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Characterization of Complex Gold Ores for Preliminary Process Selection: The Case of Kapanda, Ibindi, Mawemeru, and Itumbi in Tanzania

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Abstract : This study characterizes complex gold ores (elemental and mineralogical composition, gold distribution, ore grindability, and mineral liberation) for preliminary process selection. About 200 kg of ore samples were collected from each location using systematic sampling by mass interval. Ores were dried, crushed, milled, and split into representative sub-samples (about 1 kg) for elemental and mineralogical composition analyses using X-ray fluorescence (XRF), fire assay finished with Atomic Absorption Spectrometer (AAS), and X-ray Diffraction (XRD) methods, respectively. The gold distribution was studied on size-by-size fractions, while ore grindability was determined using the standard Bond test. The mineral liberation analysis was conducted using ThermoFisher Scientific Mineral Liberation Analyzer (MLA) 650, where unsieved polished grain mounts (80% passing 700 µm) were used as MLA feed. Two MLA measurement modes, X-ray modal analysis (XMOD) and sparse phase liberation-grain X-ray mapping analysis (SPL-GXMAP), were employed. At least two cyanide consumers (Cu, Fe, Pb, and Zn) and kinetics impeders (Mn, S, As, and Bi) were present in all locations investigated. Copper content at Kapanda (0.77% Cu) and Ibindi (7.48% Cu) exceeded the recommended threshold of 0.5% Cu for direct cyanidation. The gold ore at Ibindi indicated a higher rate of grinding compared to other locations. This could be explained by the highest grindability (2.119 g/rev.) and lowest Bond work index (10.213 kWh/t) values. The pyrite-marcasite, chalcopyrite, galena, and siderite were identified as major gold, copper, lead, and iron-bearing minerals, respectively, with potential for economic extraction. However, only gold and copper can be recovered under conventional milling because of grain size issues (galena is exposed by 10%) and process complexity (difficult to concentrate and smelt iron from siderite). Therefore, the preliminary process selection is copper flotation followed by gold cyanidation for Kapanda and Ibindi ores, whereas gold cyanidation with additives such as glycine or ammonia is selected for Mawemeru and Itumbi ores because of low concentrations of Cu, Pb, Fe, and Zn minerals.

Keywords : complex gold ores, mineral liberation, ore characterization, ore grindability
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