

PHOTO-OXIDATION OF BIOMOLECULES BY IRON (III) OXIDE. G. Ertem¹ and C. P. McKay²,
¹University of Maryland, Department of Atmospheric and Oceanic Science, College Park, MD, 20742, ²Space Science Division, NASA Ames Research Center, Moffett Field, CA 94035

Introduction: Hematite or hemaetite, $\alpha\text{-Fe}_2\text{O}_3$, is one of the sixteen iron oxides or hydroxides present on Earth: It characteristically forms either in aqueous environments or by aqueous alteration [1]. Hematite has also been observed by Opportunity rover in considerable amounts in the Terra Meridiani region (Meridiani Planum) of Mars in the form of small spherules as shown in TES (Thermal Emission Spectrometer) image below in red.

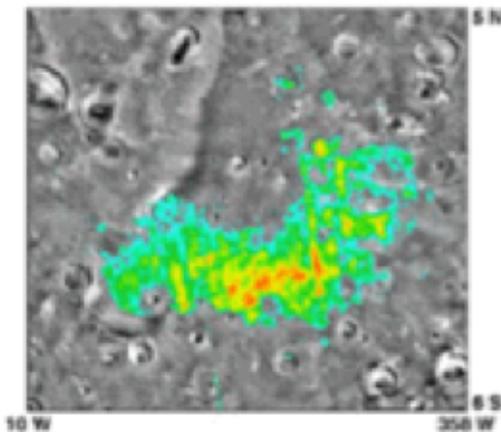


Figure: The distribution of hematite in Sinus Meridiani, where Meridiani Planum is located.

Our recent work designed to investigate the possible protective role of Martian analogue minerals for biomolecules against the effects of UV radiation demonstrated that biomolecules purine, pyrimidine and uracil undergo complete decomposition in the presence of Fe_2O_3 without being subjected to UV light as a result of photo-oxidation by Fe_2O_3 [1]. (Electrode potential of Fe^{3+} is 0.77 volt.)

Here, we are going to present our research designed to study the oxidative power of hematite in the presence of other Martian analogue minerals, i. e., mixtures of iron oxide with minerals that have been identified on Martian soil, namely calcium carbonate (CaCO_3) [2], gypsum (CaSO_4) [3], kaolinite [4], and high and low charge density phyllosilicates [5]. We have also studied the protective role of hematite-corundum mixtures, since these two minerals have similar specific density, Fe_2O_3 : 5.15 g/cm^3 Al_2O_3 : 3.987 g/cm^3 .

Experimental: Organics were removed from CaCO_3 , CaSO_4 , kaolinite and high and low density phyl-

losilicates as described in detail in Ertem et al (2017). Aqueous purine solution was prepared to contain 1% NaClO_4 , since perchlorate has been reported to be present on Martian soil [6].

Minerals were placed onto aluminum plates with 3 cm diameter and 1 mm height. 0.240 mL of purine solution was added to each 400 mg of iron (III) oxide to give a final organic concentration of 40 ppm. Mixtures stayed at 25 deg C and under ambient light for 12 days.

Extraction: Mineral-purine mixtures were quantitatively transferred into 2 mL polyethylene tubes. To each tube was added 1.0 mL of water, vortexed vigorously for 30 seconds. Extraction of organic was continued for four more hours using circular mixer. Following centrifugation at 5000 rpm/min, supernatants were removed and kept at -40°C . Extraction was repeated for two more times. Combined extracts were freeze-dried at -85°C 20-25 mbar for 12-15 hours, dissolved in water and analysed by UV spectroscopy at 260 nm.

Results demonstrated that Fe_2O_3 itself result in the complete oxidation of organic compounds, while its mixtures with Martian analogue soils we tested do not lead to oxidation or destruction of organic compounds.

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References: [1] Ertem, G. et al. (2017) *Int. J. Astrobiol.* (2017) 16, 280-285. [2] Boynton et al. (2009) *Science*, 325, 61-64. [3] Bibring et al. (2006) *Science*, 312, 400-404. [4] Carter et al. (2013) *J. Geophys. Res. Planetets*, 118, 831-858. [5] Ertem et al. (2010) *Astrobiology*, 10, 743-749. [6] Glavin et al. (2013) *J. Geophys. Res.* 118, 1955-1973.