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TETRAGONAL ANALCIME FROM SOUTHEASTERN NEWFOUNDLAND

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ABSTRACT

Pseudotrapezohedral twins of analcime, 1–7 mm across, form spotty encrustations on fracture surfaces in Late Precambrian felsic pyroclastic rocks in the vicinity of a diabase dyke in Placentia Bay, southeastern Newfoundland. These crystals are tetragonal, with known symmetry $I4_1/acd$, a 13.70, c 13.68 Å; optically (–), n_ϵ 1.484–1.487, n_ω 1.487, birefringence 0.002–0.003, $2V_x$ 0–40°, $\Delta 2\theta$ (Saha 1959) equals 1.84. Composition: SiO_2 55.58, Al_2O_3 21.69, CaO nil, Na_2O 12.89, K_2O 0.03, H_2O 9.14 (total 99.33). Formula: $(Na_{14.81}K_{0.02})\ Al_{15.15}Si_{32.93}O_{96}\cdot 18.06\ H_2O$). The crystals were probably formed by the interaction of seawater with solutions derived from the felsic tuff, and were preserved near the dyke because it acted as a buttress against small shearing movements on joint surfaces.

Keywords: tetragonal analcime, trapezohedral crystals, Precambrian tuff, Newfoundland, Avalon zone.

SOMMAIRE

Les pseudo-trapézoèdres habituels d'analcime maclée de 1 à 7 mm de diamètre forment des incrustations clairsemées le long de diaclases dans les roches felsiques pyroclastiques du Précambrien supérieur, en bordure d'un dyke de diabase (baie Placentia, dans le Sud-Est de Terre-Neuve). De symétrie connue $I4_1/acd$, a 13.70, c 13.68 Å, ces cristaux sont optiquement négatifs et variables en indices de réfraction (n_ω 1.487, n_ϵ 1.484–1.487). biréfringence (0.002–0.003) et $2V_x$ (0–40°). L'indice $\Delta 2\theta$ (Saha 1959) est de 1.84. La composition, SiO_2 55.58, Al_2O_3 21.69, CaO nil, Na_2O 12.89, K_2O 0.03 et H_2O 9.14 (total: 99.33) correspond à la formule $(Na_{14.81}K_{0.02})\ Al_{15.15}Si_{32.93}O_{96}\cdot 18.06\ H_2O$. L'analcime résulte probablement de l'interaction de l'eau de mer et de solutions issues des tuffs felsiques; elle doit sa préservation à la proximité du dyke qui l'a protégée contre les cisaillements le long des fractures.

(Traduit par la Rédaction)

Mots-clés: analcine tétragonale, trapézoèdres, tuff précambrien, Terre-Neuve, zone de l'Avalon.

INTRODUCTION

Occurrences of zeolites, relatively common and well known in Triassic rocks of eastern North America, are rather sparse in pre-Mesozoic rocks of the northern Appalachians. In the Atlantic provinces, metamorphic zeolites have been reported from New Brunswick (Mossman & Bachinski 1972) and from western Newfoundland (Baker 1979). Minor occurrences of hydrothermal zeolites filling veins and coating fractures are probably widespread, but as they are of little economic interest and usually do not contain well-formed crystals, they are seldom reported (*e.g.*, Papezik 1974). However, even such apparently insignificant occurrences should not be disregarded totally. For example, in the central and southern Appalachians, thin veinlets filled with late hydrothermal zeolites (mainly laumontite) have been used in the evaluation of "fault capability", one of several critical factors in selecting suitable sites for nuclear reactors (Butler 1977, Moody 1977). In this brief note, we report the occurrence of analcime in Late Precambrian rocks of the Avalon zone in southeastern Newfoundland.

LOCALITY

The mineral was found by Peter Elias in 1976 on the shore of Baker Cove at the head of Placentia Bay (47°50'00"N, 54°06'32"W; Nat. Topogr. Series 1M/16 East, "Sound Island"). The area is underlain by steeply dipping felsic pyroclastic rocks of the Sound Island Formation of Late Precambrian age (O'Driscoll 1977). In Baker Cove, the rock is a crystal–lithic tuff containing 1–3 mm crystals of sodic plagioclase and thin, flattened lenses of fine-grained felsic rocks, partly altered to albite, quartz, sericite, Fe oxide and minor epidote, and cut by thin veinlets of calcite. At the analcime locality, the pyroclastic rock is cut by a steeply dipping dyke of altered diabase less than 2 m wide, now consisting of albite, chlorite, hematite and abundant leucoxene, with minor calcite and quartz. The analcime is found as pseudotrapezohedral crystals, locally forming encrustations on the walls of joints and fractures in the tuff (Fig. 1). The crystals are relatively abundant within 3 m

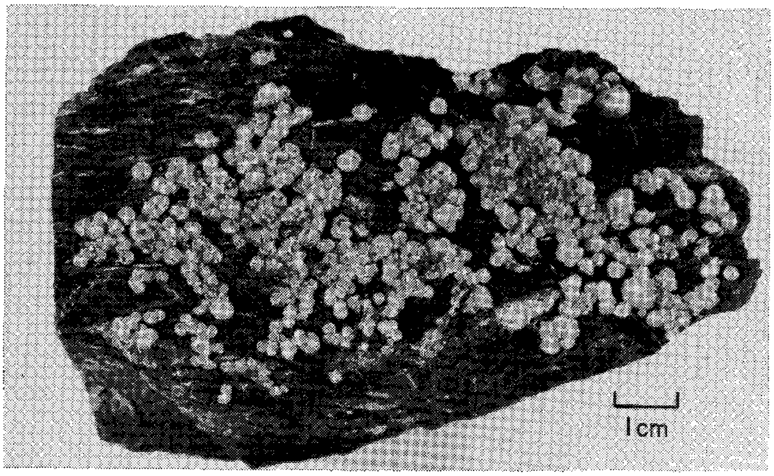

FIG. 1. Analcime crystals from Baker Cove, Newfoundland.

of the dyke, but their quantity decreases with distance; no crystals were found more than about 10 m from the dyke.

