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Behaviors of Mantle Fluid During Mineralizing Processes

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1. Introduction

In this chapter detailed discussions are given about the behavior of mantle fluid during mineralizing process. Several topics are covered to make it clear and comprehensible, which include its definition, evolvements and the contributions to mineralizing or ore forming process.

Former studies show that mantle metasomtism is universal among mantle xenoliths and related rocks. Metosomatism processes always are caused by some kind of fluid, mantle metasomatism included. However, the relationship between mantle fluid and mineralizing process is amphibious. So, in the first place it is really needed to make it clear what mantle fluid is and what mantle fluid metasomatism is, any difference between mantle metasomatism and mantle fluid metasomatism. The nature of the mantle fluid is a key window to look into its contributions to ore forming process.

Another question followed is the difference between mantle fluid and magmatic fluid. Luo et al., (2006, 2007a, 2007b and 2008) put forward a metallogenic theory on the transmagmatic fluids and classify the relationship between metallogen,ic fluid and atransmagmatic fluid in to three kinds. What we suggest is that mantle fluid is one of the most important transmagmatic fluids. His thoughts make up of our theoretic foundation.

2. Concepts of mantle fluid metasomatism

Studies show that the elevation of temperature and changes of oxygen fugacity drive the degas process of mantle (C and H_2 et al.) (Spera, 1987). Water in the mantle was mainly brought in during the process of ocean crust-underthrustion, as well as the normal elements and volatile (Peacock,1990; Philippot,1991; Su Genli et al.,1998). Mixture of mantle gas exhaustion and water dissolving CH_4 and CO_2 formed a mantle fluid, which was a supercritical fluid being of great ability of abstraction and transportation. The fluid, which led to the richment of high temperature silicate-alkali-volatile and ore-elements, was named as mantle ichors by Du (1998), who emphasized volatile, thermal and alkali in the fluid and regarded the mantle fluid metasomatism as one kind of alkali metasomatism; Shmulovich et al., (1998) treated the fluid as a system of supercritical volatile (mantle CO_2, chnoricitles and deep water) and riching in recycling original compositions in crust; Cao Ronglong et al (1995)reckoned that is rich in primal earth inner gases (such as ^{3}He and ^{36}Ar) and volatiles (such as mantle CO_2, meteorolite S, deep seated H_2O et al) which form alakali-rich silicate melt. Liu et al., (2004) recognizes that the mantle C-H-O fluid is a high temperature-density supercritical fluid with volatile of H_2O and CO_2,as well as Cl, F, S and P, being capable of dissolution huge amount of rare and normal elements. Trough experiments, Schracder et al (1994) found that mantle fluid various，it could be melt(e.g. carbonatite melt) or water-rich fluid.

Sun et al., (1995) thought that there are two fluid reservoirs in the upper mantle. The one is at the depth of 300 km-66 km. In where, a great amount of K_2O, SiO_2 and Al_2O_3 are dissolved and in equibidium with phlogopite peridotite phase, and the fluid appears as a persalic property. The other locates between 53km and the M-boundary. In where, there are of little solutions but rich in Na and alkali and in equibidium with amphibole peridotite. The patent metasomatism characteristic of Na-rich alkali mantle fluid metasomatism is expressed by the replaced minerals assembly of domain hornblende concomitant with interstitial phlogopite.

Based on the analysis above, Sun et al., (1995) summarizes the relationship between the mantle metasomatism and in-contencial metallogenism and its significance.

1. In favor of the formation of diamond-bearing kimberlita and lamprey.
2. Transport mantle-derived ore-elements into crust to enrichment.
3. Reconstruct crustal material and activate, transport and enrich ore-elements.
4. Provide with plenty of silicate and alkali for the hydrothermal deposits.
5. Cause high geothermal gradient to accelerate the mixing between deep recycle of ground water and mantle-crust-derived until the formation of low temperature hydrothermal deposits.

Yu Xuehui et al., (1995, 2006) suggested that mantle fluid process is connected with the mantle magma process, and alkali-rich magma originates from Enriched mantle where mantle fluid process developed; during alkali-rich magma crystallization, mantle fluid metasomatise alkali-rich porphyry and xenoliths in it (Liu Xianfan et al., 2006a; 2009). Xie Rongjv(1998) discovered that mantle fluid is able to escape from the magmatic rocks, flow along the deep faults and rifts to replace the wallrocks and form ore deposits in suitable spaces. This brings on a high temperature→low temperature mineralizing processes from magmatic rocks to wall rocks (Liu X F et al., 2002).

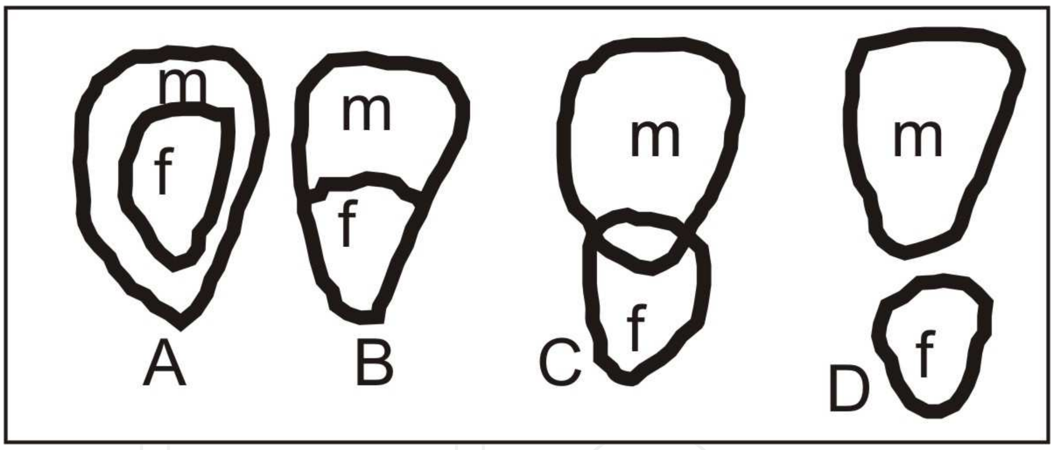
From the above all, we could conclude that the mantle fluid is a ligamerment among deep process, fluid and telescoped mineralization. Referencing to other scholars' views (including Zhu (1998)), we can conclude that generalized mantle fluid process is a synthetic impact for mantle-derived melt, supercritical fluid and the thermal from the melt or the fluid's evolvation. This process can be documented as follows:

1. Mantle metasomatism is defined as a metasomatism which occurs within the mantle accompanying the mantle gas exhaustion. During the formation of enrichmental mantle, alkali magma was formed and the stronger the metasomatism, the more alkali.
2. Mantle fluid metasomatism is defined as a metasomatism in the ascent of fluid from enriched mantle. The mantle fluid could be contained in the alkali-rich magma and

move synchronically. And it is possible to depart from the magma and move independently. In this process, the characteristics of the mantle fluid change from melt→supercritical fluid →liquid, company with the change of depth and environment corresponding with the changes of physical and chemical condition. It could carry, activate and enrich ore-material into suitable place, accelerate the crust-mantle material overprinting mineralization, and be in favor of deep ore-forming and large-super large deposit. Company with the formation of alkali-rich magma, the original mantle evolved from impoverished to enhancement (Liu X F et al., 2006). The process resulted in the enrichment of LILE (large ion lithophile elements), HFSE (high field strength elements) and some ore-elements, and prepared materials base for the mantle fluid metasomatic mineralization.

3. Deep fluid metallization and its relation to magma

Existing studies show that fluid is vital to metallogenesis, especially endogenesis metal deposits (Luo Z H et al., 2007; Mao J W et al., 2005 and Yang L et al., 2001). Yang et al. reckon that deep fluid is what comes from the under-base of basins, including mantle fluid and deep crust fluid, while Luo et al., (2007) recognize the fluid as transmagmtic fluid, in particular to metallogenic fluid, could be independent from magmatic fluid, and classifies the relationship between metallogenic fluid and magmatic fluid in to three kinds (Fig.1).



m-magmatic system; f- metallogenic fluid system (from Luo et al.,2007a)

Fig. 1. Evolution skecth map of transmagmatic fluid metallogenic system

1. If the magmatic system and metallogenic fluid system move synchronically, and cool as rapidly as possible, major of the latter will be preserved in the former , then orthomagmatic deposits are formed inside the magmatic body, constituting an orthomagmatic metallogenic system (Fig.1 A and B) .
2. If the magma emplaces deeply to some extent, the rate of consolidation will be slow. Then the most metallogenic fluid may overflow to contact zones, forming contact deposit and constituting a contact metallogenic system. (Fig.1 C) .
3. If the magma emplaces shallower, as well as the volatile is abundant and circulation conditions are well provided, the metallogenic fluid may escape from the magmatic body, and move along passageway for ore fluid to the space which is in favor of mineral enrichment, such as secondary fractures or rock interface, forming

high→middle→low temperature hydrothermal deposits and constituting a long-distance hydrothermal metallogenic system (Fig.1 D) .

Therefore，magma could be the media to schlep metallogenic fluid ascenting, while deep metallogenic fluid may push magma upward. This is because of that，on the one hand, the fluid dilates the magma and inlarge its bulk with a bigger buoyancy; on the other hand, with the pressure upward, volumetric expansion of fluid makes a push power to the magma.

