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Mineralogical Study on Some Toseki Ores (Poor Quality) in the Nomi Mountains, Ishikawa Prefecture, Japan

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Introduction

Several Toseki (pottery stone) mines are situated in the Nomi Mountains in the southern part of Ishikawa Prefecture, Central Japan. Hattori Mine is well known among them. Geological descriptions on the area were made about ten years ago.[1),2)] One of the authors (Seiji Sugiura) et al. described the mineral assemblage of good quality ores of Hattori Mine and Kawai Mine.[3)] But there is a large mass of poor quality ores in the district, and the mineralogical nature of these ores are to be studied for the purpose of utilization of them.

The Nomi Mountain area consists mainly of Miocene volcanic materials such as rhyolite, rhyolitic tuff, tuffaceous shale, and sandstone. At Hattori Mine and Kawai Mine, ores occur mainly in altered rhyolite and partly in altered rhyolitic tuff. At Tedori Mine ores occur in rhyolitic tuff intruded by quartz porphyry.

Samples

All specimens used here are poor quality ore of these mines.

HO1.	Higashiyama ore body,	Hattori Mine
HO2.	Honzan lower ore body,	〃
KO1.	L-7 ore body,	Kawai Mine
KO2.	L-5 ore body, central part,	〃
KO3.	L-5 ore body, southern part,	〃
TO1.	Honzan ore body, (debris),	Tedori Mine
TO2.	Honzan ore body, (debris),	〃

Experiments

Chemical analyses were performed by ordinary wet methods.

Specimens for microscopic experiments were prepared by solidification with high polymer resin and then made to thin section.

X-ray diffraction data were obtained by an X-ray diffractometer unit, "Geiger-flex". Experimental conditions were as follows: Cu radiation with Ni filter, 30kv 15mA; slit system, 1°-1° 0.2mm; scale factor—multiplier—time constant, 8-1-2; scanning speed 2° per minute. Random powder specimens were under 150 mesh size, and oriented specimens were under 1μ size by using centrifuge and spread over glass slide as well oriented aggregates.

In order to identify the characteristics of the 14Å mineral, the degree of expansion by ethylene glycol and the degree of collapse by HCl treatment were examined.

Differential thermal analyses were carried out by an automatic recording apparatus.

Results and Discussion

Chemical composition of these specimens is shown in Table 1.

Table 1. Chemical Composition of Toseki Ores (Poor Quality)

	HO1	HO2	KO1	KO2	KO3	TO1	TO2
SiO_2	75.70	76.02	67.68	77.51	95.80	79.57	78.10
TiO_2	0.04	0.10	0.16	0.06	0.03	0.05	0.03
Al_2O_3	15.41	13.84	19.58	16.54	1.53	13.07	13.22
Fe_2O_3	1.27	4.44	6.24	0.85	0.45	0.85	0.58
CaO	0.08	0.36	0.59	0.09	0.09	0.67	0.11
MgO	0.18	0.79	1.32	0.06	0.04	0.62	0.12
K_2O	0.81	0.65	1.08	0.46	…	1.92	1.51
Na_2O	1.26	0.75	…	0.84	0.32	0.58	1.54
I. L.	3.88	3.48	4.92	3.01	0.44	2.13	4.26
Total	98.63	100.43	101.57	99.42	98.70	99.45	99.47
Refractoriness S. K.	19	15	14	26	31^+	14	19

(Analyses —— Industrial Research Institute, Ishikawa Prefecture.)

Microscopic examination data are shown as follows:

HO1. (Plate I, a) and b))

The specimen has phenocrysts of quartz and feldspar (altered to sericite), and glassy materials (altered to fine grained quartz and sericite). Rutile and limonite are found as minor constituents. This specimen is considered as a hydrothermal alteration product of rhyolite.

HO2. (Plate I, c) and d))

The specimen seems like the construction of HO1, but includes fewer phenocrysts and much more groundmass with fine grained quartz and sericite. Sericite altered from feldspar (phenocryst), is coarse grain and high grade crystaline. Euhedral pyrite, rutile and chlorite are found as minor constituents.

