1 Geological Setting

The Ciemas Au deposit is situated within West Java at the southern margin of Sundaland, which is the continental core of SE Asia formed by the accretion of blocks to the Eurasian margin (Hamilton, 1988; Hall, 2002) and was assembled by the Late Triassic (Clements and Hall, 2007, 2008). Volcanic rocks (Citirem Formation) and metamorphic rocks (Pasrluhur schist) of Mesozoic age exposed in southern Ciemas were accreted at the periphery of Sundaland in West Java (Wakita, 2000). By the end of the Cretaceous and during the Paleocene, much of Sundaland was an emergent continental region; most likely with a passive margin southern Java (Carlile and Mitchell 1994). However, rapid northward movement of the Australia plate occurred in the Eocene. Northward subduction of the Indo-Australian Plate beneath the Eurasian Plate has most likely been continuous since the early Paleogene, although associated volcanism may not have been continuous (Hutchison 1988; Hamilton 1989). Almost all the rocks exposed on Java are Cenozoic, and they include igneous intrusions, volcanic products, siliciclastic sedimentary rocks and shallow marine carbonates (Van, 1970; Whitford et al., 1979; Katili 1989; Claproth 1989). The Ciemas gold mine is hosted by a late Eocene to early Miocene volcanic rock belt.

2 Deposit Descriptions

2.1 Quartz-sulfide vein ore deposits

Four ore blocks of Pasir Manggu, Cigombong, Cileuweung and Cibak are of the quartz vein type. Among them, the Pasir Manggu ore block has been extensively explored. Three periods of the mineralization process have been identified: 1) the early period is characterized by a banded chalcedony-silicide, generally without gold mineralization; 2) the second period is characterized by an arsenic pyrite quartz vein and brecciated process; 3) the third period is characterized by ore-bearing hydrothermal filling metasomatism forming banded structure of chalcedony cements and sulfide and intergrowth of precious metal ores. The wallrock alteration displays strong argillic alteration (mainly kaolinite, illite and montmorillonite), and the thickness of alteration zone is up to 5m in the top of ore body, getting narrow on the footwall.

2.2 Ore deposits of structure-controlled alteration rocks

The tectonic-altered deposits are mainly Ciheulang, Cibatu, Cikadu, Sekolah and Japudali. Among them, the Cibatu mine, as a typical ore deposit, is described below. Two periods of ore-formation have been identified: 1) The early phase is characterized by altered andesite forming scatted pyrite on the surfaces of the schistosity and fractures without gold mineralization. 2) The second phase is characterized by re-fragmentation of altered andesite, accompanied with ore-bearing hydrothermal filling metasomatism, forming fine vein–irregular net vein structure with gold mineralization.

2.3 Porphyry Ore Deposits

In the Cipirit ore block, Ciemas dacite presents hypabyssal or ultra-shallow intrusion into the Jmpang andesite Formation, intruded by late quartz diorite porphyrite. At the edge of the quartz diorite porphyrite, developed propytlization, forming oxidation zones 10 m to 100 m wide, with silicification and
clay alteration on the surface.

3 Ore Minerals and Ore Structure

The ore minerals are mainly pyrite, arsenopyrite, limonite, chalcopyrite, galena, sphalerite, bornite, chalcocite and rutile. The gangue minerals are mainly composed of quartz, plagioclase, chlorite, sericite, biotite, calcite, dolomite and ferrodolomite, among others. Quartz is mainly gangue mineral and displays a comb structure), radiated structure and vein structure. Textures of ore include xenomorphic fine to micrograined granular, euohedral-subhedral granular, columnar, metasomatic and metasomatic relict. The ore structures are mainly among disseminated, brecciated, comb, radiated, veinlet, interstitial sparse disseminated and massive.

4 Geochemistry

4.1 Sulfur isotope data

Nine ore samples have $\delta^{34}S$ values ranging from 4.90‰ to 6.55‰, with a difference range of 1.65‰ and a mean of 5.54‰. Three rock samples have $\delta^{34}S$ values ranging from 3.71‰ to 3.85‰, with a difference range of 0.14‰ and a mean of 3.79‰. It can be observed that the sulfur compositions of the ore and rock samples are similar, suggesting that the sulfur sources are basically the same, being close to the characteristics of the mantle sulfur source. The wallrock samples are closer to the mantle source sulfur characteristics. On the statistical histogram, 3 wallrock samples have $\delta^{34}S$ values similar to those of west Java Guntur lava flows and Krakatau volcano slag (De et al., 2001). The $\delta^{34}S$ values of the 9 ore samples are generally greater than those of the wallrock samples.

4.2 Zircon U–Pb isotope data

In the $^{206}$Pb/$^{238}$U–$^{207}$Pb/$^{235}$U age harmonic curve, data points are located in a harmonic line on the right side, parallel to the abscissa. Zircon $^{207}$Pb/$^{235}$U age changes are greater, and the $^{206}$Pb/$^{238}$U age is relatively concentrated. The calculated zircon $^{207}$Pb/$^{235}$U weighted average ages are 17.1±0.4 Ma (MSWD=3.8, n=15) (amphibole quartz porphyry), 17.1±0.4 Ma (MSWD=3.7, n=25) (tuff breccia) and 17.5±0.3 Ma (MSWD=3.3, n=27) (andesite). Ages for the determination of the three samples are close to each other within the analysis errors, indicating that in this study area the andesite eruption was within a short period in the early Miocene followed by a successive magma intrusion occurred.

4.3 Major and trace elements

Among the 12 ore samples, we chose 7 strong pyritization samples to determine the Co/Ni ratio of projection. Most of the samples are plotted in the origin of hydrothermal type deposit area. The metallogenic elements (Au and Cu, Ag, and other trace elements) display some positive correlations between Au and Cu elements, and incompatible elements Cr, Ni, Co and V display a negative correlation. Au and incompatible elements, on the whole, display a negative correlation. However, Au has poor correlation with the large ion lithophile elements K, Sr and Ba. For the incompatible element Cr to high-field strength elements P, there is less then slight enrichment with a gradual growth. Nearly all the trace elements content are near the Earth’s crust content (Palme and O’Neill, 2003), and the incompatible elements Cr, Ni, Co and V have similar variations.

5 Metallogenic Mechanism and Trinity Metallogenic Model

During the Miocene (17–19 Ma), the southern margin of the Sunda continental arc volcanic magma activity frequently included large-scale andesitic eruptions, forming magma eruptions and development of the caldera structure system. With the further evolution of andesitic magma, the volcano magma was intruded along the previous channel-formed dacite shaped in bedrock on the top of andesite, which was then intruded by quartz diorite intrusion shaped as stock. Tectonically, after the eruption of andesite in the caldera system formed in the high-angle extensional faults and then formed fractures of NE and NW directions, they underwent different degrees of extension, compression and shearing during the later multiple tectonic movements, which provided the space for magmatic-hydrothermal residence.

In the porphyry bodies and contact zone, porphyry copper and gold deposits formed, whereas in the porphyry contacts, quartz vein-type gold bodies formed. In the fault belt in the caldera and contact zone between andesite and dacite, massive quartz vein-type deposits formed, and quartz vein-type deposition in the open environment occurred. In the fault belt on the fringes of the caldera, due to the high salinity from quartz diorite magma mixed with hydrothermal fluid from precipitation, compound vein quartz vein-type gold deposits formed. Tectonic altered type gold deposits formed in the fault belt far away from porphyry, caused by rock crushing, alteration and atmospheric precipitation formed by the thermal cycle. Although these ore body mineralization types are different, they are internal relations in terms of the genesis and “the trinity” in space.

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References


