Mineral Systems Models for Clastic Dominated Zn Deposits: From the Geodynamic- to the Micro-Scales

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Clastic dominated (CD) Zn deposits are the product of time integrated processes operating from the geodynamic to the micro-scales. At rifted margins, the interplay between tectonic and surface processes may generate large volumes of sediments which may be the source, or the trap, for metals. The coupling of ASPECT rift models with Fastscape models of surface erosion and sedimentation has allowed us to assess the most prospective part of rifted margins, where faults connect source rocks (rift clastics >250°) with host rocks (organic-rich marine sediments <150°). In Paleozoic Selwyn-type deposits, the most prospective areas are sub-basins closest to the continental margin, formed in narrow asymmetric rifts. In these sub-basins, redox and temperature gradients between ore fluids and host rocks on the macro- and micro-scale control reaction permeability, metal deposition and the nature of alteration. In Selwyn-type deposits, reduced hydrothermal fluids react with, and replace, diagenetic barite (oxidized sulphur). In McArthur type deposits, an oxidized fluid reacts with diagenetic pyrite (reduced sulphur) resulting in the dissolution of carbonate and precipitation of sphalerite. Reactive transport models of replacive mineralization in both deposit types show that ore grade and alteration styles are influenced by local pore-scale mineralogy and geochemistry in prospective horizons. The formation a large CD deposit, therefore, requires the alignment of key processes from the lithospheric to micro-scales. At the district to camp scale, the nature of the redox trap is key for understanding the alteration assemblages produced by the hydrothermal system and should be considered in vectoring strategies.