KO1. (Plate II, e) and f))

The specimen has a texture of mixture of fine grained quartz and sericite. No phenocrysts are found, but pyrite is a minor constituent. This specimen shows tuffaceous texture.

KO2. (Plate II, g) and h))

The specimen has a mingled texture of quartz and sericite, and rutile and pyrite are there as accessary minerals. This is also considered as an alteration product of rhyolite.

KO3. (Plate III, i) and j))

This specimen is constructed by fine grained quartz only. This is considered as quartz vein in rhyolitic rock.

Fig. 1. X-ray diffraction patterns of random specimens of Toseki ores (poor quality)

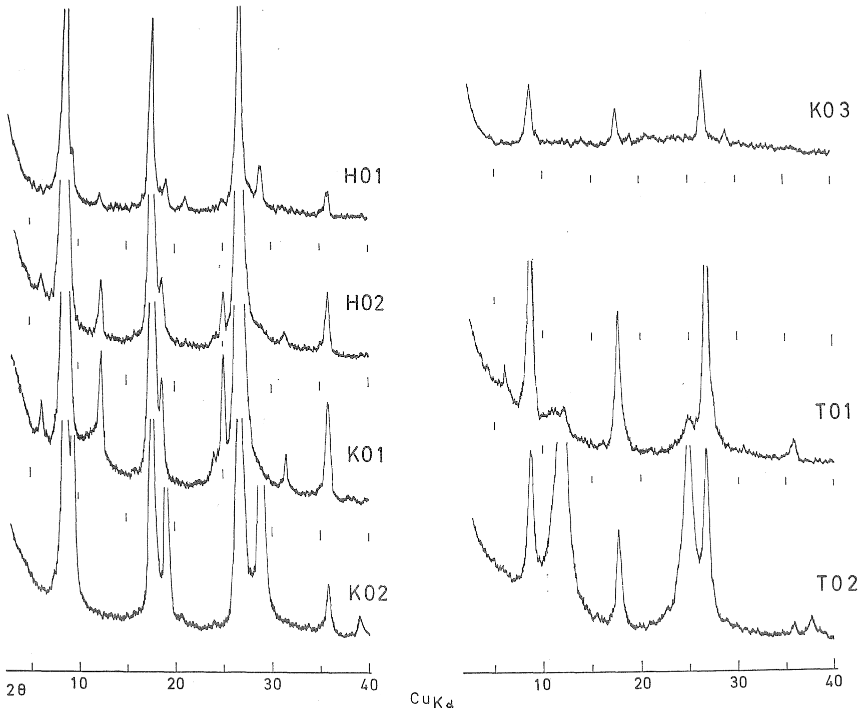

Fig. 2. X–ray diffraction patterns of oriented specimens of Toseki ores (poor quality)

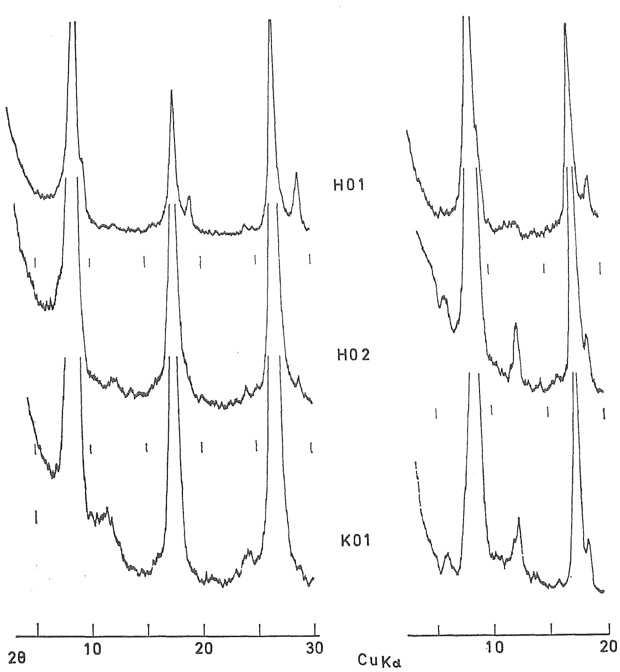

Fig. 3. X–ray diffraction patterns of oriented specimens after treatment of HC1 and Ethylene Glycol of HO1, HO2 and KO1
left : HC1 treatment right: Ethylene Glycol treatment