- Scoates and Michell (2000) take the independent metallogenic fluid system and unmixing magma or fluid injecting into the felsic magma as a kind of deep fluid. However，what this independent metallogenic fluid system is? Magma fluid, crust fluid, thermal fluid or mantle fluid?. Most previous studies are strong in geochemical analysis and theorical derivation, but weak in providing petrographical evidences. It is the complexity of the mantle fluid that makes it hard to learn what its true color is, and then many researches slide over the significance of mantle fluid unintentionally or deliberately and reckon them generally as deep fluid.
- Studies suggest that there are plentiful deep fluid under the Qinghai-Tibet Plateau (Huang W C et al., 2000 and Unsworth M J et al., 2005). The $^3He/^4He$ proved that main body of the Tibet Plateau is influenced by the iacking of the asthenosphere material flow, and the contribution of the mantle fluid can not be ignored; and the Cenozoic magmatism and metallogenesis are both controlled by the Indian- Eurasian continental collision, delamination and large Strike-slip faults. It is obviously that polymetallic mineralization in the Sanjiang- Tethy orogen and mantle fluid are closely related

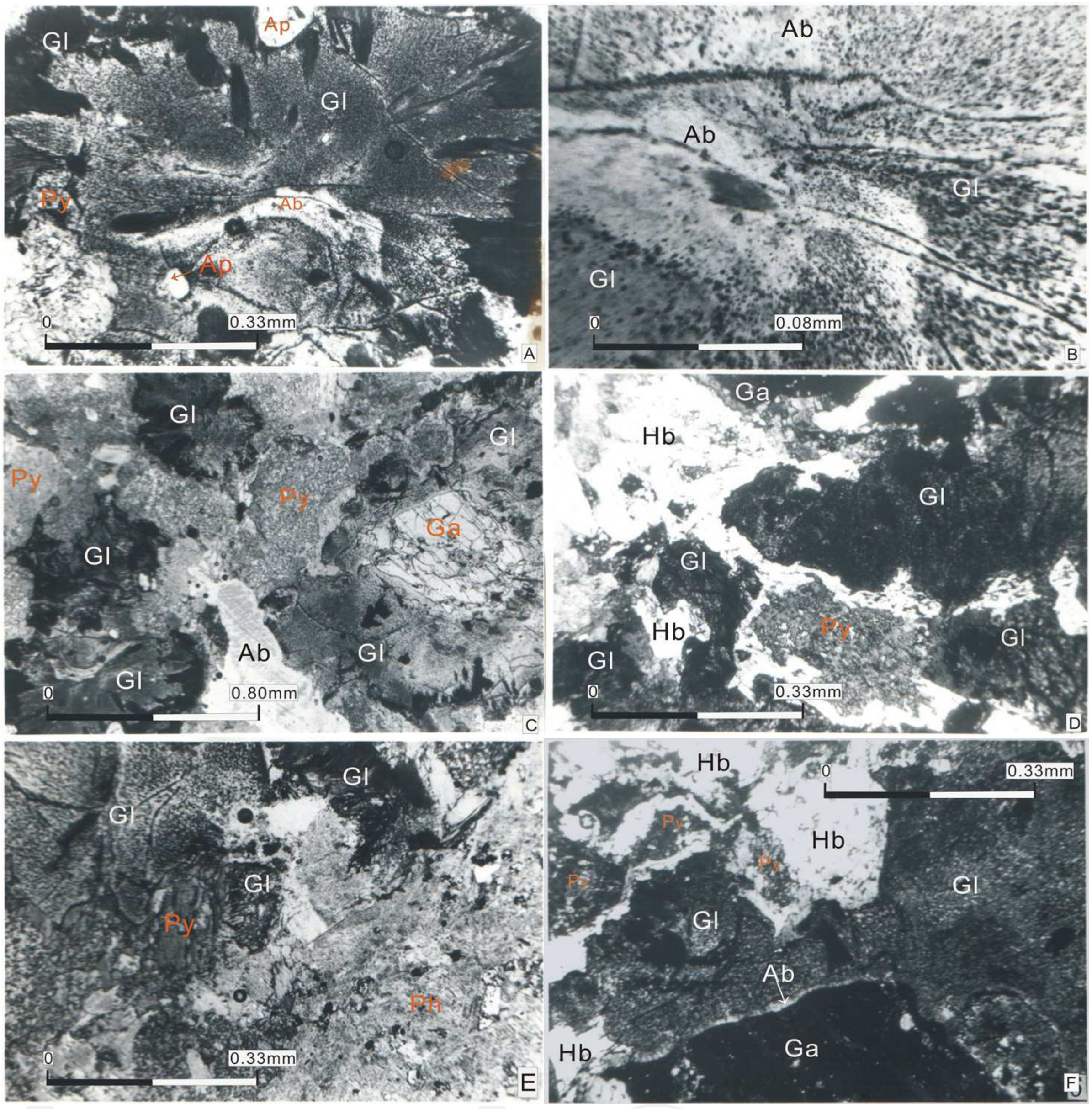
Apparently, alkali-rich prophyries and their deep xenoliths are assumed to have a close relationship to the deep fluid, especially the mantle fluid. Xenoliths are usually classified into two catagories. The one is called accidental inclusion, and the other is congnate xenolith resulting from unmixing process of different magmas or fluids, such as femic magma and felsic magma Physical process of magma or fluid unmixing is expressed as following (Luo Z H et al., 2007).

1. the viscosity of mafic magma is always lower than felsic magma.
2. as temperature reduction during magma migration, viscosity of mafic magma becomes higher than felsic magma due to femic magma crystallization earily.
3. Mafic magma crystallize earlier than felsic magma results in the formation of accidental xenoliths or inclusions, especially when emperature variation is remarkable or felsic magma accounts for a larger proportion.

4. Actual traces of mantle fluid process and its compositions characteristics

4.1 Na-rich microlite-glass in deep mafic xenoliths

A kind of Na-rich glass in the ablitizition garnet-phlogopite pyroxenite from aegerine syenite porphyry was discussed at Liuhe, western Yunnan province. Under the microscope, the Na-rich glasses are shown as microlite and embryonic crystal. Its color changes with the compositions from light gray to light black. Light black microlite glasses appear as arcauate, pitting, linear, and radical or sheet along the margin (Fig.2A-B). Light gray-white microlite glasses penetrate or round the pyroxene and garnet in veins or interpartical infilling of various shapes and sizes(Fig.2C-D). Most margins of white microlite glasses are straight or irregular,



A. In the process of transformation of Na-rich glass into microlite,iron(black),along which an edge was formed irregularly distributed consisting of infinitely small granular microlite-glass.Apatite (Ap)was include in Na-rich glass(Gl). (−)10×4
B. In the process of transformation of Na-rich glass(Gl) into microlite, iron (black) and micro-albite(Ab) (grayish-white) released from Na-glass and highly irregularly distributed in worm-like,ring or more or less oriented fluid patterns.(−)10×16
C. Na-rich glass(Gl) in irregular veinlets in interstics among pyroxene(Py) and garnet(Ga) and albite(Ab).(−)×15
D. Na-rich glass(Gl) in irregular veinlets in interstics between pyroxene(Py) and garnet(Ga); amphiboles(Hb) enclosing pyroxene(Py) and glass veinlets.(+)10×4
E. The veinlet-like Na-rich glass(Gl) in the xenoliths does not extend beyond the contact between the xenoliths and the host rock(Ph) (Aegirinite-augite orthophyre in photograph of below-right –angle). (−)10×4
F. Na-rich glass(Gl) in irregular veinlets in interstices among pyroxene(Py) and garnet(Ga); microlites albite(Ab) in the glass is in a cicular finges around garnet(Ga) (in extinction); Amphibolites(Hb) enclosing pyroxene(Py). (+)10×4.(Note: (+): crossed nicols; (−): plainlight).

Fig. 2. Microscope characters of Na-rich microlite-glass from albitized garnet-mica-pyroxenite

and account for 18% of the total volume of the xenolith, 8% of which has crystallized into albite. Microlite glasses, penetrating the xenoliths in veins, interrupt the contact surface of xenoliths and host rocks (aegerine syenite porphyry) (Fig.2E), indicating that microlite glasses formed before alkali-rich porphyry and after xenoliths. Under the electric microprobe, microlites are mainly acicular rimmed garnets (Fig.2F) or dispersed embryonic albites (Fig.2B.E.F); hornblende appears as the rim of pyroxene and veined glass (Fig.2D,F), and ilmenite, magnetite and rutile are distributed sporadically in black microlite glasses.

The main chemical compositions of Na-rich glass as shown in the table 1, include high SiO_2 (39%-65%), Al_2O_3 (14%-21%), Na_2O (7%-16%) and FeO (2%-23%), with low K_2O(0.1%-1.0%), CaO (1%-5%) and MgO (0.2%-6%). It is anisotropic that light gray glass shows high Si and low Fe (compared among samples),as well as high Ca and low Mg(compared among samples). This is in contrast to the dark gray glass. Further more, from light grayflass to dark gray flass, EMPA total amount increases, indicating that volatility is gradually lost in the involution of Na-rich glass.

- Now, it is believed that there are three possible origins of glass in xenoliths (Girod M et al., 1981 and Jones A P et al., 1983).

1. from the factional melt of basaltic magma.
2. from the escaping melt of rapidly ascending xenoliths (Rong J S et al., 1995)
3. from upper mantle fluid (melt or segregate melt) which injects the alkaline magma derived from enrichment mantle.

From the comparison between table 1 and table 2, we can see there is an obvious difference of chemical composition between the Na-rich glass and basalt, aegerine syenite porphyry，albition garnet anthrophyllite pyrxoxenite, and the host rocks. So, there is hardly a possibility that Na-rich glass derives from the rock-forming minerals of host rocks; in particular to the markable difference from the pyrxoxen, mica and garnet, and a similarity to the albite, especially the light gray Na-rich glass'SiO_2 is lower than albite, while FeO is higher than it. Enrichment of SiO_2 and impoverishment of FeO from the black→dark gray→light color microlite glass→alibite indicates that formation of crystallized albite in garnet-anthrophyllite pyrxoxenite goes with the Si-Fe segregation from the Na-rich glass. At the end of Si, albite crystallized. At the end of Fe, magnetite, ilmenite and rutile crystallized. EMPA shows that segregates and concentrates of TiO_2 going with the one of Fe. From the analysis above, we could conclude that Na-rich glass derives from upper mantle fluid with the natures of melt, volatile-saturated and low solidus temperature before the alkali-magma captures xenoliths. With the transportation of upper-mantle fluid, the rapid changes of temperature and pressure of the environment led to a sharp increase of solidus temperature driving the formation of glass before it has time to crystallize. During this process, material differentiation within the fluid or between the fluid and magma led to the formation of Na-rich glass behaving as high Si, Al, Na, Fe and low K, Ca Mg, Ti. The evolution includes early Na-metasomatism and late K-metasomatism going with the crystallization of albite, results in the formation of rimmed hornblende between the pyroxene and microlite glass (Fig.2D,F). The result indicates the diversity and polystage of the upper-mantle fluid evolution going with the change of the fluid's. chemical compositions. There are differences of chemical compositions of Na-rich glass because of varying areas, bodies and occurrence contrasting to.publicating data (Francis D M et al., 1976, Maaloe S et al., 1979, Girod M et al., 1981, Jones A P et al., 1983, Zheng H F et al., 1987 and Lin C Y et al., 1994)· Generally speaking, magma originating directly from the upper-mantle is alkali-rich, such as Na-rich (Girod M et al., 1981), K-rich or Na-K-rich. Composition of glasses derived from mantle xenoliths depends on melt rocks and minerals, not ensuring high alkali content (Maaloe S et al., 1979 and Zheng H F et al., 1987). High Na content of microlite glasses in the xenolith from Liuhe may be an important sign of mantle origin. Recenty, experiments prove that it is possible that alkali-rich fluid exits in the upper mantle (Schneider M E et al., 1986). Domestic researches on fluid inclusions fron mantle xenoliths also proved that upper mantle metasomatic fluid ia marked by being rich in volatile (H_2O or CO_2) and alkaline(Na_2O or K_2O.)

