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First Major Ore-Grade Gold Concentration on Earth's Surface: Why, When, and Where?

Hartwig E. Frimmel[1], Ryan Mathur[2]
1. Department of Geodynamics and Geomaterials Research, Institute of Geography and Geology, University of Würzburg, Würzburg, Germany, 2. Geology Department, Juniata College, Huntingdon, PA, USA

The first major gold concentration in the Earth's Crust is recorded by largely conglomeratic rocks of the c. 2.9 to 2.8 Ga Central Rand Group in the Mesoarchean Witwatersrand Basin, Kaapvaal Craton, South Africa, which accounts for almost one third of all known gold worldwide. Here we present new Cu isotope data on pyrite, carbon seams and gold from conglomerates at the base of the Central Rand Group (c. 2.90 Ga), the base of the Ventersdorp Supergroup (c. 2.78 Ga), and the base of the Transvaal Supergroup (c. 2.66 Ga). Our results indicate an overall increase in oxidation state of post-depositional fluids from 2.9 to 2.6 Ga but also synsedimentary gold precipitation by biological activity following an oxidative gradient. The highest δ65Cu were obtained from carbon seams (+2.41 ± 0.24‰) and are explained by Cu isotope fractionation due to acidophilic bacteria, thus confirming the hypothesis of first large-scale gold concentration having been triggered by oxidative microbial activity under an overall reducing atmosphere. This process probably occurred on all Archean cratons at around 2.9 Ga, but unique preservation of the Witwatersrand strata accounts for their exceptional gold endowment. Paleoplacers significantly younger than 2.9 Ga received their detrital gold load largely from the mechanical reworking of older, 2.9 – 2.8 Ga placers and, after the first peak in endogeneous gold deposit formation at around 2.75 – 2.50 Ga, more and more from the latter kind of deposits. This explains the spatial and temporal distribution of gold in Neocharchean and Paleoproterozoic conglomerates in all cratons and can help in the assessment of exploration targets within such conglomeratic successions.