess-paleosol series are the most suitable material for obtaining accurate chronological data. In luminescence dating high-resolution chronologies are series of dates obtained from samples taken at high frequency (10-20 cm). At present, there are a number of examples of successful use of this technique for studying the loess-paleosol series around the world. The high frequency of sampling allows using Bayesian modeling and increase the reliability of dating.

We have attempted high-resolution dating of the loess-paleosol series of four loess-paleosol regions of Russia: the Novosibirsk Ob region, the Lower Volga region, the Eastern Sea of Azov region, and Taman peninsula. The dating of the loess-soil deposits was carried out by the authors at the Risø NLL Laboratory, Aarhus University, Denmark. The Lozhok reference section was studied in the Novosibirsk Ob region; the Lower Volga region high-resolution chronology was

obtained for two sections – Srednyaya Akhtuba (109 ages) and Leninsk (45 ages); the Pekla section (22 ages) was dated on the Taman Peninsula; the Beglitsa reference section (28 ages) was studied in the Eastern part of the Sea of Azov. We will present the results of detailed geochronological studies of five key sections of the Eurasian loess belt. The obtained data indicate presence of significant breaks in sedimentation and incompleteness of the loess-paleosol record.

Keywords: luminescence dating, Ob region, Lower Volga region, Azov region, Taman peninsula

The study was supported by the RSF (grant № 19-77-10077).

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Rock-magnetic properties of Late Quaternary loess-paleosol sequence of Tajikistan (Khonako-II section)

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Abstract: Climate dynamics in Central Asia during the Quaternary is a fascinating topic and can be reconstructed from the study of loess-paleosol sequences. The Tajikistan loess-paleosol series are a unique paleogeographic archive that consists of glacial (loess) stages and interglacial periods (paleosols). These series usually contain several developed paleosols that are usually united in pedocomplexes (PC) separated by thin units of loess. Up to 40 pedocomplexes were described in the well-known Khovaling loess plateau (Dodonov, 2002).

We studied the loess section of Honako-II, which reflects periods of warming and cooling at least over the last 1.5 Ma, containing up to 24 PC's. We reconstructed climate dynamics using petromagnetic proxies. In this work, we studied rock magnetic properties using magnetic susceptibility and anisotropy method and minerals characteristic of the rocks magnetization.

Methods. The AMS measurement was carried out on the MFK-1 kappabridge (AGICO, Czech Republic) in three mutually perpendicular planes that define the magnetic susceptibility ellipsoid (with rotation about these axes). The Anisoft42 program was used for computer processing of the measurement results. In addition to studying the anisotropy of the magnetic susceptibility, we measured the mass-normalized magnetic susceptibility on the MFK-1 kappabridge to verify the correlation of the studied units of loess-paleosol sequences with the MIS.

Results. We will present first results of paleoclimatic reconstructions for the region based on the study of petromagnetic characteristics of the section and reflect the importance of this data for studying the evolution of the natural environment of the western part of Central Asia in the Middle and Late Pleistocene. The studied part of the section is represented by two pedocomplexes, which reflect the last two macrocycles. An analysis of the magnetic susceptibility curve made it possible to correlate the upper pedocomplex with MIS 5, and the second with MIS 7. It was found that the magnetic texture of the loess-paleosol series of Khonako-II in the upper part of the section represents a contrast record that could reflect the wind directions in the Late Quaternary.

Keywords: Tajikistan: Loess-paleosol sequences: Late Quaternary; Magnetic minerals;

Magnetic susceptibility.

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Loess magnetic susceptibility flux: A new proxy of East Asian monsoon precipitation

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Abstract: Magnetic susceptibility (χ) of loess-paleosol sequences on the Chinese Loess Plateau (CLP) has been widely used as a proxy for East Asian summer monsoon (EASM) precipitation variability. Such records typically show strong climate forcing in the ~ 100 ka orbital eccentricity band, but exhibit weak precessional (~ 23 ka) forcing relative to that seen in oxygen isotopes from marine sediments. This is puzzling as monsoons should be highly sensitive to precession variations. We assert that this lack of precessional signal is because χ is a concentration, which is strongly affected by the dilution effect of dust sedimentation rate superimposed on rainfall rate. χ -flux on the other hand corrects for dust accumulation rate and bulk density effects to better reveal pedogenic mineral ingrowth rates associated with rainfall. In this study, we compare three 600 ka records of loess pedogenic χ -flux from the CLP with Chinese speleothem $\delta^{18}\text{O}$ records and a 550 ka loess-paleosol ^{10}Be flux record from Baoji which has also been used as a monsoon precipitation proxy record. Pedogenic χ -flux exhibits clear signals of orbital precession, whereas χ (-concentration) does not.

Keywords: Pedogenic magnetic susceptibility flux; Chinese loess; Monsoon precipitation proxy; Orbital forcing

Sea-level changes constrained by coastal loess accumulations in northern China over the past 200 ka

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Abstract: Loess sequences are widely distributed in the semi-arid regions around the world, sometimes they can also be deposited in the coastal zones. The accumulations of the coastal loess could be influenced by climate and sea-level changes. Here we report sedimentological evidence from two loess sequences from the Shandong Peninsula and Miaodao Archipelago in northern China, based on high-resolution luminescence dating method. Both our quartz optically stimulated luminescence (OSL) and K-feldspar pIRIR290 signals show comparable and satisfactory luminescence characteristics up to ~100 ka, while the K-feldspar pIRIR290 ages agree well with the stratigraphic order and provide age controls up to ~200 ka. With this fully independent age model, our results reveal that this 200-ka coastal loess accumulation is episodic with a high variability in apparent accumulation rates. After comparing with global and regional sea-level records, we find that intervals with high accumulation rates coincide with low sea-level stages, and that the loess sedimentary hiatus in one of the studied sites mainly corresponds to high sea-level stages, indicating the dominant role of sea-level changes on coastal loess accumulations. We therefore conclude that regional marine regression mainly occurred during MIS 6, MIS 5b to MIS 2, with extremely low regional sea levels possibly around 150 ka, 70-60 ka and 24-37 ka, while high sea levels stood during the MIS 5e-5c and MIS 1. This study implies that coastal loess deposits with a good chronology could be used to constrain the timing of regional sea-level transgression or regression.

Keywords: Coastal loess; Sea-level change; High-resolution luminescence chronology; Paleoclimate.

Holocene moisture evolution and its response to atmospheric circulation recorded by aeolian deposits in the southern Tibetan Plateau

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Abstract: The pattern of changes in Holocene moisture conditions in the southern Tibetan Plateau (TP) and the associated driving mechanism are still controversial. Here, we present the results of an analysis of an aeolian sedimentary sequence from the Yarlung Zangbo River valley in the southern TP, which potentially provides a record of changes in moisture conditions during the Holocene, and hence changes in the atmospheric circulation process. Optically stimulated luminescence dating with the single-aliquot regeneration protocol was used to establish the chronology for this sequence, and geochemical and granulometric measurements were used to reconstruct the Holocene moisture history. The results indicate that moisture conditions were strongly influenced by the early Holocene maximum in summer insolation (30°N) and hence by the Indian summer monsoon (ISM), under which the weathering intensity was relatively high. However, at ~7.6 ka the climate abruptly became drier, probably due to the weakening of the ISM. Subsequently, with the further decrease in summer insolation and increase in winter insolation, the variations in ISM-related moisture delivery to the southern TP were regulated by the enhanced winter mid-latitude Westerlies (MLW), resulting in increasing weathering intensity. Thus, the Holocene evolution of moisture conditions in the southern TP was mainly controlled by changes in the relative intensities of the ISM and the winter MLW, which depended on the variations of summer and winter insolation at 30°N. Overall, our results provide an improved understanding of the driving mechanism of climate change in the southern TP during the Holocene.

Keywords: Climate change; Indian summer monsoon; Mid-latitude Westerlies; Aeolian sedimentary sequence; Yarlung Zangbo River

The Climate and Environment Changes in the Northeastern Iran Recorded by Loess-paleosol during the Last Interglacial

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Abstract: The Arid Central Asia (ACA) is climatically controlled by the westerlies, and this area has perennial drought, low rainfall, strong evaporation, fragile ecosystems, making the humidity changes are extremely important to the regional ecological diversity and civilization evolution. Studies have shown that in the "summer rain type" of ACA, the moisture change in the eastern ACA and the monsoonal region have an anti-phase relationship in the Holocene, and have out of phase relationship in the Last Interglacial. However, as reliable moisture changes records during the Last Interglacial are scarce, which restricts the understanding of the overall moisture change characteristics of the whole ACA. In this study, we have measured the climatic proxies such as grain size, chromaticity, magnetic susceptibility, TOC and organic carbon isotopic ratios ($\delta^{13}\text{C}$) of the sediments in the TS19 loess-paleosol profile in northeastern Iran during the Last Interglacial. The content of components with particle size greater than $40\mu\text{m}$ and less than $10\mu\text{m}$ has been used as the northern hemisphere ice volume change proxy, and compared with the SPECMAP curve that obtained after orbitally tuning the deep-sea oxygen isotopic ratio record to obtain the Last Interglacial age control point. K-feldspar pIRIR dating age have also been obtained as a reference to generate the chronology sequence of this section. Through the use of low-pass filtering and spectrum analysis, the results of climate proxies have been further analyzed to obtain more detailed climate change characteristics. The main conclusions are as follows: (1) The TS19 loess-paleosol profile in northeastern Iran has been deposited intactly since the Last Interglacial, and continuous and high-resolution climate and environmental change records can be obtained from this profile; (2) The three wettest periods in the Last Interglacial in the northeast Iran occurred at 81.7-91 ka, 101-110.7 ka, and 113-127.4 ka, respectively. However, the three low ice volume periods in the northern hemisphere indicated by the mean grain size occurred at 76.6-86.2ka, 98.5-

106.9ka and 111-124.3ka, respectively. The peak of low ice volume periods lags behind the peak of the humid periods by about 3.5-5.5 ka, and have significant phase difference. (3) There is an obvious 20,000-year precession and 10,000-year half- precession cycle in the climate change during the Last Interglacial in northeastern Iran.

Keywords: Iranian loess; Last Interglacial; Moisture change; Arid Central Asia

Variation of surface soil $^{13}\text{C}_{\text{org}}$ in the upper and middle reaches of the Yarlung Zangbo River basin, southern Tibetan Plateau, and its climatic implications

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Abstract: Understanding the origin of the stable carbon isotope composition of the organic matter ($^{13}\text{C}_{\text{org}}$) in surface soil is critical for using $^{13}\text{C}_{\text{org}}$ in geological archives to reconstruct environmental and climatic changes. However, the relationship between soil $^{13}\text{C}_{\text{org}}$ and climatic factors varies in different climatic regimes, resulting in uncertainties in climatic reconstructions. We measured the $^{13}\text{C}_{\text{org}}$ of 79 surface soil samples collected from the upper and middle reaches of the Yarlung Zangbo river basin (YZRB), southern Tibetan Plateau, in order to explore their spatial variations and environmental implications. The soil $^{13}\text{C}_{\text{org}}$ values range from -28.1‰ to -15.2‰, with an average of -22.8‰ and a modal value of around -25‰ to -23‰. Higher $\delta^{13}\text{C}_{\text{org}}$ values occur in the central part of the YZRB (Lazi-Nedong) and lower $\delta^{13}\text{C}_{\text{org}}$ values occur in the western (Gar-Lazi) and eastern (Nedong-Bomi) parts. The variations in soil $^{13}\text{C}_{\text{org}}$ are significantly correlated with altitude (with a boundary at ~3500 m a.s.l.). The co-variation of temperature and precipitation is responsible for the effect of altitude on soil $^{13}\text{C}_{\text{org}}$, with temperature (mainly warmest season temperature) being the main controlling factor above 3500 m a.s.l., and precipitation the main factor below 3500 m a.s.l. Higher absolute values of the regression coefficients for the relationships between soil $^{13}\text{C}_{\text{org}}$ and altitude (-5.1‰/km) and with mean annual temperature (+0.56‰/°C) above 3500 m may be due to the higher proportion of C_4 plants in the central part of the YZRB, making it necessary to avoid the influence of C_4 plants when using soil $^{13}\text{C}_{\text{org}}$ to reconstruct altitude or temperature. However, soil $^{13}\text{C}_{\text{org}}$ may be useful for precipitation reconstruction below 3500 m a.s.l., where C_3 plants dominate.

Keywords: Surface soil $^{13}\text{C}_{\text{org}}$; Temperature; Precipitation; Yarlung Zangbo River basin

Loess deposits in central Sweden

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Abstract: Loess deposits are common over the mid-latitudes and contain excellent records of past climate, landscape change and coarse (>5 μm) dust activity. In contrast, loess is rarely reported in Fennoscandia, but has been previously suggested to occur sporadically in central Sweden. Hörner (1927) first mapped what he suggested to be windblown loess deposits around the former glaciofluvial meltwater system at Brattforsheden. Hjulström et al. (1955) later mapped similar suspected loess deposits further north, just west of the Bonåsheden glaciofluvial delta system and aeolian dune field. However, numerous questions remain regarding the true extent and distribution of loess in Sweden, the timing of loess deposition, its relationship to other geomorphic features or sedimentary deposits, and whether these loess deposits can be used to understand past wind directions.

Here we investigate the previously reported possible loess deposits around Brattforsheden and Bonåsheden, in central Sweden. Based on detailed mapping, grain-size, SEM and quartz optically stimulated luminescence dating analyses, we confirm and extend the presence of thin (<1 m thick) windblown loess deposits at these sites. Our results imply that loess deposits in Sweden may be more common than previously believed, but also demonstrate sediment mixing and reworking in basal parts of many of these loess deposits. This may be a common feature of thin loess deposits close to former ice margins. Quartz luminescence is well suited for dating loess deposits at the sites, but ages from the mixed basal loess layers are older than expected, while ages from apparently undisturbed loess extend well into the Holocene. Taken at face value, these suggest aeolian activity and loess deposition to c. 5 ka, contrasting with the timing of main dune activity in these areas, which is constrained dominantly to the 1-3 ka post deglaciation (Bernhardson et al. 2019). Two hypotheses are proposed to explain this anomaly. One possibility is that loess deposits may record a more extended phase of periodic landscape destabilization and aeolian activity late into the Holocene in central Sweden. Alternatively, the luminescence ages from the loess may be underestimates of the true depositional age, potentially due to the effects of extensive soil formation and sediment reworking processes in these thin deposits. In any case, there is a clear topographic control on aeolian sedimentary facies, with loess covering high ground and dunes mantling valleys. Furthermore, loess deposits are only found to the south and southwest of likely glaciofluvial and dune source

areas, implying transport from the north and east. This finding contrasts with evidence for dominant NW winds based on the morphology of close by sand dunes. One possible explanation for this involves the possible effects of Ekman transport wind deflection, which would have affected higher altitude silt transporting winds, in contrast to topography-aligned surface sand transporting winds (sensu Hjulström et al. 1955).

Keywords: Luminescence; OSL; Loess mapping; SEM; High latitude dust

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Mapping the Loess Cover of Wisconsin (USA) provides insight into loess depositional and re-depositional systems, post-MIS 2

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Abstract: As part of a statewide, 1:500,000 geological mapping effort being undertaken by the Wisconsin Geological and Natural History Survey, I was charged with mapping the wind-blown sand and silt deposits of Wisconsin (a state in the Great Lakes region of the United States). The first and only other such map was produced by Dr. Francis Hole in 1951. This new project updates that map and adds considerable new detail, as shown in this poster.

Most of the loess ground truth data have been derived from loess research conducted in the field. Loess samples were collected, and loess thicknesses determined, for > 2700 stable upland sites across Wisconsin. Thus, the thickness data we present should be viewed as optimal, or maximal, values; loess thicknesses elsewhere will be thinner.

First, a map of the areal coverage of loess was developed, using soils data from the US Natural Resources Conservation Service. This map makes important distinctions between landscapes that are nearly completely loess-covered, such as western Marathon County and the southwestern part of the Driftless Area, where >80% of the landscape is loess-covered, and those where loess on stable uplands may be thick, but where most of the landscape is too steep to have retained significant amounts of loess, e.g., Buffalo, Trempealeau, and La Crosse Counties. Far more loess covers the uplands of the Gogebic Iron Range in northern Wisconsin than has been shown on previous maps. Other parts of the state contain scattered loess deposits, but only in preferred locations. This map provides a key perspective for regions where loess does not cover all of the landscape, such as at the margins of vast loess sheets. The map also provides insight into loess depositional processes, as influenced by topography, as well as areas where loess was eroded from the landscape in the immediate postglacial period. Winds during both periods were dominantly from the west-northwest.

The high density of the field data sites used to inform the loess thickness map is unprecedented. As expected, loess is thickest near the Mississippi River valley in southwestern Wisconsin, but with notable thick (> 150 cm) loess outliers, such as at the Oneota Cuesta in SE Wisconsin, and in the less of high, bedrock uplands immediately west of the Lake Wisconsin Plain. More detail is provided for areas of thin loess across the state, as compared to the previous (1951) loess map.

Keywords: Loess deposition; Loess distribution; Loess cover; Loess mapping; Wisconsin

Comparative analysis of the magnetism between Chinese and Serbian loessdeposits

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Abstract: Based on a series of rock-magnetic data from the Xifeng loess, northern China, and the Titel loess, northern Serbia, a systematic comparison regarding the magnetic properties are carried out to identify the reasons that caused the different ranges of magnetic susceptibility (χ_{lf}) enhancements from loess units to paleosol units between these two regions. Ultimately, four differences involving contents and domains of the magnetic minerals are detected. First, the different concentration of magnetic minerals, especially fine-grained ferrimagnetic minerals between the Xifeng and Titel paleosols is the leading reason. Although the factor of pedogenesis dominated the variations of magnetism for each of the loess profiles, the different degrees of pedogenesis between them seemingly cannot fully explain the different contents in magnetic minerals. We consider the difference in source distances of aeolian dust, or the related factors played a significant role in the contents of the included magnetic minerals. Second, the lower content of thermally unstable maghemite in the Titel paleosols is another important reason for the lower χ_{lf} . This difference can be attributed to different effective moisture during the courses of pedogenesis that resulted from the precipitation-evaporation difference. Third, the higher content of single-domain particles in the Titel paleosols is one of the reasons causing the lower χ_{lf} . This is an attractive point for promoting our understanding of the pedogenic mechanism under different geographical and climatic backgrounds, but the origin is still a puzzle. Finally, the higher proportion of antiferromagnetic hematite/goethite in the Titel paleosols is an element causing the lower χ_{lf} , despite that their effect is weak. The different water and heat conditions during pedogenesis maybe are responsible for this difference, and the possibility of the influence of the contemporaneous Mediterranean-like climate in the Pannonian Basin should not be excluded.

