SPINEL – AS INDICATOR FOR DIAMOND.

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This extendcd abstruct will concern primarily with macrocryst spinel classification.It is proposed first to discuss the spinel guoup populations of typical kimberlite and lamproite bodies, to discuss their significance for diamond exploration, and then to discuss their origin.Only the principal points summariged below.Detailed description of the each spinel group and discussion can be found in other papers (Zhang Andi, 1991; Zhou Jianxiong, 1991).

Spinel is one of the most characteristic minerals of kimberlite and lamproite.Although its amount in kimberlite and lamproite varies widely from trace quantities up to about 0.3–0.5% (Sobolev, 1975), it is very resistent to physical and chemical weathering, and it is easily found in the concentration.They are abundant enough to act as indicator for primary source rock.There have been some successful examples in China.One of diamond bearing kimberliee pipe and one of diamond bering lamproite field were found by tracing spinels.

Howerer, for a long time, as Mitchell said (1987), determining provenace of spinel is still very difficult.It is analogous to the olivine macrocryst problem.And the composition of spinels from kimberlite and lamproite are similar to that of spinels from a wide variety of basic and ultrabasic rocks.Recently the people found the diamond bering rocks always contain spinels which show similar chemical features to the mineral inclusions in diamond (Gurney, 1989, Dong and Zhou 1980).

In this study the classification of spinel is made by Q–cluster analysis, based upon the predominance of Cr_2O_3, Al_2O_3, $TiO_2$and MgO. The nearly 5000 analyses from above 68 rock bodies have been studed.Most of quantitative analyses were made by typical EPMA, that is wavelength dispersive spectrometry our lab.Very few came from the reference.The occurences of spinels include in diamondiferous or barren kimberlites and lamproites, and other reletive rocks, such as lamprophyres, basalts, alpine peridotities, layered basic intrusions and meteorite and so on. which are not only from 6 provinces in China, but also from South Africa, Australia, America and USSR.Fig.1 and Table 1 summary the main results obtained by the cluster analysis.These all 12 groups involve almost the all spinels occured in above mentioned rocks.It is obvious that each group is characterized by differente TiO_2, Al_2O_3, $Cr_2O_3$and MgO contents.And it is casily recognized by computer program based upon thd amount of compositions.S1, S2 and S3 groups with very high $Cr_2O_3$and MgO are all direct indicators for diamond.They all contain very low $Al_2O_3$and TiO_2, although they have a little diffrent each other.S1 group almost does not contain TiO_2.S2 group contains about 1% TiO_2.S3 group contains very high $Cr_2O_3$and MgO, mainly found in meteorite.S4 guoup can be found in a variety of occurences, including kimberlite and lamproite. Usually this guoup were further subdivided according to the TiO_2content. S5 guoup with high $Al_2O_3$is not typical to kimberlite and lamproite. S6 group with low $Al_2O_3$and high $TiO_2$is typical for kimberlite, and sometimes found in lamproite.S7 group with high $Al_2O_3$and $TiO_2$is typical for lamproite, but also found in kimberlite, especially in mica kimberlite.Other groups are not very importent and very easy to discriminate.This classification has been proved very useful for following three fields:

(1) Simplifing the quantitative description for spinel groups in kimberlite, lamproite and other rocks.Fig2 shows the spinel group populations in a few typical kimberlites and lamproites which are characterized for each rock.

(2) Simplifing the description for spinels from nature concerntrates.It is very useful to exploration of diamond.

(3) Studing spinel origin.

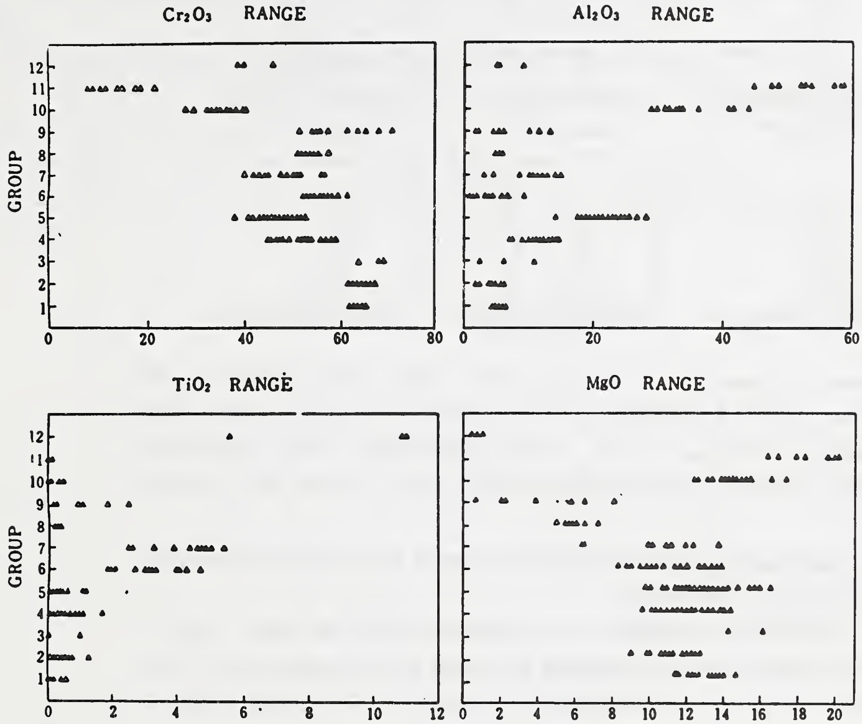

Fig.1. Compositional ranges for 12 group spinels. Obtained by cluster analysis.It shows the different among 12 group spinels.

