

Olivine and diopside sulfidation kinetics at Mercury surface conditions

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The surface of Mercury is enriched in sulfur, with abundances of up to 4 wt.%, as detected by NASA's MESSENGER mission [1]. One of the possible hypotheses regarding the origin of this enrichment involves volcanic degassing, releasing sulfur from the interior of the planet and trigger sulfidation reactions between reduced volcanogenic sulfur and surface materials [2,3]. Little is known, however, about the reaction mechanisms involved in the sulfidation of silicate minerals. In this study, we investigate the reaction kinetics and mechanisms between reduced gaseous sulfur and specifically the silicate minerals olivine and diopside, which are common constituents of the planet's surface [4], using high-temperature experiments. For each experiment, the silicate mineral – polished on one side – and sulfur powder were loaded into separate graphite crucibles, and subsequently mounted in an evacuated silica tube. The samples were exposed to temperatures ranging from 800 to 1250 °C, at which the sulfur powder forms a gas and fills the silica tube, allowing a reaction with the mineral. Experimental run durations varied from 1 hour to 1 month. Oxygen fugacity was buffered by the graphite-CO reaction, which represents the reducing conditions at the surface of Mercury. Results show a fundamental difference in the sulfidation reaction mechanism of olivine and diopside. The sulfidation of olivine is predominantly diffusion-limited, whereas in diopside, layers of intermediate phases develop at the interface, including Ca-depleted pyroxene. These outcomes shed a different light on our knowledge about such reactions on Mercury's surface, with implications for remote sensing spectroscopy by the BepiColombo spacecraft currently approaching Mercury.

[1] Nittler et al. (2011), *Science*, 333(6051), 1847-1850. [2] Renggli et al. (2022), *Earth and Planetary Science Letters*, 593, 117647. [3] Renggli et al. (2023), *Journal of Geophysical Research: Planets*, 128(12), e2023JE007895. [4] Vander Kaaden et al. (2017), *Icarus*, 285, 155-168.