An experimental approach to study the alteration of Venusian surface materials

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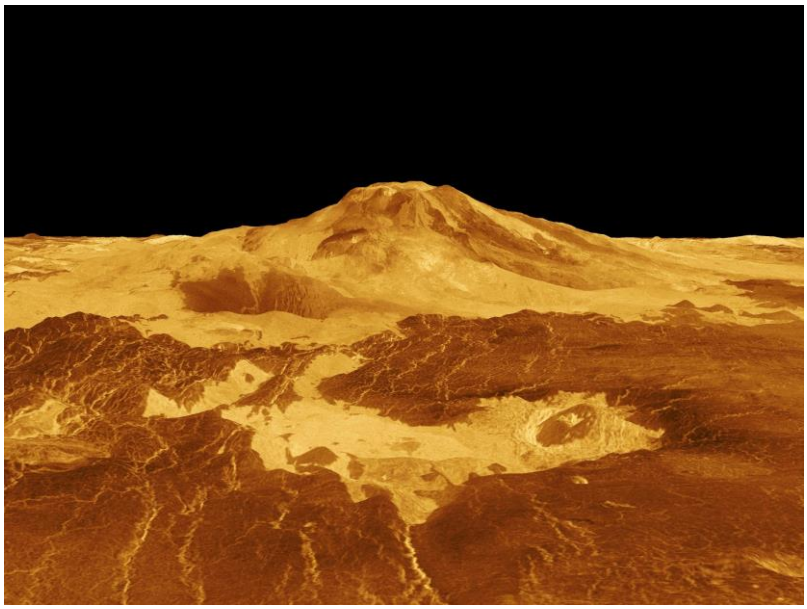

Computer-generated, three-dimensional perspective using Magellan data of Maat Mons on Venus showing lava flows (bright yellow) extending across the basaltic plains in the foreground. Determining the weathering rates of venusian surface rocks will help determine the age of these lava flows. Image credit: NASA/JPL

Project highlights:

- Run high-temperature experiments in the AstrobiologyOU environmental simulation labs and use a variety of analytical techniques.
- Provide new constraints on surface alteration mineralogy, which will be crucial to understand geological processes on Venus in preparation for upcoming Venus missions.
- Be part of an international, multi-disciplinary, diverse team with mission experience.

Project description:

The majority of Venus' surface consists of basaltic rocks, which are in contact with a hot caustic atmosphere[1]. At these conditions, chemical reactions between the basaltic crust and the atmosphere are expected to alter the venusian surface mineralogy and composition[2]. However, without the presence of liquid water, weathering is mostly restricted to oxidation reactions[2,3], which are currently not well understood for venusian surface conditions. Better constraints on the alteration mineralogy and the oxidation rate are needed to determine the ages of lava flows and to contribute to the characterisation of the mineralogy and

chemistry of the venusian surface such as near infrared (NIR) emissivity spectra, which will be used by the upcoming ESA EnVision and NASA VERITAS (Venus Emissivity, Radio science, InSAR, Topography, And Spectroscopy) missions to map the venusian surface.

This project will use an experimental approach to constrain surface alteration of mafic minerals and basalt under venusian conditions, which is crucial to understand geological processes on Venus including the question whether Venus is still volcanically active. These new constraints on the character and rate of alteration will provide an important new data set in preparation for the upcoming Venus missions.
In detail the project will seek to:

1) Run high-temperature alteration experiments simulating Venus' surface conditions (~470 °C, 90 bar) with a CO_2 only gas headspace composition using the AstrobiologyOU static reactors. The starting materials will be selected mafic minerals such as olivine and clinopyroxene and basaltic rocks or glasses that are compositionally similar to those measured on the venusian surface.
2) Modify the experimental set-up to include minor amounts of H_2O (~30 ppm) and/or SO_2 (~150 ppm) to better reflect the trace gas composition of the Venusian atmosphere.
3) Characterise the alteration mineralogy of the experimental runs using a range of analytical techniques including scanning electron microscopy, electron microprobe, RAMAN and near infrared (NIR) spectroscopy.

The two sets of simulation experiments and detailed analyses of the samples will be used to determine the alteration products and differences in reaction rates for various starting materials reflecting differences in venusian atmospheric composition.

References:

1. Taylor, F.W. et al. (2018). Venus: The atmosphere, climate, surface, interior and near-space environment of an earth-like planet. Space Science Reviews, 214:35.
2. Zolotov, M.Y. (2018). Gas-solid interactions on Venus and other solar system bodies. Review in Mineralogy and Geochemistry, 84, 351-392.
3. Fegley, B. et al. (1995). Basalt oxidation and the formation of hematite on the surface of Venus. Icarus, 118, 373-383.