Resistivity and Structural Mapping with Passive Airborne EM: Applications to Mineral Exploration

Alexander Prikhodko, Aamna Sirohey
Expert Geophysics Surveys Inc.

Mineral exploration in Alaska commonly involves rugged terrain, extensive surficial cover, and limited bedrock exposure. In these settings, subsurface resistivity mapping can help investigate the geological architecture associated with mineralization. This poster presents a workflow for integrating broadband airborne natural-field electromagnetic measurements, resistivity inversion, and structural analysis to characterize conductive and resistive domains beneath cover.

The measurement configuration combines three components of airborne magnetic-field variation with two horizontal electric-field components recorded at a stationary reference site. Data acquired over approximately 20 Hz to 20 kHz are used to derive total-field electromagnetic responses and construct subsurface resistivity models. Depending on ground resistivity, signal quality, and survey geometry, these models can investigate structures from the near surface to depths exceeding one kilometre. The depth of investigation and spatial resolution vary across the survey area and must be considered when interpreting model features.

Structural analysis examines the geometry, continuity, and boundaries of resistivity anomalies in successive depth slices and vertical sections. Correlated anomalies and resistivity gradients are traced through the models to delineate geoelectrical trends and surfaces. Their orientations, depth persistence, intersections, offsets, and changes in continuity are then evaluated alongside magnetic data and available geological information. This analysis provides a basis for interpreting possible faults, shear zones, folds, intrusive contacts, and crosscutting structural corridors.

Resistivity contrasts have multiple geological explanations. Conductive domains may represent conductive stratigraphy, alteration, or deformation zones, while resistive domains may reflect intrusive bodies, silicification, or relatively unaltered rocks. Consequently, neither an individual anomaly nor a traced geoelectrical boundary uniquely identifies a geological structure or mineralized body. Interpretation requires consideration of geological context, inversion resolution, and consistency among independent datasets.

Field examples from porphyry, volcanogenic massive sulphide, intrusion-related gold, and magmatic nickel–copper–cobalt exploration illustrate the application of this workflow. The examples examine how resistivity distributions and interpreted structural

relationships can inform the evaluation of covered targets. Particular attention is given to structural intersections, bends and splays, intrusive margins, and boundaries between contrasting resistivity domains.

The workflow extends interpretation from individual electromagnetic anomalies to the surrounding subsurface architecture. It provides a framework for developing geological hypotheses, assessing target geometry and depth extent, and identifying priorities for follow-up mapping, ground geophysics, and drilling.