Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37592

Fe-Phosphates in Sedimentary and Igneous Terrestrial Analogues Constrain Conditions of Formation in Jezero Crater, Mars.

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Fe-phosphates in polylithic conglomerate and mudstone analyzed by the M2020 *Perseverance* rover in Jezero crater, Mars represent important astrobiological targets as indicators of habitable environments[1] and significant components of a "potential biosignature"[2]. The mineral assemblage likely includes Fe-phosphates such as vivianite[1,2], metavivianite, (ferro)beraunite, ferrolaueite, and santabarbarite[1]. However, these phosphates are difficult to distinguish at the ~120-µm spot size resolution of the Planetary Instrument for X-ray Lithochemistry (PIXL). Their environment of formation is also somewhat unconstrained[1], with non-biogenic origins in both aqueous and igneous conditions under consideration[1]. On Earth, Fe-phosphates in aqueous environments can precipitate or form as authigenic minerals associated with organics. However, they can also form in igneous environments, such as in highly evolved, fluid-rich pegmatites and their occurrence in Jezero sediments may be detrital. Here, we analyze terrestrial analogues from sedimentary (aqueous) and igneous occurrences to further narrow down their origin and determine if their formation environment was habitable.

Samples were collected from a phosphate-rich marl in Monmouth County, NJ, hydrothermally brecciated ferruginous sediments in Midvale, Rockbridge County, VA, and Palermo, a pegmatite in Grafton County, NH. Initial mineral identification was done using Raman spectroscopy and SEM.

Near Crosswicks Creek, New Jersey, soil potentially containing ferrolaueite and ferrostrunzite was collected from a small dried-up gully. At a second site, green, glauconite-rich soil was collected from the bank of the orange-brown Crosswicks Creek (likely colored as such from Fe-oxide precipitation). From Midvale, beige to red siltstone samples contain cm-scale quartz veins, a <2 mm black spherical mineral (potentially rockbridgeite) and a coating of an unknown soft, green mineral (likely from the Chilhowee Group, but were not *in situ*). The medium to coarse-grained pegmatitic samples from Palermo contain vivianite group minerals (Fe-rich vivianite and Mg-rich bobierrite) as thin intergrowths in cleavages of triphylite, associated with siderite, hagendorfite, sulfides, montebrasite, ludlamite and mitridatite. Samples will be further characterized using a PIXL analogous wavelength dispersive X-ray fluorescence spectrometer and compared to PIXL results to constrain Fe-phosphate mixing relationships and textures in Jezero crater.

[1] Kizovski, T.V. et al. (2025). *Nature Comms*, *16*(1), 6470.
[2] Hurowitz, J.A. et al. (2025). *Nature*, *645*(8080), 332–340.