CORDILLERAN SECTION
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MDRU
Mineral Deposit Research Unit

The GAC-CS and MDRU are pleased to announce a presentation by 2015 Howard Street Robinson Lecturer

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Zn-rich Volcanogenic Massive Sulphide (VMS) Deposits

Location:

BCIT downtown campus, 555 Seymour Street, Atrium Theatre 825 (top floor).

Date/time:

November 18th, 4 pm

No RSVP necessary but seating is limited. The event is free.

Steve Piercey will also present talks at UBC and SFU on Friday November 20th.

Abstract

Base metal-dominated volcanogenic massive sulfide (VMS) deposits are important global resources of zinc (Zn) with many deposits having Zn as the main commodity of production. Global VMS deposits can be classified into Zn-rich, zinciferous, and anomalous based on global geological resource data. Zinc-rich deposits have Zn > 6.1% (geometric mean + one standard deviation) and >1.27Mt of contained Zn (>90th percentile for all deposits globally). Deposits that are high-grade with Zn>6.1% but have <1.27Mt are considered zinciferous, whereas deposits that have high tonnages and >1.27Mt of contained Zn, but low-grades (Zn<6.1%) are considered anomalous deposits. Collectively, these deposits with abundant Zn are collective considered Zn-enriched deposits.

Zinc-enriched deposits are preferentially associated with VMS sub-types that are associated with felsic volcanic rocks and/or sediments (i.e., bimodal felsic, bimodal mafic, and felsic siliciclastic sub-types). All Zn enriched deposits are preferentially hosted in Phanerozoic sequences, but there are significant deposits found in Archean and Paleoproterozoic rocks. Furthermore, throughout Earth's history Zn-enriched VMS deposits show a distinct secular evolution with peaks in total contained Zn in the late Archean (~2.7 Ga), Paleoproterozoic (~1.9-1.8 Ga), Cambrian-Ordovician (~510-460 Ma), and Devonian-Mississippian (~390-355 Ma), with subsidiary peaks in the Mesoarchean (~3.0 Ga), Neoproterozoic (~0.75 Ga), Mesozoic (~220-200 Ma), and Cenozoic (~110-90 Ma).

The secular distribution of Zn-enriched, and VMS deposits in general, is directly related to accretionary orogenesis and crustal growth processes. In the Precambrian, the abundance of Zn-rich VMS deposits is directly related to crust-forming events, juvenile crustal growth, and supercontinent formation, particularly in the late Archean and the Paleoproterozoic. Phanerozoic Zn-enriched VMS deposits, although associated with accretionary activity, are not directly associated with the terminal phases of supercontinent formation, and commonly formed a significant period of time (i.e., commonly >100 m.y.) prior to final supercontinent amalgamation, suggesting that other processes were more important in controlling their temporal distribution. Despite associations with accretionary orogenesis, both Precambrian and Phanerozoic Zn-enriched VMS deposits are associated with extensional geodynamic regimes (e.g., mid-ocean ridges, arc rifts, and back-arc basins).

Other factors that were favorable for the formation and siting of Zn-enriched VMS deposits include: 1) sedimentary rocks in the host stratigraphic succession and anoxic basinal conditions and 2) semi-permeable cap rocks. Sedimentary rocks deposited during reduced marine conditions (i.e., anoxic sediments at the time of VMS formation) can limit the amount of reduced sulphur in the hydrothermal fluids, and pore waters in the sediment can add chloride, both of which help increase the solubility of metals transported in the hydrothermal fluid. More importantly, sedimentary host rock enhances the preservation of VMS deposits, and the formation of large Zn enriched deposits because they promote subseafloor replacement-style VMS mineralizing processes. Marine basinal anoxic conditions were important for the formation of some Phanerozoic VMS deposits (particularly felsic siliciclastic-types). Anoxic ambient conditions (either local or large-scale) result in a stratified water column with H_2S-rich bottom waters that prevented the oxidative weathering of VMS deposits, and also provided additional reduced sulphur to fix metals discharged from hydrothermal vents. The additional H_2S present in the water column may have allowed for the more efficient trapping of metals and the formation of larger tonnage Zn-rich VMS deposits (e.g., Brunswick Number 12). The additional reducing conditions also likely prevented the oxidation of deposits, thereby, increasing their preservation potential in the geological record. Cap rocks (e.g., barite, chert, carbonate semi-permeable tuff, shales) that immediately overlie mineralization were critical for increasing the efficiency of zone-refining processes and resulted in abundant Zn-Pb dissolution, re-precipitation and upgrading of Zn grades in deposits leading to high-grade Zn-rich and zinciferous VMS deposits.

Various lines of evidence (e.g., fluid inclusions, metal assemblages, mass balance constraints) suggest that magmatic fluid and metal contributions may have been be importarge (e.g., Kidd Creek, Brunswick #12, Neves Corvo) and/or high-grade Zn-rich deposits (e.g., Buchans, Hellyer). None of the evidence uniquely suggests that magmatism contributes Zn to these deposits; however, given their size and/or grade it is conceivable that significant Zn may be derived from magmatic fluids. This question should be at the forefront of research on Zn budgets in VMS deposits in the near future.