



PB-ISOTOPE AND TRACE ELEMENTS ANALYSIS BY LA-Q-ICPMS OF GALENA FROM ARGENTINIAN EPITHERMAL DEPOSITS: A PRELIMINARY ANALYSIS

A | 125

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BACKGROUND

In situ laser ablation quadrupole inductively coupled plasma-mass spectrometry (LA-Q- ICPMS) allows us to obtain rapid, accurate, and precise Pb isotope measurements together with trace elements in galena (McFarlane *et al.*, 2016). Recent investigations have shown that galena can host a broader range of elements than previously recognized, many of them (e.g., Ag, Bi, Se, Te) can be extracted as by-products of an ore containing galena and others (Sb, Cd, Tl) exist as impurities (George *et al.*, 2015).

Pb isotopic studies have been applied as a tool in exploration of metallogenic terrains based on comparing the isotopic compositions of existing deposits within a district to prospective showings. Bouhier *et al.* (2017) presented Pb isotopic data of the Navidad Ag world class epithermal deposit. These authors indicated that the Pb isotopic ratios of Jurassic volcanic rocks and ore minerals from epithermal deposits of Patagonia have distinctive signatures in the North Patagonian Massif, the Deseado Massif, and the Andean region that vary with time in the volcanic events of the Chon Aike Volcanic Province.

The objective of this contribution is to present new Pb isotopic data and trace elements obtained with the method LA-Q-ICPMS in galena from epithermal deposits in Argentina in order to identify patterns at regional and local scales that may be useful in exploration or exploitation.

METHODS

Samples of galena were selected from epithermal deposits of Argentina: Navidad mining district (Loma Galena, Loma La Plata and Valle Esperanza deposits, hosted by Jurassic volcanic rocks, Chubut Province, North Patagonian Massif) Virginia and La Paloma (hosted by Jurassic volcanic rocks, Santa Cruz Province, El Deseado Massif), Chinchillas (hosted by Miocene volcanic rocks, Jujuy Province, Northern Puna), and Andacollo deposit (hosted by Carboniferous and Permian volcanic rocks, Neuquén Province). Polished thin sections of galena were analyzed by the quadrupole LA-ICP-MS facility at the Department of Earth Sciences of the University of New Brunswick, Fredericton, Canada (McFarlane *et al.*, 2016).

RESULTS

Galena from Chinchillas and Andacollo yields the highest ²⁰⁷Pb/²⁰⁴Pb ratios (average values 15.631 and 15.642 Chinchillas; 15.651 Andacollo), whereas the less radiogenic ²⁰⁷Pb/²⁰⁴Pb ratios are recognized in galena from Patagonia: Virginia (15.587) and Loma La Plata (15.571-15.627).

The ²⁰⁶Pb/²⁰⁴Pb results are highest in galena crystals from Chinchillas (18.583-18.618) and Andacollo (18.497) and lowest in galena from the Navidad mining district (18.231-18.262), whereas galena from La Paloma and Virginia yield intermediate ²⁰⁶Pb/²⁰⁴Pb ratios.

Galena crystals from Andacollo and Chinchillas deposits show higher ²⁰⁶Pb/²⁰⁴Pb and ²⁰⁸Pb/²⁰⁴Pb ratios than samples of galena from Patagonia (North Patagonian and Deseado Massifs). Samples of galena of epithermal deposits from the Deseado Massif (La Paloma and Virginia) yield higher ²⁰⁶Pb/²⁰⁴Pb ratios than samples from the North Patagonian Massif (Navidad mining district).

The ²⁰⁸Pb/²⁰⁴Pb ratio is highest in galena from the Chinchillas deposit (average values of 38.750 and 38.827) and lowest in the samples from the Navidad mining district (average values of 38.203 and 38.311).

Silver is the most abundant trace element in the crystals analyzed. The highest mean concentrations of Ag were recorded in samples from epithermal Ag-rich deposits from Patagonia (e.g., Navidad 9958 ppm, Virginia 5901 ppm). In La Paloma deposit, galena has average contents of 127 ppm Ag. Samples from Andacollo deposit have mean values of Ag of 895 ppm, and two samples of galena from Chinchillas have average values of 3510 and 4471 ppm Ag.

Mean Sb concentrations in galena crystals show a wide range, from 2.7 ppm in a sample from Navidad deposit to 4412 ppm in galena from Chinchillas deposit. The highest concentrations of Bi were obtained in galena from the Andacollo deposit (mean value of 92 ppm).

Selenium concentrations vary over 3 orders of magnitude in the studied samples. Galena from La Paloma shows the highest Se contents. The highest mean Cd concentrations were obtained in galena crystals from Navidad



(262 ppm) and La Paloma (190 ppm) deposits. In Virginia, Andacollo, and Chinchillas, Cd values are very low, with mean concentrations ranging from 17 to 23 ppm. Tellurium concentrations in galena from the Andacollo deposit show a wide range of values (26 to 1060 ppm) with a mean of 150 ppm Te.

CONCLUSIONS

We present new Pb isotopic data and trace elements in galena from Argentinian epithermal deposits. The Pb isotopic data obtained allow correlate galena to geological provinces and ages. Within the Patagonia it is possible to differentiate galena from the Deseado Massif and the North Patagonian Massif according to their isotopic signatures, especially their $^{206}\text{Pb}/^{204}\text{Pb}$ and $^{208}\text{Pb}/^{204}\text{Pb}$ ratios. We suggest that these analyses could be useful to identify metallogenetic events in Patagonia and could be applied in regional mining exploration complemented with conventional exploration techniques.

Pb isotopes in galena from Chinchillas have the same signatures as the Eastern Cordillera basement domain defined by Aitcheson *et al.* (1995) and the Antofalla domain of Mamani *et al.* (2010). The similarity in isotope ratios with host volcanic rocks and regional volcanism (e.g., Caffè *et al.* 2002) suggests that Pb isotope compositions of Chinchillas ores were inherited from magmas in which the basement participates through different mechanisms (mixing of crustal and arc melts or as contaminants in AFC processes) that affect Puna backarc magma evolution (Caffè *et al.*, 2002; Kay *et al.*, 2010).

Regarding trace elements, large standard deviations recognized in Ag and Sb contents in Navidad, Virginia and La Paloma samples, are interpreted as the result of nano-inclusions of Ag mineral phases and Sb-sulfosalts in galena. The relative low standard deviations recognized in Andacollo and Chinchillas samples suggest that Ag and Sb in these crystals could be present as solid solution.

Similarly, low standard deviations in Se from La Paloma galena crystals suggests its presence in solid solution. Bismuth values show high standard deviations in all the samples consistent with the presence of sub-micron-size Bi-bearing phases. The wide range of values of Te in Andacollo deposit suggests microinclusions of telluride minerals.

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