Re-Os isotope systematics of 3.8 Ga banded iron formation and cherts from Isua supracrustal belt, SW Greenland

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The 3.8-Ga Isua supracrustal rocks have been recognized to be among the oldest rocks in the Earth. They are composed of a simple succession of greenstones with low-K tholeiitic (MORB) characteristics, banded iron formations (BIFs), and turbidites in ascending order, which is similar to the oceanic plate stratigraphy of the Phanerozoic age (Komiya et al., 1999). The Isua BIFs that are mainly comprised of magnetite and quartz have very high Fe_2O_3* contents (83.8 wt% at maximum), whereas the cherts are solely composed of quartz. The Isua BIFs and cherts show LREE-enriched patterns with remarkably positive Eu anomalies, reflecting a large contribution from MOR hydrothermal fluids into the water column from which the BIFs and cherts precipitated. The BIFs and cherts are expected to present key constraints on the marine environments in the early history of the Earth. Here we utilize the Re-Os isotope system of the Isua BIFs and cherts, because the isotope ratio of Os, one of platinum group elements, can be an excellent tracer of materials from continental crust and mantle and is considered to be sensitive to redox conditions in the marine environments.

Re and Os concentrations of the Isua BIFs and cherts range from 15 to 45 ppt and from 3 to 15 ppt, respectively, which are similar to those of 3.46-Ga iron-rich cherts from Pilbara, NW Australia (Suzuki et al., 2002). The Isua BIFs and cherts yield the initial $^{187}Os/^{188}Os$ ratios of 0.12-2.1, which is much higher than that of 3.8-Ga chondritic mantle (0.101). The high initial Os isotope ratio (0.8) relative to mantle was also obtained for the 3.46-Ga Pilbara cherts (Suzuki et al., 2002). These results suggest that a component with the elevated $^{187}Os/^{188}Os$ ratio, possibly continental crust, significantly contributed both to the 3.8-Ga Isua BIFs and cherts and to the 3.46-Ga Pilbara cherts.

Week positive correlation between Os and Fe contents of the Isua BIFs and cherts can be seen as observed in the Phanerozoic submarine ferromanganese sediments. Also, the Os contents of the Isua samples strongly correlate with the Cr contents (0.1 – 300 ppm). This result might be associated with the redox conditions in the marine environment, because these elements are redox-sensitive.

References

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Submarine groundwater spring and its impact on the marine environment in Toyama Bay, Japan

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Recently, a discharge of freshwater from the continental shelf directly into the marine environment has been recognized as a very important entrance both of water and materials to the ocean. This discharge route was linked to the groundwater system of the adjoining land. The material flux of this submarine groundwater discharge is possibly more important than its contribution to the water balance, since the concentration of dissolved material in typical groundwater is greater than that in river water. Moreover, the colloids have a comparatively small effect than those in the estuary region during the removal process. The existence of submarine groundwater springs (SGS) has been confirmed in Toyama Bay, central Japan. The purpose of this study is to use chemical-based techniques to clarify the circulation of the SGS, its mechanisms and spatiotemporal changes, and its impact on the costal marine ecosystem.

A new technique was used for freshwater sampling, enabled the collection without any contamination by seawater. As the results, it became clear that the SGS originated from precipitation that had fallen on mountains with an average altitude of 800 to 1200 m by using its δD and δ18O values. Depending on the geographic/geological conditions and tritium concentrations of SGS, it can be presumed that SGS waters pass through an old river pathway (distributed gravel and sand with high permeability) and gush from the seafloor over 10 to 20 years after having permeated the underground. As a source of nutrient supply to the ocean, SGS, with little change in its chemical composition, seems to mix upward into the circumferential seawater due to the water density difference. This is contrary to the effect of river water, where most nutrients and minerals settle to the sediment in the estuary due to the salinity gradient. Especially in early summer, the estuary receives nutrient-rich surface water originating from river flow and deep water supplied as Japan Proper Water, but these sources are exhausted in middle water depth (5 to 40 m) due to seawater stratification. However, high chlorophyll concentrations were observed near spring areas, which indicates a significant nutrient discharge and a major impact on the marine ecosystem by SGS. Since the average annual precipitation exceeds the total amount of evaporation and river runoff in Toyama Prefecture, it is possible that the SGS quantity corresponds to about 30% of the river runoff to Toyama Bay. Therefore, the SGS may supply up to two times more nutrition than the river water to the coastal marine ecosystem. Accordingly, as the SGS is a direct entrance to the ocean for both natural and anthropogenic dissolved materials, it is an urgent task to clarify its role in spreading pollution caused by human activity.