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Distribution of Magmatic Rocks and Geochemical Characteristics in Geza Arc, Western Yunnan

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1 Introduction

The subducting of oceanic crust(B-type) generally lead to the development of arc orogenic belts, volcanic magmatic arc is the main boby of subduction orogenic belts, its typical mineralization is mainly formed massive sulfide deposits(Franklin *et a1*.,1981;Ohmoto *et a1*.,1983; Lydon *et a1*.,1988), such as "Gacun" superlarge Zn-Pb-Cu massive sulfide deposits(Hou et al.2004); porphyry copper deposits(Silitoe *et al*.,1972), such as Pulang porphyry copper deposit(Li *et al*.,2007),and epithermal gold deposits(Simon *et a1*.,1999; Richard.,2010), such as Nongduke Au-Ag polymetallic deposit. Yidun arc collision orogenic belt is a composite orogenic belt in eastern part of the Tibet Himalaya orogenic belts, which located in the Sanjiang area of southwest China. It began large scale oceanic crust subduction in the late Indosinian epoch (210～235 Ma); thereafter, where experienced collision orogenic process in Yanshan phase(80～88 Ma), and finally suffered intracontinental convergence and large scale shear translational action superimposed reformation in Tethyan period (Hou *et al*.,2001;Yang *et al*.,2002).

Geza arc is the important parts of Yidun arc in the southwest of Sanjiang tectonic magmatic belts, it located in the southern tip of the Yidun arc, which is newly discovered copper polymetallic ore concentration area in recent years in China, such as Pulang super-large porphyry copper deposits, Xuejiping large porphyry copper deposits, Hongshang large sized skarn-porphyry copper and so on. Geza arc kept the characteristics of Yidun arc in the structure and temporal evolution(Hou *et al*.,1991;Zeng *et al*.,2003), that is widely distributed the upper Triassic series volcanic and sedimentary rocks series.The volcanic rocks mainly developed calc-alkalinean desite-dacite series, and invaded by later shallow and sub-hypabyssal acid porphyrite rock series(Yang *et al*.,2002), which constituted a typical volcano magmatic rock belts. Geza area was in passive continental margin of western Ganzi-Litang ocean basin in Early Triassic; in the late Triassic, oceanic crust occurred westward subduction, Hou and Yang (2004) suggested that the subduction time limit of oceanic crust in 235-210 Ma. In Geza area, the subducted oceanic crust formated the stressed arc and outputed the porphyry copper deposits related compressional tectonic environment because of the slowed angle subduction.but in the northern of Yidun arc, where formated extensional arc and outputed extensional environment-related massive sulphide deposits because of the faster and steep angle diving (Mo *et al*., 2001; Hou *et al*.,2001; Li *et al*.,2001,2007).

2 Geological background

This area located in the eastern edge of Dege-Zhongdian continental blocks of Gazi-Litangwest plate junction, the southern of Yidun arc in Indosinian, the tectonic framework spread NNW-trending(Fig.1). Late Paleozoic carbonate platform was developed. As the Ganzi-Litang oceanic crust westward subduction, where formated active continental margin in rengional during late Permian-early of late triassic epoch. Late Triassic was the stage of magmatic arc development, where formed a set of thick clasti-carbonate-volcanic construction, the lithologic mainly consisted of sandslate clip limestone, andesite basalt-andesite, dacite, as so the formation was divided into qugasi group(T_3q), tumugou(T_3t), lamaya (T_3lm) group. The NW treading tectonics belong to extensional structural environment in the region, NW and

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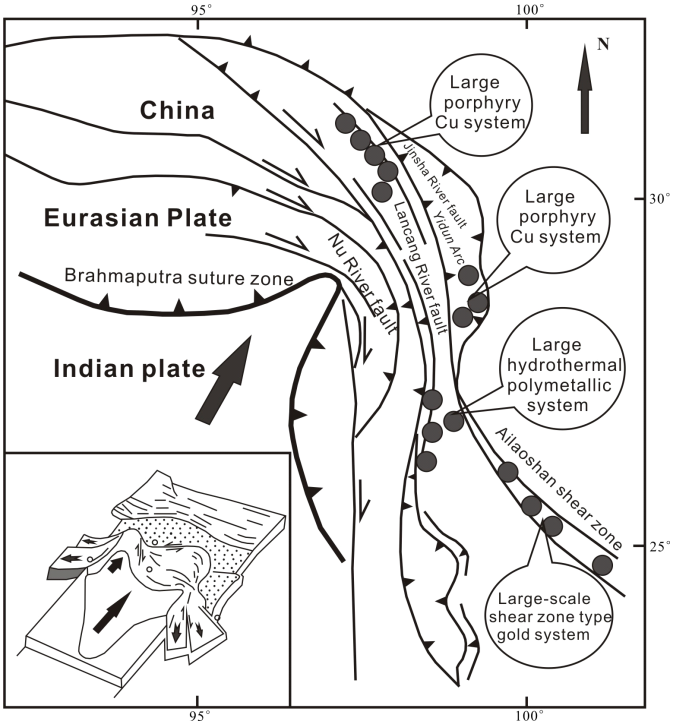

