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Celebrating Lindgren and Others: Rebooting Mineral Deposit Classifications

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Mineral deposit classifications employ selected properties to identify deposit types and to facilitate concise communication of complex detail. To avoid confusion, and often argument, they need to ensure that the properties they reference are also part of equally well structured classification systems. Knowledge engineering applications of artificial intelligence (AI) provide the tools necessary for these purposes, which materially contribute to Lindgren's quest for a complete mineral deposit classification. Additionally, a 21st-century mineral deposit classification is required to facilitate communication not only between humans but also between humans and computers and between different computer systems.

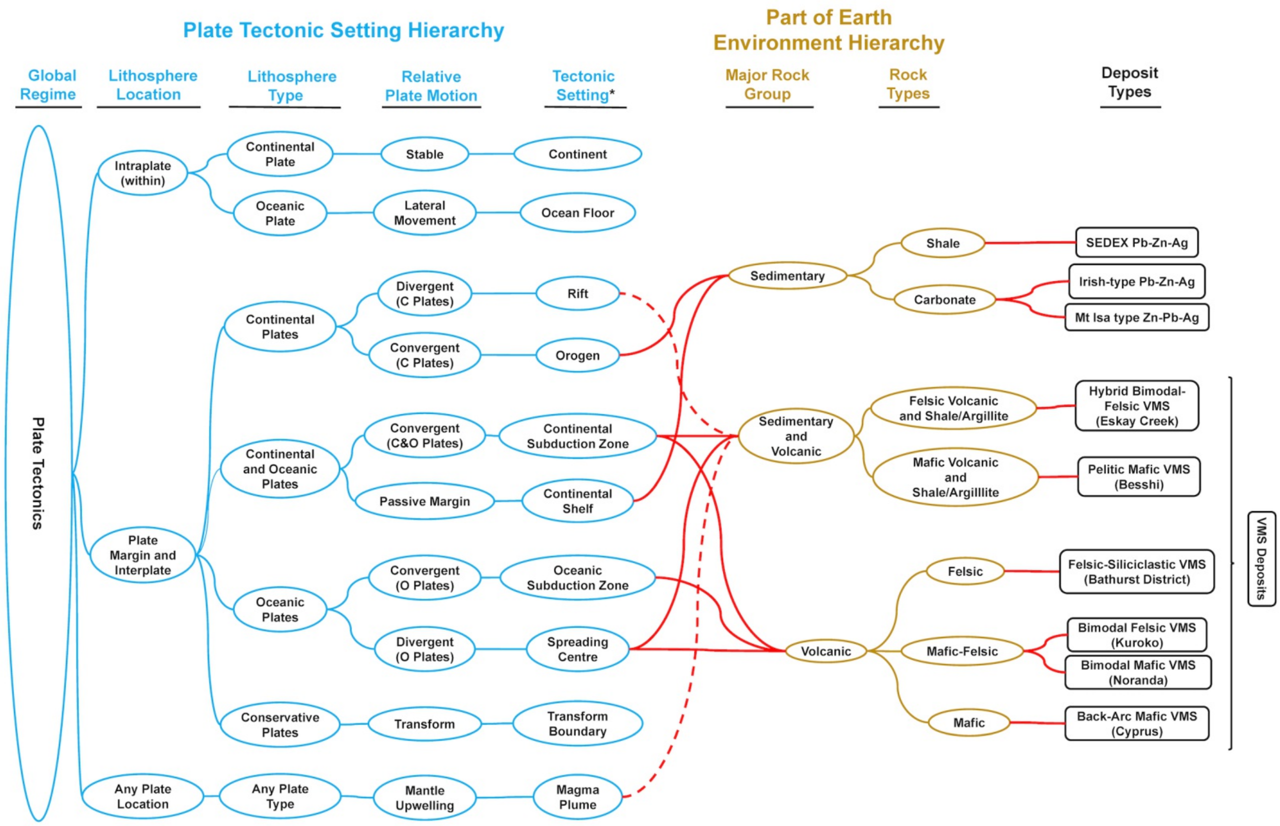
The authors have developed a prototype mineral deposit classification system that harnesses research documented by Lindgren, Stanton, Von Cotta, and many others to meet these objectives. The Multi-hierarchical Mineral Deposit Classification (MMDC) uses plate-tectonic settings, mineral systems parameters, host earth materials, ore textures, mineralogy, commodities, and other properties to characterise deposit types. As a starting point, the MMDC has been populated by drawing on deposit profiles published by the British Columbia Geological Survey (BCGS).

The MMDC has a graph structure, rather than a tree structure, meaning that a particular deposit type may qualify as a subtype of more than one supertype. This structure can help economic geologists to better understand the distinctions between similar deposit models, such as various types of massive sulphide orebodies (Fig. 1). The ability to use classification graphs becomes extremely important when tackling a complete classification of all metallic, industrial mineral, precious stone, and gemstone deposits.

The Aristotelian Class Editor (ACE) is a free, online taxonomy editor that is used for this project to capture deposit model properties sourced from published mineral deposit models. ACE provides a logically consistent framework for organizing mineral deposit properties and managing the resulting hierarchies of deposit-type classes that are created from combining those properties. Some of these classes will be novel groupings of mineral deposits with matching properties, which may constitute a "new" deposit type. The formally defined ACE files are well suited for use in AI systems engineered to assist in minerals exploration, geometallurgy, and environmental protection.

The MMDC is built on internationally documented terminology and data exchange standards. Used in ACE, these standards enable the coexistence of any number of different deposit models. Mining industry workers and academic researchers can collaborate to select the properties and related attributes they wish to use to classify mineral deposits, name their models, compare them efficiently with other models, and choose the models for their particular purpose. New models can be added and are automatically categorized. MMDC files can be exported in Excel or JSON formats for use with other software to explore the relationships between models, between deposits and models, or between specific deposits.

Fig. 1. A graph structure is used to classify volcanogenic massive sulphide and selected sedimentary-hosted stratiform and stratabound mineral deposit models. It uses a plate tectonic hierarchy and a portion of an earth environment hierarchy to separate these deposit types more effectively than a traditional tree structure.



* Only selected primary tectonic settings are shown.