The Economic Implications of Kimberlite Emplacement

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Abstract

The economic potential of kimberlite bodies is defined by the ore volume and diamond content which are summarised in three dimensional geological models. A comparison of available geological models that form the basis of resource estimates reveals that distinct types of kimberlite bodies reflect contrasting styles of emplacement. Summary geological models and macroscopic petrography, in particular the use of olivine macrocrysts as a proxy for macrodiamonds, are used to demonstrate the economic implications of emplacement. The volume and diamond content of the pre-emplacement magmas are determined by processes that occur in the mantle and during ascent towards surface. Kimberlite magmas which carry the maximum load of solids from the mantle to surface have the greatest potential to be significantly diamondiferous. The final volume and diamond content of a kimberlite body (grade and distribution) reflects the near-surface emplacement history of multiple batches of magma. During emplacement the abundance and distribution of the olivine macrocrysts in the pre-emplacement kimberlite magmas can be modified by dilution, concentration and/or sorting. These modifications, which vary with different emplacement processes and products, are used in the prediction of macrodiamond grades and distributions relative to the pre-emplacement magma. The majority of kimberlites are subsurface bodies which are both difficult and costly to evaluate. Maximizing the value of expensive drillcores and related materials by applying these underutilized powerful and practical techniques leads to better evaluation strategies, more reliable geological models and enhanced resource estimates. These techniques can be applied at all stages of evaluation and mining as soon as drillcores, exposures or samples are available and during the standard procedures undertaken in the development of geological models. A significant advantage of macroscopic petrography is that larger, more economically relevant and representative areas are analysed. Olivine macrocrysts are relatively easy to measure and are much more abundant than macrodiamonds as well as other mantle-derived xenocrysts (e.g. garnet). Importantly, the variations in olivine size, abundance and distribution, although a consequence of diverse emplacement, can be determined without knowledge of the rock textures and emplacement processes. Understanding the textures and emplacement processes, however, significantly improves the degree of confidence in any predictions. The value of the results to the project, however, will depend on the nature of rocks and the experience of the investigator.