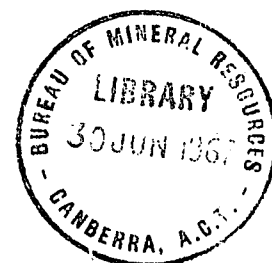


AGE OF DOLERITE DYKES IN THE VESTFOLD HILLS,  
ANTARCTICA

by

R.R. Harding and I.R. McLeod



RECORDS 1967/57

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A swarm of dolerite dykes is emplaced in metamorphic rocks of the granulite facies in the Vestfold Hills, Princess Elizabeth Land, Antarctica. The age of the dykes was measured, using the rubidium: strontium method, as  $1030 \pm 220$  m.y. Although recrystallization is evident in some of the samples, this age is interpreted as the age of intrusion of the dykes.

The Vestfold Hills, one of the so-called Antarctic oases, is an area of exposed rock on the coast of Princess Elizabeth Land, Antarctica. The hills, together with the numerous adjacent islands, form a triangular area about 30 km from north to south and the same distance from east to west. The Australian National Antarctic Research Expeditions (ANARE) station Davis is situated in the south-west of the hills at lat.  $68^{\circ}35'S$ , long.  $77^{\circ}58'E$ .

The Vestfold Hills are composed principally of orthopyroxene-quartz-feldspar gneiss and granulite which contain various amounts of garnet, biotite, and hornblende (McLeod, et al. 1966; Ravich, 1960). These metamorphic rocks originally crystallized in the granulite facies, but many now show retrogressive mineral changes (McCarthy, 1965, 1966). Orthopyroxene commonly is converted partly to hornblende and biotite, or, in a few examples, garnet, and some plagioclase is partly altered to carbonate and muscovite. Cataclastic deformation of mineral grains is widespread, leading to partial recrystallization in places. Evidence for migmatization, with local potash metasomatism, has been found at several places (Ravich, 1960; McCarthy, 1965).

Ravich and Krylov (1964) list results of age measurements of five samples of the country rock of the Vestfold Hills collected by the Soviet Antarctic Expedition. The ages, measured by the potassium-argon method on whole-rock samples, range from 1185 m.y. (alaskite granite vein) up to 1525 m.y. (migmatite). High-grade metamorphic rocks east and west of the Vestfold Hills are much younger (Ravich & Krylov, 1964): 420 and 540 m.y. at the Larsemann Hills, 110 km to the south-west; and 415 to 550 m.y. in the vicinity of Mirny, 680 km to the east.

A swarm of dolerite dykes has intruded the gneisses. The dykes range in width from a few centimetres up to 25 m, although most are less than 3 metres wide. Individual dykes can be traced on aerial photographs for distances up to 25 km. Most of the dykes strike between  $15^{\circ}$  and  $30^{\circ}$  east of north, and most of the remainder between  $35^{\circ}$  and  $45^{\circ}$  west of north; a few trend north or east. Ground observations suggest the dip of the dykes is generally greater than  $65^{\circ}$ , and that at least some of the dykes striking east-west are slightly coarser than those of other directions. Other than this, no difference is apparent between dykes with different trends, and the dykes probably all belong to one episode of intrusion.

At the request of one of us (I. McL.), Ian Black, Geophysicist of the Bureau of Mineral Resources seconded to ANARE, collected samples of six dykes in 1964 for isotopic age determination. The dykes sampled were selected largely for

convenience of access. Table 1 shows the width and strike of each dyke from which a sample was collected. Sample GA5429 was blasted from a dyke about 400 metres north-north-east of the hut used for filling meteorological balloons at Davis. The others were obtained by sledge hammer from five different dykes along the southern side of Heidemann Bay, ranging from 1.4 km south-south-west to 1.3 km south-south-east of the station.

