

Sulfidation of silicates under Mercury's reducing conditions

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Mercury's surface exhibits an elevated abundance of sulfur of up to 4 wt.%, as observed by NASA's MESSENGER mission. One of the hypotheses to explain this enrichment is volcanic degassing, which would allow release of S from Mercury's interior, triggering sulfidation reactions between the reduced S-bearing gas and crustal materials. However, the underlying reaction mechanisms are poorly understood. In this study, we investigated the mechanisms of reactions between reduced S gas and the silicate minerals olivine and diopside using high-temperature experiments. These experiments were performed inside evacuated silica glass ampules, which contained a graphite crucible with the silicate mineral – polished on one side – and another graphite crucible with elemental S powder. Samples were exposed to temperatures between 800 and 1200 °C for durations between 1 hour and 1 week. At these conditions, the S powder forms a gas and fills the ampule, allowing it to react with the silicate mineral. Mercury's reducing conditions were buffered by the graphite-CO reaction inside the ampule. The results show fundamentally different sulfidation reaction mechanisms between olivine and diopside. This has important implications for future findings by the BepiColombo mission, which is scheduled to enter Mercury's orbit in November 2026.