Tellurium mineralisation in a post-collisonal alkaline epithermal Au deposit, Cripple Creek, Colorado

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The Cripple Creek Au-Te deposit is a world-class example of Au mineralisation in a low-sulphidation alkaline-hosted epithermal environment comprising high-grade accumulations of tellurides, native Au, base metal sulphides, and both barren and Au-Te bearing pyrite. Tellurium is an important semi-metal in low-carbon energy technologies and due to increasing demand a shortage is expected in the future. Thus, understanding the Te mineralisation processes in ore assemblages is fundamental to secure its future supply.

The Cripple Creek district is hosted in Oligocene alkaline diatreme-type volcanic and intrusive rocks ranging in composition from phonolites to lamprophyres. The post-collisional magmatic history of Cripple Creek was associated with the extensional magmatism of the Rio Grande rift.

We report on the mineralogy and chemistry of ore samples from active (WHEX and Cresson pits) and historic (Vindicator Valley, VV) mine sites of the Cripple Creek district. The main Te mineralisiton stage at WHEX and Cresson is expressed by the precipitation of different telluride species, which are mainly hosted in late-stage quartz-fluorite veins. Pyrite associated tellurides were only rarely identified. High-grade bulk ore contents of Au and Te reach 55 and 35 ppm, respectively. Although, VV was an important historic production site for Au and Te, no telluride phases were obsered suggesting that none of the mined high-grade material is preserved. Laser Ablation ICP-MS spectra revealed that pyrite from WHEX and Cresson is relatively barren with respect to most trace elements including Au and Te compared to typically more As-rich pyrite from VV. Time-resolved depth profiles of VV pyrite suggest that trace metal inclusions are common and that As-rich zones tend to be enriched in other trace elements, such as in Te and Au.

We conclude that pyrite mainly pre-dates the main stage of Te mineralistion at WHEX and Cresson. In contrast, the high Au and Te contents in arsenian pyrite from VV rather suggest at least in parts a simultaneous mineralisation. The trace metal enrichment in As-rich pyrite further implies that As enhances the incorporation of other trace elements either in solid solution or as micro-inclusions.