The high-resolution luminescence chronology of loess-paleosol records from central-Eastern Asia revealed differential ice volume and orbital modulation of Quaternary moisture patterns between Central and East Asia

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Abstract: The variability and interaction of the East Asian summer monsoon (EASM) and mid-latitude Westerlies have dominated Eurasian hydroclimates over orbital timescales and currently influence over a billion lives in Asia. Despite this, the extent of EASM and variation of westerlies influence the climatic changes of central-East Asia and the mechanisms influencing EASM-Westerlies variability are still a matter of considerable debate. Here we present eight loess-paleosol sequences from Tianshan Mountain-Junggar Basin and three loess-paleosol sequences from the NE Tibetan Plateau dated at high-resolution by 356 K-feldspar pIRIR and 80 quartz OSL ages to produce the most detailed and longest luminescence chronology for any loess record within the central Asia and Tibetan plateau. Combined with sedimentology, magnetic susceptibility and grain size analyses with climatic modelling (e.g., Flexible Global Ocean-Atmosphere-Land System model, TraCE-21ka model) to constrain atmospheric controls on climatic changes over the central-East Asia during the past two glacial-interglacial cycles. Our result shows that (1) The K-feldspar pIRIR dating can be used to date less from central Asia-Tibetan Plateau up to 250-300 ka. (2) Depositional hiatuses spanning few kyr to more than 50 kyr are frequently occur in central Asia loess sequences during past 250 ka, likely induced by strong erosion resulting from increased wind strength and dry-cold climate with poor vegetation cover in the region. (3) Loess at central Asia-Tibetan Plateau has shown a rapid deposition occurring during the glacial periods and very slow deposition during interglacial periods. Loess

accumulation inside glacial and interglacial periods at different locations of the site had remarkably different rates, which indicate that not only climatic changes influenced loess deposition and preservation but by complex interaction of local geomorphology, wind velocity, and changes of materials in dust origins. (4) A sharp dichotomy in moisture variation between lowland and high mountain areas. The lowland areas of central Asia are subjected to persistent aridity during past 250 ka, while highland areas clearly show dry-glacial and moist-interglacial changes. (5) Over interglacial-glacial cycles, climatic changes have shown a consistent warm-moist interglacial and cold-dry glacial conditions across central-East Asia, which is likely dominated by variation in atmospheric humidity in response to the variation of coupled ice volume and greenhouse gases on glacial-interglacial cycles. By contrast though, moisture changes in central Asia during interglacials are dominated by the intensities of Westerlies, which in turn are driven by the solar insolation gradient at 35-65 °N. This contrasts to the moisture changes in NE Tibetan Plateau and its eastern regions that the insolation forced EASM intensity strongly controls moisture changes at these regions but that EASM precipitation changes consistently lag 30 °N summer insolation by 2-5 kyr. (6) This study suggests that coupled ice volume and greenhouse gases variations dominated climatic variability in both central Asia and East Asia over glacial-interglacial cycles. However, the out of phase relationship between the intensity of the Westerlies and EASM during interglacial periods indicates that precessional forcing is responsible for differences in moisture patterns between Central Asia and East Asia. The high-latitude forcing effectively modulates Westerlies intensities, and EASM intensity and that factors such as ice volume, greenhouse gases, and freshwater input to northern Atlantic and Southern oceans critically influence monsoonal dominated East Asia paleoclimatic conditions.

Keywords: K-feldspar luminescence dating; Westerlies; East Asian summer monsoon; Climatic changes; Glacial-interglacial cycles.

Holocene moisture variations in western arid central Asia inferred from loess records from NE Iran

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Abstract: Holocene variations in precipitation in central and eastern arid central Asia (ACA) have been widely investigated, but the pattern in western ACA remains unclear. We present records of the stable carbon isotope composition of bulk organic matter ($\delta^{13}\text{C}_{\text{org}}$), magnetic parameters, and sediment color, from five loess-paleosol sequences in NE Iran, in western ACA, with the aim of reconstructing Holocene precipitation. The Yellibadragh (YE) section (the thickest among the five sequences) was selected for OSL dating of the coarse-grained quartz (63–90 μm) fraction, and its $\delta^{13}\text{C}_{\text{org}}$ record was used to quantitatively reconstruct mean annual precipitation (MAP). The record indicates a dry early Holocene (~11.8–7.4 ka), with nearly constant MAP (~93 mm), followed by a wetting trend from the mid-Holocene (~7.4 ka) onwards, with the wettest period in the late Holocene (~4.0–0.0 ka, ~390 mm). The stratigraphic observations and environmental proxies support the reconstruction. The other loess profiles show stratigraphic features and trends of environmental proxies which are similar to those of the YE profile. A dry early Holocene and wetting trend since the mid-Holocene, with the wettest climate in the late Holocene in NE Iran, are both consistent with records from sand dunes and lake sediments from adjacent areas, and with loess records from central and eastern ACA. Comparison with loess records from monsoonal Asia supports the interpretation of a “westerlies-dominated climatic regime” (WDCR) which was proposed mainly on the basis of lake sediment records from the region. Changes in solar insolation may have been responsible for the persistent wetting trend during the Holocene in western ACA.

Keywords: Iranian loess-paleosol sequence; Holocene; Precipitation trend; Western ACA

Late Miocene East Asian Summer Monsoon change recorded by Aeolian deposits of Jianzha Basin in the Northeastern margin of the Tibetan Plateau

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Abstract: Jianzha Basin is located in the northeastern part of the Tibetan Plateau and contains a thick sequence of Cenozoic sediments which are crucial for investigating the growth of the Tibetan Plateau and the record of the evolution of the Asian inland arid environment. Magnetostratigraphic results show that Late Cenozoic sedimentary sequence from the Jianzha Basin has recorded a continuous geomagnetic polarity sequence from C5r.3r to C3r, the section spans the interval from 11.8-5.8 Ma in the Late Miocene. Based on the high precision paleomagnetic dating framework and frequency susceptibility index (χ_{fd}), the cycle stratigraphy of Jianzha Basin was studied, whose results show the χ_{fd} of the deposit sediment displays a significant periodic change at around 7.2 Ma, which the record reveals that the East Asian summer monsoon (EASM) is dominated by 41 ka obliquity period before ~7.2 Ma, and controlled by 100 ka short eccentricity period after 7.2 Ma. Spectral analysis of oxygen isotope records of benthic foraminifera from the South China Sea shows strong short eccentricity period and weak obliquity period between ~5.8 and ~7.2 Ma, and strong obliquity period and weak short eccentricity period between ~7.2 and ~11.8 Ma, which is consistent with the spectral analysis of frequency susceptibility (χ_{fd}) from the Jianzha Basin. In addition, it is found that the EASM climatic transition from 100,000-year orbital period to 40,000-year obliquity period occurred around 7.2 Ma, which is similar to the climatic transition around 0.9 Ma in the Middle Pleistocene. Therefore, the climate change result will provide a new similar model for predicting future monsoon climate changes.

Keywords: Late Miocene; East Asian Summer Monsoon; Aeolian deposits; Jianzha basin; Tibetan Plateau

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Seasonality of Response to Millennial-scale Climate Events of the Last Glacial: Evidence from Loess Records over Mid-latitude Asia

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Abstract: Although difficult to resolve, seasonality is an important element in considering paleoenvironmental records and simulated results, and it is therefore critical to address this shortcoming in order to develop more accurate reconstructions of past climate. In this study, climatic proxies with seasonal implications (magnetic susceptibility and mean grain size) are analyzed for several high-resolution loess sections from mid-latitude Asia using the Ensemble Empirical Mode Decomposition (EEMD) to detect their response to millennial-scale oscillations during the last glaciation. In so doing, we are capable to estimate the amplitude and relative contribution of the reconstructed climate components. Combined with an analysis of modern processes, magnetic susceptibility (χ) can be interpreted as representing summer and spring precipitation, while mean grain size (Mz) can be interpreted as representing spring and summer dust activity in the Chinese Loess Plateau (CLP) and southern central Asia (SCA), respectively. Our results show that the spring and summer signals are clearly correlated with Heinrich events, but that the spring signal is more prominent than the summer signal during Dansgaard-Oeschger (D-O) oscillations of the last glacial. These results are consistent with modelled simulations. It is proposed that weakening or complete shutdown of AMOC influences the response of seasonal signals to abrupt climate events. The study highlights the need for further high-resolution climate proxies with robust seasonality indicators in order to develop a deeper understanding of the response of mid-latitude Asia to rapid climate events.

Keywords: Seasonality; Abrupt climate events; Late Quaternary; Mid-latitude Asia; Ensemble Empirical Mode Decomposition

Reflectance spectra of Late Miocene Sediments from the Jianzha Basin in Northeastern Margin of the Tibetan Plateau and their Paleoclimatic Significance

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Abstract: Climate change has always been one of the hot spots of research in the field of earth sciences. Various explorations and studies have been carried out on the methods of paleoclimate reconstruction. The evolution of the Earth's environment is extremely complex, it is usually necessary to compare and verify several indicators in order to make a correct judgment on the evolution of climate and environment. Some scholars have made more detailed studies on the evolution of paleoclimate by improving the resolution of weathering indicators, and some scholars have sought new paleoclimate indicators to reflect the evolution of climate and environment. Spectroscopy is a rapidly developing science that can obtain important information about mineralogy with little or no sample preparation, and it is rapid, inexpensive and non-destructive. Here, we use the reflectance spectroscopy to extract paleoenvironmental information from the Miocene red clay deposits of the Jiarang section in the Jianzha Basin in the northeastern margin of the Tibetan Plateau. We obtained visible/near-infrared and short-wave infrared spectroscopy data and analyzed their relationship with records of magnetic susceptibility and clay mineral content from the section. The results show that increases in visible/near-infrared spectral parameters such as D500, D900 (where D represents the depth of the corresponding absorption peaks) reflect decreases in weathering and pedogenesis under a dry and cold climate and they are more sensitive to temperature than precipitation. Short-wave infrared spectral parameters, including AS1400, D1400/D1900 and D1900 (where AS represents the asymmetry of the corresponding absorption peaks) are correlated with clay mineral indicators, with increases in D1900 indicating reduced weathering intensity, while increases in AS1400 and D1400/D1900 represent increased weathering. The SWIR parameters are more sensitive to the weathering intensity. The variations of spectral parameters are consistent with independent paleoclimatic records in the Jiarang section, which demonstrates their utility as paleoclimate proxies in red clay deposits. Age profiles of these spectral parameters are consistent with the global marine $\delta^{18}\text{O}$ record and applicable as paleoenvironmental indicators.

Keywords: Reflectance spectra; Red clay; Paleoenvironmental reconstruction; Late Miocene; Northeastern Margin of the Tibetan Plateau

Endemic evolution and Ice age refugia in a thermal lake at the fringe of a loessy landscape during the Late Glacial and the Holocene

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Abstract: Understanding the mode, speed and underlying reasons of endemic evolution in ancient ecosystems is a key issue of modern paleobiological, paleoecological research. Lacustrine paleoenvironments are especially ideal for such purposes. On the one hand, their restricted size hosting numerous habitats as well as rapid changes in habitat conditions favors genetic isolation and speciation. On the other hand, lacustrine deposits are ideal agents for preservation of faunal as well as geological, geochemical records. Mollusks are one of the key groups with numerous endemics occurring in long-lived lakes.

Microcolpia parreysi (Phillipi, 1847) is a relict gastropod taxon restricted to a single thermal spring-fed lake in northwestern Romania. The nature reserve includes three ponds and a rivulet with thermal water at roughly constant 30° C temperature. The largest of the ponds Lake Petea, a small, thermal lake is home to many endemic taxa including the beautiful tropical night blooming waterlily *Nymphaea lotus varietas thermalis* or the referred gastropod. Recent geological and paleoecological investigations at Lake Petea complemented by ¹⁴C dates have elucidated a unique evolution of the pond and its fauna since the last ice age. According to these findings, during the last ice age a thermal rivulet emerged turning to a shallow, well-lit, oligotrophic pond rich in dissolved carbonate and other salts. This pond with water temperatures ranging between 15-23°C harbored several warmth-loving freshwater gastropod taxa including the prevalent SE European *Fagotia acicularis* and the subordinate Pannonian *Theodoxus prevostinianus*. The pond itself thus was a refugee to these warmth-loving taxa during the ice age. During the Holocene the prevailing gastropod taxon was replaced by a new taxon *Microcolpia parreysi*. Based on morphological, morphometric as well as genealogical analyses, *M. parreysi* seems to be an ecophenotype of the older *Fagotia acicularis*. The emergence of this new taxon during the Holocene is related to hydrogeological changes in the pond system due to reactivation of faults bringing about a drop in the water level on the one hand. In addition, an increase in water temperatures to values above 30°celsius occurred. This resulted in a bottleneck effect favoring the evolution of the new endemic taxon *M. parreysi*. Recent human activities related to sewage reposition, thermal water extraction for personal use and agricultural activities have resulted in the extinction of this taxon in 2014. Research has been carried out within the framework of University of Szeged, Interdisciplinary Excellence Centre, Institute of Geography and Earth Sciences, Long Environmental Changes Research Team. Support of the Ministry of Human Capacities, Hungary NKFIH Grant 12926, Grant 20391-3/2018/FEKUSTRAT and GINOP-2.3.2-15-2016-00009 'ICER' is acknowledged.

Keywords: Refugia; Endemic evolution; Thermal lake; Late Glacial; Holocene

Global climate change and East Asian dust sources: combined rutile geochemistry and zircon U-Pb analysis from Baode, Chinese Loess Plateau

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Abstract: The Neogene-Quaternary aeolian dust deposits (Red Clay and loess) on the Chinese Loess Plateau (CLP) are valuable records of past climate and environment changes. Constraining the provenance of these deposits provides crucial information on long-term links between climate and dust evolution in East Asia. Despite its importance, the CLP dust provenance and its possible changes at the Mio-Pliocene and Plio-Pleistocene global climate transitions remain debated. Uncertainties derive partly from the complex dust cycle of Central-East Asia, where dust is transported stepwise from multiple mixed sources that cannot be differentiated explicitly with bulk sediment analysis methods, and partly from ambiguities related to interpretations of single-grain detrital zircon U-Pb data. Furthermore, dust provenance changes can result from both global- and regional-scale processes, which also operate on different time scales, complicating interpretation. To tackle these complexities, here we use multiple single-grain provenance proxies at high sampling resolution to analyse the provenance of the 6.91–2.64 Ma Baode Red Clay. Baode is located on the marginal northeastern CLP, closer to the northern dust source areas and likely less influenced by pre-depositional recycling of the dust than the sites on the southern or central CLP. Our data consists of joint detrital rutile trace element geochemistry and detrital zircon U-Pb ages of the Baode Red Clay as well as detrital rutile geochemistry data from 14 potential sedimentary source areas. The data indicate that the Mio-Pliocene and Plio-Pleistocene global climate transitions were coupled with gradual dust provenance changes. We also identify multiple shorter, including geologically abrupt, periods of provenance variation, caused by regional and/or global environmental changes. Implications of our results not only shed light on the wider causal mechanisms of dust emission and deposition in the late Cenozoic, but also verify that a multiproxy single-grain approach is needed for reliable provenance analysis of the CLP dust.

Keywords: Red Clay; Detrital rutile; Detrital zircon; Multiproxy single-grain provenance; Late Cenozoic climate change

Multimillennial paleoenvironmental, temperature variations and aeolian dynamics of the past 1 My inferred from a multiproxy study of the thickest, best resolved independently dated loess/paleosol record from SW Hungary

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Abstract: An overview of the results of a comprehensive study of grain-size (GS), geochemical and mollusk-based paleoecological data of one of the best developed (ca. 100 m) and longest loess/paleosol profile of the Carpathian Basin dating back ca. 1 Ma is presented. The chronology of the sequence is built on biostratigraphically controlled independent magnetostratigraphic ages beyond 50 ka down to 1.1 Ma. ¹⁴C ages helped to constrain the chronology in the youngest part of the sequence. The continuously sampled sequence provides us an exceptional resolution of local paleoclimatic variations at ca. 3 kys. Spectral analyses of the grain-size (GS) variations indicate that climatic dynamics are dominated mainly by the changes in orbital eccentricity and sub-dominantly by obliquity over the past ca. 1 million years with varying strength. These are moderately strong from 900 to 600 kys. Glacial-interglacial paleotemperature differences are likewise moderate (3-4°C). The decrease in both glacial and interglacial temperatures from 800 ka to 500 ka is minimal (1-2°C) in line with gradually increasing global CO₂. The mildest glacial is MIS 12, which is also the one with the highest concentration of global CO₂. In general, paleotemperature data is congruent with that on humidity inferred from mollusks. Hygrophilous taxa are dominant throughout all glacials, while interglacials are clearly prevailed by xerophilous taxa from 1 Myr. MIS 11 is the warmest interglacial after which glacial- interglacial temperature differences are doubled (ca. 5-7 degrees). The strongest 100 kyr periodicities in GS are noted after 400 kys also. As in the Chinese profiles the 400 kyr GS cycles tended to be weaker than the 100 kyr ones in the entire profile. The warmest glacial after the Mid-Brunhes transition is MIS 4. A comparison of our paleoclimate record with other coeval regional and extraregional paleoclimate records for the past 1 Ma revealed strong teleconnections with the expansions of the NH ice sheets, North Atlantic, western Mediterranean margin and SE Europe. Research has been carried out within the framework of University of Szeged, Interdisciplinary Excellence Centre, Institute of Geography and Earth Sciences, Long Environmental Changes Research Team. Support of the Ministry of Human Capacities, Hungary grant 20391-3/2018/FEKUSTRAT and GINOP-2.3.2-15-2016-00009 'ICER' is acknowledged.