Fig.1 Setting of Geza arc zone(modfied by Li et al., 2007)

NE trending fractures control the late indosinian compressional calcium alkaline rocks distribution, and there are lots of homologous porphyry (porphyrite) rocks distribution.

3 Intrusive complexes distribution and geochemical characteristics

Geza volcanic magmatic arc is the products of Ganzi-Litang oceanic crust westward subduction in the late Triassic. where was lake basin volcanic flysch phase and deposited a thick clastic-carbonate rocks-volcanic construction during the late Triassic, the lithology is mainly composed of sand slate limestone, andesitic basalt-andesite, dacite. From the point of view on the horizon, volcanic rocks developed in Qugasi group and Tumugou group of the upper Triassic; point of view from space, it is shown banding distribution almost everywhere in the region, which constituted the Geza arc volcanic belts. In this area, NNW-trending faults were early tensile fracture, which controled the Triassic volcanic rocks and homologous intermediate-mafic intrusive rocks in the distribution.

Base on the development stage of arc orogenic, the distribution of intrusive rocks, rocks composition, geochemical characteristics, granit belts of Geza arc can be divided into ①Geza-Xuejiping arc porphyry subzones (western belt); ②Qiansui-Pulang arc porphyry subzones (middle belt); and③Yaza-Zhuoma arc porphyry subzones (eastern belt).

Geza—Xuejiping arc porphyry subzone

porphyry outputting obviously contrled by the regional structure and near to the Xiangcheng-Geza fault. Rock masses are shown rock strain, rock branches, rock wall outputting, and NNW-trending extension, the number of rock masses up to 24. Magmatic intrusion activity time Ar-Ar plateau age of 249 Ma(Zeng *et al*.,2003), zircon U-Pb isochron age of 213～219 Ma(Lin *et al*.,2006; Cao *et al*.,2009; Ren *et al*.,2011).

The rocks association is diorite-quartz diorite-monzonite porphyry-quartz monzonite porphyry-granite porphyry. Zonation of rock masses is not obvious and rocks has porphyritic-fine block structure. In general, rocks strongly altered, phenocrysts are developed in the rock massess which mainly composed of plagioclase, hornblende, biotite and a small amount of quartz, occasional appear pyroxene.

The oxide content SiO_2 is 60.93%～71.22%, belong to the acid rocks. The content of Al_2O_3 is 9.13%～15.99%, all alkali(Na_2O+K_2O) content is 3.23～8.23, average of 5.64. In TAS diagram, all of the samples plot in the field of subalkaline rocks; in SiO_2-K_2O diagram, most of the samples plot in the high-K calc-alkaline series. Rittmann index is 0.58～3.22, consolidation index(SI)in the range of 11.2～17.9, similar to the local andesite, differentiation index(DI)in the range of 58.91～86.6, and similar to andesite-dacite, which reflect the degree of magmatic differentiation is medium. Oxidation rate(OX)in the range of 0.39～0.88, average of 0.51. All kinds of rocks REE composition show that the ΣREE changes in the range of 164.82×10^{-6}～334.69×10^{-6}, ΣCe/ΣY 19.08～24，average of 14.13. $(La/Yb)_N$19.08～59.07, average of 27.53, the distribution patterns are typical LREE enrichment. Compared porphyrite to porphyry, the former ΣLREE/ΣHREE and $(La/Yb)_N$ are more larger, which reflect the porphyry has a higher degree of differentiation during the magma formation. The porphyry (porphyrite) representative samples of trace elements very similar to acidic volcanic rocks and arc granite, rocks enriched in Ba, La, Hf, Au, chalcophile elements Cu,Pb, siderophile elements Mo, Ni, and depleted in Rb, Nb, P, Ti.

