THEME 6: THE EARLY EARTH AND PLANETS

Session 6.4: Early giant ore bodies

CONVENED BY:

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Many of the world's largest and most profitable orebodies formed early in the Earth's history. Investigation of these orebodies yields critical information about physical and chemical conditions of the early Earth as well as key data on ore-forming processes. Furthermore, different types of giant deposits formed at different times in the Earth's history. Why? How important were changes in the hydrosphere and atmosphere? What role did changes in lithosphere thickness play? We invite contributions on giant Archaean and Proterozoic ore bodies, in particular those focussing on comparisons of mineralising systems and what they reveal about changes in conditions and processes throughout the Precambrian. Contributions addressing thermal and chemical (e.g. pH, redox) conditions and their implications for Earth evolution will also be welcomed.

6.4.11

The Witwatersrand mineralising system

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The Archaean Witwatersrand Gold-Uranium mineralised system is the largest system of its type yet discovered on Earth. Approximately 80% of Gold so far produced on Earth has been derived from this system. The controversy concerning the origin of the Witwatersrand gold deposits has waxed and waned more than 100 years with the balance of thinking favouring a paleo-placer model. Some recent studies support this classical view in contrast to others that support a hydrothermal model of deposit formation. The purpose of this paper is to explore the concept that the Witwatersrand gold deposits were products of a giant hydrothermal or at least giant epigenetic system. This paper presents a number of numerical models for the formation of the Witwatersrand Mineralising System in an attempt to understand the critical controls on both mineralisation and hydrothermal alteration.

We consider two contrasting models of gold transport and deposition. Firstly an intra-crustal fluid convection model that in general terms accounts for the gross distribution of the deposits and mineralogy within the Central Rand Group as well as the observed mineralogy and paragenesis within deposits. In this model, hydrocarbons mix with circulating acid, oxidised fluids, derived from the Transvaal Dolomites, and are transported through the basin by convection systems, thus generating regional gradients in Eh and pH. In a second model we entertain the concept the giant gold deposits of the Witwatersrand Basin are products of water poor, hydrogenous fluids (HCNSO) from the mantle with hydrogen being derived from the deep mantle or core and the gold and PGEs being transported by organometallic complexes. Mixing with hydrous fluids within the Basin causes gold deposition. Such a model not only accounts for the gross architectural and mineralogical properties of the Witwatersrand gold deposits but also accounts for the Re-Os isotopic data as well as linking to global-scale models that attempt to rationalize the distribution of major and giant gold and base-metal deposits through Earth history.