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## Geological Geochemical Characteristics and Genesis Discussion of Hutouya Polymetallic Deposit in Qimantage Area, East Kunlun

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Hutouya polymetallic deposit, 345km east of Golmud, is located on the northern slope of Qimantage Mountains in East Kunlun orogen, north of the Nalingguole fault, belonging to the East Kunlun north tectonomagmatic belt. Fe-Cu-Pb-Zn-Sn-Mo-W, all of these elements could form ore bodies. Besides the special geographic position and long complex tectonic evolution, detailed intensive research about the geological characteristics and regional geological background and with geochemical evidence, the genetic type of this polymetallic deposit may be got relatively accurately.

There are two controversies about the regional tectonic evolution. One is subduction collision based on the classical plate theory, also named accretionary orogeny. The other is collisional orogeny, without obvious such plate spatial structure sequence subduction zone island arc, deep trench and fore-arc basin. According to the collected previous research datas, Zircon U-Pb ages of the granite in Hutouya polymetallic deposit are  $204.1 \pm 0.6$  Ma ~  $256.0 \pm 9.6$  Ma, mainly concentrated in the 220Ma-235Ma. Thus, the intrusion in Hutouya deposit formed in Triassic, Indosinian intracontinental orogenic evolution stage. The granite of the area is probably not formed in the island arc or continental margin volcanic arc environment, but formed in the consolidated continental margin, having nothing to do with the subduction of oceanic crust. Newborn or consolidated continental margin expand after early orogenic stage.

### 1 Geological Characteristics

The exposed strata in Hutouya deposit area from old to

new are Jixian system Langyashan group (Jx<sub>1</sub>), the central volcanic section of Ordovician-Silurian Tanjianshan group (OST<sup>b</sup>), lower Carboniferous Dagangou group(C<sub>1</sub>dg), upper Carboniferous Di'aosu group(C<sub>2</sub>d), the upper Triassic Elashan group(T<sub>3</sub>e) and Quaternary(Q<sub>4</sub>).

Intrusions in Hutouya deposit area are granite dominately, The main lithology is K-feldspar granite, monzonite granite, granodiorite, granodiorite porphyry, granite porphyry, porphyritic monzonite granite. The east and west sides of the rock mass intruded in Ordovician - Silurian Tanjianshan group, intruded lower Carboniferous Dagangou group toward south, northward to the upper Carboniferous Di'aosu group. Rock mass producted between the two east-west folds ,and cut an east-west trending fault. Special structural position, causing magmatic activity of this area lasted long time, with a high degree of differentiation. In addition, a granodiorite strains exposed in the northern part of the mine, irregular elongated outcrop area  $3.175\text{ km}^2$ , a syenite gabbro-diabase dike in southern, 1.5km long, 40m - 100m wide , toward  $250^\circ$ .

The tectonic structure in Hutouya deposit is east-west, from Jingren to Yingqinggou to Langyashan outside to Yemaquan, both faults and folds existed. But the tectonic structure in regional area is north-west or north-west-west. Rocks, composed of east-west tectonic belt, are the Proterozoic Langyashan group, proposing it is a residual ancient tectonic belt. Thus, the east-west residual tectonic belt formed earliest, maybe belong to the product of Caledonian. NWW-trending structural zone formed earlier than north-west tectonic zone, the former beginning in Variscan activities , other starting its activities in Indosinian. Both the faults and folds in the deposit are weak areas, most likely causing magma pouring.

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hydrothermal activity, and mineralization. Fault fracture zone and interlayer fracture zone caused by faulting and folding are favorable ore accommodation space.

## 2 Mineralizing Belts and Orebodies

There are very many mines in this area and most of them are located in the same broken alteration zone. Based on their outcrop characteristics, Hutouya polymetallic mining area is divided into seven mineralized zone, separately belong to three kinds.

### 2.1 Orebodies formed in the contact zone between the granite and carbonate rocks

I, III mineralized zone and eastern section of II mineralized zone close to the granite mass output, are located in the central of the mine. The ore bodies are formed in the contact area of the rock mass and Carboniferous carbonate strata. The orebodies of I, III mineralized zone are only magnetite, and orebodies of astern II mineralized zone are Fe-Cu-Sn-based multimetal ore bodies. They are the typical contact metasomatic skarn-type orebodies.

### 2.2 Orebodies formed in the fault fracture zones

Faults developed in the mining area, with a multi-phase activating character and widely developing fracture zones. Western of II mineralized zone from the main rock 2-3 km, besides, the VI mineralized zone from the main rock east, extending about 2 km. Both of the two mineralized zones produced with the fracture zones, which was between the lower Carboniferous Di'aosu group and the Ordovician-Silurian Tanjianshan group. There are many orebodies found, mainly Cu-Pb-Zn, associated Fe, Mo.

### 2.3 Orebodies formed in the interlayer fracture zones

Jingren anticline and Langyashan syncline nearly east-west trending folds influenced by multiple regional tectonic movement, which resulted that strata fracture and break slide appeared in the weak parts, good space for fluid action and ore storage. IV mineralized zone nearly parallel with Jingren anticline, formed in the interlayer fracter zone and occurrence strict being controlled by the broken alteration zone. The V mineralized zone is located in the north of Jingren anticline, produced in the secondary fracture zone. Both of the two mineralized zones formed in the lower Carboniferous Di'aosu group. VII mineralized zone is located in the south of the mine, formed in the interlayer fracter zone produced by Langyashan syncline.

Composition of the formation is the Jixian System Langyashan group. Metallogenetic elements is Pb, Zn dominately, associated Cu, and Ag only in VII mineralized zone.