TO1. (Plate IV, k) and l))

The specimen has phenocrysts of coarse grained quartz and feldspar which are fresh, but some feldspar crystals alter to clayey materials and microcrystalline quartz grain. Alteration products of groundmass are almost kaolin minerals and sericite. As a minor constituent pyrite crystals are shown. This ore is slightly altered from quartz porphyry.

TO2. (Plate IV, m) and n))

This specimen shows phenocrysts of quartz. Kaolin and sericite occur in groundmass.

X-ray diffraction data are shown as follows: (Fig. 1—3)

HO1.

The random specimen gives reflections of quartz, sericite and pyrophyllite, but the oriented specimen shows reflections of sericite, pyrophyllite and kaolinite.

HO2.

The random specimen consists of quartz and sericite, but the oriented specimen shows reflections of sericite, kaolinite and chlorite.

KO1.

The random specimen indicates reflections of quartz and sericite, but the oriented specimen shows those of sericite, kaolinite and chlorite.

KO2.

The mineral assemblage of the random specimen is quartz, sericite and pyrophyllite, and the oriented specimen shows reflections of same quantity of sericite as of pyrophyllite.

KO3.

The random specimen gives reflections of quartz only, and the oriented specimen shows reflections of a few quantity of sericite.

TO1.

The random specimen is composed of quartz and feldspar, and the oriented specimen shows reflections of sericite, kaolinite and chlorite.

TO2.

The random specimen is the same as TO1, but the oriented specimen shows reflections of kaolinite and a small amount of sericite.

The result of differential thermal analyses of HO1, HO2 and KO1 shows that peaks of chlorite of HO2 and KO1, such as 140°C and 700°C, do not appear in the sample of HO1. (Fig.4)

According to the results of these experiments, Toseki ore zone in the Nomi mountain area is divided into two types with regard to mineral assemblage; one is a higher grade hydrothermal alteration zone at Hattori Mine and Kawai Mine, and