Keywords: Loess/paleosol sequence; Paleoenvironment; Aeolian dynamics; Middle & Upper Pleistocene; Hungary

Temperature dependence of pedogenic magnetic mineral formation in loess deposits

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Abstract: Loess sequences provide some of the most important continental records of climatic change, and various pedogenesis proxies from Chinese loess deposits have provided humidity records for the Miocene through Holocene. Among these proxies, magnetic properties have often been used to reconstruct paleoprecipitation; however, an increasing number of studies have recognized that magnetic records from loess deposits are also influenced by temperature and hence they can be used to reconstruct paleotemperatures. Our study, the magnetic characteristics of modern loessic soils and loessic paleosols from six regions, including Niger, Spain, Tajikistan, Xinjiang, Loess Plateau, Zhejiang, spanning a broad climatic gradient were studied to investigate the temperature dependence of the pedogenic production of magnetic minerals. The results indicate that the magnetic characteristics are dependent on the temperature of particularly season, rather than mean annual temperature in temperate region. The findings can potentially provide insights into changes in climatic seasonality on geological timescales.

Keywords: Loessic soil; Seasonal dependency of magnetic mineral formation; Hematite; Magnetite; Temperature

Microcharcoals witness the Holocene vegetation history across the Loess Plateau and its implications on the plant management

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Abstract: Located in the marginal zone of the East Asia Summer Monsoon (EASM) and bordered by major desert areas, the environment and vegetation in the Loess Plateau are sensitive to climate change. As the world's largest ecological restoration project, the Grain-for-Green Program (GFGP) has achieved a great success in increasing the vegetation cover on the Loess Plateau. However, the complicated climate, soil types, and dense population here make it an investigating question that the priority and adaptability between forest and grassland. A long-timescale perspective of the Holocene will provide a reference to this issue. The vegetation type in the Loess Plateau during the Holocene is a controversial issue and impedes the understanding of the paleo-vegetation change in this area. Microcharcoals are the product of incomplete combustion of plants, especially the L/R ratios (L: sub-long type microcharcoal; R: sub-round type microcharcoal) can indicate the vegetation type (grass or wood) burned in the wildfire, thus can be used as an ideal index for wildfire history (i.e., fire intensity and/or frequency) and vegetation evolution. In this study, we obtained 431 samples from 5 sections across the Loess Plateau, to establish the wildfire history and vegetation type during the Holocene. The results show that wildfires difference among sections, the wildfires in LC (Luochuan) and JJ (Jinjie) sections remained relatively frequent with strong fluctuations, in LT (Lingtai), XG (Xigao) and WY (Weiyuan) sections show an overall increase during the Holocene. This may be attributed to spatial heterogeneity and human activities. Whereas, a consistent trend of increasing during the early Holocene, decreasing during the late Holocene, and reaching the peak in the Holocene megathermal exist in the L/R ratios in these 5 sections. Otherwise, the synthesized L/R records across the Loess Plateau are correlative to the precipitation driven by the EASM. Therefore, we infer that humid conditions might have played a dominant role in the evolution of the ratio between grass and wood, which means that the vegetation in the Loess Plateau is mainly grass, especially during the Holocene megathermal, which was supported by the previous studies including pollen and C₄/C₃ records. It possibly provides inspiration for the information policy formulation, sustainable future management, and maintenance of the GFGP achievements to mitigate climate change.

Keywords: Microcharcoal; Holocene vegetation; The Loess Plateau; Wildfire

Geological features of Quaternary loess and its significances

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Abstract: Loess and paleosol sequences are widely distributed over the world, and more and more studies on paleoclimate based on loess records are reported in recently years. The loess/paleosol characteristics, such as magnetic minerals, pedogenic horizons, particle size and so on, are found varying with climatic zoning. However, loess as a fully mixture aeolian dust, the distribution pattern of rare earth elements is thus very similar to the component of upper Earth crust. Loess aeolian origin is gradually recognized mainly since the last 7 decades, implying that reddish aeolian deposits of loess and paleosols with perfect bedding/pedogenic horizon, carbonate nodules or/and carbonate beds, were normally recognized as water-lain in origin before that age, many red deposits (red beds) in earlier geological age were also known as lake or marine sediments. Recent days loess-paleosol is fully accepted as product of aeolian deposit, evidently such origin of the red beds with older geological age should be re-recognized based on the features of Quaternary loess and paleosols.

Keywords: Loess-paleosol; Aeolian; Water-lain; Red beds; Sedimentary origin analysis

Late Quaternary wind erosion of Chinese loess and proximal desert evolution recorded by the accumulation of aeolian deposits on the southeastern margin of the Mu Us dune field

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Abstract: The alternating loess-paleosol sequences on the Chinese Loess Plateau (CLP) are one of the most important terrestrial archives of past climate variability and global atmospheric circulation, providing important information on the dust cycle and dust-climate interactions at various timescales. Understanding the nature of loess deposition and the processes that could affect these are critical for establishment of the relationship between relevant loess proxies and paleoclimatic changes. However, they have not been particularly investigated in detail within loess-based climatic reconstructions. Here we investigate two aeolian sequences on the southeast margin of the Mu Us dune field using integrated analyses on stratigraphic variability and climatic proxy, including grain size (GS), magnetic susceptibility (MS) and loss of ignition (LOI). Combined with the quartz optically stimulated luminescence (OSL) and K-feldspar post-IR Infra-Red stimulated luminescence (IRSL) techniques supporting reliable chronologies for sections, we suggest that the Mu Us dune field existed at least during the late Middle Pleistocene, approaching the studied area before 230.1 ka and being fixed during 230.1-225.4 ka. However, during the MIS 5d period, the Mu Us dune field expanded southwards, accompanied by strong erosion and depositional hiatuses. Our results showed that the typical loess distributed in the upwind areas relative to the modern CLP, and acted as an important homogeneous source of the leeward loess deposition due to wind erosion during glacial period. This process complicated the interpretation on applied proxies of loess sedimentary sequence and should be considered in using these proxies to recover the history of climate and dust changes.

Key words: Desert marginal CLP; Aeolian sedimentation; Deposition processes; Mu Us dune field; Late Quaternary

Loess in the Southeastern Margin of the Chinese Loess Plateau as a Record of the Yellow River Evolution and Human Disturbance

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Abstract: Variations in susceptibility, grain size or accumulation rates of eolian sequences in the Sanmen Gorge entry and exit points and on the Loess Plateau were compared at different time scales. Synchronous changes in multiple proxies occurred during the formation of S14/L14 at different locality. However, the accumulation rates and magnetic properties were different between the sections in S2 or above, implying that there was significant difference in the proximate source for the gorge entry and exit points. It is suggested that the linking of the middle and lower reaches of the Yellow River occurred at around 1.2 Ma (million years ago) after progressively incising the gorge, while the acceleration in loess accumulation at 0.2 Ma can be attributed to its strong incision in the middle reaches and further channelization in the study area. By contrast, the Holocene loess at Sanmenxia bears no significant imprint of local floodplain formation. Multi-disciplinary investigation of the Sanmenxia loess suggests that human impacts began to increase soil erosion on the Chinese Loess Plateau since the middle Holocene. In addition to the accelerating soil erosion being decoupled from drying climate after 4 ka, renewed intensification of soil erosion was suggested to occur within the interval 1.5-2.5 ka as a result of enhanced human activities. Such a temporal pattern is similar to that of the intensification of pastoralism revealed by Lake Gonghai in the northeastern margin of the plateau.

Keywords: The Chinese Loess Plateau; The Yellow River; The Sanmen Gorge; Soil erosion; Environmental magnetism

OSL Chronology of Tora River's Aeolian Profile in the Qaidam Basin, China

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Abstract: Aeolian sediments are widely distributed in the Qaidam Basin, northeastern Qinghai-Tibetan Plateau. Aeolian sediments are ideal information carriers for studying the environmental evolution of the basin. In this study, we use single aliquot regeneration protocol of Optically Stimulated Luminescence (OSL) and combine with comprehensive analysis of grain size and elements, to study the natural aeolian profile (TLH) exposed by river downcut in the lower Tora River, Qaidam Basin. Results showed that aeolian sand accumulation in this region started at 70.45 ka BP, this may be due to the river downcutting caused by the Gonghe Tectonic Movement (the third phase of Qinghai-Tibetan Plateau uplift, since 150 ka BP), which provided deposition space and sand source for the accumulation of aeolian sand. 60.87-70.45 ka BP, the climate was cold-dry, and 68.87-70.45 ka BP appeared dating results inversion, the wind was strong, which resulted in the ancient dunes activated. 60.87-58.56 ka BP, the sedimentary environment was humid relatively, the characteristics of fluvial deposits were obvious. 58.56-38.89 ka BP, the climate alternated between arid and humid, and freeze-thaw fold layer and aeolian sand layer developed. Topography, sand source and climate comprehensively affected the formation of climbing dunes above this profile, and the ancient dunes activated and fluvial deposits were the main sand sources.

Key words: Aeolian sediments; Qaidam Basin; Luminescence dating; Climbing dune

Clay mineralogy of the Stari Slankamen (Serbia) loess-paleosol sequence during the last glacial cycle — Implications for dust provenance and interglacial climate

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Abstract: Clay minerals in loess-paleosol sequences carry important information on dust source and the paleoenvironments of the areas of loess distribution. The loess-paleosol sequences in the Serbian part of the Carpathian Basin are among the most complete Quaternary terrestrial sedimentary sequences in Europe. However, relatively little is known about the origin and temporal variations of clay minerals in these deposits and their paleoclimatic implications. Here we present the results of high-resolution XRD clay mineral analysis of the Stari Slankamen loess-paleosol sequence through the last glacial cycle, at a 10 cm-interval in paleosol and a 20 cm-interval in loess horizons.

XRD analysis was carried out using a PANalytical X'Pert PRO X-ray diffractometer with CuK α radiation, operating at 40 kV, 40 mA, at Taishan University. Slides were scanned from 3.5° to 50.0° 2 θ with a step size of 0.013° 2 θ for MgCl₂-saturated samples under air-dried (Mg-AD), ethylene-glycol-saturated (Mg-EG) and glycerol-saturated (Mg-G) conditions, and for KCl-saturated samples under air-dried conditions (K-AD) followed by heating to 400 °C (K-400 °C) and 550 °C (K-550 °C). To distinguish chlorite (0.354 nm) from kaolinite (0.358 nm), the range of 24.0–26.0° 2 θ was also measured with a step size of 0.004° 2 θ and a scan speed of 0.006°/s. Semi-quantitative estimates of peak areas of the basal reflections for the main clay mineral groups of smectite (including illite-smectite mixed-layers) (1.7 nm), illite (1.0 nm), and kaolinite/chlorite (0.7 nm) were carried out on the Mg-EG curve using the MacDiff software.

The results show that illite (range of 27–63%, average of 42%) and smectite (including illite-smectite mixed-layers, range of 9–49%, average of 32%) dominate the clay fraction, while chlorite (range of 12–22%, average of 17%) and kaolinite (range of 6–13%, average of 9%) are less abundant for the 12.70-m thick section. The roughly constant composition of the clay minerals within the loess unit and most of the paleosols suggests that the clay minerals are of detrital origin and that pedogenic transformation has only occurred in the lower part of paleosol V-S1, which corresponds to the climatic optimum of Marine Isotope Stage (MIS) 5e. This

provides a basis for addressing several important issues regarding the Carpathian Basin loess deposits, including its provenance, glacial dust activity, and the interglacial climate. The smectite-rich characteristic of the glacial loess provides a diagnostic indicator for confirming local sources for the Carpathian Basin loess deposits, and that these sources made little contribution to the dust deposited in Greenland during the last glacial. The first application of illite crystallinity and the chlorite ratio to the Carpathian Basin loess-paleosol sequence suggests that they are more sensitive indicators than the clay mineral proxies previously used in European loess studies. The enhanced precipitation during MIS 5e indicated by the new proxies and the transformation of clay mineral potentially provide new insights into understanding the regional climatic response to future global warming.

Keywords: Loess; Carpathian Basin; Clay mineralogy; Last glacial cycle; Provenance

Paleosols in Upper Devonian red-beds from northwest China and their paleoclimatic and paleoenvironmental characteristics

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Abstract: Paleosols have been discovered in the Upper Devonian (Famennian) Shaliushui Formation in the eastern North Qilian Mountains, and are recognized by evidence of root traces, soil horizons and soil structures. Root traces are remnants of substantial woody plants, reaching deeply within profiles as clayey infills and as drab-haloed root traces. Soil horizons include thick layers of large calcareous nodules (Bk horizon), and subsurface accumulations of clay (Bt horizon), and slickensided claystone (vertic Bw horizon). Soil structures include blocky peds and calcareous nodules. The nodules and drab-haloed root traces formed syndepositionally during the Upper Devonian, because they were also observed in clasts of paleosol and nodules in fluvial conglomerates interbedded with the paleosols. Analyses for Rb/Sr and Ba/Sr ratios and magnetic susceptibility measurements confirm that the more strongly developed paleosols with larger calcareous nodules and higher clay content are also more chemically differentiated. Moderately developed paleosols with progymnosperm trees reaching heights of height 9.7 m formed on well drained floodplain environments, weakly and very weakly developed paleosols with shorter vegetations were closer to streams and other sources of disturbance. The distribution of drab-haloed root traces in paleosols show closed canopy dry woodlands and desert shrublands ecosystems in the Upper Devonian. This suite of paleosols is evidence of semi-arid to sub-humid, highly seasonal climate under dry woodlands and shrublands. Paleosols of the Shaliushui Formation are a potentially valuable archive of Upper Devonian palaeoclimates and paleoenvironments of northwest China.

Keywords: Paleoclimate; Paleoenvironment; Geochemistry; Shaliushui Formation; Upper Devonian

Spatially variable provenance of the Chinese Loess Plateau

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Abstract: Loess sequences of the Chinese Loess Plateau (CLP) compose one of the most complete Neogene–Quaternary terrestrial paleoclimatic archives. Understanding the CLP's sediment sources is critical to tracing Asian aridification, atmospheric circulation patterns, and Asian monsoon evolution. Commonly, the sediments that compose the Quaternary strata of the CLP are considered largely homogeneous, and thus numerous studies have applied a uniform source model when attempting to use CLP-derived proxies as paleoclimate indicators. Here we present large-n detrital zircon U-Pb geochronology data from the Quaternary CLP. These data support spatial variability in sediment provenance across the CLP. At least three distinct provenance zones are recognized for Quaternary loess strata: central western, eastern, and northeastern. These zones received sediment primarily from their neighboring river systems. This finding conflicts with the classic views that attribute the Quaternary loess principally to the deserts north and west of the CLP. We conclude that fluvial processes, and thus precipitation, played an important and previously underemphasized role in Quaternary dust production in northern China. Furthermore, nonuniformity in CLP Quaternary sediment provenance raises questions about the validity of using paleoclimate information archived in the CLP to make sweeping regional interpretations.

Keywords: Loess; Provenance; Zircon U-Pb ages; Spatial variation

Aeolian-fluvial interaction sequence indicates landforms process in the Paiku Co basin, central Himalayas

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Abstract: Aeolian and fluvial processes are important factors for shaping landforms, but are largely studied in isolation despite there being many locations where both processes are interacting and influencing each other. Here we use Optically Stimulated Luminescence (OSL) dating and sedimentological analysis to provide an interpretation of interrelated Holocene fluvial and aeolian process on Paiku Co basin, central Himalayas. The pIR50IR170 ages for K-feldspar could identify the pronounced periods of high river levels of Daqu at 5-4.5 ka BP. During this period, as temperature rising, glacial meltwater intensified, Daqu rivers were at unstable higher levels. While a transient rise in lake level of Paiku Co. at 4.5-4.0 ka BP, river levels were falling and wind forces were in domination, thus, the sand in the river channel is blown towards the river bank, indicating a cooler and drier climate. As a result, aeolian-fluvial interaction was primarily driven by climate change in the Paiku Co basin.

Spatial and temporal provenance variations of the Chinese Loess Plateau over the late Miocene to early Pleistocene: a window into the reorganization of the Yellow River and monsoon activity

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Abstract: The Miocene–Holocene Red Clay, paleosol, and loess sequences composing the Chinese Loess Plateau (CLP) are one of the most complete terrestrial eolian sediment archives on Earth. We present the first large-n detrital zircon U-Pb geochronology dataset for the Miocene–Pliocene sequence from the northeastern CLP. The depositional ages of these samples are like those of other data sets from the central CLP, allowing comparison of spatial-temporal differences. These data show that the CLP had spatially varied provenance over the late Miocene–Pliocene, similar to the Quaternary strata. The data from the northeastern CLP indicate two shifts in dust sourcing around the Miocene–Pliocene and Pliocene–Quaternary boundaries. The shift around the Miocene–Pliocene boundary is consistent with elongation of the proto-Yellow River to incorporate the present-day ‘big bend’—allowing sediment transport to and ultimately through the Yinchuan–Hetao graben. The provenance shift around the Pliocene–Quaternary boundary is consistent with increased sediment contributions from the Lüliang Shan and the Cretaceous strata overlying the North China Craton. These interpretations challenge assertions linking eolian sediment accumulation on the CLP over the late Miocene–Pliocene primarily to aridification within the continental interior of eastern Asia, but rather point to the importance of riverine transport, catchment reorganization, sediment storage, and increased climatic fluctuations.

Keywords: Provenance; Red Clay; Zircon U-Pb ages; Yellow River; Chinese Loess Plateau

Paleoclimate implications documented in a luminescence-dated palaeosol from the Chinese loess over the penultimate interglaciation

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Abstract: Knowledge of past climate changes in the Central Shandong Mountains (CSM) obtained during astronomical simulations of the current interglacial period may help us understand future climatic patterns. However, few studies have explored the penultimate interglacial (S2) period compared to the existing research on the Holocene (S0) and last interglacial (S1) periods. The absolute ages and palaeoclimatic implications during the penultimate interglacial palaeosol and whether the climate was arid during the time of glaciation in the currently humid and semihumid areas are still unclear. In this work, the luminescence ages and paleoclimate proxies in the Dongheishan (DHS) section were studied. Multi-elevated-temperature post-infrared infrared-stimulated luminescence (MET-pIRIR) dating results were obtained in the DHS section (90 ka-250ka). The palaeosol ages during S2 and S1 were derived almost continuously based on luminescence ages on the orbital scale, indirectly suggesting that the study area was arid during the glacial loess sedimentation periods. The analysed chroma and magnetic susceptibility results suggest that the weathering intensity of the palaeosols in the last interglacial period was stronger than that in the penultimate interglacial period; this finding was also supported by the measured percentages of particles below 2 μm . Furthermore, the median grain sizes and contents of particles larger than 63 μm in the loess-palaeosol deposits located in the lower reaches of the Yellow River indicate variations in the proportions of proximal materials in the total deposition flux. The utilization of luminescence ages and multiple proxies can provide a reference for researching the pattern and evolution of palaeoatmospheric circulation in East Asia.

