

Integrated Interpretation of Airborne ZTEM, Aeromagnetic, and Ground MT Data for Exploration Targeting (Piedras Verdes Porphyry Cu–Mo System, Sonora, Mexico)

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Integrated geophysical datasets are increasingly used to improve exploration targeting in porphyry systems, where complex alteration and structural controls obscure the surface expression of mineralization. This case study presents the integration of airborne Z-axis tipper electromagnetic (ZTEM), airborne magnetic, and ground magnetotelluric (MT) datasets over the Piedras Verdes (PV) porphyry Cu–Mo deposit. The objective was to characterize the subsurface electrical resistivity structure and its relationship to magnetic lineaments and known geological features to identify potential exploration targets within the broader mining district. A fixed-wing magnetic and radiometric survey covering ~472 km² was flown in 1997 to assess mineralization potential within the mining district. N-S flight lines spaced at 400 m yielded regional-scale coverage suitable for reconnaissance exploration. A helicopter-borne ZTEM and magnetic survey covering approximately 765 km² was flown in 2012 to map conductivity contrasts and structural features across the district. N-S flight lines spaced 200 m apart also provided regional-scale coverage. A ground MT survey deployed in 2023 within the open pit was subsequently integrated with a subset of the airborne dataset to improve depth constraints and generate joint 3D inversions of the electromagnetic data. The resulting 3D resistivity and magnetic (MVI) models image the upper ~1 km of the crust and reveal six large conductive anomalies (C1–C6) and several magnetic areas with bordering magnetic lineaments interpreted as potential structural or alteration-related zones within the porphyry system. Several of these conductive features show spatial correlation with regional and local magnetic lineaments, suggesting structural pathways that may control hydrothermal fluid flow and mineralization. The conductive anomaly C1 near the open pit is consistently resolved in both ZTEM-only and MT–ZTEM joint inversion results and represents the highest-priority exploration target. Together, these datasets provide an improved geophysical framework for exploration targeting, geological interpretation, and future drilling within the PV district.