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Kinichilite, a new mineral from the Kawazu mine, Shimoda city, Japan

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Abstract

Kinichilite, a new mineral from the Kawazu mine, is hexagonal with $a=9.419$ Å, $c=7.666$ Å, space group $P6_3$ or $P6_3/m$. The empirical formula derived from the chemical analysis is: $(Fe^{2+}_{1.13}Mg_{0.47}Zn_{0.43}Mn^{2+}_{0.17})_{\Sigma 2.20}(Te_{2.97}Se_{0.03})_{\Sigma 3.00}O_{9.00}(H_{1.38}Na_{0.22})_{\Sigma 1.60}\cdot 3.2H_2O$, corresponding to Fe^{2+} dominant analogue of zemannite.

It is dark brown in colour. Subadamantine luster and brown streak. No cleavage. Density (calc.) 3.96 g/cm^3 from normalized empirical formula and $Z=2$.

Introduction

A dark brown mineral of hexagonal prism was found in a hand specimen of the Kawazu mine collected by late Dr. Yozo Shimizu.

According to X-ray and preliminary EPMA studies, the mineral was found to be isomorphous with zemannite, $(Zn, Fe)_2(TeO_3)_3Na_xH_{2-x}\cdot yH_2O$. After ICP spectroscopic analysis, it has been clarified to be iron (II) analogue of zemannite.

A similar specimen was recently found from the Hinokizawa ore body of the Kawazu mine by Mr. Toru Oishi, and was offered to this work.

The name is for Dr. Kin-ichi Sakurai, a well known amateur mineralogist, who has described many tellurium minerals from the Kawazu mine.

The mineral and the name have been approved by the Commission on New Mineral and Mineral Names, I. M. A. The type specimen is preserved in the National Science Museum, Tokyo, Japan.

Occurrence

The Kawazu mine is located at about 3 km north of Shimoda station, near the southern end of Izu peninsula, Japan (Fig. 1). The ore deposits of the Kawazu mine consist of epithermal quartz veins cutting altered Neogene pyroclastic rocks (Kato, Shibata and Nakamoto, 1933), and had been worked for gold

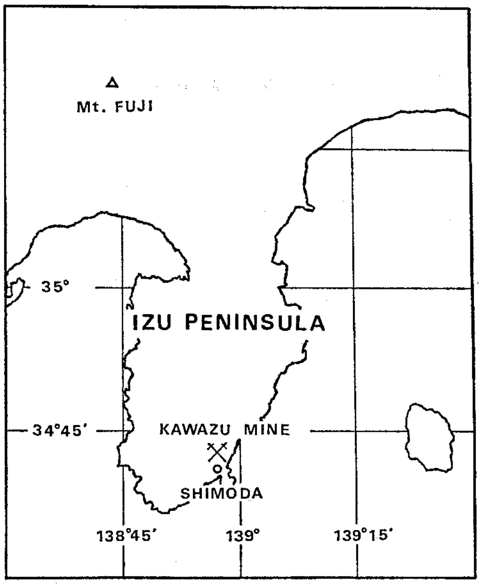

FIG. 1. Locality of the Kawazu mine.

and silver till 1963. According to Kato and Sakurai (1968), the veins are classified into two kinds: gold-silver-tellurium-bearing quartz veins and gold-silver-copper-zinc-lead-bearing quartz veins with only a small amount of tellurium. As tellurium minerals, tellurium (Watanabe, 1936), rickardite (Watanabe, 1934), hessite, empressite and stuetzite (Takasu, 1965), tellurite (Kato, Shibata and Nakamoto, 1933), paratellurite (Sakurai and Kato, 1965a), sylvanite, tellurobismuthite and kawazulite (Editorial committee IMA-IAGOD meeting 1970, 1970; Kato, 1973) and possibly spiroffite (Sakurai and Kato, 1965b) occur in the former, and teineite and goldfieldite (Kato and Sakurai, 1968), tellurite and possibly emmonsite (Sakurai, private communication) occur in the latter.

Hinokizawa ore body, from which kinichilite was found is situated at the southwestern end of the Kawazu mine and belongs to the former kind of veins. Kinichilite occurs as a unique tellurium mineral in a small cavity of quartz vein (Fig. 2). The crystal is an approximately hexagonal prism less than 2 mm long having somewhat curved basal pinacoid.

Chemical composition

The chemical analysis of kinichilite was carried out by ICP emission spectroscopic method after dissolving 1.02 mg of handpicked material in dilute nitric acid (Table 1). The empirical formula calculated on the basis of Te+Se

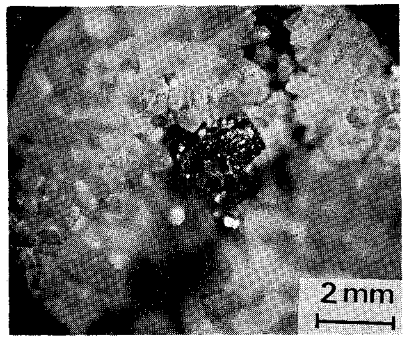

FIG. 2. Photograph of kinichilite. Black crystal : kinichilite, colorless crystal : quartz.