Keywords: Palaeosol; Luminescence; Central Shandong Mountains; Climatic patterns; Penultimate interglacial period

Leachate lithium content records paleoclimate change during the last glacial-interglacial cycle on the Loess Plateau of China

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Abstract: The substances in the loess-paleosol leachate, as the variable components in weathering, can record the geochemical information of the soil formation after the accumulation of aeolian dust. Silicate weathering on the surface releases a migratory element, Lithium (Li). Under heavy precipitation, Li will migrate downward with the soil solution, and clay minerals will absorb part of the Li in the paleosol layer. However, it could enrich the original layer due to evaporation. To better understand the geochemical element behaviour during the last glacial-interglacial cycle, inductively coupled plasma mass spectrometry (ICP-MS) was used to analyse the leachate lithium of loess-paleosol samples from two different latitudes during the same depositional period. Leachate lithium content was determined and compared with magnetic susceptibility, mean grain size, carbonate content, Rb/Sr ratio and CIW (Chemical Index of Weathering). The leachate lithium content showed low values presented in the loess layers of both profiles (Luochuan and Weinan), and high values appeared in the palaeosol layers. The result indicated that the leachate lithium content has excellent potential in the climate change characteristics of the entire last glacial-interglacial cycle sequence, especially be consistent with the millennium-scale Heinrich cold event and the five sub-levels of the fifth stage of the marine oxygen isotope (MIS 5a, b, c, d and e). It revealed that the lithium content of leachate is more sensitive to the global climate change driven by ice volume. The leachate lithium content displayed similar frequencies and amplitudes to the magnetic susceptibility when indicating the pedogenesis and East Asian summer monsoon precipitation in the Loess Plateau at different latitudes during the same period, which seems to imply that the leachate lithium content could trace to the pedogenesis and precipitation in the targeted area. Therefore, the leachate lithium content of loess-paleosol could be regarded as a sensitive and reliable proxy to characterise high-resolution climate change during the last glacial-interglacial cycle.

Keywords: Leachate lithium content; Loess-paleosol sequences; The last glacial-interglacial cycle; Paleoclimate change; Evaporation

Holocene dust storm variations over northern China: transition from a natural forcing to an anthropogenic forcing

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Abstract: Asian dust storms have long been a major environmental concern in China, affecting the lives of about one billion people. However, it is unclear whether the mechanisms responsible for Asian dust storms during the Holocene varied on different timescales, and thus it is unclear whether there was a shift from a natural forcing to an anthropogenic forcing of dust storms. We reconstructed a high-resolution Holocene record of dust storms from the sediments of an undisturbed alpine lake on the Chinese Loess Plateau. We found that Asian dust storm activity generally increased during the Holocene, with the largest fluctuations occurring during the past 2000 years. The increase in dust storm activity was in contrast to the decrease in East Asian winter monsoon (EAWM) intensity during the Holocene, indicating that the EAWM played a limited role in modulating dust storms. By contrast, the increase in dust storms corresponded to a decrease in East Asian summer monsoon (EASM) precipitation. This demonstrates that EASM precipitation was the dominant control of dust storm activity on a millennial timescale, because decreased EASM precipitation expanded the desert area and thus increased the dust storm activity. The increasing intensity of human activity in the region since the Bronze Age resulted in an acceleration of dust storm activity against the background of decreased EASM precipitation. As human disturbance continued to intensify, beginning at least at ~2 cal ka BP, increased dust storms were closely linked to increasing human populations in the dust source regions, and there is a strong temporal coherence between increased dust storms and higher EASM precipitation. This was completely different from when natural processes are dominant. During that period, fewer dust storms occurred during periods of a strengthened EASM. Therefore, there was a shift from a natural forcing to an anthropogenic forcing of dust storms on a multi-decadal to centennial timescale, and was a mode in which “human activity overtook the EASM as the dominant control of the Earth surface system”.

Keywords: Asian dust storms; East Asian summer monsoon; Human activity; Northern China; Early anthropogenic hypothesis

High-resolution optically stimulated luminescence ages of monsoon records over the last glacial-interglacial cycles from the loess of the Chinese Loess Plateau

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Abstract: Chinese loess has always been considered a good carrier of continental paleoenvironmental records of glacial-interglacial climate variations. However, the ages of the Pleistocene/Holocene boundary are controversial and range from ~20 ka to ~8 ka based on luminescence dating of loess from the Chinese Loess Plateau (CLP). Here, with the recently developed Bacon age-depth model, we present high-resolution quartz optically stimulated luminescence (OSL) ages from the Xifeng CLP site that extend back to 50 ka. The results indicate that the loess accumulation was continuous over the last glacial-interglacial cycles on orbital timescales, supporting assertions of the CLP paleosol were aggradational soils. Bacon age-depth modelling of the OSL ages was utilized to obtain an age framework. The boundary age of the Pleistocene/Holocene palaeosol from the Xifeng section is ~10 ka based on the OSL Bacon age-depth model. Magnetic susceptibility, grain sizes and chroma examination with OSL ages show apparent broad agreement with the timing of the last glacial maximum (LGM) and Heinrich 1 and 8 ka cold events, implying that the climate change processes of the continent and ocean are basically synchronous.

Keywords: Chinese loess; OSL dating; Last glacial time; Pleistocene/Holocene boundary; Climatic events

Large-number detrital zircon U-Pb ages reveal global cooling caused formation of Chinese Loess Plateau during Late Miocene

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Abstract: The formation of the unique landscape of Chinese Loess Plateau (CLP) is debated because of uncertainties on dust provenance and transport pathways. We present a detailed quantitative estimation of dust source contributions of the CLP, based on more than 37,100 detrital zircon U-Pb ages, combined with mineral assemblages and isotope analyses. Our results reveal that the CLP was stepwise formed by ~8 Ma, and is mainly composed of material from Northeastern Qinghai-Tibet Plateau (NQTP), with increased dust contributions from NQTP occurring at ~2.5 Ma and ~1.2 Ma, and the CLP was formally established. We infer that these changes were driven by stepwise global cooling, which induced aridification and enhanced silt production in glaciated high mountains, the NQTP, as well as dust ablation in the expanded arid regions. We propose that the global cooling, rather than regional tectonic deformation, was the main driver of the formation and evolution of the CLP.

Clay mineralogical and geochemical record from a loess-soil sequence in Chinese Loess Plateau during the past 880 ka and the implication on the East Asian Summer Monsoon

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Abstract: The loess-soil sequences in northern China provide an ideal near continuous record of Quaternary paleoclimate in East Asia. There is an almost continuous Quaternary loess-soil and red clay sequence in the Shaozhai Section, which located in the southeast of the Lingtai District, Pingliang City, Gansu Province. The upper 60 m of the loess-soil sequence in the Shaozhai Section consists all layers from L9 to S1. To reveal the evolution history of the East Asian Summer Monsoon (EASM) during the past 880ka in the southern Loess Plateau, 84 samples are collected from L9 to S1 loess-soil sequence in the Shaozhai Section. In this paper, the clay mineral assemblages, and geochemical elements of clay-fractions and microcharacters of clay minerals were analyzed by using X-ray diffraction (XRD), and X-ray fluorescence spectroscopy (XRF) and scanning electron microscope (SEM) methods, respectively. Our results show that clay-fraction minerals are mainly composed of illite, vermiculite and a small amount of HIM (1.42 nm mixed-layer minerals), smectite (including of I/S) and kaolinite in the loess-soil sequence. The chlorite is absent in all samples of L9-S1 in the Shaozhai section, which is different to the clay mineral assemblages of other areas in the Chinese Loess Plateau. More illite is present in soil layers than those loess layers, and smectite (I/S) is absent in all soil layers above S5. SEM and geochemical characters of clay-fractions show that illite is mainly derived from aeolian debris, some detrital illite has transformed to vermiculite and some illite is newformed from the weathering of primary minerals (e.g. feldspar, mica) during local pedogenic weathering with the leaching of K element. The relationships between clay mineral assemblages and geochemical elements show that the content of K element in clay-fractions is highly related to illite. Therefore, the chemical weathering indexes (e.g. CIA, PIA) related to K element are not suitable for paleoclimatic reconstructions due to multi-sources of illite. Smectite (I/S) and kaolinite are mainly derived from primitive aeolian debris, and smectite (I/S) is much unstable and can be transformed to HIM with the intense of local pedogenic weathering degree; vermiculite and HIM are new-formed clay minerals under local climatic weathering conditions. The elements of Na, Fe and Mg in clay-fractions are correlated to

vermiculite, HIM and smectite (I/S), which are mainly controlled by the chemical weathering degree, therefor, CIW' and TFe_2O_3/MgO of clay-fractions from the loess-soil sequence can well record the variation of the paleo-weathering intensity. The CIW' and TFe_2O_3/MgO indexes of the past 880 kyr show that the EASM varied with the alternation of interglacial-glacial period on the orbital scale, and increased significantly at ~850 ka, ~620 ka, ~550 ka, ~420 ka and ~127 ka, respectively. The variation of the EASM during the past 880 ka possibly affected by the global climate changes related to orbital parameters, ice sheet, CO_2 concentrations.

Keywords: Chinese Loess Plateau; Clay minerals; Clay-fraction geochemical indexes; The paleo-weathering intensity; East Asian Summer Monsoon

Size-dependent geochemical characteristics of loess sequence from the Central Shandong Mountainous region: Implications for the provenance of eolian deposits in China

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Abstract: The loess of Shandong Province is distributed in the transitional zone between land and sea, as the eastern edge of Chinese loess. It is an important component of the East Asian eolian deposition system and records the paleoclimatic and environmental changes in the monsoon region. The Gaozhuang section (36°10'27"N, 117°36'58"E) is located on the fluvial terrace from the Muwen River in Gaozhuang Village, Laiwu, Ji'nan City, Shandong Province. The exposed thickness of the profile is about 1020 cm, with typical loess-paleosol characteristics. Here we combined end-member modelling of grain-size distributions with major elements, after optically stimulated luminescence (OSL) dating, to reconstruct sedimentary environments and transport mechanisms. The results show that: (1) The OSL ages of the Gaozhuang section ranged from 2.26 to 77.91 ka, suggesting that sediments were mostly deposited since the late Pleistocene. (2) The grain-size components of the sediments in this section were divided into four end members: EM1 (first mode grain size 0.56 μm) represents the mixed clay component of pedogenesis and transported sediment; EM2 (first mode grain size 6.32 μm) represents the fine silt component transported by the high-level westerly wind over long distance. EM3 (first mode grain size 17.83 μm) represents material that settles as floating dust; EM4 (first mode grain size 35.57 μm) represents the silt component transported via low-level suspension by the local wind systems. (3) The Gaozhuang loess is dominated by the major elements of SiO_2 , Al_2O_3 and Fe_2O_3 , which is in primary chemical weathering stage and has high consistency with other loess provenance in central Shandong. (4) According to the climatic proxies such as the grain-size end-member content, major elements, magnetic susceptibility and chromaticity, combined with the results of OSL, this effectively indicated the stage change and differences of the sedimentary environment in the Gaozhuang section since the late Pleistocene and reflected the regional response to global climate change.

Keywords: Loess; End-member analysis; Geochemistry; Provenance; Palaeoclimate

A physical weathering control on the aeolian-dust Fe bioavailability

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Abstract: Iron (Fe) is an indispensable element for marine life, which impacts oceanic primary productivity and thus the atmospheric carbon dioxide (CO₂) and global climate. One aspect of the global iron cycle that has received little attention concerns the controlling mechanisms of the bioavailable Fe in terrestrial dust and sediment, which are important iron sources to living things in many region of the ocean. Here, we examine the landscape-scale link of Fe bioavailability in aeolian dust with various potential controls (physical and chemical weathering, climate and geology) using a compiling data from 10 Chinese deserts. Our results show that physical weathering relative to chemical weathering and source geology controls the Fe bioavailability in the dust sources. Thus, it is important to consider the role of high physical processes (e.g. mountain uplift) in Fe fertilization and biotic CO₂ cycling.

Keywords: Global iron cycle; Aeolian dust; Physical weathering; Carbon cycle; Chinese desert

Effect of plant roots on radiocarbon dating results in arid central Asia

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Abstract: Radiocarbon dating and OSL dating are two main approaches in dating aeolian deposits in arid central Asia (ACA). Mutual verification of these two methods has been conducted in previous studies. Previous results showed ¹⁴C ages are not reliable beyond 25 kyr age range comparing to OSL dating approach. Besides the common ¹⁴C dating materials as humin component, the total organic carbons or snail shells that had been applied in previous researches, a pyrolysis-combustion technique of ¹⁴C dating was applied on the ACA loess deposits in this study. ¹⁴C dates of the pyrolysis volatile (Py-V) and pyrolysis residue (Py-R) fractions at 800 °C were obtained. The comparison of pyrolysis volatile dates, pyrolysis residue dates, humin dates and total organic carbons dates were conducted on two loess sections (Hoalin section in western Pamir Mountain and TLD16 section in northern Tianshan mountain) in ACA. Furthermore, the ¹⁴C dates were compared with the correspondingly OSL ages. It was proposed that various dating materials result in different ¹⁴C ages. Besides, the underestimation of ¹⁴C age to OSL age was encountered in whole ¹⁴C age range. By regional comparison in ACA, it is proposed that the possible reasons for the underestimation was the elongation of plant roots that grew in arid area which caused sample contamination of ¹⁴C dating material.

Keywords: ¹⁴C dating; Pyrolysis-combustion technique; OSL dating; Plant roots elongation; ACA

Holocene temperature variations recorded by the loess-paleosoil sequence from the Ganjia Basin in the northeastern Tibetan Plateau

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Abstract: In the context of the global warming, the research on global and regional Holocene temperature evolution is significant for understanding present temperature variations and for predicting future climate change. Meanwhile, there is still a conundrum that the contradiction on Holocene global temperature variations since last deglaciation, which is a hot topic need to be addressed urgently. In the present study we show a GDGTs-based mean annual temperature (MAT) record from a loess-paleosoil sequence (BSY19A) from the Ganjia Basin in the northeastern Tibetan Plateau during the past ~14,000 years. The reconstructed temperature record shows that the Younger Dryas (YD) interrupted the warming trend during the last deglaciation, and that a long-term lower temperature persistently occurred during the early Holocene (12-8 ka). The temperature rose rapidly after 8 ka and reached its highest level during 8-4 ka, followed by a cooling trend since late Holocene (4 ka). By comparing the temperature driving factors of solar radiation, ice cover, and atmospheric CO₂ content, we suggest that the early-Holocene melting of the high-latitude ice sheets may depress the early Holocene temperature in the northeastern Tibetan Plateau. Our study provides an important temperature evidence for the pattern of paleotemperature and precipitation variations in the northeastern Tibetan Plateau.

Keywords: Holocene; Northeastern Tibetan Plateau; Temperature; GDGTs; Loess

Dust accumulation process determined via grain size end-member modelling of Xifeng loess over the last interglacial on the Chinese Loess Plateau

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Abstract: The loess distribution on the Chinese Loess Plateau (CLP) is the most typical example worldwide, providing a complete documentation of Quaternary glacial- interglacial cycles. Nevertheless, quantitative studies on the provenance of CLP loess via grain size end- member (EM) modelling are scarce. Through parameterized EM analysis of the grain size, the sources of different grain size components, sedimentary dynamic processes and sedimentary environments were separated considering complex sediments of Xifeng loess on the CLP since the last interglacial period. The results indicated that the grain size dataset could be subdivided into five EMs. The modes of EM1, EM2, EM3, EM4 and EM5 were 0.8, 6, 24, 31 and 59 μm , respectively. Among these EMs, EM1 represents the pedogenic and weathering component, and the proportion could reach 4%; EM2 reflects distant-source aeolian sedimentation, with a content of 36%; EM3 comprises near-source sedimentation (32%); EM4 indicates a change in the East Asian winter monsoon intensity (22%); and EM5 represents local-source storms (6%). The above grain size EM combinations of Xifeng loess could notably reflect the sedimentary dynamic combination process, which is significant in palaeoclimate change reconstruction and a reliable carrier for research of global palaeoclimatic characteristics.

Keywords: Xifeng loess; End-member analysis; Last interglacial; Dust accumulation; Grain size

The evolution history of the Asian monsoon and westerly winds over the past 14 ka: evidences from the grain size of ash in the Hongyuan peat on the northern Qinghai-Tibetan Plateau

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Abstract: The relationship between the Asian monsoon and westerly winds (WWs) at different timescales is still under debate. The Zoige wetland in the northern Qinghai-Tibetan Plateau is sensitive to climate change, and sediments from this region can be used to explain the atmospheric circulations varying characteristics. The grain size composition of ash in the Hongyuan peat HY2014 profile from the Zoige wetland were measured with high-resolution. Combined with the application of end member (EM) model, we reconstruct the evolution history of atmospheric circulations since the last deglaciation. The significances of each EM were determined based on the frequency of the EMs and environmentally sensitive grain-size component analysis. The composition of ash in the sediments from HY2014 profile is mainly silt, and the grain size frequency curves of sediments from different depth are mainly bimodal. Three end-members were inverted from the grain size data of ash in the Hongyuan peat. Among them, EM1 represents long-distance suspension materials from distal sources, EM2 represents the sediments of short-distance brought by low-altitude circulation, and EM3 represents sediments with shorter transport distance than EM2. EM1, EM2, and EM3 reflect, respectively, WWs, Asian summer monsoon (ASM), and Asian winter monsoon (AWM). The WWs was positively correlated with the ASM, and almost showed a synchronous varying trend, while the WWs was inversely related to the AWM. During the last deglaciation period, the AWM was the predominant circulation, while the WWs and ASM were weak; in the early Holocene, the AWM weakened, while the intensity of ASM and WWs increased; during the middle Holocene, the WWs and ASM still played dominant roles, while the AWM further weakened. After 2800 cal. a BP, the WWs and ASM became stronger and varied significantly, and the intensity of AWM slightly increased. Furthermore, this study also shows that the variation of each atmospheric circulation system is mainly controlled by solar activity since 14 ka BP.