	color	SiO_2	TiO_2	Al_2O_3	CaO	MgO	MnO	Na_2O	K_2O	Cr_2O_3	FeO	Total
1	white	61.62	0.04	19.89	2.06	0.85	0.05	8.42	0.86	0.01	2.74	96.52
2	white	62.48	0.04	20.77	2.93	1.03	0.10	8.38	0.34	0	1.29	96.82
3	white	59.16	0.02	23.68	1.14	1.69	0.18	9.50	0.96	0	2.12	98.45
4	white	62.96	0.58	17.77	5.20	0.20	0.11	8.13	0.09	0.03	2.42	97.49
5	white	61.92	0.05	18.44	2.11	0.72	0	8.68	0.29	0.02	3.15	95.37
6	white	60.85	0.09	19.31	3.87	1.95	0.08	7.53	0.47	0	3.78	97.93
7	darkgray	47.88	0.79	17.96	5.08	0.39	0.04	16.39	0.14	0.06	7.04	95.76
8	darkgray	57.11	0.02	20.71	1.21	0.33	0.01	13.61	0.20	0.01	2.64	95.85
9	darkgray	65.35	0.23	18.16	2.57	0	0.15	8.42	0.20	0	3.37	98.45
10	darkgray	59.74	0.42	19.78	2.98	0.39	0	9.76	0.07	0.03	6.75	99.96
11	darkgray	62.62	0.18	18.85	2.79	1.57	0.13	8.79	0.38	0.02	3.43	98.76
12	black	38.84	0.10	13.96	5.49	6.65	0.29	10.23	0.49	0	23.19	99.24
13	black	48.68	0.18	17.85	4.66	5.51	0	6.59	0.53	0.04	13.91	97.95
14	black	51.51	0.08	15.69	1.00	1.77	0	9.53	1.23	0.02	18.04	98.86
15	black	49.74	0.13	14.86	2.15	3.32	0.12	8.15	1.16	0	19.61	99.24
16	black	46.82	0.16	17.23	2.87	3.53	0.22	8.82	1.91	0.07	18.15	99.78

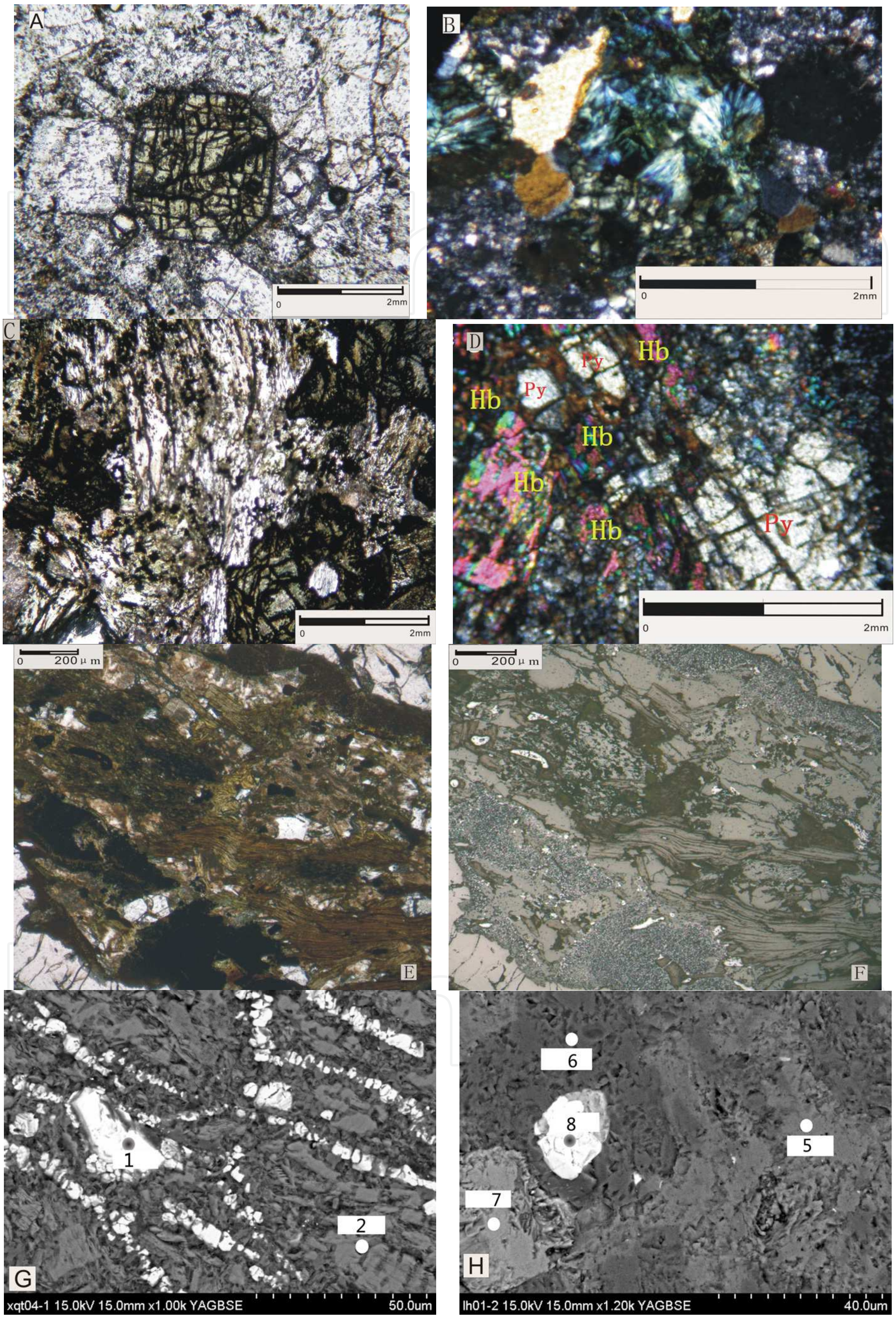
Table 1. Chemical composition of the Na-rich glass in deep xenoliths from Liuhe (ω_B/%)

Rocks	Mineral	SiO_2	TiO_2	Al_2O_3	CaO	MgO	MnO	Na_2O	K_2O	FeO	Fe_2O_3	Total
Aegirine orthophyre	bulk	58.04	0.62	16.39	4.50	2.20	0.10	3.53	5.30	2.01	2.59	95.28(a)
Basalt (Yunnan)	bulk	52.74	1.73	12.22	7.36	5.47	-	2.84	1.63	11.99	4.27	100.25
Albitization garnet phlogopite pyroenite (xenolith)	bulk	43.13	2.13	15.90	10.80	5.50	0.35	2.42	0.97	9.17	5.43	95.80(a)
	(5) pyroxene	51.13	0.32	2.04	24.10	12.32	0.12	0.58	0.03	9.59		100.24
	(3) phlogopite	34.65	3.62	15.80	0.06	15.86	0.26	0.70	8.69	15.62		95.26(a)
	(2) garnet	38.28	0.16	20.89	8.36	5.48	2.38	0.09	0.01	24.19		99.84
	(4) albite	66.80	0.01	20.19	0.93	0.02	0.04	11.53	0.12	0.21		99.85

Table 2. Chemical composition of host rock and rock-forming mineral in xenoliths

4.2 Alkali-rich porphyry and Fe-rich glass in xenoliths

Petrographic studies show that Fe-rich glasses inject, penetrate or envelope the minerals along the intergranular or cleavage crack (Fig.3A-D). Those opaque materials under transmitted microscope were simply treated as charcoal, ferrum or dissemination of metallic minerals. EMPA, scanning electron microscope and energy spectrum studies affirm this kind of Fe-rich glasses being made up of nonmetal minerals such as microlite silicate and



A. Egyrinaugite in the aegirine syenite porphyry from Jinhe intrusive body,with cleavage cracks of aegirine full of Fe-rich glass (—).

B. Egyrinaugite in the aegirine syenite porphyry from Xiaoqiaotou intrusive body,with partly developed chloritization and silicatization,Fe-rich glass are found all over the phenocrysts and quasi-matrix. (+)
C. Hornblende in xenoliths from Xioaqiaotou intrusive body is replaced by epidote and chlorite or uralite,Fe-rich glass are of reticulate or star-spot distribution. (—)
D. Amphibole(Hb) replacing pyroxene(Py),and Fe-rich glass existent as disseminated replacement in xenoliths from Jinhe intrusive body. (+)
E. (Plainlight under transmission condition) and
F. (Plainlight under reflex condition), twain maps'field of view is same. F. Wrapped margin of Fe-rich glass at garnet(Ga)from xenoliths in Liuhe aegirine syenite porphyries,and biolte,especially homblende is replaced dissenminately by Fe-rich glass.The phenomena of disport dissolve(or: differentiation by liquation)between metal and nonmetal is expressed by plainlight under reflex condition in Fe-rich glass. G. Specularite(white) and silicate(dimgrey) unmixing intergrowth texture in Fe-rich glass from Xioaqiao xenoliths is expressed by back scattered electrons,graph of SEM.H. Specularite(white)and quatz and silicate(dimgrey) unmixing intergrowth texture in Fe-rich glass from Liuhe xenoliths is expressed by back scattered electrons graph of SEM (Scanning Electronic Microscpoy). (Label point at Fig.G and Fig.H are corresponding with the data of Table4)

Fig. 3. Microscope characteristics of Fe-rich glass in the alkali-rich porphyries and xenoliths from western Yunnan

quartz. The phenomena of liquating or unmixing intercrescence texture (Fig.3E, F) for fine metal metariel in disseminatedly and microlite nonmetal mineral were observed (under the condition of high-power reflected lightof polarizing microscope) . In the Fe-rich glasses, especially, we found mantle typomorphic minerals，such as moissanite, native iron, ilmenite , titanium iron glance et al., and exceed microlite liquating or unmixing intercrescence texture (Fig.3G and H, table3 and 4) to be made up of mantle typomorphic minerals and rock-forming minerals-silicate and quartz.