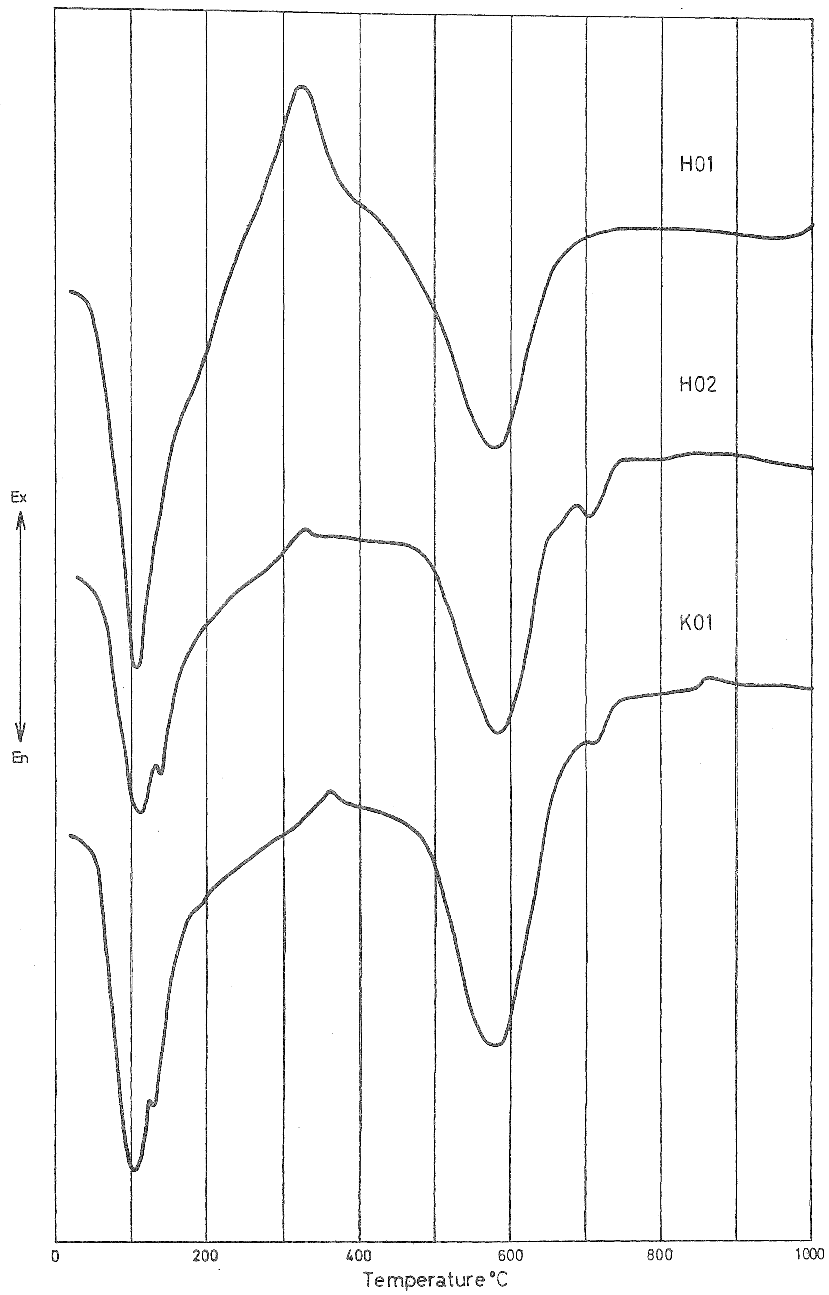

Fig. 4. D. T. A. curves of HO1, HO2 and KO1

the other is a lower grade hydrothermal alteration zone at Tedori Mine. The former type is further divided into two types such as alteration zone of rhyolite and that of rhyolitic tuff. The type of rhyolite alteration is shown as HO1 and KO2. These ores consist of mainly quartz and sericite, and/or pyrophyllite and kaolinite. The type of rhyolitic tuff alteration is shown as HO2 and KO1. These ores consist of quartz, sericite, kaolinite and chlorite. The latter type is a low grade alteration of quartz porphyry. Most feldspar grains are not altered, but a few are altered to kaolinite and sericite.

Mineral assemblage is a method of presumption of general trend of alteration of this area.

1. High grade is quartz + sericite + pyrophyllite + diaspore.[3)]
2. Middle grade is quartz + sericite + kaolinite + chlorite.
3. Low grade is mainly quartz + feldspar, adding a small amount of kaolinite + sericite.

At Hattori Mine and Kawai Mine, good quality ore has a mineral assemblage of 1, and poor quality ore has a mineral assemblage of 2. At Tedori Mine good quality ore is the same alteration grade as poor quality ore, and has a mineral assemblage of 3.

Acknowledgment

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PLATE I

Explanation of Plate I

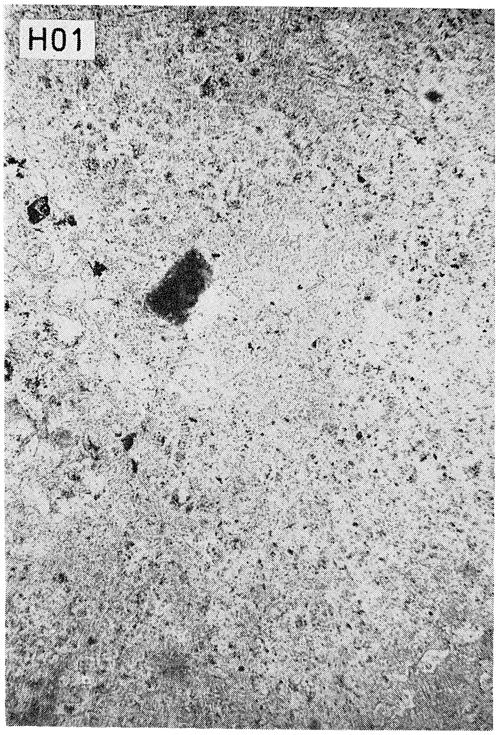
Microphotographs of Toseki ores (Hattori Mine) in ordinary light and under crossed nicols. $\times 60$

HO1 : Altered rhyolite with fine grained quartz and sericite.

