



Ge archaeological remote sensing in the Sud LÍpez mining district, polymetallic belt, Bolivia

Jean-Paul Deroin (1), Florian Téreygeol (2), Pablo Cruz (3), and Ivan Guillot (4)

(1) EA 3795 GEGENAA, Université de Reims-Champagne Ardenne, France, (2) UMR 5060 CNRS IRAMAT and CEA, Saclay, France, (3) CONICET INAPL, Buenos Aeres, Argentina, (4) UMR 7182 CNRS ICMPE, Université Paris-Est Créteil, France

From the Upper Oligocene onward, the collision and subduction of the Nazca plate caused a constant deformation that formed the great volcanic arc along South America's Pacific shoreline. At the heart of this arc is the metallogenic belt of the Altiplano and Western Cordillera provinces, the so-called polymetallic belt, composed of polymetallic and epithermal vein-type Ag-(Au)-Zn-Pb-Cu deposits. These deposits formed during the Middle-Late Miocene and Early Pliocene, when volcanism led to formation of widespread precious and base metal-bearing epithermal deposits. The most important metallogenic features include mineralization of intermediate- and high-sulfidation type associated with small, shallow subvolcanic plugs, ignimbrite shields, flow domes, stratovolcanoes, and pyroclastic rocks of dacitic, rhyolitic, and andesitic composition.

The Sud-LÍpez mining district is the southernmost area of Bolivia near the border to Argentina. It contains a number of polymetallic vein style Ag-Zn-Pb deposits which were exploited for silver (soroche) as early as the 13th century, notably at San Antonio de LÍpez and San Pablo de LÍpez (also known as Buena Vista). These were the earliest silver discoveries made by the Spaniards in the middle part of the 16th century. The area was abandoned when rich silver ore was discovered at Porco and above all, at the Cerro Rico of Potosi. Another interesting place is located further east at Santa Isabel where Ag-Au-Sn-Zn mineralization was exploited.

New investigations have been launched in the frame of a joined French-Argentine project dealing with the mineral resources and the metal production in the Andean plateau from the 10th to the 18th century. Geoarchaeology of the area is revisited using multispectral and multisource remote sensing data including Landsat ETM+/TM (spatial resolution 15/30 m), EO-ASTER (15 m), ALOS AVNIR-2 (10 m), SPOT 5-HRG (5 m), and CBERS-HRC (2.7 m) images. The emphasis is on integrating all the geological features such as morphologies, petrology of the volcanics, lithology of the sedimentary rocks, regional and local faulting, veins, hydrothermally altered rocks, etc. The structural control of the mineralization is particularly studied because some veins are clearly related to the N.120° direction (at San Pablo de LÍpez for example). Moreover, satellite images allow a better mapping of the archaeological remains that are particularly numerous at San Antonio de LÍpez, with shallow pits, shafts connected in depth with adits, old miner's villages, etc.