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Potentially the Largest Unexploited 'Invisible Gold' Reserve Hosted in the Detrital Pyrites of Historical Witwatersrand Tailings Dumps

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The Witwatersrand Basin is the world's largest gold province hosting over 53 000 tons of native Au predominantly in quartz pebble conglomerates. The Witwatersrand gold tailings dumps are subjected to secondary mining operations which involve traditional extraction techniques (further comminution and cyanide leaching) that lead to 30-50 % recovery of gold missed by the historical beneficiation. This leaves a projected 1325-1855 tons of refractory gold together with an estimated 30 million tons of sulphide material which reports to the discard stream after secondary mining. The mineralogical deportment of this remaining refractory gold is not well constrained. The study is a dedicated gold deportment and ore characterization of 47 kg composite Witwatersrand tailings material from the Klerksdorp and Carletonville Goldfields. The tailings material is subjected to a modified preconcentration to define density fractions. The analysis involves optical microscopy, X-ray powder diffraction, quantitative evaluation of materials by scanning electron microscope, fire assay, aqua regia digestion, inductively coupled plasma mass spectrometry and laser ablation inductively coupled plasma mass spectrometry. Results from the analyses indicate that about 80,16 % (2,42 g/ton) of gold is distributed in the heavy mineral concentrates which are predominantly made up of silicates (44,15 %), sulphides (35,12 %), and oxides (20,12 %). Detailed in situ analyses suggest the gold in the concentrate fraction is 'invisible-' or 'solid-solution' gold hosted predominantly in pyrite and arsenian pyrites, Au grades range from 0,11- 48,69 g/ton. Given that the Witwatersrand Basin is historically a native gold deposit, identification of invisible gold in detrital pyrites (stable under Archean surface conditions) represents a potentially under-exploited resource which explains the refractory nature of the 50-70 % Au remaining after secondary mining. The implications of these findings for the economics, tailings remaining, and for the genesis of the Witwatersrand goldfields will be discussed.