We could get the characteristics and rules from Figure 4, table 3 and table 4:

1. Figure.3A-F exhibit the basic matter phases and characters for rock-forming minerals and Fe-rich glasses penetrating the alkali-rich porphyry and xenoliths. Fluid metasomatism (alteration) between the host rocks and xenoliths held a close association with the Fe-rich glasses. The metasomatic alteration expressed as a retrograde reaction in order of pyroxeney→amphibole→biotite→chlorite,at the same time resulting in siliconizing. Therefore, the Fe-rich glasses were an important power and material provider to the alteration of alkali-rich porphyry and xenoliths.
2. Figure.3G and H represent two different parts for Fe-rich glasses under the scanning electric microscope back distribution scatter, the white part constitution of microlite minerals of heavy elements while the black part of the less heavy elements. Their compositions are determinedby the electric microprobe and energy spectrum(table 3 and 4), the white part is various compositions metallic mineral microlite , and the black part is nonmetal microlite, such as silicate and quartz. So the Fe-rich glasses, as black opaque material under transmitted microscope, is a microlite solid..ts composition is mainly of nonmetallic minerals-silicate and quartz, and contains some special metallic minerals.
3. What should be give great attention is the date of measuring point 5,9 and 10 in table 3.Total weight of some mineral in Fe-rich glass of alteration pyroxenite xenoliths is obviously over 100%. The existence of dominating element compound.SiO_2 is

Point	lkali-rich porphyr	Xenoliths	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	Cr_2O_3	Total	Mineral
1	Xiaoqiaotou	alteration amphibolite	33.81	0.20	21.95	14.29	0.39	14.30	0.03	0.16	9.78	0.03	94.59	alike biotite
2		banded migmatite	63.19	0.02	20.59	0.37	0.02	0.09	4.29	9.20	0.64	0.02	98.43	alike albite
3		alteration biotite garnet gabbro	55.26	0.04	26.88	0.90	0.02	0.02	9.63	5.95	0.26	0.01	98.96	alike labradorite
4		alteration biotite garnet gabbro	50.21	0.07	3.05	23.59	0.44	22.66	0.32	0.06	-	0.29	100.68	hypersthene
5		amphibolization gabbro	156.36	0.004	0.19	0.39	0.02	0.04	0.15	0.02	0.01	0.01	157.19	moissanite
			SiC：			Si-73.13,		C-31.23					104.36	
6	Jinhe	alteration biotite pyroxenite	37.97	3.38	12.92	6.03	0.04	21.90	0.01	0.43	12.94	1.01	96.63	magnesian biotite
7		alteration biotite gabbro	91.89	0.05	4.16	0.13	0.00	0.05	0.23	1.26	2.25	-	100.02	quartz
8		alteration biotite gabbro	51.31	0.34	1.50	8.64	0.52	14.42	22.13	0.78	0.01	0.01	99.66	clinopyroxene
9		alteration biotite pyroxenite	1.05	0.05	0.10	99.97	0.96	0.02	0.11	-	0.26	27.86	130.38	hromium-bearing ferrit
		Fe、Cr				77.71						19.06	96.77	
10		alteration biotite pyroxenite	3.80	0.17	0.78	87.07	0.70	0.16	0.49	0.08	1.25	24.47	118.97	hromium-bearing ferrit
		Fe、Cr				67.68						16.74	84.42	
11		alteration biotite gabbro	0.27	9.77	1.18	81.41	0.52	0.85	-	0.02	-	0.21	94.23	titaniferous specularite
		Fe_2O_3		9.77		90.48							100.25	
12		alteration peridot gabbro	0.03	4.99	0.57	81.63	1.05	2.15	-	0.03	0.01	0.17	90.63	titaniferous specularite
		Fe_2O_3		4.99		90.72							95.71	
13	Liuhe	alteration diabase	59.83	0.03	23.81	0.64	-	0.06	4.87	10.03	0.38	0.02	99.68	alike albite
14		alteration garnet bistagite	39.45	0.09	9.84	30.06	0.20	12.42	0.84	0.36	0.38	0.05	93.69	alike chlorite
15		alteration biotitepyroxenite	54.19	0.17	4.53	2.47	0.03	13.82	15.91	2.24	0.12	0.24	93.71	alike amphibole
16		alteration garnet bistagite	0.01	78.96	0.11	18.71	0.10	1.65	0.05	-	0.03	0.06	99.65	ilmenite

Table 3. EMA of Fe-rich glass in deep xenoliths from alkali-rich porphyries

Point	Alkali-rich porphyry	Xenolith	Si	Al	Fe	Mg	Ca	Na	K	O	Total	Mineral	Note
1	Xiaoqiaotou	alteration amphibolite			65.09					34.91	100	specularite	Corresponding to Fig.4G
2		alteration amphibolite	16.52	10.55	9.05	7.85			6.80	49.23	100	alike biotite	Corresponding to Fig.4G
3	Jinhe	alteration biotite pyroxenite		3.53	53.51	2.55				40.40	99.99	specularite	
4		alteration biotite pyroxenite	23.16	13.50			6.52	4.22		52.60	100	alike plagioclase	
5	Liuhe	alteration garnet pyroxenite	29.26	9.19					12.47	49.08	100	K-feldsparoid	Corresponding to Fig.4H
6		alteration garnet pyroxenite	44.61							55.39	100	Quartz	
7		alteration garnet pyroxenite	23.93	1.12	7.44	6.13	14.18	0.98		46.22	100	alike amphibole	
8		alteration garnet pyroxenite			70.26					29.74	100	specularite	

Table 4. Energy spectrum analyses of Fe-rich glass in deep xenoliths from alkali-rich porphyry and zircon. All of these further prove that Fe-rich melt xenoliths are of mantle characteristics.

expressed as measuring point 5 in table3, other compositions content to neglect. The result suggests principal part of silicon, which atom mass fraction at 73.13%, in the matter. Apparently, the matter could not be simple substance silicon but exist undetected missing material. Based on the most common simple silicide under deep circumstance, we may presum the missing material to be C. By the way of calculating the proportion of SiC, we get that C atom mass fraction at 31.23%, and both (Si and C) total weight percentage at 104.36%. The data is near to the standard total weight percentage (100%). Therefore, microlite mineral of measuring point 5 should be carborundum .Microlite mineral of measuring point 9 and 10 in table3 may be Fe-Cr alloy or chrome native iron. By conversion, we get the each weight percentage of atomic iron (77.71% and 67.08%) and corresponding weight percentage of atomic chrome(19.06% and 16.74%). Hereby, corresponding total weight percentage (96.7% and 84.42%) is near to the standard total weight. Due to atomic weight similarities of Fe and Cr, iron-chrome alloy could not match the data above. Therefore, microlite mineral of measuring point 9 and 10 should be chrome-bearing native iron. Chrome is isomorphism element in native iron.

4. as shown data of measuring point 11 and 12 in table 3, there are still titanium iron-oxide in Fe-rich glass. FeO conversion of according to Fe_2O_3 based on weight percentage of atom, we get the total weight percentage of Fe_2O_3 and TiO_2 reaches almost 100%. So the microlite mineral should be titanium-bearing specularite. Titanium is isomorphism element in specularite. Standard ilmenite (point 16 in table 3) is detected in alteration garnet diopsidite in Liuhe rock-body, referring to the existence of chrome native iron and titanium specularite, we could conclude that Fe and Ti behave in different ways as special metal mineral in Fe-rich glass.
5. Although the data in table 4 are only semiquantitative, composition species and data characteristics are corresponding to data of table 3. So total weight percentage obvious deficiency of measuring point1,6,14 and 15 in table 3, which reason is that hydrogen couldn't be detected by EMA, is proved that there is no key or important composition missing.

The reason of total weight deficiency of measuring point 11 and 12 is mass fraction vacancy caused by treating actual Fe_2O_3 as FeO. The reason of total weight overfillment of measuring point 9 and 10 is treating actual iron-chrome element compound as oxide.

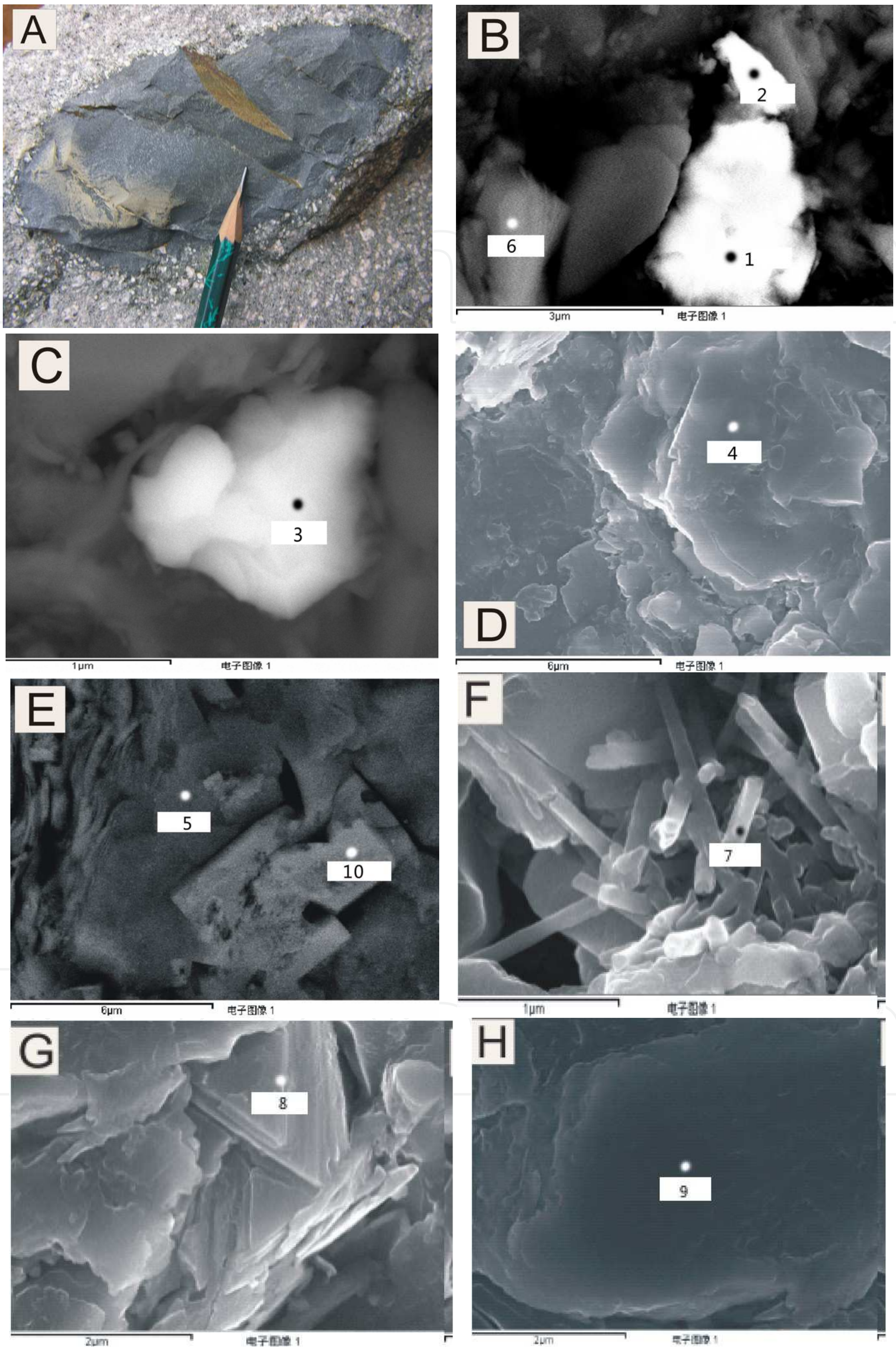
6. From Figure.3G-H and table 3 and 4, we could draw such a conclusion that the light gray part of Fe-rich glass are constitutes of metal microlite minerals of Fe, Cr and Ti in various status, while the dark black part is of nonmetal microlite minerals, such as silicate, quartz and moissanite. The two partsformed unmixing texture. From the above, we recognize that Fe-rich glass is a microlite solid to be mainly constituted of nonmetal minerals---silicate, quartz and so on, liquating some mantle typomorphic mineral, such as native iron, ilmenite, titanium-specularite and moissanite and so on.

