The Distribution Pattern of Kimberlites and Their Cognate Rocks in Shandong, China

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Extended Abstract

INTRODUCTION.

The co-existence of kimberlites and cognate rocks is a common phenomenon. The study of the regional distribution patterns of kimberlites and their cognate rocks is an important way of predicting and prospecting for diamond deposits. Some research projects have been conducted in Shandong, China to select target areas for primary diamond deposits. Some diamondiferous kimberlites and related basic dykes, (distributed in an E-W direction), have also been found in Liaoning and Guizhou Provinces in China and these are thought to have been emplaced during the Silurian and Carboniferous. Some cognate rocks are found in the area surrounding the Liaoning kimberlite field and these will be studied in the future. The kimberlites in Guizhou, which lie at the contact between an upwarp axis and a syneclise, are associated with dykes and sills of mica-peridotite containing minor diamond. We will take the western Shandong platform as an example to illustrate the regional distribution pattern of the kimberlites and their cognate xenoliths.

A. THE KIMBERLITES NEAR MENG YIN.

The kimberlites in Meng Yin occur near the centre of the western Shandong platform. Three kimberlite zones, consisting of 11 pipes and dozens of dykes, have been found, all containing diamond. Most of them are surrounded by Archaean gneiss and the dykes trend in a NNE direction. The depth of erosion is estimated to be more than 1km and only the root zones are preserved. The kimberlites are characterised by having little picroilmenite, but abundant picrochromite, (Cr_2O_3 >54%), and perovskite. This mineralogy is the result of the initial crystallisation of chromite, (caused by its higher lattice energy compared with that of ilmenite), and a consequent removal of iron from the magma, making the mass crystallisation of ilmenite difficult. Later, large quantities of perovskite crystallised as well as certain transitional minerals between picrochromite and picroilmenite, such as the new mineral of yimengite, which suggests that the magma forming the kimberlites in this region may have had a higher temperature and deeper source than magmas which form kimberlites with a higher picroilmenite content.

B. THE COGNATE ROCKS.

The cognate rocks of the kimberlites in Meng Yin, Shandong are distributed on the fringe of the western Shandong platform, Fig. 1, a distance of 80kms from the centre of kimberlite emplacement. Some glimmerites and carbonatites occur in the north, (Laiwu and Zibo areas), and some lamprophyres and olivine glimmerite breccias are found in the south, (Xuecheng and Zaochuang areas). They are mostly in the form of sills and dykes, occasionally of pipes. Chemically, they belong to the subalkaline and ultrabasic rock groups. The main constituent minerals of these rocks are Fe-phlogopite, calcite, aegerine-augite, apatite and titano-magnetite. Calcite is the chief member of the carbonates and no nepheline occurs, which indicates the very high initial temperatures and deep source of the parent magmas.

C. RELATIONSHIP OF KIMBERLITES AND COGNATE ROCKS.

Both kimberlites and cognate rocks show similar patterns of rare earth elements, which belong to the "Ce-rich" and "Y-depletion" trends and implies that both are cognate products formed under high pressure. It can be seen from Fig. 2 that HREE contents in these rocks are low, with smooth and gentle curves, indicating an undifferentiated source region of garnet-lherzolite, (the unmelted garnet has been found in some nodules). On the La/Sm - La diagram, the points for both the kimberlites and the cognate rocks show an oblique line pattern that implies they were produced by partial melting. H_2O is greater than CO_2 in the kimberlites, whereas CO_2 is greater than H_2O in the cognate rocks; the ratio of H_2O/CO_2 controlled the differentiation path of the magma.

D. AGES OF THE INTRUSIONS.

The K-Ar isotopic ages for the cognate rocks range between 123 and 126Ma. Large quantities of volcanic breccia with a confirmed early Cretaceous age have been found in a carbonatite pipe in Boshan County. Also, clasts of volcanic rock with an early Cretaceous age have been found in thin sections of a kimberlite that cross-cuts a 113Ma old diabase dyke. The diabase formed somewhat later than the ultrabasic rocks. Both the kimberlites and the cognate rocks are controlled by the structures on the western Shandong platform which began to uplift in the Triassic period. Prof. Li Siguang suggested that the Meng Yin kimberlites may be related to the Tanlu fault, which is of Mesozoic age. However, the isotopic age data of the kimberlites are variable: the K-Ar method gives an age of 77 to 88Ma, whereas the Sm-Nd method and the K-Ar method from mica give ages of 400 to 500Ma, perhaps resulting from the presence and interference of the xenocryts from deep sources in the kimberlites. This remains to be studied in the future. Based on the field geological relationships and the isotopic data available, I consider the kimberlites were formed in the Cretaceous and are contemporaneous with the cognate rocks.

