

SEG 100 Conference: Celebrating a Century of Discovery

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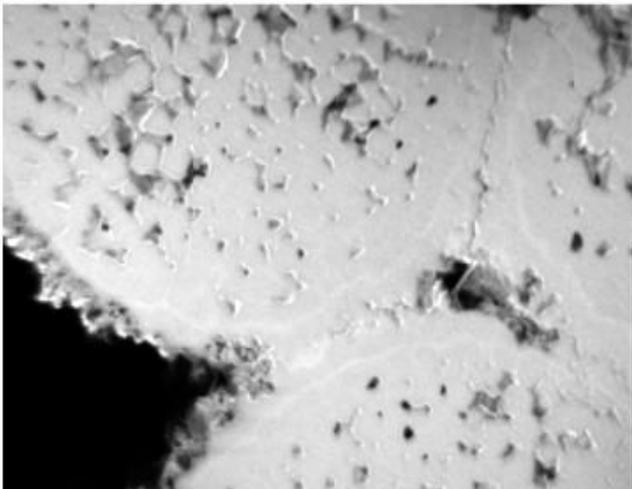
The Distribution and Redox State of Arsenic in Low- to Medium-Temperature Massive Sulfides

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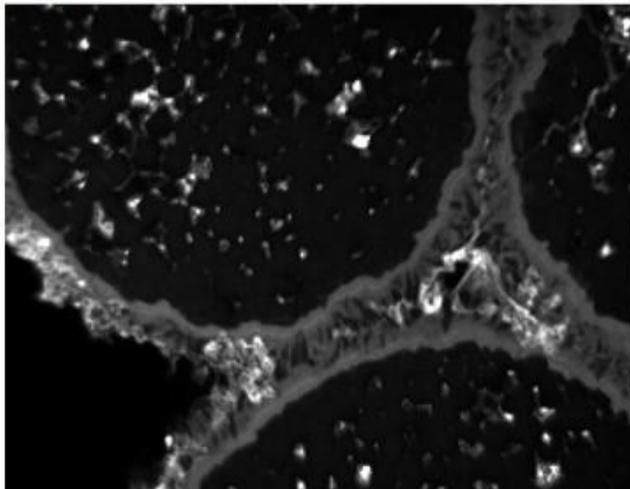
Arsenic is an important element in economic geology, both in its co-occurrence with Au and in its potential adverse environmental impacts after mine closures. In addition to individual As minerals such as arsenopyrite, realgar, or orpiment, pyrite can often contain large amounts of As. Arsenic redox states have been argued to affect the uptake of several trace elements. When As substitutes for S(-II), potentially as As(-I), it is thought that incorporation of elements like Co and Ni are enhanced. Conversely, when As—potentially as As(+III)—substitutes for Fe(+II), it results in a dislocation in the pyrite structure that accommodates large cations like Au. Additionally, how the pyrite structure is altered by the presence of As displaying different redox states may affect its oxidation rate.

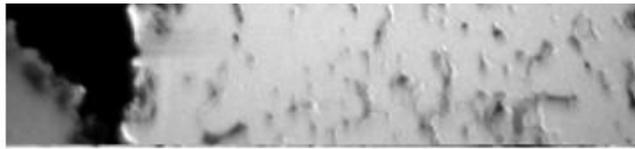
In this contribution we use a series of microanalytical techniques to document the variability of As content from the cm to nm scale. We first utilize LA-ICPMS spot analyses to track As content in different pyrite textures in samples from the Leicester pyrite member, New York, and the Black Bute SEDEX deposit, Montana. Areas representative of the most abundant textures were then selected for LA-ICP-MS mapping. These analyses highlight the variation in As and other associated trace elements across the cm-scale samples (with the spot data) and at the mm scale in the different maps. This is followed with NanoSIMS trace element mapping of pyrite textures of interest informed by the LA-ICP-MS analyses. The NanoSIMS analyses revealed microscale enrichments of As, often at the intersection of different generations of pyrite. These interfaces were targeted for atom probe tomography, which identified late As enrichments between the microcrystals that make up pyrite framboids. In addition to elemental concentrations, we also investigated As speciation using μ -XANES analyses. Taken together, our new findings suggest As spatial distribution is quite heterogeneous in the pyrite and that the redox state of the As may range from (-II) to (+III). This is likely to significantly affect both where less abundant elements, like Au, are to be found in the pyrite and how easily extractable these elements are likely to be. These findings will have important implications for the effectiveness of heap leach processes. Incorporating microanalytical techniques should be considered to implement new strategies to improve our management of different types of pyrite in tailings facilities.

