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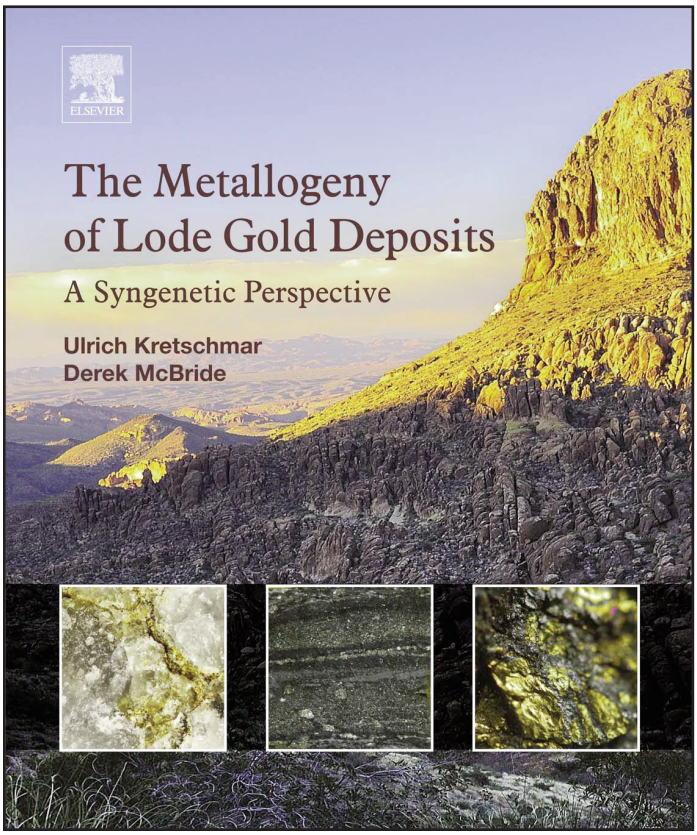
REVIEW



The Metallogeny of Lode Gold Deposits: A Syngenetic Perspective

Ulrich Kretschmar and Derek McBride

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The publisher's synopsis of this abundantly illustrated and colourful book of 350 pages claims that it "*presents a ground-breaking formation theory for lode vein gold deposits coupled with practical exploration guidelines*." The book is written by two Canadian exploration geologists Ulrich Kretschmar (who passed away in 2014) and Derek McBride, and their thesis is that lode gold deposits are syngenetic and were formed by hydrothermal fluids emanating on the seafloor and ponding in depressions. These fluids deposited ore minerals in a silica gel that later crystallized as quartz laminations conformable within the local sedimentary sequence. The main quartz veins of lode gold deposits, now mostly steeply dipping, were therefore originally flat lying, and their previously interpreted 'crack-seal' laminations represent sedimentary or diagenetically developed lamina. An underlying premise throughout the book is that the authors' approach is primarily based on field evidence that they have seen in outcrop and that they consider as not explained adequately by other genetic models.

As requested by the authors, I started reading this book with an open mind as I went through the various chapters that present the authors' evidence for syngenesis. Their evidence is mostly personal observations made whilst exploring lode gold and Volcanogenic Massive Sulfide (VMS) deposits in eastern Canada, along with some supporting information based on reviews of selected literature on these types of deposits and on modern seafloor massive sulphide systems. As a Kiwi geologist I was disappointed that the reviews made no mention of the New Zealand orogenic/mesothermal shear-zone lode gold deposits, particularly of the Reefton Goldfield, which clearly do not fit a syngenetic model because most of the quartz veins crosscut bedding, and bedding-parallel veins are rare. Nevertheless, I continued with an open mind rationalizing that maybe the authors were not suggesting that all lode gold deposits were syngenetic and that I should try and see the possibilities for some deposits in other parts of the world. Unfortunately, there is no world map included showing the lode gold deposits that the authors include in their syngenetic class.

Chapter 1 provides a review of various models for lode gold formation in an historical context, in some instances with the authors' comments on their views on the inadequacies of the models and how their syngenetic model would better explain specific characteristics. The chapter finishes with a discussion on syngenetic gold formation concepts, listing some factors that most geologists would consider to negate a syngenetic origin and then attempts to counter these. For example, radiometric dates of mineralization that are much younger than the sedimentary host rocks are dismissed as dating errors resulting from non-representative sampling or resetting of

ages by later thermal events such as igneous intrusions. I immediately thought of the extensive Ar–Ar dating done on the deposits in Victoria, Australia by Denis Arne, Frank Bierlein and others, that shows several periods of gold mineralization many millions of years after host rock deposition. Also, there is an enormous volume of literature on structural controls and development of lode gold deposits (e.g. contributions by Rick Sibson, Francois Robert and Stephen Cox) that is ignored or given only passing reference in review sections of the book, because the structural aspects are considered to postdate vein formation.

Chapter 2, *Interpreting Textures in Outcrop*, describes several features of lode gold deposits in the Ordovician turbidite rocks of the Meguma Group of Nova Scotia emphasizing the bedding-parallel nature of the main veins and suggesting that they are bedding-concordant. Crosscutting veins are considered as feeders to the bedding-concordant veins. The Archean deposit in the Kenty mine, Ontario, is also included to show an example of crosscutting 'feeder' veins and a link to Youtube videos on the Stawell and Morning Star mines in Victoria, Australia, both of which are definitely not syngenetic deposits. Chapter 2 also introduces the term 'gold cycle' that is explained in Chapter 3, *Introduction to Gold Cycles*. In this very short Chapter 3, the gold cycle concept envisages the quartz veins as part of sedimentary cycles such as Bouma-sequence turbidite units, with the quartz veins primarily associated with the fine sediment of pelagic or abyssal mud, ash or crystal tuff, and carbonate. Lamprophyres noted in many lode gold deposits are suggested to be mistakenly identified and to actually represent dark green or black chlorite-rich, fine-grained interflow sediments or tuff. Examples of gold cycle stratigraphy are given from Larder Lake and Timmins.

