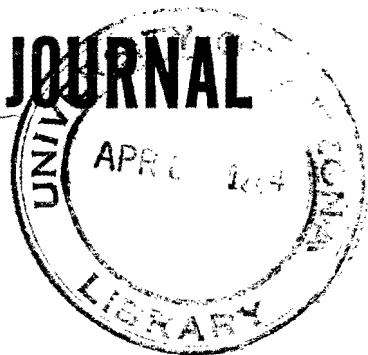


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Ruthenium, a new mineral from Horokanai, Hokkaido, Japan

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ABSTRACT

A new mineral ruthenium in a concentrate from the Horokanai platinum placer, Hokkaido, is described.

Electron-microprobe analysis of this mineral gave the following weight percentages: Ru 64.43, Ir 14.62, Pt 9.14, Rh 7.05, Os 5.29, Pd 0.49, Fe 0.21, Ni tr., Cu tr., total 101.23. The result corresponds to the composition $Ru_{1.47}Ir_{0.18}Rh_{0.18}Pt_{0.11}Os_{0.06}Pd_{0.01}Fe_{0.01}$, and the proportions between three principal metals are Ru:Ir:Rh=81.5:9.7:8.8, which falls in the region of mineral ruthenium because Ru content is more than 80 atomic percent of the three elements. This mineral is, therefore, named ruthenium after its chemical composition.

Reflection colour is white with light creamy tint, and reflectivity is about 60 percent. It shows optically weak anisotropism. It occurs as a tabular crystal associated with rutheniridosmium in the peripheral area of a platinum grain. The size of the crystal is 35×7 microns in polished section.

The mineral ruthenium and the name have been approved by the Commission of New Minerals and Mineral Names, IMA.

Introduction

In Hokkaido, platinum placers derived from ultrabasic rocks are distributed along the central zone extending from south to north. They have scarcely yielded any platinum ores since about 1945. Some of platinum-group minerals from Hokkaido have been investigated by means of chemical, X-ray spectroscopic and/or electron-microprobe analyses (Aoyama, 1936; Takahashi, 1941; Urashima *et al.*, 1972). Maximum ruthenium content of the platinum-group minerals from Hokkaido is 21.08 weight percent (Aoyama, 1936). Ruthenium-rich iridosmine from California described by Snetsinger (1971) contains 29.8 weight percent ruthenium.

A new mineral ruthenium containing more than 60 weight percent ruthenium has been discovered in the specimen from the Horokanai platinum placer, Hokkaido, kindly sent to one of the authors (Y. U.) by the Sakurai Collection. The specimen consists principally of platinum grains selected from the concentrates.

A polished section containing the native ruthenium will be preserved in Kagoshima University, Kagoshima.

Procedures

The sample, mounted in cold-setting plastic, was polished on a cloth lap, using diamond abrasives down to 0.25 micron. Reflectivity measurements were made in air, using a Leitz standard. The apparatus consists of a Leitz Ortholux-Pol microscope and a Leitz MPE microscope photometer. The employed objective was FI 45/0.85(P). The light was monochromatized by a Leitz filter.

A Shimadzu-ARL electron-microprobe X-ray analyzer EMX-SM was used for the investigation of the sample, carbon-evaporated for the thickness of about 200Å. The accelerating voltage and the sample current were set at 20 KV and 0.01 μ A respectively. The

diameter of electron beam was about $1\ \mu$. The X-ray take-off angle was 52.5° . Characteristic X-rays used were $L\alpha$ for platinum-group elements and $K\alpha$ for Fe, Ni, and Cu. A PET analyzing crystal of four inch focusing circle and a Kr gas-sealed detector were used for Ru, Rh and Pd, but for other elements LiF of four inch focusing circle and an Ar gas-sealed detector were used. Intensities of characteristic X-rays of the detected elements were compared with those of the pure metals, and integrated time of measurement for each element was 10 seconds for every five times. After corrected for the thickness of evaporated carbon films, primary measured values were corrected for absorption effect (Philibert, 1962), atomic number effect (Poole and Thomas, 1962) and for fluorescence effect due to characteristic X-ray (Reed, 1965).

Microscopic properties

Ruthenium occurs as a tabular crystal reaching 35×7 microns in polished section, and is partly included in platy rutheniridosmium. They are found in the protuberance of a native platinum grain (Figs. 1 and 2).

