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Crystal size distribution (CSD) of periclase in contact metamorphic dolomite marbles from the southern Adamello Massif, Italy

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The crystallization history of a rock is recorded in the size and the distribution of its minerals. Crystal size distributions (CSD) provide information about the complex interaction of nucleation and growth of minerals with respect to changing pressure, temperature, and fluid composition. While a number of studies have shed light on CSD´s of crystals grown in metamorphic systems due to temperature or pressure changes, less is known about CSD´s for minerals grown due to fluid infiltration.

We present a study combining textural analyses and geochemistry data of a brucite (after periclase) dolomite marble from the southern Adamello massif, Italy. The outcrop is located on the western flank of the Cima Uzza. Small stocks of mafic intrusions occur at the border and within the tonalitic batholith. Seven samples of a 4m x 6m-sized marble outcrop consisting of dolomite, calcite and brucite pseudomorphs after periclase were collected as a function of the distance to its contact with the mafic intrusion. Cores of 3mm in diameter were drilled out of the samples and X-ray Microcomputer tomography images with a resolution of 3.88μm per pixel were obtained. The total number of grains were normalized to 1ccm and the diameters of brucite pseudomorphs were corrected for the volume change of the retrograde periclase $\rightarrow$ brucite reaction, to obtain the original grain size of periclase.

Analyses reveal that the number of grains per unit volume decreases with increasing distance from the contact. The grain size histograms mimic a Poisson-distribution. The peak of the Poisson distribution is at a radius of about 40μm and is independent

of distance from the contact. With increasing distance to the contact the distributions become broader, reflecting the bigger grain sizes.

All samples still contain the reactant dolomite, indicating that the reaction did not go to completion. Surprisingly, the volume fraction of periclase is constant, and hence reaction progress exhibits no correlation with the distance from the intrusion.

Stable isotope compositions for oxygen and carbon were obtained for the bulk carbonate samples. Results show a depletion of ^{13}C and ^{18}O for samples near the contact, with lowest measured values of 14.6 permil (VSMOW) for oxygen and -3.2 permil (PDB) for carbon. Isotope composition changes rapidly with increasing distance from the contact. At only 80cm distance the sedimentary values of δ^{18}O $\approx$ 28 permil and δ^{13}C $\approx$ -1.0 permil were found. Calcite-dolomite thermometry data yield temperatures between 544˚C and 590˚C. These temperatures are clearly too low to represent the formation temperature of periclase and thus rather reflect the effect of retrogression during cooling.

Taken together the geochemistry data confirm the presence of a fluid phase and the observed crystal size distributions are interpreted to be the result of high temperature fluid infiltration.