4.3 Fe-rich melt xenolith in alkali-rich porphyry

Recently, a special xenolith was discussed in the Liuhe aegirine syenite porphyry. As exhibited in Fig.4A, the xenolith, in long-ellipse shapes with a longest radius of 14cm and a shortest radius of 6cm, has a clear contact boundary with the host rocks without an roasted or chilled border - only a narrow contaminated transition zone is observed under the magnifying glass. The black xenolith is of microlite-cryptocrystal texture and compact block structure. Owing to its very fine particles, there is hardly any optical character under ransmission and reflection microscope. The petrography character suggests that this special xenolith is a microlite-crypocrystal Fe-rich melt xenolith with some special compositions and natures other than common olcanic glass.

Preliminary study is documented as follows:

1. As shown in table 5, the domain compositions are SiO2, FeO and Al2O3, and SiO2 content for as high as 57%, while CaO and MgO content are low. Thinking about silicon isotope for the xenolith. $\delta^{30}Si=-0.8$ (this paper data), we could conclude that compositions and origin of Fe-rich melt xenoliths have a certain connection with mantle.
2. As shown in table 5 and 6, besides domain mineral assemblage---silicate and quartz, there are still special mantle typomorphic minerals---moissanite and iron---as well as accessory minerals to be formed in mantle, such as apatite
3. Analysis of moissanite in table 5 is similar to that of Fe-rich glass in Xiaoqiaotou rock body. As with the microlite iron in table 6, data of measuring point 1 is nearest to the standard one. The matter cannot be ferrous silicate with ferrous content for 84.02% and little Si, Al and O. Comparing figure .4B and C with measuring point 2 and 3 in table 6 indicates that the increase ($15.95 \rightarrow 32.75$) of Si, Al and O corresponding to the decrease ($2.50\mu m \rightarrow 0.63\mu m$) of microlite iron diameter. Therefore, we regard the reason for Si, Al and O increasing, as well as emergence of Mg as touched microlite silicate, which encircled the iron, increase by ray spot., There is no doubt that the microlite of measuring point 1-3 is iron.
4. Fe-rich microlite rodshaped-sheet silicates (Figure 4F-G) corresponding to measuring point 7 and 8 in table 6, which do not have similarity to any known common silicate, suggest that there is more Fe-rich silicate, which formed in the mantle, in Fe-rich melt xenolith.
5. Mineral chemical compositions and species are identical to the bulk-rock analysis of Fe-rich melt xenolith. The conformity indicates that domain minerals, which detected by electric microprobes and the energy spectrum, could represent basic mineral characteristics of Fe-rich melt xenolith. While iron and moissanite are opaque minerals, the others (including Fe-rich silicate) are transparent minerals, those content are much more than opaque minerals. The phenomenon of its black color, opaque and no optic property is caused by its exceed microlite property of particles diameter ranging from 1-6(μm).
6. As shown in figure 5, identify icon of X-ray crystal powder diffraction for Fe-rich melt xenolith shows that there are still many exceed microlite-amorphous material, which could not cause X-ray to diffract, besides quartz, clinochlore, illite and albite. The icon further confirmed the result of electric microprobe and energy spectrum analyse. Why are not there the mantle typomorphic minerals in the icon? two reasons as following:The mantle typomorphic minerals are few and dispersed, and they are exceed microlite or amorphous. The xenolith is electric-microscope grade microlite Fe-rich silicate melt solid.



A. Fe-rich melt xenoliths in aegirine syenite porphyry (photograph of hand specimen from Hedong hamlet,Liuhe village,Heqing county,Yunnan Provice); B. The iron (points 1 and 2) and chlorite (point 6) in the Fe-rich melt xenolith; C.The iron (point 3) in the Fe-rich melt xenolith; D.Microcrystalline quatz (point 4) in the Fe-rich melt xenolith; E.Chlorite (point 5) and apatite (point 10) in the Fe-rich melt xenolith; F. Columnar iron-rich silicate mineral (point 7) in the Fe-rich melt xenolith; G. Sheet-shaped iron-rich silicate mineral (point 8) in the Fe-rich melt xenolith; H.Microcrystalline zircon (point 9) in the Fe-rich melt xenolith.

Fig. 4. Characteristics of hand specimen and its composition of micro-minerals for Fe-rich melt xenolith

Point	SiO_2	Al_2O_3	FeO	Fe_2O_3	Na_2O	K_2O	MgO	CaO	TiO_2	Cr_2O_3	MnO	CO_2	SO_2	H_2O^+	H_2O^-	Total	Mineral
	57.04	11.58	13.81	4.53	0.08	0.14	3.66	1.43	0.46	SO_2 0.01	P_2O_5 1.38			5.63		99.75	whole rock
	57.44	11.38	11.65	4.31	0.08	0.24	3.24	2.83	0.23	P_2O_5 2.25	0.06	0.98	0.13	5.13	0.72	100.67	
1	164.08	0.10	0.47		—	0.02	0.02	0.04	0.04	-	0.04					164.79	moissanite
	SiC：Si-76.73；C-30.77；															106.50	
2	150.50	1.44	1.72		0.13	0.16	0.20	0.46	0.04	0.02	0.04					154.70	
	SiC：Si-70.37；C-30.05；															100.42	
3	83.38	4.96	0.06		0.06	0.16	1.53	1.07	0.04	-	0.05					97.31	microlite quartz
4	30.88	18.22	31.10		0.04		5.31	0.60	0.03	0.03	0.04					86.25	microlite chlorite
5	27.56	25.45	32.12		0.03	0.02	7.72	0.22	0.03	0.10	0.01					93.26	microlite chlorite

Table 5. Whole-rock chemical composition and electron microprobe analyses (EMPA) of micro-minerals in the Fe-rich melt xenolith

Piont	Si	Al	Fe	Mg	Ca	P	O	Total	Mimeral
1	4.95	2.07	84.02				8.97	100	iron (Fig.5B)
2	8.76	5.16	67.22	1.59			17.27	100	iron (Fig.5B)
3	13.36	0.92	74.96				10.76	100	iron (Fig.5C)
4	40.66			Br 1.50			57.84	100	microlite quartz (Fig.5D)
5	13.29	10.55	17.33	5.46	Ti 1.62		51.75	100	microlite chlorite (Fig.5E)
6	14.91	8.78	16.61	3.31	0.86	0.80	54.74	100	microlite chlorite (Fig.5B)
7	30.43	11.81	23.85				33.91	100	Fe-rich columnar silicate (Fig.5F)
8	17.81	10.16	30.74	3.61	1.25		36.43	100	Fe-rich sheet silicate (Fig.5G)
9	15.75			Zr 53.43			30.84	100	zircon (Fig.5H)
10			1.16	F 4.65	35.32	19.83	39.03	100	apatite (Fig.5E)

Table 6. Energy spectral analyses of minerals in the Fe-rich melt xenolith

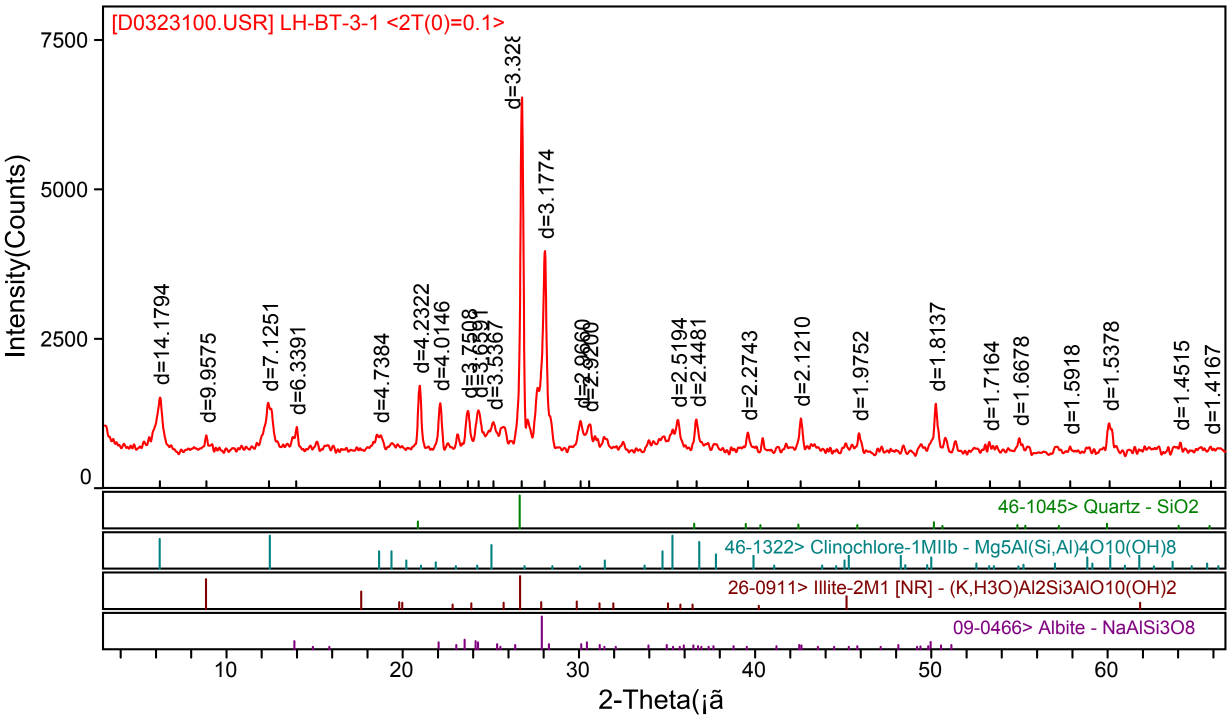


Fig. 5. Checkup icon of X-ray crystal power diffraction for the Fe-rich melt xenolith

5. Geological significances of the mantle fluid actual microcosmic traces

As discussed above, microcosmic traces and existing modality of the mantle fluid from alkali-rich porphyry and xenoliths can be directly manifested as following：

1. Na-rich glasses, which appear as microlite and embryonic crystal under optical microscope, interpenetrated and altered, nervatedly and disseminatedly, in garnet-mica-pyroxenite. The glass has the characteristics of colour change with its composition variation, high Si, Al, Na and Fe, low K, Ca, and Mg, and the assemblage of albite, amphibole, magnetite(specularite) and ilmenite. The microlite glass is an upper mantle fluid that was formed before alkali-rich magma caught it.
2. Fe-rich glasses interpenetrated and altered, nervatedly, agglomeratedly and disseminatedly, host rocks and various xenoliths.
3. Black microcrystalline iron-rich melt xenoliths as a special independence in aegirine syenite porphyry.

