

Anomalous metal concentrations in soil and till at the Ballinalack Zn-Pb deposit, Ireland

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Metals such as zinc, iron, arsenic and lead are commonly found in low concentrations within soils. These signatures may occur as a result of natural dispersion from metal-bearing geological formations and (or) from anthropogenic sources. Prior to investigating any high or anomalous concentrations of metals in the surficial environment, it is important to reconcile potential sources of metals and verify whether element anomalies are in response to buried mineralization.

Here we show how to distinguish true elevated concentrations from naturally occurring variations within a soil system. The research area is situated above the limestone-hosted Ballinalack Zn-Pb deposit in the central Irish Midlands. To investigate the pedogenesis and its related geochemical signature, top of the till and the BC soil horizon were sampled. Although the area can be described as pasture land, it does not preclude previous anthropogenic influences from former agricultural use and local small scale peat harvesting. For the soil BC horizon as well as in the top of the till, aqua regia-digestible element concentrations vary significantly and locally reach anomalous levels: Zn (median: 104 ppm; range: 27 - 13150 ppm), Pb (median: 16 ppm; range: 2 - 6430 ppm), As (median: 7.7 ppm; range: 1.4 - 362 ppm), Ag (median: 0.12 ppm; range: 0.04 - 19.9 ppm), Ba (median: 40 ppm; range: 10 - 1230 ppm), Cd (median: 1.5 ppm; range: 0.2 - 68 ppm), Co (median: 7.3 ppm; range: 0.5 - 22 ppm), Ni (median: 37 ppm; range: 3 - 134 ppm), Fe (median: 17900 ppm; range: 5000 - 52300 ppm), Ga (median: 2.4 ppm; range: 0.3 - 7.6 ppm), Sb (median: 1.2 ppm; range: 0.1 - 197 ppm) and Tl (median: 0.3 ppm; range: 0.02 - 8.6 ppm). Comparison with background levels from the area and grouped according to underlying geology, enrichment factor calculations (against Nb and Zr) indicate an elemental response to metalliferous-bearing bedrock. These results confirm that soil anomalies of Zn, Pb, As, Ag, Ba, Cd, Ni, Sb and Tl, are consistent with the characteristics of buried Waulsortian-hosted sulphide mineralization; furthermore, Mo, Se, Sn and V are anomalous. Principal component analysis reveals a strong geochemical relationship between Ag, As, Ba, Cd, Pb, Sb, Tl and Zn in soils, representing metal dispersion from a shallow sulphide lens underneath till and soil horizons. Results of laser ablation ICP-MS analyses of pyrite and sphalerite from the Ballinalack deposit confirm this geochemical relationship.

These outcomes have helped to distinguish between true geological anomalies and possible anthropogenic inputs, an important consideration for any mineral exploration activities on cultivated land.