## Chile's First Defined Intrusion-Related Gold System: Ternera's Hydrothermal Footprint in the El Zorro Gold District

**Eduardo Fritis**[1], Nicholas H. S. Oliver[2,3], Julie V. Rowland[1], Michael C. Rowe[1], Ruben Cahuana[4], Zeffron C. Reeves[4], Kevin Faure[5], Laure A.J. Martin, Shane Askew
[1]School of Environment, The University of Auckland, Private Bag 92019, Auckland 1142, New Zealand, [2]HCOVGlobal consultants, 6 Hancock Rd, Alligator Creek, Australia, [3]Economic Geology Research Unit, Division of Tropical Environments and Societies, James Cook University, Townsville, Australia, [4]Tesoro Gold Limited, Level 48, 152-158, St Georges Terrace, Perth, Australia, [5]GNS Science, 1 Fairway Drive, Lower Hutt, New Zealand, [6]Centre for Microscopy, Characterisation & Analysis, University of Western Australia, 35 Stirling Highway, Perth, Australia

The El Zorro gold district is the most recent gold discovery in northern Chile and the first intrusion-related gold (IRG) system identified in the country. Ternera is the most significant deposit, with resources of 1.282 Moz, and is surrounded by over eight active IRG prospects within a 30 km gold corridor. Mineralization occurs in Upper Triassic to Lower Jurassic felsic to intermediate, ilmenite-series intrusions of the Relincho and Cuevitas plutons (~205–185 Ma) and in Devonian to Carboniferous metasedimentary rocks of the Las Tórtolas Formation. Hydrothermal alteration is confined to mm- to dm-scale selvages adjacent to mineralized veins, without large-scale halos typical of porphyry or IOCG systems. The mineralization consists of Bi-Te-Ag-W-Sn-Sb ± As-S assemblages, closely linked to high-temperature fluid circulation along structurally controlled vein arrays.

Carbon, oxygen, and sulfur isotope data support a dominantly magmatic source with minor crustal contributions. Carbon and oxygen isotope compositions from calcite veins and whole-rock samples indicate magmatic-derived fluids with $CO_2$ from degassing during fractional crystallization of mafic magmas and assimilation of high-$\delta^{18}O$ metasediments in the magma source, with limited fluid–rock interaction at the emplacement site. Sulfur isotope values ($\delta^{34}S$ = –8 to –2‰) reflect a reduced magmatic-hydrothermal system some metasedimentary input, mostly in the melt source region and no significant contribution from evaporitic or seawater-derived sulfur.

Spatial and temporal features suggest a magmatic-to-hydrothermal transition, marked by aplitic dikes evolving into quartz–sulfide veins, miarolitic cavities, and evidence of magma mingling. These features imply that mafic–felsic magma interaction may have triggered fluid exsolution and ore formation. Combined geological, geochemical, and structural evidence supports classification of El Zorro as a reduced IRG system, similar to the Tintina Belt IRG intrusions in Yukon/Alaska. This expands the metallogenic framework of northern Chile, highlighting the potential for IRG mineralization beyond traditional Andean porphyry and IOCG models.