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An Experimental Study of Tellurium Solubility in Water Vapor Between 150 - 300 °C: Implications for Ore Formation

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Tellurium is becoming of increasing importance in green energy technologies in the production of photovoltaic cells, semiconductors, metal-alloys and is considered a critical mineral. Tellurium has extremely low crustal abundances and is rarely enriched to economic levels. Tellurium is a common constituent in Cu-porphyry and epithermal systems, occurring as telluride minerals and a trace component in sulfides and sulfosalts, that can be considered a byproduct of mining precious and base metals. Prediction of the role of tellurium mobility and speciation in vapors depends on the availability of thermodynamic properties of gaseous Te species at temperatures and pressures prevailing in magmatic-hydrothermal systems. Several gaseous tellurium species are known including Te_g, $Te_{2,g}$, H_2Te_g, $TeCl_{x,g}$, $TeF_{x,g}$, TeO_g, $TeO_{2,g}$, $TeO_2(H_2O)$, and $TeO_2(H_2O)_2$. For most species thermodynamic data are available to predict volatility, however magmatic-hydrothermal vapors are dominantly H_2O, which acts as a solvent promoting metal solubility with increasing temperature and vapor density. Previous experimentally derived thermodynamic properties for hydrated $TeO_{2,g}$ indicate log fugacities ranging from -5.73 to -3.66 between 450 and 700 °C. Previous numerical models of natural systems implicate H_2Te_g will be the dominate gaseous Te species in magmatic-hydrothermal systems. Here we present tellurium solubility experiments determined in pure water vapor between 150 and 300 °C using batch-type Ti-autoclaves. TeO_2 and native tellurium with oxide mineral buffers (MoO_2-MoO_2 and WO_2-WO_3) will be used to test the role of oxidation states of different gaseous Te species on the overall tellurium solubility. Experiments will be conducted in a high-temperature muffle furnace for ~ 15 days, after which quenched condensates and reacted solids will be extracted and analyzed using ICP-MS for determination of Te concentrations and SEM/EPMA/XRD for solid characterization. Thermodynamic properties will be extracted from these experiments and implemented into the GEMS code package for simulating the factors controlling tellurium mobility in ore-forming systems.