Both matters of (2) and (3), as black opaque materials, are of submicroscopic crystalline texture under the electron microscope, but almost no optical properties (transmitted and reflected light). Their chemical compositions are expressed as high Si, Al and Fe, low Ca, Mg, Na and K. Their main mineral compositions are silicate and quartz, as well as moissanite, native iron with chromium, specularite with titanium, ilmenite and apatite et al. The unmixing texture, which is assumed by immixing of minerals between micro-metal and nonmetal, indicates the mantle fluid's melt property and immixing with alkali-rich magma. Widely developed alteration, such as amphibolization, silification and chloritization et.al., and corresponding retrograde reaction in order of pyroxeney→amphibole→biotite→chlorite resulted in the mantle fluid disseminating and replacing the host rocks and xenoliths. Na-rich glass, which was characterized by microlite-embryonic-crystal, originates from upper-mantle fluid before being captured by alkali-rich magma. However, what fluid property was expressed by the Fe-rich glasses and Fe-rich melt xenolith?

5.1 Solid for crystallize ? Cryptocrystalline? Submicrolite ? Or amorphous ?

It is well known that these are possible materials appearing as black-opaque under the transmitted microscope----black glass, char matter, metal mineral or crystallized minerals smaller than 10μm. As detected by an electron scanning microscope, electric microprobe and energy spectrum, as well as being exhibited in a background-scattering electron photograph(Fig 4G and H and 5B-H), the domain mineral of Fe-rich melt xenoliths is silicate, with some quartz, metal minerals and mantle typomorphic minerals. The majority of the minerals are smaller than 10μm., most of which are 5μm and of a crystal shape. Therefore it cannot be black glass or char matter.

5.2 Melt fluid or thermal fluid?

As mention above, Fe-rich melt glass is found in host rocks and deep xenoliths as veins, net-veined, scattering dissemination and lump. The characters themselves are results of fluid process，but differ to general hydrothermal fluid:

1. The domain mineral of Fe-rich glass is silicate, together with some quartz metal and minerals, and mantle typomorphic minerals. The mineral assemblage is different from the composition of hot brine.
2. Crystallized minerals are reconstructed by hydrothermal fluid to form new crystallized minerals through solid-solid direct metasomatism, except for cryptocrystal or amorphous solids. So the matter facies of cryptocrystal- amorphous were formed in the rapid cooling process of melt fluid.
3. Differentiation by liquation structures among the metal minerals and silicate minerals are exhibited in Fig.4G, and H, Fig.5B and C.The characters are similar to Bea et al., (2001) study suggesting the compositional unmixing structure developed in alkali magma during the rapid cooling process.

According to the discussion above, we could conclude that Fe-rich glass is a kind of crytocrystal-amorphous solid forming in the metasomatic process of mantle fluid in host rock and xenoliths going with the changes of temperature and pressure, resulting in a decrease of volatility and increase of solidus temperature. Pertofacies and compositions of Fe-rich melt xenolith are similar to those of Fe-rich glass.

5.3 Mantle fluid or magmatic fluid?

Generally speaking, magmatic fluid is regarded s a recapitulate for magma and postmagmatic thermal fluid. Magma has the ability to self-crystallize, while postmagmatic thermal fluid derives from magmatic fractional crystallization. The melt fluid defined in this paper approaches the basic properties of mantle fluid, evidence as following:

1. Nowadays, one is inclined to think that mantle fluid is a kind of high temperature and density supercritical alkali-rich silicate melt. The melt can concentrate rarity gas elements(^3He , ^{36}Ar) and volatiles (mantle CO_2, meteorite sulfur, deep H_2O) in inner-

earth and dissolve and carry a great lot of major, trace amount and metal element (Cao R L et al., 1995, Liu C Q et al., 2004, Sun F Y et al., 1995 and Shmulovich K I et al., 1995). Schrauder's experiment (1994) suggests that mantle fluid, as a kind of media, could be a melt (carbonate melt) or H_2O-rich fluid of great diversity. Therefore, mantle fluid metasomatism has a close connection with mantle magmatism. Aegirine syenite porphyry is the product (Deng W M et al., 1998, Liu X F et al., 2009 and Yu X H et al., 2006) of alkali-rich magma derived from enrichment mantle. Ascending alkali-rich magma captures mantle fluid，which has melt property and is unmixing with magma, or xenoliths. The mantle fluid replaced or disseminated host rocks and xenoliths in the diagenetic stage of alkali-rich magma.

2. Moissanite, Cr-native iron and Ti-specularite are detected in Fe-rich glass and Fe-rich melt xenoliths(Table3,4,5,6 and Fig.3G and H, Fig.4B and C). The three minerals are reckoned as typical mantle typomorphic mineral, demonstrating as following:

a. Moissanite occuring mainly in kimberlite and lamproite, especially in podiform chromites in serpentine, has a close genetic relation with diamond; more importantly, Bai, et al., (2001,2004) discovered fine mantle mineral inclusions, such as native silica, calc-aluminosilicate, and accrete alloy Fe_3Si_7 as interlocking crystals in moissanite. Yajima, et al., (1998) compound β-moissanite and α-moissanite at 1500℃ and 2400℃ respectively. Taking pressure related to the temperature and geothermal gradient into account, moissanite's forming depth was at least as upper-mantle. Therefore, moissanite could be treated as mantle typomporphic mineral.

b. Native iron was first discovered in diamond inclusion, and then in kimberlite at the North China Platform. It is acknowledged that native iron forms in a deacidizing environment. Addition chrome as a mantle typomorphic element, Cr-bearing native iron could be treated as mantle typomorphic mineral. In accordance with the Si-Fe binary phasor, Zhao, et al., (1993) suggests that the crystalline temperature of native iron in kimberlite is 1528℃. If the Si-Fe binary diagram could be applied to Fe-rich melt xenoliths, taking Zhang's experiment phasor (1981) of girdle orthoclase from alkali rock in Western Yunnan into account, the crystallizing temperature of native iron in Fe-rich glass and Fe-rich melt xenoliths is higher than the diagenetic temperature of aegirine syenite porphyry. The characters suggest that it is time for the alkaline magma crystallizd,volatiles abruptly lost in the alkali magma diagenetic stage and lead to a solidus temperature correspondence increase of Fe-rich silicate melt. Under this circumstance, going with mantle melt fluid disseminating and replacing host rock and xenoliths, electric microscope-grade microlite solids were formed.

c. Although specularite, which may origin from alike micaceous hematite to be formed in metamorphic process, is an iron-oxidization, it could mostly origin from the transform of relative deacidizing magnetite to be formed in the endogenic hydrothermal fluid process. The fact for symbiosis in both of Ti-specularite and Cr-native iron indicates that Ti-specularite is an evolvement product of Ti-magnetite going with mantle fluid changes from deacidizing to oxidation. Previous studies show that magnetite forms in an endogenic-deoxidize environment. Addition, Ti as a mantle element, it is reasonable to conclude that Ti-magnetite (specularite) is a mantle typomorphic mineral. Zircon and apatite (measuring point 9 in Fig 5H and measuring point 10 in Fig5E) in clear crystal form are detected, as well as ilmenite and rutile, The four accessory minerals are commonly considered deriving from mantle.

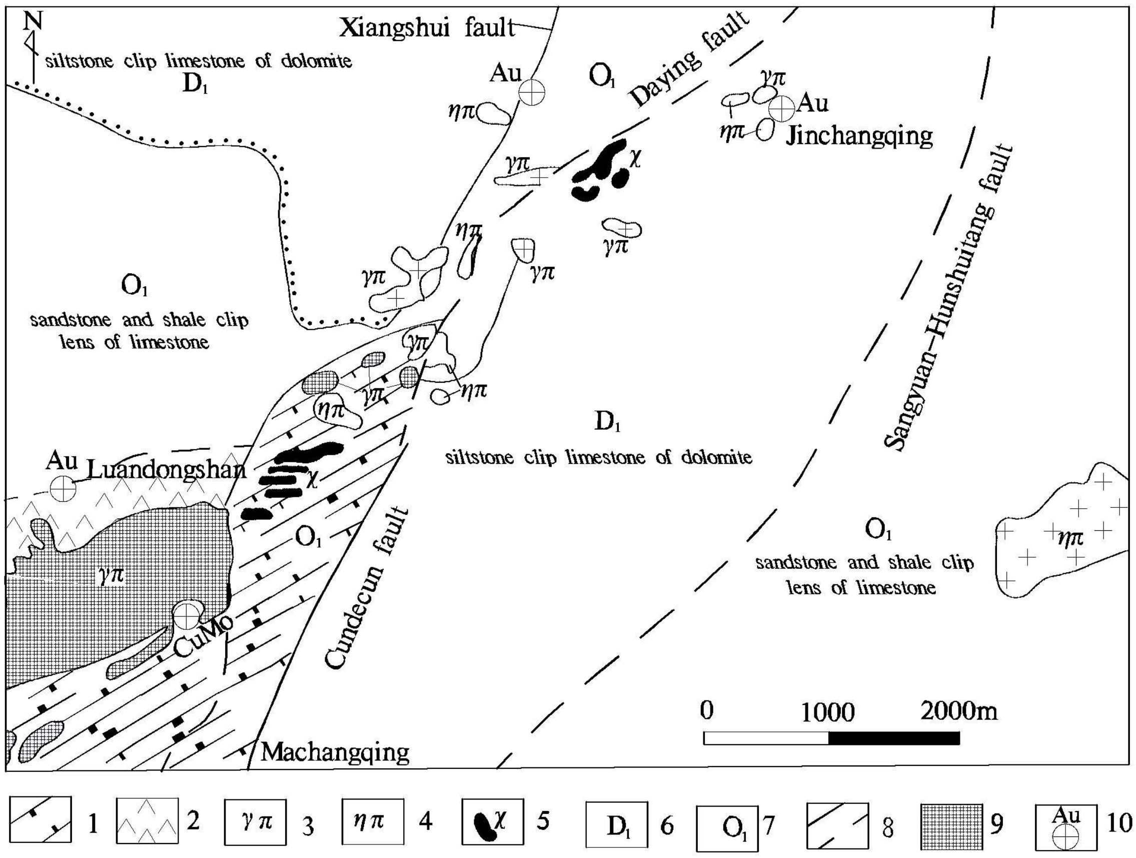
Based on the discussion above, we can conclude that compositions of Fe-rich glass penetrating host rock and xenoliths as vein and disseminated stockwork are almost identical to independent Fe-rich melt xenoliths. Both (Fe-rich glass and Fe-rich melt xenoliths) of them are electronic microscope-grade cryptocrystalline-sunmicrolite- amorphous solid derived from mantle melt and supercritical fluid. The mantle fluid was captured and moved synchronously by alkali-rich magma, at one time disseminated and replaced host rock and xenoliths going with volatile loss and alkali-rich magma diagenesis. This kind of cryptocrystalline-sunmicrolite- amorphous solid is an important microcosmic modality of mantle fluid which causes silication, kalium matter alter, albitization and retrograde reaction of dark minerals, as well as in favor of various mineralizations.

