Re-Os systematics in modern estuarine sediments from the Tama and Yasaka rivers, Japan

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The concentrations of rhenium and osmium and their isotopic compositions have been obtained on modern sediment samples from two estuarine areas: the Tama river in Tokyo and the Yasaka river in Oita, Japan. The high concentrations of Os (29-105 ppt) and low $^{187}Os/^{188}Os$ ratios (0.3029-0.4035) in the Tama river estuary sediments indicate relatively high input of this element to the sediment. This is probably due to human activity, because the Tama river flows throughout the Tokyo metropolitan area, which has large amounts of industries and transportation. There is a sharp increase of Os concentrations at depth around 25 cm in the sediment but $^{187}Os/^{188}Os$ ratios are within a narrow range for all samples. This may indicate that Os of all samples were derived from the similar source and that iron sulfide formation promoted by sulfur reducing bacteria under the reducing condition leads to enrichment of Os in the deeper parts of the sediments. This process is consistent with the other geochemical parameters such as iron speciation, some major and trace elements. For the Yasaka estuary, two groups of samples with clear variation of Os content and $^{187}Os/^{188}Os$ ratios can be identified. The content of Os in the Yasaka estuary sediments is lower than that of the Tama river but still higher than the average Os concentration of continental crust, indicating input of Os from human activity although the other geochemical investigations reported that the Yasaka river is considered to be less polluted. However, a relatively higher $^{187}Os/^{188}Os$ ratio may suggest less pollution in the Yasaka river than the Tama river. There is a large decrease of Re content with depth in the Yasaka river sediment whereas less variations of Re were found in the Tama river sediment, which implies that the Re content of estuarine sediment may be used as an indicator of the sedimentation and very early diagenetic conditions.

Zircon U-Pb dating on fluid mobility during UHP rock exhumation

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Dating metamorphic events and associated fluid mobility is a challenging task for isotope geochronology. Zircon U-Pb dating has been documented to be successful not only for ultrahigh pressure (UHP) metamorphic rocks that have protoliths of the oceanic crust but also for quartz veins that developed during prograde metamorphism (thus plate subduction). But difficulties were encountered in dating the UHP metamorphic rocks that have protoliths of the continental crust because of its relative lacking and immobility of fluid that prohibit zircon growth during prograde and peak UHP metamorphism. Occurrence of low $\delta^{18}O$ eclogite and granitic orthogneiss in the Dabie-Sulu orogen provides us an opportunity to date the timing of fluid mobility during exhumation of the continental crust.

LA-ICP-MS U-Pb dating was carried out for zircons from UHP eclogite and granitic orthogneiss at Qinglongshan in the Sulu terrane. Zircon CL investigations reveal two categories of morphology: (1) cores of magmatic zoning and rims of metamorphic overgrowth; (2) small grains with or without zoning. CO_2 laser fluorination analysis on the zircon samples gave low $\delta^{18}O$ values of −9 to −1‰ (SMOW), indicating the involvement of meteoric water in protoliths of the UHP rocks. Paragenesis zoisite + kyanite + coesite/quartz was observed in the eclogite, and coesite was observed in some of zoisite. These suggest lawsonite decomposition and thus water release in the early stage of UHP slab exhumation. Exsolution of hydroxyl dissolved in UHP minerals is also expected due to rapid decompression during exhumation. Therefore, significant amounts of aqueous fluid were available from the UHP rocks themselves subsequent to the peak metamorphism at middle Triassic.

The LA-ICP-MS dating on the metamorphic grains shows 212±7 to 218±13 Ma for the eclogite and 212±2 to 217±2 Ma for the granitic orthogneiss. The zircon core ages of 689 to 789 Ma are consistent with protolith ages for metaigneous rocks in the Dabie-Sulu orogen. They correspond to rift-magmatic activity during the mid-Neoproterozoic in the northern margin of the Yangtze craton and thus the timing of meteoric-hydrothermal alteration to their protoliths. On the other hand, the Late Triassic U-Pb ages for the zircons are considerably younger than the peak UHP metamorphic age at middle Triassic, suggesting zircon growth (and overgrowth) in the course of slab exhumation to HP eclogite-facies and amphibolite-facies environments.

Because zircon growth depends on fluid availability during high-grade metamorphism, the present U-Pb dating has defined the timing of fluid mobility at Late Triassic, during which the UHP rocks were exhumed to the HP eclogite-facies and amphibolite-facies levels and the significant amounts of aqueous fluid were released from the lawsonite decomposition and the hydroxyl exsolution.