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Archives of Holocene geomorphological development in the Khangai Mountains, Mongolia

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The aim of this work was to obtain a deeper understanding of the factors triggering geomorphological processes in the semi-arid mountain forest-steppe of the Khangai Mountains in central northern Mongolia. We hypothesized that the pattern of geomorphological processes in this region is strongly influenced by (i) the spatial distribution of aeolian sediments and (ii) forest fires. We further assumed that the spatial and functional relationships between these two geomorphological factors lead to various types of sediment-soil archives of landscape evolution in different relief positions. These different types of archives should have recorded different pieces of information, which might be combined into a reconstruction of the landscape evolution in this area. We intended to use these different archives to reconstruct the Holocene landscape evolution, and in particular, to identify the roles of aeolian sediment distribution and forest fires on the geomorphological processes that took place over the Holocene.

The area is dominated by steppe vegetation. Only the north-facing slopes of the mountains, where reduced evapotranspiration leads to somewhat increased soil moisture, have forest. The bedrock on the slopes is overlain by Pleistocene periglacial slope deposits (PPSD), consisting of rock debris, which is mixed with fine sand in its upper part. These PPSD are widely covered by an aeolian sand sheet, which is usually more than one meter thick. IRSL ages indicate that the main deposition of these sediments took place 13-11 ka ago. Sediments at the toe slopes and on the valley bottom consist of layered, dark and lighter-colored, silty and sandy material with cryoturbation features. They apparently originate from soil material that has accumulated at the toe slopes and in the valleys by colluvial, fluvial and aeolian processes.

On the slopes under forest, charcoal commonly occurs in the upper 20 cm of the soils and provides calibrated ^{14}C ages of up to 2 ka. Calibrated ^{14}C ages of charcoal and soil organic carbon of the sediments at the toe slopes are generally older (up to 4.4 ka). This difference suggests that the charcoal produced by earlier forest fires, together with the sediment in which it is embedded, has been washed from the upper and mid slopes down to the toe slopes and valleys. Charcoal of later fires is at least partially still in the place of its origin, on the slopes.

Based on a set of 25 ^{14}C and 24 IRSL ages, we distinguish three main periods, i.e., (1) a period of extensive aeolian transport and deposition during the late glacial period, 16-11 ka ago, (2) a period

of geomorphological stability from early until mid-Holocene, and (3) a period of enhanced aeolian, colluvial, and alluvial processes since 4.5 ka. The abundance of charcoal, indicating frequent forest fires during the late Holocene, points to a severe change of environmental conditions and geomorphological dynamics. It is not yet clear whether this change is due to more arid climate or human activities. Therefore, our further research will focus on distinguishing natural and human influence on the landscape evolution in Mongolia since the mid-Holocene.