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Early Life and Ancient Gold

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Conglomerate-hosted gold deposits of the Witwatersrand-type represent the largest known concentration of gold in the Earth's crust next to orogenic-type deposits. The richest of these deposits reflect a gold mega-event at around 2.9 Ga, when probably >80 % of all known gold entered the crust. This preceded the main peak in orogenic gold production by a few hundred million years, thus excluding the possibility of ancient orogenic gold deposits having been the principal source of Witwatersrand-type gold. While all available evidence points to a (hydrothermally modified) palaeoplacer origin for Witwatersrand-type gold, irrespective of the host stratigraphic unit or even craton, the source of this gold has remained enigmatic. Specific point sources, such as eroded lode gold, VMS, or older palaeoplacer deposits are indicated for most Neoarchaean to Palaeoproterozoic examples. For the richest, Mesoarchaean palaeoplacers, however, such sources were not available in sufficient quantity to explain the extraordinary amounts of gold therein and are not indicated by textural observations. Instead, a process that can lead to extensive leaching of gold at more or less background concentrations in whatever hinterland and subsequent focusing of this gold into spatially restricted trap sites within the sedimentary environment is called for and has been suggested by [1].

The key to explain the trapping of huge amounts of gold in Mesoarchaean alluvial, fluvial to littoral clastic sediments lies in the chemistry of the contemporaneous atmosphere and hydrosphere in combination with the evolution of early life forms [2]. Acid rain in a reducing atmosphere led to deep chemical weathering of Palaeo- to Mesoarchaean granitoid-greenstone terrains while groundwater chemistry was ideal for maximum solubility of gold, thus resulting in a very high Au-flux off the Archaean land surface. Extraordinary concentrations of gold in stratiform layers of kerogen, draping erosional unconformities, scour surfaces and bedding planes in 2.9 Ga near-shore sedimentary successions, testify to the importance of microbes in binding gold from the surrounding waters. Organic chemical and isotopic data [3] leave little doubt in the microbial derivation of these kerogen seams. It is, therefore, suggested that the singular 2.9 Ga gold mega-event was linked to a unique change in Earth's biosphere, i.e., the transition from anaerobic anoxygenic to oxygenic photosynthesizers. The first "whiffs" of photosynthetic O_2 thus produced under an overall reducing atmosphere provided the ideal trap for Au dissolved in meteoric and shallow seawater. Oxidative precipitation of gold on the surface of first O_2-producing microbes, presumably cyanobacteria, is likely to have fixed huge amounts of gold over large areas. This gold provided the principal source for the rich placer deposits that formed by subsequent sedimentary reworking of the delicate microbial mats on aeolian deflation surfaces, into fluvial channels and delta deposits, represented by Meso- to Neoarchaean auriferous conglomerates, best preserved in the Witwatersrand rocks of South Africa. Elsewhere, these gold-rich sediments became tectonically reworked, which explains the secular peak of orogenic-type gold deposits at c. 2.7-2.4 Ga. As the gold-enriched Archaean sediments became progressively eroded, covered or tectonically recycled, their role as source for younger placer deposits diminished. This explains why Witwatersrand-type deposits younger than 2.4 Ga are rare and far less endowed, and effectively missing after 1.8 Ga.

References:
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[3] Spangenberg J and Frimmel HE (2001) Chem Geol 173: 339-355