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Simulating Venus: Experimental Investigation of Mineral Stability using the Glenn Extreme Environment Rig

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Although Venus is our closest planetary neighbor, many aspects of the Venusian surface remain a mystery, including the mineralogy, owing to the opaque atmosphere that disallows observations in the visible wavelengths. Several researchers have hypothesized on the mineralogy at three locations on the surface based on in situ measurements [1]. However, the relatively high surface temperature (460°C) and pressure (93 bar), and its atmosphere of reactive supercritical gases such as CO_2 could affect mineral stability over time [2].

To investigate the mineralogy of Venus, several minerals (enstatite, forsterite, nepheline, anorthite, wollastonite, albite, muscovite, phlogopite, brucite, calcite, magnesite, and siderite) were exposed to simulated Venus conditions in the Glenn Extreme Environment Rig (GEER) located at NASA GRC. The minerals were exposed for 60 days at 460°C/93 bar under CO_2, N_2, SO_2, H_2O, OCS, CO, H_2S, HCl, and HF gases. The minerals were analyzed using a suite of analytical techniques, including XRD, XPS, CHN Analyzer, SEM, EDS, FTIR ATR, and ICPMS.

The optical properties of the minerals were clearly altered with many of the minerals darkening after the experiment [3]. XPS analysis revealed the presence of sulfate in all samples, with the largest abundance present in calcite followed by wollastonite. Analysis of spectra collected by FTIR ATR determined OH loss in both phlogopite and brucite. Moreover, XRD analysis verified the conversion of brucite into periclase and magnesite. Lastly, some of the powdered samples showed changes in chemistry with depth into the crucible. Our results indicate the instability of some hydrated minerals and can be used to predict the water budget of Venus' crust. Additionally, several minerals act as a sulfur sink, which has important implications for Venus' volcanic history. The results of these experiments will be applicable to the upcoming Venus missions VERITAS and Envision, since both will use emissivity mappers to identify the bulk composition of the surface [4].

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