

BOOK REVIEWS

GOLD METALLOGENY AND EXPLORATION. Edited by R. P. Foster, Blackie and Son Ltd. (U. K.), 1991; pp 432; Price £ 85.00

Most of us are aware that the world is now witnessing gold rush on an unprecedented scale. Naturally, we are having a surge of publications including those arising from many major symposia on various aspects of gold exploration. This book (a collection of chapters written by different geoscientists), aims at providing a succinct synthesis of all major aspects of gold metallogeny and exploration. The contents include chemical distribution of gold in the earth's crust, the hydrothermal chemistry of gold, Archaean and Phanerozoic lode deposits, epithermal environments, chemical sediments, ancient placer deposits, geochemical exploration in different terrains, geophysical exploration and the economics of gold deposits.

Crocket's chapter on distribution of gold in the lithosphere incorporates selected major data bases. In the Indian context, it is worth noting that granulites are probably depleted in gold relative to lower grade rocks by metamorphic processes that generate granulites. In gold-poor greenstones, deformation and metamorphism might be the causes for the subsequent dispersal of gold. In Precambrian iron formation gold exceeds 100 ppm in sulphidic interflow beds within volcanic sequences (e.g., Kambalda). Oxide-dominated iron formations occasionally host replacement gold deposits in association with discordant quartz or felsic porphyry intrusions. Depositional environment may exert control on gold content in volcanic-hosted oxide facies iron formation when compared to shelf sediment-hosted iron formation. This chapter also includes excellently-tabulated mineral data representing extensive survey of original literature.

Seward in the chapter on hydrothermal geochemistry of gold discusses the current state of knowledge concerning high temperature, high pressure aqueous chemistry of gold and its relevance to gold ore formation. Several mechanisms of gold deposition and the importance of gold complex equilibria in determining how and where gold precipitation occurs are described. It is stated that surface chemistry may be a significant factor in the deposition of gold and sulphide colloids may act as extremely efficient scavengers of gold providing an additional potent mechanism for concentrating gold. Thus, adsorption and subsequent reduction of gold complexes on mineral surfaces such as pyrite become important.

The chapter by Groves and Foster describes the lode gold deposits in the Archaean granite-greenstone terrains (though characterised by a heterogeneous distribution of mineralisation) which have largely contributed to world gold production. Structural styles which play a dominant role in controlling the distribution of gold and the geometry of ore shoots are described. On the timing of mineralisation, it is stated that in any one terrain, gold mineralisation broadly represents a single event related to late-deformation accompanying or outlasting peak metamorphism and post-dating the intrusion of most granitoids, felsic porphyries and lamprophyres. It is mentioned that the most prospective greenstone belts (related to volcanic arc/marginal basin complexes in convergent margin settings) and those containing giant gold deposits appear to be Ca 2.7 Ga in age, although restricted areas of older greenstone belts may also be well mineralised. Besides

listing the most important parameters of mineralisation for exploration, the authors state that geological models will become increasingly important as a guide in addition to geochemical and/or geophysical exploration combined with basic field mapping.

Phanerozoic gold deposits are characterised by their heterogeneity/variety and include epithermal, intrusion-related, Carlin-type and auriferous massive sulphide deposits. Nesbitt focuses mainly on geological and geochemical characteristics of mesothermal gold deposits. These do not appear to be closely associated with any particular host-rock lithology, though, they appear to be restricted to greenstone facies metamorphic units. There is close similarity between Archaean and Phanerozoic mesothermal deposits, but disparity in gold abundance (larger accumulation in Archaean deposits) remains enigmatic. Henley describes some case studies of epithermal gold deposits in volcanic terrains, viz., Hishikari, Japan; Kelian-Kalimantan, Indonesia; and Ladolam, Lihir Island, Papua New Guinea. Since the majority of large epithermal systems are characterised by extensive alteration haloes, regional geochemistry and mapping of alteration in bed rock or float material in conjunction with geophysics (airborne and ground) are of prime importance in exploration. Sillitoe documents the variety of intrusion-related gold deposits and their interrelationship and origin. Many of them possess characters common to porphyry type Cu, Mo and/or gold mineralisation. From the exploration point of view, recognition of the style(s) of gold mineralisation during prospecting may help in selecting the most suitable methodology. The various Tables furnished depict the characteristics of different kinds of deposits, e.g., porphyry and non-porphyry type, skarn and carbonate replacement type, breccia-hosted and vein type related to intrusions.

