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The Structural Localisation and Control of Porphyry-Related Alteration and Mineralisation: a Study of the Quellaveco District, Southern Peru

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Since the Paleocene, the Andes have been subject to complex tectonics, such as varied subduction rates and plate obliquity, which has led to the formation of five, highly prolific, margin parallel, metallogenic belts. The Quellaveco Cu-Mo porphyry deposit is located within the northern segment of the Paleocene-Eocene metallogenic belt of southern Peru. Quellaveco, and its neighbouring deposits, Toquepala and Cuajone, are situated along major NW to WNW structural trends that dominate the region. These fault systems are associated with the regional-scale (400+ km strike length) Incapuquio Fault System. This major fault structure is thought to be connected to the Incaic Megafault to the north, and the Domeyko Fault System to the south in northern Chile, which strongly controls the location of the well-known Chuquicamata porphyry deposit [1]. The distribution, however, of the mineralising centres in the area appears coincident with the intersection points of secondary, NE-trending fault structures. Constraining the kinematics and temporal relationship of key structures in Quellaveco will help define the timing of fluid flow paths in relation to the mineralisation and alteration of the area.

Magma and fluid transport in the crust is predominantly controlled by the permeability structure of rocks [2]. Permeability is increased locally by brittle fracture damage surrounding faults, which creates pathways for the ascent of both magma and magmatic-related fluids and volatiles. This project focusses on how porphyry-related fluid flow and alteration utilises such structural pathways, and focusses on mineral exploration examples from the Quellaveco porphyry deposit. The distinct alteration footprint that is associated with porphyry deposits can extend up to 10 km away from the ore zone in the form of weak propylitic alteration. This enlarged footprint relative to the more obvious proximal alteration styles therefore potentially provides a useful guide for exploration. As porphyry-related fluids are channelled by changes in crustal permeability structure, it might be expected that the nature of the propylitic alteration halo will reflect a fault damage patterns imparted by district-scale structures. This may be expressed in the form of subtle gradients in whole rock and alteration mineral geochemistry around such features. If so, the recognition of such features going forward could allow the identification of key structures, and ultimately the identification of the magmatic foci [3]. The combination of an advanced understanding of the spatial and genetic relationship between structures and porphyry-related alteration is thus extremely useful for future exploration.

References:

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