Keywords: Zoige wetland; Peat ash; End member model; Atmospheric dust accumulation; Last deglaciation

Cenozoic Asian dust provenance changes linked to the Tibetan Plateau uplift

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Abstract: The arid interior of Asia is the largest source of dust deposited in the North Pacific Ocean, and some dust is even transported to Greenland. Investigating the provenance history of Asian dust can provide strong constraints on the evolution of topography and climate in the Asian interior. Eolian dust Nd isotopic records preserved in North Pacific Ocean sediments since ~40 Ma provide a spatially integrated first-order constraint on the provenance changes of Asian dust. However, a lack of similarly long dust Nd isotopic records from Asian dust source areas, namely, the northern Tibetan Plateau and the Central Asian Orogenic Belt, has hindered a full understanding of Asian dust provenance changes linked to the Cenozoic evolution of tectonics, climate and topography in inland Asia. Here, we have constructed the first fine-grained and whole-rock Nd isotopic records from sediments deposited on the northern Tibetan Plateau since ~52 Ma. The results indicate two major changes, a gradual increase in ϵ_{Nd} values between ~42 Ma and ~25 Ma and a general decrease since ~25 Ma, which were probably caused by the incremental northward growth of the Tibetan Plateau. Further mass balance estimates based on comparisons between the Nd isotopic characteristics of dust from the northern Tibetan Plateau and the North Pacific Ocean indicate that a rapid increase in the contribution of the Central Asian Orogenic Belt to Asian dust at ~25 Ma can be closely linked to rapid exhumation caused by tectonic uplift and aridification in inland Asia. Our provenance analyses, together with the onset of eolian sediment in central and eastern Asia, suggest that a modern-like regime promoting Asian dust emissions and transport might have been in place since the late Oligocene.

Keywords: Tectonic uplift; Central Asian drying; North Pacific Ocean; Tarim Basin; Xining Basin

Late Pleistocene dynamics of dust emissions related to Westerlies in northern Central Asia: New insights from quantifying loess provenance in the North Tian Shan

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Abstract: Loess, as the geological record of dust, is a promising archive to explore paleoclimate evolutions and source-to-sink fluctuations of aeolian dust in the Westerly-dominated Central Asia (CA). However, the physical connections between the mid-latitude Westerlies and loess deposition in CA were still not fully established. In this study, based on trace element analyses of the Nilka (NLK) loess section, we used sediment source fingerprinting (SSF) and random forest (RF) to quantitatively restore loess provenance changes in the Ili Basin in North Tian Shan, CA, covering the past 71ka. The results suggested that piedmont slopes and alluvial-proluvial plains within the Ili Basin and in SE Kazakhstan and North Kyrgyzstan provided the primary source materials for the NLK loess (averaging ~80%), with less contribution of deserts in SE Kazakhstan (~20%). The SSF results are verified by the RF model. The temporal variations of the source contributions suggest that the Westerlies-linked moisture transport controlled by both obliquity and precession forcings and thus the source strength has modulated the long-term loess accumulation in the Ili Basin. The analyses also demonstrated the operation of changes in intensity and position of the Westerlies on supply of fine-grained sediments for the NLK loess. Variations in Westerly intensity influenced by the strength of the Atlantic meridional overturning circulation (AMOC) play a key role in transporting fine-grained aeolian deposits to the NLK section during MIS3 and MIS4. While southward shift of the mid-latitude Westerlies caused by redistribution of the global configuration of latitudinal climatic zones forced by the higher northern hemispheric ice

volume could have limited delivery of fine particles to the NLK section during MIS2. In conclusion, quantifying loess provenance changes in the North Tian Shan represents one potential approach for resolving the relationships between dust cycles and climate systems. Additionally, based on the SSF and RF results, this study attributed the less proportion of desert sediments in the NLK loess to scarce replenishment of fine particles and inefficient aeolian abrasion of coarse grains in the deserts. Overall, this study enhances the current knowledge regarding the interrelations between the mid-latitude Westerlies and loess deposition in the North Tian Shan, a place sensitive to large-scale atmospheric reorganizations, which offers an important benchmark for longer-term palaeoclimate reconstruction based on proxies of CA loess.

Keywords: Central Asia; Tian Shan; Loess deposits; Westerlies; Last glacial

Critical altitudinal shift from detrital to pedogenic origin of the magnetic properties of surface soils in the western Pamir Plateau, Tajikistan

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Abstract: Sedimentary archives of the westerlies-influenced Pamir Plateau in Tajikistan, a climatically sensitive region in arid central Asia (ACA), provide information on past climatic changes and the tectonic evolution of the northern Tibetan Plateau. However, due to the scarcity of meteorological stations, knowledge of the recent precipitation history of the region is limited. In this study, we conducted a detailed rock magnetic investigation of 34 surface loess samples from the western Pamir Plateau. The results show that on the windward side, below an altitude of ~2100 m a.s.l., the concentration of magnetic minerals initially decreases and then begins to increase with increasing altitude. Below ~2100 m a.s.l., the surface soils are enriched in multidomain (MD) magnetite particles, suggesting a detrital origin of the magnetic minerals, whereas above this altitude the samples are enriched in fine superparamagnetic (SP) magnetite/maghemite grains of pedogenic origin. The inferred variations in pedogenic intensity, combined with analysis of the available meteorological data and the content of organic matter and clay, support the occurrence of an altitudinal threshold separating a predominantly detrital control on surface soil magnetic mineral assemblages from a predominantly pedogenic control. Within the plateau interior, the surface loess samples exhibit low and uniform values of magnetic concentration parameters and organic matter and clay content, which is attributed to the decreased supply of moisture from westerly sources because of the rain shadow effect. Our results indicate that rock magnetic investigations can be used to define a critical climatic boundary in ACA.

A Combined Rock Magnetic and Meteorological Investigation of the Precipitation Boundary Across the Tibetan Plateau

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Abstract: Characterizing the spatial distribution of precipitation across the Tibetan Plateau (TP) is important for understanding how the topography and atmospheric circulation influence the climatic patterns of the region. We collected 143 surface soil samples from the central and southeastern TP (SETP) for rock magnetic characterization of the spatial distribution of the pedogenic intensity. Comparison with meteorological data shows that pedogenic intensity decreases significantly along the pathway of moist air across the SETP toward the interior, and that there is a positive correlation between pedogenic magnetite/maghemite content and mean annual precipitation. By contrast, the samples from the central TP show a low degree of pedogenic alteration, consistent with the limited precipitation within this area. The results indicate the possibility of using magnetic properties of surface soils to determine the precipitation distribution in areas lacking meteorological stations. These observations, combined with published soil magnetic results, help to define the climatic boundary in the TP.

Keywords: Surface soils; Rock magnetic; Meteorological data; Precipitation boundary; Tibetan Plateau

Developing the uranium comminution age and its applications in aeolian system

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Abstract: Deciphering the aeolian source of Chinese loess is essential to understand the mechanisms of dust production and transportation, to interpret paleo-environment records in the aeolian deposits, to predict the environmental impact of atmospheric dust, and to facilitate the control of modern dust emission. One of the major challenges of tracing the aeolian source is associated with the traditional geochemical tools that could only reflect the composition or ages of the eroded rocks but can hardly discriminate the differing production mechanisms and transportation pathways for the dust with the same petrological source. As one of the rapidly developing isotopic tracing methods in recent years, the activity $^{234}\text{U}/^{238}\text{U}$ ratio of fine-grained ($\leq 50\ \mu\text{m}$) materials can record the time since the breaking of particles due to the effect of alpha-recoil of the ^{238}U decay series, which may provide a new tool to resolve the production and transportation of aeolian dust.

We first successfully tested the uranium comminution age model using the loess deposits collected from the Chinese Loess Plateau (CLP), and investigated the effects of complicating factors, such as weathering dissolution, surface characterization, and precipitation of authigenic phases, on the uranium comminution age. On this basis, we then use the uranium comminution age to trace the provenance of Chinese loess, including the loess deposits in the CLP, eastern China and northeast China, and to constrain the mechanisms of desert silt production.

Keywords: Uranium isotopes; Aeolian system; Comminution age; Source tracing; Silt production

Present-day and historical dust emission from northern China associated with climate change and land-use management

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Abstract: Dust cycle is actively involved in the Earth's climate and environmental systems. Identifying dust sources and investigating the causes of dust emission are crucial not only to understand the comprehensive picture of dust cycle, but also to interpret the preservation of dust (loess) as paleoclimatic records. This study first investigates the spatiotemporal pattern and recent trend of dust emission from China and Mongolia using remote sensing techniques. A relatively long satellite-based time series of dust activity from 2001 to 2020 has been obtained, and it reveals that the Tarim Basin, Gobi and Qaidam Basin Deserts are three major dust sources in East Asia. It also finds that dust activity in northern China has been substantially reduced, and this trend and its pronounced interannual variability can be linked with recent changes in both climatic conditions and land-use management. Secondly, we use dune sedimentary records to reconstruct historical dust emission from one typical semi-arid dune field in northern China. It is found that dust emission has diminished significantly around 300 years ago because of policy-driven vegetation rehabilitation and dune stabilization. However, changes in human land-use since about 200 years have resulted in dune reactivation, and a large amount of dust was released due to erosion of pre-existing soil surfaces. These results indicate that dust emissions both during the historical period and at present in northern China are strongly influenced by climate change and land-use management. It also implies that the combined effects of climate change and human interference should be considered when evaluating the future potential of dust emission from these regions.

Keywords: Dryland environment; Dune activity; Dust emission; Dust sources; Remote sensing

Statistical analysis of tropical-cyclone-induced remote precipitation in Henan Province, China during 1961 and 2015

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Abstract: Tropical cyclones in the Western North Pacific could affect China directly through disasters caused by high winds and heavy rainfall, and could also indirectly impact the precipitation in the mid-latitudes of China beyond the closed circulation of tropical cyclones (thousands of kilometres), i.e., tropical-cyclone-induced remote precipitation, through interactions with the westerly circulation and topography. Extreme weather events at mid-latitudes associated with tropical-cyclone-induced remote precipitation could bring serious disasters. For example, the extreme rainstorm event in Zhengzhou, the capital city of Henan Province, on July 20, 2021, brought extremely serious loss of life and property to local residents. To further expand our knowledge on the tropical-cyclone-induced remote precipitation, we use NCEP1 reanalysis data to statistically analyse the characteristics (path, intensity and frequency) of the Northwest Pacific tropical cyclones that triggered remote precipitation in Henan Province from June to September during 1961 and 2015, and further discuss their remote impacts on the precipitation in Henan Province, focusing on the related variations of circulation and water vapour transport. The tropical cyclones triggering remote precipitation in Henan Province from 1961 to 2015 mainly occur in July (42.6%) and August (34.0%), with the maximum wind speed larger than the fresh gale. Those tropical cyclones could be divided into four clusters of paths, giving priority to the cluster of the westward moving path. The remote precipitation triggered by tropical cyclones in the Western North Pacific is heavier in the southern and eastern parts of Henan Province than that in the north-western and south-eastern parts, which may be related to the regional mountainous topography. The tropical cyclones in the cluster of the westward moving path provide the largest moisture transport for remote precipitation in Henan Province, resulting in the largest average single process rainfall for remote precipitation, together with the low pressure center located in Hainan Island and the Western North Pacific subtropical high extending more westward. To better forecast the tropical-cyclone-induced remote precipitation in Henan Province, it's necessary to pay attention to the tropical cyclones in the cluster of the westward moving path and focus on their interaction with the mid-latitude westerly jets and Western North Pacific subtropical high.

Keywords: Tropical cyclone; Remote precipitation; Henan Province; Western North Pacific subtropical high; Westerly jet

Pedogenesis and paleoclimate significance of Late Quaternary loess in Kashmir Valley: Evidence from stratigraphy, chronology, and geochemistry

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Abstract: The aeolian-derived terrestrial loessic-paleosol sequences (LPS) are widespread across the globe and are considered important archives for the reconstruction of the late Quaternary-Holocene climate shifts on spatio-temporal scales. Although high-resolution paleoclimate records of LPS are reconstructed from Europe and East Asia, there records remain elusive from the Indian subcontinental regions, particularly from the Kashmir Valley, Northwest Himalayas. We provide here an overview of the pedogenesis and paleoclimate significance of loess-paleosol units studied in the Kashmir Valley using multiproxy records (bulk geochemistry, clay mineralogy, stable isotope composition of soil organic matter ($\delta^{13}\text{C}$ SOM) and pedogenic carbonate ($\delta^{18}\text{O}$ SC), and mineral magnetic parameters) since the MIS4. These LPS occur as thin veneers and display the development of several polycyclic palaeosol units across the Kashmir Valley providing clues to reconstruct past environmental shifts. The maximum thickness (~22 to ~24 m) of these LPS is seen along the southwestern fringe of the Kashmir Valley and tapers towards the northeastern part of the valley (~4 to ~5 m). A detailed study on the provenance and comparisons of these loessic sediments reflects a basic rock composition likely sourced from the local lithology of the Panjal traps. Further, the loessic sediments seem to have undergone various degrees of chemical alterations and leaching resulting in weak to moderately weathered palaeosol development. An overall $\delta^{13}\text{C}$ SOM value of -26.19 to -22.47‰ do not indicate any rapid shift from C₃ to C₄ vegetation in the Kashmir Valley, although short periods of dwindling Indian Summer Monsoon and the westerlies favoured a dominance of C₄ vegetation cover. The prevalence of moderate climate conditions from 65.8 ± 7.2 ka to 44.3 ± 5.8 ka and strong pedogenic alteration between 43 ka to 34.7 ± 2.3 ka is observed. The loess deposition in the valley corresponds to greater wind strengths (reduced monsoons) while the pedogenic paleosols represent the periods of stable and ameliorated climatic conditions (enhanced monsoons) and both these phases reveal a lead-lag effect. The records indicate that the last deglaciation in Kashmir began around ~14ka BP at 1600 to 3000m altitude and also support the recent global evidence of deglaciation that began several millennia before the Holocene period. The paleoclimate shifts in the LPS presented here tie well with the Guliya ice core $\delta^{18}\text{O}$ records, high lake water levels in the Tibetan Plateau, and other LPS records in China.

Keywords: Kashmir Valley; Late Quaternary; Loess-paleosol; Pedogenesis; MIS4

Holocene variations of hydroclimate and dust activity as recorded in lakesediments in the northern margin of East Asian summer monsoon

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Abstract: Basin-closed lakes in the desert-loess transitional zone in northern China, located in the northern margin of the East Asian summer monsoon, are ideal archives in documenting hydrological climate and dust activity, and thus may provide insights into the effect of future warming on hydroclimate and dust activity. Here we present a well-dated and high-resolution record of grain-size, carbonate minerals and $\delta^{18}\text{O}$ values from Lake Bayanchagan (41.64°N, 115.21°E) since 11.2 cal. ka B.P. Using grain-size end-member analysis, three end-members (EMs) are distinguished and linked to different sediment transport processes. EM1 (1–7.5 μm) and EM2 (5–60 μm) represent variations of local hydraulic conditions and relatively lake level during the times of deposition; while EM3 (75–270 μm) indicates the strength of regional dust activity for its mode is similar to that of local aeolian dunes. The precipitation and oxygen isotope composition of carbonate minerals in closed lakes are mainly controlled by salinity and $\delta^{18}\text{O}$ values of lake water, respectively. As salinity increases, calcite precipitates first, followed by aragonite and dolomite. The lake water $\delta^{18}\text{O}$ values are dependent upon the balance between precipitation and evaporation. Increased monsoonal precipitation produces lower water $\delta^{18}\text{O}$ values while evaporation results in higher $\delta^{18}\text{O}$ values.

The results show that there is a strong similarity between carbonate $\delta^{18}\text{O}$ values and grain-size curves, implying that fluctuations of lake level and dust activity were related to monsoonal precipitation. From 11.2 to 10.2 cal ka B.P., an increase in the portion of EM1 and EM2, and decreases in EM3 content and carbonate $\delta^{18}\text{O}$ values suggest increased precipitation and lake level, and decreased dust activity. The high lake level associated with enhanced monsoonal precipitation occurred between 10.2 and 6 cal. ka B.P., reflected by higher percentages of EM1 and EM2, and decreased carbonate $\delta^{18}\text{O}$ values. After 6 ka, EM1 and EM2 dropped while EM3 and $\delta^{18}\text{O}$ values increased, together with the presence of dolomite and decreased content of calcite, indicating that the gradual decline in lake level and an increase in dust activity were correlated to reduced monsoonal precipitation.

Keywords: Holocene; East Asian summer monsoon; Grain size; Carbonate; Lake level; Dust activity

An empirical study on the variability of luminescence ages for coeval loess samples

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Abstract: An increasing number of studies exploit the advantages of a single-aliquot regenerative-dose protocol (SAR) for equivalent dose determination with sampling at relatively closely-spaced vertical intervals (of the order of 10-30 cm). The resulting ages are, at least in principal, ideally suited for age-depth modelling. The modelling, however, is made difficult owing to the variety and complex combination of uncertainties associated with luminescence dating. Moreover, we previously reported on a variability in age results for coeval loess samples that is significantly larger than expected and remains to be understood.

In this study, we examine this problem explicitly by observing the degree of precision and accuracy that can be achieved by luminescence dating of multiple coeval loess samples of known age. The main goal is to improve our understanding of how luminescence ages are to be incorporated into age-depth models, thus increasing their robustness and accuracy.

Fourteen samples were taken at closely-spaced horizontal intervals from loess deposits immediately over- and underlying the Campanian Ignimbrite/Y5 tephra layer ($40\text{Ar}/39\text{Ar}$ dated to 39.2 ± 0.1 ka), as exposed at a section in the Lower Danube Basin in southeastern Europe. Luminescence analyses were carried out using the single-aliquot regenerative-dose (SAR) protocol and OSL signals from 63-90 μm quartz fraction. We report an average age of 47 ± 2 ka for the seven samples collected below the tephra layer and 42 ± 3 ka for the seven samples collected above it. The individual random and systematic uncertainties contributing to the individual ages vary from 2.4 % to 5.6 % and from 6.0% to 6.1 %, respectively. We obtain an improved overall precision on the age of the sedimentary context by calculating the weighted average age and combining the individual random and systematic uncertainties following Aitken (1985, Appendix B). Thus we report weighted average ages of 46 ka and 41 ka for the horizontally sampled sediment layers intercalating the ash layer and associated overall random uncertainties of 1.5 % and an overall systematic uncertainties of 6.1 %. The insights gained from this are discussed in relation to age-modelling studies of luminescence-dated paleoclimate archives, and loess deposits in particular.

