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Formation of contact metamorphic reaction rims in the southern Adamello Massif, N-Italy: A natural study on transport controlled growth mechanisms

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Metamorphic reactions in contact aureoles are often driven by fluid-infiltration leading to large element fluxes and metasomatism between adjacent lithologies with different bulk composition. Quantitative knowledge of mechanisms, rates, and controlling parameters is crucial to extract detailed information of the time-dependent evolution of the reaction rim. In this study, we present a detailed petrographic and geochemical characterization of the evolving reaction rims in rocks of the Buchenstein formation, which is part of the Adamello contact aureole. Here, the intrusion of the southern Adamello batholith into mainly dolomitic and calcareous sequences of lower to middle Triassic sediments produced a variety of metamorphic reactions and metasomatic textures. The investigated sequence, which is part of the so-called Buchenstein formation, consists of well bedded pure limestones with nodular chert layers and some volcanoclastic, shale and sandstone intercalations. Studied samples have a distance of about 400 m to the next igneous rocks.

On thin section scale four layers can be distinguished. Progressing from hornfels to marl layers the zones are as follows: (1) A hornfels layer that consists of biotite and a fine-grained matrix of plagioclase and k-feldspar, (2) a reaction layer containing clinopyroxene and increasing amounts of plagioclase accompanied by a decrease of k-feldspar, (3) an almost monomineralic wollastonite layer, and (4) a calcite marble with abundant small clinopyroxene grains. This whole sequence is about 5 cm in length and repeats itself on hand specimen scale, whereas the exact width of different layers can vary between samples. We determined two different reaction rims formed at distinct interfaces: (a) between a fine-grained, dark brownish hornfels and a thin silica-rich layer, (b) between the silica-rich layer and a coarse grained calcite marbles.

The chemical composition of plagioclase, k-feldspar and clinopyroxene has been measured with EMPA along the observed layer structure. Compositions of clinopyroxenes suggest a slight increase in Fe-content torwards the wollastonite layer. K-feldspar does not show large variations in composition. The anorthite-component (An) in plagioclase increases with decreasing distance to the calcite marble. Taken together, these gradients represent the major element fluxes of Ca, and Si during fluid-infiltration at elevated temperatures. The effective element flux resulted in different reaction types during infiltration of a magmatic fluid phase [$X(CO_2)<0.2$]. On one hand, we observe an almost monocrystalline wollastonite layer that is formed by a net mass transfer reaction growing from the original interface into the calcite marble controlled by the effective silica flux. In the opposite direction, the flux of calcium into the Si-rich layer is recorded by a recrystallization of plagioclase with higher An-content (An80-90).