E. CONCLUSIONS.

It is suggested that the liquid produced by the partial melting under high temperature and pressure in the mantle was separated into two parts: one part was kimberlite magma under high P and T which then ascended and was emplaced into the centre of the platform forming the pipes and dykes; the other part was the residual magma which, due to the decrease of pressure, was emplaced obliquely into the structures on the fringe of the platform, forming sills, dykes and a few pipes. Because the cognate rocks are more abundant than the kimberlites, the distribution patterns of the cognate rocks can be used for predicting and searching for diamondiferous kimberlites. This "central distribution pattern" is very similar to those in South Africa and Siberia.

COMPARATIVE DISCUSSION.

In Western Australia, by comparison, the lamproites, kimberlites and their cognate rocks, which are their fractionation products, are distributed on the fringe of the Kimberley block, where some new rock types have also been found. Some other kimberlites are distributed on the margins of the Australian continent. This could be related to the structure of the blocks where the lamproites and kimberlites occur, such that even at depths of 300-400kms the asthenosphere cannot have been touched. Therefore the large scale geology of the region must be taken into account when using a distribution pattern to predict and search for a diamondiferous kimberlite.

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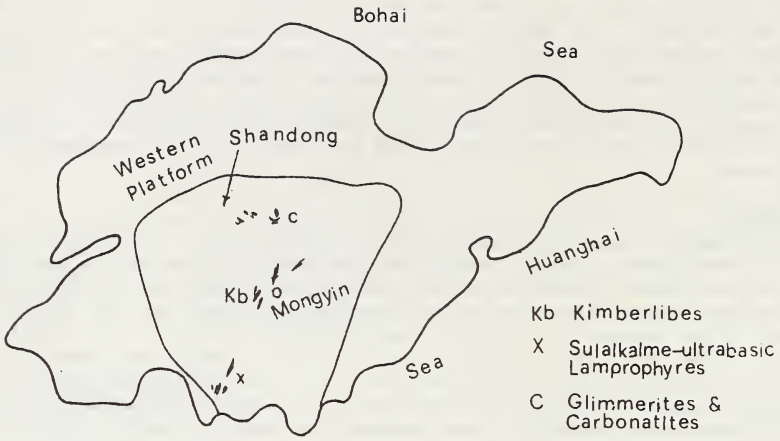

Fig1. The Distribution of Kimberlites & Their Conate Rocks in Shandong, China.

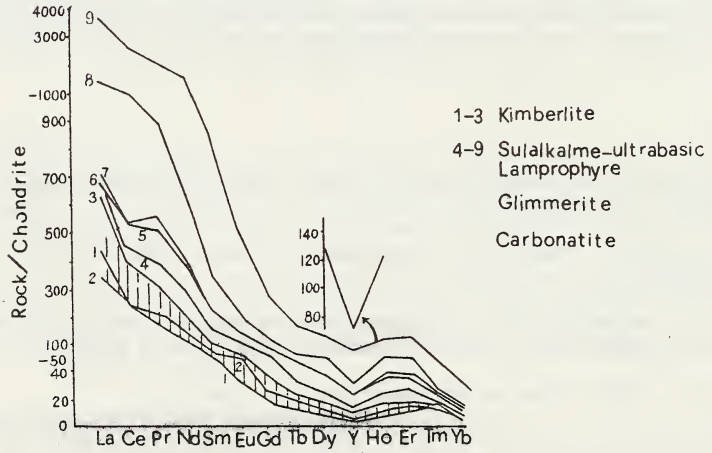

Fig2. REE Distribution Pattern of Kimberlites & Their Cognate Rocks in Shandong, China.