Graphite mineralization in the Oshirabetsu Gabbroic Complex (Hokkaido, Japan)  
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INTRODUCTION

The mantle is the largest reservoir of carbon on earth (Coltice et al., 2004). Mantle-derived carbonate and carbon-bearing rocks are direct indicators of the Earth’s solid carbon cycle. The mantle provides CO$_2$ to the surface through degassing and magmatism whereas carbon from sediments (as carbonaceous matter) and altered oceanic crust (mostly as calcite veinlets) can be recycled into the mantle through subduction. The competition between degassing and incorporation of carbon into the mantle by subduction is the basis of the geodynamic carbon cycle. This idealized cycle can be disrupted as a consequence of the incorporation of crustal carbon to magmas rising from the mantle to upper crustal levels. Thus, carbon can be assimilated by mantle-derived magmas and, in some instances, redeposited as solid carbon, i.e. graphite.

The aim of this paper is to present preliminary data of a graphite-sulfide occurrence in mantle-derived rocks from Oshirabetsu (Hokkaido, Japan). The association of graphite with sulfides is investigated in order to establish the mutual relationships between the origin of sulfur and carbon and also between the deposition of sulfides and that of graphite.

GEOLOGICAL SETTING

The graphite-sulfide mineralization studied in this paper is located within the Oshirabetsu Gabbroic Complex (OGC), a basic-intermediate intrusive complex in the Hidaka Metamorphic Belt (HMB). The HMB comprises the Nakanogawa Group (considered as an accretionary complex made from coherent, turbidite and mélange facies; Nanayama, 1992) to the west, and the Hidaka metamorphic rocks to the east (Fig. 1). Metamorphic conditions reached amphibolite and granulite facies, and within these metamorphic rocks there is a large amount of associated gabbroic and granitic intrusions.

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![fig 1. Simplified geological map of the Hidaka Metamorphic Belt](image)

Graphite, pentlandite and nickel-bearing pyrrhotite mineralization was found in the OGC. The Oshirabetsu mine operated until 1958 as nickel and graphite deposit. The deposit was studied at the two main outcrops remaining after mine works: Taisho and Nisho adits (Fig. 2).

![fig 2. Geological map of the study area and location of sampling points](image)

![fig 3. Detail of the graphite ore body at Taisho adit](image)
Graphite occurs as rounded nodules containing abundant inclusions. These inclusions may form rings inside the nodules or be unevenly distributed. Frequently graphite nucleates on these inclusions. Graphite is commonly associated with sulphides, mainly pyrite and chalcopyrite. Locally, the nucleation of graphite on these sulphides can be recognized. During the optical microscopy and EMPA studies, other minerals on which graphite nucleates inside the nodules were observed, including titanite, ilmenite, apatite, zoisite and chlorite.

The most abundant morphology of graphite crystals is platy, although spherulite-like forms can be also recognized. Flaky graphite (some 100 µm long in average) is often bent resulting in ring-like forms (Fig. 5).

Graphite nodules are surrounded by hydrous minerals (e.g., chlorite) that can be also included within the nodules.

The structural characterization of graphite has been carried out by XRD and Raman spectroscopy. The results indicate that graphite is highly crystalline, both along the stacking direction and the basal plane. The DTA and TG curves of the graphite are in good agreement with this high crystallinity. The maximum of the exothermic peak due to graphite combustion is close to 830 °C.

The δ13C values of graphite from Oshirabetsu samples are very uniform and show low 13C/12C ratios (δ13C values from -21.6 to -22.3‰). Samples from different points (some millimetres away from each other) within the same graphite nodule yield virtually the same δ13C values.

**DISCUSSION**

Graphite occurrences in ultrabasic and basic, mantle-derived rocks are rather unusual and scarce information exists about the mantle or crustal origin of carbon in these rocks in which graphite is commonly associated with sulphides (e.g., Luque et al., 1992; Crespo et al., 2006; Tomkins et al., 2012).

The light δ13C values of graphite from Oshirabetsu point to the organic derivation of carbon, as previously stated by Tsuchiya et al. (1991). This is in good agreement with the sulfur isotopic systematics in the norites of the OGB which indicates that at least half of the sulfur was of sedimentary origin (Takahashi and Sasaki, 1983).

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**REFERENCES**


