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BOOK REVIEW

Neil Phillips: Formation of Gold Deposits

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This book is the extract of more than 40 years of observation and critical thinking and teaching about gold deposits. It is a pleasure to read from the beginning to the end because it is written by an independent and creative spirit aiming at the essentials. The book is surely not a weighted average of all opinions on gold formation, but is an extremely well-informed personal perspective with a high degree of reductionism. Gold deposits are grouped into two categories: (1) gold-only deposits (about 80% of all-time world gold production) and (2) gold-plus deposits, i.e., those with economic base metals. This simple grouping is derived from observation, but also has a sound scientific basis: The most important elements in nature that can act as ligands for gold complexing, and as such control the aqueous solubility of gold, are sulfur and chlorine. Reduced S works well with Au^{+}, and Cl^{-} works well with Au^{3+}. Reduced and low-salinity metamorphic fluids then can form gold-only deposits, while more saline and oxidized fluids will also transport gold, but with base metals. The message for the gold-only deposits is simple: "Metamorphism of altered basaltic rocks and some clastic metasedimentary rocks at 400–500°C and 10–15 km depth produces a fluid dominated by H_2O-CO_2-H_2S that carries gold. This auriferous fluid is produced on a grain-by-grain scale before it amalgamates and moves via a fracture network upwards to around 5 km depth and 350°C. Active deformation and high fluid pressure facilitate fluid-rock interaction and quartz vein formation. The deposition of gold is primarily, but not exclusively, by reduction and wall-rock sulfidation" (p. 157). This model is demonstrated by many natural examples from all continents and by extensive chemical background knowledge on gold geochemistry. In particular, the concept of electronegativity and the important role of CO_2 as a pH buffer near the H_2S-HS^{-} equilibrium is recalled. Apparent exceptions, such as gold ore deposits in granulitic terrain, are critically reevaluated and simply explained as metamorphic overprint on greenschist-facies gold. The gold-only and gold-plus grouping has another bonus: It is considered "unreasonably effective," i.e., the simple conclusions have many more implications and greater value than initially expected, including exploration success. This aspect is explained with two encouraging case histories from Australia (Yilgarn and Bendigo) where the application of new metallogenic concepts led to successful exploration and mining.

The metamorphic devolatilization model avoids terms such as "orogenic," "epithermal," or "mesothermal" with their continuously evolving definitions and is incompatible with the popular "continuum model" (epizonal to hypozonal). Indeed, metamorphic devolatilization provides access to vastly more gold in any larger rock volume than alternative processes and explains well the gold-only signature of most gold deposits, possibly also Carlin-style gold deposits for which, unexpectedly, a regolith setting with long-lasting (40 Ma) deep weathering is proposed. The model is maybe less convincing for gold-plus deposits, where the author (tentatively) also applies the metamorphic fluid concept and invokes meta-evaporites as a source of salinity. This explanation may be so for some IOCG deposits, but will be difficult to defend for Cu–Au porphyries.

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Although the author likes the big scale, the transcrustal nature of metamorphic belts with their volcanoplutonic components may be underestimated. It appears that the metamorphogenic model sensu stricto could well be complemented by translithospheric processes of devolatilization and metasomatism. But as the author states, the book is a practical and personal approach without any obligation for completeness.

The book is relevant and inspiring to anybody interested in Earth science and particularly for young and old economic geologists (also recommended for "retired scientists"; sic! Preface) and professionals from the mineral industry.

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