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Preservation of Organics in Martian Clays

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The Sheepbed member in Gale crater, the Curiosity rover study site, is a mudstone interpreted as the remnant of an ancient fluvio-lacustrine environment, optimal for organic matter preservation. Chlorinated organic compounds were identified with SAM in the Cumberland (CB) drill sample; however, there was meager organic matter detection in the very close John Klein (JK) borehole. CheMin XRD patterns show that the main mineralogical difference between CB and JK is the basal spacing (001) of clay minerals: from 13.2 Å in CB to 10 Å in JK.
We investigated whether the exposure to different environmental conditions (acid vs. alkaline fluids) can compromise the capacity of specific clays to protect organic compounds (i.e. glycine) under Mars-like conditions. We chose nontronite as the mineral matrix, which is known to preserve organics on Mars. For comparison, we used pyrite, a mineral sensitive to photoactivity and unstable under current subaerial Mars conditions. Nontronite and pyrite samples were purified and characterized by mineralogical and chemical analyses (XRD, FT-IR, Raman, SEM, XPS, GM-CTD) before and after exposure to 80 h under present-day martian UV flux conditions, inside the Planetary Atmosphere and Surface Chamber (PASC) at Centro de Astrobiología.
Results show amorphization of the basal peak d(001) of nontronite, that migrated to higher distances (from 12.6 Å to 14.5 Å) following reactions with HCl, suggesting a change in the structure of nontronite. After reaction with a glycine suspension, the swelling capacity of acid-treated nontronite to incorporate organic matter was lower than that of the alkaline-treated sample. Both treated clays efficiently protected amino acids against UV, with a loss of only <1% of the C content, compared with a 2% loss observed in the pyrite sample. Raman spectroscopy also suggests that the alkaline-treated clay acts as a better shielding agent against UV radiation. These results may help guide the search and detection of biosignatures with the upcoming ExoMars and Mars2020 rovers.