Keywords: Luminescence dating; Precision; Random uncertainty; Quartz

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The structure of the Early Pleistocene paleosols of the Alchak-Sedlovina section (the Crimean Peninsula)

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Abstract: The loess cover is one of the main archives reflecting landscape and climatic changes in the Quaternary. This paper proposes a study of the loess-paleosol Alchak-Sedlovina section, located on the southern coast of the Crimean Peninsula. The uniqueness of the Alchak-Sedlovina section is that it is located in the mountainous part of the Crimea, where detailed studies of paleosols have practically not been carried out. The loess-paleosol sequence (LPS) of the section is represented by three paleosols (PS-1AS, PS2-AS and PS3-AS), the profiles of which are superimposed on each other, they are crowned by the modern Cambisol. The LPS study will expand knowledge about the structure and development of the paleosols of the Crimean Mountains. Multi-proxy analysis with detailed sampling will make it possible to classify the paleosols type and compare them with modern soil analogues. Based on this, we will be able to reconstruct the landscape and climatic conditions that prevailed in this area in the Early Pleistocene.

The Alchak-Sedlovina section is morphologically described according to the FAO. The color of the deposits was determined using the Munsell color system on a fresh section wall. Sampling for laboratory analysis was performed continuously with a step of 4 cm. Magnetic susceptibility in field was measured with a PIMV kappameter with same interval. A total of 51 bulk samples were taken for physical and chemical analyses. The 10 bulk samples were taken from each paleosol horizon for morphoscopy of sandy quartz grains. Soils were described according to IUSS Working Group WRB 2014.

The investigation of the LPS of the Alchak-Sedlovina section showed that in the mountainous part of the Crimea, the paleosol sequence is quite distinctly preserved, represented by paleosols of the Cambisols type. Two automorphic soils: PS1-AS - Calcic Cambisol (Argic), PS3-AS - Cambisol and one hydromorphic soil PS2-AS - Gleyic Cambisol. In the section, the LPS is underlain by the V Perchem terrace, the age of which makes it possible to correlate the studied paleosols to starting from MIS 17 and younger one. On the territory of the East European Plain, paleosols of this age with a reddish color are associated with the Vorona paleosol complex (MIS 13/15).

During the formation of the lower part of the LPS profile (PS2-AS, PS3-AS), coarse clastic material was introduced. Later, the climate became drier and warmer, steppe, similar to the modern one; during the formation of the PS1-AS, such a climate dominated for a much longer

time, but erosion processes were activated, which removed the humus horizon of the soil.

During soil formation, the stability of sedimentation was preserved. The main agent for the formation of the LPS was aeolian transport as a source of silty material, according to granulometric analysis data. According to the morphoscopy data of quartz grains, slope processes and temporary streams were the agents of sandy material. An insignificant number of grains with eolian signs and traces of eolian processing indicates the stabilization of eolian processes during the redeposition of the material. The predominant unrounded and slightly rounded grains of sandy material with glossy and quarter-matte surface types indicate that during the formation of the LPS, additional material was introduced from a nearby source a mountain range. In the study area in the interval MIS 13/15, paleosols were formed under conditions of warm steppes or forest-steppes with periodic moistening and often local stagnation of moisture; in the cold season, there was slight freezing of the surface.

Keywords: Soil; Loess-paleosol sequence; Interglacial; Changing of the climate

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Late Quaternary loess in the Ciscaucasia (South of Russia): distribution, composition, and source of mineral dust

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Abstract: One of the largest loess areas on Earth is located in the south of the East European Plain. The greatest loess thicknesses (up to 140 m) were observed in the southern part of the plain – the piedmont of the Caucasus Mountains: this region is called the Ciscaucasia. It has dimensions of 600x300 km and covers the plains between the Sea of Azov and the Caspian Lowland. Loess overlaps the interfluves and high river terraces. The age of loess reaches 700–800 ka and contains 5–7 complexes of interglacial paleosols (Velichko et al., 2012).

The Late Pleistocene loess thickness is highly variable, from 5 to more than 20 m (Mazneva et al., 2021). However, the nature of this variability is still not clear. There is no consensus on the sources of mineral dust and the main directions of its transport. Also, the issue of changes in the rates of loess accumulation during the warm and cold phases of the late Pleistocene and Holocene has not been fully studied. We analyzed our own and published data on the structure, composition, and age of the Late Pleistocene and Holocene loess in the region. Based on 25 boreholes and cross sections, a map of spatial changes in thickness and grain size distribution of loess was compiled. The average rates of sedimentation and the content of the sandy fraction are calculated for the main climatostratigraphic units of Late Quaternary - from MIS 5 to MIS 1.

As a result of our analysis, a clear trend of a decrease in loess thickness from east to west was revealed, as well as a decrease in particle size. The explanation for this is the presence of huge massifs of sandy deserts in the east of the region - in the Caspian Lowland. The sand in these deserts is the reworked alluvium of the Volga, Terek and Kuma rivers, as well as marine deposits of the Pleistocene transgressions of the Caspian Sea. In an arid climate, these sands are blown away by strong East winds, and masses of mineral dust are transported far to the West, as far as the Sea of Azov. This process is also observed at the present time in form of strong dust storms moving from East to West in autumn and spring (Mazneva et al., 2021). We also observed an anomalous increase in the thickness and sand content in the loess near wide sections of the valleys of large rivers (tens of kilometers) - Don and Kuban. Terraces of these rivers are a secondary (local) source of mineral dust.

We found that during cold stages of MIS 4 and MIS 2, the average rates of loess accumulation were about 1.5 and 2.5 times higher, respectively, than the average rates during warm stages of MIS 5, MIS 3, and MIS 1. The content of sand in loess horizons corresponding to cold stages of MIS 4 and MIS 2 is on average ~1.3 times higher than in the soils of warm horizons (MIS 5, MIS 3, and MIS 1). The growth of aridization in cold stages led the expansion of the area of

dust sources due to the degradation of the vegetation cover and drying of the substrate. An increase in the production of mineral dust in the areas of deflation entailed an increase in the sedimentation rate in the areas of accumulation. And the increase in wind speed in cold stages provoked an increase of the sand fraction in loess. An important but secondary factor in the change in the area of dust sources could be a change in the level of marine basins (Caspian and Black seas).

Keywords: Caucasus Mountains; Late Pleistocene; Aridization; Dust; Paleosols

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Paleo-Loess from the Late Paleozoic of Eastern Equatorial Pangaea

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Abstract: The thickest (>1000 m) loess deposits in Earth history date from the upper Carboniferous-Permian in equatorial Pangea. Ancient loess deposits from the late Paleozoic world signal perhaps the dustiest atmosphere in Earth's history, and archive important paleoclimatic factors that enabled the generation, transport, and accumulation of such voluminous silt deposits. As dust is both an archive and an agent of climate change, understanding the origin and extent of loess deposits in the late Paleozoic world provides valuable information for climate models (past and present). Loessites are well-recognized in western equatorial Pangaea (western-midcontinent U.S.) and recently in the Lodève Basin, France (eastern equatorial Pangaea) as well. Here, thick successions of exclusively fine red mudstone (the Salagou Formation) are interpreted to record loess deposition sourced by rapid, physical erosion of local Variscan paleohighlands, supporting the controversial hypothesis that the Central Pangean (Variscan) Mountains may have been glaciated. And while the Salagou Formation may represent the most complete, and perhaps oldest deposit of Permian loess in western Europe, we speculate that similar facies attributes of correlative fine-grained "playa" and "floodplain"-interpreted deposits in late-Variscan intramontane rift basins across western Europe (e.g., Germany, Morocco, Spain, Italy) may be unrecognized paleo-loess deposits. Here, we present preliminary results of our further investigation into other French basins—the Dome de Barrot (southern French Alps) and St. Affrique (central France)—to test this working hypothesis and document the nature and extent of Permian dust deposits in western Europe (eastern equatorial Pangaea). If this material indeed records dust and loess deposition, it implies widespread dust generation that increased substantially near the peak of the Late Paleozoic Ice Age.

Keywords: Loess; Permian; Equatorial Pangea; Late Paleozoic Ice Age

Provenance and paleoclimatic implications of loess deposits in Shandong Province, eastern China

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Abstract: The extensive loess deposits in Shandong Province in eastern China potentially provide valuable insights into past environmental changes. However, their precise provenance and paleoclimatic implications are unclear. We studied three loess sections located in the piedmont of the Central Shandong Mountains (PCSM) and in an offshore island in Bohai Gulf. The loess sequences have thicknesses of 1.1–7.5 m, and contain 1–3 visible paleosol units. Optically stimulated luminescence (OSL) dating shows that the loess sediments in the PCSM accumulated mainly since the Last Glacial Maximum, while the offshore loess-paleosol sequence accumulated since the last interglacial interval. Both the glacial loess and interglacial paleosol units are characterized by a coarse grain size that are similar to those of loess in the central part of the Chinese Loess Plateau (over 600 km northwest of Shandong loess areas), indicating a proximal sediment source. Using the “grain size–transport distance” model established for the Chinese Loess Plateau, the estimated source-sink distance is ~200–300 km for the PCSM loess and ~100–200 km for the coastal loess. This suggests that fluvial deposits of the Yellow River system in the North China Plain and sediments on the adjacent continental shelf are the major provenance for the Shandong loess. In contrast to the Chinese Loess Plateau, the Shandong loess does not show a consistent pattern of coarse grain size and low magnetic susceptibility values in glacial loess compared with interglacial paleosols, likely due to frequent changes in dust sources caused by diversions of the Yellow River and local hydroclimatic conditions. Nevertheless, the loess-paleosol alternations in the Shandong loess are a product of global glacial–interglacial cycles.

Keywords: Shandong loess; OSL dating; Grain size; Magnetic susceptibility; Provenance and paleoclimate

Wind-blown origin and erodibility of the black soil in Northeast China: evidence from particle size characteristics

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Abstract: Black soil is widely distributed in Northeast China. Previous studies have shown that the black soil was formed during the Holocene, however, the source of its parent material remains unclear. In this study, we examined particle size distributions of samples taken from 45 black soil sections over the plains of Northeast China. The results show that most of the samples show a bimodal distribution with a principal mode in the coarse fraction and a secondary mode in the finer fraction, which are similar to the grain-size distribution pattern of loess and modern aeolian dust deposition. From west to east, the median grain size decreases rapidly from >75 μm to <40 μm . This spatial differentiation is consistent with the direction of dust transporting winds during spring, indicating a wind-blown origin of the black soil in Northeast China. In addition, the black soil in Northeast China has coarser particle size compared to the interglacial paleosols developed on the Chinese Loess Plateau, and thus considered to have lower threshold shear velocity. Given the strong dust transport winds in Northeast China, the black soil is therefore very vulnerable to wind erosion.

Keywords: Black soil; Northeast China; Particle size; Aeolian deposition

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Revisiting natural and laboratory electron spin resonance (ESR) dose response curves of quartz from Chinese loess

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Abstract: Natural and laboratory ESR dose response curves (DRCs) of $[\text{AlO}_4/\text{h}]^0$ and $[\text{TiO}_4/\text{M}^+]^0$ were investigated for samples of quartz from the Luochuan loess-palaeosolmaster section, Chinese Loess Plateau. The natural and laboratory DRCs show a clear divergence above ~ 1000 Gy, with much lower D_0 values and saturation levels observed for the natural DRCs, which is in agreement with the previous study by Tsukamoto et al. (2018). Young (< 15 ka) samples from Luochuan and Jingbian – another site of the Chinese Loess Plateau, together with two modern samples of Chinese loess, were used to investigate the residual signals of $[\text{AlO}_4/\text{h}]^0$ and $[\text{TiO}_4/\text{M}^+]^0$ centres. Our results are in line with published studies and show that the significant residual signals corresponding to several tens to hundreds of Gy are present in both Al and Ti centres. These need to be taken into account before laboratory DRC construction. ESR pulse annealing experiments performed on samples irradiated with different doses show an apparent dose-dependent thermal instability of $[\text{AlO}_4/\text{h}]^0$ and $[\text{TiO}_4/\text{M}^+]^0$, with the signals for higher doses decaying faster with increasing temperature. We attribute the change in D_0 with preheat reported in Tsukamoto et al., 2018, as well as the difference between laboratory and natural DRCs, to this apparent dose-dependent thermal instability of the signals. The saturation level of the natural DRC, being the result of reaching the equilibrium between filling of the traps and emptying them due to thermal decay, is therefore additionally affected at higher doses, due to the increased thermal instability. The inability to recreate in the laboratory the same response to irradiation as the one observed in nature questions the accuracy of dating samples beyond ~ 1000 Gy.

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High resolution luminescence chronology of loess records from Hexi Corridor of NW China revealed the spatial extent of the East Asian summer monsoon during past 21000 kyr

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Abstract: The Hexi Corridor is located at the transition zone of East Asian summer monsoon (EASM) and Westerlies dominance, and thus is very sensitive to the extent of EASM and variation of Westerlies over different timescales. The widely distributed loess-paleosol at mid-eastern Hexin Corridor provide a reliable archive for exploring of the how westerlies and EASM variability influence climatic changes at their transition zone. However, due to the lack of sufficient age controls and high-resolution chronological constrains, the paleoclimatic change of loess records from this region is still poorly understood. In this study, we systematically investigated four loess- palaeosol sequences from middle-eastern the Hexi Corridor. The quartz OSL dating methods were applied to 66 coarse-grained (63-90 μ m) quartz samples from these sections Bacon age-depth model is used for chronology determination. In combination with proxy indexes analysis of magnetic susceptibility, grain size, color, our result shows that (1) quartz OSL dating can be used to date samples at least since 21 ka from Hexi corridor regions. (2) loess began to be deposited in the region since at least 21 ka, and depositional hiatus up to a few thousands year were occurred at loess-paleosol sequence at Hexi corridor. (3) loess deposition rate has shown an obvious high glacial and low interglacial pattern in the region with a highest rate appeared at last glacial maximum (LGM). Loess depositional rate has shown spatial-temporal different, indicating a multiple factor of climate, source, local geomorphological changes and erosion influence loess deposition in the region. (4) The moisture in the region has shown a dry LGM and last deglacial and moisture has shown an increasing trend from early Holocene to mid-Holocene and reached the maximum moist at 6-7 ka, followed by a decreasing trend through mid-late Holocene. These results indicate a warm-moist interglacial and cold-dry glacial conditions over interglacial-glacial cycles, consist to monsoonal Chinese Loess Plateau and Westerlies-dominated Central Asia but anti-phase to Central Asia during the Holocene substages. These results highlight that variation in EASM intensity strongly controls climatic changes at Hexi corridor moisture changes.

Keywords: Loess-paleosol; Quartz OSL dating; Depositional dynamics; Climate change; Hexi Corridor.

Insolation and CO₂ impacts on the spatial differences of the MIS-9 and MIS-11 climate between monsoonal China and central Asia

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Abstract: Marine oxygen isotope records and ice cores in Antarctica suggest that Marine Isotope Stage (MIS) 9, an interglacial occurring about 300 ka ago, is a strong interglacial and has the highest greenhouse gases (GHG) concentrations during the past 800 ka. However, the China loess records show that the paleosol S3 that corresponds to MIS-9 is not necessarily strong as compared to some other paleosol units such as the S4 soil that was formed during MIS-11, suggesting relatively drier climate condition during MIS-9. By contrast, in Tajikistan of southern central Asia, the paleosol S3 is the most developed soil over the past 800 ka, indicating a relatively warm and humid climate conditions. The difference in the paleosol formation and the MIS-9 climate between monsoonal China and central Asia is intriguing. In this study, we combine loess records from monsoonal China and central Asia as well as climate simulation results to understand the spatial difference of the MIS-9 climate in particular in comparison with the climate of MIS-11. The individual and combined contributions of insolation and greenhouse gases are quantified through simulations with the LOVECLIM model and using the factor separation technique. Our results show that the simulated effective moisture conditions between northern China and southern central Asia are consistent with the loess records and field observation. Insolation leads to much more annual mean precipitation than GHG during MIS-9 in southern central Asia, explaining a much wetter MIS-9 there. By contrast, both insolation and GHG lead to more annual mean precipitation and evaporation during MIS-9 in northern China, leading to only a slight difference in the effective moisture between MIS-9 and MIS-11. In addition, compared to MIS-11, the larger obliquity and higher GHG concentration during MIS-9 lead to an anomalous atmospheric circulation pattern similar to negative phase of North Atlantic Oscillation (NAO), favoring precipitation increase in southern central Asia and therefore explain strong soil development in Tajikistan.

Investigation of warmer-drier and warmer-wetter mismatch in double atmospheric CO₂ concentration experiments

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Abstract: Modern observations and future projections demonstrate a drying trend in China with increased atmospheric CO₂ concentrations since the Industrial Revolution. However, many geological reconstructions show that climate is often wetter in warmer conditions, differing from the modern observations and future projections. The geological reconstructions reflect an equilibrated situation, whereas modern climate studies consider climate variabilities in a transient condition. This mismatch is likely relevant to the unequilibrated or equilibrated climate backgrounds but still needs further investigations. Here, we use the Norwegian Earth System Model (NorESM1-F) to conduct numerical experimental ensembles, in which atmospheric CO₂ concentrations increase by one percent per year and remain constant after doubling. We further analyze the hydroclimate changes using the Self-calibrating-Palmer Drought Severity Index (Sc-PDSI). Our simulations show that doubling atmospheric CO₂ concentration leads to increased meteorological drought in China under both unequilibrated or equilibrated climate backgrounds. Although annual precipitation in the China region increases with the rise of atmospheric CO₂ concentration at a rate of 0.413mm/y, the increased precipitation does not necessarily indicate that the climate becomes wetter. With increased rainfall, surface air temperature also rises, leading to enhanced annual potential evapotranspiration at a rate of 1.234mm/y. Since the rate of potential evapotranspiration increase is greater than the rate of precipitation change, meteorological drought is intensified in China. The above differences between paleoclimate and modern climate studies stem from their definitions of dryness and wetness, reflecting different aspects of the same change. Modern climate studies employ the definition of meteorological drought that indicates the residual between precipitation and evaporation. In contrast, paleoclimate studies emphasize rainfall, humidity, or vegetation, which generally increases in a warm climate.

