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Soil erosion and development in the loess landscape of the Trzebnica Hills reflected in isotopic analyses (^{10}Be, $^{239+40}$Pu) and OSL dating.

ABSTRACT

Loess landscapes are very susceptible to erosion processes which affects the stability, productivity, and transformation of soils. The Trzebnica Hills located in south–western Poland are one of such areas.

In present study, isotopic methods such as ^{10}Be in–situ, $^{239+240}$Pu were used to determine soil erosion rates. ^{10}Be in–situ, which is directly produced in the quartz crystal lattice as a result of cosmogenic rays, enables to determine long–term erosion, i.e., occurring since the surface was formed. In contrast, $^{239+240}$Pu, which were globally introduced into the environment mainly as a result of the production and testing of nuclear bombs in the 1960s, give a possibility to calculate short–term erosion rates, which has occurred over the past 60 years. In addition, optically stimulated luminescence (OSL) dating was used to reconstruct temporal erosion–deposition processes. Directions for the development of agriculturally used soils under conditions of intensive erosion were also identified.

Two transects along two slopes with pronounced erosional features were sampled in the southern part of Trzebnica Hills. In collected soil samples basic physico-chemical analyses and isotopic analyses (^{10}Be in–situ, $^{239+240}$Pu) were performed. Moreover, in selected soil horizons OSL dating, and micromorphology analyses were done.

Long–term soil erosion rates ranged from 0.44 to 0.85 t/ha/yr, while short–time erosion rates ranged from 1.2 to 10.9 t/ha/yr. These values lie within the range of data presented for other loess areas in Europe. Short–term erosion rates are significantly higher than long–term due to the intensification and mechanisation of agriculture in the XX century, but also climate change may be an additional factor intensifying erosion processes. Moreover, short–term erosion rates considerably exceed tolerable erosion rates which range from 0.5 to 1.0 t/ha/yr, thus soils in the study area are subject to degradation. It is reflected in the shallowing of the eluvial and argic horizons in soils classified as Luvisols. Progressive

erosion processes lead to the complete removal of these horizons, so the soils are transformed into Regosols. However, in the lower parts of slopes eroded material was deposited, soils with solimovic qualifier occurr. OSL dating reveal that the first phase of sediment redeposition on the slopes occurred about 9.1 ka ago. Subsequent ones occurred in the Neolithic (6.4 ± 0.3 ka), Bronze Age (3.8 ± 0.2 ka), Medieval (1.5 ± 0.1 ka) and early Modern Period (0.4 ± 0.02 ka). These results are consistent with those of other studies in Central Europe, thus confirming the occurrence of a dynamic denudation system and multiple erosion–accumulation events in the loess landscape of south–western Poland.

Key words: Loess landscape, soil erosion, denudation, ^{10}Be in–situ, $^{239+240}$Pu, radionuclides, OSL dating, Luvisols.