DIAMOND MINING ON KIMBERLITE DIKES OF SOUTH AFRICA.

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The most significant mining operations on kimberlite dikes in South Africa are confined to six occurrences of Group II kimberlite intrusions. These are Bellsbank, Bobbejaan and Ardo dikes, northwest of Kimberley in the Cape Province, Roberts Victor and Star, east of Kimberley in the Orange Free Sate, and the Helam Mine, near Swartruggens in the northern Transvaal. Although kimberlite dikes have also been mined in China and West Africa, and trial mining has been attempted in North America, only in South Africa has mining development proceeded to depths greater than 100m below the surface. Some of the South African dikes have been developed to depths of more than 500m, and some mines have operated more or less continuously for nearly 50 years.

Kimberlite dike occurrences are complex systems sometimes with strike lengths greater than 5 km which are located within extensional structures as a swarm of dikes intruded sub-parallel to each other. Most individual dikes were emplaced as a series of discrete lenses which are interwoven in an en echelon arrangement. The lenses pinch and swell along strike, ultimately to pinch out as the next lens develops, offset by some meters and interconnected by thin stringers of kimberlite or calcite. The various dikes do not, and never did, all outcrop at the surface. They vary from extremely thin veins (< 1cm wide) to lenses typically about 60cm wide at their widest development and rarely reaching a maximum width of more than 1m. In some cases only one dike is commercially viable, with width of ore being an important criterion. At other localities more than one dike can be profitably mined. At some mines the commercially viable dike is cut by small vents which probably reached the land surface at some time during kimberlite intrusion. Dike continuity and changes in strike and dip are frequently at least partially controlled by wall rock characteristics. Dikes intruded into competent crystalline basement or basalt are more consistent in strike and dip than those emplaced in shales. Dike emplacement can also be affected by pre-existing paths of weakness such as faults, shear zones, bedding planes, foliations, changes in rock types and geological contacts. Occasionally the same path is exploited by separate intrusions of different mineralogy, diamond content, and age.

Evidence for multiple intrusion events within individual dikes has been reported in a number of earlier descriptions and is confirmed by the present study. The kimberlites are all

hypabyssal-facies rocks, and the mineralogical composition of the six viable occurrences is similar. They typically contain rounded olivine and less abundant phlogopite macrocrysts (> 0.5mm diameter) set in a groundmass composed predominantly of fine-grained phlogopite. Calcite, minor apatite, perovskite, and complex opaque oxide intergrowths are additional common groundmass components. Flow differentiation of olivine macrocrysts is common.

The diamond contents of the economically viable kimberlites are normally in the range of 30 to >200 carats per 100 tonne. Variations in diamond morphology, colour, inclusion characteristics and value are also within the range reported for kimberlite pipes in southern Africa. Where information is available, the diamonds have inclusions which fall into the peridotitic and eclogitic parageneses established for kimberlite occurrences world-wide.

The mantle macrocryst minerals in the kimberlite include both peridotitic and eclogitic mineral phases, some of which are interpreted to be linked to diamond genesis on the basis of chemical composition. The proportion of these minerals vary widely, both from within a single dike set, and between sub-parallel dikes at specific localities. These variations, considered in the light of the narrow widths of kimberlite dike intrusions, are interpreted to reflect lack of mixing of the non-cognate mantle component sampled by the kimberlite at depth, even during transport into the near surface earth's crust. This lack of homogeneity in the transported mantle sample suggests that it may be possible to preserve variations in diamond abundance throughout the dikes which are the products of the primary distribution of diamonds in the upper mantle and the sampling mechanisms of kimberlite at depth. Dikes should on this basis show more grade variation than the better mixed material found in diatreme-facies kimberlite.