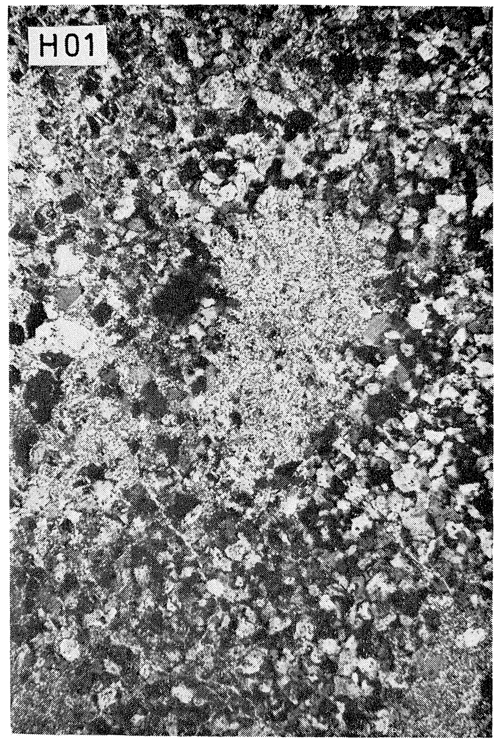
HO2 : Altered rhyolitic tuff with fine grained quartz and sericite.

a) and c), ordinary light; b) and d), crossed polars.

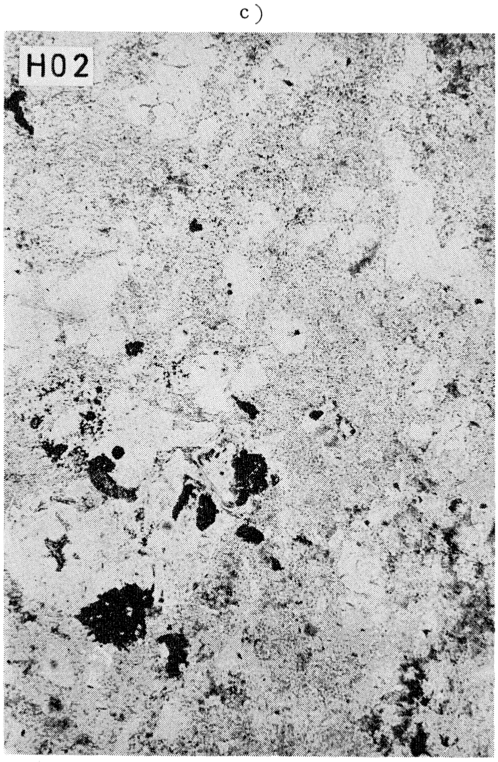
a)



b)



c)



d)

