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ABSTRACTS

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KAROO BASALTS OF THE SPRINGBOK FLATS, TRANSVAAL: GEOCHEMISTRY AND CORRELATION

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Karoo basalts underlie an area of about 3750 km^2 of the Springbok Flats. The Basalts are poorly exposed and nearly all the available information on these rocks has been obtained from borehole intersections. The basalts are confined to two synclinal basins elongated north-east and are downfaulted against older rocks on their northern margins. Borehole data indicate that in the northeastern basin, the basalts have a maximum thickness of about 460 m (Visser and Van der Merwe, 1959). In the southwestern basin the preserved basalt sequence is thicker, being in excess of 750 m. Individual flows vary from 1 to 30 m in thickness and are characterized by amygdaloidal bases and tops. Flow-top breccias are common. Four borehole cores, two from each basin, were logged and sampled for detailed petorgraphic and chemical analysis. Most of the flows are of fine-grained aphyric or sparsely plagioclase-phyric basalt. In one borehole (RTL1) from north of Immerpan siding in the northeastern basin, 5 flows, totalling about 25 m of a plagioclase macroporphyritic basalt, occur interbedded as a unit with the aphyric lavas about 300 m above the base of the volcanic succession.

Table 1 presents and compares the average chemical composition of the Springbok Flats basalt with those of the Sabie River Formation of the Lebombo and the widespread Lesotho type of the Central Karoo area. The macroporphyritic basalts in borehole RTL1 are similar to the Sabie River basalts of north-central Lebombo although in detail the former have lower MgO, total iron, Ni, Cr and Sc and higher Al_2O_3 and incompatible elements (Y, Zr, Nb, K_2O, P_2O_5, Ba, Sr). Bristow (1982) has described flows in the Sabie River Formation near the Lataba River which are petrographically indistinguishalbe to the macroporphyritic basalts in RTL1.

The aphyric basalts exhibit strong compositional affinities to both the Lesotho and Sabie River basalts from the southern Lebombo but are distinctive in having higher Cr and Co (Fig. 1). Preliminary Sr- and Nd-isotopic data support these conclusions (Fig. 2). The macroporphyritic samples have ε_{Sr} and ε_{Nd} which are identical to incompatible element-enriched lavas of northern Lebombo. The aphyric lavas exhibit a wide range in positive ε_{Sr} similar to that of the Sabie River basalts of southern Lebombo, yet the former have much less negative ε_{Nd}, being similar to those of the Lesotho and other Central area basalt types.

Vertical compositional variations encountered in single boreholes in the northeastern (RTL1) and southwestern (LB1) basins are illustrated in Fig. 3. The distinctive composition of the macroporhyritic lavas in RTL1 is evident. Their five-fold enrichment in Ba, Sr, Zr and P, yet similar Ni, SiO_2, V and lower Cr and Sc when compared with the aphyric lavas is inconsistent with these types being related by fractional crystallization. Amongst the aphyric lavas more evolved basalts in terms of Mg# and Cr occur towards the top of the sequence but this evolved character is not apparent in the data for other element (e.g. Zr, and in RTL1, Ni). In LB1 the P_2O_5/Zr ratios are suggestive of the presence of two types of basalt and this distinction is apparent when other ratios, e.g. Zr/Y, are considered. Either one or both of these types are present in the other boreholes and they may be interbedded. More work is necessary to characterize the two types more fully and to determine their extent and stratigraphic significance.

SACS (1980) currently correlates the Springbok Flats basalts with the Letaba Formation, the name applied by SACS to all mafic lavas below the rhyolites in the Lebombo. However, work in the Karoo volcanics project of the NGP has resulted in considerable refinement of the volcanic stratigraphy in the Lebombo (Cleverly and Bristow, 1979). The term Letaba Formation is now reserved for olivine-rich lavas which are chemically and petrographically quite unlike the Springbok Flats types and their correlation with the Letaba Formation should be abandoned. On the basis of data presented here, correlation of the Springbok Flats basalts with either the Sabie River Formation or the Lesotho Formation (Lock et al., 1974) is possible. Until more data are available it is proposed that the basalts discussed here be grouped into a Springbok Flats Formation with the presence of macroporphyritic lavas strongly supporting a correlation with the Sabie River Formation.

This study also allows the geographical extent of the incompatible element-enriched clan of Karoo Lavas to be refined. Their southern limit extends from between Komatipoort and the Sabie River in the Lebombo through the northeastern basin of the Springbok Flats to Serowe in eastern Botswana.

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Table 1

Average compositions of various Karoo basalts

	Springbok	Flats	Letaba*	SRBF*	SRBF*	
	aphyric	macrophyric	N.L.	N.L.	S.L.	Lesotho*
SiO_2	51.44	51.74	49.97	51.92	52.84	51.50
TiO_2	.99	3.26	3.07	3.23	1.44	.95
Al_2O_3	15.37	15.30	8.22	13.13	14.87	15.69
Fe_2O_3	11.01	11.86	12.02	13.28	12.32	10.96
MnO	.17	.15	.16	.17	.17	.16
MgO	7.58	3.93	15.52	5.34	5.51	7.01
CaO	9.90	8.40	7.07	7.98	9.27	10.69
Na_2O	2.34	2.35	1.43	2.34	2.55	2.17
K_2O	.77	2.26	2.10	2.08	.78	.70
P_2O_5	.14	.66	.45	.53	.25	.16
Ba	293	1024	917	853	295	174
Sr	203	1068	1002	856	316	192
Rb	19.4	45.6	55.4	45.1	19.1	12.0
Y	26.4	45.0	27.8	36.0	28.8	24.4
Zr	105	508	402	349	134	94
Nb	4.0	29.1	19.0	19.5	5.3	4.9
Zn	79	113	110	120	96	86
Cu	77	124	83	113	130	87
Ni	89	64	827	84	76	94
Co	56	49	81	49	48	48
Cr	352	79	804	85	136	283
V	249	237	204	246	261	240
Sc	32.5	17.7	21.1	24.0	29.9	33.0
No. of samples	39	6	19	9	37	49

