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Trace and minor elements in galena: A reconnaissance LA-ICP-MS study

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Abstract

Minor and trace elements can substitute into the crystal lattice of galena at various concentrations. In situ LA-ICP-MS analysis and trace element mapping of a range of galena specimens from different deposit types are used to obtain minor/trace element data, aimed at achieving insight into factors that control minor/trace element partitioning. The previously recognized coupled substitution $Ag^{+}+(Bi,Sb)^{3+} \leftrightarrow 2Pb^{2+}$ is confirmed. However, the poorer correlation between Ag and (Bi+Sb) when the latter elements are present at high concentrations (~>2000 ppm), suggests that site vacancies may come into play: $[2(Bi,Sb)^{3+}+\square \leftrightarrow 3Pb^{2+}]$. Galena is the primary host of Tl in all mapped mineral assemblages. Along with Cu, Tl is likely incorporated into galena via the coupled substitution: $(Ag,Cu,Tl)^{+}+(Bi,Sb)^{3+} \leftrightarrow 2Pb^{2+}$. Tin can reach significant concentrations in galena (>500 ppm). Cd and minor Hg can be incorporated into galena; the simple isovalent substitution $(Cd,Hg)^{2+} \leftrightarrow Pb^{2+}$ is inferred. This paper shows for the first time, oscillatory and sector compositional zoning of minor/trace elements (Ag, Sb, Bi, Se, Te, Tl) in galena from two epithermal ores. Zoning is attributed to slow crystal growth into open spaces within the vein at relatively low temperatures.

The present data show that galena can host a broader range of elements than previously recognized. For many measured elements, the data sets generated display predictable partitioning patterns between galena and coexisting minerals, which may be dependent on temperature or other factors. Trace element concentrations in galena and their grain-scale distributions may also have potential in the identification of spatial and/or temporal trends within individual metallogenic belts, and as markers of ore formation processes in deposits that have undergone superimposed metamorphism and deformation. Galena trace element geochemistry may also display potential to be used as a trace/minor element vector approach in mineral exploration, notably for recognition of proximal-to-distal trends within a given ore system.

Keywords: Galena, trace elements, laser ablation-inductively coupled plasma-mass spectrometry, compositional zoning, substitution mechanisms