

Plate Interactions, Evolving Magmatic Styles, and Inheritance of Structural Paths: Development of the Gold-Rich, Miocene El Indio Epithermal Belt, Northern Chile

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Abstract

Ore deposits constitute singularities in the Earth crust, and form in response to a combination in time and space of a variety of geological processes. We here explore the complex setting that led to formation of an outstanding belt of precious-metal epithermal deposits in northern Chile, including the world class Au-Cu-As El Indio deposit. We discuss the formation of the El Indio belt in terms of Oligocene–Miocene plate tectonic and magmatic evolution of the Nazca–South America margin. The analysis of Landsat images allows recognition of a highly fractured domain involving a major Oligocene NW–SE–trending fault zone, with associated R_1 – R_2 –type structures. We suggest that a set of time-coincidental factors that occurred between ~10 and 6 Ma may have led to formation of the Late Miocene El Indio belt. Late Miocene subduction of the Juan Fernández Ridge (JFR) coincided with a substantial shift in magmatic emplacement style, linked to a compositional change from andesitic to dacitic, which resulted in the passage from stratovolcanoes to dome and dike complexes. It is not the composition alone, but the style that may be the crucial element here to understand why mineralization developed. Although stratovolcanoes easily vent volatiles and metals (via violent eruptions and quiescent outgassing), intrusions tend to retain these, and therefore, can generate volatile-, metal-rich hydrothermal solutions. We further propose that subduction of the JFR may have involved increased plate coupling, and the reactivation of older NNE trending R_2 type shears (inherited structural corridors), along which the belt would have formed preferentially.

Introduction

ORE DEPOSITS, especially the important ones, are anomalous features in the Earth crust, and this explains why an unusual combination of geologic processes is required to form them. If this is true for a single occurrence, imagine what it takes to form an entire belt of ore deposits. We suggest that it was a very unusual combination of Miocene events in northern Chile (Coquimbo Region) that allowed for-

mation of the El Indio belt (Fig. 1). The Coquimbo region is located in northern Chile and is one of the richest in mineral deposits (Fig. 1). The Andean realm of this region hosts one of the most spectacular belts of hydrothermal alteration zones, including economic gold deposits of the epithermal type. Among these we highlight the world-class El Indio Au-Cu-As deposit (Fig. 1). The belt formed during Late Miocene time (Bissig et al., 2002a), and most of the alteration zones and deposits in the Coquimbo Region occur along a relatively narrow NNE-trending corridor (Figs. 1 and 2). We here discuss the

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