* From Duncan et al. (1984)

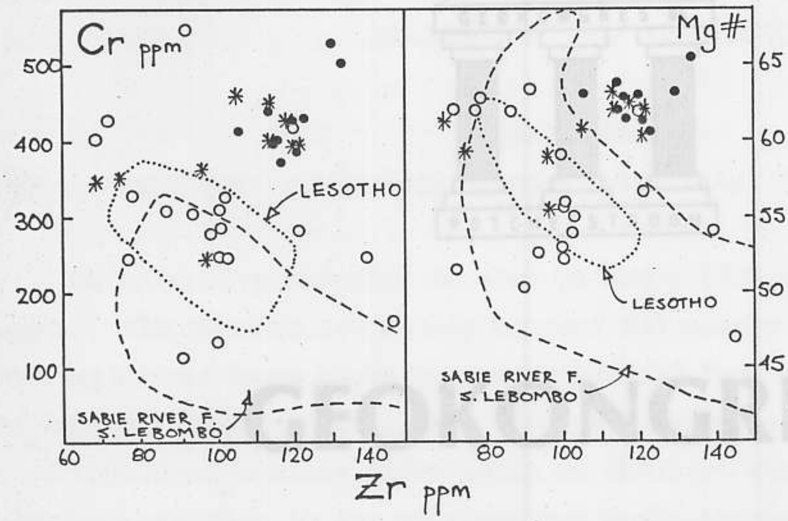


Fig. 1

Zr vs Cr and Mg No.. Dots-borehole WD4; stars-borehole LB1; circles-borehole RTLI excluding the macrophyric samples.

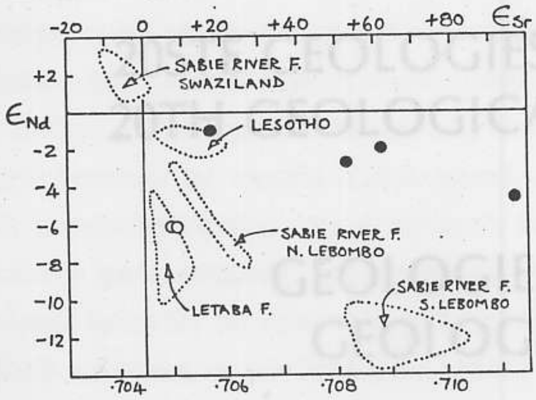
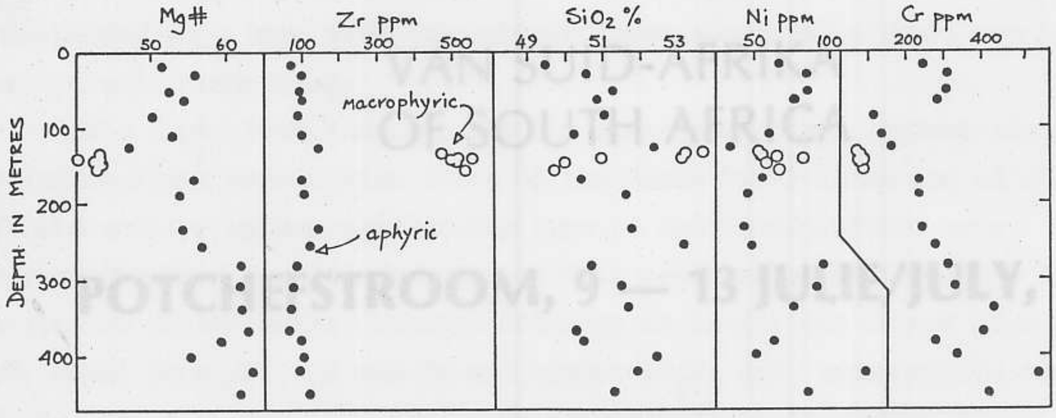


Fig. 2: Sr- and Nd-isotopic compositions at 190 my. Dots aphyric basalts; circles macrophyric basalts. Field for other basalts from Hawkesworth et al. (1984)



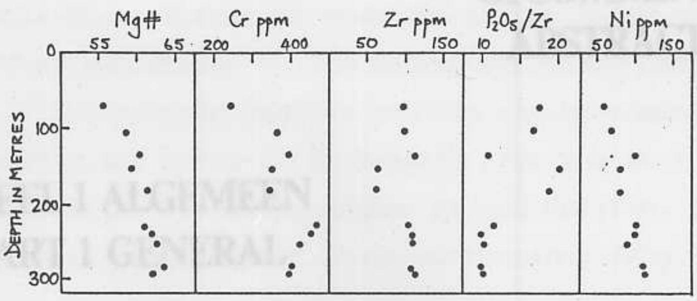


Fig. 3: Vertical composition variations in RTLI (above) and LBI (left).