MINERALOGICAL MAGAZINE, DECEMBER 1976, VOL. 40, PP. 853–6

An occurrence of eudialyte and manganoan pectolite in a phonolite dyke from south-eastern Queensland

GRAHAM R. CARR AND EVAN R. PHILLIPS
Dept. of Geology, University of Wollongong, Wollongong, 2500 Australia
AND P. R. WILLIAMS
204 Hamilton Road, Wavell Heights, 4012 Brisbane, Australia

SUMMARY. A phonolite dyke at Mount Goonneringerringgi, south-eastern Queensland, carries prominent pink specks of eudialyte, together with manganoan pectolite (ranging to calcian serandite), aegirine, albite, arfvedsonite, nepheline, natrolite, and analcime. This is the first confirmed occurrence of eudialyte in Australia.

EUDIALYTE and manganoan pectolite occur in the northernmost of two phonolite dykes forming cliffs at Mount Goonneringerringgi located between Kilcoy and Somerset Dam, south-eastern Queensland (grid references 650476 and 652460 Caboolture 1-mile military map). The dykes intrude the north-western part of the Billycan Creek anticline developed in the Triassic Bryden Beds and Neara Volcanics (Hill and Denmead, 1960, Fig. 38). This Queensland occurrence appears to be the first confirmed discovery of eudialyte in Australia, although Süssmilch and Jensen (1909) noted the possible presence of eudialyte in a comendite from the Canobolas Mountains, near Orange, New South Wales.

In hand-specimen the phonolite is leucocratic and grey-green in colour. It has a porphyritic texture with black phenocrysts of pyroxene and pink eudialyte specks prominent. Apart from the eudialyte and manganoan pectolite, the phonolite is composed of microperthitic alkali feldspar phenocrysts, poikilitic phenocrysts of aegirine locally cored with aegirine-augite, and euhedral nepheline forming both small phenocrysts and inclusions within the aegirine. The groundmass minerals are pilotaxitic feldspars (dominantly albite), nepheline, natrolite, and analcime. Accessory minerals include arfvedsonite and calcite. The natrolite and analcime replace nepheline and possibly groundmass feldspar; potash feldspar is partially altered to clay. Chemical analyses of two phonolite specimens appear in Table I and the rocks belong to the agpaitic division of the nepheline syenites (Gerasimovskii, 1956; Sørensen, 1974, p. 23). Comparison with average analyses of phonolite and agpaitic phonolite (Sørensen, 1974, Table 3) shows that the Queensland rocks have relatively low TiO_2, CaO, and P_2O_5 whereas MnO and Na_2O are higher than average. This chemistry is reflected in the absence of sphene and apatite from the phonolite. Much of the MnO must be present in the pectolite (Table I, analyses 4 and 5).

TABLE I. *Chemical analyses*

	Bulk rocks				
	21102	21103	Eud.	Ser.	Pect.
SiO_2	55.08	55.85	53.40	52.15	51.40
TiO_2	0.02	0.02	-	-	-
ZrO_2	0.17	0.20	13.02	-	-
CeO_2	-	-	1.73	-	-
Al_2O_3	20.32	20.07	0.17	0.23	1.82
La_2O_3	-	-	0.81	-	-
Fe_2O_3	3.73	3.37	-	-	-
FeO	0.27	0.28	4.08	2.58	2.10
MnO	0.32	0.27	1.87	23.90	16.30
MgO	0.45	0.39	0.05	0.02	0.03
CaO	0.47	0.56	9.65	10.93	17.74
SrO	-	-	0.27	-	-
Na_2O	10.41	9.92	5.93	9.77	9.06
K_2O	4.16	4.77	0.80	-	0.53
P_2O_5	0.01	<0.01	-	-	-
Nb_2O_5	-	-	1.41	-	-
Cl	-	-	0.74	-	-
Ign.	4.09	3.86	-	-	-
O Cl	-	-	0.17	-	-
Sum	99.50	99.57	93.76	99.58	98.98

	C.I.P.W.norms	
	21102	21103
or	24.58	28.19
ab	35.53	33.66
ne	24.84	23.31
ac	5.91	6.38
di	1.76	2.12
ol	0.21	0.01
he	0.41	-
mt	1.86	1.69
il	0.04	0.04
ap	0.02	<0.02
z	0.25	0.30
ag*	1.06	1.07

