FLUID INCLUSION STUDY ON CARBONATITE DYKE AND ASSCOCIATED QUARTZITE IN BAYAN OBO, INNER MONGOLIA, CHINA

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Bayan Obo Fe-Nb-REE deposit in Inner mongolia, China (110°E, 42°N), is the world largest Fe-Nb-REE deposit. The deposit is hosted by a dolomite marble, the origin of which is controversial. (Tu, G. Z. et al., 1985; Chao, E. T. C. et al.,1992; 1993; 1997; Liu, T. G., 1986; Yuan, Z. X. et al.,1992; Le Bas, 1997).

Within the mine areas, there occurs more than 40 carbonatite dykes, which intruded into different part of early Proterozoic sedimentary-metamorphic basement (Bayan Obo Group) (Geological brigade of Inner Mongolia, 1972; Zhou, Z. L., 1980; Chen, H. and Shao, J. A., 1987; Institute of Geochemistry, Academia Sinica, 1988). The first detailed geochemistry work on one typical carbonatite dyke in this region - the "1988"carbonatite dyke –, was conducted by Le Bas (1992). After then, more and more works have been done on Bayan Obo carbonatite dyke, including mineralogy, geochemistry and isotope studies (Pan, Q. Y, 1997; Zhang J. S. and Lei, R. Y., 1997; Tao, K. J. et al., 1998; Yan X. M. et al., 1998; Wang, K. Y., 2002). In this study, The "1988"carbonatite dyke and associated quartzite (Bayan Obo Group), which was intruded by carbonatite dyke, were chosen for detailed fluid inclusion study. It is also the first detailed fluid inclusions research work on fluid inclusions related to carbonatite dyke activity in Bayan Obo mine area.

Fluid inclusions in carbonatite dyke

Table.1 Fluid inclusion type and microthermometry of carbonatite dykes

fluid inclusion type		Size (μm)	gas ratio (%)	Tm_{CO2} (□)	Tm_i (□)	Tm_{ice} (□)	Tm_h (□)	Th_{CO2} (□)	Th_d (□)	Th (□)	salinity (eq.wt.% NaCl)
melt inclusion	multi-solid inclusion	10-18	20-30							680-720	
fluid inclusion	NaCl-H_2O inclusion	3-10	10-30		-20.5- -26.5	-1.5- -7.5				192-336	3-12
	NaCl-H_2O-CO_2 inclusion	6-14	40-60	-56.4- -57.2			1.5-8.5	24-30		240-390	4.0-14
	NaCl-H_2O±daughter minerals inclusion	6-10	5-20						160-250	420-450	30-35

Tm_{CO2}: CO_2 triple point, Tm_i: initial melting temperature, Tm_{ice}: ice melting temperature, Tm_h: gas-hydrate temperature, Th_{CO2}: CO_2 homogenization temperature, Th: total homogenization temperature, Th_d: daughter mineral melting temperature

Fluid inclusion types of carbonatite dyke in Bayan Obo mining area consist of multi-solid inclusion, aqueous inclusion , CO_2-bearing inclusion and daughter mineral-bearing inclusions. Petrography and microthermometry of the fluid inclusions in carbonatite dyke are listed in Table.1.

Fluid inclusions in quartzite associated with carbonatite dyke

Quartzite associated with carbonatite dyke contains abundant fluid inclusions, which can be briefly divided into three types: aqueous inclusion, CO_2 inclusion and mixed H_2O±CO_2±solid inclusions. Petrography and microthermometry of fluid inclusions in quartzite are listed in Table.2. Meanwhile, combined work, such as CL characteristics, REE and trace elements ICP-MS determination, laser Raman analysis, SEM-EDS analysis and Rb-Sr isochrone dating also have been done on fluid inclusions from associated quartzite.

Table.2 Fluid inclusion type and microthermometry of quartzite associated with carbonatite dyke

fluid inclusion type	size (μm)	Gas ratio (%)	Tm_{CO2} (□)	Tm_i (□)	Tm_{ice} (□)	Th_{CO2} (□)	Th (□)	Td (□)	salinity (eq. wt% NaCl)
NaCl-H_2O	3-10	10-55		-20 - -26	-0.6 - -13.2		190-430		1-17.8
CO_2	4-12	20-45	-56.2 - -57.0			23-30			
H_2O±CO_2± solids	5-60	10-40	-56.4 - -57.0	-20 - -28	-1 - -15	20-30	240-417 L+V	345-750	

Tm_{CO2}: CO_2triple point, Tm_i: initial melting temperature, Tm_{ice}: ice melting temperature, Th_{CO2}: CO_2 homogenization temperature, Th: :total homogenization temperature, Td: decrepitation temperature

Conclusions and discussions

1. Fluid inclusion study in "1988" carbonatite dyke in Bayan Obo mine area indicates that these fluid inclusions have great similarity to the fluid inclusions in typical carbonatites distributed in other parts of the world, which suggest the magmatic origin.

2. The fluid inclusions study in associated quartzite suggests that the fluids trapped in the quartzite are the magmatic fluids from the carbonatite dyke. These fluid inclusions provided the best means to study the carbonatite fluid which preserved in the geological process.

3. The carbonatitic fluids related with the carbonatite dyke are very rich in ore-forming elements and volatile. It has the capability to transport REE, Th, U, Zr, Hf, Cu, Pb, Zn, Ag, Mn, Ti, Rb, etc. The Rb-Sr isochrone age of carbonatitic fluid is 368Ma. It is in great agreement with banded ores (the main ore type) in main ore body of Bayan Obo Fe-Nb-REE deposit (354Ma, monazite,SHRIMP), which suggest that there must be a carbonatitic magmatic activity of Caledonian period.

4. Carbonatitic magmatic fluid from the carbonatite dyke activity of Caledonian period could be the origin of Caledonian period ore-forming fluid for the formation of main ore body in Bayan Obo giant Fe-Nb-REE deposit.

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References

LE BAS, M. J., KELLER, J., TAO, K. et al. (1992): Carbonatite dykes at Bayan Obo, Inner Mongolia, China, Mineral. Petrol. **46,** 195-228

BURN, B. & RANKIN, A. H. (1999): Composition of natural, volatile-rich Na-Ca-REE-Sr carbonatitic fluids trapped in fluid inclusion, Geochimica et Cosmochimica Acta, Vol, **63**, No.22, pp. 3781-3797