Fluid enhanced element mobility along lithological contacts: An example from Skallevikshalsen, Lützow Holm Bay, ..

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Lithological contacts are weak zones in crustal regimes, where fluids and melts can penetrate and move, and enact extensive chemical alterations. The presence of fluids and melts can also enhance mobility of elements. Although, earlier studies have focused on fluid-rock interaction along lithological contacts, several ambiguities still remain regarding the length-scales, time dependency and compositional effects of fluids. Here we present a detailed petrologic and stable isotopic case study of fluid-enhanced metasomatism and related mineralogical changes along a contact between a lens of calc-silicate rock enclosed in pyroxene gneiss at Skallevikshalsen, Lützow Holm Complex, East Antarctica. Here orthopyroxene felsic gneiss, garnet-sillimanite gneiss, garnet-spinel-sillimanite gneiss, garnet-biotite gneiss and marble layers are the dominant lithological units. Earlier studies on the metamorphic evolution at this locality suggested a peak metamorphic P-T condition of around 850ºC and 0.6-1.1 GPa. Presence of kyanite and staurolite inclusions in garnet and formation of retrograde cordierite-bearing assemblages in this region is indicative of a clockwise P-T evolution with a prominent decompression during retrograde metamorphism.

The calc-silicate lens of the present study is about 2 m thick, 10 m long and has tapering ends. The margins and intermediate portions of the lens comprises of calc-silicate minerals such as grossular, wollastonite, scapolite and diopside, whereas the inner core of the lens is mostly of calcite. This zonal structure of the calc-silicate lens suggests that the calc-silicate minerals were formed by decarbonation reactions that occurred during the interaction of calcite-rich marble with the surrounding pyroxene gneiss during the regional granulite facies metamorphism. The contact zone of the calc-silicate lens with the pyroxene gneiss is marked by the occurrence of a centimeter thick graphite-rich domain. A felsic domain of about 3 to 5 cm thickness is observed toward the pyroxene gneiss. Nearer to the graphite-rich zone, polygonal grains of scapolite, diopside and titanite are observed. Few millimeters away from graphite-rich zone, spectacular microstructures of partial or complete replacement of plagioclase with a symplectite intergrowth of scapolite and K-feldspar is observed. Scapolite is meionitic in composition (EqAn ˜58) and contains only 0.5 wt.% of K2O, whereas K-feldspar contain minor amounts of Na2O (Or85Ab15). Minor amounts of graphite, diopside and titanite are also observed. Quartz and calcite are absent in this zone.

Progressive development of scapolite-K-feldspar symplectite can be observed at different stages within a single thin section in this domain. It is evident that the symplectite develop at the expense of plagioclase (Ab62An36Or2). However, the product phases have a reintegrated composition of ˜Ab30An30Or40. In addition, CO2 has also been added to form the scapolite. This suggests that potassium and CO2 has moved in to the system from outside. Either a melt or a fluid enriched in potassium and CO2 should have infiltrated this contact to form the symplectite.

We envisage the formation process of symplectite as a perfect example of fluid enhanced metasomatism along the contact zone between calc-silicate lens and orthopyroxene felsic gneiss. Pooling of CO2 at the contact resulted in the formation of scapolite and precipitation of graphite along the contact. This conclusion is in agreement with the widely observed CO2-rich fluid infiltration in the Lützow Holm Complex. We also present detailed carbon and oxygen isotope results of calcite (delta13C = -1.2? and delta18O = 19.3?) and graphite (delta13C = -4.4?) in the contact, which further suggests that the CO2 fluid was derived locally from the decarbonation of the marbles in stratigraphically lower horizons during the regional metamorphism.