6. Metallogenic significance of mantle fluid metasomatism

Many studies suggest that large-scale fluid migration is necessary for mineralization, since there are wide and intensive wall-rock alterations in endogenic metal ores. Therefore, it is of great importance to study the properties, origins, effects and migration of fluid, as well as reasons and spaces for metallogenic elements sink (Luo Z H et al., 2007).

It is well known that the polymetal deposits in Western Yunnan have a close relation with alkali-rich porphyry. Preliminary studies show the intrinsical unified mechanism is an effective combination of mantle fluid metasomatism, deep faults transporting and controlling metallogenic elements, and sub-faults and wall-rock or strata as a host space. The mechanism is represented as the effect of series metallogenesis in western Yunnan (Liu X F et al., 2002).

Both alkali-rich magma and mantle fluid, which is shown as three microcosmic modalities, coexist and migrate together, but unmixed because of the differences of composition and properties. On the basis of synthesis analyses in combination with theory of metallogenesis by transmagmatic fluid, the following conclusions are drawed: the alkali-rich porphyries were synchronically self-replaced and alterated by the mantle fluid accompanying the process of alakali-rich magma crystallizing while the fluid and magma was trapped well, and the otrthomagmatic deposit was formed in the magma body or its depths,and the typical deposit of otrthomagmatic metallogenic system is Machangqing porphyry Mo-deposit; that if perturbation of tectonization happened in the process of diagenesis and metallogeneis, the mantle fulid would enter into the contact zone between magma bodies and wall rocks or strata next to the contact zone, and replacing and alterating took place to form the contact-metasomatic system, and the typical deposit of the contact-metasomatic metallogenic system is Machangqing porphyry Cu-deposit in skarn-marble zone, and porphyry Au-deposit mainly in atrsta rocks; if the Au-deposit exists in a porphyry body, it is commonly controlled by the fractures after diagenesis; if the deep fractures, as magma and fluid channels, are well developed, and the environment is relatively open, the ore-bearing mantle fluid will flow far from alkali-rich magma along branch fractures and enter into different strata and rocks, and the replacing and alterating occurred along with diagenesis process, and the typical deposit of epithermal metallogenic system is Lanping Jinding supper-large Pb-Zn deposit. In this process, the mantle fluid's properties were changed from magma→supercritical fluid→liquid by the changes of depth and environment, and corresponding to the changes of physical and chemical conditions, and the moving fluid carried, activated and enriched ore-material at suitable places; It is the deep process and the action of fluid that accelerated crust-mantle materials overlapping, facilitated the deep ore-forming and benefited the formation of large and supper-large deposits.



1. skarn-marble zone; 2.horn zone; 3.granite porphyry; 4.monogranite porphyry; 5.lamprophyre; 6. siltstone clip limestone of dolomite quality from lower Devonian series;7.fleet turn sandstone and shale clip lens of limestone from lower Ordovician series;8.fault or inferred fault;9.high-grade Mo-Cu orebody in granite porphyry;10.site and type of ore deposits.

Fig. 6. Sketch geological map of Machangqing Mo-Cu-Au deposits area (base map from gold unit thirteenth detachment,brief simplification and modification)

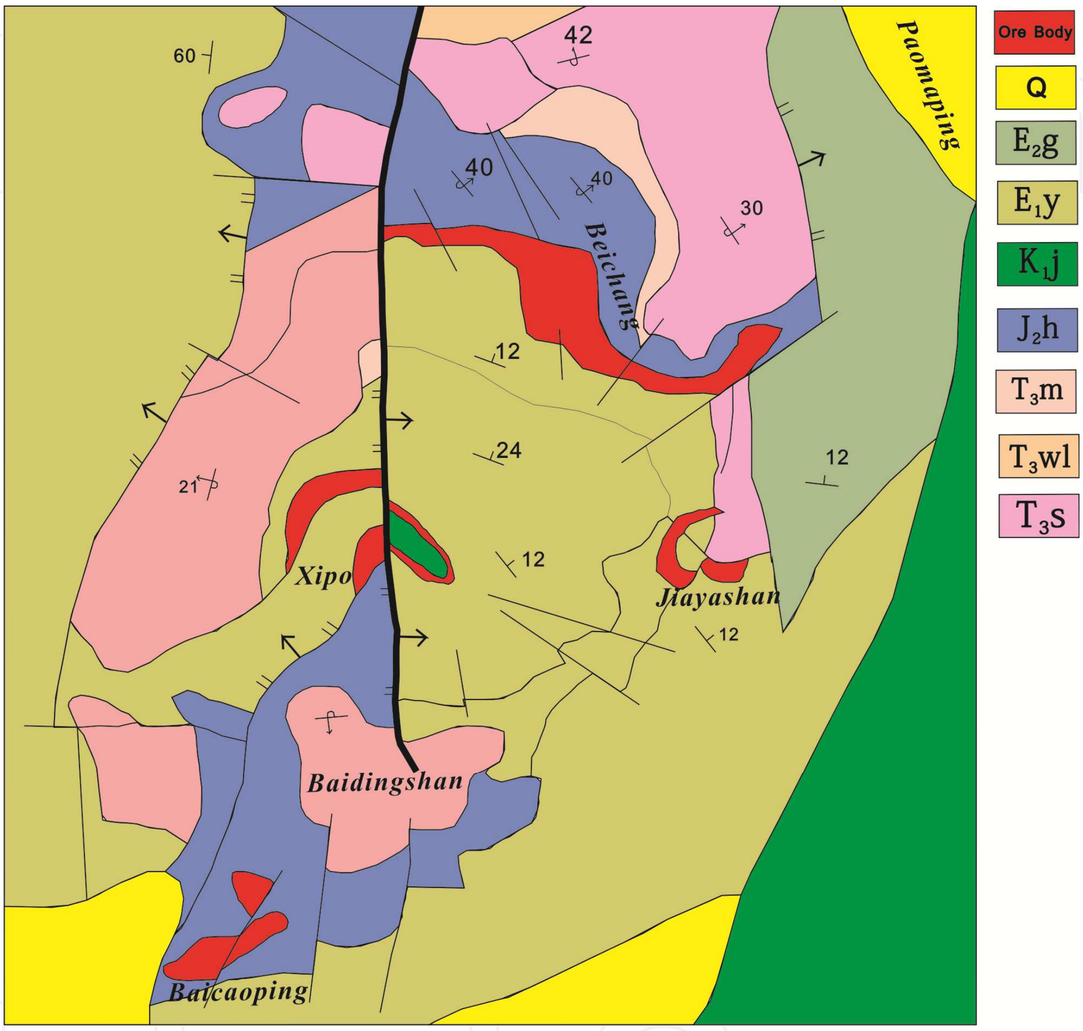
The Machangqing Mo-Cu deposit is located at northern block of the Jinshajiang- Ailaoshan gold zone, and on the intersection of the Jinshajiang-Ailaoshan deep fault and the Cehgnhai-Binchuan fault. The main strata(Fig.6) are siltstone clip limestone of dolomite quality from lowe Devonian series,fleet turn sandstone and shale clip lens of limestone from lowe Ordovician series. The ore body is controlled by trunk faults trending northwest to southeast andnorth to south, which develop with secondary faults and anticline of various types and scales tending northeast to southwest, east to west, northwest to southeast and southeast. The main intrusive rocks are granite porphyry, monzonitic granite porphyry, and sills and typhoons, forming during Himalayan period. There are still some lamprphyre, agabbro and dolerite as dikes and veins. Contact zones of intrusive rocks and wall-rocks are hornstone and sharn-marble. From south to north there are three ore blocks - Machangqing Cu-Mo ore block occurrences in porphyry, Luandongshan Cu-Mo-(Au) ore blocks in sharnmarle, and Jinchangqing Au ore blck in wall rocks (O1&D1). There are still some Au-Ag ore spots in the faulted fracture zone which cuts porphyry and contact zones.Mo-Cu-Au ores and alkali-rich porphyry are of concordant ages (34-45Ma). The forming ages of independent Au-(Ag) ore spots may be 15Ma later than the diagenetic age of alkali-rich porphyry (Peng J T et al., 2005 and Liu X F et al., 2000). Besides that Cu-Mo-Au ores occurrence in porphyry and contact zones, they are also found in sharn, altered gabbro, dolerite and lamporphrye, which indicates that mineralization is unified control of structures and mantle fluid processes. Geochemical and Pb, Si, Sr, Nd stable isotopic researches of alkali-rich porphyry and its typical minerals suggested that source of alike-rich magma appear to be low partial melted EMⅡ enriched mantle; while metallogentic mantle fluid is HIMU mantle with high U/Pb. At the same period of alkali-rich magma transportation and crystallization, mantle fluid self metasomates and alters the alkali-rich porphyry, which makes metallogenic material, carried in alkali-rich magma and mantle fluid, mineralized at suitable spaces. He-Ar studies of pyrite fluid inclusions in mineralized porphyry indicate the existence of mantle fluid (Hu R Z et al., 1997).

The Jinding super-large Pb-Zn deposit is located in the northern part of Lanping Basin, at the junction of Indian and China continental plates. The atructureal zone at which Jinding is located was active during the Mesozonic and reached its peak in the Himalayan period. Studies of host atata, isotopes and metallogenic fluid suggest that the ages of ore-forming are 27-34Ma (Li Z M et al., 2006).

Structures controlling the deposit consist of a top broad dome and a napped fault. The Jinding deposit is made of seven ore blocks - Jiayashan, Beichang, Nanchang, Xipo, Beicaoping, Paomaping and Fengzishan et al, which are zones circling the core of the dome. The napped fault separates the strata into two different systems - (a) the foreign system-upfaulted block includes inverted strata T_{3s}, T_{3wl}, T_{3m}, J_{2h} and K_{1j} (from old to new), the lithogical of which is a varicolored fine-clastic rock of interbed carbonate; (b) the proto system-domnfaulted block includes normal strata E_{1y} and E_{2g}, the lithogical of which is dark red siltstone and thick bedded sandstone interbed olistostrome. Pb-Zn ore body occurrence in napped fault and its secondary faults.

