SETTING, GEOCHRONOLOGY AND GEOCHEMICAL CHARACTERISTICS OF 1600 M.Y. KIMBERLITES AND RELATED ROCKS FROM THE KURUMAN PROVINCE, SOUTH AFRICA.

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INTRODUCTION

Recent radiometric dating of kimberlites and related alkaline intrusions (in particular Elston, Zero, Bathlaros, and Riries) from the Kuruman district of the northern Cape, South Africa (Fig. 1), has shown that these intrusions are approximately 1600 m.y. old and thus represent the oldest known kimberlites yet documented. Though known of for many years the Proterozoic age of these alkalic rocks was previously not suspected. Drilling and trenching of these localities has exposed material suitable for a wide range of petrographic, mineralogical, geochemical and isotopic studies. In addition the Zero kimberlite was found to contain an excellent suite of mantle xenoliths including peridotites, eclogites and metasomatized rocks (see Shee et al., this conference). The geological setting, geochronology, and major and trace element and isotope chemistry are reported in this paper.

GEOLOGICAL SETTING

The Kuruman intrusives include kimberlites (sensu stricto), marginal kimberlites, and alkalic rocks distinct from kimberlites and referred to as lamprophyres (see Shee et al., this conference). They are present in the form of small eroded pipes and dykes and are located near the inferred western edge of the Kaapvaal craton (>2500 m.y.) adjacent to the younger Kheis Belt (∿1800 m.y.) of the northern Cape Province. The pipes and dykes intrude early Proterozoic Ghaap Plateau dolomites and overlying Asbestos Hills Banded Ironstones of the Griqualand West Sequence. Outcrops of these intrusives are typically weathered and the rocks tend to be extensively carbonatized. Xenoliths of dolomite are common along with other crustal inclusions. Zero contains abundant mantle inclusions.

GEOCHRONOLOGY

The majority of the Kuruman kimberlites contain phlogopite mica, which may be present as both a macrocryst and groundmass phase. In view of this, phlogopite was separated from a number of the intrusives for Rb-Sr dating purposes. Ages have been obtained for four intrusions represented by three kimberlites (Bathlaros, Zero and Elston) and a phlogopite rich lamprophyre (Riries). The results are presented in Table 1 and indicate an overall age slightly higher than 1600 m.y. A possible age progression may be present from west (Elston) to east (Riries) though this is by no means unequivocal, particularly as some of the data are only model ages.

TABLE 1

Locality	Age	Comments
Elston kimberlite	∿ 1674	Rb-Sr mica model age
Bathlaros kimberlite	∿ 1649	Rb-Sr mica isochron
Zero kimberlite	∿ 1635	Rb-Sr mica model age
Riries lamprophyre	∿ 1606	Rb-Sr mica model age

WHOLE ROCK CHEMISTRY

Eight of the freshest kimberlite samples obtained from a borehole drilled into the Bathlaros kimberlite have been analysed for major and trace elements. Abbreviated averages of these analyses are presented in Table 2; average analyses of Group I and II kimberlites, and lamproites are included for comparison (Shee, 1986). Inspection of Table 2 shows that the average Bathlaros kimberlite is broadly similar to the average Group I kimberlite. Some exceptions are present, notably in TiO_2, Fe_2O_3, CaO, Sr, Nb and Ba. Nb and Ba are particularly enriched in Bathlaros, relative to Group I and II kimberlites and lamproites. Differences in TiO_2, Fe_2O_3 and CaO may be due to fractionation effects. Reasons for the extreme enrichment in Nb and Ba are presently not clear. However the possibility of contamination with dolomite xenoliths and carbonatization of the intrusives affecting some major and trace element abundances cannot be excluded. Also a point that should be noted is that average Ba data presented for Group I kimberlites is probably not a true reflection of the actual value. The reported value is probably too high due to bias introduced by the presence of altered samples in the data set.

TABLE 2

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	Rb	Sr	Y	Sr	Nb	Ba
K	31.9	2.6	2.5	10.4	30.0	6.9	0.3	1.4	73	771	14	323	389	2926
GI	30.3	1.9	2.9	8.6	29.6	10.1	0.4	1.3	77	1186	16	318	171	1399
GII	36.1	1.0	3.2	8.2	27.3	6.6	0.2	3.1	141	1023	16	286	98	1392
LAMP	50.0	5.2	6.9	7.5	11.2	3.5	0.5	8.2	399	1150	16	1100	157	10865

Key :- K = Bathlaros kimberlite, Kuruman Province; GI = Group I kimberlite;
GII = Group II kimberlite; Lamp = lamproite.

ISOTOPE CHEMISTRY

Presently available isotopic data suggest that the Kuruman kimberlites have initial-Sr and initial-Nd ratios which were enriched relative to Bulk Earth at 1600 m.y. As such, and in spite of significant age differences, the Kuruman kimberlites appear to show similarities to the Jurassic-Cretaceous Group II kimberlites of southern Africa which have been equated (isotopically) with derivation from an enriched lithosphere (Smith, 1983). On this basis, southern African kimberlites emplaced at 1600 m.y. and the Jurassic-Cretaceous appear to represent magmas tapped from a source characterized by an enrichment in Sm/Nd and Rb/Sr. Data for the Kuruman kimberlites are in contrast to data for the Premier (∿ 1200 m.y.), Zimbabwe (∿ 500 m.y.) and younger Group I kimberlites which have isotopic ratios compatible with derivation from an asthenospheric-type source (Smith, 1983). The isotopic data obtained from Kuruman do, however, to some extent contradict petrographic and geochemical data which suggest that these rocks are close to Group I kimberlites. Additional isotopic analyses presently in progress should resolve this and it is possible that the alteration (carbonatization) referred to above is effectively masking many of the original primary petrographic characteristics of these rocks.

CONCLUSION

Kimberlites and related rocks from the Kuruman Province of South Africa have been dated at 1600 m.y. and presently represent the oldest documented kimberlite province. The location of these intrusions near the inferred margin of the Kaapvaal craton is considered significant in that previously the oldest known kimberlites (Premier Group) had been documented near the craton centre. The recognition of 1600 m.y. old kimberlites in southern Africa means that four major periods, viz. 1600 m.y. (Kuruman), 1200 m.y. (Premier), 500 m.y. (Zimbabwe) and 240-80 m.y. (Southern Africa), of kimberlitic and related alkalic magmatism have been recognized on the subcontinent (see Allsopp et al., 1985; Smith et al., 1985).

Ongoing studies of the Kuruman intrusives and their associated mantle xenoliths will provide important information on regional geological events, and mantle processes and compositions at, and prior to 1600 m.y.

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Acknowledgement : K Fraser is thanked for providing some isotopic data for Bathlaros.

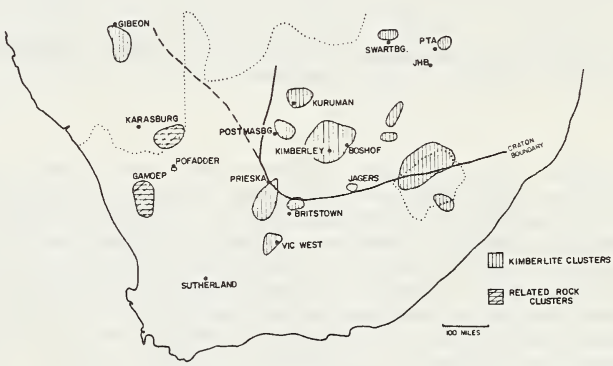

FIGURE I