The geochemical footprint of a giant: The Fruta del Norte epithermal Au/Ag deposit, Cordillera del Cóndor, Ecuador

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The geochemical footprint of the giant Fruta del Norte (FDN) epithermal Au/Ag deposit in southeastern Ecuador is examined using insightful geochemical and spatial studies. We look at intuitive coding and thematic attributes in ME-ICP and XRF data at deposit and at district scales. These are explored in iterative steps for the purposes of geological modeling, in providing vectoring strategies to mineralization and in relating FDN, in terms of its geochemical and structural context, to the Cordillera del Cóndor metallogenic district. The methodology entails defining the percentile associations of Au, Ag and Cu with traditional pathfinder and commodity elements as an empirical targeting rationale. We also look at molar element ratios that semi-quantitatively track the effects of K-metasomatism through variations in alteration indices (e.g., ISer, Ishikawa, CCPI) as well as weathering indices (A-CNK). REE and other trace elements reveal variations in primary arc magmatic composition, useful in the evaluation of porphyry copper potential (e.g., Sr/Y vs SiO₂).

FDN is hosted by andesitic volcanic successions and diatreme breccias of the Jurassic calc-alkaline Zamora Arc. The deposit is buried by up to 400 m of late-mineral basinal volcaniclastic rocks, tuffs and lavas of the Suárez Formation and further capped by post-mineral Early Cretaceous quartz sandstones of the Hollín Formation. With locally spectacular visible gold, bonanza grades (up to 2447 g/t Au), exquisite preservation of crustiform, colloform and often brecciated epithermal textures, added to its extensional structural geological and regional (Sub-Andean) tectonic settings, FDN is renowned as an exemplary green-field exploration success and a valuable lesson to economic geologists working in arc terrains with significant late or post-mineral cover.

The study illustrates the composite fault architecture of the known ore-body through renderings in Leapfrog-Geo. These depict the concentric Au grade increase toward the northern part of FDN, characterized mostly by often-times bladed quartz-carbonate. Dramatic displacement of this portion of high grade Au to the north may imply the preservation of a late-stage catastrophic faulting dynamic involved in Au grade distributions. Our work further relates the geochemistry and structure of FDN to that of the Cordillera del Cóndor metallogenic district which is well endowed with other epithermal Au/Ag as well porphyry Cu-Mo±Au and skarn Au deposits. To elucidate elements of the Cordillera’s metallogeny, alteration and structure, we examine the percentile overlaps of key pathfinder and commodity elements from a substantial inventory of ME-ICP core, rock, soil and stream sediment sample data acquired by Aurelian Resources Ltd between 2001 and 2008. The critical element associations are reduced to a matrix of points and these are further networked by Voronoi polygons so as to illuminate the Au-Ag-Cu potential of the
Cordillera. The study reveals how the 2006 discovery of this buried gold deposit relates to regional structural and lithological controls on hydrothermal alteration and the resulting geochemical and Au grade domains within FDN. It further demonstrates how the integration of multi-element geochemistry to 2D and 3D modeling can be strategized in all stages of mineral exploration, resource evaluation and in understanding and reducing the associated project risks.