FALLA OESTE FAULT SYSTEM : RECORD OF ITS REGIONAL SIGNIFICANCE AS EXPOSED IN THE CHUQUICAMATA OPEN PIT, NORTHERN CHILE

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INTRODUCTION

Late Eocene subduction related magmatic arc tectonics produced orogen-normal shortening and dextral orogen-parallel strike-slip motions in the Precordillera of northern Chile (Scheuber and Reutter, 1992). This Incaic tectonic phase, within the Precordillera, formed the Domeyko Fault System along which numerous Eocene-Oligocene intrusive complexes bearing porphyry copper mineralization were emplaced.

The Falla Oeste is often referred to as the essential branch of the Domeyko (Maksaev, 1990) or Precordilleran (Reutter et al., 1991) Fault System in northern Chile. The Falla Oeste is best defined as a fault system of regional scales ,with individual branches or sub-systems of faults that record approximately 40 m.y. of regional deformation.

Within the Chuquicamata district the Falla Oeste fault system is comprised of the Mesabi, Estanques Blancos, Balmaceda, Nor-Oeste, Este, Americana, Calderones, West Fissure, Chucos, San Lorenzo, Zaragoza, C2 and several important un-named faults and fault systems. The regionally important Falla Oeste, which has tectonic significance, must be differentiated from the district scale fault that traverses the Chuquicamata open pit, herein, the West Fissure, as displayed on original district and deposit scale maps (see Lopez, 1939).

Differences in the kinematics of the Domeyko fault system (right-lateral, unknown total displacement) with those of the West Fissure (left-lateral, estimated 35-40 km (Ambrus, 1979)) have been explained by a tectonic inversion of the fault system (Reutter et al., 1993).

Due to poor surface exposure along its length, little is known about the relationships between the fault systems and alteration/mineralization processes. The open pit of the Chuquicamata porphyry copper deposit offers an unprecedented lateral (3.3 km) and vertical (0.55 km) surface exposure of the West Fissure and all of the related faults of the Falla Oeste fault system (Figure 1). This exposure enables a detailed examination of the fault systems their relative timing relationships and association with multiple alteration-mineralization events.

The Mesabi fault, probably the oldest in the Falla Oeste system, is concentrated within and along a Triassic through Cretaceous(?)volcano-sedimentary package. This mylonitic, N10-30^{O} fault consistently displayes a right-lateral sense of displacement. Mineralization along this fault (magnetite bodies) appears restricted to zones of intersection with later faults, such as those of Estanques Blancos. Ductile deformation fabrics, such as foliations, lineations, and mylonitic shear zones are irregularly distributed throughout the open pit and to the north east, being increasingly more common as the Mesabi fault is approached. It is expected that a similar fault may be located on the western side of the Chuquicamata intrusive complex but this fault has not been recognized. The ductile nature of these shear zones indicates that dextral deformation at relatively high temperatures continued during or just after intrusion (~33-34 Ma) of the complex. Newly discovered thrust zones within the

