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Weathering of rock surfaces in the Zermatt-Saas area (Swiss Alps), weathering rinds resulting from water-rock interaction

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The geogene component of the chemical composition of most surface waters is contributed by interaction of precipitation water with silicate rocks exposed in the catchment. Mineral solubility and rates of dissolution reaction control the water-rock interaction process. We have studied the chemical composition of surface waters and weathering crusts of exposed rocks in high Alpine catchments of the Zermatt-Saas area (Swiss Alps). Surface water in this area is predominantly controlled by the interaction of meteoric water with the exposed rocks.

Water-rock interaction acquires solutes for the surface waters but also chemically and mineralogically alters the near surface volume of the exposed rocks. Exposed rocks in Zermatt-Saas area include various metamorphic oceanic rocks of the Zermatt-Saas ophiolite unit (ZSU) and continental rocks of the nappes above and below the ZSU. During early stages of Alpine orogeny, the ZSU has been subducted and transformed to eclogites and other high-pressure rocks. Fragments of the oceanic material were returned to the surface as serpentinites, eclogites, eclogite facies metagabbro and metasediments. At many outcrops exposed rocks show distinct signs of surface alteration and are coated with rust-colored weathering crusts. These crusts often display a rough surface texture and are porous as a result of intense chemical weathering. For the purpose of this study we collected typical samples of strongly weathered common rocks of the area, including serpentinite, greenschist and gneiss. The sampling locations were typically close to bodies of surface water.

We found that the penetration depth of the interaction between surface water and exposed rocks ranges from 0 - 20 mm. In some strongly altered rocks the interface of the alteration reaction between altered and fresh rock was located several cm below the surface. The presence and thickness of reaction crusts is limited by access of water to the reaction sites (reaction front), specifically to the amount of reaction-created porosity and other water-conducting features. Six pairs of carefully separated weathered and fresh parts of rocks were analyzed by X-ray fluorescence to study the bulk composition evolution. 15 thin sections from the weathered part of the rock samples were examined by microscopy. Clear alteration textures were observed on most reactive minerals, like olivine, chlorite, serpentine, pyrite and others. Reaction related chemical changes of such minerals were analyzed by electron microprobe.

Weathered rocks from the same lithology have texturally and chemically very similar alteration crusts throughout the area. In metabasaltic rocks like greenschist, chlorite was found to be very finely intergrown with Fe-oxyhydroxide on a μm scale in the alteration zone close to and at the weathered surface. In ultramafic rocks like serpentinite, the alteration from olivine to chrysotile was commonly found. The bulk composition differences between weathered and fresh parts of the rock samples can be correlated with the chemical characteristics of surface water from the respective catchments.