Re-Os ages of Besshi-type massive sulfide deposits associated with *in situ* basalt as a new age constraint for ridge subduction

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Introduction

We report two Re-Os ages for the Makimine and Shimokawa (Kyusyu and Hokkaido area, southwestern and northeastern parts of Japan, respectively) Besshi-type massive sulfide deposits in the Northern Shimanto Belt. These Besshi-type deposits are characterized by close association with an *in situ* basalt whose geochemical composition is similar to those of mid-ocean ridge basalts. Terrigenous clastic materials such as sandstone and mudstone directly overlie massive sulfide layers, indicating that the Makimine and Shimokawa deposits were formed in the marginal sea.

Results and Discussions

The Re-Os ages obtained for the Makimine and Shimokawa deposits are ca. 89 Ma and 48 Ma, respectively. Based on the stratigraphic and geochemical features of two Besshi-type deposits, we interpret these Re-Os ages as a timing of sulfide deposition on a paleo-seafloor when the Kula-Ridge subducted to the paleo Japanese island arc in the Late Cretaceous. The Re-Os age of the Makimine deposit (89 Ma) is generally consistent with the timing of the ridge subduction determined by microfossils in the sedimentary rocks. The plate motion model has documented the the northeastward migration of ridge subduction occurred at the Late Cretaceous Japanese island arc. Considering that the distance between two Besshi-type deposits is about 1, 600 km, this migration speed is estimated to be 4 cm/yr, which is very consistent with the model estimation.

Asthenospheric signature in mantle xenoliths from Enmelen, NE-Russia?

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The late Cenozoic intra-plate Bering Sea Basalt Province (BSBP) comprise 17 volcanic fields that occur on islands in the Bering Sea, on the west coast of Alaska and on the northeast cost of Russia. The lavas are mainly tholeiitic and alkaline olivine basalts with subordinate basanites and nephelinites. The Enmelen volcanic field in east Chukotka, NE Russia, differs from the other volcanic fields in that the majority of the lavas are strongly undersaturated (nephelinites, olivine melanephelinites and basanites) and carry abundant mantle xenoliths. The sampled xenoliths hosted by the lavas are mainly fertile spinel lherzolites but few depleted spinel lherzolites occur as well.

Based on the bulk rock and clinopyroxene trace element analyses the Enmelen spinel lherzolites can be divided into three groups. Group A represents non-metasomatized xenoliths that have experienced 3-4% fractional melting. Group B is represented by spinel lherzolites that have whole-rock chondrite-normalized REE patterns with strongly enriched LREE relative to HREE (La_N/Yb_N=9). Their clinopyroxenes are also enriched in LREE and plot sub-parallel to the whole-rock REE patterns (La_N/Yb_N=7). The lack of hydrous phases suggests that group B has experienced cryptic metasomatism. Group C is characterized by the presence of amphibole. Chondrite-normalized REE from the core of clinopyroxenes have patterns with depleted LREE similar to those of group A. However, their rims show, relative to the core, an increase of the LREE (La_N/Sm_N = 0.21 and 2.44 for core and rim respectively). The introduction of fluids, rich in H_2O, LREE, Sr and Ti and the formation of amphibole must have taken place shortly prior to the incorporation of the rocks into the host lavas and before re-equilibration could be achieved.

The clinopyroxene Sr, Nd, and Hf isotope systematics generally overalap the range of MORBs $^{86}Sr/^{87}Sr$= 0.70222-0.7310, $^{143}Nd/^{144}Nd$=0.51303-0.51333 $^{176}Hf/^{177}Hf$=0.28303-0.28363). These depleted isotopic compositions coupled with the trace element enrichements suggests that any metasomatc overprint must have been relatively recent. These data colectively suggest that the Enmelen peridotite xenoliths most likely originate from the convective asthenosphere.