

## **Epithermal (Au-Ag) Quartz Veins and Hydrothermal Alteration Related to the Early Cretaceous Magmatism in Western Patagonia Argentina**

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### **Introduction**

Precious metal-bearing quartz veins and related alteration zones are located at the northeast of the Fontana Lake (44° 30' -45° 00' S and 70° 50' -71° 15' W), in southern Argentina.

Main geological investigations were developed by Ramos (1981), Ploszkiewicz (1987), Dejonghe et al. (2002), and Lanfranchini et al. (2007). No geochemical exploration data are available for these vein deposits, despite surface mining activities in the district carried out during 1990-2000. As a result of these researches, several interesting precious metal targets appeared.

### **Geological Setting**

During the Andean Orogeny a widespread calc-alkaline magmatism was developed in a Jurassic-Cretaceous volcanic arc (Fig. 1), as a result of the convergent eastward subduction of the Nazca Plate beneath the South American Plate (Sillitoe, 1974).

Basaltic-andesitic rocks (Upper Jurassic) constitute the oldest unit in this region. During the Upper Jurassic–Lower Cretaceous an extensively distributed marine-continental sedimentary sequence was deposited. This succession was interrupted by the spread of rhyolitic to basaltic rocks, concomitant with the intrusion of acid igneous bodies (El Gato Formation, and other units, Lower Cretaceous). Subsequently, granitic to gabbroic rocks were intruded during the Upper Cretaceous, constituting the Patagonian Batolith, which is poorly exposed in this region.

An extensional structural regime was developed during the Upper Jurassic to Early Cretaceous, which was followed by the Andean Orogeny, since the Upper Cretaceous, with the development of a compressive episode that reactivated existing faults, and provoked tectonic inversion and crustal shortening (Folguera and Ianizzotto, 2004).

### **Epithermal deposits**

Epithermal Au-Ag quartz vein deposits occur in the Payaniyeu Range, in the hills Teta, Colorado and Pedrero, and in the southern sector of Cordillera of Sakmata. They are spatially related to the rhyolitic and rhyodacitic-dacitic dikes of the El Gato Formation and are strongly controlled by NW-SE fracture system. Even though quartz veins constitute discontinuous outcrops, they show a defined alignment, across a 300 Km<sup>2</sup> area. These veins are near vertical,

they have a few centimeters to several meters thick, and tens to hundreds meters long. Conspicuous stockworks accompany the silicic structures.

The main quartz veins crop out in the Pepita Farm and Mina de Plomo sectors of the Payaniyeu Range; they are up to 900m-length and up to 7 m-thick, and they are hosted by rhyodacitic dykes. The hypogene mineral assemblage is composed by galena ± pyrite > chalcopyrite > hematite.

Strong silicification, constituted by quartz and chalcedony is developed nearby the veins. Sericite and pyrite are frequently disseminated in the wall rocks, and within the quartz veinlets, where also small amounts of euhedral rhombic adular crystals appear. Argillized alteration is poorly developed close to the vein structures, while a moderate propylitic alteration is restricted towards the distal sectors.

Assays of grab samples from some quartz veins show anomalous amounts of precious and base metal elements (Table 1), especially at Pepita Farm and Mina de Plomo areas. Gold was also recognized by microprobe analysis performed on sulfides. Besides, several trace elements, such as As, Sb and Hg, point out interesting values for future exploration works.

In addition, hydrothermal quartz veins related to the El Abuelo calcic-Fe skarn, located at Pepita Hill (Lanfranchini et al. 2007), exhibit some anomalous metal contents.

	<b>Au</b> (ppm)	<b>Ag</b> (ppm)	<b>Cu</b> (ppm)	<b>Pb</b> (ppm)	<b>Zn</b> (ppm)	<b>As</b> (ppm)	<b>Sb</b> (ppm)	<b>Hg</b> (ppb)
Pepita Farm	5.7	26.5	4549.0	16200.0	1950.0	380.0	42.6	4.0
Mina de Plomo	1.6	223.8	1180.0	46633.0	648.0	429.0	46.0	110.0

Table 1. Representative geochemical analysis of the main quartz veins.

