EGU22-6290, updated on 20 Mar 2023
https://doi.org/10.5194/egusphere-egu22-6290
EGU General Assembly 2022

The influence of mineralogical composition on degradation of badland materials under different climate conditions

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Badlands are areas with limited vegetation, reduced or no human activity, and a great variety of geomorphic processes present. Besides lithology, the climate has a crucial role in the initiation and development of badlands. Controlled conditions during laboratory experiments provide detailed insight into processes that occur in the nature. Many studies have shown that the type and content of clay minerals, specifically presence of smectite is important for predicting the behavior of sediments subjected to different weathering treatments like freezing, thawing, wetting, and drying.

This study is aimed at comparing changes in physico-chemical properties of sediments caused by simulations of climatic conditions. For these experiments, three unweathered samples with different mineralogical content were taken from the Vallcebre and Bagà badlands in Spain. Besides quartz and calcite as dominant minerals, one sample contained smectite and gypsum, the second smectite, and the third neither smectite nor gypsum. The experiment was set up in a way that each sample had three sub-samples from which one was subjected to rain, the second to snow, and the third was the control sample. The experiment had two parts. In the first part, after simulation of rain (~140 ml) or snow (~150 g), samples together with a control sample were placed in a climate chamber at a temperature of -3 °C. After initial 15 cycles, in the second part of the experiment, all samples regardless of the previous treatment were subjected to rain (~140 ml), after which together with the control sample were placed in a climate chamber at a temperature of 50 °C. These treatments were repeated 8 times.

Throughout the experiment, after each cycle, samples were photographed for monitoring surface changes, while the leached solution was collected and its volume, pH, electrical conductivity (EC), and ion concentrations were measured. Field Emission Scanning Electron Microscopy (FESEM)

results showed that the changes in microstructure occurred after weathering experiments, while Brunauer-Emmett-Teller (BET) surface area analysis confirmed that the sample with only smectite had the highest specific surface. Also, it was corroborated that temperature without simulation of rain or snow does not affect the decomposition since the control samples remained intact during the whole experiment. Results have shown that snow is a more destructive agent, especially for the sample with smectite. Due to the content of gypsum, which increases the weathering resistance of the material, the sample with smectite and gypsum has shown a lower degree of degradation than the sample with only smectite, while sample without smectite and gypsum has shown the lowest degradation of the structure. Furthermore, the sample with smectite and gypsum has shown significantly different values of leachate pH, and EC. The concentration of sulphate was the highest in the sample with smectite and gypsum, which is a consequence of the dissolution of gypsum. The obtained results confirm that the response of sediment to different climatic factors depends on their mineral and physico-chemical properties and provide a basis for further research of prediction land degradation in conditions of climate change.