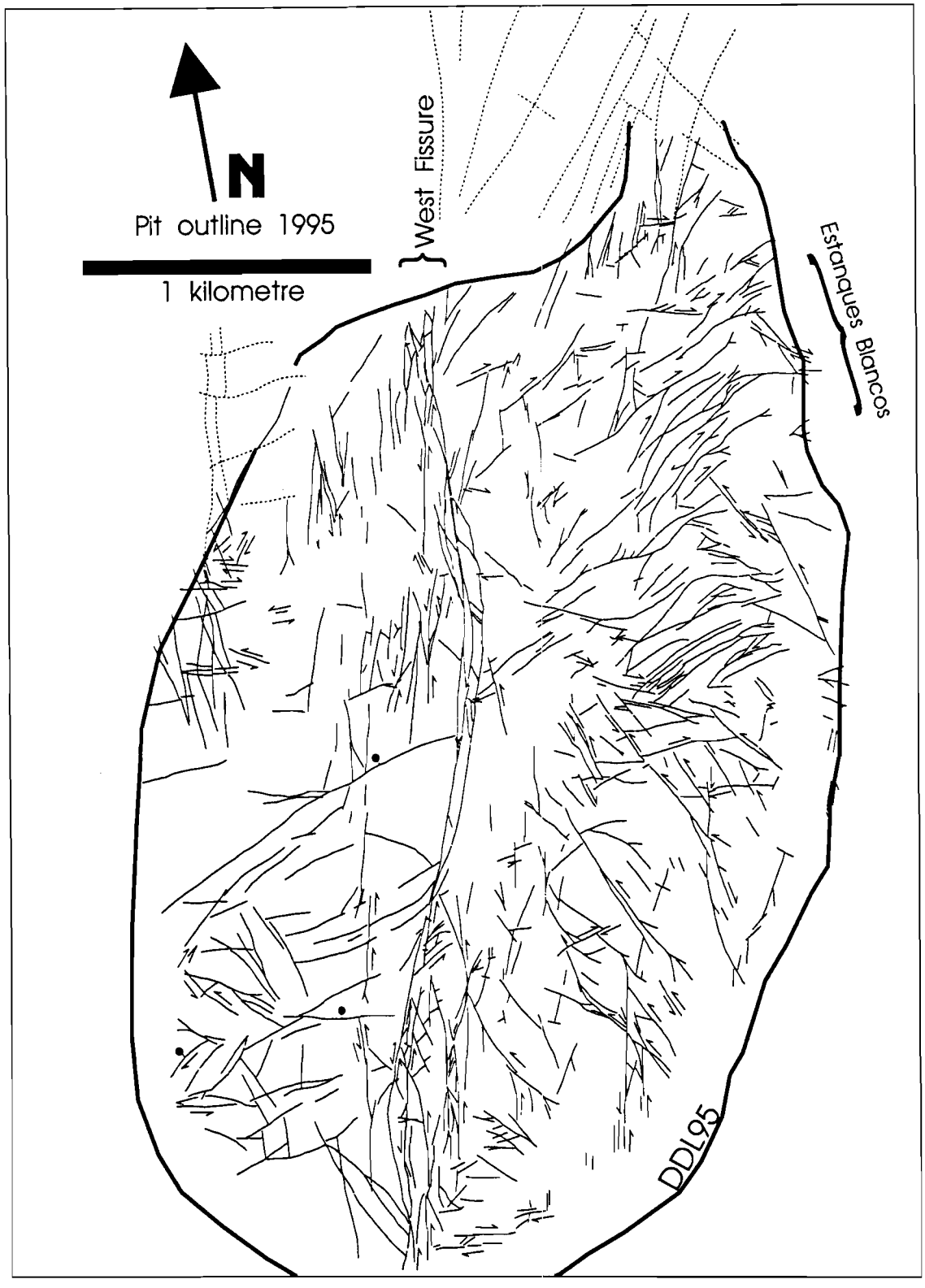

Fig.1. Distribution of mapped faults and fault-veins found within and adjacent to the Chuquicamata open pit. All faults are within the domain of the Falla Oeste fault system. The West Fissure can be seen to be comprised of a number of distinct but inter-related fault branches. Sense of displacement shown.

Chuquicamata complex support a NE-SW directed compressive stress regime at this time. Late magmatic alteration and porphyry copper mineralization took place as the intrusive cooled. Plate tectonic reconstructions and estimates of relative plate velocities indicate that a dextral transpressive tectonic regime was likely active during Eocene-Oligocene times (Pardo-Casas and Molnar, 1987; Pilger, 1984).

The Estanques Blancos fault system is within a domain that contains an array of streaming veins and veinlets indicating a structural control and anisotropy of mineralization. The dominant faults are all brittle features bearing breccia and fault gouge containing dextral shear sense indicators. In a number of cases the gouges are almost completely composed of the sulfides chalcocite and pyrite. The majority of these faults have sericite alteration halos. Recent ^{40}Ar-^{39}Ar radiometric dating indicates this alteration-mineralization event occurred at ~31 Ma. This fault system dextrally displaces the Mesabi fault system approximately 500 m. These faults although having displacements along strike may also have a substantial normal component of slip.

Field mapping, geochemical traverses and grain size analysis show the West Fissure to have undergone periodic, multiple, weakly oblique strike-slip events beginning after mainstage mineralization. Original cross-sections based on drillcore intersections with the fault illustrated a geometry incapable of large strike-slip motions. Relogging and interpretation of this fault in drillcore shows a system of inter-related branches capable of the previously hypothesized tens of kilometres (35-40 km) of displacement (Ambrus, 1979). Different metals concentrate within different fault branches indicating distributed displacements and increasing the potential for displaced mineralized fault slivers, or side wall rip-outs. Although some of the faults in the Falla Oeste fault system show structural fabrics inversion (Reutter et al., 1993); (eg. Mesabi), a detailed study of the West Fissure shows no indication of inversion and shows no evidence of high temperature ductile deformation within, or adjacent to, the present fault zone.

CONCLUSIONS

The superb exposure of the Falla Oeste fault system outcropping in the Chuquicamata open pit allows one to observe early deep ductile emplacement and pre- to syn-mineralization structural features through late upper crustal brittle features and their relationships to multiple mineralization events. Conclusions that can be drawn from mesoscopic to microscopic analyses of structural features are as follows :

- The Falla Oeste is a large fault system that has been active in northern Chile since the Eocene. Different faults and fault systems within the Falla Oeste can be differentiated and evaluated with respect to mineralization and alteration events.
- Earliest deformation is associated with the emplacement of the Chuquicamata intrusive complex and continued transpressive deformation associated with the late Eocene Incaic tectonic phase.
- Main stage mineralization occurred after the peak of the Incaic tectonic phase and prior to the development of the West Fissure.
- The Estanques Blancos fault system had formed and was active during the latest alteration-mineralization event ~31 Ma.
- The West Fissure is a late upper crustal structure that played no part in the emplacement of the Chuquicamata intrusive complex, or the initial development of the associated porphyry copper deposit. However, it played an important role in the control of mineralization during the ~31 Ma and the supergene mineralization events.

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