

Tacharanite from Noaki, Yaizu City, Shizuoka Prefecture, Japan

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Introduction

Tacharanite is an uncommon hydrous calcium silicate originally described by SWEET (1961) in amygdules of olivine dolerite from Portree, Isle of Skye, and the similarity to tobermorite was suggested after the chemical analysis and X-ray powder study. In 1975 CLIFF *et al.* have obtained the ideal formula as $\text{Ca}_{12}\text{Al}_2\text{H}_6\text{Si}_{18}\text{O}_{54} \cdot 15\text{H}_2\text{O}$ and a monoclinic subcell with a 17.05, b 3.65, c 27.8 Å, β 114.1°, $Z=1$. where a and c are possibly and b is certainly doubled, using the materials of subsequent finds. Also SUTHERLAND (1976) reported the extensive occurrence in hyaloclastites of basalt lavas and breccias from Tasmania.

The present paper reports its first occurrence in Japan and the content has been already spoken at the Annual Meeting of Mineralogical Society of Japan in 1977. The chemical analysis specifies the material to be a sodium-bearing one and to have less hydrous ideal formula, and the X-ray powder study requires the existence of less prominent subcell of CLIFF *et al.* (1975) along with b -direction.

Occurrence

Tacharanite was found in an altered alkali basalt forming a member of alkali rock complex occupying Takakusayama and its vicinity located about 10 km southwestward of Shizuoka City, Central Japan and the studied materials were collected from a dump of a quarry near Noaki, Yaizu City (Fig. 1), where an altered alkali basalt is found in association with an altered basic tuff. Nearby the quarry is an exposure of

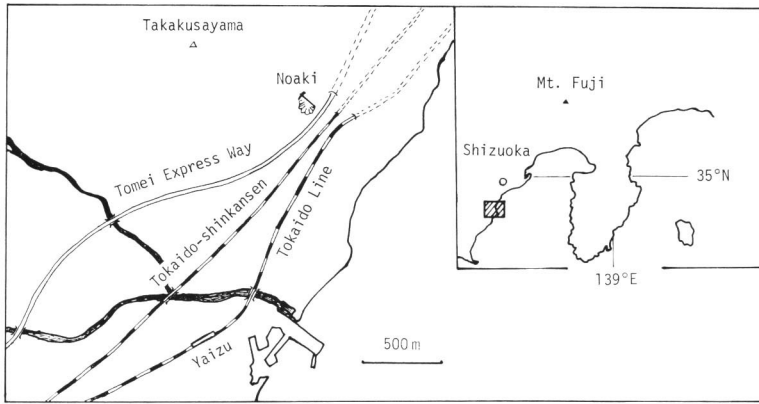


Fig. 1. Index map of the locality.

pillow lava of similar but less altered nature.

Tacharanite occurs as white amygdule-filling material involving aggregates of gyrolite and analcime in alkali basalt of less and more altered natures. Less altered one has a dark grey groundmass including plagioclase phenocrysts of about a millimetre across, whereas more altered one has a light grey green matrix with a glassy appearance and conchoidal fracture, though the phenocrysts are reserved.

Under the microscope the former consists of olive yellow matrix with minute prisms of clinopyroxene, aggregate of celadonite and opaque spherulitic aggregate of pumpellyite composed of radially grown minute fibres. More altered one is characterized by the presence of abundant pumpellyite and disappearance of original texture of groundmass. The texture of groundmass suggests that the alkali basalt is a product of rapid cooling and the formation of amygdule-filling material was due to a late-magmatic action without any significant alteration of mafic minerals in the groundmass.

The amygdules reach a few centimetre across in maximum and have a concave and convex outlines. Tacharanite is generally found as a rimming material of the amygdule wall or overlies analcime in which radial aggregates of gyrolite are involved (Fig. 2a and 2b). The other minerals found in amygdules include thomsonite, tobermorite, minor chabazite and laumontite. Among them, tobermorite and laumontite occur as replacing masses to tacharanite. Tacharanite is exclusively found in the altered alkali basalt in the quarry. The altered basic tuff in the quarry is veined by laumontite and calcite, and devoid of any other zeolites.

Physical and Optical Properties

The mass of tacharanite is white in colour and has a porcelain-like appearance with a conchoidal fracture. Hardness of mass is about 5 in Mohs' scale. Density measured by the Berman microbalance method is 2.25 g/cm^3 , which is reasonably close to