### 2.4 Mineral Composition

The typical skarn rocks of mineral assemblages in I, III mineralized zones and eastern of II mineralized zone: magnetite, garnet, diopside, epidote, calcite.

Hydrothermal alteration mineral assemblages produced in the fault fracture zones such as VI mineralized zone and western of II mineralized zone: magnetite, chalcopyrite, covellite, sphalerite, diopside, garnet, calcite, chalcopyrite, galena, sphalerite, pyrite, covellite, diopside, tremolite, chlorite, epidote, vesuvianite, wollastonite, calcite and quartz.

The mineral assemblages of hydrothermal alteration produced in the interlayer fracture zones: galena, sphalerite, chalcopyrite, pyrite, pyrrhotite, arsenopyrite, diopside, tremolite, quartz, epidote, chlorite, sericite, garnet and calcite.

## 3 Geochemistry

### 3.1 Sulfur Isotope Geochemistry

The  $\delta^{34}\text{S}$  of Hutouya polymetallic deposit (Table 1) is between -0.97‰ to +8.3‰, with an average of 4.83‰, and concentrated in 5‰ to 7‰. V mineralization has low  $\delta^{34}\text{S}$  in 0.4‰ to 1.2‰, VII mineralization with the  $\delta^{34}\text{S}$  of 6.1‰ to 8.3‰. The  $\delta^{34}\text{S}$  of VI mineralization tested by Liu yunhua (2006), is concentrated between 3.09‰ to 5.69‰ except a minimum value -0.97‰. Thus, the little change of  $\delta^{34}\text{S}$  in every each mineralization suggests relatively stable physical and chemical condition during the ore-forming process. And, that the same kind mineral  $\delta^{34}\text{S}$  varied greatly in different mineralized zones shows the sulfur sources of the deposit are at least two. The sulfur sources of V mineralization are deep, suggesting the ore-forming hydrotherm is magmatic hydrothermal fluid. The sulfur sources of VI, VII mineralization are a mix of deep sulfur sources and crust-derived sulfur, and VII mineralization with a high degree of mixing. The ore-forming hydrotherm VI, VII mineralization are mixed by magmatic hydrothermal fluid and groundwater. VI mineralized zone is located in the east side of the main rock, and from the rock closely, so have more magmatic hydrothermal fluid composition.

### 3.2 Lead Isotope Geochemistry

**Table 1 Sulfur Isotope analysis**

Sample	Sulfide	Location	$\delta^{34}\text{S}/\text{‰}$	Source
JRD09	Ccp	V	0.4	
JRD10	Ccp		1.2	
HT-01-1	Ccp		6.1	
HT-01-2	Gn		8.3	
HT-02-1	Gn		7.6	
HT-03-1	Gn	VII	6.3	
HT-01-3	Sp		6.4	
HT-02-2	Sp		8.2	
HT-03-2	Sp		6.6	
80	Py		3.82	
1	Gn		5.31	
13	Gn		-0.97	
58	Gn	VI	3.09	Liu yunhua (2006)
77	Gn		5.49	
97	Gn		5.69	
78	Py		3.68	

Pb isotopic compositions of the sulfides in Hutouya polymetallic deposit are as below:  $^{206}\text{Pb}/^{204}\text{Pb}$  being 18.503 to 18.685,  $^{207}\text{Pb}/^{204}\text{Pb}$  being 15.58 to 15.684,  $^{208}\text{Pb}/^{204}\text{Pb}$  being 38.268 to 38.585. Pb isotopic compositions of granite rocks in the deposit are that,  $^{206}\text{Pb}/^{204}\text{Pb}$  being 19.021 to 20.056,  $^{207}\text{Pb}/^{204}\text{Pb}$  being 15.636 to 15.692,  $^{208}\text{Pb}/^{204}\text{Pb}$  being 38.854 to 39.516. A high content of radiogenic Pb suggests characteristics of crust source. A little change of Pb isotope ratios shows a single source. In the  $^{206}\text{Pb}/^{204}\text{Pb}$ - $^{207}\text{Pb}/^{204}\text{Pb}$  and  $^{206}\text{Pb}/^{204}\text{Pb}$ - $^{208}\text{Pb}/^{204}\text{Pb}$  diagram, the Pb isotopic compositions of fluid and granite showed a good linear array, so the ore-forming elements have a homologous relationship.

## 4 Discussion and Conclusion

The characteristics of orebodies in Hutouya polymetallic deposit have obvious zonation as the temperature changed: around the rock is skarn-type orebody, away from the rock is hydrothermal vein type orebody; around the rock is magnetite, away from the rock is lead, zinc, copper polymetallic ore body.  $\delta^{34}\text{S}$  of the orebodies near the rock mass is 0.4‰-1.2‰,  $\delta^{34}\text{S}$  of orebodies in fault fracture zone is 3.09‰-5.69‰,  $\delta^{34}\text{S}$  of the orebodies in interlayer fracture zone is 6.1‰-8.3‰. So the zonation is obvious.

Obtained comprehensive researches, the hutouya polymetallic deposit has skarn type and hydrothermal vein type orebodies, The hydrothermal vein type orebodies are divided into that producing in fault fracture zone and producing in interlayer fracture zone. The ore bodies constitutes the skarn type-hydrothermal vein type polymetallic deposit (Fe-Cu-Pb-Zn-Sn-Mo-W) metallogenetic series which is related to the intermediate-acid intrusive rocks. The Hutouya polymetallic deposit is a typical magmatic hydrothermal deposit, consisting of both skarn-type orebodies and hydrothermal vein type orebodies.

**Key words:** Ore genesis, Hutouya, Qimantage, East Kunlun