Weathering and Alteration of Carbonate Rock Interfaces in the Aeration Zone of the Hainich Critical Zone Exploratory, Germany

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Biogeochemical processes in the Aeration Zone (AZ) controls the transfer of energy, matter, and information from the soils sensu stricto to the groundwater aquifers and vice versa. However, typically less attention was given to their significance in the pristine mountainous recharge areas. Hence, we study the biogeochemical weathering and alteration of exposed rock surfaces (carbonate rocks) in the AZ of the Hainich Critical Zone Exploratory (Hainich CZE), Germany. A majority of the subsurface of the Hainich CZE is subject to strong, rapid and frequent groundwater fluctuation. Rock samples were acquired from outcrops and six boreholes, up to 43 m in depth, representing surface exposures, aeration zone, groundwater fluctuation zone, and the saturation zone. Visual examinations of prepared thin sections were made by means of digital microscopy and SEM, while elemental and mineralogical analyses are planned to carry out based on SEM-EDX, LA-ICP-MS, μ-XRF, and XRD. Moreover, selected rock samples will be used to find out the microbes that contribute to surface coatings with specific emphasis of the AZ. Fracture wall surfaces of limestones in the AZ are composed of a dark-brownish colored thin weathered crust. Selected samples show a sharp boundary between the weathered crust and the host rock, while others exhibit a gradual weathering front. Dissolution of micritic limestone has resulted in enrichment of clay minerals and iron-bearing minerals along the fringes of the dissolved calcite crystals. SEM-EDX analysis revealed that clay minerals and iron oxides are the main components of the alterated rim. Interbedded clay-rich marlstones exhibit a higher weathering in the AZ, could directly provide clayey particles to the percolating water. These results suggest that the clays and iron oxides can be products of authigenic formation within dissolved shell fragments and in vugs or/at exposed rock surfaces or substituting deposition of clayey residue inside the dissolved calcite probably due to percolating waters. However, our investigations will lead to a comprehensive understanding of the implications of weathering and alteration and the effect of groundwater fluctuation on the exposed rock surfaces in the AZ of the Hainich CZE.