A Pilot Study of the Swartruggens Kimberlite Dyke Swarm

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Helam Mine is known for its exceptionally high grade of diamonds (Mitchell, 1995). The diamond grade of the kimberlite dykes varies from more than 200 ct/100 t in the Main Dyke, to 20 ct/100 t in the Changehouse Dyke, down to zero in the Muil Dyke. A pilot study was initiated to investigate the cause of this large variation in grade. Special attention was paid to petrogenetic links between the dykes and whether the barren dyke actually is a kimberlite.

The Swartruggens Kimberlite Dyke Swarm is situated approx. 10 km north of the town of Swartruggens in the North West Province, South Africa. It strikes in an ESE-WNW direction with a lateral extent of approx. 6 km and a thickness of up to 1.5 m. The emplacement of the dykes was controlled by the local jointing pattern in the country rock and by a thrust fault. At the time of this study six dykes of the Swartruggens Kimberlite Dyke Swarm were mined by Helam Mining (Pty) Ltd.

To understand the factors that control the variations in diamond grade at Helam Mine the petrography, bulk rock composition, single grain composition and heavy mineral concentrates of the kimberlite dykes were studied. The resulting data set was then used in major and trace-element modelling. Garnet and chromite data were analysed using discriminant function analysis to identify host assemblages for these minerals. The chemical composition of the garnets identifies them as similar to lherzolitic, eclogitic, and peridotitic garnet inclusions (Richardson et al., 1993). Garnets from the Changehouse Dyke are similar in composition to the Lace garnet megacrysts suite (Bell et al., 1995).

Our data suggests that the six kimberlite dykes at Helam Mine can be grouped into three different sets of dykes and our petrogenetic model links all six dykes to a common precursor melt. The composition of the kimberlites shows an evolutionary trend from Group II kimberlites (Main Dyke) to a magma transitional in composition between kimberlites and lamproites (Clement and Skinner, 1985; Mitchell, 1995; Rock, 1991; Skinner and Clement, 1979). The members of each set are variants of each other rather than separate, unrelated intrusions. The dykes were intruded in three pulses and chemical differentiation occurred by fractionation of mineral phases from the melt. The first set of dykes is characterized by a high diamond grade and the absence of garnet megacrysts. The second set of dykes is characterized by the presence of garnet megacrysts and a drop in diamond grade by 90% to 20 ct/100 t. The third set of dykes, the Muil Dyke, is characterized by the complete absence of any mantle minerals. This dyke has never yielded any diamonds. It constitutes an extreme end-member of the Group II kimberlites.

The presence of garnet megacrysts indicates that the second and third batch of magma were delayed in their ascent for long enough to allow the formation of new garnet phases (Hops, 1989). Thus, the variation in diamond grade of the Swartruggens Kimberlites is controlled by secondary processes related to magmatic differentiation processes which took place during the ascent of the magma. In this study we identified garnet megacrysts as indicators for a reduced diamond grade in the kimberlite where previously identified garnet suites would have indicated a higher grade.

References

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