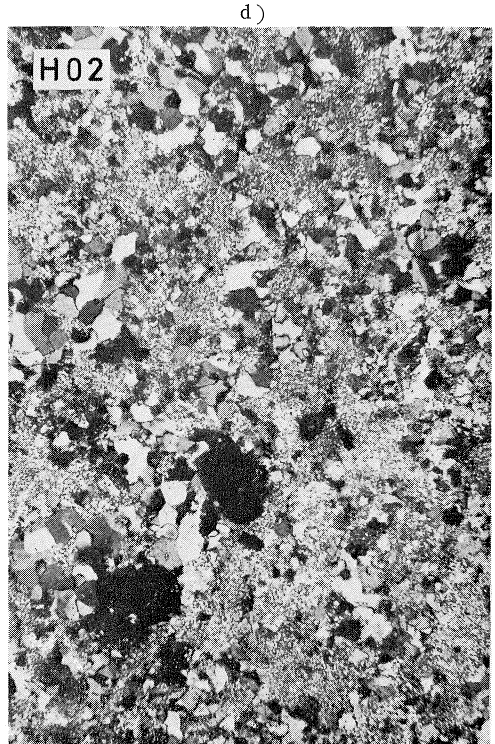


PLATE II

Explanation of Plate II

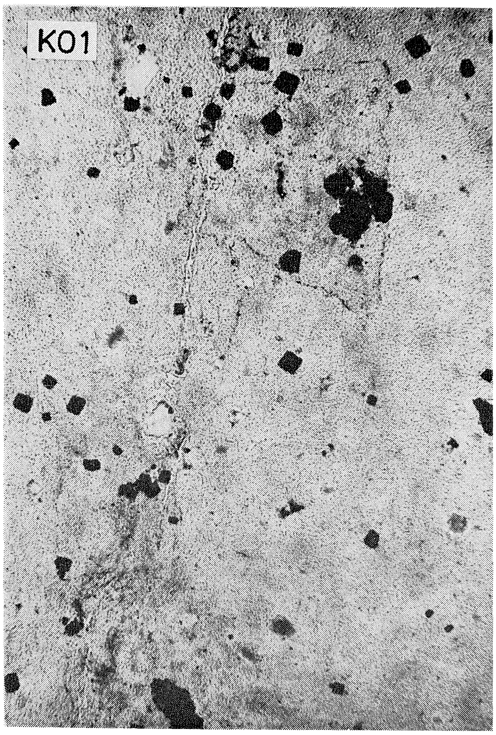
Microphotographs of Toseki ores (Kawai Mine) in ordinary light and under crossed nicols. $\times 60$

KO1 : Altered rhyolitic tuff with euhedral crystals of pyrite.

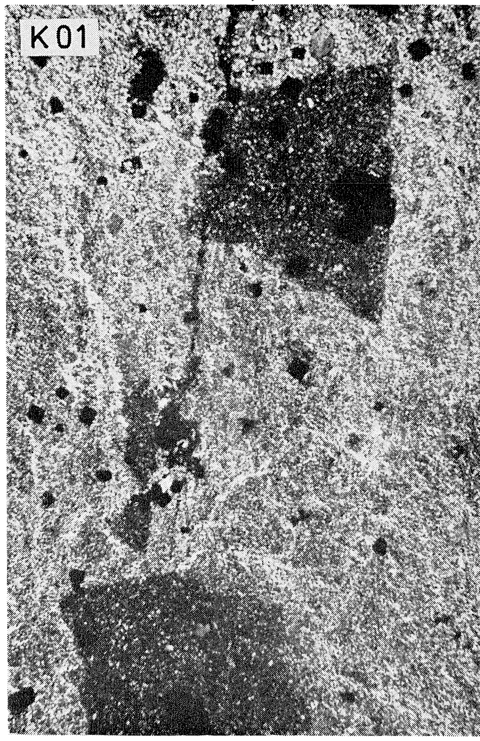
KO2 : Altered rhyolite with fine grained quartz and sericite.

e) and g), ordinary light; f) and h), crossed polars.

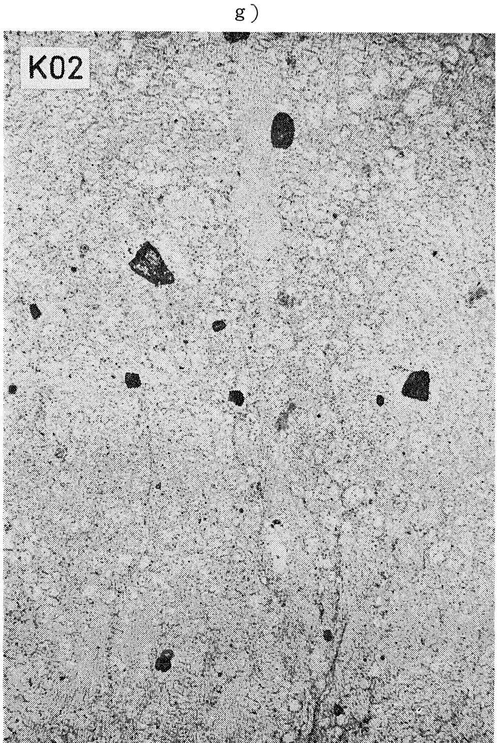
e)



f)



g)



h)

