

Desautelsite from Konomori, Kochi City, Japan

By

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Abstract—Desautelsite from Konomori, Kochi City, occurs as the last fissure mineral in a fractured serpentinite, forming somewhat flocculent crust generating from the underlying manganese dioxide film. The wet chemical analysis gave MgO 36.0, NiO 0.3, Mn₂O₃ 21.0, Fe₂O₃ 0.1, CO₂ 8.5, H₂O 33.6, total 99.5%, corresponding to (Mg_{6.14}Ni_{0.03})_{Σ6.17}(Mn_{1.83}³⁺Fe_{0.01}³⁺)_{Σ1.84}(CO₃)_{1.32}(OH)_{15.22}(H₂O)_{1.46}·3.75H₂O on the basis of total cation=8 and total anionic group (including (H₂O))=18, reasonably close to the ideal formula Mg₆Mn₂³⁺CO₃(OH)₁₆·4H₂O, with a slight excess of CO₃²⁻, uncommonly known in the minerals of pyroaurite series. It is trigonal, R3m or R $\bar{3}$ m, *a* 3.110(1), *c* 23.488(9) Å, Z=3/8. It is bright orange in fresh colour with the same streak and vitreous to earthy luster. Cleavage basal, perfect. Optically it is uniaxial and negative with nE=1.544(2) and nO=1.568(2). Dichroism is strong with axial colours E=orange yellow and O=deep orange.

The mineral was formed after a reaction of magnesium and carbonate-bearing meteoritic water with a filmy amorphous manganese dioxide covering fissure walls in a fractured serpentinite.

The acid treatment on some materials labelled as pyroaurite disclosed the additional occurrence of desautelsite at five localities in Japan, indicating its commoner occurrence.

Introduction

Desautelsite, Mg₆Mn₂³⁺CO₃(OH)₁₆·4H₂O, is a new mineral of pyroaurite series (DUNN *et al.*, 1979) found as the last stage mineral in altered serpentinites from four discrete localities, and the common occurrence is suggested from its apparent similarity to pyroaurite as well as its mode of occurrence.

In October 1981, Mr. Yoshinobu TAMURA of Kochi City presented the first and second authors a bright orange powdery fissure mineral from a quarry of serpentinite at Konomori, Kochi City, for identification. The sufficient quantity enabled its complete wet chemical analysis by the third author, indicating it to be the first desautelsite in Japan together with a slight excess of CO₂ as a rare example in the minerals of pyroaurite series.

A chemical test using HCl (1:1) to distinguish the mineral from pyroaurite (DUNN *et al.*, 1979) on materials labelled as pyroaurite in the mineral collection of National Science Museum disclosed the occurrence of desautelsite from five localities in Japan.

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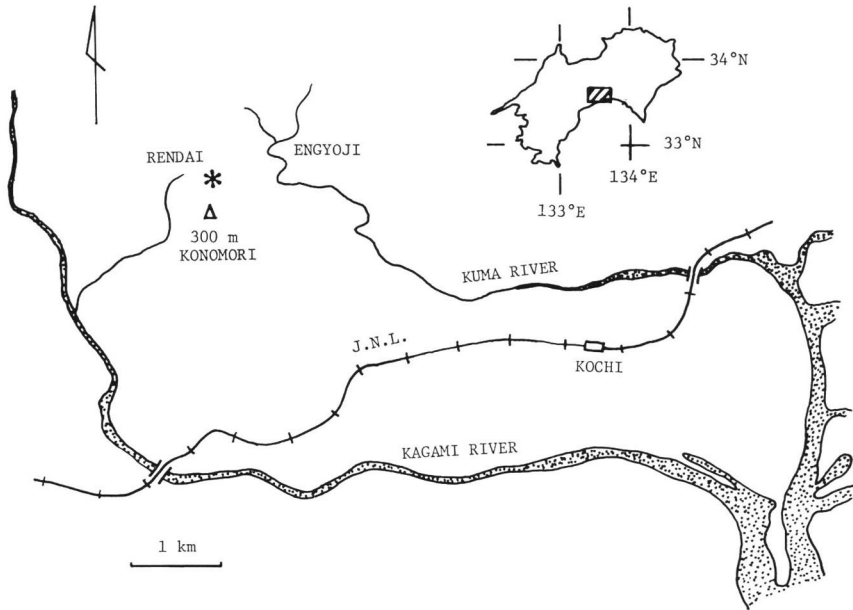


Fig. 1. The index map of the locality (star mark).

We express our sincere gratitude to Mr. Yoshinobu Tamura, who provided the materials for study and helped our field work.