The polishing hardness of ruthenium inferred from the pseud-Becke line and the secondary or the backscattered electron image is nearly the same as that of the adjacent rutheniridosmium which is remarkably harder than the associated platinum. No microhardness measurement was made, because the grain was too small.

Ruthenium is white with light creamy tint in reflected light. The

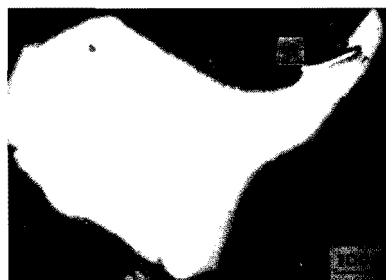


Fig. 1. Photomicrograph of platinum grain (No. ZKG2-1), Horokanai, showing platy inclusion (a) consisting of ruthenium and rutheniridosmium. Plain reflected light.

reflectivity value is 60.1 percent for the wavelength of 530 nm. Reflection pleochroism is indiscernible. Between crossed polarizers it shows weak anisotropism in air. Like pure ruthenium and Ru-Os alloy, this mineral may be hexagonal.

Chemical composition

The secondary electron image shows that native ruthenium from Horokanai is darker than the adjacent rutheniridosmium or platinum (Fig. 2A). Platinum-group elements and Fe in the ruthenium were quantitatively determined. The result is given in Table 1. This mineral is very rich in one element Ru, and it contains several percent of Ir, Rh, Pt, Os and small amounts of Pd and Fe. Traces of Ni and Cu were detected. Its composition corresponds to the

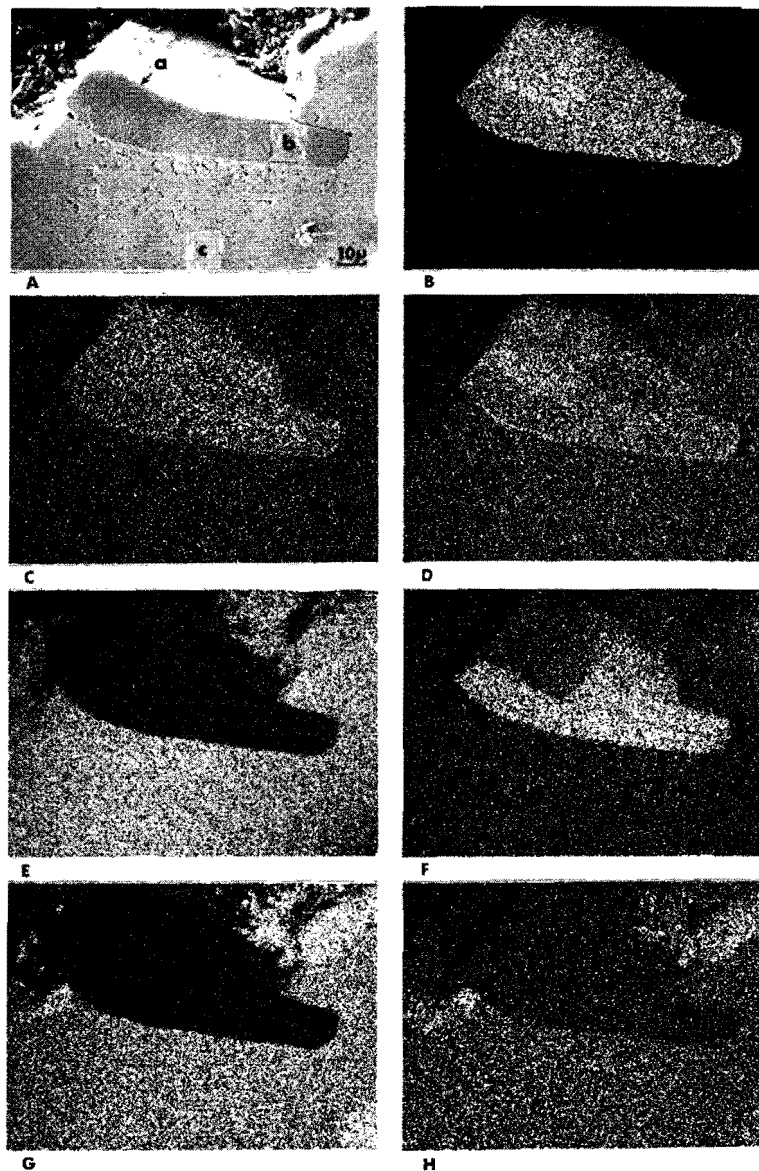
Table 1. Electron-microprobe analysis of ruthenium from Horokanai, Hokkaido.

