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LITHOGEOCHEMISTRY OF ALTERED WALLROCKS, SULLIVAN SEDEX Zn-Pb-Ag DEPOSIT AND ASSOCIATED DISTRICT-SCALE GRABEN

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The Sullivan deposit is located within a north-south graben >6 km long by 1-3 km wide, parallel to the rift axis of the Aldridge time, Belt-Purcell basin. An east-west composite geochemical section through the Sullivan deposit and extending across the graben displays the distribution of selected major oxides (SiO_2, Fe_2O_{3t}, MnO, MgO, CaO, Na_2O, K_2O, H_2O, CO_2, S_t) and trace elements (Ag, As, B, Ba, Bi, Cu, Hg, La, Pb, Rb, Sb, Sn, Zn), uncorrected for volume changes, that reflect alteration processes. Other oxides (Al_2O_3 and TiO_2) and trace elements (Nb, Y, Zr) are relatively immobile and can be used to estimate the amount of volume change during alteration. Some trace elements (Cr, Sc, V) distinguish altered gabbros from sediments.

High SiO_2 (>75%) is associated with quartzitic wackes in the hanging wall Middle Aldridge Formation and the footwall quartzite. Local silicification associated with muscovite alteration in the Sullivan upflow zone is only rarely detected chemically, but intense silicification is associated with the Kimberley Fault. Depletion of SiO_2 indicates intense leaching of quartz associated with chlorite or albite alteration. Elevated Fe_2O_{3t}, MgO and S_t are associated with tourmaline- or chlorite-pyrrhotite alteration in the footwall vent zone or immediately surrounding the orebody; low Fe_2O_{3t} and MgO are associated with muscovite or albite altered rocks. Elevated MnO is found in and below the ore horizon, for up to 1 km from the edge of the vent, and (with elevated CO_2) also indicates garnet- or carbonate-rich upflow and/or exhalitive zones west of Sullivan. Spot highs for CaO and CO_2 indicate muscovite-carbonate alteration, locally of tourmalinite, or epidote alteration of gabbros. Na_2O is low in the footwall vent zone, moderate in hornfels or granophyre near gabbros, and high in albitite in the Sullivan hanging wall and near the Kimberley Fault. Elevated K_2O is not diagnostic of muscovite alteration since biotite hornfels, granophyre and very argillaceous rocks have even higher values; low values are found in the footwall tourmalinite. However, both extensive stratabound and discrete crosscutting muscovite alteration zones are delineated by elevated trace metals (As, Sb, Hg, Zn, Pb). Correlation matrices suggest Ba, Rb and in part Nb covary with K_2O in the deposit-scale data; however, on the graben scale Ba is depleted close to the deposit relative to background levels further away. Elevated H_2O values are due to hydrous phyllosilicates (chlorite and muscovite altered rocks) in and around the ore horizon. Pb, Zn, Ag, Sb, Bi, Cu and Hg delineate the ore horizon and a deep chlorite-altered root at the east margin of the vent complex, below the Transition Zone. A weak halo is evident for As, Sb and Hg, particularly to the west of the deposit with elevated Pb and Zn. At the deposit scale, As is concentrated in the footwall pipe with Cu, Sn B and La. Sn and B are also high in former hanging wall tourmalinite that has been albitized, and Sn is high on the periphery above the ore horizon; high La indicates mobilization of LREE in the footwall pipe. At the graben scale, B is low immediately surrounding the Sullivan vent zone and near the Kimberley Fault.