Using pillowed flows to locate effusive centers and explore for volcanogenic massive sulfide deposits: an example from the Archean Abitibi Greenstone Belt of Canada

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There is a well established relationship between the locations of submarine effusive centers and volcanogenic massive sulfide (VMS) deposits. The fluids that create the Cu-Zn-Pb-Ag-Au VMS deposits rise along synvolcanic faults in extensional environments; these faults can also control the location of dikes feeding felsic to mafic lavas. Therefore, locating effusive centers can help target mineral exploration in prospective districts. Pillow lavas are well suited for this purpose due to their relatively consistent lateral facies and thickness variations. In the absence of pre-eruptive topography, the maximum thickness of such lavas should be found near the vent. Mafic to intermediate flows tend to be massive to pillowed in proximal areas; the proportion of hyaloclastite and pillow breccia increases, whereas the proportion of massive rocks decreases, away from the source. Pillow size can decrease in distal areas. For ancient successions, such variations can be documented in outcrop but also in exploration drill cores. Furthermore, if it can be assumed that a stratigraphically and geochemically consistent package of flows emanated from a single vent area, then facies variations can be compiled for this entire package rather than individual flows. This approach is illustrated for a 132 m-thick package of tholeiitic basaltic andesite flows in the Hebecourt Formation (Blake River Group) from the 2.7 Ga Abitibi Greenstone Belt in Quebec, Canada. These non-vesicular variolitic rocks are part of a submarine lava plain, perhaps in a back-arc basin. The proposed effusive centre for the basaltic andesite unit, identified using thickness and facies variations, is just above replacement-style VMS mineralization in an underlying rhyolite flank breccia.