* Agpaitic coefficient

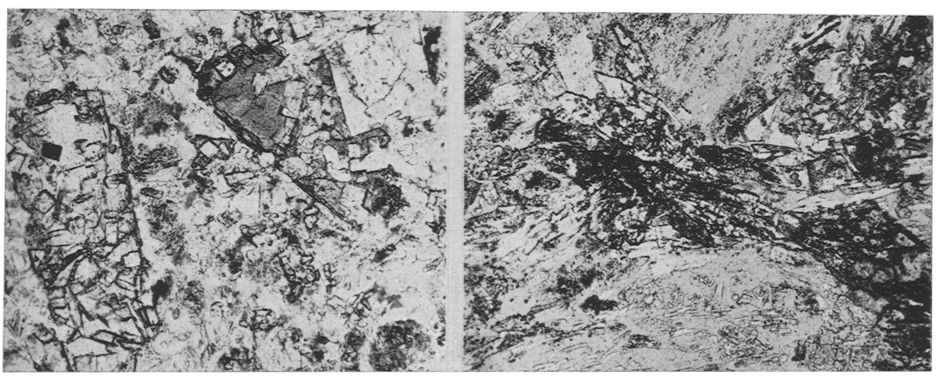
	Ions per 18 oxygen		
	Eud.	Ser.	Pect.
Si	6.6061	6.3288	6.1780
Zr	0.7855	-	-
Ce	0.0747	-	-
Al	0.0248	0.0329	0.2579
La	0.0370	-	-
Fe^{2+}	0.4221	0.2619	0.2111
Mn	0.1960	2.4568	1.6595
Mg	0.0092	0.0036	0.0054
Ca	1.2792	1.4213	2.2847
Sr	0.0194	-	-
Na	1.4224	2.2989	2.2115
K	0.1263	-	-
Nb	0.0789	-	-
Cl	0.1551	-	-

	Trace elements
	21102
Yt	43p.p.m.
Sr	50
Rb	246
Th	73
Pb	49
Ga	57

Eud., eudialyte
Ser., calcian serandite
Pect., manganoan pectolite

Bulk rock XRF analyses by R.Flood.Univ.of Queensland rock nos., = 4698 and 4699 Univ.of Wollongong.

Mineral microprobe analyses by L.Bronkhurst; minerals from rock 21102.



FIGS. 1 and 2: FIG. 1 (left). Poikilitic eudialyte crystals (left and upper right) in a matrix composed essentially of feldspar, nepheline, analcime, and natrolite. The square and rectangular inclusions within the eudialyte are of nepheline. The larger square outline at the top right is a core of nepheline partially replaced by natrolite. Plane-polarized light; FIG. 2 (right). An aggregate of wedge-shaped pectolite crystals set in a matrix of analcime and laths of feldspar. Plane-polarized light. The width of the field of view in both figs. is 1 mm.

The eudialyte occurs as subhedral poikilitic phenocrysts with a tabular habit (fig. 1, cf. Bordet, Freulon, and Lefranc, 1955) and as irregular aggregates of anhedral to euhedral crystals. It is dichroic with ϵ = pale pink, ω = rose pink and a good cleavage parallel to {0001} is developed. The mineral is optically positive ($\epsilon = 1.607$, $\omega = 1.603$) but it has a negative sign of elongation. The identity of the eudialyte was confirmed by means of an X-ray powder photograph (Table II) and an electron microprobe analysis is given in Table I. Initial microprobe analyses gave very low Na values and the longer the electron beam was left on a spot, the lower were the counts for Na. It was thought that ionic Na was transformed to metallic Na, which was volatilized in the beam. The only effective method of attempting to analyse for Na in eudialyte using the electron microprobe appeared to be by raster counting and by this means consistent results were achieved. However, a comparison with analyses of eudialyte obtained by other methods (e.g. Kempe and Deer, 1970; Giuseppetti, Mazzi, and Tadini, 1971; Golyshev, Simonov, and Belov, 1971; Edgar and Blackburn, 1972) shows that the amount of Na in the analysis in Table I is still too low.

TABLE II. *X-ray diffraction lines of eudialyte*

d	I	d	I	d	I	d	I	d	I
7.13 Å	100	5.40 Å	10	3.94 Å	10	3.43 Å	*	2.90 Å	*
6.51	*	4.34	80	3.80	30	3.21	*	2.69	60
5.65	*	4.13	30	3.54	40	3.00	60	2.59	50

* Masked by impurity: nepheline, natrolite or analcime.

Eudialyte crystals concentrated from the phonolite from Mt Goonneringerringgi rock no. 21102 University of Queensland University of Wollongong no. 4698

Pectolite occurs as rare colourless subhedral crystals, which commonly project out of aegirine phenocrysts. It also forms aggregates of characteristic wedge-shaped grains (fig. 2) showing perfect {100} and {001} cleavages. Both habits suggest a primary origin (cf. Lacroix, 1932). The mineral is optically positive and elongate grains are length slow; birefringence was estimated at about 0·025. The electron microprobe analyses of pectolite listed in Table I came from two points within the same crystal. They indicate an irregular distribution of Mn, Ca, and Al such that the name manganoan pectolite may be applied to analysis 5 and (calcian) serandite to analysis 4 (Schaller, 1955). (In the terminology of Machatschki (1932) the corresponding names are 'Mangan-Calciumpektolith' and 'Calcium-Manganpektolith').

