SHORT NOTES

TRACE-ELEMENT VALUES FOR DOLERITES FROM WESTERN DRONNING MAUD LAND

By L. M. JUCKES

THE petrology and geochemistry of dolerites from Mannefallknausane and Vestfjella have been described by Juckes (1968); trace-element determinations have been carried out on the same specimens with a Philips PW 1212 X-ray fluorescence spectrometer, using methods essentially similar to those described by Leake and others (1969), and the results are given in Table I.

TABLE I. TRACE-ELEMENT VALUES (p.p.m.) AND K/Rb AND K/Ba RATIOS FOR DOLERITES FROM WESTERN DRONNING MAUD LAND

	1	2	3	4	5	6	7	8	9
Cr	434	1,105	1,555	812	410	138	61	407	287
Ni	163	842	1,235	390	127	113	44	144	411
Cu	148	192	154	213	233	241	471	170	216
Zn	89	81	92	77	75	88	109	80	88
Ga	19	16	16	16	17	19	21	19	19
Rb	20	11	8	23	8	14	25	4	7
Sr	238	174	134	225	213	218	251	251	236
Y	13	15	10	17	17	11	40	23	23
Zr	117	78	64	100	99	109	278	94	138
Nb	10	5	*	4	7	10	27	*	12
Ba	221	84	92	86	82	104	293	144	159
La	13	5	*	6	7	8	39	5	13
Ce	29	*	*	14	17	21	85	18	32
Pb	3	4	4	*	11	18	*	*	*
Th	6	43	11	8	*	8	*	5	8
K†	0·43	0·16	0·15	0·19	0·18	0·25	0·95	0·15	0·54
K/Rb	215	145	188	83	225	179	380	375	771
K/Ba	19	19	16	22	22	24	32	10	34

* Below limit of detection (3 p.p.m.). † Values in per cent.

1. Z.388.1 Dolerite dyke; Wildskorvene, Mannefallknausane.
2. Z.391.6 Olivine-dolerite (cumulate), 15 cm. above the base of a sill 5 m. thick; Wildskorvene, Mannefallknausane.
3. Z.391.1 Picrodolerite (cumulate), centre of the sill at Wildskorvene, Mannefallknausane.
4. Z.391.5 Chilled dolerite, upper margin of the sill at Wildskorvene, Mannefallknausane.
5. Z.391.4 Olivine-dolerite, 15 cm. below the upper margin of the sill at Wildskorvene, Mannefallknausane.
6. Z.391.2 Olivine-dolerite, 0·6 m. below the upper margin of the sill at Wildskorvene, Mannefallknausane.
7. Z.399D.4 Iron-rich dolerite, near the top of a thin sill; Wildskorvene, Mannefallknausane.
8. Z.395.1 Dolerite; "VA Nunataks", Vestfjella.
9. Z.92.1 Dolerite from a sill 0·3–2·4 m. thick, intruding Basement Complex gneisses at Johnsonhogna, Tottanfjella (Worsfold, 1967). Because of the different crushing equipment used, some Ni and Cr contamination may be present.

This table also includes values for a specimen of dolerite from Tottanfjella (Z.92.1) which was described by Worsfold (1967), who considered it was Jurassic in age.

The values for the undifferentiated specimens Z.92.1, 388.1 and 391.5, and for specimen Z.395.1 (which is assumed to be from a dolerite intrusion) are comparable with those of the Jurassic basalts from Heimefrontfjella and Sembberget (Juckes, 1970), although the Cr and Ni values are somewhat higher.

The trace-element contents of the specimens from the sill at Wildskorvene in Mannefallknausane show the effects of the differentiation. Cr and Ni are predictably concentrated in the olivine-rich cumulates but the apparent concentration of Th in the more basic specimens with a corresponding impoverishment in the more acid fraction is contrary to the normal trend (Adams and others, 1959). In view of the small number of specimens, it would be unwise to attach too much significance to this apparent trend without further data. Cu, Zn, Ga, Rb, Sr, Y, Zr, Nb, Ba, La and Ce show varying degrees of enrichment with increasing fractionation, while the remaining elements do not exhibit distinct trends.

The K/Rb and K/Ba ratios for these specimens are also given in Table I. Because of the relative inaccuracies of flame photometry at the low levels involved, the X-ray fluorescence values for K have been used in preference to those given by Juckes (1968). The K/Rb ratio for specimens Z.92.1 and 395.1 are comparatively high, as are those of the basalts from Heimefrontfjella and Sembberget (Juckes, 1970), whereas that for specimen Z.388.1 is more similar to those reported by Erlank and Hofmeyr (1968) for dolerite specimens collected farther east in western Dronning Maud Land. The K/Ba ratios are more irregular, with an exceptionally low value for specimen Z.395.1. This appears to have been a result of the low K content, and it may indicate selective removal of K by deuteric alteration or weathering processes (which might imply that the K/Rb ratio has also been modified).

