Giant Ore Deposits – Products of Unique Combination of Fortuitous Environmental Constraints: The Example of Gold

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Ore deposits require special physical and/or chemical conditions to form. Understanding these conditions is critical for establishing a metallogenic model, which, in turn, is a prerequisite for any successful future exploration strategy. The secular distribution of metals concentrated in ore deposits of a given genetic type illustrates that in many cases the concentration was punctuated and took place only at specific short intervals in the long history of Earth when a number of favourable factors coincided in space and time. Gold is a prime example. It is concentrated in a great variety of magmatic, hydrothermal, and sedimentary deposit types, ranging in age from Mesoarchaean to Recent. Almost all requirements for the formation of this variety of gold deposits are reasonably well understood, that is, transport medium, pathways, structural/tectonic setting, trap, and perservation potential. Poorly known is, however, the source of the gold. Recent studies on the secular and spatial distribution of the various gold deposit types and the amounts of gold contained in them, combined with thermodynamic considerations, have suggested that the formation of gold deposits reflects fundamental changes in environmental conditions, biological evolution and styles of large-scale tectonism over the past four billion years. The first major concentration of gold in the Earth's crust took place over an astonishingly short period at around 2.9 Ga when first photosynthesizing microbes scavanged gold from H_2S-rich meteoric waters under an O_2-deficient atmosphere. Gold in these waters was derived from leaching of the Archaean hinterland by acid rain in a warm climate. Mechanical reworking of the gold-rich microbial mats led to the richest placer deposits between 2.9 and 2.7 Ga, particularly well preserved in the Witwatersrand Basin of South Africa. Formation of the other major gold deposit types, orogenic and porphyry/epithermal, required some form of plate tectonics, which began to operate probably at around 3 Ga. A potential gold source in tectonically recycled sediments became available only from 2.9 Ga, which explains the secular peak in orogenic-type gold at 2.75-2.55 Ga. Most of the gold present in younger deposits, regardless of genetic type, is recycled gold initially conentrated on the early crust during the 2.9 Ga gold mega-event.