



## Recrystallization of amorphous magnesium sulfate hydrates: A low-temperature formation pathway for kieserite ( $\text{MgSO}_4 \cdot \text{H}_2\text{O}$ ) on Mars?

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**Introduction:** Numerous detections by the Mars Reconnaissance Orbiter spacecraft's *CRISM* instrument have established that the mineral kieserite ( $\text{MgSO}_4 \cdot \text{H}_2\text{O}$ ) is an important component of many sulfate deposits on Mars<sup>1-4</sup>. These orbital detections were enabled by the distinct infrared absorption fingerprint of kieserite. Most recently the *Curiosity* rover's *CheMin* instrument has detected the mineral kieserite in situ at Gale crater<sup>5</sup>, resulting in a renewed interest in the formation of this mineral. Wang et al. (2018)<sup>6</sup> and Kong et al. (2014)<sup>7</sup> reported intriguing Raman spectra of an enigmatic 'low-humidity kieserite' phase occurring at Dalangtan Playa, an arid salt deposit in China. The maximum temperature at this field site barely exceeds 30 °C during summer, thus starkeyite ( $\text{MgSO}_4 \cdot 4\text{H}_2\text{O}$ ) should be the stable phase under these conditions<sup>8</sup>. Wang et al. (2018)<sup>6</sup> hypothesize that the formation of kieserite outside of its stability field was enabled via the formation of a transient amorphous phase that then crystallized to form kieserite. Higher hydrates (epsomite and hexahydrite) readily turn amorphous under dry, low-pressure conditions<sup>9</sup> and amorphous magnesium sulfate hydrates are likely present in many samples analyzed by the MSL *Curiosity* rover<sup>5,10</sup>. Therefore, the Wang et al. (2018)<sup>6</sup> results suggest that kieserite formation potentially facilitated by an intermediate amorphous phase might explain the widespread occurrence of kieserite on Mars. To test this hypothesis, we have studied recrystallisation of amorphous magnesium sulfate both under simulated terrestrial and Martian environmental conditions.

**Results:** No indications of the presence of kieserite were found in our experiments, thus our preliminary results do not lend support to the hypothesis that kieserite may form via an intermediate amorphous phase. The kieserite occurrences on Mars and at Dalangtan Playa remain enigmatic and additional experiments at higher and lower temperatures, at varied RH, and on longer timescales are in progress.

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