Occurrence

There is a row of ultrabasic rocks represented by serpentinite in the northward of Kochi City running with E-W direction and some of them have been quarried. The locality of desautelsite is located about 400 meters north of the top of Mt. Konomori, Kochi City (Fig. 1) and a part of quarry currently operated by Tanaka Olivine Mining Company, where rosenhahnite was recently found (KATO and MATSUBARA, 1984).

The exposure of desautelsite-bearing fissure is a highly fractured surface of serpentinite with minutely developed veinlets of serpentine minerals with aragonite. The wallrock of fissures is so fragile that the materials were removed from the surface with caution. The crust of desautelsite is somewhat flocculent and in many places underlain by deep brownish black film of manganese dioxide, which is amorphous to X-ray. The bright orange colour of desautelsite imparts a very outstanding feature in the exposure unless weathered, enabling the collection of fresh and pure material for study.

Under the magnifier desautelsite is composed of at random aggregate of fine hexagonal tablets reaching 0.3 mm across. Under the electron microscope, they consist of base and small prism only (Fig. 2).

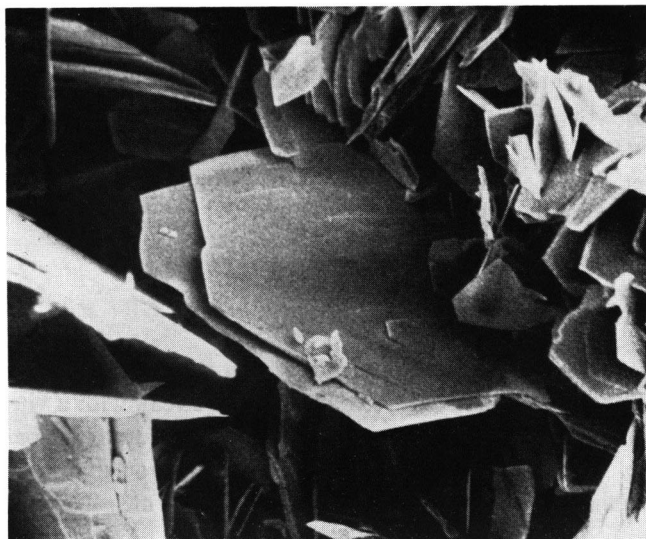
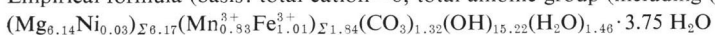


Fig. 2 Scanning electron microphotograph of desautelsite. View, $80 \times 95 \mu\text{m}$.

Table 1. Chemical analysis of desautelsite.

	wt. %	recast to 100%	molecular quotient	cation number	theoretical weight %
MgO	36.0	36.2	0.8982	6.14	36.65
NiO	0.3	0.3	0.0040	0.03	
Mn ₂ O ₃	21.0	21.1	0.1336	1.83	23.92
Fe ₂ O ₃	0.1	0.1	0.0006	0.01	
CO ₂	8.5	8.5	0.1931	1.32	6.67
H ₂ O	<u>33.6</u>	<u>33.8</u>		25.64	<u>32.76</u>
total	99.5	100.0			100.00

Empirical formula (basis: total cation=8, total anionic group (including (H₂O))=18):



Chemical Analysis

The monominerallic nature of crust made it so easy to prepare pure material for wet chemical analysis by a simple handpicking. However, its flocculent nature provided lesser quantity of material than expected, leading to the delivery of chemical analysis down to one place of decimals.

The chemical analysis listed in Table 1 indicates its reasonably proximity to the

theoretical figure for $\text{Mg}_6\text{Mn}_2^{3+}\text{CO}_3(\text{OH})_{10}\cdot 4\text{H}_2\text{O}$ and the excess of CO_2 as a rare example in the minerals of pyroaurite series. The present calculation of empirical formula is due to a tentative base with the total cation=8 and total anionic group (including (H_2O))=18. The latter part of basis comes from the crystal structure of pyroaurite (ALLMANN, 1978) in which an interlayer unit $(\text{CO}_3\cdot 4\text{H}_2\text{O})^{2-}$ is disordered. The total number of $\text{CO}_3+\text{H}_2\text{O}$ in the empirical formula is 5.07, which is close to 5 in ideal pyroaurite structure.

Physical Properties

The physical properties are well coincident with those of the original description (DUNN *et al.*, 1979). It is bright orange in colour and streak with a vitreous to earthy luster. After being weathered it loses its brightness. Hardness on basal cleavage is 2 in Mohs' scale. The calculated density is 2.16 g/cm^3 for the empirical formula. Optically it is uniaxial and negative. The refractive indices measured by the immersion method are $n_E=1.544(2)$ and $n_O=1.568(2)$, respectively. Dichroism is very strong with axial colours E=orange yellow and O=deep orange. It is readily soluble in HCl (1: 1) forming a deep brown solution. The reaction is very sensitive but effervescence is not always clear.

