

Textures and Geochemistry of Pyrite and Arsenopyrite from the Leon Sediment-Hosted Gold Deposit, Ratatotok District, Indonesia: Implications for Ore-Forming Conditions

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The Leon gold deposit, situated in Ratatotok district, North Sulawesi, Indonesia, is hosted by Miocene silty and fossiliferous limestone, which is overlain by Pliocene andesitic volcanic rocks and intruded by porphyritic andesite. Ore mineral paragenesis in the limestone and porphyritic andesite is divided into three stages: pre-ore, ore (early, main, and late), and post-ore. The pre-ore stage is characterized by framboidal pyrite disseminated and filling fractures in limestone. The limestone-hosted early-ore substage consists of anhedral to subhedral pyrite and marcasite, which occur as overgrowths of pre-ore pyrite and replacement of foraminifera. Early-ore substage in porphyritic andesite has subhedral-euhedral marcasite and pyrite with rutile and apatite inclusions. The main-ore substage in both rock types is characterized by arsenopyrite and arsenian pyrite, occurring as euhedral-subhedral, elongated, and skeletal grains or surrounding the early-ore pyrite. The late-ore substage in the limestone includes arsenian pyrite overgrowing the main-ore substage pyrite, with minor stibnite, realgar, orpiment, and trace chalcopyrite, sphalerite, and cinnabar in vugs of limestone. The late-ore substage in the porphyritic andesite includes arsenopyrite that overgrows the earlier arsenopyrite. The post-ore stage includes hematite and goethite replacing pyrite and realgar. $\delta^{34}\text{S}$ values of pyrite in the pre-ore stage and early- and main-ore substages range from +5.0 to +8.9‰, -1.6 to +1.2‰, and -3.1 to +2.3‰, respectively, while those of realgar and orpiment in the late-ore substage are -3.1‰ and -0.1‰, respectively. Arsenopyrite of the main- and late-ore substages contains 31–33 at.% As and 30–31 at.% As, respectively. This suggests formation temperatures and sulfur fugacity of ~427–475 °C ($\log f\text{S}_2 = -6.3$ to -5.3) for the main-ore substage and ~363–395 °C ($\log f\text{S}_2 = -7.7$ to -6.9) for the late-ore substage. Gold occurs mainly as solid solution in arsenian pyrite of the main-ore (average 150 ppm Au) and late-ore substages (average 139 ppm Au).