PHYSICAL PROPERTIES

Crystals of analcime from 1 to 7 mm across are well developed but flattened parallel to the surface of the rock fracture and thus "hemispherical". The trapezohedron is the only form observed. In appearance, the crystals vary from water-clear to milky with a reddish cast caused by small quantities of finely dispersed hematite. They adhere firmly to the fracture walls but can be detached with a knife.

Microscopic examination shows that the analcime is weakly anisotropic (birefringence 0.002–0.003), and optically negative. It has a very fine lamellar twinning. Different parts of the same 5-mm crystal were found to be uniaxial or biaxial, $2V_x$ ranging from 0 to 40°. In view of the low birefringence, such anomalies may be caused by differences of less than 0.001 in the refractive index along the horizontal axes, possibly as a result of stress. Refractive indices and specific gravity are given in Table 1.

The powder-diffraction pattern of the analcime agrees closely with published data (*e.g.*, PDF 19–1180). Single-crystal study by precession techniques shows that the mineral is tetragonal, space group $I4_1/acd$. The space group and cell dimensions (Table 1) are in good agreement with the data for tetragonal analcimes from various localities given by Mazzi & Galli (1978); however, it is possible that some crystals (or even different parts of some of the larger crystals) may have isometric or orthorhombic symmetry.

TABLE 1. PROPERTIES OF BAKER COVE ANALCIME

Tetragonal, $I4_1/acd$, a 13.70Å, c 13.68Å

$\Delta 2\Theta$* 1.84 ± 0.01, CuKα

ω1.487, ε1.484 - 1.487; 2Vx 0-40°

S.G.(meas.)** 2.260 ± 0.011

S.G.(calc.) 2.286

* 2Θ analcime$_{639}$ - 2Θ silicon$_{331}$; Saha (1959).

** Berman balance, average of six fragments.

TABLE 2. COMPOSITION OF BAKER COVE ANALCIME

		Atoms per 96 O	
SiO_2	55.58	Si	32.93
Al_2O_3	21.69	Al	15.15
CaO	0.00	Ca	-
Na_2O	12.89	Na	14.81
K_2O	0.03	K	0.02
H_2O*	9.14		
	99.33	H_2O	18.06
(Average of six spot analyses)		(Si+Al)	48.08
		(Na+K+2Ca)	14.83
* By LOI		Si/Al	2.17

Electron-probe analysis by M. Bonardi, Geological Survey of Canada, Ottawa.

H_2O by J. Vahtra, Memorial University.

The $\Delta 2\theta$ value (*i.e.*, 2θ $\text{analcime}_{639} - 2\theta$ silicon_{331}: Saha 1959) was determined by triplicate scanning of the interval between 76 and 79° 2θ (Cu $K\alpha$) on three separate mounts, using silicon as an internal standard. The average $\Delta 2\theta$ value (1.84: Table 1) lies in the middle of group C of Coombs & Whetten (1967), which includes "silica-poor analcimes . . . formed by direct precipitation or by reaction of highly alkaline water with sediment."

CHEMISTRY

An electron-microprobe analysis of the Baker Cove analcime is given in Table 2. Total water was determined separately by loss on ignition. The analysis corresponds to $Na_{0.93}Al_{0.95}Si_{2.06}O_6 \cdot 1.13\ H_2O$, close to the ideal formula $NaAlSi_2O_6 \cdot H_2O$, with only a small excess of Si (Si/Al 2.17) and a small deficiency of alkalis. The dominance of Na, very low K and the absence of detectable Ca may indicate that seawater had a prominent role in the formation of the mineral. However, it is possible that during probe analysis, the original alkali content may have been modified by differential volatilization under the electron beam in a vacuum (Bonardi 1979).

ORIGIN

The analcime crystals were probably formed by the reaction of seawater with solutions rich in Si and Al derived from the felsic tuff, at a time when seawater was first able to penetrate the fractures and at a temperature which need not have been much above the normal climatic range (Liou 1971). The observed close spatial relationship of the analcime crystals to the diabase dyke is not likely to be the result of a thermal or chemical gradient. It is more probable that analcime crystals, perhaps formerly more common throughout that part of the felsic pyroclastic rocks exposed to the action of seawater, may have been largely destroyed by small-scale movements along joints and fractures; the dyke may have acted as a buttress, preventing such small shearing movements in its vicinity and thus protecting the crystal-coated surfaces. As the crystals can be detached fairly easily from the rock surface and probably would not survive a large number of freeze–thaw cycles, the locality appears to be ephemeral, unless further crystal-coated fractures are exposed by shoreline erosion.

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