Textures of progressive garnet growth recorded in Ti-rich metagabbros from the southern Tongbai Mountains, central China

CHIN-HO TSAI[1]*, HANWEN ZHOU[2], YOSHIYUKI IIZUKA[3] AND RACHEL J. BEANE[4]

[1]Institute of Earth Sciences, National Hualien University of Education, Hualien 970, Taiwan (tsai@mail.nhlue.edu.tw)
[2]Faculty of Earth Sciences, China University of Geosciences (Wuhan), PR China
[3]Institute of Earth Sciences, Academia Sinica, Nankang, Taipei 115, Taiwan
[4]Geology Department, Bowdoin College, USA

A suite of garnet-bearing Ti-rich metagabbros crops out in the southern Tongbai Mountains, in which one of the largest rutile ore deposits in China is located. Field occurrence shows that the garnet-bearing metabasites were derived from gabbroic plutons with internal compositional variation. Major mineral constituents are garnet, amphibole, and rutile. Rutile is remarkably abundant and relatively large compared to those in most metabasites. Minor, accessory, or secondary minerals include paragonite, albite, chlorite, titanite, epidote, clinozoisite, quartz, ilmenite, pyrite, apatite, carbonate, and zircon. In some relatively more felsic samples, albite and paragonite are the major phases. Foliations, if existing, are mainly defined by paragonite and epidote. Whole-rock XRF data show high TiO_2 content, up to 4.2 wt %. Petrographic features show at least three textural types of garnet: (1) aggregated porphyroblasts (Type I), commonly forming a atoll-like chain which surrounds rutile, green amphibole, and quartz; (2) relatively more euhedral but individual porphyroblasts (Type II), mainly in more felsic samples; and (3) fine-grained, optically-anisotropic neoblasts (Type III) in strange dendritic alignment, with high-angle connecting with the Type I garnet chain and pointing inwards. Type II garnet porphyroblasts seem to have been grown from coalescence of smaller precursors. Some Type III garnet grains contain elongated ilmenite rods. Element mapping analysis on Type I with EPMA shows weak zoning. In general, Type I is rich in almandine (62-77 mol %) and grossular (11-26 %). An EBSD study has been performed on three samples from this suite. Preliminary results show that, crystallographically, Type I chain-like garnets are randomly oriented. There are significant grain boundaries between Type I and Type III garnets, indicating separate nucleation of the latter. The different garnet textures represent different stages of metamorphic recrystallization or reaction.

Modelin Phosphorus cycling and Carbon burial during Cretaceous oceanic anoxic events

I. TSANDEV*, C.P. SLOMP, P. KRAAL AND P. VAN CAPPELLEN

Utrecht University, Utrecht, Netherlands
(*correspondence: i.tsandev@geo.uu.nl)

During the warm humid world of the Cretaceous, there were episodes of oxygen depletion in the deep ocean associated with enhanced organic carbon burial in sediments (black shales). In this study, we use a box model of the oceanic phosphorus (P), organic carbon and oxygen cycles to test the hypothesis that enhanced delivery of phosphorus from the continents can trigger deep ocean oxygen depletion (anoxia) and black shale formation under Cretaceous ocean conditions.

We find that, for the Cretaceous ocean, with large continental shelves, slow oceanic overturning and high sea surface temperatures, oceanic anoxic events (OAEs) can be triggered by enhanced P supply from land and that the system is particularly sensitive to oceanic mixing conditions. In this scenario, the deep sea becomes completely anoxic, while the shelves attain only partial anoxia. Sedimentary burial differs between the shelves and open ocean: while organic carbon burial is enhanced in both regions, deep sea reactive P burial decreases dramatically under anoxia, but not on the shelves, where oxygen depletion is only partial.

Furthermore, our model results suggest that OAEs can be sustained by P recycling from sediments under low oxygen conditions. We find that, to terminate the anoxic event, a feedback from accumulating atmospheric oxygen is required. This atmospheric oxygen cycle needs to be further modulated by land processes such as forest fires and oxidative weathering. Our model findings are corroborated by C and P burial data from the geological record for OAE-2 (~94 Myrs BP).

Through a sensitivity analysis we identified two necessary criteria for OAEs: low mixing of surface and deep waters (poor ocean ventilation) and enhanced sedimentary P recycling under low oxygen conditions. When these criteria are met, ocean anoxia is a robust result to a mild increase of continental supply of nutrients, under a wide range of environmental conditions.