TABLE 1. Chemical analysis of kinichilite.

	wt. %	mol ratio (Te+Se)=3.00	mol ratio $\Sigma M^{2+}=2.00$
FeO	11.6	1.13	1.03
MgO	2.70	0.47	0.43
ZnO	4.97	0.43	0.39
MnO	1.72	0.17	0.15
TeO_2	67.6	2.97	
SeO_2	0.53	0.03	
Na_2O	0.93	0.11	
H_2O (difference)	9.9	3.9	
total	100.0		

=3 and O=9 is $(Fe^{2+}_{1.13}Ma_{0.47}Zn_{0.43}Mn^{2+}_{0.17})_{\Sigma 2.20}(Te_{2.97}Se_{0.03})_{\Sigma 3.00}O_{9.00}(H_{1.38}Na_{0.22})_{\Sigma 1.60}\cdot 3.2H_2O$ after reference to the structural formula of zemannite derived by Matzat (1967). H^+ was not quantitatively determined but calculated to maintain the charge balance. The ideal formula of this mineral is $(Fe^{2+}, Mg, Zn, Mn^{2+})_2(TeO_3)_3(H, Na)_2\cdot 3H_2O$, where $Fe^{2+}>Mg+Zn+Mn^{2+}$ and H>Na. The former relation serves to the distinction from zemannite which is $Zn^{2+}>Fe^{2+}$ (Mandarino, Matzat and Williams (1976)). It is readily soluble in HCl and HNO_3.

Physical properties

Kinichilite is dark brown in colour. Subadamantine luster and brown streak. Hardness is very low and could not be measured accurately on account of its fragile nature. Cleavage was not observed. Density is calculated as 3.96 g/cm³ from the normalized empirical formula and $Z=2$.

TABLE 2. X-ray powder data for kinichilite and zemannite.
Radiation: Cu/Ni, internal standard: quartz, method: diffractometer

	kinichilite			zemannite*	
hkil	$d_{calc.}$ (Å)	$d_{obs.}$ (Å)	I/I_0	$d_{obs.}$ (Å)	I/I_0
$10\bar{1}0$	8.157	8.15	90	8.15	100
$11\bar{2}0$	4.710			4.69	5
$20\bar{2}0$	4.079	4.079	100	4.07	80
0002	3.833	3.824	35	3.80	30
$10\bar{1}2$	3.469	3.465	15	3.44	10
$21\bar{3}0$	3.083	3.087	15	3.07	40
$11\bar{2}2$	2.973	2.966	30	2.96	60
$21\bar{3}1$	2.860	2.861	50	2.845	60
$20\bar{2}2$	2.793	2.790	85	2.778	90
$30\bar{3}1$	2.563	2.564	15	2.547	30
$21\bar{3}2$	2.402	2.402	8	2.390	30
$22\bar{4}0$	2.355	2.353	10	2.345	50
$11\bar{2}3$	2.243			2.242	5
$30\bar{3}2$	2.218	2.218	15	2.207	40
$31\bar{4}1$	2.170	2.171	9	2.160	50
$40\bar{4}0$	2.039	2.041	5		
$22\bar{4}2$	2.006	2.004	6	1.998	30
$21\bar{3}3$	1.967			1.952	5
$31\bar{4}2$	1.948			1.942	5
0004	1.917	1.917	5	1.906	20
$10\bar{1}4$	1.866	1.866	6		
$30\bar{3}3$	1.862			1.855	30
$32\bar{5}1$	1.818	1.819	10	1.812	20
$40\bar{4}2$	1.800	1.802	3	1.792	40
$11\bar{2}4$	1.775			1.767	5
$20\bar{2}4$	1.735	1.735	20		
$22\bar{4}3$	1.732			1.726	60
$31\bar{4}3$	1.694			1.686	40
$21\bar{3}4$	1.628	1.629	3	1.622	10
$41\bar{5}2$	1.614	1.611	6		
$40\bar{4}3$	1.594			1.59	20
$30\bar{3}4$	1.566			1.563	5
$33\bar{6}1$	1.538			1.535	5
$32\bar{5}3$	1.510	1.511	8		
$10\bar{1}5$	1.507			1.504	50
$22\bar{4}4$	1.486	1.484	5	1.481	20
system		hexagonal		hexagonal	
space group		$P6_3$ or $P6_3/m$		$P6_3/m$	
lattice constants					
	a	9.419(5) Å		9.41(2) Å	
	c	7.666(5) Å		7.64(2) Å	

*Mandarino *et al.*, 1976 (Camera method, CuK radiation)

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X-ray studies

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Optically, it is uniaxial, positive. Rapid and violent reaction with the immersion liquids prevented measuring refractive indices, but both N_o and N_e were higher than 1.8. It is weakly dichroic from light brown to yellowish brown in thin section.

X-ray studies

The X-ray powder data for kinichilite are given in Table 2. The unit cell parameters calculated from the powder data are a=9.419(5) Å and c=7.666(5) Å, which are very close to those of zemannite, a=9.41(2) Å and c=7.64(2) Å (Mandarino, Matzat and Williams, 1976). The hexagonal symmetry is confirmed by the precession photographs, which indicate the space group $P6_3$ or $P6_3/m$, the latter being more likely from the analogy with zemannite (Matzat, 1967).

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