ZIRCONIUM IN ALKALINE DYKES FROM THE TUGTUTÔQ REGION, SOUTH GREENLAND

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Zr values are reported for 30 alkaline dykes from the Tugtutôq area, South Greenland. Concentrations increase in the fractionation series trachydolerite → aegirine microgranite to a maximum of 7175 p.p.m., but it is not yet clear how Zr is distributed between the various minerals in the silicic dykes.

The rocks occur as swarms of dykes of Gardar age intruded into basement granites some 1150 m years ago (Bridgwater, 1965). The geological setting and details of the igneous activity have been given by Upton (1962, 1964a), while Macdonald (1969) has described the petrology of the dykes, giving 33 rock-analyses. Macdonald & Edge (1970) have presented data for F, Cl, Rb, Sr, Ba, Sc, Y, La, Ce, Nb, Cr, Cu, Ga and Pb in the analysed specimens.

The dykes form a series from trachydolerites through hastingsite- and riebeckite-microsyenites to devitrified microgranites and rhyolites. Though the dykes are thought to represent the products of the extreme fractionation of alkali basalt magma, the compositions of the acid types have been modified by devitrification, resulting in a loss of Na (and to a lesser extent K), Cl, H_2O, Li and Ga (Macdonald, 1969; Macdonald & Edge, 1970).

Results

The results of the analyses are given in table 1, and values are plotted against a Fractionation Index (F.I. = Σ normative q + or + ab + ac + ns) in fig. 1. The determinations were made by X-ray fluorescence, using the following technique.

After grinding to -125 mesh in an agate "Pulverisette", two 2.5 g splits of each rock were fused with lithium tetraborate (Parker, 1968). The resulting beads were then analysed for zirconium on a Philips PW1540 X-ray spectrometer with: a tungsten anode tube operated at 50 kV, 40 mA; fine colli-

Table 1. Zr concentrations in Tugtutôq alkaline dykes

Rock types and GGU collection nos	Zr p.p.m.	F.I.	Rock types and GGU collection nos	Zr p.p.m.	F.I.
Trachydolerites			Riebeckite		
40471	305	53.9	microgranites		
50093	335	57.7	30685	1255	92.8
50149	230	68.6	30758	1770	93.9
			40427	4450	93.3
Hastingsite			40449	1990	88.0
microsyenites			40493	1895	93.8
30713	190	82.3	40495	4045	97.8
40429	175	79.0	40575	1960	94.7
40433	435	81.5	50163	2630	93.6
40462	435	82.1	50181	1120	94.5
40498	190	86.0	50187	1985	94.0
40570	415	83.2	50237	1810	92.6
50169	460	85.9			
			Aegirine micro-		
Riebeckite			granites		
microsyenites			30691	2135	99.3
30645	1160	87.5	40554	2305	97.1
30739	515	85.0	40600(a)	2390	97.4
50050	1430	83.0	50197	7175	97.7
50051	1485	84.7			
50167	590	85.0			

F.I. = Fractionation Index – Σ norm. q + or + ab + ac + ns (Macdonald, 1969).
Values are averages of four determinations.
Analysts: A. Parker, G. J. Smith and J. Ward.

mator; LiF 200 analysing crystal; and scintillation counter. Duplicate determinations were made on each bead, making a total of four per rock. The method was calibrated using a number of international rock standards together with artificial mixtures of "specure" oxides approximating in composition to the rocks being analysed. Corrections were made for strontium interference using the values quoted in Macdonald & Edge (1970). The estimated precision of the method is ± 2.5 % relative.

The absolute values may be compared with those from other Gardar intrusive rocks, which are among the most Zr-rich in the world: trachytic dykes from the Qagssimiut region, 890–3880 p.p.m. (Ayrton & Burri, 1967); the differentiated nepheline syenites of the Hviddal composite dyke, 360–750 p.p.m. (Upton, 1964b); and the syenite-granite suite of the Kûngnât intrusion, 52 – approx. 7000 p.p.m. (Upton, 1960). The Tugtutôq microgranites are analogous to the highly differentiated lujavrites of the

