



Northern Tian-Shan paleosol sedimentary sequences as a record of major climatic events in the last 30.000 years

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Global warming and impending sea-level rise have attracted increasing interest in regional climate changes in the Pleistocene and Holocene. The soil cover of the extensive territory of Tian-Shan (Kyrgystan) is represented by mono- and polygenetic Holocene soils and by buried in loess soil horizons of Late Pleistocene and Holocene age. Specific features of all these soils are due to the action of elementary present-day and relic soil processes of different age and intensity, that could either coincide or alternate under the influence of glacier movements and climatic fluctuations. A soil chronosequence was studied in the central part of Kirgizskiy Range (at the longitude of the city Bishkek) at elevations between 1800 and 3400 m above sea level (interfluvium of the rivers Alamedin and Ala-Archa). All examined soils (40 profiles), representing the change of soil types from the foothill to the top of slope in the Taty, Chon-Kurchak, Kurchak-Tor valleys, were grouped into three genetically similar units in accordance with soil profile morphology. The older members of the chronosequence developed on the lowest frontal moraines (Last Glacial Maximum (LGM)) at altitudes of 1900-2100 m, represented by the monogenetic full-Holocene mountain Chernozem (Calcic Chernozem according to FAO) under sweetbrier-herbage-estragon meadow-steppe. These soils have several buried in loess horizons (Bb1, Bb2, Bb3). Upvalley, moraines are present at 2100, 2350, 2450 and 2600 m above sea level. These moraines characterize Late Glacial ice advances. The soils of Late Glacial age are classified as Chernozem-like soils or Faiozem by FAO under a prairie-grass-herbage meadow steppe and dry subalpine meadows. Some of these full-Holocene polygenetic soils have buried A and B horizons. Monogenetic incomplete Holocene soils in the initial stages of their formation at altitudes of 3100 m were described under cobresia meadow, represented by the alpine-meadow soil-rankers (Umbric Leptosol according to FAO). These soils are

developed on the frontal moraines with large porphyrite and granite-diorite boulders. The focus of this paper is on soil morphological description combined with chemical properties of humus and radiocarbon dating. The $^{13}\text{C}/^{12}\text{C}$ ratio in carbonates and humus has been under examination for loess and soils in order to clarify the type of vegetation and conditions promoting carbonates formation. Based on the radiocarbon chronology and $\delta^{13}\text{C}$ data of the burial soils the following major climatic events can be reconstructed: $\delta^{13}\text{C}$ value -4 - -5‰ in the C2 and C3 horizons of the mountain Chernozem (on the LGM moraine) characterized the glacial climate with the temperature about -25 grad of C. Unfortunately, no organic material was found for radiocarbon dating. We can assume, that the age is greater than 24-25 kyr BP. $\delta^{13}\text{C}$ Based on the data about -8 - -10‰ the cold and dry climatic period with temperature about 0 grad of C, with little alpine desert vegetation and highly weathered soils like Brjansk soil of Eastern Europe can be reconstructed. This period likely corresponds to the North Atlantic 2 Heinrich event. A similar horizon is described by Zech in Western Tian-Shan (24300 \pm 1160 years BP), as well as by Yan et al. in Tibet (25910 \pm 400 years BP). $\delta^{13}\text{C}$ According to data in the B1b horizon (-24.41‰) of a Chernozem-like soil, the warm period is reconstructed at about 14030 \pm 880 years BP with C-4 type of vegetation. It conforms to the 1 North Atlantic Heinrich event. $\delta^{13}\text{C}$ Cold and dry climate with temperatures about 0 grad of C and SAM-type of photosynthesis (in the C1 horizon -7 - -10‰) predominant, probably in the Early Holocene at about 10100 \pm 564 and 9130 \pm 640 years BP. $\delta^{13}\text{C}$ At the 8-6 kyr BP, we reconstructed the warm and dry period with temperature about $+150\text{C}$, when peats spread out in the piedmonts and lowlands due to glacial melting, the C-3 type of plants commenced to develop (values range from -19 to -29‰), composed mainly of meadows. The age of B horizon at the altitude 2350 and 2450 m in studied valley is 7130 and 6440 years BP respective. $\delta^{13}\text{C}$ The Holocene optimum events with a warm and dry climate, air temperatures greater than at the present, a C-3 type of vegetation on the Chernozem soils in the valleys can be reconstructed at 6-4 kyr BP. The age of the Ab horizon, as described above, is 5560 \pm 90 years BP. $\delta^{13}\text{C}$ Modern subalpine and alpine vegetation and Chernozem-like soils below the 3000 m, and subalpine soils at the altitude above 3000 m began to develop at 4-3 kyr BP, and a trend towards increasing humidity has taken place ever since ($\delta^{13}\text{C} = -28\text{‰}$). The age of the present-day A horizon in Chernozem-like soils is 3010 \pm 90 years BP and in alpine soil - 109 \pm 47 years BP. Thus, climatic changes in the Holocene in the mountain regions of Tian-Shan (Kyrgystan) seem to coincide in Tibet, Eastern Europe, North-western Caucasus and correspond to the global climate changes. But, these changes in Central Asia were probably less intensive than it in the other regions.