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The Crustal Gold Cycle

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Gold is concentrated in the Earth's crust in a multitude of different deposit types. These include orthomagmatic deposits, a great variety of hydrothermal deposits with and without magmatic affiliation, as well as syn-sedimentary deposits, such as placers. This wide range in deposit types reflects the multitude of physical and chemical processes that can lead to enrichment in gold from typical crustal background values of a few ppb to economic ore grade values of several ppm.

The temporal variation in gold endowment with regard to different deposit types throughout Earth's history reveals that certain time periods were more suitable for specific styles of gold mineralization than others. From an economic point of view, there are only four deposit types that play a superordinate role. Of all the gold that has been mined so far and that is known to exist as reserves and suspected as resources, about 30 % occurs (occurred) as orogenic-type gold, further 30 % as conglomerate-hosted Witwatersrand-type, 16 % was (is) in porphyry (Cu-)Au and 12 % in epithermal deposits. All other deposit types together account for not more than 12 %, with the Carlin-type being most noteworthy. Focusing on the most important deposit types, a good correlation between the secular distribution of gold in mesothermal, typically shear zone-hosted quartz veins and intensity of orogenic activity has long been recognized [1], hence the term "orogenic-type". Similarly, the strong temporal bias of porphyry-hosted and epithermal gold towards Cenozoic ages has long been explained by low preservation potential of such shallow crustal phenomena in older units. The dominance of orogenic and porphyry/epithermal gold highlights the significance of gold recycling by means of subduction, collision and orogenic crustal growth. Notwithstanding the fact that for some deposits, e.g. the Palaeozoic Muruntau deposit, a juvenile, mantle-derived addition of gold to the crust seems indicated [2], most of the post-2.8 Ga gold is suggested to have been recycled gold that had entered the crust in the course of a singular gold mega-event at around 2.9 Ga [3].

Although most of the continental crust must have formed prior to 3.0 Ga [4], no major orogenic gold deposits are known from pre-Neoarchaean times, suggesting a lack of crustal gold available for tectonic recycling at those early times. This changed with the postulated 2.9 Ga gold mega-event, which led to the formation of Witwatersrand-type deposits, preferentially in Mesoarchaean fluvial conglomerates, first possibly by microbial fixation of gold that had been dissolved in Mesoarchaean rivers and seawater, followed by the sedimentary reworking of the thus formed gold-rich microbial mats into placers [3]. In spite of the very low preservation potential of these surface deposits, the largest proportion of known gold was, or still is, bound to these Mesoarchaean conglomerates. Much of the younger gold deposits, irrespective of their genesis, is likely to be derived from gold originally concentrated into the crusts by

the 2.9 Ga mega-event. This is supported by the extraordinary chemistry of the 2.9 Ga gold, which contains orders of magnitude more Os than younger gold.

References:

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