Carbonic fluid production during regional and contact metamorphism in the Black Hills, USA

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Introduction

Graphitic metapelites constitute significant portions of collisional orogens. If graphite gets consumed during metamorphism, there is potential for release of massive amounts of carbonic fluids into the atmosphere. We investigated consumption of graphite and production of carbonic fluids in Black Hills metapelites that were regionally metamorphosed and later intruded by the Harney Peak Granite during the Proterozoic Trans-Hudson orogeny. Regional metamorphic grade ranges from greenschist facies to lower amphibolite facies. The contact-metamorphic overprint heated the rocks to the second-sillimanite conditions.

Composition of graphite and fluid inclusions

Crystallinity of graphite, as revealed by X-ray spectra, is the same at all metamorphic grades. However, $\delta^{13}C$ values range from –30.4‰ to –21.3‰. Although there is a weak correlation of increasing values with grade, there is greater amount of correlation with the amount of graphite in the rocks, where rocks with most graphite tend to have the lowest $\delta^{13}C$ values. Whereas most lowest-grade metapelites have abundant graphite, rocks in the aureole of the Harney Peak granite have little graphite, mostly as inclusions in regional garnets. In the contact aureole, graphtie has been mostly consumed from the matrix. The aureole has also elevated Li concentrations, which can be attributed to metasomatism by infiltrating magmatic fluids from the granite and its pegmatite aureole [1].

Fluid inclusions in syn-metamorphic quartz veins, as revealed by microthermometry and Raman spectroscopy, are complex mixtures of H_2O-CO_2-CH_4-N_2 and other species. Many samples are dominated by H_2O-CH_4 mixtures, suggesting that methane may have been the dominate carbonic species evolved and its production caused increase in $\delta^{13}C$ of the graphite. The apparent dominance of methane contrasts with the predicted composition of fluid in equilibrium with graphite, which should have equimolar CO_2 and CH_4 concentrations [2].

References

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Structure and diversity of microbial communities at two methane seep sites (Gulf of Guinea)

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During the French oceanographic cruises Biozaire 1 (January 2001) and Biozaire 2 (November 2001) in the Gulf of Guinea two methane seeps, lately discovered by the geologists of Ifremer (DRO/GM), have been investigated. Sampling of animals and sediments have been done with a Remote Operated Vehicule (Victor 6000). Sediment cores have been taken on bacterial mat and close to animals known as organisms depending on chemoautotrophic nutrition (Bivalvia Mytilidae and Vesicomyidae, Pogonophora). Measurements of physico-chemical parameters (temperature, methane, dissolved oxygen, sulfides and pH) have been carried out.

In sediments, microbial aggregations of methane-oxidising archae (ANME2) and sulfate-reducing bacteria (Desulfosarcinales) have been observed using fluorescent *in situ* hybridisation (FISH). These aggregates are known to be involved in the anaerobic oxidation of methane (AOM).

This study compares the number and the repartition of microbial aggregates in sediments for different places of the methane seep (close to mussels, close to clams, beneath a microbial mat …). The results are interpreted in relation with methane and sulfide concentrations.

Bacterial symbionts in mussels and clams have been identified by 16S rDNA. The presence of both methanotrophic and thioautotrophic symbionts in mussel gills, and only thioautotrophic symbiont in clam gills is discussed in function of methane concentrations and repartition of microbial aggregates involved in AOM.

References

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