X-Ray Powder Diffraction Study

The X-ray powder diffraction pattern is very close to that of the original material (Table 2), although the employment of X-ray powder diffractometer provided a significant enhancement of intensity of basal diffractions. The unit cell parameters calculated from the pattern are $a=3.110(1)$ and $c=23.488(9) \text{ \AA}$, respectively, with $Z=3/8$. No violation of extinction rule for the space group $R3m$ or $R\bar{3}m$ is found. A weathered material gave somewhat broader peaks especially in non-basal diffractions.

Genesis

It is obvious that the origin of manganese of the present desautelsite is in the underlying deep brownish black film composed of an amorphous manganese dioxide. Although the mineralogical nature of this material is unknown due to its amorphous nature to X-ray, it contains Mn^{4+} as an essential constituent, since the treatment by HCl gives off an irritating odour. Therefore, the formation of desautelsite needs the reduction of manganese from tetra- to trivalent state, despite under a superficial condition. Anyway, the reaction of a meteoritic water containing magnesium and carbonate ions with the manganiferous material took place under a neutral to alkaline condition accompanied by a very low temperature and unexposed circumstance.

Table 2. X-ray powder diffraction pattern of desautelsite.

1.			2.		
$d_{\text{obs.}}$	$d_{\text{calc.}}$	I	$d_{\text{obs.}}$	I	hkil
7.893	7.833	1000	7.76	100	0003
3.921	3.913	650	3.88	60	0006
2.623	2.623	30	2.622	50	01 $\bar{1}$ 2
2.336	2.336	30	2.332	60	01 $\bar{1}$ 5
2.104	2.100	1			10 $\bar{1}$ 7
1.985	1.985	40	1.981	60	01 $\bar{1}$ 8
1.955	1.957	1			000.12
1.770	1.770	10	1.768	20	10 $\bar{1}$.10
1.674	1.673	10	1.670	20	01 $\bar{1}$.11
1.555	1.555	4	1.557	20	11 $\bar{2}$ 0
1.525	1.525	5	1.527	30	11 $\bar{2}$ 3
1.500	1.500	9	1.498	20	10 $\bar{1}$.13
1.445	1.445	2	1.446	10	11 $\bar{2}$ 6
1.423	1.423	3b	1.421	5	01 $\bar{1}$.14
1.338	1.338	$\frac{1}{2}$			20 $\bar{2}$ 2
1.312	1.312	2b			02 $\bar{2}$ 4
			1.297	10	000.18
1.293	1.294	} 7b			20 $\bar{2}$ 5
1.289	1.289				10 $\bar{1}$.16
1.224	1.224	2	1.226	5	20 $\bar{2}$ 8
$\underline{a} = 3.110(1)\overset{\circ}{\text{A}}$			$\underline{a} = 3.114(1)\overset{\circ}{\text{A}}$		
$\underline{c} = 23.488(9)\overset{\circ}{\text{A}}$			$\underline{c} = 23.39(2)\overset{\circ}{\text{A}}$		

1. Desautelsite. Konomori, Kochi City, Japan. Cu/Ni radiation. Diffractometer method. b=broad.
2. Desautelsite. Cedar Hill Quarry, Lancaster County, Pennsylvania, U.S.A. Cu/Ni radiation. Gandolfi camera method. After DUNN *et al.* (1979).

Additional Localities of Desautelsite

More than ten specimens labelled as pyroaurite in the mineral collection of National Science Museum were examined in terms of the method of DUNN *et al.* (1979) to find desautelsite therein. The treatment of flakes by 1:1 HCl produced deep brown solution on materials from the following five localities. In all of them the mineral occur as fissure mineral in fractured serpentinites:

1. Torigoe, Hidaka-mura, Takaoka-gun, Kochi Prefecture
2. Gochi-toge, Toba City, Mie Prefecture

3. Shiraki, Toba City, Mie Prefecture
4. Sasaguri, Sasaguri-machi, Kasuya-gun, Fukuoka Prefecture
5. Utonai, Nakagawa-machi, Nakagawa-gun, Hokkaido.

In the original description, the authors referred to the occurrence of desautelsite from Japan in the form of private communication of the second author. The material is from the fourth locality, though the examined material is different from that being the source of referred information.

References

- ALLMANN, R., 1968. The crystal structure of pyroaurite. *Acta Cryst.*, **B24**: 972–977.
- DUNN, P. J., D. R. PEACOR & T. D. PALMER, 1979. Desautelsite, a new mineral of the pyroaurite group. *Amer. Mineral.*, **64**: 127–130.
- KATO, A. & S. MATSUBARA, 1984. The presence of essential CO_3^{2-} in rosenhahnite from Engyoji, Kochi City, Japan. *Bull. Natn. Sci. Mus.*, Ser. C, **10**: 1–8.