S⁻

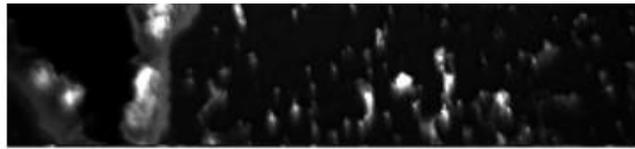


CN⁻

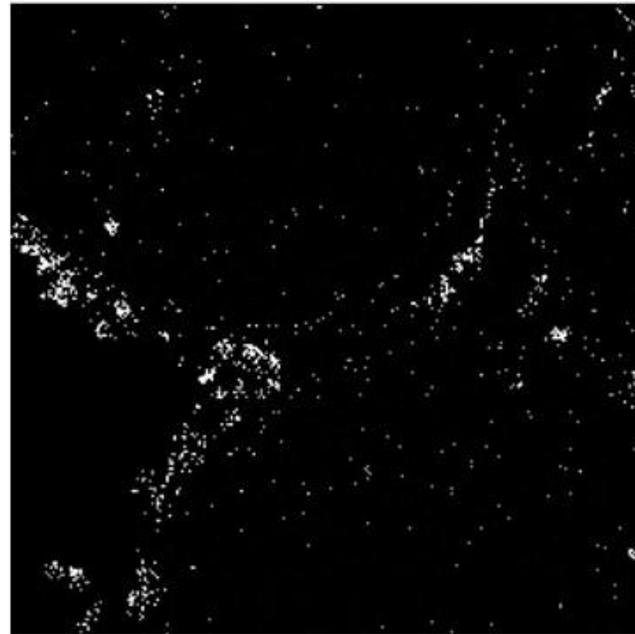
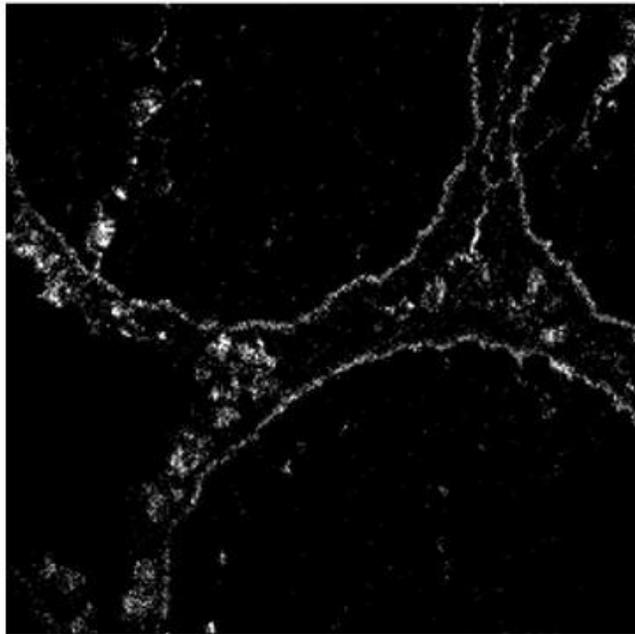




Se⁻



As⁻



20 μm

Figure 1: NanoSIMS trace element maps of pyrite from the Leicester pyrite member. Note that the As is primarily enriched on the outer rim of the pyrite framboid, similar to, but at a later stage than, the Se enrichment. Further, these trace elements are associated with organic matter (as indicated by the CN⁻ map).