Keywords: Global warming; Drought; NorESM1-F; Climate simulation

Correlation and discussion of Chinese loess stacked records based on nonlinear time series analysis

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Abstract: In recent years, nonlinear time series analysis has become an effective method to study the characteristics of climate transition and climate dynamics mechanism in palaeoclimatology research. As one of the most essential terrestrial archives, Chinese loess provides valuable information on regional and global changes in the Quaternary. Here, we conducted multiple nonlinear time-series analyses to the loess stacked curve Chiloparts to identify the critical climate transitions and potential turning points in the loess record. Our data showed obvious nonlinear transitions in the grain size stack at 1.2 Ma, 0.8 Ma, and 0.5 Ma. The potential analysis of Chiloparts revealed these increases in the number of climate potential, which were also identified by the recurrence analysis. The order entropy analysis also argued significant changes in complexity, with significant uncertainties partly from the data averaging in the stacked loess records. We thus analyzed the loess sections, which were compiled into the Chiloparts. Our data showed the similar transitions and spatial heterogeneity within the four sections. Overall, nonlinear time series analysis reveals that the loess-paleosol sequence has recorded multiple climate transitions, which might be related to the evolution of the East Asian monsoon. Our work shows that time series analysis has the potential to study Chinese loess and provides supplementary information on the nonlinear dynamics of paleoclimate.

Keywords: Chinese loess; Grain size; Nonlinear time series analysis; Climate transition.

A simulation study on the interdecadal variation of summer precipitation in North China in the Late Ming and Early Qing Dynasties

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Abstract: Human activities and civilization processes are closely related to climate change. In the late Ming and early Qing dynasties, China's societal reorganizations and dynasties change are supposed to be closely related to the climate fluctuations. The role of the East Asian summer monsoon in the societal reorganizations in the late Ming and early Qing dynasties is worth further study. Using the CESM1 Last Millennium Ensemble (CESM-LME) simulation data, combined with reconstruction evidence, we conducted a preliminary analysis on the characteristics and causes of the interdecadal climate change of summer rainfall in North China during this period. Both the simulation and reconstruction evidence show that the summer precipitation in North China in the late Ming and early Qing dynasties experienced obvious interdecadal fluctuations, and decreased significantly in 1608–1618 CE and 1637–1647 CE. The interdecadal fluctuations of summer precipitation in North China are related to changes in the location and intensity of the Western North Pacific Subtropical High. With the interdecadal change of the East Asian summer monsoon, droughts, locust plagues and plagues occurred frequently in North China, which played an important role in the social unrest in the late Ming and early Qing dynasties.

Keywords: Late Ming and early Qing Dynasties; Paleoclimate Modeling; East Asian monsoon; Western North Pacific Subtropical High

Orbital and millennial Asian monsoon variations across Northern Hemisphere glaciation

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Abstract: About 2.7 million years ago (Ma), the intensification of Northern Hemisphere glaciation (iNHG) led to the establishment of modern-like climates and environments. Although the evolution of global climate and cryosphere across the iNHG are well documented, the Asian monsoon responses to and impacts on the global changes remain poorly constrained. Here, we report on a centennial-resolution grain size record from the Chinese Loess Plateau that tracks orbital- to millennial-scale Asian winter monsoon (AWM) variability from 3.6 to 1.9 Ma. We observe persistent ~40- and ~100-thousand-year cycles in the AWM record, in pace with orbital-scale ice sheet oscillations. Moreover, we find that the iNHG did not alter orbital-scale AWM periodicities, but instead caused a stepwise increase in the oscillating amplitudes and both glacial and interglacial intensity. Superimposed on orbital variability, we find persistent millennial AWM intensity fluctuations during both the warmer (higher-CO₂) late Pliocene and colder (lower-CO₂) early Pleistocene—two million years earlier than previously recognized. We speculate that the millennial variability reflects a nonlinear AWM response to high-latitude NH winter insolation. Our results show that the AWM oscillated on both orbital- and millennial time scales across a much broader range of climate-cryosphere boundary conditions.

Keywords: Northern Hemisphere glaciation; Pliocene–Pleistocene; Orbital- to millennial-scale; Asian winter monsoon; Grain size

Pécel: a special Middle and Late Pleistocene loess profile from the Northern part of the Carpathian Basin

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Abstract: The loess-paleosol profile of Pécel is an approximately 26-meter-high well-preserved sequence in the Northern part of the Carpathian Basin, Hungary which was sampled in high resolution. The researcher team found the nearby Rákos stream's river sediment beneath the sequence of which the forming and movement of the riverbank can be traced. The loessy sediment was deposited on that sediment with an erosion horizon presumably due to water flow. There were 20 radiocarbon measurements were made from the upper 8 meters. According to them and the magnetic susceptibility measurements, the developing progress can be traced from this river sediment to the recent surface. There were also 65 XRF measurements made to investigate the geochemical compounds. Sedimentological analysis and geochemical indices were used to show the rate of weathering. The source of the dust can be concluded from the geochemical compounds. The former research showed, that at about 10 meters, based on the trace elements' changes it is an alteration of the dust transportation's direction. We assumed that the uppermost, weakly-developed paleosol layer could be redeposited, which is also proved from radiocarbon dates, and sedimentological and magnetic susceptibility data. 5 paleosol layers can be found in the whole sequence. Further research will be based on malacological investigations, geophysical measurements or probably OSL/IRSL measurements to get to know the sequence's exact age.

Keywords: Loess; Loess-paleosol; Radiocarbon; Geochemistry; Paleoecology.

ENSO events during the LIG period under the background of sea level rise

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Abstract: The global annual average temperature of the last interglacial period is 2~3 °C higher than today, which is the latest period of global temperature approaching the predicted temperature in the 21st century. Therefore, the study of the last interglacial period may provide ideas for the operation of future climate change models. And the sea level height of the last interglacial period is higher than that of the modern 5-10 meters. It is also significant to study the performance of ENSO in the last interglacial sea level rise scenario. In this paper, the sea surface temperature data of paleoclimate reconstruction during the LIG period are compared with the sea surface temperature results of historical tests simulated by the NorESM. The NorESM is used to carry out the control test and the sensitivity tests of sea level rise by 5 meters and 10 meters respectively. The tests run for 200 years, and the performance of ENSO events under different sea level rise is analyzed. The results show that the average strength of El Nino and La Nina during LIG is weaker than that of control test. In the simulation experiment of 5 m sea level rise, the average amplitudes of El Nino and La Nina events reached the maximum; the frequency of El Nino and La Nina events increased significantly in the 10 m sea level rise test compared with the historical test.

Keywords: Last interglacial; Sea level rise; ENSO

Investigation on the deformation and failure patterns of loess cut slope based on the unsaturated triaxial test in Y an'an, China

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Abstract: The large-scale implementation of the Gully Stabilization and Land Reclamation (GSLR) project induces various failures of loess slopes due to excavation in Yan'an, China. However, the deformation and failure behavior of these excavated loess slopes have not been fully understood. In this study, field investigation was undertaken for analyzing the distributions and failure features of excavation-induced loess slope failures. It is found that plastic failure mainly occurs in Q3 loess layers and brittle failure in Q2. To understand the underlying failure mechanism, a series of triaxial shear tests were conducted on intact Q3 and Q2 loess samples that with different water contents, namely natural water content (natural), dry side of the natural value (drying 5%), and wet side (wetting 5%). The characteristics of stress-strain curves and failure modes of the samples were analyzed. Results show that the stress-strain curves of Q2 samples are dominated by strain-softening characteristics, while Q3 samples mainly exhibit strain-harden features except in the drying state. Correspondingly, shear failures of Q3 specimens are mainly caused by shear crack planes (single, X or V-shaped). For Q2 loess, the dominance of tensile cracks is observed on the surface of damaged specimens. These disclose the different failure modes of excavated slopes located in different strata, that is, the arc sliding failure of Q3 loess slopes and the stepped tensile failure of Q2 loess slopes, and are helpful in the design and management of the ongoing GSLR projects in the Loess Plateau.

Keywords: Loess slope; Slope stability; Failure patterns; Deformation behavior

Time-dependency deterioration of two ecological materials in loess cut-slopeprotecting

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Abstract: Ecological materials are increasingly being applied in the loess slope protection, and the time-dependency deterioration of materials is an important criterion in evaluating their protective effects. Taking polypropylene fiber and guar gum as examples, the protection tests of these two ecological materials were carried out for a typical bare cut-slope on the Loess Plateau in this study. We quantified the erosion deterioration based on the approach of LiDAR, and the deterioration processes of both the ecological materials were then comprehensively evaluated. Results showed that both the materials could generate good protective effects on the test slopes, and the guar gum mixed soil (GGS) was slightly better than polypropylene fiber reinforced soil (PFS) at initial time. However, the two materials deteriorated diversely with the increasing service time. The scouring erosion was mainly observed in PFS, which is different to the surface spalling observed in GGS, and the erosion mass presented different stepwise growth along the slope downward. In addition, the protective advantage of GGS was decreasing and even disappearing over time. Revealed by the dry-wet cycle tests, the rapid attenuation of disintegration resistance of PFS and shear strength parameters of GGS were the main reasons leading to the different deterioration of the two materials. For evaluating deterioration behavior of slope protection materials, the time-dependency deterioration model was furthermore established by combining the average intensity of effective rainfall as well as the disintegration rate and shear strength parameters of slope protection materials. Thus, the quantitative prediction on the deterioration process and the protective effect of slope protection materials were realized, with results indicating that the influences of disintegration rate, cohesion, and internal friction angle enhanced successively on the promotion of slope protection materials. This study is of great significance for revealing the deterioration mechanism and promoting continuous improvement of slope protection materials.

Keywords: Loess slope protection; Ecological materials; LiDAR; Deterioration characteristic; Time-dependency deterioration model

Coupled Hydro–mechanical Behavior of Compacted Loess during Isotropic Compression

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Abstract: Understanding the coupled hydro–mechanical behavior of compacted loess during isotropic compression is essential for establishing the complete constitutive model for unsaturated soils, which is of significance for predicting the deformation of loess fills in engineering. In this research, a series of constant suction isotropic compression tests are conducted to study behavior of compacted loess. The experimental results show that volume change and soil–water characteristics are mutually affected during compression and that the normal compression curves flatten out but shift downward with the decrease in suction. Based on the experimental observations, the normal compression surface is modified, and the loading–collapse (LC) yield curve is deduced for the compacted loess. An equation associated with void ratio is used to describe the effect of the volume change on the soil–water characteristics. Furthermore, a coupled hydro–mechanical constitutive model for the compacted loess under isotropic compression conditions is proposed within the framework of the Barcelona basic model (Alonso et al., 1990). Model predictions of the mechanical and hydraulic behaviors of compacted loess for constant suction isotropic compression tests and wetting tests at constant net stresses are compared with experimental data to validate the performance of the proposed model. The comparisons indicate that the proposed model can accurately reproduce the coupled hydro–mechanical behavior of compacted loess under isotropic compression conditions.

Keywords: Coupled hydro–mechanical behavior; Compacted loess; Soil–water characteristics; Volume change

Settlement prediction of filling compacted loess soil subjected water infiltration

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Abstract: To alleviate the pressures on building land, the land creation engineering was carried out in several cities located on the loess plateau over the past few years. Although these projects available extended the urban space, the filling loess, featured with large thickness, partial saturation and inadequate compaction, also brings many challenges for the constructions carried out on it. For instance, the settlement of the filling soil commonly occurs under the infiltration events. However, there is lack of the suitable model yet to describe settlement of compacted loess layer under infiltration condition. Water infiltration in fill can increase water content of compacted soil, which will subsequently decrease the matric suction of soil and cause wetting collapse. This paper proposes a model to calculate the settlement of filling compacted loess. In this model, the soil-water characteristic curve (SWCC) is a tool of the coupled the water flow and deformation processes in unsaturated compacted loess. Because the SWCC is a parameter controls water flow in unsaturated soils, the change of soil voids is introduced into SWCC, which substantially takes the effect of soil deformation on water flow into account. In addition, the relationship between variations of matric suction in SWCC and void ratio is also introduced, which means that the response of soil deformation to suction changes induced by water infiltration can also be captured. The model is finally used to predict settlement of filling compacted loess in Yan'an city, and the agreement between the predicted and the measured values illustrates the usability of the proposed model.

Keywords: Compacted loess; Water infiltration; Unsaturated soil; Matric suction; Wetting settlement

Water migration characteristics in thick compacted loess due to mega engineering projects

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Abstract: There is an increasing number of mega engineering projects of removing the tops of hills to fill in valleys for new lands creation in the Loess Plateau of China. On the one hand, these unprecedented land-creation projects alleviate the pressure on land usage and bring substantial local economic benefits. On the other hand, they drastically change the landform, disturb the original structure of loess and significantly change the hydrogeological conditions of the site, contributing to various geological disasters. The engineering risks may arise either from the hydrological environment variation or substantial settlement. One of the key issues associated with the hydrological condition is the water migration in thick compacted loess, which may induce differential settlement, slope failure, etc. The problem how surface water infiltrates in thick unsaturated loess has drawn paramount interest. However, most of the studies are focused on the intact loess layer in the plateau where the hydraulic condition is in a dynamic equilibrium state. There are rare investigations on water migration in thick compacted loess where the initial condition is out of equilibrium. This paper aims to explore the water migration in a thick compacted loess layer in the Yan'an New District using in-situ measurement and numerical simulation. In-situ data for a period of one year was collected, including the rainfall, evaporation, and soil water content at different buried depths. Numerical analysis considering the ground-atmosphere interaction was conducted for better understanding the water migration and redistribution characteristics under the influence of rainfall and evaporation. Results show that the topsoil (e.g., 0-2 m) undergoes significant variation of the soil water content, while the underlying soil seems to have a constant value, which almost keeps the value that the soil was compacted. The insignificant rainfall and strong evaporation have a limited influence on the soil water content below 2.0. While slow water redistribution does occur in this apparent steady state zone (< 2.0 m) under the driving force of gravity, matric suction, and temperature. On the other hand, due to the slow process of the water redistribution and migration, the water-induced disasters (e.g., differential settlement) may be neglected in thick compacted loess under the natural conditions regardless of human activities (e.g., pile line leakage of water, irrigation).

Keywords: Mega engineering; Compacted loess; Water migration; Moisture redistribution; Hydraulic condition

Microstructural insight into the characteristics and mechanisms of compaction of an intact, compacted and remolded loess for land-creation project from the Loess Plateau

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Abstract: Loess is widely distributed in northern China on the Loess Plateau, which is well-known for its serious soil erosion and shortage of urban land. Undertaking filling construction under the conditions of an optimum water content is very difficult for so many mega-engineering projects in loess regions because of the i) moisture loss that occurs over a certain transport distance, ii) water shortage, and iii) construction costs. Consequently, the inadequate compaction behaviours of such compacted loess without improvement may have significant effects on the safety and reliability of man-made structures. This study focuses on the compaction mechanism of large-scale and high-fill compacted soil under complex construction conditions by comparing intact loess with in-situ compacted loess from a microstructural perspective. The morphological characteristics of the particles and pores of i) intact soil obtained from a typical 75-m high loess–paleosol section, and ii) compacted soil obtained from a 30-m deep filling section are described. The main experimental comparisons between the intact soil and compacted soil are discussed with respect to the pore size distribution (PSD), microstructural micrographs, and characteristics of the particle/pore structure. The results showed that both the intact soil and compacted soil exhibited trimodal characteristics in their PSDs; hence, a new pore classification is presented to agree with the pore name. The compaction mechanism of compacted loess was mainly attributed to two aspects: one is the progressive and ordered transformation of different pore sizes, and the other is the gradual rearrangement of order and close cementation of particles under dynamic loading. The results of the present study are very useful for better understanding the properties of loess soil and improving engineering construction safety in loess areas.

Keywords: Loess; Paleosol; Microstructure; Pore size distribution; Mercury intrusion porosimetry; Scanning electron microscopy

High Erodibility of Black Soil with Loess Parent Materials in Northeast China

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Abstract: Parent materials of black soil in Northeast China are composed of Quaternary loess and non-loess sediments (such as lacustrine and fluvial sediments). Under the pressure of maintaining high grain yields, the black soil of the region is undergoing severe erosion. However, the contribution of types of parent materials to soil erosion remains unclear. Here we analyzed magnetic susceptibility (χ) of 115 samples from black soil horizon of both 12 soil sections with loess parent materials and 5 sections with non-loess parent materials, which covers in an area of severe and slight erosion. Our results reveal that the χ is roughly proportional to decreases in erosion rate. In the area of slight erosion, the χ of soil sections with non-loess parent materials is prominently higher than that of sections with loess parent materials. This is because the relatively coarse grains of the loess fail to protect ferromagnetic materials from erosion. Additionally, the observed pattern is absent in the area of severe erosion, partly due to that ferromagnetic materials with fine particle size have been eroded. We speculate that loess parent materials enhanced the erodibility of black soil in Northeast China. Sustainable soil management policies to protect the black soil with loess parent materials are therefore necessary and urgent.

Keywords: Black soil; Soil erosion; Magnetic susceptibility; Northeast China.

Holocene prehistoric human activities recorded by palynology in the Mu Us Desert, China

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Abstract: The influence of anthropogenic activities on climate change may be causing deviation in Holocene climate reconstruction. Therefore, it is necessary to investigate Holocene human activities and clarify their relationship with climate. Owing to being located in the farming-pastoral ecotone of East Asian summer monsoon marginal, environmental variation in the Mu Us Desert is very sensitive to climate changes response. Here, we quantitatively reconstructed the Holocene Human Impact Index (HII) in Mu Us Desert by using Random Forest (RF) models, based on modern HII and pollen datasets. Moreover, we clarify Holocene anthropogenic subsistence strategies in the Mu Us Desert by synthesizing multiple information, such as HII, human-related pollen taxa, and charcoal concentration. The results show that the earliest Neolithic humans appeared in the Mu Us Desert during 8.5–6.4 cal kyr BP. In addition, the value of reconstructed HII remains relatively low (16.7) before 4.9 cal. yr BP, rises gradually (18.8) at 4.9–2.6 cal. kyr BP, and increases abruptly (21.5) after 2.6 cal. kyr BP, indicating the increasing impact of anthropogenic activities on climate change. Furthermore, the anthropogenic subsistence strategies were mainly dominated by agricultural cultivation from 6.4 to 4.9 cal. kyr BP, and grazing began to appear after 4.9 cal. kyr BP. At 2.6–2.1 cal. kyr BP, grazing was the mainly ancient anthropogenic lifestyle. Anthropogenic activities had a weak influence on the climate before 2.6 cal. kyr BP, whereas then this impact may increase gradually with the continuous improvement of anthropogenic production and lifestyle. The result of this study may provide a scientific basis for recognizing Holocene anthropogenic activities.

