H Kimberlite Research Notes

H1 KIMBERLITES IN CHINA AND THEIR MAJOR COMPONENTS: A DISCUSSION ON THE PHYSICOCHEMICAL PROPERTIES OF THE UPPER MANTLE

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Kimberlite bodies have been found mainly on the North China Platform, such as near the Huangjiachuan, Majuan and Tumen villages, and some on the Yangtze Platform, such as near the Shenchong and Pengjiabang villages.

The Huangjiachuan and Majuan kimberlite bodies occur on the western and eastern sides of the Tancheng-Lujiang Deep Fault Belt. The Huangjiachuan kimberlite bodies appear in a NNE trending zone, and form two groups of kimberlite pipes and veins and one group of kimberlite veins, intruded into the Archaean hornblende-biotite gneisses, Proterozoic migmatites and Cambrian limestones, thin layered sandstones and shales. The Majuan kimberlite bodies lie in a nearly east-west trending zone and form three groups of kimberlite pipes and veins intruded into the Sinian quartzites, thin layered argill(ac)eous limestones and shales and Cambrian limestones.

The Tumen groups of kimberlite veins are located in a NNE trending zone on the western side of the Taihangshan Deep Fault Belt, and intruded into Cambrian limestones.

The Shenchong group of kimberlite veins is located in a NE-ENE trending zone on the southern side of the Taihangshan Deep Fault Belt and intruded into Cambro-Ordovician limestones and dolomites.

The Pengjiabang group of kimberlite pipes and veins occur in a NW trending zone and intruded into Cambrian limestones. They are closely related to the NW trending deep faults on the northern border of the Yangtze Platform.

Most of the veins are composed of porphyritic kimberlite. The rims of some veins are formed of kimberlite-breccia with porphyritic kimberlite at their centres. Individual veins are thinned out, and there is a transition from porphyritic kimberlite to kimberlite-carbonatites. Some veins show a linear flow structure.

Most of pipe's cores are porphyritic kimberlite and their rims are usually kimberlite-breccia. In some kimberlite pipes has been found kimberlite-carbonatite. Some groups of kimberlite pipes at depth are transformed into veins, and individual pipes are thinned out. In an open mining pit of a kimberlite pipe near the Huangjiachuan village, the porphyritic kimberlite shows linear flow structure having NW 55° trend and dip to north at an angle of 40° at the contact with kimberlite-breccia. In the Majuan and Huangjiachuan area, some blind kimberlitic pipes were found at shallow depth. This fact indicates that they are of hypabyssal origin.

The kimberlites are strongly serpentinized and carbonatized, and sometimes silicified. Fresh kimberlitic rocks only locally appear at great depth in a pipe of the Huangjiachuan area. The major minerals of the kimberlites are olivine (serpentinized), phlogopite, pyrope, chrom diopsite, clino-pyroxene, picotite, magnesiochromite, perovskite, ilmenite, magnetite, rutile, anatase, apatite, moissanite, zircon, caldasite, serpentine, calcite, graphite, and diamond, and very rare picrotanite. The pyrope is usually altered and covered by a green or black "shell".

The kimberlites are one kind of sub-alkaline magmatic rocks. They have very high volatile component. Chemical composition of porphyritic kimberlite is as follows: SiO_2 25.84-40.15%, Al_2O_5 1.47-3.5%, MgO 24.63-35.1%, MnO 0.1-0.23%, P_2O_5 0.26-2.94%, K_2O (0.17-3.9%) more than Na_2O(0.04-1.32%), in some samples K_2O(0.05-0.27%) less than Na_2O (0.07-1.65%); CO_2 0.03-23.1%, H_2O^+ 1.69-12.79%, and Cr, Ti and Co less than that in ultrabasic rocks.

The kimberlites show no significant variation in different tectonic settings. This indicates that the chemical properties of mantle sources were also not much different.

But the kimberlites from different tectonic zones and different orogenic belts vary in their ultramafic xenolithes and mineral components, It indicates difference in physicochemical properties of the upper mantle. For example, the Huangjiachuan kimberlite bodies are the product of the Yenshanian orogeny. They contain peridotite and chrome-spinel lherzolite xenolithes. In thin-sections of rocks from Huangjiachuan bodies, the fresh clino-pyroxene crystals show exsolution texture with platy intergrowths of ilmenite. This ilmenite might come from more 250 km depth in the upper mantle because pyroxene and ilmenite can form a solid-solution at the pressures greater than

70 kbar. The Majuan kimberlites of the Caledonian age contain xenolithes of peridotite, garnet-mica pyroxenite and the early large crystals of phlogopite. In thin sections of rocks from Majuan bodies, the fresh acicular clino-pyroxene crystals and the fresh platy phlogopite crystals show their microspinifex texture respectively, and the early large crystals of phlogopite show exsolution texture with platy intergrowths of magnetite. These facts indicate that the pressures and temperatures were unstable in the upper mantle.

Under the electron microscope, the (111) crystal faces of magnesiochromite show a growth texture from polycrystalline seeds which indicates that magnesiochromite might be formed at high pressures in the mantle. The (111) crystal faces of the rhombic-dodecahedron-octahedron shaped diamond shown the dislocation growth lamellae, which lie at an angle of 35° with the stress plane, and the arcuate impact texture has been found on the (111) crystal faces of diamond octahedra. This dislocation of growth lamellae on the crystal face (110) of diamond shows that some diamond crystals have grown in the solid or sub-solid stage, but not in the liquid or gas state. The arcuate impact texture on the (111) crystal face of diamond octahedra appears as a result of the impact stress after crystal growth.

