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Petrogenesis and Mineralization of the Paodaoling Au Deposit in Guichi Ore-cluster Region, Middle-Lower Yangtze Metallogenic Belt

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1 Regional Geological Background

The Paodaoling gold deposit is an important polymetallic deposit in Guichi ore-cluster region in the Middle-Lower Yangtze Metallogenic Belt (eg., Chang et al., 1991), the magmatic rock of Yanshan period related to the metal mineral acid calcium alkaline intrusive mass (Mao et al., 2006; Xie et al., 2012). The Paodaoling gold metal quantity is over 20 tons of gold possibly being a largest independent rock gold deposit along Middle-Lower Yangtze Metallogenic Belt .

The strata are composed of Jurassic clastic rock formation to Odovician carbonates. In this area, faults of EW and NNE intersect across part of the basement (Chen et al., 2002), which control the distributions of magmatic rocks and deposits. Zone of intrusions are named as Qingyang, Tanshan and Huayuangong. The Paodaoling gold deposit is located in the south side of Huayuangong intrusion with a forming age of 141Ma (Duan et al., 2012).

2 Characteristics of Deposit

Wallrocks in the Paodaoling Au deposit are mainly consisting of Silurian strata, being composed of silty shale, sandstone, sandy shale. Outcropped magmatic rock is dacite porphyrite with an area of ca. 0.6 km^2, as the main gold ore body occurrence,. Most mineral components of dacite porphyrite have phenocryst contents with 20% ~ 20%, mainly consisting of plagioclase, and a small amount of biotite, amphibole and quartz. Most phenocrysts have carbonatization and chloritization. Matrix with fine structure is mainly consisting of microcrystalline of plagioclase, quartz, K-feldspar, and a small amount of biotite and hornblende.

Mineralized alteration mainly occurs in the dacite porphyrite, small part developed in Gaojiabian Group (S_{1g}), thus this deposit has been regarded as porphyritic Au type (Duan et al., 2012). Hydrothermal alteration occurred at the same time with magmatic intrusion. Mineralized alteration types mainly include sericitization, silicification and carbonatization, chloritization, pyritization, a small amount of galena, sphalerite and chalcopyrite, magnetite, dolomitization, kaolinite, some ore blocks have strong realgar, orpiment mineralized alteration. Pyritization mainly with disseminated, thin vein, net vein distribution is close with Au mineralization.

3 Geochemistry

According to six pieces of dacite porphyrite, chemical results show that an average of $SiO_2$66.34%; $Al_2O_3$14.93%, Fe_2O_3 14.93% and 6.48%, 4.14% K_2O + Na_2O, TiO_2 0.86%, 0.73%, Mg# MgO 18.4 and CaO 0.03%. Rocks are characterized by enrichments of silicon, aluminum, potassium, and depletions in alkali, calcium, magnesium, sodium, belonging to high potassium calc-alkaline series. Trace elements show depletion in Sr (59.3-31.2ppm) , enrichments in Y (27.3 - 16.0ppm) and Yb (2.97 -1.50ppm), with average of ∑ REE of 143.0 ppm, $(La/Yb)_N$ of 10.33, and negative Eu anomaly of 0.83. The REE and trace element distribution patterns with chondrite-normalized diagrams of the Paodaoling dacite porphyrites present features of average crust and island arc volcanic rocks, without obvious difference with that of N-MORB.

The dacite porphyrite zircons have ∑REE 230.3-1028ppm, with Chondrite standardized distribution patterns of depletions in light rare earth, enrichment s in heavy rare earth and Eu negative anomaly, having characteristics of typical magmatic origin. Two zircon samples have Ce^{4+} / Ce^{3+} values ranging between 66.80-472.9, 171.2-1299, respectively; and Eu_N/Eu_N* values ranging from 0.46 ~ 0.46, 0.50-0.85, respectively.

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According to method of Ballard et al. (2002), zircon Ce^{4+} / Ce^{3} and Eu_N/Eu_N* characteristics can be indicators of oxygen fugacity of magma, we compared oxygen fugacity of magma in the Paodaoling dacite porphyrites with those igneous rocks related to porphyritic Cu-Au deposit in Chile, showing that two zircon samples in the Paodaoling dacite porphyrite have higher Ce^{4+} / Ce^{3+} and Eu_N/Eu_N* features than those rocks in Chile, falling a region within the scope of the ore-bearing rocks.

4 Deposit Origin

Compared with the porphyry deposit in the world, the Paodaoling gold deposit has geological characteristics of porphyry deposits, part of deposit had been experienced a late stage hydrothermal transformation. Geochemical features show that rock samples belong to island-arc origin according to discriminating diagrams from Pearce et al. (1984) .

In the diagram of $(La/Yb)_N$ vs.$(Yb)_N$, all Paodaoling rock samples fall to island-arc region, not belonging to adakitic region. From anomalies of Ce^{4+} / Ce^{3+} and Eu_N/ Eu_N* of zircons, the Paodaoling Au-bearing dacite porphrite falls to the same region of those rocks of Cu-Au deposits in Chile, indicating magmatic environment of high oxygen fugacity. Oxygen fugacity in subduction zone is higher than intraplate and MORB (Mungall, 2002; Sun et al., 2004; Sillitoe, 1997). The Paodaoling dacite porphyrite has age of 141Ma, similar to those of Cu-Au -bearing igneous rocks along Middle-Lower Yangtze Metallogenic Belt. Based on geochemistry and tectonic background, we deduced that the Paodaoling dacite porphyrite formed in the subduction of oceanic slab environment with crystallization differentiation of the mantle wedge melting. According geochemical features proposed by Sillitoe (1997), the characteristics of the Paodaoling dacite porphyrite has possibility to form a largest porphyry copper-gold/ epithermal gold deposits.

5 Conclusion

The Paodaoling gold mine displays geological characteristics as an independent porphyry type deposit, with the same diagenetic age and geochemical characteristics as those of middle-lower Yangtze copper-gold mineralization belt. It is conjectured that this gold deposit formed in ancient subduction of the Pacific tectonic background, possibly as a subduction zone of crystallization and differentiation from the mantle melting wedge.

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