The samples are typical of the dykes generally. They are essentially plagioclase-clinopyroxene rocks, with andesine laths up to 0.8 mm long and pyroxene grains up to 0.3 mm in diameter. Rare plagioclase phenocrysts are zoned from sodic labradorite in the core to calcic andesine at the rim.

TABLE 1

WIDTH AND STRIKE OF DYKES

<u>SAMPLE NO.</u>	<u>WIDTH (Metres)</u>	<u>STRIKE</u>
GA5429	9	005°
GA5430	12	171°
GA5431	3.5	110°
GA5432	6	005°
GA5433	2.5	115°
GA5434	2.5	115°

Clinopyroxene, probably augite, is strongly schillerized and is partly replaced by uraltite (some of which is in turn rimmed by minor biotite) and opaque minerals, and by orthopyroxene in GA5429, and tremolite in GA5431 and GA5432. GA5429 contains a very small amount of secondary interstitial quartz. Thin sections of GA5430, GA5431, and GA5433 are traversed by zones of cataclasis up to 9 mm wide along which carbonate, garnet, and biotite have replaced the plagioclase and pyroxene.

One of us (R.R.H.) analysed the samples at the Department of Geophysics and Geochemistry, Australian National University, Canberra, for rubidium and strontium using the isotope dilution method. The analytical data are shown in Table 2.

TABLE 2

(All samples total rock)

No.	Rb $\mu$ g/g	Sr $\mu$ g/g	Rb <sup>87</sup> / Sr <sup>86</sup>	Sr <sup>87</sup> / Sr <sup>86</sup>
GA5429	29.3	163.8	0.5163	0.7131
GA5430	18.9	153.0	0.3567	0.7100
GA5431	14.4	269.9	0.1540	0.7073
GA5432	26.5	153.3	0.4997	0.7121
GA5433	14.2	274.3	0.1492	0.7072
GA5434	14.3	273.9	0.1504	0.7077

$$\lambda_{\text{Rb}} = 1.39 \times 10^{-11} \text{ yr}^{-1}$$

$$\text{Sr}^{88}/\text{Sr}^{86} = 8.3752$$

$$\text{Initial Sr}^{87}/\text{Sr}^{86} = 0.7052 \pm 0.001$$

$$\text{Age } 1030 \pm 220 \text{ m.y.}$$

The indicated age of the six dykes is  $1030 \pm 220$  m.y. at the 95 percent confidence level, calculated according to McIntyre et al. (1966). When plotted on a  $\text{Sr}^{87}/\text{Sr}^{86}$  vs  $\text{Rb}^{87}/\text{Sr}^{86}$  diagram the six total rock data lie on a straight line (within experimental error). The rather large possible error of 220 m.y. is caused by the extremely low rubidium enrichment and low range in rubidium/strontium ratio in these rocks.

The measured age could represent the time of injection of the dykes, or of a later metamorphism which also affected the country rocks. The indicated initial strontium-87/rubidium-86 ratio of 0.7052 is within the accepted limits for the composition of "mantle" material, and is no help in deciding whether the rocks were intruded or metamorphosed 1030 m.y. ago.

Evidence for a 1000 m.y. event, probably metamorphic, has been obtained at places from 1000 km to 2200 km east of the Vestfold Hills (Webb, 1962; Picciotto & Coppez, 1963; Ravich & Krylov, 1964; Webb & Warren, 1965). However, the petrography of the Vestfold Hills dolerites suggests that they have not been metamorphosed to any extent; the primary textures and uranitization of the pyroxene are typically igneous in all specimens. Although GA5430, GA5431, and GA5433 show evidence of recrystallization along narrow zones of cataclasis, the data for all six samples define the 1030 m.y. isochron to within experimental error, and therefore we regard this age as the time of injection of the dolerite dyke swarm in the Vestfold Hills.

Thanks are due to ANARE expedition members who helped collect the samples, and to members of staff in the Department of Geophysics and Geochemistry, Australian National University, Canberra, for helpful discussion and advice concerning methods of analysis.

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