Geophysical Research Abstracts
Vol. 19, EGU2017-783, 2017
EGU General Assembly 2017

Experimental observation and modelling of rock – water interaction in a landslide-prone loess area of Hungary

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It is well known that water from precipitation or other sources (e.g. groundwater, river) contributes to the triggering of landslides by means of infiltration into the slope, which causes an increase in the pore pressure and a reduction in the strength of the involved material. The physical failure is commonly coupled with chemical changes in landslides due the fact that soluble components dissolve in the pore water and others precipitate during rock-water interaction. Thus the composition of sediments and water chemistry are used jointly as indicators of the development of landslides. Rock-water interaction, however, takes a long time, and depends on hydrology and geochemistry of the landslide area; therefore, many researchers have focused on numerical simulation and laboratory experiment for setting up a landslide early warning system.

Since water chemistry can change over time in landslides due to the seasonal rainfall pattern, groundwater fluctuation and flood events, the intensity of rock-water interaction (e.g. dissolution, precipitation) may also vary. Thus, the physicochemical processes cannot be elucidated precisely without understanding both the solution evolution and the mineral alteration in landslides. From this aspect, field survey, mineralogical (XRD, FTIR, DTG) and chemical measurements (ICP-OES), and geochemical modelling (PHREEQC) were conducted in a landslide-prone loess area along the River Danube (Hungary). Water from the River Danube and three springs were sampled during four field campaigns at Kulcs over a year. Additionally, landslide deposits including sliding surface and secondary precipitations were collected at Kulcs and Dunaújváros. In combination with previous hydrochemical analyses of the area and average rainfall composition of Hungary, it is possible to model the kinetic dissolution and precipitation of minerals during rainfall events and flooding periods of the river.

The chemistry of springs shows that the Mg-Ca-HCO_3 facies with high electrical conductivity (898 – 1227 μS/cm) may occur due to the dissolution of carbonates and silicates throughout the year. During occasional rainstorms in summer, however, it is found that the pH of the springs slightly increased while their electrical conductivity decreased tenfold. This can be attributed to the rapid infiltration of rainwater through fractures and holes of the loess deposit. Similar process can take place at Dunaújváros, however, larger subsidence happened there than at Kulcs. The secondary precipitations indicate that dissolved components in groundwater precipitate as calcite at the foot of the Dunaújváros landslide. Furthermore, the comparison between model of loess-river water and loess-spring water interaction suggests that the dissolution of dolomite, Ca-montmorillonite and chlorite is stronger during flooding than during low water level of the river. Therefore, frequency and duration of rainstorms and floodings may have deeper consequences for loess landslides.