THE GEOLOGY AND GEOCHEMISTRY OF THE VENETIA KIMBERLITE CLUSTER, NORTHERN PROVINCE, SOUTH AFRICA.

Seggie, A.G.[1], Hannweg, G.W.[2], Colgan, E.A.[3], and Smith, C.B.[1]

1. Anglo American Research Laboratories, P.O.Box 106, Crown Mines, 2025.
2. Venetia Mine, P.O. Box 668, Messina, 0900
3. elizabeth.colgan@wmc.com.au

GEOLOGY OF THE CLUSTER

The Venetia kimberlite cluster is situated 16 km south of the border between South Africa and Zimbabwe, 50 km from both Messina and the River Ranch kimberlite. It comprises twelve pipe and dyke bodies, numbered roughly according to decreasing size from K1 to K12, and is situated within the central zone of the Limpopo Belt. This region has as its basement, the Sand River Gneisses which in turn, are covered by the Beit Bridge Complex (a supracrustal succession of gneisses, schists and amphibolites). The geology of the country rocks immediately surrounding the Venetia bodies is a a sequence of amphibolite, quartzofelspathic gneisses, intrusive augen biotite gneiss, amphibolite, biotite schist, metaquartzite and marble (Parrish, 1989), forming part of the Beit Bridge Complex.

Parrish (op. cit.) mapped the structural features immediately surrounding the Venetia K1 and K2 pipes. His proposed structural evolution for the area follows the sequence : lithological layering of the gneiss, two generations of isoclinal folding (producing respectively, an axial planar fabric and a lineation seen as a mineral fabric in the gneiss), a main folding event (of inclined tight similar variety), subsequent large-scale warping of the area, and finally, local faulting (which produced offsets of the folded lithologies).

Table 1 : Summary of petrographic information for the Venetia cluster.

Venetia Kimberlite	Facies for which description is available	Textural classification	Mineralogical classification	Comments
K1	diatreme TKB	type 1 : few magma pellets type 2 : abundant magma pellets		Country rock xenoliths account for 20-30 vol.% of the rock. There are localized flow zones of finer grained tuffisitic kimberlite, and localized zones of reddish gritty tuffisitic kimberlite.
	western hypabyssal complex	macroporphyritic, with uniform to segregationary groundmass textures	monticellite-phlogopite kimberlite varieties (three)	
	north-eastern hypabyssal complex		altered phlogopite-monticellite kimberlite varieties (five)	
K3	hypabyssal	breccia		shows flow alignment
	transitional TKB			
	TKB	pelletal		
K7	hypabyssal	macrocrystic to segregationary	monticellite kimberlite	
K8	hypabyssal	macrocrystic to uniform	carbonatised monticellite kimberlite	noteworthy absence of foreign xenoliths
K9	hypabyssal	macrocrystic (zones of aphanitic material present)	calcite-monticellite kimberlite	partly flow-aligned
K10	diatreme	pelletal	phlogopite-monticellite TKB	extensively altered
K11	transitional diatreme facies	varies from segregationary hypabyssal through xenolith-rich TKB to pelletal TKB	predominantly monticellite kimberlite (phlogopite-bearing on the southern side of the pipe)	hypabyssal stringers and dykes cut through the TKB in a +/- E-W trending belt

The Venetia kimberlite comprises predominantly hypabyssal and diatreme facies TKB, with several varieties of monticellite-, phlogopite- and calcite- kimberlite occurring. A summary of the petrographic data is given in Table 1.

Two extensive drilling programs, completed during the evaluation and early mining stages of the mine's short history, have yielded information on kimberlite alteration and pipe density. Alteration of the kimberlite phases is highly variable between pipes, allowing in some cases, for the "freeloading" of ground down several benches into the pit, during the mining process. Pipe densities are dependant on the yield of heavy mineral concentrate produced by the metamorphic country rock entrained in the kimberlite. Wall rock contacts range from pristine (often where the kimberlite is hypabyssal) to strongly "disturbed".

WHOLE ROCK MINERAL CHEMISTRY

XRF whole rock analysis of thirteen powdered rock samples was performed at the Anglo American Research Laboratories. The results are typical of kimberlitic data, but show some evidence of crustal contamination in the slightly elevated Na_2O, Al_2O_3 and SiO_2 concentrations, and corresponding contamination indices (Clement,1982) greater than one, for a few of the samples. Comparison of these data with chemical compositions for other Group I and Group II kimberlites on the Kaapvaal craton (Smith et.al., 1985) indicates that the Venetia kimberlite is marginally enriched in major element chemistry, with respect to other Group I bodies. For example, the dataset overlaps both the Group I and Group II fields of a TiO_2 vs K_2O plot (Allsopp et.al., 1995). Trace element patterns are however, relatively depleted, and are characteristic, therefore, of Cretaceous Group I kimberlites.

WHOLE ROCK ISOTOPE ANALYSIS

Isotope analyses were performed at the Bernard Price Institute at the University of the Witwatersrand, on six of the samples analysed for whole-rock geochemistry : K4/27, K4/32, K4/38 (hypabyssal kimberlite), K1/135 (altered kimberlite), K9/3 (dyke material) and K11/30 (country rock infused with kimberlite). The isotope dilution technique (Faure, 1986) was to calculate Rb, Sr, Sm and Nd concentrations from the raw data.

For an age of just over 500 Ma, the Venetia kimberlite's initial $^{132/144}$Nd and $^{87/86}$Sr ratios are depleted relative to bulk earth (Fig. 2), and ξ_{Nd} for all but one of the samples is positive. Along with the trace element data for the cluster, these results confirm the cluster's Group I signature. The trend towards higher $^{87/86}$Sr values at lower $^{143/144}$Nd is suggestive of crustal contamination of the samples, as the higher Sr and lower Nd samples are also those with the highest C.I. values. The steepness of the alteration trend is a product of the fact that Sr is less sensitive to alteration than Nd, which therefore, shows the greater variation.

REFERENCES

Allsopp, H.L., Smith, C.B., Seggie, A.G., Skinner, E.M.W. and Colgan, E.A., 1995, The emplacement age and geochemical character of the Venetia kimberlite bodies, Limpopo Belt, northern Transvaal. : S.Afr.J.Geol., Vol. 98 (3), p. 239-244.

Clement, C.R., 1982, A Comparative Geological Study of Some Major Kimberlite Pipes in the Northern Cape and Orange Free State : PhD Thesis (unpubl) University of Cape Town, RSA.

Faure, G., 1986, Principles of Isotope Geochemistry. John Wiley and Sons, New York.
Parrish, S.L., 1989, Country Rock Mapping around Kimberlites K1 and K2 on the Farm Venetia 103MS, Northern Transvaal, RSA. : M.Sc Thesis (unpubl.) Camborne School of Mines, Cornwall, UK.
Smith, C.B., Gurney, J.J., Skinner, E.M.W., Clement, C.R. and Ebrahim, N., 1985, Geochemical character of southern African kimberlites : a new approach based on isotopic constraints : Trans.Geol.Soc.S.Afr. Vol. 88, p. 249-266.

Figure 1 : Alteration trend for Venetia samples as indicated by their initial isotopic ratios.