Magmatic epidote: A tracer of peritectic reactions in wet mafic magmas

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Epidote is commonly known as primary igneous mineral in intermediate plutonic rocks. Experiments done at different pressure indicate a minimum stability of epidote around 650°C and 0.3-0.7 GPa depending mainly on the fO_2 and bulk composition. However only few data are available on epidote stability in more mafic systems at H_2O (under)saturated conditions.

Epidote-bearing gabbros are very sparse and always associated with the deep part of continental crust (>30 km) as in the Kohistan Arc Complex (Pakistan) (P=1.2-1.5 Gpa) or in the Chelan Complex (USA, Washington State) (P=0.8-1.0 GPa).

Whereas epidote is an accessory phase (~2%) in the Chelan Complex compared to the Kohistan Arc Complex (~20%), they both show similar quartz-epidote intergrowths interpreted as the near solidus product of crystallisation in these systems. The major element composition of epidote indicates a Xep (Fe/(Fe+Cr+Al-2)) between 0.3 to 0.7. Epidotes of the Chelan Complex are on the most iron rich side (Xep=0.55 to 0.7) and aluminium rich epidotes are found in paragonite gabbros of Kohistan (Xep 0.3 to 0.55). In rare cases vermicular allanitic cores are present as well as some intergrowth of different epidote in paragonite epidote gabbros. The REE patterns show more complicated variations within a single grain indicating different reactions forming epidote. The strongly enriched pattern in LREE $(La/Yb)_N$ ~100) are interpreted as equillibrium crystallisation from a liquid. The depletion in LREE with $(La/Yb)_N$ down to 0.03 could indicate epidote growth at the expense of garnet whereas epidote enriched in MREE $(Gd/Yb)_N$ ~20) could be the product of a peritectic reaction involving hornblende or pyroxene.

We propose that the trace element chemistry of epidote is a useful monitor to decipher peritectic reactions in wet mafic magmas at high pressure (1.0 to 1.5 Gpa).

Interpreting the variability of oceanic oxygen

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Oxygen plays a fundamental role in the biogeochemistry of the ocean, integrating photosynthesis and respiration along circulation pathways, and influencing the physiology of marine organisms and important chemical reactions. I will review mounting evidence for pervasive changes in ocean oxygen concentrations in order to highlight two recurrent features that call for a mechanistic explanation. First, the magnitude of variability is particularly strong at decadal time scales and second, it shows a pronounced maximum in the lower thermocline. A simple model of the oxygen cycle suggests that these statistical descriptors could arise from random fluctuations in biological productivity and/or circulation. Similar patterns are illustrated using state-of-the-art numerical simulations. These results suggest that along with long-term climate change, stochastic processes may be an important influence on the large-scale decadal variability in the biogeochemical state of the ocean.