

From micro to nano, the fate of tellurium in pyrite – a HR-TEM and APT study

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Photovoltaic panels have become broadly available over the last decades, usable in most places on the Earth's surface, protecting the climate and offering independence from fossil fuels. Highly efficient CdTe thin films in photovoltaic applications are an important technological leap, however, a secure supply of tellurium (Te) is required to make their production economical. Mineral deposits with a high potential for Te mining are mostly related to epithermal systems hosted by alkaline igneous rocks, where Te in pyrite may reach 1.6 wt. % [1, 2]. As such, pyrite from these deposits may represent a yet underestimated source for Te. However, metallurgical processing techniques must be modified to recover Te from pyrite, which requires a full mineralogical and chemical characterization to the nano-scale. Electron microprobe WDS maps of pyrite from the Vatukoula epithermal Au-Te deposit (Fiji) revealed that As and Te are decoupled on the micro-scale (Fig. A,B). Subsequent transmission electron microscopy (TEM) of the low-As and high-Te zone showed that oscillatory As zoning on the nano-scale follows the growth zoning detected in the WDS mapping.

Inclusions occur, independent of the growth zoning, giving evidence of a secondary emplacement (Fig. C). In addition, areas of the outer rim that do not host inclusions as in Fig. C yield Te levels of more than 0.15 wt. %. Atom probe tomography (APT) analysis from the Te-rich rim revealed nanometer thick linear and planar structures, in which Te is significantly enriched (up to 1 at. %) together with As, Cu, Sb, Ag, Pb. These structures may hold the majority of the trace elements in the pyrites, which is a yet unknown relation. We propose that the formation of the Te-rich inclusions is possibly related to a second ore-forming stage along micro- to nano-fractures intersecting the growth zones of the host pyrite.

[1] Börner et al. (2021), *Ore Geology reviews* 137, 104314. [2]

