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Jarosite in Antarctic deep ice supports the ice-weathering model for jarosite formation on Mars

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On Earth, jarosite is a weathering product forming in acidic-oxidative environments from the alteration of iron-bearing minerals in presence of liquid water. Typical settings where this iron-potassium hydrated sulphate is found, are weathering zones of pyrite-rich deposits, evaporative basins and fumaroles. Jarosite is not only known on Earth, it also occurs on Mars, where it was firstly identified by the Opportunity rover. The mineral was in fact recognized in the finely layered formations outcropping at Meridiani Planum and that were accurately investigated by the rover (Klingelhöfer et al. 2004). Since jarosite requires liquid water to form, its occurrence on Mars has been regarded as an evidence for the presence of liquid water in the geologic past of Mars (Elwood-Madden et al., 2004). Since then, many models have been proposed to describe the environments where the precipitation of Martian jarosite took place. The most accepted ones deal with evaporative basins similar to Earth's playas, others concern volcanic activity and hydrothermal processes. An alternative proposal predicted that jarosite may have formed as a consequence of weathering of mineral dust trapped in massive ice deposits, i.e. the ice-weathering model (Niles & Michalsky, 2009). The hypothesis that jarosite formed on Mars because of low-temperature, acidic and water limited weathering, is not new (Burns, 1987), but until now no direct evidences were available to support it.

A potential Earth analogue to investigate such processes is deep Antarctic ice. We present a first investigation of deep ice samples from the Talos Dome ice core (East Antarctica) aimed at the identification of englacial jarosite, so as to support the ice-weathering model. Evidences gathered through independent techniques showed that jarosite is actually present in deep Antarctic ice and

results from the weathering of dust trapped into ice. The process is controlled by the re-crystallization of ice grains and the concurrent re-location of impurities at grain-junctions, which both depend on ice depth. This study demonstrates that the deep englacial environment is suitable for jarosite precipitation. Our findings support the hypothesis that, as originally predicted by the ice-weathering model, paleo ice-related processes have been important in the geologic and geochemical history of Mars.

References

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