6.5.P06

Tellurium isotopes in Archean sulfides

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The discovery of mass-independent fractionations (MIF) of S isotopes in Archean sulfides older than 2.0 Ga is important because such records may be used to infer the evolution of oxygenation of the early atmosphere of the Earth [1]. The MIF of S isotopes is thought to be due to UV-induced photochemical reactions of gaseous S-species that were delivered to the oxygen-free Archean atmosphere by volcanic activity. The chalcophile element Te displays a geochemical behavior akin to S and significant degassing of Te appears to occur during volcanic activity. Volatile Te species may have been stable in a reducing Archean atmosphere and photochemical reactions similar to those proposed for S may also have generated MIF effects for Te isotopes.

To investigate this possibility, we determined the Te isotope compositions of five ~2.5 Ga old Precambrian sulfides from the Hamersly Basin, Australia. A previous S isotope study showed that these samples have large anomalies in $\Delta^{33}S$ [2]. The isotopic measurements of Te utilize MC-ICPMS and internal normalization relative to $^{125}Te/^{128}Te$ for the correction of mass discrimination. Any MIF of Te isotopes should thus be detectable in Archean sulfides. If ~100 ng of Te are available for analysis, Te isotope compositions can be determined with a precision (2sd) of about 4.5‰ for $^{120}Te/^{128}Te$, 0.14‰ for $^{122}Te/^{128}Te$, 0.1‰ for $^{124}Te/^{128}Te$, 0.03‰ for $^{126}Te/^{128}Te$, and 0.06‰ for $^{130}Te/^{128}Te$. Our results were also used to evaluate mass-dependent Te isotope fractionations, but these data have a limited precision of 0.3-0.6‰/amu.

The Te concentrations of the Archean pyrites vary over three orders of magnitude and our measurements were unable to detect any mass-dependent or mass-independent isotope effects for Te. The sample with the largest $\Delta^{33}S$ anomaly of +6.20 has a high Te content and it was found to be identical to our Te standard in $^{126}Te/^{128}Te$ (following normalization to $^{125}Te/^{128}Te$) to within ± 0.05‰.

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6.5.P07

The earliest sea-floor type hydrothermal system on Earth

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Supracrustal rocks occurring in the Isua Greenstone Belt (Greenland) have been deposited at ca. 3.7 to 3.8 Ga, towards the end of the great primordial meteorite bombardment. They represent the oldest piece of oceanic crust still preserved at the Earth's surface [1]. Despite predominantly intense deformation, associated to high-grade metamorphism, few domains, all located in the North-Eastern part of the belt, show a surprising preservation of a number of pre-metamorphic, volcano-sedimentary features: pillow lavas, pillow breccias, debris flow, polymictic conglomerate, etc. [2]. Some pillow basalts now occur as muscovite-biotite gneiss, indicating a complete transformation of the initial basalt into a clay-rich mixture by some kind of sea-floor type hydrothermal alteration.

A remarkable occurrence of vesiculated pillow breccia has been investigated in detail [2]. Spherical quartz-filled vesicles are interpreted as degassing bubbles in the ascending lava, filled by silica-rich material at the time of the hydrothermal alteration. Quartz crystals in the vesicles has been strongly annealed duirng subsequent metamorphism, but they have preserved rare fluid inclusions, interpreted as remnants of hydrothermal fluids [3]. The fluid composition (immiscible mixture of saline aqueous solutions and gases) strongly resembles present-day hydrothermal systems occurring at mid-oceanic ridges, with the additional indication that methane has been found to be the only gaseous component. In other Early Archean, somewhat younger systems (Barberton, ca 3.54 Ga), comparable inclusions have been found, but with CO_2 as the gaseous component [4].

At present, CH_4-bearing sea-floor hydrothermal systems are mainly found in a deep sea environment, whereas CO_2 characterizes more a shallower setting, like in Barberton.. These systems represent a very favorable environment for living organisms, and it is likely they they have played an important role for the apparition of life on our planet. If we can extend the comparison with present-day systems , a deep sea setting at Isua could explain the absence of direct evidence for life at Isua, even of the alternative of some delay after the great bombardment cannot be excluded.

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