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Climate Change Evidenced by Paleosol Records in the Kazakhstan Steppe Area

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Loess deposits and generated ancient soils (paleosols) represent one of the most diagnostic proxies of past climate history in North-Central Eurasian regions characterized by an extreme continental regime. The Quaternary climate evolution in the parkland-steppe areas and semi-desert depressions of East Kazakhstan are evidenced by accumulation of aeolian (silty and sandy) sediments (Fig. 1) accumulated in cold stages and surface stabilization with formation of variously developed paleosols during warmer climatic intervals. Thickness of the local loess cover (5-25 m) is considerably less than on the northern Altai Plains (30-150 m) with deeply stratified aeolian formations encompassing most of Pleistocene [1, 3-4]. The East Kazakhstan territory of a broken relief configuration aligned by the Altai, Targabatay and Alatau mountain ranges attests to a complex Cenozoic history and associated environmental transformations by large-scale geomorphic processes of mass sediment transfer, weathering and erosion in the central Bukhtarma and Zaisan Basins linked to past climate variations in conjunction with neotectonic activity. Marked climatic shifts are seen in stratigraphic terrestrial sedimentary records and the preserved palaeo-landscape forms of an up-lifting topographic gradient. These in conjunction with palaeoecology and geoarchaeology environmental proxies indicate long-term variations in the regional atmospheric temperature and humidity balance [2]. Following the warmer Early Pleistocene climates witnessed by strongly pedogenically altered Fe/Si oxide-rich red paleosols, the progressing continentality during the Middle and Late Pleistocene led to formation of chernozemic parkland-steppe soils, brunisolic taiga forest soils and Arctic periglacial tundra gleysoils following loess deposition in the foothills during extreme cold and hyper-arid stadial/glacial stages. Palaeolithic sites positioned in diverse geo-settings bear sings of inhabitation of this marginal area and adaptation to the regional Pleistocene ecosystems preceding the modern environmental mosaic. Contextual magnetic and non-magnetic sedimentary proxy data correlate well with the North Altai Plains' Pleistocene loess-palaeosol sequences also matched by the global MIS (7-1) records. In spite of the close distance, the East Kazakhstan loess formations evidently represent a separate geological entity pre-disposed by the regional climate regime and wind-direction patterns within the transitional geographical zone affected by the Siberian, Central Asian as well as the NW Chinese atmospheric circulation. The local loess records illustrate a diversity of the stratigraphic formation and pedogenic modification of air-born silty aerosols. Differences in the specific parent material mineralogy with the regional Quaternary climate regimes and sediment weathering processes are assumed to be the principal factors behind the recorded "mixed" one-section magnetic susceptibility variations with the dominant soil-enriched MS trends in contrast to the Siberian low-MS soil trend.

Figure 1. Loess cover of the Bukhtarma basin.

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