K-Ar Age and Sulfur Isotopic Ratio of Ores from the Itaga Tungsten Deposit, Tochigi, Japan.

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Abstract: Muscovite and biotite from the greisenized granite of the Itaga wolframite deposits were dated at 63.4 ± 1.4 Ma and 63.0 ± 1.4 Ma, respectively. The age belongs to the younger group of granite activities of the Ashio Mountains. Lollingite disseminated in the altered granite shows $\delta^{34}$S of ca. -5 permil, which is very similar to the average value of the ilmenite-series ore deposits of the Chubu-Kinki district.

Introduction

The Itaga wolframite deposits, known for their unusual gangue minerals such as andalusite, corundum and topaz (Sakurai, 1943; Shibata, 1952), had been the second largest tungsten producer in the Kanto district after the Takatori deposits up to the early 1960's. The area had been explored for gold-silver and copper since the Meiji Era (Nakazawa and Mononoбе, 1957), but wolframite was discovered from a steep mountain slope of the Ashio Mountains in 1939 (Fig. 1) and was open-pit mined from the orebodies hosted in granites during World War II (Sakurai, 1943), which is called the endo-granitic ore deposit in this paper. The official statistics of production during this period are not available.

Later in 1952, wolframite quartz veins hosted in sedimentary wall rocks, which will be called the exo-granitic ore deposit hereafter, were discovered at some 200 m south of the endo-granitic deposit, and wolframite concentrates of 23.5 tons had been produced by 1961. The Itaga mine was sole example in Japan where profitable amounts of tungsten were mined from both endo-granitic disseminated-type and exo-granitic vein-type orebodies.

The mine area is located in the late Paleozoic-Mesozoic sedimentary terrane of so-called Ashio Mountains in the northern part of the Kanto District. The sedimentary rocks are extruded and intruded by felsic magmas during the late Cretaceous time, which are considered an eastern extension of the late Cretaceous-Paleogene granitoids of the Sanyo belt (Ishihara, 1977). Yet its age determination has been scarcely made.

Sulfur isotope study of granitoid-related ore deposits has revealed consistent negative values in wolframite deposits with greisen alteration in the Inner Zone of Southwest Japan (Sasaki and Ishihara, 1980). It is interesting to know of the ratio on sulfides of the Itaga deposits.

We have obtained recently the ore samples from the Itaga deposits to study their age and sulfur isotopic ratio. The results, which may be a supplement to our previous works (Sasaki and Ishihara, 1980, Ishihara et al., 1988, 1992), will be reported in this short communication.
Geology of the Itaga Deposits

Kamitsuga County of Tochigi Prefecture is underlain by late Paleozoic to Mesozoic sedimentary rocks, which were extruded and intruded by the late Cretaceous to Paleogene rhyo-dacitic volcanic rocks and granite-granodiorite of stock size (<100 km², Fig. 2). The granitoids are magnetite-free, ilmenite-series, according to the measurement of magnetic susceptibility. The sedimentary rocks exposed in the Itaga mine area are mostly phyllitic quartzites, with some amounts of siliceous slate, slate and sandstone, which strike N40-60° and dip 40-60° SE and NW (SASAKI, 1959). These rocks are intruded by biotite granite, whose marginal facies is porphyritic. The granite crops out at few places as "Fenster" with dimensions less than 200 by 750 m (SASAKI, 1959). The tungsten mineralization is seen both in the granite body and in its roof pendant sedimentary rocks.

Endo-Granitic Deposit

The deposit occurs in the apical part of the porphyritic granite that has been greisenized and veined with feldspars and quartz. Tungsten minerals are disseminated in the altered granite and may also occur in the pegmatitic quartz veins (SAKURAI, 1943). Ore minerals are wolframite, and small amounts of scheelite, löllingite, molybdenite, chalcopyrite and pyrite.

Characteristic of this deposit is common occurrence of high alumina minerals like corundum and andalusite. SAKURAI (1943) described purple-blue sapphire crystals coexisted with feldspars in the pegmatite. The hexagonal platy one is 1-2 mm in diameter, while the lamellar crystal occurring in feldspars is 1 cm in length. Andalusite occurs also in pegmatite together with sapphire, as pale pink to reddish crystals growing up to 1 cm wide and 3 cm long. Other gangue minerals are topaz, up to 2-3 mm in diameter, tourmaline, up to 1 cm in diameter and 2 cm long, muscovite and quartz.

Exo-Granitic Deposit

The exogrannitic deposit is developed at some 200 m south of the open pit and is vein type occurring in phyllitic quartzites, within 15-20 meters from the granite contact (SASAKI, 1959). The ore veins are composed of many small ones whose width ranges from 3 to 20 cm with an average of ca.7 cm. They are grouped into two; the gentle-dip one with N-S strike and 30°W dip, and the steep-dip one with N15-20°E strike and 70°E dip. The vein-forming minerals are mostly quartz and wolframite. The wolframite has high Fe/Mn ratios between $\text{Fe}_0.87\text{Mn}_{0.13}\text{WO}_4$ and $\text{Fe}_0.83\text{Mn}_{0.17}\text{WO}_4$, thus properly called as ferberite (SASAKI, 1959). The other minerals are trace amounts of scheelite, feldspar, topaz, muscovite, biotite. Sulfides are very rare, but löllingite, chalcopyrite and pyrite could be visible.

