

Native iron and serpentinization of peridotite, Oshika Village, Nagano Prefecture, Japan

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Serpentinization is a reaction to form serpentine from peridotite and hot water, and Fe^{2+} becomes Fe^{3+} since magnetite is formed from Fe^{2+} in forsterite. At that time, hydrogen is generated, and a more reducing environment is formed iron, awaruite ($\text{Ni}_2\text{Fe-Ni}_3\text{Fe}$) (Frost, 1985).

Peridotite in Oshika Village, Shimoina-gun Nagano Prefecture is located mainly in Irisawai and Ogawara, and iron formed by serpentinization is reported for the first time in Japan (Okamoto et al., 1981; Sakai & Kuroda, 1983). Serpentine veins have three stages. Iron is found in veins composed chrysotile- $2M_{c1}$ and brucite in the 2nd stage of serpentine veins. In this study, the peculiar serpentine vein was reexamined for the purpose of the elucidation of the formation of iron and awaruite.

Obtained samples were analysed by powder X-ray diffraction (XRD) to determine the constituent serpentine species. The selected samples were analyzed by optical microscope, scanning electron microscope (SEM) with energy dispersive spectrometer (EDS), electron microprobe analyzer (EPMA) and transmission electron microscope (TEM). Experimental devices was Ultima IV and Rint Rapid II (XRD), JSM-7001 (SEM), JMS-8530FF (EPMA). TEM observation was carried out at 300kV using JEM 3200FSK at the Ultramicroscopy Research Center at Kyushu university.

The peridotite is composed of forsterite and chromite, linear serpentine veins ranging from a few cm to 10 of μm in width. There were up to 4 directions of the vein. Serpentinization was made to be 4 stages from the anteroposterior relation of the vein by the observation by the slice. The vein of these 4 stages was made to be serpentine veins I, II, III, IV from the early one. The serpentine veins consisted lizardite, chrysotile- $2M_{c1}$, brucite, magnetite, iron, and awaruite. The serpentine veins are characterized in Table 1. Serpentine vein IV have elliptical and striated areas rich in brucite. Iron has irregular shapes, and some change to magnetite. Awaruite is a minute crystal, and it is unevenly distributed in the vein. The chemical compositions of serpentine and brucite in the veins were measured by SEM-EDS, and $\#Mg = Mg / (Mg + Fe)$ was obtained. The serpentine of veins I and II was $\#Mg = 0.94$, that of veins III and IV was $\#Mg = 0.96$, and that of brucite was $\#Mg = 0.66 \sim 0.79$ $0.77 \sim 0.86$.

Iron is in serpentine veins III and IV, ranging in size from 1 μm to 100 μm , and contains up to 3.2% Ni and 3.1% Co. Iron of serpentine vein III was arranged in the position in which the long axis of the ellipse was perpendicular to the serpentine vein, and the iron of serpentine vein IV was irregularly shaped. Native iron was also found in the serpentine veins, which were not linear. Awaruite is found in all serpentine veins and most of them are in the range of 50 nm to several 100 nm, and many of them are automorphic crystal. Awaruite consists of $\text{Ni}_{0.79}\text{Fe}$ to $\text{Ni}_{2.55}\text{Fe}$ and is rich in iron.

Keywords: serpentinization, iron

表1 蛇紋石脈の特徴

	蛇紋石脈Ⅰ	蛇紋石脈Ⅱ	蛇紋石脈Ⅲ	蛇紋石脈Ⅳ
脈の幅	2, 3 mm～ 数100 μm	2, 3 mm～ 数100 μm	10 μm ～ 100 μm	200 μm ～ 300 μm
脈の色	黒(肉眼) 黒褐色(薄片)	緑黒色(肉眼) 褐色(薄片)	灰緑色(肉眼) 白色(薄片)	緑褐色(肉眼) 褐色+白色(薄片)
蛇紋石の#Mg	0.94	0.94	0.96	0.96
ブルース石の#Mg	0.66～0.79	0.66～0.79	0.77～0.86	0.77～0.86
自然鉄	無し	無し	1～100 μm 楕円形をしている。	不規則な形
アワルワ鉱	50～数100 nm少 量	50～100 nmの 結晶が全体的 に多く含む	50～数100 nm 脈の中心と縁に見 られる。	部分的に小さい結 晶が集まっている。
磁鉄鉱	ほとんど見られ ない	不規則な形	自然鉄の自体が磁 鉄鉱化している	不規則な形をした ものが多く見られ る。

Table 1. The characteristics of serpentine vein

serpentine vein	I	II	III	IV
Vein width	2, 3 mm～ several 100 μm	2, 3 mm～ several 100 μm	10 μm ～ 100 μm	200 μm ～ 300 μm
Vein color (naked eye) (flakes)	black dark brown	green-brack brown	grayish green colorless	green brown brown and colorless
#Mg of serpentine	0.94	0.94	0.96	0.96
#Mg of blucite	0.66～0.79	0.66～0.79	0.77～0.86	0.77～0.86
Iron	none	none	1～100 μm elliptical shape	irregularly shape
Awaruite	50～several 100 nm Small amount	50～100 nm	50～several 100 nm	Small crystals are unevenly distributed.
Magnetite	Small amount	irregularly shape	Iron are surrounded by magnetite.	irregularly shape