### Geological and metallogenic evolution

The hydrothermal activity associated to the Early Cretaceous magmatism was the responsible for generating the studied epithermal quartz veins. In this sense, sulfur isotope data point out a magmatic sulfur source for the mineralizing solutions ( $\delta^{34}\text{S}_{\text{CDT}}$ : -1.32‰ to +0.78‰), while O-D data indicate mixing of meteoric waters with the magmatic fluids.  $\delta^{18}\text{O}_{\text{H}_2\text{O}}$  ranges from -2.43‰ to -2.33‰ in quartz crystals, and between -2.85‰ and -0.91‰ in primary FI of quartz.  $\delta\text{D}_{\text{H}_2\text{O}}$  vary between -106.4‰ and -103.4‰ also in FI of quartz. Moreover, FI data are consistent with mixing process pointing out a thermal interval between 200 and 280°C and up to 3.9 NaCl wt percent equiv. for the hydrothermal solutions. Then, temperature and fluid pressure decrease during the fluid upwelling causing its partial degassing and pH increase. Consequently, boiling process occurs; it is supported by the presence of primary FI with different proportions of vapor phase that homogenized at the same temperature, together with the occurrence of FI denoting necking down. Simultaneously, rhombic adular formed. These geochemical conditions favored metal sulfide precipitation with the incorporation of Au-Ag contents.

Finally, the general features of the studied mineralizations allow to characterize them as low sulphidation-type (adularia-sericite paragenetic association). Its widespread distribution, and shallow structural emplacement level, together with the anomalous precious metal values obtained in surface geological researches, encourages the implementation of further exploration plans in this region.

## References

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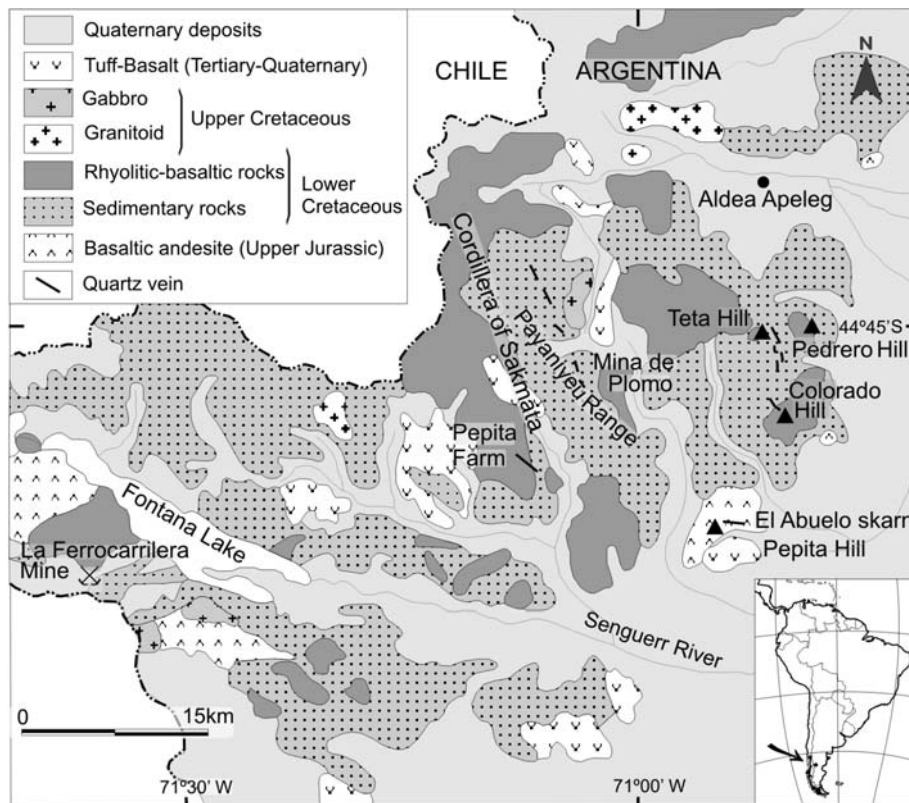


Fig. 1. Regional geologic map of the study area.