Analyzed Samples and Analytical Results

Analyzed samples were collected from the endo-granitic orebody in 1950s. The sample for the age determination is coarse-grained "greisenized" granite with fair amounts of muscovite, biotite and andalusite (Fig. 3). Under the microscope, biotite has Z=Y color of pale brown and andalusite shows a weak pleochroism. Both muscovite and biotite were separated by an Isodynamic Separator.

K-Ar dating of muscovite yielded an age of 63.4 ±1.4 Ma, while biotite was 63.0±1.4 Ma; the two values agree within the analytical error (Table 1). It is inferred that the Itaga mineralization has a Paleogene age, and the granites occurring in the Itaga-Karasawa mine area (Fig. 2) must have a similar age, because granites and related Mo-W-Sn deposits usually give us identical ages. Thus
Fig. 3 Photomicrograph of the studied greisen for the age dating. Euhedral andalusite (high relief) filled with muscovite (white with cleavage) and biotite (dark with cleavage).

Table I K-Ar age data of the Itaga greisen from the north open-pit, Tochigi Prefecture, analyzed by the Central Lab., Mitsubishi Material Co., Ltd.

<table>
<thead>
<tr>
<th>Sample number</th>
<th>Minerals analyzed</th>
<th>K content (wt%)</th>
<th>Rad.40Ar (10^-10/cc/g)</th>
<th>K-Ar age (Ma)</th>
<th>Air cont. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>57AS01M</td>
<td>Muscovite</td>
<td>7.19±0.14</td>
<td>1803±21</td>
<td>63.5±1.4</td>
<td>5.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1798±20</td>
<td>63.3±1.4</td>
<td>4.7</td>
</tr>
<tr>
<td>57AS01B</td>
<td>Biotite</td>
<td>6.69±0.13</td>
<td>1663±19</td>
<td>63.0±1.4</td>
<td>6.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1661±19</td>
<td>62.9±1.4</td>
<td>4.3</td>
</tr>
</tbody>
</table>

1 Decay constants used are λe=0.581×10^-10/Y and λβ=4.962×10^-10/Y (STEIGER and JAEGGER, 1977).

2 40K/K=0.01167 atom %

3 Error estimation based on NAGAO et al. (1984).

The granites in the Itaga-Karasawa mine area are definitely younger than the Sori granodiorite (91 Ma) and is similar to that of the Yokoneyama granitic stock (65 Ma, Fig. 2).

The granitic activities of the Ashio Mountains are clearly divided into two: the older one (ca. 90 Ma) represented by Sori granodiorite and the younger one (ca. 63 Ma) which includes most of the small bodies associated with coeval volcanic rocks occurring in the northern part (Fig. 2). Thus the granite related to the Itaga tungsten mineralization belongs to the younger group of granitoid in the Ashio Mountains.

Vein muscovite of the Takatori tungsten deposits of Ibaraki Prefecture was dated at 68.7 Ma (SHIBATA and ISHIHARA, 1974) and recalculated as 70.4 Ma using the new decay constant by STEIGER and JAEGGER (1977) (ISHIHARA et al., 1988). Greisenized chert discovered in an exploration drill hole to the west of the main No. 7 vein of the Takatori mine is found to have similar age of 71.8 Ma (OGASAWARA et al., 1993). It is suggested that the tungsten mineralization of the Itaga deposits is slightly younger than that of the Takatori deposits.

Sulfur isotope ratio of $\delta^{34}S_{CDT}$ (permil) was analyzed by A. SASAKI on two specimens of löllingite disseminated in the greisenized granite. The result are -4.5 and -5.1 permil (average -4.8 permil). This value is lighter than $\delta^{34}S_{CDT}$ of -3.6 permil of ore sulfurs from the Takatori mine area (SASAKI and ISHIHARA, 1980), which contains arsenopyrite and some pyrite, and is similar to an average value of ilmenite-series ore deposits in the Chubu-Kinki District (Fig. 4).

Concluding Remarks

K-Ar age determination on muscovite and biotite from the greisenized granites of the Itaga
tungsten deposits gave a Paleogene age (63 Ma), indicating that the mineralization occurred related not to the older (90 ± Ma) but the younger (65 ± Ma) granitic activity. Löllingite of the ores revealed δ34S_CDT value of -5.1 permil. These results are consistent with those of ISHIHARA et al. (1988), and SASAKI and ISHIHARA (1980), respectively, thus reinforcing our previous conclusions.

We acknowledge Dr. Nobukazu KANBE for his generous contribution of one of the löllingite-bearing ores for this study.

References


栃木県板荷タングステン鉱床のK-Ar年代と硫黄同位体比

石原舜三・佐々木昭

要旨：板荷鉱床のグライゼン変質帯に含まれる白雲母と黒雲母の年代は63.4および63.0 Maを示し、この鉱化作用が足尾地域の古期（90Ma前後）、新期（65Ma前後）の2時期の花崗岩活動の内、後者に属することが判明した。この年代は同じ関東地方の高取タングステン鉱床の70－72 Maより少し若い。グライゼン変質帯に析出する砒鉄鉱の硫黄同位体比は-4.8～-5.1パーミルであり、チタン鉛鉱系花崗岩に関連する鉱床の値を示し、特に中部－近畿地方の鉱床の平均値と同じであった。

Reference