The K/Rb ratio for specimen Z.391.5 is so different from those for other parts of the sill that it must be suspected that the Rb value is high as a result of either contamination or considerable inhomogeneity within the specimen. Apart from this exception, the K/Rb ratio shows a general increase with differentiation in contrast to the decrease which usually occurs in more acid rocks (Taylor, 1963). The Rb content in fact increases with fractionation (Table I), the difference being that it does not concentrate as rapidly as K. The K/Ba ratio increases with differentiation from 16 in an olivine-cumulate rock to 32 in a late-stage iron-rich dolerite. These values, though lower, follow a similar trend to those for the Ferrar Dolerites of south Victoria Land (Gunn, 1965).

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REFERENCES

ADAMS, J. A. S., OSMOND, J. K. *and* J. J. W. ROGERS. 1959. The geochemistry of thorium and uranium. (*In* AHRENS, L. H., PRESS, F., RANKAMA, K. *and* S. K. RUNCORN, *ed. Physics and chemistry of the Earth*, **3**. London, New York, Paris, Los Angeles, Pergamon Press, 298–348.)

ERLANK, A. J. *and* P. K. HOFMEYR. 1968. K/Rb ratios in Mesozoic tholeiites from Antarctica, Brazil and India. *Earth & planet. Sci. Lett.*, **4**, No. 1, 33–38.

GUNN, B. M. 1965. K/Rb and K/Ba ratios in Antarctic and New Zealand tholeiites and alkali basalts. *J. geophys. Res.*, **70**, No. 24, 6241–47.

JUCKES, L. M. 1968. The geology of Mannefallknausane and part of Vestfjella, Dronning Maud Land. *British Antarctic Survey Bulletin*, No. 18, 65–78.

———. 1970. The geology of north-eastern Heimefrontfjella, Dronning Maud Land. *British Antarctic Survey Scientific Reports*, No. 65.

LEAKE, B. E., HENDRY, G. L., KEMP, A., PLANT, A. G., HARVEY, P. K., WILSON, J. R., COATS, J. S., AUCOTT, J. W., LÜNEL, T. *and* R. J. HOWARTH. 1969. The chemical analysis of rock powders by automatic X-ray fluorescence. *Chem. Geol.*, **5**, No. 1, 7–86.

TAYLOR, S. R. 1965. The application of trace element data to problems in petrology. (*In* AHRENS, L. H., PRESS, F., RUNCORN, S. K. *and* H. C. UREY, *ed. Physics and chemistry of the Earth*, **6**. Oxford, London, Edinburgh, New York, Paris, Frankfurt, Pergamon Press, 133–213.)

WORSFOLD, R. J. 1967. *The geology of southern Heimefrontfjella, Dronning Maud Land*. Ph.D. thesis, University of Birmingham, 176 pp. [Unpublished.]

WEATHERING HOLLOWS IN CHARNOCKITE AT MANNEFALLKNAUSANE, DRONNING MAUD LAND

By L. M. JUCKES

WEATHERING hollows, which may be either a poorly developed or an incipient form of cavernous weathering, occur on massive charnockite at Baileyranten in Mannefallknausane. The hollows, which are 0·1–0·5 m. in diameter and about 20 cm. deep (Fig. 1), are present on the north-facing slope of a small outcrop. Most of them contained snow, although there had been neither snowfall nor drift for at least 36 hr. and the rest of the outcrop was clear of snow.

The deepening of an initial depression to form such a hollow appears to be affected by freeze-thaw action with the removal of debris by the wind. After a snowfall the more convex parts of the outcrop would probably be cleared of snow by melting and run-off or evaporation on the first following sunny day, but the depressions themselves would be subjected to freeze-thaw action for several days and nights. Drift snow would tend to be deposited only in the depressions, giving the same effect, and as it could be deposited in concavities on inclined surfaces it might be instrumental in initiating the process there. The weathering hollows may be restricted to this type of outcrop because of the greater susceptibility of the coarse feldspar crystals to frost-shattering and the massive nature of the rock.

Van Autenboer (1964*a*, *b*) has described well-developed cavernous weathering of certain outcrops in the Sør-Rondane. These he attributed largely to physical processes, although he considered that chemical weathering may also have been active. In the occurrence at Mannefallknausane the rock in the hollows did not appear to be more chemically weathered than that forming the rest of the outcrop nor were there any superficial mineral encrustations such as those of gypsum (Van Autenboer, 1964*a*, *b*) or calcite (Juckes, 1970) which sometimes form on rock exposures in this region of Antarctica. Thus physical processes alone, mainly freeze-thaw action, are believed to be responsible for the occurrence described here.

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Fig. 1. Weathering hollows in coarse charnockitic gneiss at Baileyranten, Mannefallknausane.

REFERENCES

AUTENBOER, T. VAN. 1964*a*. The geomorphology and glacial geology of the Sør-Rondane, Dronning Maud Land, Antarctica. *Meded. K. vlaam. Acad.*, **26**, Nr. 8, 91 pp.

———. 1964*b*. The geomorphology and glacial geology of the Sør-Rondane, Dronning Maud Land. (*In* ADIE, R. J., *ed. Antarctic geology*. Amsterdam, North-Holland Publishing Company, 81–103.)

JUCKES, L. M. 1970. The geology of north-eastern Heimefrontfjella, Dronning Maud Land. *British Antarctic Survey Scientific Reports*, No. 65.