The Tumen kimberlites are the product of the Himalayan movement. In these kimberlites, some altered pyroxene exhibites chrom spinel exsolution textures. It is suggested that the depth of the original kimberlitic magma in this area was probably less than that of Huangjiachuan kimberlitic magma.

The Shenchong and Penjiabang kimberlites were formed during the Caledonian period. In the Shenchong kimberlites, the picrotanite is rare, too; but anatase and rutile contain more niobium. The lherzolite xenolithes found in the Penjiabang kimberlites indicate that the depth of magma chambers for the Shenchong and Penjiabang kimberlites might be less than 250 km.

H2 GEOLOGY OF BRAZILIAN KIMBERLITES

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In the Late Cretaceous, the South American Platform was affected by a huge magmatism accompanied by the intrusion of a great amount of kimberlites, rocks with kimberlite affinities, alkaline rocks and associated carbonatites (Svisero et al. 1979a). The majority of the bodies with kimberlite characteristics are located in the west part of Minas Gerais State ; nevertheless, there are several occurences in the States of Mato Grosso, Piaui, Santa Catarina and Rondônia.

Svisero et al. (1979b) summarized the main geological surveys of kimberlites carried out in Brazil in the last decade by local and foreign mining companies. Although much of these results have not been published yet, it is admitted that the number of diatremes and rocks with kimberlite affinities surpasses two hundred bodies. Some of these intrusions have been proved to be kimberlites, namely the Vargem 1 and the Redondão (Svisero et al 1977), as well as the diatreme of Limeira 1, Limeira 2 and Indaiâ (Svisero et al. 1980). Others are still being investigated.

In an attempt to increase the information regarding Brazilian kimberlites, this paper presents mineralogical and geological data on Limeira 1, Limeira 2, Indaiâ 1, Indaiâ 2, Vargem 2, Santa Clara, Japecanga, Pimenta Bueno, Mamões, Poço Verde and Morungaba kimberlites. Excepting Pimenta Bueno in Rondônia, all the other mentioned kimberlites are located in west Minas Gerais which seems to be the most important kimberlitic province in Brazil.

Kimberlites occur in west Minas Gerais as diatremes which range from 50 to 400 meters in diameter or as small dikes, mostly clustered in the headwaters of the Paranaiba River. Although weathered on the surface, the yellow-ground usually contains several kimberlitic minerals such as Cr-pyrope garnet, Mg-ilmenite and diopside, whose chemical compositions are similar to their counterpart kimberlites from worldwide localities. Twelve diatremes have been proved to be true kimberlites up to now ; geological and geophysical data, however, suggest that the total amount may reach for beyond that number.

Limeira 1 is a dark porphyritic kimberlite with large amounts of olivine, monticellite, phlogopite, perovskite and opaque minerals, dispersed in a fine-grained matrix having the same mineral assemblage plus serpentine and carbonates. Geophysical surveys (scintilometry, electro-resistivity, magnetometry and thermometry) showed a regular almost oval outline measuring 300 x 250 meters. Limeira 2, the twin body of Limeira 1, is a small elliptic diatreme whose N-S main axis is no longer than 80 meters. Limeira 2 has a gray aphanitic matrix rich in phenocrysts of fractured olivines and numerous xenoliths of crustal rocks, breccias and dunite. Indaiâ 1 is similar in size, color, texture and mineralogy to Limeira 1. Indaiâ 2 is a small satellite of Indaiâ 1, similar to Limeira 2. Limeira's and Indaiâ's diatremes, 1.5 Km apart, are all intrusive in rocks of the crystalline basement, mostly granites, schists and cataclasites. Vargem 2, Santa Clara, Japecanga, Mamões, Poço Verde and Morungaba kimberlites have been characterized by mineral chemistry of their resistant minerals recovered from yellow-ground .

As mentioned before, kimberlites occur scattered throughout Brazil, such as Pimenta Bueno in Rondônia and Redondão in Piaui. Despite the lack of specific studies, the kimberlites of Paranatinga, Mato Grosso State, and the recent discoveries of Lajes, Santa Catarina State, should be mentioned as well. Geologic and tectonic characteristics of these occurences suggest the existence of at least four more kimberlitic provinces in Brazil besides that of west Minas Gerais : Pimenta Bueno in Rondônia, Gilbuês in Piaui, Lajes in Santa Catarina and Paranatinga in Mato Grosso.

West Minas Gerais, Lajes and Paranatinga Provinces display geological similarities,as all are located on the border of the Paleozoic Parana Basin ; furthermore, they are related to Cretaceous tectonic arcs that favoured the intrusion of a great number of alkaline rocks and associated carbonatites. Gilbuês Province in the southern Paranaiba basin, another Paleozoic basin in north Brazil, apparently is related to reactivation of important Precambrian structures. Field relations of Redondão, the only reported kimberlite in this province, indicate the kimberlite as Cretaceous. On the other hand, very little is known about the tectonic evolution if Pimenta Bueno in east Rondônia. The kimberlites could either be related to Proterozoic tectonics or be Cretaceous as in West Minas Gerais, Gilbuês, Lajes and Paranatinga Provinces.