Temperatures of Neoproterozoic Regional Carbonate Alteration in the Eastern Desert of Egypt

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Neoproterozoic ophiolites in the Eastern Desert (ED) of Egypt are pervasively carbonated and listvenitized. Two types of carbonation are recognized: 1) intergrown magnesite (and to lesser extent dolomite) with serpentine and talc that in cases form pure carbonate veins, and 2) cryptocrystalline magnesite veins filling the fractures crosscutting other ophiolitic host rocks. Few studies address the conditions of carbonate alteration of ultramafic rocks, especially the temperature of altering fluids. We employ clumped isotope thermometry on natural dolomite and magnesite from 17 variably carbonated ophiolitic rocks and veins in the ED. Five samples of antigorite-bearing serpentinite, talc-carbonate, and associated carbonate veins yield wide range temperatures of magnesite and dolomite between 213 to 426°C (285±73°C). These temperatures are comparable with previous fluid inclusion thermometry carried out on some of the vein samples (homogenization temperature between 225 to 383°C; Boskabadi et al. 2017). Ten samples of fully quartz-carbonate altered peridotites (i.e. listvenites) record even a wider range of clumped isotope carbonation temperatures between 90 and 452°C (227±112°C). In contrast, two samples of late-stage veins of cryptocrystalline magnesite record lower temperatures of 19 and 28°C. While the constraints on the pressure of carbonation are lacking, the wide range of temperatures for the carbonates in antigorite-bearing serpentinite, talc-carbonate, and listvenite lithologies suggest that carbonation probably occurred at variable depths, whereas the low temperature of cryptocrystalline magnesite veins points to conditions nearer the surface most likely associated with post-obduction processes. Therefore, different sources of carbon and CO$_2$-bearing fluids should have been responsible for the formation of high- and low-temperature carbonates in the region.