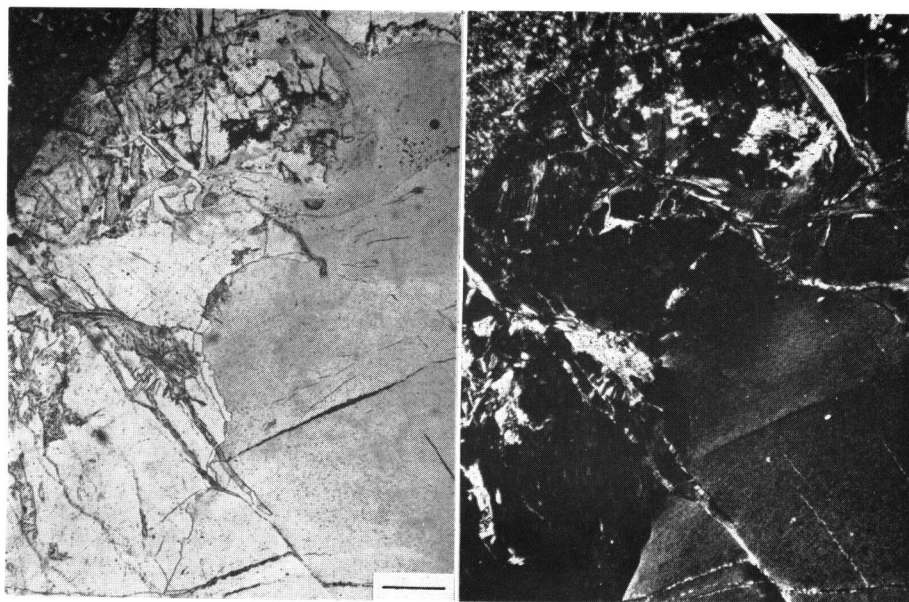


Fig. 2. Photomicrograph of tacharanite-bearing cavity.

Groundmass (left upper), partially altered plagioclase phenocrysts (middle upper), analcime including radial aggregates of gyrolite (left under), and tacharanite (right half). Bar indicates 0.2 mm. a) one polar, b) crossed polars.

2.30 g/cm³ calculated from the empirical formula and unit cell parameters.

Under the microscope, the mass is colourless to light brown and composed of very fine grains of submicroscopic size, impeding the direct measurement of optical properties of grains, except for the refractive index, $n=1.532$ (2), by the immersion method. The birefringence is lower than 0.004 and no anomalous interference colour is observed.

In some aggregates with a weak birefringence, a vague conoscopic figure is seen and judged to be biaxial positive with a large optic angle. In the thinnest part of thin section, some parallel traces of parting are observed in the mass and the extinction is parallel to them with a positive elongation, though the extinction of aggregate is not sharp but undulatory as seen in radially aggregated micaceous minerals.

X-Ray Powder Study

The X-ray powder pattern obtained by the diffractometer method is essentially identical with that of the material from Bramburg, Germany (CLIFF *et al.*, 1975). But the present pattern involves a weak but reproducible diffraction at $d=7.3$ Å, which requires the index (010) after the b -doubled cell of CLIFF *et al.* (1975), who have suggested the possibility of b -doubling. In Table 1, the pattern of two tacharanites are com-

Table 1. X-ray powder diffraction pattern of tacharanites.

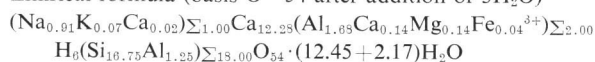
1						2					
hkl*	d _{obs.}	I	d _{obs.}	d _{calc.}	I	hkl*	d _{obs.}	I	d _{obs.}	d _{calc.}	I
100			15.76	15.62	2	027	2.581	vvw	2.582	2.576	2
002	12.7	vvs	12.87	12.80	90	0.0.10			2.554	2.554	1
102				12.80		427	2.509	vw	2.506	2.506	5
102	8.34	mw	8.402	8.513	10	523	2.491	vw	2.485	2.487	5
202				8.333		504	2.434	ms	2.434	2.438	20
010				7.237	5	127				2.435	
104	7.1	vw				704				2.430	
004	6.4	vvw	6.366	6.389	1	1.0.10	2.367	vw	2.377	2.372	6
204				6.375		2.0.12			2.310	2.304	1
202	5.69	mw	5.712	5.698	10	521	2.295	vvw			
302				5.689		029	2.234	vvw	2.232	2.237	3
104	5.19	ms	5.205	5.213	30	625				2.230	
304				5.199		623				2.230	
300				5.199		2.0.10	2.176	vw	2.180	2.179	6
204	4.145	vvw	4.168	4.170	5	425	2.128	mw	2.126	2.129	8
404				4.156		327	2.077	vw	2.079	2.082	1
106	3.736	w	3.742	3.737	7	702			2.065	2.056	5
406				3.729		802	2.053	vvw/d	2.060	2.053	5
208	3.489	w	3.504	3.496	10	4.2.11			2.053	2.053	5
022				3.499		621				2.052	
122				3.499		1.0.12	1.993	mw	1.996	1.994	9
504	3.405	m	3.414	3.420	15	800	1.948	mw	1.947	1.947	8
108				3.414		729	1.913	mw	1.913	1.913	4
308				3.410		427				1.911	
304				3.406		508	1.873	vvw			
402	3.353	w	3.361	3.363	2	908					
502				3.360		704					
122				3.354		904					
223	3.273	vvw	3.276	3.269	6	329	1.851	w	1.850	1.851	5
221	3.206	vvw				3.2.13				1.850	
008	3.178	w	3.191	3.193	10	040	1.822	s	1.819	1.819	20
408				3.188		042	1.805	w			
123				3.175		142					
125	3.048	vs	3.046	3.046	100	9.0.12	1.735	mw	1.732	1.729	6
321				3.041		925	1.676	mw	1.677	1.676	3
323				3.039		927				1.676	
025	2.980	vvw	2.966	2.963	1	440	1.649	m	1.649	1.648	5
508				2.902		923				1.648	
315	2.888	ms	2.884	2.883	25	929				1.647	
311				2.882		2.0.14	1.633	vvw	1.631	1.631	1
126	2.853	ms	2.857	2.856	22	8.2.13	1.613	vvw			
404				2.849		627					
306	2.775	s	2.783	2.782	20	10.0.0	1.563	vvw			
502				2.778		644	1.537	mw	1.535	1.532	5
421	2.731	vvw	2.728	2.723	4	049			1.527	1.532	5
425	2.687	vvw				642			1.524	1.521	4
4.0.10			2.695	2.696	2		1.490	vvw	1.493		1
							1.460	vw	1.458		1