There are two different kinds of ores, (a) sandstone, which is mainly found in Beichang, Jiayashan, Fengzishan and Xipo; (b) brecciola, which is found in Jiayashan, Nanchang and Paomaping et al.

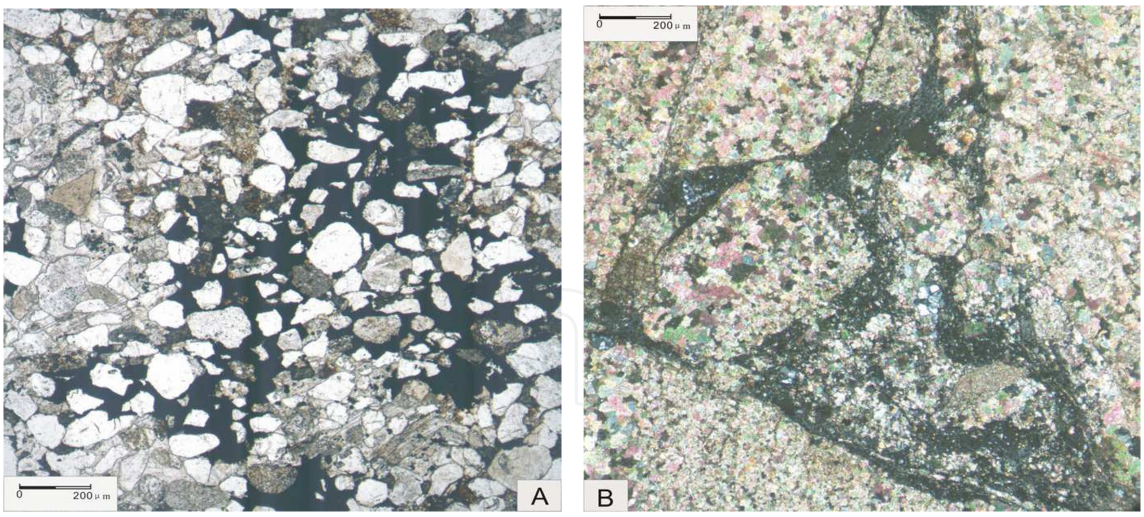
What should be given great attention is that metallogenic elements are in the conditions of microlite sulfide (galena and sphalerite) and carbonate (siderites) which occur in black opaque cements (Fig.8A, 8B). In sandstone ores, black opaque material partially disseminates, replacing primary cements (98). In brecciola ores, black opaque material is siliceous cryptocrystal-microlite and other sunmicroscoptic cements. Obviously, this phenomenon inhibits characteristics of fluid injection metasomatism. Electron microprobe analysis shows that, besides microlite sulfides, there are still great amounts of carbonate minerals, including microlite calcite, dolomite, smithsonite and siderite. Preliminary studies suggested that black opaque material derives from mantle carbonatite melt mixing sulfides and crystallizing in the overcooling process. Evolution and tectonic settings of this mantle carbonatite fluid are similar to the mantle fluid which forms the Na-rich glass, Fe-rich glass and Fe-rich melt xenoliths. The mantle fluid escapes from alkali-rich magma and enters into wall-rocks mixing with crustal fluid in a relatively open environment. We propose that the sulfides and microlite carbonate are products of supercriticle-melt mantle fluid which escapes from alkali-rich magma , extracts metallogenic materials along the way and alters wall-rocks.



1.thrusting fault;2.normal fault;3.character incertitude fracture; 4.line of geological limitation; 5.surface of uncomformity; 6.normal strata occurrence; 7.inversion strata occurrence; 8.Pb-Zn orebody; 9.Quaternary Syterm; 10.Eocene series guolang group;11.Paleocene Series Yunlong group; 12.low Cretaceous Series Jingxing group;13.middle Jurassic Series Huakaizuo group;14.upper Triassic Series Maicuqin group;15.upper Triassic Series Waluba group;16.upper Triassic Series Sanhedong group.

Fig. 7. Geological sketch of the Jinding lend-zinc ore deposit (area) (from Li et al.,2006)

A great deal of research proposes that carbonatite is the product of mantle magma. Fan H R et al., (2001) proposed that the intrusion of magma is associated with crust thinning. Liu et al., (1999) discussed the mantle upthrust and crust thinning processes of West Yunnan province. Yang X M (1998) pointed out that carbonatite is a fingerprint rock of lithosphere and mantle metasomatism. Although no carbonatite has been discovered in the Jinding deposit, the carbonatie melt could be regarded as a direct actual trace of mantle fluid.



A. Sandstone type ore with sand shape texture and basement type cementation, there are thereinto some cement to be replaced disseminatedly by black opaque materials.(plainlight under transmission condition) B.Limestone debris type ore with brecciform structure, there is cement, which is composition of tocryptocrystal- microcrystal kiesel and super-minuteness crystalline,to be injected to among debris. (crossed nicols under reflex condition)

Fig. 8. Mcroscope characters of cement in two type ores from Jinding Pb-Zn deposit.

Due to the fact that Jinding deposit occurs in sedimentary rocks, for a time it was treated as a typical strata-bound (sediment-reformation) deposit. However, present studies make a breakthrough about the genesis of this deposit. Based on the studies of REE, Wang J B et al., (1991) proposed that the metallogenic material derives from CO_2-rich fluid. After study of the Pb isotope, Zhang Q (1993) found that after syndeposition and reformation, Jinding was overprinted by mantle Pb. Zhu S Q et al., (2000) pointed out that some signs indicate that mantle fluid was part of the mineralization process. Based on the spot survey and the fact that asphalt is rich in brecciola ores, Gao L et al., (2005) suggested that the brecciola is a kind of emplaced brecciola of hervidero, which brought the metallogenic materials from depth. Our research shows that cements of the two kinds of ores are of emplacement characteristics, and the emplaced fluid is carbonatite melt which irregularly immixes sulfides. The carbonatite melt injects and cements the sedimentary rocks through the channel of large scale napped faults. Researches regarding the black opaque material in the ores inhibit a new way of mantle metasomatism and mineralization.

7. Conclusion

Formation and evolution of plentiful alkali-rich porphyries with deep-xenoliths have an inevitable connection to Cenozoic continental deformations, tectonisms, mantle magmas, anantectic fluids, and associated abundant polymetallic deposits. Study of petrographical, petrochemical, electron microprobe, scanning electron microscopy and energy spectrum analysis indicate that the connection is brought about by deep geological processes and ore-bearing mantle fluids action. Microcosmic traces and existing modality of the processes and the action can be directly manifested as following：

Na-rich glasses, which is showed as microlite and embryonic crystal under optical microscope, interpenetrated and alterated , nevatedly and disseminatedly, deep-xenoliths.

The glass have the characteristics of colour change with its composition variation,high Si, Al, Na and Fe, low K, Ca, and Mg,and the assemblage of andesine, amphibole, magnetite(specularite) and ilmenite. The microlite glass is a upper mantle fluid hat was formed before alkali-rich magma caught it..(2) Fe-rich glasses interpenetrated and alterated, nevatedly, agglomeratedly and disseminatedly, host rocks and various xenoliths.(3) Black microcrystalline iron-rich melt xenoliths as independent in aegerine syenite porphyry. Both matters of (2) and (3) are of submicroscpic crystalline texture under the electron microscope, but almost no optical properties (transmitted and reflected light) as black opaque materials are seen under the optical microscope. Their chemical compositions are expressed as high Si, Al and Fe, low Ca, Mg, Na and K. Their main mineral compositions are silicate and quartz, as well as moissanite, native iron with chromium, specularite with titanium, ilmenite and apatite et al. The unmixing texture, which is assumed by unmixing of minerals between micro-metal and nonmetal, indicates the mantle fluid's properties of magmatic melt and unmixing with alkali-rich magma. Widely developed alteration, such as hornblendication, silification and chloritization et.al., and corresponding retrograde reaction in order of pyroxeney→amphibole→biotite→chlorite resulted in the mantle fluid disseminating and replacing the host rocks and xenoliths.

Both alkali-rich magma and mantle fluid, which are shown as three microcosmic modalities, coexist and migrate in step, but unmix due to the differences of compositions and properties. On the basis of synthesis analyses in combination with metallogeny theory by transmagmatic fluid and demonstration in this paper, the following conclusions are reached: the alkali-rich porphyries were synchronically self-replaced and alterated by the mantle fluid going with the process of alakali-rich magma crystallizing while the fluid and magma was trapped well, and the otrthomagmatic deposit was formed in magma body or its deep-seat,and the typical deposit of otrthomagmatic metallogenic system is Machangqing porphyry Mo-deposit;if perturbation of tectonization was happened in the process of diagenesis and metallogeneis, the mantle fulid would enter into the contact zone between magma body and wall rock or strata next to the contact zone replacing and alterating to form contact-metasomatic deposit, and the typical deposit of the contact-metasomatic metallogenic system is Machangqing porphyry Cu-deposit, which exists in skarn-marble zone, and porphyry Au-deposit, which exists mainly in atrsta rocks; if the Au-deposit exists in porphyry body, it is commonly controlled by the fractures after diagenesis; if the deep fractures ,as magma and fluid channels ,are well developed , and environment is relatively open, the ore-bearing mantle fluid will flow far from alkali-rich magma along branch fractures and enter into different strata and rocks ,replacing and alterating to go with the process of diagenesis, and the typical deposit epithermal metallogenic system is Lanping Jinding supper-large Pb-Zn deposit. In this process, the mantle fluid's properties were changed from magma→supercritical fluid→liquid going with the changes of depth and environment, and corresponding the change of physical and chemical condition. Moving fluid carried, activated and anriched ore-material at suitable places. It is the deep process and the fluid action to accelerate crust-mantle materials overprinting mineralization and profit to deep ore-forming and large and supper-large deposits.

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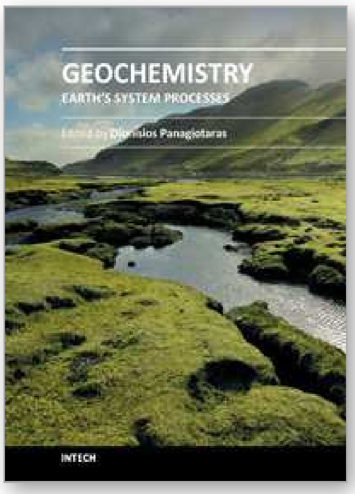

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