

The role of hydration in the transport of tellurium in aqueous vapors at 150 to 300°C

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Tellurium is a critical mineral of increasing importance in green energy technologies. Numerical simulations using previous thermodynamic data predict up to ~0.1 ppm in epithermal vapors with H₂Te(g) as the dominant vapor species [1]. However, fluid inclusion studies show up to hundreds of ppm Te in vapor inclusions from epithermal ore deposits [2]. In this study, we determined tellurium solubility in hydrothermal vapors experimentally and aim to determine hydrated tellurium speciation in water vapor. Hydration is the effect of water vapor molecules binding to a metal, greatly increasing its solubility [3]. Experiments were conducted in batch-type Ti Parr reactors at 150 – 300°C and a range of water vapor pressures (P_{H₂O}) using different oxygen buffers (e.g., MoO₂-MoO₃, WO₂-WO₃ and Ni-NiO). Kinetic experiments were conducted between 1 and 25 days at 250°C and 20 bar for different redox conditions. At oxidizing conditions, equilibrium conditions were reached after ~10 days at a 1.33 ±0.01 ppm Te and in N₂-degassed experiments after ~22 days at 0.669 ±0.004 ppm Te indicating slower reaction kinetics and reduced solubility at lower redox conditions. Experiments at 250°C and logfO₂ of -24 (MoO₂-MoO₃ buffer), show increasing Te solubility with increasing P_{H₂O} ranging from 1-3 ppm Te between 15-25 bar to 12.27±0.01 ppm Te at 35 bar. The MoO₂-MoO₃ buffered experiments overlap in concentrations with results from the kinetic series at oxidizing conditions. Previous experimental work has shown enhanced solubility of TeO₂ in water vapor due to the formation of TeO₂·xH₂O with x = 1 and 2 [1,4-5], whereas in this study show higher hydration numbers similar to other metals [3]. Our results demonstrate the significant role of P_{H₂O} on TeO₂ solubility in low density fluids. We anticipate the data generated to be applied in thermodynamic models to discern tellurium mobility in hydrothermal systems.

[1] Grundler et al., (2013) *Geochim. et Cosmochim. Acta* **120**, 298–325.

[2] Wallier et al., (2006) *Econ. Geol.* **101**, 923–954.

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[5] Glemser et al., (1966) *Omagiu Raluca Ripan*, 253-262.