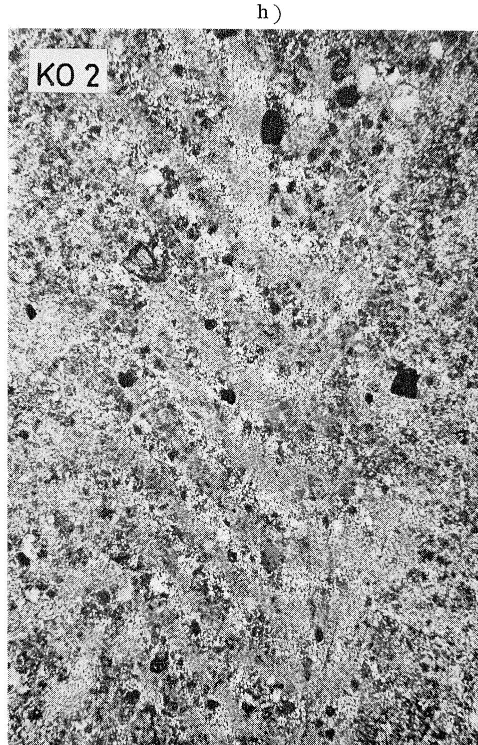


PLATE Ⅲ

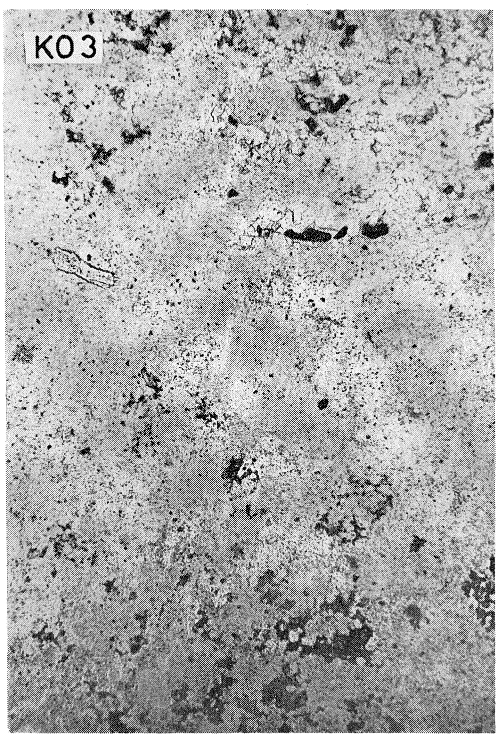
Explanation of Plate III

Microphotographs of Toseki ores (Kawai Mine) in ordinary light and under crossed nicols. ×60

KO3 : Fine grained quartz aggregate.

i), ordinary light; j), crossed polars.

i)



j)