1. Tacharanite. Bramburg, Germany. Cu-radiation. Diffractometer and Guinier camera method. After CLIFF *et al.* (1975).
2. Tacharanite. Noaki, Yaizu City, Shizuoka Prefecture, Japan. Cu/Ni radiation. Diffractometer method.
(*hkl indices are due to *b*-doubled cell of the present material.)

Table 2. Chemical analysis of tacharanite (analyst: T. TIBA).

	wt%	recast to 100%	molecular quotient	metal number	oxygen number	cation number
SiO ₂	45.22	45.53	0.7578	0.7578	1.5155	16.75
Al ₂ O ₃	6.70	6.75	0.0662	0.1324	0.1986	2.93
Fe ₂ O ₃	0.13	0.13	0.0008	0.0016	0.0024	0.04
MgO	0.26	0.26	0.0065	0.0065	0.0065	0.14
CaO	31.34	31.56	0.5628	0.5628	0.5628	12.44
Na ₂ O	1.26	1.27	0.0205	0.0410	0.0205	0.91
K ₂ O	0.14	0.14	0.0015	0.0030	0.0015	0.07
H ₂ O+	12.50	12.59	0.6989	1.3977	0.6989	30.89
H ₂ O-	1.76	1.77	0.0983	0.1965	0.0983	4.34
total	99.31	100.00				

Empirical formula (basis O=54 after addition of 3H₂O)



pared. From the indexing, the unit cell parameters of the present tacharanite are calculated as a 17.07, b 7.276, c 27.96 Å, β 114.0°, $Z=2$.

Chemical Analysis

The chemical analysis was made on a hand-picked material by the ordinary wet method (Table 2), yielding the ideal formula $\text{NaCa}_{12}\text{Al}_2\text{H}_6\text{AlSi}_{17}\text{O}_{54} \cdot 12\text{H}_2\text{O}$ from the obtained empirical formula, after the removal of water corresponding to H₂O (–). The slight difference from the formula of CLIFF *et al.* (1975) is explained by the substitution of NaAl for □ Si and by the discrimination of H₂O (–) from H₂O (±).

Consideration on Genesis

On account of lack of synthetic data for tacharanite, available informations coming from the existence are not always copious. Alike to other tacharanites except for the original one, the present material is apparently stable in the dump or on the exposed surface, though tobermorite and gyrolite, decomposition products of the original tacharanite, are found in cavities of the similar rock to that comprising tacharanite. This suggests the condition of formation of tacharanite to be allied to those of gyrolite or tobermorite, and minor chemical differences in circumstance will determine the phase to be produced. And, of course, the formation will be significantly affected by the participation of aluminum, which must have interfered the formation of tacharanite and favoured that of calcium-bearing zeolites like laumontite and chabazite, all of which are found in the dump of the quarry.

Also, the field observation suggests its incompatible nature with calcite, which is exclusively found in altered basic tuff devoid of pumpellyite and associated with laumontite. The basic tuff comprises iron-rich chlorite as its essential constituents. Very

probably, the formation of tacharanite was favoured under CO₂-poor condition alike to the case of tobermorite and possibly to that of pumpellyite.

The presence of amygdules with mineral assemblages devoid of tacharanite suggests that they were formed under discrete and slightly different condition, where minor compositional differences in the products were allowed despite the closer presence of neighbouring amygdules. The less altered nature of inter-amygdule parts favours this interpretation.

An extensive mineralogical observation at the quarry did not lead to the find of any silica-rich zeolites with the Al/Si ratio smaller than 1/2 in their ideal formulae, i. e., stilbite, epistilbite, heulandite etc, are not found therein. This suggests that the formation of tacharanite is excluded under a silica-rich condition where above-mentioned zeolites are favourably formed.

References

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