Alkaline hydrothermalism in S-, rare metal and P-rich black shales

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Alkaline hydrothermal fluids favor phosphate chemistry and the dissolution of organic acids and bases, and were proposed as a possible scenario for the emergence of life in the Archaean (Russell & Hall, 2002). In high S₂ environments, Fe-sulfide membranes would have thus played a major role. Most of the studies on microfossils in Archaean chert plead however for acidic fluids. Furthermore the record of sulfurized microfossils in S-rich cherts is poorly known (Rasmussen, 2000). To improve the experiential knowledge in this field, we studied Upper Devonian black shales from a continental margin (Selwyn Basin, Canada) for micromineralogy and mineral chemistry (SEM-EDX-EMP-PIXE-NR). The sediments have been pervaded by alkaline fluids (< 260°) that precipitated successively Na-, K- and Ba-K-feldspar, quartz, Ca- and REE-phosphates, U-Ti-oxides and Ag-Cd (Cl) alloys. Tube worms (about 30µm) as known from hydrothermal vents, are preserved as Fe-(Ni)-sulfides. Biogenic silica bands are separated by nanometric Znsulfides, probably derived form microbial reduction. Sulfurized worm tubes host several hundreds to thousands ppm of Se, Mo, As, Sb, Tl. Diagenetic abiogenic sulfides are Ni and Se rich. Nitrogen was analysed in biogenic and abiogenic sulfides (about 400 ppm), phosphatic fossil fragments (800 ppm), organic matter (OM, 6000 ppm), quartz (800 ppm). Highest contents occur in hydrothermal feldspars (1-2 wt.%). A two-step N release is proposed for the present N-repartition: (1) OM breakdown provides nutrients for the tube worms. (2) Biomineralisation of the fauna partly releases N to the diagenetic fluids and is incorporated in abiogenic sulfides and quartz. Ammonium (NH_4^+) derived from the breakdown of organic matter is fixed in feldspars (at high T), where it replaces K⁺ in the silica structure.

References

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Zircon geochemistry of Mid-Miocene adakites in the southern Patagonian province

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Zircon (ZrSiO₄) occurs extensively in most igneous rocks of mafic to felsic compositions, and remains stable against weathering, alteration and plutonic/ metamorphic processes due to chemical resistance and refractory. Some of igneous zircons are possibly crystallized in earlier stage of magmatic process, and therefore zircon geochemistry combined with U-Pb dating can provide advanced petrogenetic information. Recent studies (e.g., Belousova et al., 2002) have demonstrated geochemical signature for igneous zircons could be used to discriminate most rock type. However, the geochemical characteristics of zircon in adakite are still unknown. Our research group has determined major and trace element compositions and U-Pb ages, using EPMA and LA-ICP-MS, of about 50 zircon crystals each extracted from the Mid-Miocene adakite bodies in Cerro Pampa (CP; 12Ma) and Puesto Nuevo (PN; 16Ma, unpublished data), Patagonian province (Ramos et al., 1994).

Our result has shown that all CP zircons were recycled and originated from pre-Tertiary country rocks (123–1766Ma). In contrast, most PN zircons were crystallized at the time of generation of the adakitic magma in Miocene times [14.1±3.6Ma (SD)]. The REE pattern for PN zircons showed positive Ce and slightly negative Eu anomalies and their slopes from La to Lu were gentler than those of arc-granitic rocks. Estimated coexisting felsic melt from average of PN zircon compositions indicated 3–5 times higher concentrations in REE and slightly larger Gd/Yb_N than whole rock composition of PN adakite. This suggests that PN zircons were disequilibrated to the whole rock composition, and that they might be crystallized in melt pockets in which over 80% of original adakitic magma interacted with mantle peridotite above the subducted slab.

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