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The Italian Solfatara as an analog for Mars fumarolic alteration

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Abstract

The first definitive evidence for continental vents on Mars is the in situ detection of amorphous silica-rich outcrops by the Mars Exploration Rover Spirit. These outcrops have been tentatively interpreted as the result of either acid sulfate leaching in fumarolic environments or direct precipitation from hot springs. Such environments represent prime targets for upcoming astrobiology missions but remain difficult to identify with certainty, especially from orbit. To contribute to the identification of fumaroles and hot spring deposits on Mars, we surveyed their characteristics at the analog site of the Solfatara volcanic crater in central Italy. Several techniques of mineral identification (VNIR spectroscopy, Raman spectroscopy, XRD) were used both in the field and in the laboratory on selected samples. The faulted crater walls showed evidence of acid leaching and alteration into the advanced argillic-alunitic facies, with colorful deposits containing alunite, jarosite, and/or hematite. Sublimates containing various Al and Fe hydroxyl-sulfates were observed around the active fumarole vents at 90 °C. One vent at 160 °C was characterized by different sublimates enriched in As and Hb sulfide species. Amorphous silica and alunite assemblages that are diagnostic of silicic alteration were also observed at the Fangaia mud pots inside the crater. A wide range of minerals was identified at the 665 m diameter Solfatara crater that is diagnostic of acid-steam heated alteration of a trachytic, porous bedrock. Importantly, this mineral diversity was captured at each site investigated with at least one of the techniques used, which lends confidence for the recognition of similar environments with the next-generation Mars rovers.

Keywords: Mars analog, hydrothermalism, vents, fumaroles, alteration patterns, Solfatara, VNIR spectroscopy, Raman spectroscopy, XRD; Special Collection: Earth Analogs for Martian geological materials and processes