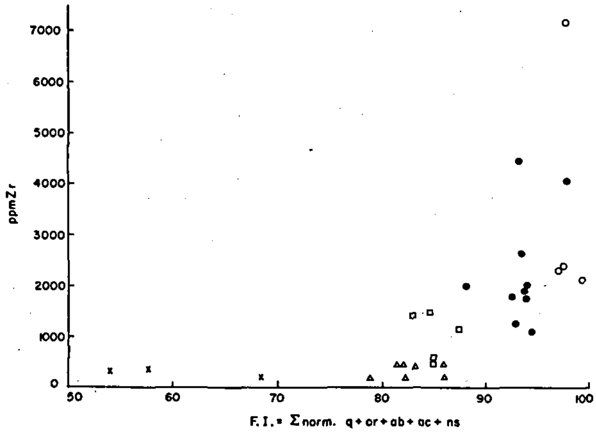

Fig. 1. Variation diagram for Zr in alkaline dykes from the Tugtutôq region. Crosses: trachydolerites; triangles: hastingsite microsyenites; squares: riebeckite microsyenites; closed circles: riebeckite microgranites; open circles: aegirine micrograntes.

Ilímaussaq intrusion, which contain up to 12 000 p.p.m. Zr (Ussing, 1912, Gerassimovsky & Kuznetsova, 1967).

Discussion

Goldschmidt's (1954) studies on the geochemistry of Zr established that Zr becomes concentrated in the late magmatic and pegmatitic stages of fractionation, especially in highly alkaline melts. Degenhardt (1957) pointed out that alkaline rocks contain on average twice as much Zr as calc-alkaline types. Further, though zircon is a common accessory in calc-alkaline granites, it is remarkably scarce in peralkaline, Zr-rich rocks, (Mathew & Watson, 1953; Chao & Fleischer, 1960; Siedner, 1965; Bowden, 1966). This feature has been attributed to the high solubility of Zr in alkaline melts and the subsequent restriction of zircon crystallisation. Many data are now available to show that Zr can enter alkali amphiboles and pyroxenes to a large extent, and Bowden (1966), for example, has concluded that most of the Zr in the riebeckite-granites of the Northern Nigerian ring-complexes is present in the lattices of aegirine and riebeckite. Bowden was able to demonstrate that the concentation of Zr in the Younger Granites varies sympathetically with the alkalinity of the liquids, expressed as the agpaitic coefficient.

Similar behaviour is shown by the Tugtutôq dykes. There is an overall increase in Zr concentration in more peralkaline rocks, i.e. with increasing F.I. (fig. 1). This regular behaviour suggests that unlike Li and Ga, Zr was not expelled to any great extent during devitrification of the dykes.

The distribution of Zr among the minerals of the silicic dykes is not well understood at present. Zircon is rare in the peralkaline dykes and is restricted to certain riebeckite-rich varieties. It appears to be completely absent from rocks containing normative sodium metasilicate. Furthermore, in zircon-free dykes, Zr is not all held in the pyroxenes or amphiboles, as might be expected from the experience of previous workers. In the microgranite 40495, the aegirine aggregates replacing amphibole phenocrysts have 1400 ± 150 p.p.m. Zr, the rock 4045 p.p.m. The riebeckite-arfvedsonite phenocrysts of the microgranite 40427 carry 760 ± 100 p.p.m. Zr, whereas the rock has 4450 p.p.m. Assuming fairly comparable concentrations in the groundmass amphiboles and pyroxenes, which is reasonable especially in the former case since pyroxene aggregates and groundmass pyroxene must have formed more or less contemporaneously, these minerals do not carry anywhere near the bulk of the Zr in these rocks. It is possible that submicroscopic Zr-rich accessory minerals are present in the silicic dykes. In the more coarsely crystalline granite sheets of western Kûngnât (Upton, 1960), which are chemically very similar to the Tugtutôq microgranites, zircon and pyrochlore are common accessories, and indeed pyrochlore has been recorded from two microgranite dykes. The crystallisation of zircon in the Kûngnât granites apparently contradicts previous observations that zircon is absent from strongly peralkaline rocks.

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Dansk sammendrag

Zr-indhold opgives for 30 alkaline gange i Tugtutôq-området i Sydgrønland. I fraktioneringsserierne trachydolerit ægirin mikrogranit ses Zr-koncentrationen at stige til maksimalt 7175 p.p.m. Zr-fordelingen mellem de forskellige mineraler i de sure gange er dog endnu uklar.

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