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A comprehensive emplacement scheme for the interior layered deposits of Valles Marineris

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Sulfates are abundant on Mars, primarily from volcanic eruptions and degassing. The thickest deposits are in the interior layered deposits (ILD) of Valles Marineris, interpreted as either sedimentary or weathered volcanic products. We used nonlinear spectral unmixing of eight laboratory mineral mixtures and compared them with the CRISM spectrum of the lower ILD in Ophir Chasma. The best fit included primary igneous minerals (orthopyroxene, plagioclase), coquimbite, kieserite, and szomolnokite. Geomorphological evidence suggests that the igneous minerals are from a source within the ILD. Findings indicate that deposition was influenced by Tharsis-related activity and the redox state of an overlying Valles Marineris sea, similar to volcanogenic massive sulfide deposits on Earth. Cooling climate, possibly due to waning Tharsis activity, led to sea freezing, altering volcanic ash and forming the upper ILD, ending with erosion by glacial flows, shaping the current chasmata.