Both analyses confirm the notion that a relatively high Mn content appears to be typical of pectolites in syenitic rocks (e.g. Johannsen, 1938, p. 162; Adamson, 1944, p. 208; Schaller, 1955; Deer, Howie, and Zussman, 1963).

An association between eudialyte (or the optically negative eucolite: Deer, Howie, and Zussman, 1966; Kempe and Deer, 1970, p. 65) and (manganoan) pectolite in alkaline rocks has been noted briefly elsewhere (e.g. Winther, 1901; Shand, 1928, p. 138; Lacroix, 1931, p. 190; Jérémine, 1950; Nockolds, 1950; Danø and Sørensen, 1959, p. 17; Chao *et al.*, 1967). The Queensland occurrence is an example of this association where both minerals are primary.

Acknowledgements. We would like to thank the following people for help in the preparation of this note: at the Division of Mineralogy, C.S.I.R.O., Sydney, Mr. L. Brunckhorst, Dr. W. Ryall; at Macquarie University, Dr. R. Flood; at the University of Queensland, Mr. J. B. Cameron; and at the University of Wollongong, Professor A. C. Cook, Dr. B. E. Chenhall, Mrs. S. Greenwood, and Mr. B. K. Johnston. Financial assistance from Special Research Grant No. 14–164–06, University of Wollongong, is gratefully acknowledged.

REFERENCES

ADAMSON (O. J.), 1944. *Geol. För. Stockholm Förh.* **66,** 113.
BORDET (P.), FREULON (J. M.), and LEFRANC (J. P.), 1955. *Bull. Soc. franç. Min. Crist.* **78,** 425.
CHAO (G. Y.), HARRIS (D. C.), HOUNSLOW (A. W.), MANDARINO (J. A.), and PERRAULT (G.), 1967. *Can. Min.* **9,** 109.

DANØ (M.) and SØRENSEN (H.), 1959. *Medd. Grønland*, **162**, no. 5.
DEER (W. A.), HOWIE (R. A.), and ZUSSMAN (J.), 1963. *Rock-forming Minerals*, **2**, Chain Silicates. London (Longmans).
—— —— —— 1966. *An Introduction to the Rock-forming Minerals*. London (Longmans).
EDGAR (A. D.) and BLACKBURN (C. E.), 1972. *Can. Min.* **11**, 554.
GERASIMOVSKII (V. I.) [Герасимовский (В. И.)] 1956. *Geochemistry*, **5**, 494.
GIUSEPPETTI (G.), MAZZI (F.), and TADINI (C.), 1971. *Tschermaks Min. Petr. Mitt.* **16**, 105.
GOLYSHEV (V. M.), SIMONOV (V.I.), and BELOV (N. V.) [Голышев (В. М.), Симонов (В. И.), и Белов (Н. В.)], 1971. *Soviet Physics—Crystallography*, **16**, 70.
HILL (D.) and DENMEAD (A. K.) (eds.), 1960. *Journ. Geol. Soc. Aust.* **7**, 1.
JÉRÉMINE (É.), 1950. *Compt. Rend. Acad. Sci. Paris*, **230**, 110.
JOHANNSEN (A.), 1938. *A Descriptive Petrography of the Igneous Rocks*, **4**, *the Feldspathoid Rocks, the Peridotites and Perknites*. Chicago and London (The University of Chicago Press).
KEMPE (D. R. C.) and DEER (W. A.), 1970. *Medd. Grønland*, **190**, no. 3.
LACROIX (A.), 1931. *Compt. Rend. Acad. Sci. Paris*, **192**, 189.
—— 1932. Ibid. **194**, 670.
MACHATSCHKI (F.), 1932. *Zentr. Min. Geol. Palae.* 69.
NOCKOLDS (S. R.), 1950. *Min. Mag.* **29**, 27.
SCHALLER (W. T.), 1955. *Amer. Min.* **40**, 1022.
SHAND (S. J.), 1928. *Trans. Geol. Soc. South Africa*, **31**, 97.
SØRENSEN (H.), ed., 1974. *The Alkaline Rocks*. London (John Wiley & Sons).
SÜSSMILCH (C. A.) and JENSEN (H. I.), 1909. *Proc. Linnean Soc. New South Wales*, **34**, 157.
WINTHER (C.), 1901. *Medd. Grønland*, **24**, 196.

[*Manuscript received 2 February 1976*]

Errata: Table I, last line of notes, for Bronkhurst read Brunckhorst.