

1.4.P02

Crystallographic controls on trace element incorporation in auriferous pyrite from the epithermal high-sulphidation Pascua deposit, Chile-Argentina

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The distribution of gold and other trace elements in the ore-stage pyrite from the high-sulphidation Au-Ag-Cu Pascua deposit in northcentral Chile, was studied using electron-microprobe and secondary ion mass spectrometry (SIMS). Au and Cu are concentrically zoned, and Ag, As, Se and Te are zoned both concentrically and preferentially enriched within specific crystallographic sectors. The dominant trace element associations are As-Ag and Se-Te. It is proposed that the association As-Ag reflects coupled substitutions for Fe, whereas Te and Se replaced S by homogeneous substitution. The nearly identical sector zoning patterns of Ag and As suggest that both elements entered the structure of pyrite via a coupled substitution for Fe: $\text{Ag}^+ + \text{As}^{3+} = 2\text{Fe}^{2+}$, yielding $(\text{Ag}_{0.5}\text{As}_{0.5})\text{S}_2$.

Gold and copper were excluded for an interval during which growth conditions promoted the development of {hk0} sectors at the expense of {111} sectors, and their enrichment patterns show only slight evidence of sectoral preferences. The association of Au and Cu is interpreted to reflect a coupled substitution for Fe: $\text{Au}^{3+} + \text{Cu}^+ = 2\text{Fe}^{2+}$ ions, yielding $(\text{Au}_{0.5}\text{Cu}_{0.5})\text{S}_2$. The suggestion that gold could have been incorporated as Au^{3+} rather than Au^+ is consistent with evidence of unusually oxidizing conditions during the formation of the Pascua deposit. It should be noted, however, that the analytical methods employed do not rule out the possibility that gold was incorporated as minute inclusions of native gold.

The zonation of invisible gold and associated trace elements in the ore-stage pyrite at Pascua is the first documented example of crystallographic surface structural control on the incorporation of multiple trace elements in pyrite. It provides clear evidence that incorporation of gold in pyrite does not necessarily involve coupled substitution with arsenic, as has been proposed for many other ore deposits. Not only can arsenic behave as a metallic cation in the structure of pyrite, but this results in a sectoral pattern of incorporation that is potentially a sensitive indicator of redox conditions during mineralization.

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Structure and crystallization behavior of the (Ba,Sr)HAsO₄·H₂O solid solution in aqueous environments

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Crystals of different members of the (Ba,Sr)HAsO₄·H₂O solid-solution have been synthesized, and the first structural studies indicate that they crystallize in the same space group *Pbca*, with $Z=8$. The unit-cell parameters are $a_0 = 7.436(2) \text{ \AA}$, $b_0 = 8.481(1) \text{ \AA}$, $c_0 = 14.348(6) \text{ \AA}$ and $a_0 = 7.752(1) \text{ \AA}$, $b_0 = 8.759(1) \text{ \AA}$, $c_0 = 14.668(3) \text{ \AA}$ for the strontium and barium end-members, respectively. Both end-members have a layered structure with slices parallel to (001) linked by hydrogen bonds from the water molecules. These features are consistent with both the perfect cleavage on {001} and the morphological importance of this form in the crystals obtained. However, the two end-members are not isostructural showing differences in both the anionic hydrogen positions and number of hydrogen bonds. Complementary powder-diffraction measurements indicate that the cell parameters increase in a non-linear way with the barium content indicating that the solid solution is complete but could be non-ideal. Preliminary data suggest that barium partitions preferentially into the solid phase when crystallizing this solid solution from aqueous solutions.