PALACOZOIC LITHOSPHERE MANTLE FEATURE BENEATH FUXIAN, LIAONING PROVINCE, CHINA: THE INFORMATION FROM No. 50 KIMBERLITE PIPE.

Lu, Fengxiang; Zheng, Jianping*; Zhao, Lei**; Zhang, Hongfu***.*

China University of Geosciences, Wuhan 430074, P.R. China; ** China University of Geosciences, Beijing 100083, P.R. China; * Northwest University, Xian 710096, P.R. China.*

Abstract

GEOLOGICAL SETTING

Liaoning diamondiferous district is located in North China Platform. There are two kimberlite fields, Tieling and Fuxian kimberlite field. The former is in north margin of North China Platform, the latter being 340 km south of it. 25 kimberlite bodies are known to occur in Tieling but all of them are barren. 18 kimberlite pipes and 58 dykes are distributed in Fuxian and belong to 3 clusters. Some of these bodies are diamond–rich and have grade type. No. 50 pipe is the best one of diamond–rich kimberlites. It has been eroded to level at the transition from diatreme to root zone.

KIMBERLITE AGE OF NO. 50 PIPE

K–Ar datings of kimberlite whole rocks and micas are 422–462 Ma and 398 Ma respcetively which may represent the magma emplacement age and crystalline age of mica. But the Rb–Sr isochron age of whole rock is 1109 Ma which may reflect the original age of kimberlite. Most diamonds in No. 50 pipe contain significant amount of nitrogen concentrates to form various type of aggregation which link with age of diamond. This process obeys second order kinetic equations. According to Erans and Harris (1989) method, the two population of the modal age of diamonds in No. 50 were revealed. They are 2200 Ma and 1200–1500 Ma. Obviously, the first group of diamonds were formed older than kimberlite No 50 pipe and the second is near the isochron age.

GEOCHEMICAL CONSTRAINS

The mea values of major elements of the kimberlites in No. 50 pipe are as following : SiO_2 32.63%, MgO 27.68%, TiO_2 1.2%, K_2O+Na_2O 0.79%, P_2O_5 0.66%, MgO / (MgO+FeO) 0.88 and the trace elements are Ni 775–1228ppm, Cr 557–606ppm, Ni / Co 9.10–26.24, K / Rb 9.67–17.46, Th / U 9.25, Nb / Ta 19.71–31.95, La 93.71–130.67ppm, La / Yb 205–348, Like all kimberlites in the world, No. 50 pipe kimberlites are characterized by simple linear REE distribution pattern showing extreme light REE enrichment. La and Yb are enriched 150–350 and 1.5–8 times chondritic aboundances respectively. The initial $^{87}Sr / ^{86}Sr$ is 0.7074 near the ratios from group–II kimberlites in South Africa; $\delta^{13}C$ in kimberlites range from −4.4 to −5.4 which are included by the range in $\delta^{13}C$ of diamonds (from −4 to −8) from No. 50 pipe. Compared with Shandong kimberlites, No. 50 pipe has relative low MgO, Mg / (Mg+Fe), and high TiO_2 , P_2O_5 and REE. These facts may imply that there is a metasomatic mantle beneath Fuxian showing more enriched with LREE, K, Rb, Sr, Ti, and P, and lesser ultrabasis feature than that beneath Shandong kimberlite feild.

We think that kimberlites are the products of hybridization of three components; they are xenocrysts derived from mantle which are represented by many kinds of macrocrysts, kimberlitic magmas and volatiles. Most of macrocrysts are olivine exhibiting relatively large (> 3mm) rounded–anhedral and including octahedeon diamonds, Cr–rich garnets and

chromites in No. 50 pipe. They present in considerable (30–40%) quentities in kimberlites. Subtracted those olivines, the approximate composition of bearing–volatile kimberlitic magmas can be obtained. Using least squares method, kimberlitic magmas in No. 50 pipe are roughly fitted for the melting product from phlogopite (10%), magnesite (15%), clinopyroxene (50%), garnet (10%) phases and H_2O, $+CO_2$(15%). This result of calculation agrees with the high–pressure experiments that kimberlitic magmas may be produced by eutectic–like melting of phlogopite magnesite garnet lherzolite and implies that the source of magmas must include clinopyroxenes to provide CaO to magma.

MINERALOGICAL CONSTRAINTS

Garnets were found at least 5 types in which three types are considered as mantle–derived. Moderate–Ca chrome pyrope (G9) are more abundamt than low–Ca chrome–pyrope (G10) and the concentration of Cr_2O_3 and CaO contents in the formers range from 4.39%–12.77% and 4.55%–8.49% respectively. These garnets increase Ca being correlated with increasing Cr indicating solid solution toward uvirovitc. Green uvarovite–pyropes were also found in No. 50 pipe which are characterized by Ca–rich (14.85%) and Cr–rich (7.67%). All information from mantle–derived garnets show that most of them crystallized in a moderate–high calcium and chrome medium. Orange titanian pyropes are considered megacrystal occurence. These garnets are typical poor in Cr_2O_3(<1%). Yellow–green andradites are secondary phases and replaced the globular segregation or as the aggregations set in matrix.

Nature Fe, wustites, $FeSi_2$ and Ti–$FeSi_2$ have been found in heavy minerals. This mineral assamblege defines low fo_2 environment and close to iron–wustite (IW) buffer. In contrast, according to Sack (1980) and Mo (1982) method, No. 50 pipe kimberlitic magmas are relatively oxidized and approximate to fo_2's defined between WM and EMOG buffers. It may be better to explain that the fo_2 of source region of diamond was more reduced than that of magmas. Mantle–derived garnet, orthopyroxene and clinopyroxene from No. 50 pipe give pressure and temperature of 51 kb and 1206℃. Obviously the depth at which the upper mantle melt to form kimberlitic magmas should be deeper than 160km.

XENOLITH

Three kinds of xenoliths were found in No. 50 pipe kimberlite. They are peridotite series, phlogopitite series and lower crust as well as country rocks materials. Most of peridotite xenloiths are dunite and garnet lherzolite and Cr–rich garnet harzburgite xenoliths are rare. Phlogopitite series including garnet phlogopitite and olivine phlogopitite are relatively coarse–grained and considered to represent autoliths or cumulates of early–generation kimberlite. The REE pattern of garnet lherzolite xenoliths are similar to that of kimberlites, La / Yb = 195.2, and La is enriched 13 times chondritic abundances. Although a garnet peridotite lithosphere is depleted in basaltic constituents by igneous events, it is subequently enriched in elements such as REE by a component derived from greater depth.

CONCLUTION

1. There was a cool, thick and low fo_2 lithosphere beneath Fuxian area at Palacozoic.

2. It consisted of at least four components, dunites, garnet harzburgites, garnet lherzolites and phlogopitites. No ocean lithosphere material such as eclogite so far has been found and lherzolite plaied an important role during that time.

3. No: 50 pipe kimberlites are derived from an enriched source with respect to bulk–earth Rb / Sr ratio and slighted enriched than that in Shandong kimberlites.

4. Lithologic and chemical variations observed in mantle xenoliths from other parts of the world have been explained by multiple depletion and enrichment events. But how to explain a relative high calcium enviroment appeared in the upper mantle beneath this area?

First possibility is that lithosphere may consist of Cr–garnet lherzolites with low–Ca Cr–pyrope ha zburgite harzburgite and the dunites lenses. Second possibility is that these lherzolite might represent mixtures of depleted harzburgite ordunite and basalic melt or Ca–rich fluid.