Exploring fracture dominated flow and spatially variable chemical weathering in the Boulder Creek Critical Zone Observatory, Colorado, USA

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The spatial and temporal evolution of saprolite development on hillslopes controls soil production and sediment supply to rivers. We study the interaction between fluid flow and chemical weathering in the Boulder Creek watershed, a 1160 km^2 catchment that ranges in elevation from 4120 m at 1480 m. We developed our understanding of the formation of saprolite in a granitic mountain catchment by modelling the subsurface flow paths in an environment dominated by fracture flow. Two-dimensional hillslope hydrology models were constructed in a Richards equation-based model to visualize flow paths in the unsaturated zone. We expect fracture density and fracture size in the bedrock to exert the strongest control on both the depth of water penetration into the bedrock, and its residence time in the subsurface. The importance of fractures on the routing of water and development of saprolite in the unsaturated zone will be explored further through XRD and XRF analysis of selected samples of soil, saprolite, and bedrock collected along road cuts at specific points relative to the local fracture system

Geochemistry of tonalites formed by partial melting of eclogites: Experimental modelling

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Processes of the partial melting of the metagabbroic rocks (eclogites) in subduction zones may lead to tonalites formation. Experiments aimed to study the formation mechanisms of the clinopyroxene-plagioclase symplectite textures that usually occur during decompression of eclogites. Piston cylinder experiments were performed at 700ºC and 9-11-13 kbar (corresponding to T-minima of wet basalt solidus) at the experimental petrology laboratory of the University Kiel. Run durations varied from 18 hours to 16 days. As fluid phase 0.1 M NaCl-H_2O was used. Starting material was unaltered bimineral (garnet+omphacite) eclogite from the Marun-Keu complex (Polar Urals), formed at 670-690ºC and 16-18 kbar.

During the experiments, the eclogitic garnet grains remained stable, but the composition of their rims changed. Primary omphacites were unstable and were partly or totally recrystallised. As a result, clinopyroxene and plagioclase intergrowth (often accompanied by hornblende) was formed. The compositions of newly formed minerals are in very good agreement with symplectites of the Marun-Keu eclogites. In the association with the symplectites, melt (quenched glass) was found. The melt formed domains, which are sometimes surrounded by a Cpx rim. Also the melt was found as a part of the newly formed symplectitic intergrowth and as a rim around primary eclogitic garnets. The melt (glass) corresponds to a tonalitic composition, with SiO_2 varying from 54 to 71 wt% and Al_2O_3 from 22 to 12 wt% accordingly. Furthermore, the melt contains up to 14 wt% of a fluid phase; the fluid amount increases with decreasing SiO_2 content. Trace elements compositions of the melt domains were obtained by ion microprobe. They show general depletion of the studied elements (exept for Sr) compared to the initial eclogites that correspond to MORB, while Sr is clearly enriched. Moreover a peak in Eu content is noticable.

In summary, our experimental results show formation of tonalitic melt with unusual low trace element content by partial melting of eclogite in equilibrium with garnet and newly formed clinopyroxene at 700°C.

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