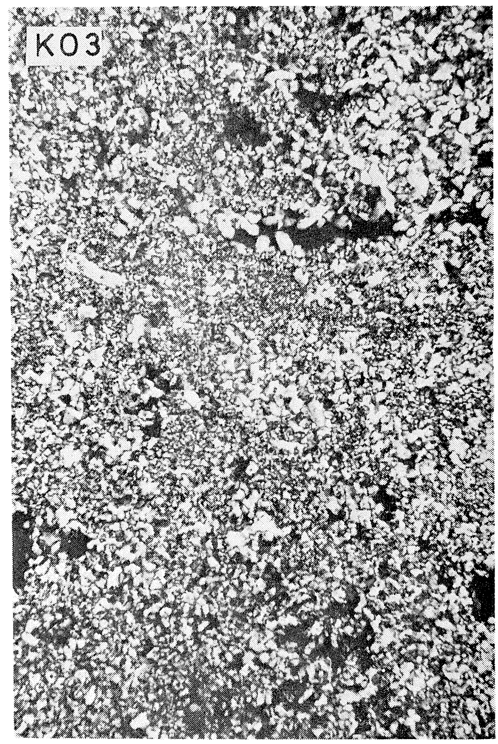


PLATE Ⅳ

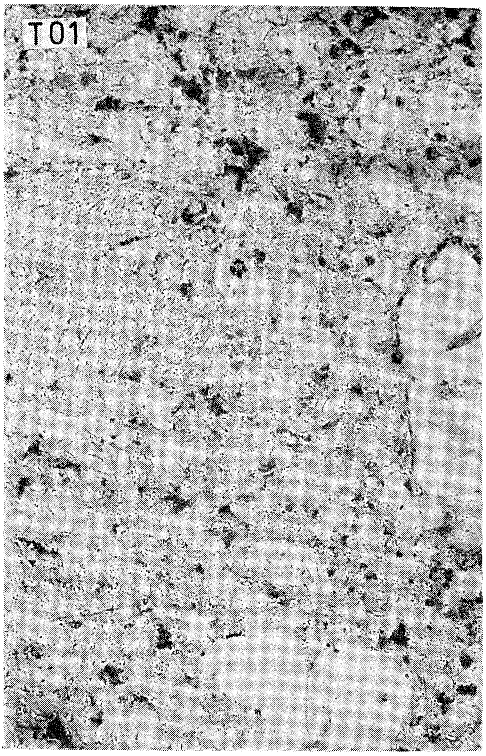
Explanation of Plate IV

Microphotographs of Toseki ores (Tedori Mine) in ordinary light and under crossed nicols. $\times 60$

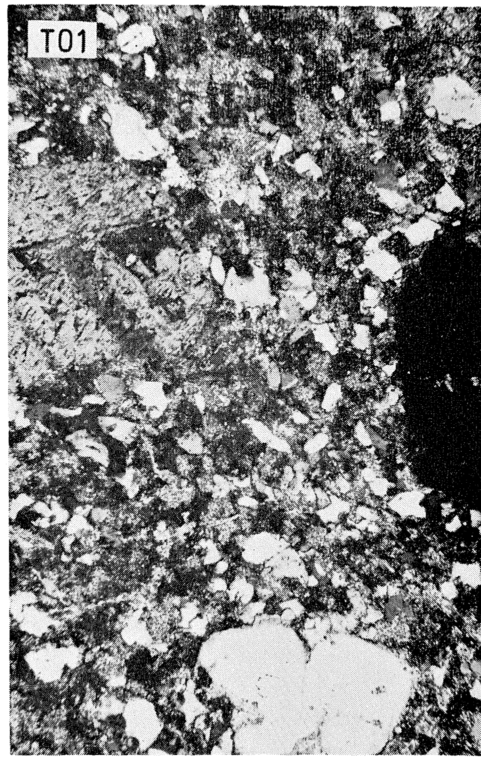
TO1, TO2 : Altered quartz porphyry.

k) and m), ordinary light; l) and n), crossed polars.

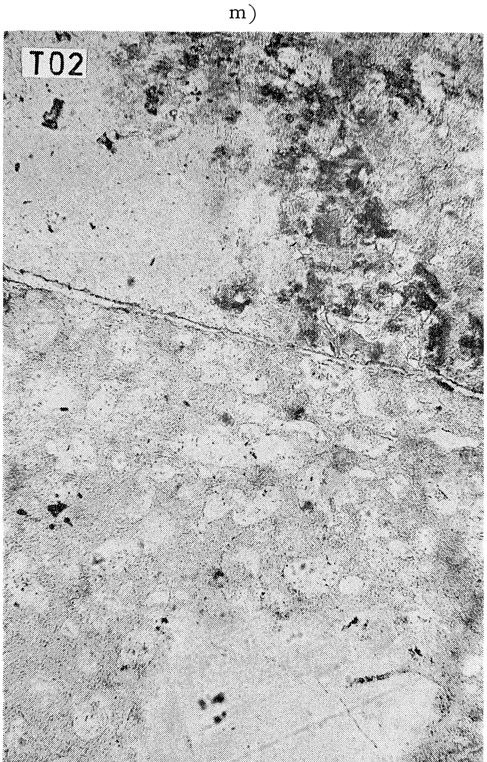
k)



l)



m)



n)