Carlin-type gold deposits which are essentially carbonate-replacement types and associated with alkaline igneous intrusion characterised by high gold to silver ratios are described in detail by Berger and Bagby. This type of deposit has not been identified in India (such a geological setting may exist in the Himalayan regions). The exploration guide-lines such as the use of jasperoid as a tool aided by trace element geochemistry and petrographic studies may help in the identification of economically valuable deposits.

Hannington *et al.*, describe the occurrence and distribution of gold in modern hot spring deposits and discuss aspects of gold transport and deposition in sea-floor hydrothermal systems and origin of gold deposits in auriferous chemical sediments. Such deposits are found throughout the geologic record. Many Archaean deposits do show similarities to gold-bearing hydrothermal precipitates on modern sea-floor.

In the chapter on ancient placer gold deposits, Minter describes geological setting (in South Africa-Kaapwal Craton, Brazil-Sao Francisco and Ghana-West African Craton), geometry, mineralogy, structural control and their common characteristics as related to the stage of crustal evolution, the nature of earth's atmosphere, lithology of the source terrain, degree of weathering and the sedimentary processes that prevailed. Braid-delta model of coalescing placers seem to account for the many characteristics of ancient placer deposits.

Zeegers and Leduc have lucidly described utilisation of geochemical techniques for gold exploration in varied terrains such as temperate, arid, semi-arid and rain forest and have pointed to specific signatures with examples and case histories. They emphasize that the geochemical signature of gold mineralisation obtained in different surface and sub-surface sampling media mostly depends upon the behaviour

of gold and accompanying minerals in the relevant supergene environment. In tropically weathered terrains, the signature in the mineralised bed rock is altered in different horizons of the weathering profile. Some elements are leached, others maintained or even enriched. Thus, most of the pathfinder elements which are immobile or only partly mobilised during weathering, can be used even in deeply leached environments. Panning for visible gold is stressed as the most pragmatic approach to regional geochemical exploration though secondary gold which is commonly very fine-grained may not be detectable by panning. Multi-element analysis helps in identifying styles of mineralisation in deeply weathered terrains. Problems specific to exploration for gold in till-covered glaciated terrain are described by Coker and Shilts in a separate chapter.

Paterson and Hallof have described geophysical methods used in gold exploration. The main focus is to locate appropriate geological environments in which gold is most likely to occur. The authors mention the characteristics that constitute typical signatures of environments in which gold deposits commonly occur alongwith methods and exploration strategies illustrated by case histories. For regional exploration, aeromagnetic, gravity, radiometric, airborne E.M. and ground controlled source audio magneto-telluric (CSAMT) methods have been found to provide useful information. In palaeo-placer, the seismic reflection method is stated to be useful both as a regional and detailed exploration tool.

The final chapter on the economics of gold deposits examines in terms of historical production trends, evaluation procedures, and illustrative deposit characteristics. It is stated that future growth potential and the pattern of world supply will be shaped by changing relationships between overall market forces and the geological environment in which gold deposits occur. To quote Mackenzie, the author,—‘Although economic gold deposits are elusive, they are, as illustrated in this chapter, a prize worth seeking’.

An exclusive chapter on exploration techniques employed in lateritic terrains could have been included though some aspects are dealt in the chapter on geochemical exploration. Similarly, exploration for alluvial gold with case histories would have further enhanced the value. The book has a number of useful tables; charts and reference lists. Though, expensive, it will be very useful for all those professional geologists who are engaged in gold exploration.

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PRINCIPLES OF SEDIMENTARY BASIN ANALYSIS. By Andrew D. Miall,
Second Edition, 1990. Springer-Verlag. 668 pp. (DM. 128/-).

The author, as in his first edition which was published in 1984, claimed that the book was intended to serve as a practical hand-book for those engaged in the task of analysing the palaeogeographic evolution of ancient sedimentary basins. The science of sedimentology has unfortunately grown too much on the theoretical side and very little guidance is available on methods, observation, mapping and interpretation. The book is aimed to fulfil this need. Emphasis is on what one can really see in outcrops, well-records, cores and geophysical profiles especially seismic profiles. Hence, the book involves a new approach to stratigraphy and explains the genesis and not formal description and naming of lithounits. The other sections which have merited detailed consideration are principles of facies