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Petrology of ultramafic rocks in the Gosaisho series, northeastern Japan: Is the Gosaisho series the SSZ ophiolite?

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The Abukuma plateau, which extends ˜180km in N-S and ˜50km in E-W directions, is located along the Pacific coast of northeastern Japan. This plateau is composed mainly of Cretaceous granitic rocks and regional metamorphic rocks. In the Gosaisho-Takanuki district that is located in the central part of the plateau, the Gosaisho metamorphic rock series in the east overthrust onto the Takanuki metamorphic rock series in the west (e.g. Umemura, 1979). The Gosaisho series is mostly composed of mafic and siliceous rocks, and the Takanuki series is mainly composed of pelitic-psammitic rocks. In the Gosaisho series, many small ultramafic bodies are present in the areas adjacent to the Takanuki series. Metamorphic rocks in the Abukuma Plateau have been well studied since the late 19th century, excepting these ultramafic rocks.

The ultramafic rocks in the Gosaisho-Takanuki distinct are affected by contact metamorphism of the Cretaceous granitic rocks in various degrees, but their protoliths are judged as mantle peridotites and ultramafic cumulates based on their bulk rock chemistry. The ultramafic cumulates are sometimes accompanied by metagabbros. In an ultramafic body called Mount Ohtsube, mantle peridotites are distributed at the foot of the mountain and cumulates occupy its top part. It is likely that the ultramafic bodies in this area are the fragments of the lower part of an ophiolite. We also note that cortlandites and associated gabbroic rocks are present in this area. They are always contained in granitic bodies, and it is likely that intrusion of cortlandites coincided with the Cretaceous felsic magmatism.

The bulk rock chemistry of the peridotite is poor in Ca and Al contents (CaO $<$0.6 wt. %, Al_2O_3 $<$1.6 wt. %). This suggests that they are highly depleted mantle peridotite. On the one hand, Cr# of spinel in the peridotite, which supposedly correspond to the degree of mantle depletion, show a wide range (14 - 87) from place to place. The spinel is poor in Ti content (TiO_2 $<$0.2 wt. %). These characteristic features of spinel suggest that the mantle section was of arc origin (Arai et al., 2011). This is consistent with the bulk rock chemistry of the associated metagabbro which is rich in Ca and Al, and poor in Ti contents (CaO = 11.6 - 17.0 wt. %, Al_2O_3 = 13.8 - 18.5 wt. %, TiO_2 = 0.06 - 1.06 wt. %). It is also noteworthy that some ultramafic cumulates are very rich in Fe (up to Fo = 73).

In the Gosaisho series, siliceous rock contain early Jurassic radiolarian fossils (Hiroi et al., 1987). In addition, some low-grade metamorphic rocks show original pillow structure (Nohara and Hiroi, 1989). Hiroi et al. (1998) argued that the Gosaisho Series represents the mid-ocean ridge origin oceanic crust which overthrust onto the terrigenous Takanuki Series. However, in some places, there are calc-alkaline intrusions which have experienced regional metamorphism with the country rocks (Umemura, 1970). This is consistent with our idea that the ultramafic rocks are of arc origin. Therefore, it is suggested that the Gosaisho Series is the arc-related, supra-subduction zone ophiolite which thrust onto the Takanuki Series in the Jurassic period. However, it is also possible that the early Paleozoic Hayachine-Miyamori ophiolite (e.g. Machida and Ishiwatari, 2013). Comprehensive study of mafic and ultramafic rocks in the Gosaisho series is needed to solve this problem.

Keywords: supra-subduction zone ophiolite, ultramafic rock, Abukuma metamorphic rocks