Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12338

THE OXIDATION STATE OF SULFUR IN MARTIAN APATITE-IMPLICATIONS FOR REDOX OF SURFICIAL PROCESSES.

PROTEEK CHOWDHURY[1], MARYJO BROUNCE[2], JEREMY W BOYCE[3] AND FRANCIS M MCCUBBIN[4]

[1]University of California, Riverside
[2]900 University Drive
[3]NASA
[4]NASA Johnson Space Center
Presenting Author: proteekc@ucr.edu

Martian meteorites record a range in fO_2 from ΔIW = -1 to ΔIW+6.5. Explanations for this include that the mantle is heterogeneous in fO_2, or that differentiation and/or alteration change(s) the fO_2 of magmas after extraction from the source. Apatite is found as a late-forming mineral and can incorporate both S^{2-} and S^{6+}. The relative proportions of S^{6+}/S^{2-} in apatite depend on the fO_2 when apatite forms (with *P*, *T*, and major elements). We present measurements of S^{6+}/S^{2-} in apatite from two Martian "finds" using S-XANES: QUE94201 and NWA7034. We compare records of fO_2 from apatite with those from earlier-formed minerals to quantify the changes in fO_2 recorded by single meteorites during assimilation and/or alteration.

The S-XANES spectra of apatite grains in NWA7034 have a single peak at 2482 eV, indicating the presence of only S^{6+}, $S^{6+}/\sigma S$ = 1.0 and fO_2 of ≥ΔIW+6.5. The S-XANES spectra of apatite grains in QUE94201 have peaks at 2470, 2477 and 2482 eV, consistent with the presence of both S^{2-} and S^{6+}, $S^{6+}/\sigma S$ between 0.06 and 0.91- fO_2 during apatite crystallization of ~ΔIW+2.4 to ΔIW+6.4. Estimates of fO_2 from Fe-Ti oxides in NWA7034 range from ~ΔIW+4.5 to ΔIW+6.5. and from clinopyroxene in QUE94201 range from ~ΔIW-1.0 to ΔIW+1.0 indicating that S-in-apatite records higher fO_2 than other igneous minerals in these meteorites. Hydrogen isotopic compositions of apatite in QUE 94201 vary from 1700-3500‰ and in NWA7034 from 1000-2000‰, which are distinct from terrestrial water values (-480 to +130‰) but overlap with Martian crustal values (750 to 2500‰) and have been interpreted (with other mineralogical evidence) as being imprinted on the apatite in the rock during hydrothermal alteration in the Martian crust. In the case of the breccia NWA7034, this fluid is thought to have lithified the rock through thermal annealing. Our S-XANES measurements of these apatite demonstrate through direct measurements that hydrothermal fluids percolating through the Martian crust can increase the fO_2 of the rock from the value recorded by igneous minerals of ΔIW~0 to ΔIW+6.4 in the case of QUE94201, and at least as high as ΔIW+6.5 in the case of NWA7034.