Qiansui-Pulang arc porphyry subzone

This porphyry subzone is more widely distributed in Geza arc. The porphyries distribution along the complex cells and secondary anticline axis, its outputting under the significant control of the structural, the number of rock masses up to 46, which outputed with rock plant, rock branch , dike shape and overall assumes the NNW trending extension. The rock masses developed in the Tumugou group, the depth of intrusion is shallow, and the surface outcrop is larger, the porphyry mineralization is

more developed, which represented by Pulang composite porphyry body. The time limit of magmatic activity Ar-Ar plateau age of 216.3Ma, isochron age of 220Ma(Zeng et al.,2006); quartz monzonite porphyry molybdenite Re-Os age of 213Ma, mineralized porphyry K-Ar dating age of 221～235Ma(Li et al.,2007); zircon U-Pb isochron age of 226-228Ma (Wang et al.,2006); the ore-bearing quartz diorite porphyry zircon U-Pb(LA-ICP-MS) age of 220.5±3.2Ma, the ore-bearing quartz monzonite porphyry age of 214.5±2.2Ma(this article).

The rocks association is diorite-quartz diorite-monzonite porphyry-quartz monzonite porphyry-granit porphyry, facies belt of the rock is not obvious. The content of SiO_2 is 61.03%～68.57%, it belong to the acid rocks. The content of Al_2O_3 is 13.77%～14.94%, all alkali (Na_2O+K_2O) content is 5.58～8.72, average of 6.38, In TAS diagram, all of the samples plot in the field of subalkaline rocks; in SiO_2-K_2O diagram, most of the samples plot in the high-K calc-alkaline and shoshonitic series, the exceptional sample plot in calc-alkaline series. Rittmann index range of 1.96～2.80, average of 2.40, Oxidation rate(OX)in the range of 0.16～0.56, average of 0.33, it is shown that the emplacement depth is deeper than the Western belt. All kinds of rocks REE composition see, the ΣREE change in 55.1×10^{-6}～218.6×10^{-6}, ΣCe/ΣY 19.08～24, average of 14.13. $(La/Yb)_N$ 2.68～5.86, average of 3.96, the distribution patterns are typical LREE enrichment. The δEu values range from 0.71 to 1.0, its shown that the rocks have no obvious Eu anomalies. Whereas, compared porphyrite to porphyry, the former ΣLREE/ΣHREE and $(La/Yb)_N$ is more larger, it reflects the porphyry has a higher degree of differentiation during the magma formation. The distribution of trace elements in porphyry and porphyrite are very similar to acidic volcanic rocks and arc-type granite, enriched in Ba, La, Hf, Au, chalcophile elements Cu, Pb, siderophile elements Mo, Ni, and depleted in Rb, Nb, P, Ti.

Yaza—Zhuoma arc porphyry subzones

The porphyry subzone located in the eastern of Militang fracture zone and has the minimum number of porphyry bodies, which outputted with rock plant, rock branch and dike shaped. The porphyrite bodes generally has a small surface outcrop, but the deep of the granite intrusion would be more larger, so it is concealed rock masses in general. The time limit of magmatic activity zircon U-Pb isochron age of 214.7±1.1Ma(Li et al.,2011).

The content of SiO_2 is 56.75%～64.33%, rocks have relatively high alkali metal content rather than aforementioned porphyry(porphyrite) rocks. Rittmann index (δ) at 2.87～3.28, rocks are belong to high-K calc-alkaline rock series. Rock oxidation ratio (OX) range of 0.14～0.64, average of 0.32, greater than the middle and weastern belts which represents the depth of emplacement is more deepper. Rocks REE composition similar with the composition of acidic volcanic rocks in the region. the ΣREE changes in 168.11×10^{-6}～184.38×10^{-6}, ∑Ce/∑Y 4.76～14.25, average of 10.08. $(La/Yb)_N$ average of 16.98, the distribution patterns are more typical LREE enrichment.

In conclusion, the similarities of element content and composition of porphyry(porphyrite) and regional acidic volcanic rocks in the main element, REE and other trace elements suggest that they both have the same or similar magmatic source rocks. The porphyry(porphyrite) and arc granite rocks have the same rock series (calc-alkaline) and the same genetic type (I-type granite).

Key words: arc orogenics; geochemical characteristics; Indosinian; Geza; Yunnan