Ru	Ir	Pt	Rh	Os	Pd	Fe	Ni	Cu	Total
64.43	14.62	9.14	7.05	5.29	0.49	0.21	tr.	tr.	101.23 wt. %*
73.69	8.79	5.42	7.92	3.22	0.53	0.43			100.00 at. %

* The data given in the proposal of a new mineral ruthenium to the Commission of New Mineral and Mineral Names, IMA, was as follows: Ru 61.77, Ir 14.19, Pt 8.71, Rh 6.75, Os 5.14, Pd 0.47, Fe 0.20, Ni tr., Cu tr., total 97.23 weight percent. The composition given in this table is obtained according to another correction method.

Fig. 2. Electron beam scanning images showing ruthenium (a), rutheniridosmium (b) and platinum (c) from Horokanai. Obtained by EMX-SM.

- A: Secondary electron image.
- B: $RuL\alpha$ characteristic X-ray image.
- C: $IrL\alpha$ characteristic X-ray image.
- D: $RhL\alpha$ characteristic X-ray image.
- E: $PtL\alpha$ characteristic X-ray image.
- F: $OsL\alpha$ characteristic X-ray image.
- G: $FeK\alpha$ characteristic X-ray image.
- H: $CuK\alpha$ characteristic X-ray image.



formula $\text{Ru}_{1.47}\text{Ir}_{0.18}\text{Rh}_{0.16}\text{Pt}_{0.11}\text{Os}_{0.06}\text{Pd}_{0.01}\text{Fe}_{0.01}$.

The platinum grain including the ruthenium and rutheniridosmium is heterogeneous and the marginal zone is richer in Fe and Cu than the inner part (Fig. 2A~2H). The ruthenium minerals associate with the former part of platinum.

Discussion

A ruthenium-rich mineral from Horokanai, Hokkaido, was investigated by using the ore microscope and the electron-microprobe analyzer. Measurement of microhardness and X-ray diffraction studies could not be made because of very tiny grain. The mineral has high reflectivity and shows anisotropism. It is very rich in Ru and contains small quantities of other platinum-group elements and Fe.

Rutheniridosmium (refined ruthenosmiridium) from Uryu, Hokkaido, described by Aoyama (1936) has the composition $\text{Ru}_{0.67}\text{Os}_{0.65}\text{Ir}_{0.65}\text{Rh}_{0.03}$. An incompletely analyzed Os-Ir-Ru alloy from Alaska recorded by Leonard *et al.* (1969) contains 33.5 ± 2 weight percent Ru. The composition of Ru-rich iridosmine from California described by Snetsinger (1971) is $\text{Ru}_{0.86}\text{Os}_{0.52}\text{Ir}_{0.42}\text{Pd}_{0.06}\text{Rh}_{0.05}$, and another mineral having the composition $\text{Ru}_{1.21}\text{Os}_{0.39}\text{Ir}_{0.20}\text{Pd}_{0.19}\text{Rh}_{0.06}$ was found from Ural Mountains by Snetsinger (Cabri, 1972; Keil, 1973; Snetsinger, unpublished).

The nomenclature of ruthenium in the Os-Ir-Ru system proposed by Harris and Cabri (1973) is that: "the name ruthenium is for hexagonal alloys with ≥ 80 at. % Ru." Ru contents of these minerals are lower than 80 atomic percent in the proportions of three principal elements. No occurrence of native ruthenium has so far been reported.

On the other hand, the composition of the present mineral from Horokanai is $\text{Ru}_{1.47}\text{Ir}_{0.18}\text{Rh}_{0.16}\text{Pt}_{0.11}\text{Os}_{0.06}\text{Pd}_{0.01}\text{Fe}_{0.01}$. The proportions of three principal elements, Ru, Ir and Rh in this case, are Ru : Ir :

Rh=81.5: 9.7: 8.8, and those of Ru, Ir and Os are 86.0: 10.3: 3.7.

Because the Ru composition of three principal elements of this natural hexagonal alloy is higher than 80 atomic percent, the authors propose that this mineral might be named "ruthenium" without any adjective qualification (Schaller, 1930) after the nomenclature proposed by Harris and Cabri (1973).

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