

THE PETROLOGY OF THE CLEVE KIMBERLITE, EYRE PENINSULA, SOUTH AUSTRALIA.

Wyatt⁽¹⁾, B.A.; Shee⁽¹⁾, S.R.; Griffin⁽²⁾, W.L.; Zweistra⁽³⁾, P. and Robison⁽¹⁾, H.R.

(1) Stockdale Prospecting Ltd., 60 Wilson Street South Yarra Vic 3141 Australia; (2) CSIRO, Div. Exploration Geoscience, PO Box 136, North Ryde NSW 2113 Australia; (3) Anglo American Res. Labs., PO Box 106, Crown Mines, 2025 South Africa.

INTRODUCTION

The Jurassic Cleve-01 kimberlite is situated some 10kms north of the town of Cleve on the Eyre Peninsula. It occurs as a small dyke and blow complex, having a width of 20m and strike length of a few hundred metres, and has been dated at 180 ± 3 Ma on U-Pb in groundmass perovskite (Bristow, unpublished data).

The Eyre Peninsula forms part of the Archaen Gawler Craton which has undergone 3 cycles of protracted orogenic development during the early to mid-Proterozoic, but has essentially remained stable since ca.1450 Ma (see Fanning et. al. 1988). Cleve-01 intrudes the Mangalo schists of the Proterozoic Hutchison formation. To the west, a thick sequence of younger Palaeozoic and Mesozoic sediments occur in the nearby Poldia Trough, an intra cratonic half graben with which the emplacement of Cleve-01 may be associated.

Petrography

The petrographic terminology used in this paper is based on Skinner and Clement, (1979). Cleve-01 consists of both diatrema and hypabyssal facies kimberlite suggesting derivation from the lower levels of a diatrema. Mineralogically it can be described as an opaque-bearing phlogopite-monticellite kimberlite of Group 1 type (Smith, 1983). Three varieties of kimberlite are present; porphyritic, porphyritic breccia and pelletal-tuffisitic kimberlite.

The porphyritic variety contains abundant euhedral, serpentinised olivine phenocrysts (mean = 0.5mm, up to 1.2mm in size), scarce ilmenite microcrysts (0.3 to 0.6mm in size) and occasional baked country rock xenoliths (up to 6mm in length) set in a matrix consisting of granular serpentinised monticellite (0.025 to 0.060mm, mean = 0.04mm) and lesser phlogopite. Extremely rare, rounded macrocrystic grains of serpentinised olivine up to 4mm are also present. The phlogopite occurs as small (0.01 to 0.02mm) laths and platelets interstitial to the monticellite. Possible melilite is also present. Scarce, small (0.5mm) irregular segregations of calcite and serpentine occur in the matrix. Coarse (0.025 to 0.08mm) groundmass spinel and perovskite are abundant (10%) and occur as subhedral to euhedral grains or in clusters up to 0.25mm across. Subhedral to euhedral pyrite up to 0.02mm is also fairly common. Rare groundmass ilmenite up to 0.03mm is also present. Texturally, this variety is classified as a hypabyssal facies, weakly segregationary and porphyritic kimberlite. Mineralogically, it is an opaque-bearing phlogopite-monticellite kimberlite.

In some instances country rock xenoliths exceed 15 volume per cent. In such cases, the rock is classified texturally, as a hypabyssal facies, porphyritic breccia and, mineralogically as a richterite and opaque-bearing phlogopite-diopside-monticellite kimberlite. Petrographic relationships clearly indicate that the richterite and diopside have formed by reaction between the country rock xenoliths and the kimberlite magma.

The pelletal-tuffisitic kimberlite consists of irregular to rounded pelletal lapilli and country rock fragments of biotite-quartz-feldspar gneiss up to 10mm in size, set in a serpentinised matrix. The lapilli average 0.6mm across with a few reaching 2mm in diameter. The lapilli are cored by subhedral to euhedral olivine phenocrysts (no macrocrysts were observed) up to 1.3mm in size and fragments (usually plagioclase or lesser quartz) of country rock xenoliths. The matrix of the lapilli consist of euhedral olivine microphenocrysts, euhedral and atoll textured spinels up to 0.1mm, subhedral perovskite, subhedral to euhedral pyrite (0.015mm), granular serpentine probably after monticellite, fine phlogopite, secondary clays and fine diopside microlites. The diopside occurs mainly toward the outer margins of the lapilli matrix. The interpelletal matrix consists predominantly of fine grained serpentine, abundant diopside microlites and rare phlogopite. This variety is classified texturally as a diatrema facies pelletal-tuffisitic kimberlite. Mineralogically, it is an altered (clay mineralised), phlogopite-monticellite kimberlite.

Mineral Chemistry of Concentrate Minerals.

Cleve-01 is dominated by macrocrysts of ilmenite with lesser amounts of chromian spinels, garnets and rare clinopyroxene. The size distribution of the ilmenites are very strongly biased towards the finer 0.3-0.5mm fractions compared to the coarser 1.0-2.0mm fractions, with the compositions varying distinctly with size (Figure 1). MgO varies from a mode of 8 wt% in the coarse fraction to 11 wt% in the fine fraction. Cr_2O_3 and Al_2O_3 is mostly less than 0.3 wt% for all fractions. Proton probe trace element data for ilmenites show a reasonably well defined positive Nb-Zr relationship (ca 800-2000 ppm Nb, 400-800ppm Zr) but poorly defined Nb-Ni (ca 0-700 ppm Ni) and Ni-Mg relationships when compared to the well constrained megacrystic suite from Monastery (Moore et al, in press).

The Cleve-01 ilmenites therefore probably derive from sampling of multi-batch magmas, of which at least the fine high-MgO fraction may correspond to coarse grained microphenocrysts crystallising as an early groundmass phase in the kimberlite magma.

The majority of the chromian spinels have 55-65 wt% Cr_2O_3 and less than 1 wt% TiO_2 . Two populations are defined by MgO contents; 8-12 wt% and 13-15 wt% respectively. A significant minority of grains have TiO_2 1-6 wt%, some of which may derive from coarse groundmass spinels. The trace element contents of the spinels are more or less in keeping with Group 1 kimberlites with respect to Zn (400-700ppm) and Ga (10-60 ppm), but are high in Ni (1000 ppm compared to 600-700 ppm for other Group 1 kimberlites). They therefore do not have any obvious association with spinels from harzburgites or lherzolites (Griffin et al, this vol.). The high Ni may suggest a high temperature origin.

The Cleve-01 garnets are distinctly bi-modal, with low and high Cr_2O_3 populations being present (1-3 wt% and 5-9 wt% Cr_2O_3), and the vast majority belonging to the lherzolitic paragenesis (Sobolev, et al. 1973). Virtually all the garnets are low TiO_2 varieties (less than 0.4 wt% TiO_2), and typical high TiO_2 megacrystic garnets are not present. Using the Ni garnet geothermometer (Griffin et al, 1989) essentially two temperature populations are defined; one at ca 650-800°C ($\text{Y/Ga} > 2$) and the other, 1000°-1250°C ($\text{Y/Ca} < 1$) corresponding to the low and high Cr_2O_3 groups respectively (Figure 2). Although the high temperature garnets fall into the diamond stability field assuming a normal continental geotherm, the very low Y/Ga ratios are atypical of most African and Siberian kimberlites (Griffin and Ryan, unpublished data). This population in fact may be related to a separate high- Cr_2O_3 suite formed at relatively low pressures as defined by the low temperature garnet population.