Chapter 4, *Field Examinations in a Variety of Gold Settings in Canada: The Meguma, Nova Scotia; Chester Twp and Beardmore, Ontario; Maskwa, Manitoba, and Nugget Pond, Newfoundland* is, as the title states, a series of geological descriptions of the above-named gold deposits. Many of the intrusive rocks of the Chester Complex are reinterpreted as basaltic to rhyolitic volcanic rocks and these enclose 'Gold Cycle' units. The descriptions of disseminated sulphides, sulphide bands and siliceous bands in some of the prospects do indeed conjure up images of VMS deposits. Mapped intrusive rocks of the Maskwa Pluton that host some large veins are also interpreted as originally volcanic rocks that have been metamorphosed to resemble plutonic rocks. Mafic dykes, lamprophyres and shear zones are reinterpreted as former pelagic-pelitic sedimentary units. I was impressed by photos of the Golden Mile vein in the Beardmore area that is 1.5 m thick, extends for > 1 km, and said to be hosted by mafic and felsic flows, and began to be swayed into considering a possible syngenetic origin for this one.

Chapter 5, *Why Lamprophyres Have No Role in Lode Vein Genesis*, uses examples in the Chester Complex, Maskwa Pluton and a few other locations to demonstrate that the lamprophyres in these areas studied by the authors are fine-grained 'Gold Cycle' interflow sedimentary units. This is partly done on the basis of geochemical data presented in several tables and in geochemical discrimination diagrams.

Chapter 6, *Felsic Volcanism Associated with Mineralization in the Chester Complex – Type Gold Deposits*, describes the Chester Complex volcanic rocks and their setting and then compares them to the Noranda Camp.

Chapter 7, *Understanding Hydrothermal Systems*, is a review of seafloor hydrothermal systems, the transport and deposition of silica and gold, and the role of carbon (graphite) in gold deposition. The Papua New Guinea Manus Basin and New Zealand Kermadec Arc, both of which are known to have gold-rich hydrothermal systems, are not mentioned.

Chapter 8, *The Role of Structural Geology and Remobilization*, describes the process of folding and cleavage development and then discusses shear zones as post-mineralization deformation, in contrast to accepted interpretations that the shear zone is the site of veining and mineralization in lode gold deposits. I found it confusing that the Heath Steele VMS deposit in New Brunswick was used as an example to show the negligible effects of remobilization on mineralization. A section of deformation of minerals and veins again confusingly includes some VMS examples, but has some excellent photos of folded veins in the Meguma Group. The chapter primarily aims to convince the reader that the structural aspects of lode gold deposits postdate mineralization. It didn't convince me.

Chapter 9, *Lode Gold Deposits: Their Geometry and Evidence For Seafloor Vent Systems*, uses maps, level plans and sections of lode gold deposits, mostly Canadian, taken from published and unpublished literature, to illustrate the geometry of the deposits and their geological setting. The selected deposits are ones in which the authors have 'personal experience' and hence many of the classic deposits where structural control is paramount are not mentioned.

Chapter 10, *Toward a Syngenetic Model and Vent Geometry*, develops the syngenetic model and includes sections on "Observations to aid exploration applications" and "Area selection." The titles offer promise, but the text is rather disappointing based mainly on distinguishing younging direction, stratigraphic correlation, 'vent tracing' based on the proportion of quartz (assuming this increases toward the seafloor vent), stratigraphic control, volcanic facies mapping and geochemistry to establish proximity to vents. Examples, where given, are only briefly described. Mostly this is a section of suggesting which exploration approaches might work. The area selection section is a generic list that applies to any mineral exploration so there is no specific advice in this list for syngenetic lode gold deposits. The chapter also includes a section on identifying and targeting volcanic rocks in units previously described as tonalite, trondhjemite and granodiorite, as well as a syngenetic classification of deposits and a recipe for using the model for target selection based on spatial relationships.

Chapter 11, *Comparisons, Conclusions, Suggestions for Further Work and Application of the Syngenetic Model*, summarizes many aspects of the preceding chapters and includes a table of characteristics of lode gold deposits comparing and contrasting the epigenetic and syngenetic interpretations. The chapter and book end with a short section on "The proof is in the success of the model in its positive application." It claims that application of the model was a key factor in the discovery of the

Nugget Pond deposit, the first gold find in the Bett's Cove Ophiolite Complex by a team led by McBride.

The authors' writing style is easy to read and chatty in many sections. There are a number of minor typos and errors in the text and figures, but none are critical. There is some repetition of information between sections and chapters, and three photos are produced twice in different chapters (Fig. 2.4 = Fig. 4.24; 2.5 = 4.26; 2.3 = 7.1). There are many instances of photos and tables that appear before their first mention in the text. I think the book would have benefited from more careful peer review and editing. I was supplied with a PDF version and printed it for my review. However, I found many of the field scene photos too small on the printed page to see what was illustrated and had to revert to the PDF to view the photos enlarged on screen. The review nature of some sections results in a large number of old references and many of the more recent references are unpublished exploration reports by the authors, giving the impression that the information is a bit dated. However, of the 568 reference listed in the references section 19% are from 2000–2009 and 11% are from 2010–2015. Nevertheless, references from the 1990s to recent publications on the genesis of orogenic gold deposits are limited and those included are mostly dismissed.

In conclusion, the book contains some informative photos and illustrations, some interesting but biased reviews of lode gold deposits, but an unconvincing development and description of the syngenetic model with little practical information for use in exploration. I recommend a quick look at a library copy, but I would be very disappointed if I had paid for my copy.

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