Table 1. Averaged compositions each group

Group	Name	TiO_2	Al_2O_3	Cr_2O_3	MgO	Occurences
S1	poor Ti, Al rich Mg chromite	0.12	5.29	· 64.00	12.72	Inc KimD LamD
S2	titanian poor Al rich Mg chromite	0.42	4.29	64.63	11.07	Inc KimD LamD
S3	High Mg, Cr chromite	0.36	6.54	67.37	15.43	Met Inc KimD
S4	poor Ti rich Al, Mg chromite	0.48	12.17	52.81	11.69	Lay Chr Lam Kim
S5	poor Ti high Al chromite	0.43	21.67	47.21	13.04	Lap Kim Chr
S6	rich Ti poor Al chromite	3.14	3.87	57.52	10.89	Kim Lam
S7	hith Ti rich Al chromite	4.08	10.25	48.43	10.32	Lam Kim2
S8	poor Al low Mg chromite	0.28	3.35	54.51	5.91	Ler
S9	low Ti rich Fe chromite	0.68	6.17	60.71	3.56	Met Chr
S10	poor Ti rich Cr Mg–Al spinel	0.13	34.14	35.38	14.40	Lap Kim
S11	chrome Mg–Al spinel	0.06	52.50	14.35	18.56	Bas
S12	high Ti rich Fe chromite	9.15	6.49	41.77	0.72	Met

Notes: Inc, inclusion in diamond; KimD, diamondiferous kimberlite; LamD, diamonodiferous lamproite; Kim, Kimberlite; Kim2, mica kimberlite; Lam, lamproite; Lay, layered basic intrusion; Chr, alpine chromite deposits; Lap, lamprophyre; Ler, lherzolite; Met, meteorite; Bas, basalt.

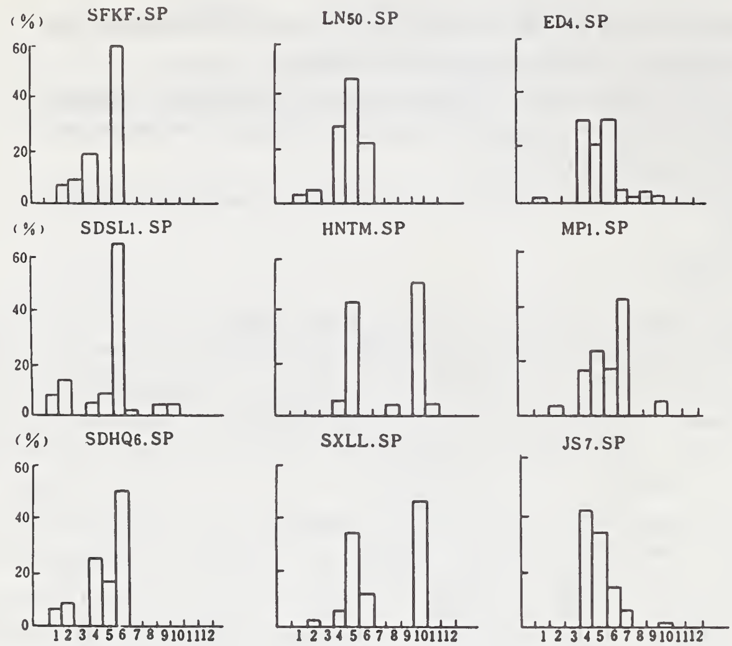

Fig. 2 Histograms of spinel group population from some typical kimberlites and lamproites.Diamondferous: SFKF, Koffiefontein SA; ED4, Ellendal, WA; SDSL1, Shandong SL1 China; SDHQ6, Shandong HQ6 China: LN50, Liaoning LN50 China; MP1, Guizhou MP1 China, lamproite; Barren: HNTM, Hunan TM China; SXLL, Shanxi LL China; JS7, Hubei JS7 China,lamproite.

The results of present studing show the following criterias which the geologists must consider during the exploration of diamond:

(1) Chemically spinels from kimberlites and lamproites exhibit the widest ranges in TiO_2, Al_2O_3, $Cr_2O_3$and MgO contents comparing with those of non–kimberlites.This is a very importent criteria which we must consider any time. The distrbution figers of $Cr_2O_3-Al_2O_3$, $Cr_2O_3-TiO_2$and $Cr_2O_3$and Cr_2O_3-MgO are very importent for estimating of source rocks.

(2) Macrocryst spinels can be considered to be xenocrysts derived from dunites, harzburgites, lherzolites and pyroxenite which have different P and T physical conditions.In other words, as the paragenesis from dunite to pyroxenite the Cr_2O_3in spinel decreases with similtaneous increase in amount of Al_2O_3. That is why that diamondiferouse rocks usually contain more groups than barren rocks.

(3) S1 and S2 group spinels directly indicate if the diamond present or not.Diamond bearing kinberlites or lamproites always contain these spinels (see Fig.2) .It is possible to use these spinels as semiquantitative criteria.These spinels can be called syngenetic chromite with diamond or diamond phase chromite, and may be used as indicator for finding of new source rocks.

(4) S6 group spinel is very special indicator for kimberlite, S7 group spinel is very special indicator for lamproite.It is very clear to see in the Fig.2.Only in barren rocks S6 and S7 groups were replaced by S5 and S10 groups, for example, the spinels in Hunan and Shanxi kimberlite fidles, China (Fig.2) .

(5) According to above mentioned criteria, a comprehensive understand about spinel in a kimberlite or lamproite body can be made based upon at least 50 grain spinel

analses.It means that more analyses of spinel must be done during the exploration, otherwise it is possible to lose useful information.

(6) Spincls from reletive rocks are different from spinels in kimberlices and lamproitcs in spinel group population.It is easy to discriminate each other.

Reference

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