Keywords: Human influence index; Human-related pollen taxa; Random Forest model; Mu Us Desert; Holocene

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Excavation at Jhang Bahatar, Pakistan

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Abstract: The site of Jhang Bahatar, provides important evidence for early settled communities along the Indus River near modern Attock, Pakistan. The extant appearance is a round mound, about 80 meters in diameter, about 9-11 meters from the surface of the present farmland, without any archaeological excavation or test excavation. The work at the site in 2018-2019 by a team of Chinese archaeologists has focused on exposing the earliest levels dating to the Harappan culture. These early levels revealed important evidence for pit dwellings. This paper will present the results of these initial excavations and discussions of the bronze objects, pottery and other artifacts recovered from the site. The discovery may eventually provide us with more possibilities to further explore the early cultural exchanges between the Harappan Culture and the northwest in China. Overlying these prehistoric deposits are occupation levels dating to the Early Historic Period and Islamic Medieval period.

Loess deposition in eastern Qinling Mountains, central China and its impact on ecosystem and Paleolithic human occupation

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Abstract: The conception of ‘loessic paleolithics’ or ‘loess lithic industry’ had been proposed since 1990s (Ranov, 1995; Liu Tongsheng, 1999) which revealed that most of the Paleolithic sites in Eurasian Continent are distributed in the loess deposition area based on investigation of the Paleolithic sites in both Europe and Asia and, therefore, it's suggested that aeolian dust deposition might have critical effects on early human dispersal and culture development. Chinese Loess Plateau is the most typical and largest loess deposition area in Asia. Dust emitted from the arid and semiarid regions of Central Asia and deposited in this region with broad environmental impacts. While the existed archaeology statistics from both in and around the Chinese Loess Plateau show that the majority Paleolithic sites are not distributed in the central area of the loess plateau but in its margin belt. Accordingly, loess formation and its climate setting are vital in looking into the effects of dust deposition on ecosystem and early human activities. In this study, loess deposits in the Eastern Qinling Mountain region which is located in the southern margin of Chinese Loess Plateau and is considered to have the most density Paleolithic sites in China is selected. Sr/Nd isotopic analysis are carried out on 60 samples taken from 8 loess sections, including HSY, QJY, SBC, LW, LGS, LJY, WTC, GM, which located in different basins of the Eastern Qinling Mountains to reveal the loess provenances and climate changes in Pleistocene. Combine with grain-size and stable carbon isotopic analysis, the results indicate that: loess deposits in Eastern Qinling Mountains have a multiple provenance; Provenance changes according to the regional climate changes; Loess origin and characteristics have evident effects on the local vegetation and early human activities.

Keywords: Loess; Ecosystem; Environment; Paleolithic; Qinling Mountains

Loess archaeological sites of Final Middle Palaeolithic in the Rubas valley (North-Eastern Caucasus): stratigraphy, chronology and archaeology

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Abstract: The main part of the Middle Paleolithic sites known in the Caucasus are located in its southern and western parts, and almost all of them are associated with caves. Recently, in the North-Eastern Caucasus in the valley of the Rubas River (Coastal Dagestan), two multi-layered open-type sites were discovered: Tinit-1 and Rubas-1. Both sites are characterized by archaeological materials which occur in thick loess units, which is unique for the region.

Tinit-1 site is located in the middle reaches of the Rubas River. A composite section of Quaternary deposits up to 5.5 m thick was described at this site. Nine lithological units were identified, in which 11 archaeological horizons were recorded. The exposed deposits are a series of subhorizontal, interbedded, monotonous dark brown and gray-brown loess-like loams, with an insignificant content of fine clastic material, strongly bioturbated in some parts. Paleosol was recorded in the upper part of the section. The genesis of the deposits is eolian and colluvial. The total collection of stone artifacts includes >1600 items. For site Tinit-1 a series of five AMS dates were obtained in the interval of 39–48 ka BP and a series of five OSL ages, showing a slightly older age.

The technical and typological analysis allowed dividing the archaeological collection into two groups, differing both in the characteristics of the primary splitting and in the tool: archaeological horizons 1-4 and 5-11. The more ancient group is characterized by the developed Levallois technique with predominating side-scrapers. Collection contains knives, Levallois and Mousterian points, notched tools and scrapers.

In younger assemblage only parallel splitting was used, including close to volumetric splitting. The Levallois technique was not recorded. The tools are few. Basically, these are scrapers-knives, knives and scrapers. There are incisors, piercings, truncated chips. The Rubas-1 site is located 14 km downstream from Tinit-1. A composite section of Quaternary deposits up to 18 m thick is recorded at the site, including three complexes of archaeological materials of different age (Early-Middle Paleolithic). The upper industry, dating back to the end of the Middle Paleolithic, is associated with the loess sequence covering the upper part of the section, up to 5 m thick. This sequence has a complex genesis and is composed mainly of light gray-brown loam with silt. Aeolian sedimentation was actively disturbed by slope processes and so loess has many features of colluvial processes. An underdeveloped paleosol was identified in the upper part of the section. Loess-like unit contains 8 levels of archaeological material occurrence. For upper part of the section covering the loess-like unit a series of five OSL ages

was obtained, showing that its formation took place in the interval of ~80–40 ka BP (late MIS 5, MIS 4 and 3).

The total collection of stone artifacts includes >1200 items. An analysis of the archaeological material allows us to divide it into two groups (archaeological horizons 1–3 and 4–8), which are close in their characteristics to the groups identified at Tinit-1. It should also be noted that horizons 1–3 and 4–8 were apparently separated by a long time interval – this is evidenced by an archaeologically sterile unit up to 1 m thick separating them. The chronological hiatus in the archaeological sequence is also confirmed by OSL.

Thus, the Tinit-1 and Rubas-1 sites belong to an extremely rare type of Paleolithic sites of the Caucasus – an open-air type sites associated with the loess deposits. Their materials demonstrate the presence of at least two different industries in the territory of the Northeast Caucasus at the end of the Middle Paleolithic, which may indicate a change in the population of this territory. The reasons for the significant difference between these assemblages and other synchronous industries of the Caucasus may be related to differences in the types of economic activity at open and cave sites, however, require further study. It is important that for studied sites in the valley of the Rubas River we for the first time obtained a series of absolute dates for the Middle Paleolithic of the Eastern Caucasus, using different dating methods, which allows a more reasonable reconstruction of the processes of human occupation of this territory in the Late Pleistocene.

Keywords: Coastal Dagestan; Open-type sites; Tinit-1; Rubas-1; OSL; AMS; Human occupation; Late Pleistocene

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Study of the origins of sacrificial victims from the Yinxu Royal Tomb using dietary isoscapes

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Abstract: During the Late Shang period, the origins of sacrificial victims have been a significant scientific breakthrough in social structures, rituals, and the integration and conflict of different cultures. Loess Plateau is difficult to trace human origins by strontium isotope due to the homogeneity of its geological environment. Dietary differences between sacrificial victims and Yinxu residents can be used as evidence of geographic traceability. Bone collagen carbon and nitrogen stable isotopes data from sites in northern China dating from the Late Neolithic to the Bronze Age were analyzed in this study. There was a comparison between residents of Yinxu, Hexi Corridor, Upper Yellow River, Loess Plateau, Guanzhong Plain, Central Henan, Xiliao River Plain, and Shandong Region to sacrificial victims. The dietary isoscapes, oracle inscriptions, and archaeological evidence all point to the sacrificial victims being from the Lijiaya region, not the Siwa region as previously thought.

Keywords: Yinxu; Sacrificial victims; Loess Plateau; Dietary isoscapes

Kurgans – a special burial site in the loessy region of the Carpathian Basin

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Abstract: Kurgans are the most distinctive human-made phenomena of the Eastern European and Western Asian steppe zone. Most of them already have been destroyed by agricultural activity, leaving only a fraction of their hundreds of thousands intact. This makes their protection and study an important scientific task. These objects are burial mounds, the construction of which can be connected to several different cultures. Most of them were built by the Yamnaya (Pit Grave) Culture in the Late Copper - Early Bronze Age. This culture was presented throughout the entire steppe zone of Eastern Europe and Western Asia. It had a great influence on the cultures that followed (linguistic and cultural elements) during the history of Europe and Asia, which increases the importance of their study. The area of the Carpathian Basin was the westernmost extension of this culture of stock-breeding, and nomadic people. The kurgans they built are almost always can be found on elevated parts of lowland, loessy areas, elevated areas along the banks of defunct rivers or on loess-formed chernozem soil-covered residual surfaces. This fact can be observed in the case of all the kurgans we have studied. They were built up from soil material formed on loessy sediments. They are strongly prominent in the topography of the area, which, under the altered surface and local hydrological conditions, preserved the characteristics of the former loess areas, even in areas more exposed to groundwater during the second half of the Holocene, due to the presence of loess sediment and the formation of both vegetation and classic chernozem soil formed on the loess. Thus, they can be considered as a kind of anthropogenically formed and modified classical steppe surfaces. Their study, therefore, requires not only archaeological methods but also geoarchaeological, sedimentological, pedological, and natural scientific ones, which are also used in the classical study of loess sediments. Based on the comparative analysis of the buried and recent layers of the soil and sediment material of the kurgans, information can be gained about the environmental changes in the local environment. For this purpose, sedimentological analyses (grain size distribution, magnetic susceptibility measurements, organic matter and carbonate content analyses) can be used. For the reconstruction of the former environment, even malacological and pollen analysis can be carried out. Thus, besides the archaeological results, it is possible to reconstruct steppe-like environmental conditions before and during construction in the local surroundings of the kurgans. This study presents these methods and results through the examination of some of the kurgans of the central Carpathian Basin.

Keywords: Kurgan; Geoarcheology; Yamnaya; Sedimentology; Carpathian Basin

Loess and Civilization: Integrated Archaeological Evidence to Reveal the Interplay of Millet Agriculture with Chinese Civilization in the Loess Areas

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Abstract: Loess areas cover large regions in North China and are the birthplaces of millet agriculture and Chinese civilization. However, the interplay of millet agriculture and civilization under the context of loess soils has not been fully revealed. In this presentation, the property of loess soils was introduced at first to show the soil fertility. Subsequently, several lines of archaeological findings from archaeobotany, archaeozoology, and stable isotope analysis, have been integrated together to illustrate the evolution of millet agriculture. Then, the supports from development of millet agriculture to the expansion of human settlements and increase of human populations were discussed. At last, the roles of farming management and consequent labour investments played in fostering the increase of cultural complexity and the occurrence of Chinese civilization were discussed.

Keywords: Loess; Millet agriculture; Chinese civilization

Isotopic Analysis on Bone Artefacts of Bone Workshop during the Qin Dynasty in Niejiagou, Xianyang, China

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Abstract: The official handicraft industry was an important economic section during the Qin Dynasty (221-206 BCE). The records about employees, production management, and product circulation were well documented, while the source of raw materials was relatively obscure. We here conducted isotopic analysis on cattle bones excavated from a Qin Dynasty bone workshop Niejiagou at Xianyang, the ancient capital of the Qin Dynasty, to investigate the source of bones for the first time.

Our data showed that cattle (n=57) in the Niejiagou bone workshop had isotopic composition with limited variations, indicating that most animals likely shared similar origins. Specifically, the $\delta^{13}\text{C}$ ($-3.5\pm 0.8\text{‰}$) of bone showed that C4 crops contributed significantly to the cattle diet, and the $\delta^{18}\text{O}$ of atmospheric precipitation estimated from the $\delta^{18}\text{O}$ of bone ($-7.7\pm 0.6\text{‰}$) was slightly lower than that of the present. At the same time, the $^{87}\text{Sr}/^{86}\text{Sr}$ values (0.71156 ± 0.00019) of Niejiagou cattle bone are similar to the strontium isotope baseline of river water in the Guanzhong area. Cluster analysis suggested that most animals (n=52) might come from the nearby Guanzhong area, whilst only a few individuals (n=5) were from the north of the Chinese Loess Plateau or the east of the Qinling Mountains.

It is worth noting that the strontium isotope in the contemporary Xuechi sacrificial site showed that the cattle and horses were imported afar. The significant differences between the two sites were possibly rooted in the differences in their functions and properties: the sacrificial site was designed to proclaim the territories, while the handicraft sites preferred the uniform quality of products.

Keywords: Isotopic analysis; Bone workshop; Qin Dynasty; Niejiagou

Holocene extreme flood records and their social impact on the Yangguanzhai Archeological site (Neolithic), middle Yellow River Basin, China

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Abstract: Approaching to ca 4000a B.P. was an important milestone in the history of Chinese civilization, which marked a profound transition from the end of Neolithic to the earliest state. Although the reasons of the impulses of ancient Chinese civilizations are very complicated, the variations of climate and environment should be taken into consideration.

The identification of the pre-historical flood of ca 4000 a B.P., spreading to Yangguanzhai Site (a key Neolithic archeological site at middle reach of Yellow River), provides the evidence of regional hydrological environment and its possible influence on the ancient human societies. There are successive deposits of 7000 a B.P.-4000 a B.P. dated by ¹⁴C comprising lots of pottery shards among the huge moat of YGZ Site. Two sets of hydrological sediments were recognized based on sedimentary criteria, including the rain-washed block loess of 7000-5000 a B.P. and slack water deposits of flood of 4000 a B.P. The two paleo-hydrological periods correspond to flourishing period and the end of Neolithic age of YGZ site, respectively, and coincide with contrasting climatic context of humidity and aridity documented in China's monsoonal regions.

By means of the hydrologic calculation and analysis, it is suggested that rainstorms, deposition of fluvial silt and channel obstruction were intensified by weaken summer monsoon, which contributed to the occurrence of the extreme flood together. It is inferred that the highly variable and weaken trend of Asian summer monsoon during the middle-late Holocene, documented in the other paleo-climatic proxies studies, triggered the 4000a flood. The regional river system at arid-semi-arid area recorded and responded to global change in the form of extreme flood.

Given the decrease of Neolithic sites in density and size and the cultural decline of YGZ site approaching 4000a, the ancient humans were likely to have difficulties to adapt to the climatic and hydrological fluctuation (i.e. drought and flood) in this region. This may facilitate the migration and transformation from settlement to the earliest state. As a center of middle Neolithic Culture, the decline of YGZ site may witness the decline of Neolithic age in Guanzhong Basin, the middle reach of Yellow River. The paleo-hydrological research of YGZ Site provides significant perspective for our understanding on climatic fluctuation in this origin, development and transfer of ancient Chinese civilization.

Keywords: Yangganzhai Neolithic site; Prehistoric extreme flood; Middle-Holocene; Ancient civilization; Yellow River; China

Atlantic meridional overturning circulation modulation of late Pleistocene to middle Holocene Asian summer monsoon variability and palaeoanthropological implications

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Abstract: Asia contains more than half the world's population, and their lives are significantly related to summer monsoon moisture supply. Here, we investigate features and dynamics of late Pleistocene–middle Holocene Asian summer monsoon variability in the Nihewan Basin, North China, which was a critical home for early humans in East Asia throughout the Quaternary. We present new mineral magnetic records between 16 and 5 ka from the Yujiagou archeological site in the northern Nihewan Basin, which contains more than 40,000 stone tools, 2 pottery pieces, and 19,686 mammal fossils. Magnetic properties of the Yujiagou section are dominated by pedogenic fine-grained magnetite/maghemite concentration, which ranges from superparamagnetic/single domain up to fine pseudo-single domain sizes. We use multiple environmental magnetic proxies, which measure pedogenic magnetite/maghemite concentration, to document that summer monsoon precipitation was low before ~14.5 ka and high during the Bölling-Allerød warm period (14.5–12.8 ka), and shifted to low values at the onset of the Young Dryas cold period ~12.4 ka, followed by a sustained long-term increasing trend from 12.4 to 5 ka. We relate these monsoon precipitation changes to the consistent Atlantic meridional overturning circulation variability, which modulated North Hemisphere temperatures and displacements of Inter-Tropical Convergence Zone and Walker circulation over the Pacific Ocean. The observed large-amplitude deglacial Asian monsoon changes may have played a role in several key evolutionary changes in Asia implicated by the Yujiagou archeological evidence, including Paleolithic to Neolithic culture transition, Asian pottery development, and early human dispersals from Asia to America.

Keywords: Environmental magnetism; Asian summer monsoon; Atlantic meridional overturning circulation; late Pleistocene; Nihewan Basin

Sustainable intensification of millet-pig agriculture in Neolithic North China

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Abstract: The emergence of complex societies represents one of the major developments of human prehistory. Diverse agricultural strategies were implemented to produce the increased grain surplus necessary to allow the development of complex societies across the world. Little is known, however, about the millet-pig system that developed in Neolithic North China and ultimately underpinned the more complex societies, such as cities and states, in this region. Our data from studies of phytoliths and starches from pig dental residues and stable isotopes of millet grains excavated from the Dadiwan site demonstrate that an intensive crop-livestock system was in practice by at least 5500 years ago. This novel system, characterized by the feeding of millet crop residues to pigs and the fertilization of millet fields with pig and/or human dung, enabled sustainable intensification in agriculture and fed the early complex societies in North China.

Keywords: Complex society; Origins of civilization; Crop-livestock system; Microfossil analysis; Stable isotope analysis

Livestock supply to an imperial sacrificial site of the Early Chinese Empires evidenced by strontium isotope ratios

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Abstract: A newly excavated ritual site, Xuechi, exposed abundant sacrificial livestock, allowing to understand the supplies and managements of livestock during the early Chinese Qin-Han Empires. Here we reported animal enamel $^{87}\text{Sr}/^{86}\text{Sr}$ values from the Xuechi site that are obviously higher than those of local snails and surface water, as well as calcites of the Chinese Loess Plateau (CLP) where the site was located, strongly suggesting that these sacrificial animals were not raised in the vicinity of the site. The regional bioavailable $^{87}\text{Sr}/^{86}\text{Sr}$ isoscape further indicates that some livestock were probably derived more than one hundred kilometers away, suggesting a complex social network for recruiting and managing the sacrificial activities. In the context of other Neolithic-Bronze Age records on the CLP, an increasing trend in variation of faunal $^{87}\text{Sr}/^{86}\text{Sr}$ values shows a robust correlation to Chinese states' trajectory, in concordance with the territorial expansion model for state formation.

Herding revolution in the Loess plateau

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Abstract: During the late third millennium BCE, cattle and sheep were introduced into northwest and north China, then they were widespread adopted under the 4.2 ka climate event, which was associated with the rise of early states. With the synchronous exploitation of primary and secondary products, herding revolution could explain cultural dynamics in the Loess Plateau.