The Pahrump region (Gale Crater, Mars) marks a critical transition between sedimentary environments dominated by alluvial-to-fluvial materials associated with the Gale crater rim, and depositional environments fundamentally linked to the crater’s central mound, Mount Sharp. At Pahrump, the Murray formation consists of an approximately 14-meter thick succession dominated by massive to finely laminated mudstone with occasional interbeds of cross-bedded sandstone, and is best interpreted as a dominantly lacustrine environment containing tongues of prograding fluvial material. Murray formation mudstones contain abundant evidence for early diagenetic mineral precipitation and its subsequent removal by later diagenetic processes.

Lenticular mineral growth is particularly common within lacustrine mudstone deposits at the Pahrump locality. High-resolution MAHLI images taken by the Curiosity rover permit detailed morphological and spatial analysis of these features. Millimeter-scale lenticular features occur in massive to well-laminated mudstone lithologies and are interpreted as pseudomorphs after calcium sulfate. The distribution and orientation of lenticular features suggests deposition at or near the sediment-water (or sediment-air) interface. Retention of chemical signals similar to host rock suggests that original precipitation was likely poikilotopic, incorporating substantial amounts of the primary matrix. Although poikilotopic crystal growth is common in burial environments, it also occurs during early diagenetic crystal growth within unlithified sediment where high rates of crystal growth are common. Loss of original calcium sulfate mineralogy suggests dissolution by mildly acidic, later-diagenetic fluids. As with lenticular voids observed at Meridiani by the Opportunity Rover, these features indicate that calcium sulfate deposition may have been widespread on early Mars; dissolution of depositional and early diagenetic minerals is a likely source for both calcium and sulfate ion-enrichment in burial fluids that precipitated in ubiquitous late-stage hydrofracture veins.
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Presenting Author
L.C. Kah
University of Tennessee
1412 Circle Drive
Department of Earth & Planetary Sciences
Knoxville, TN 37996
Phone Number: 8659746399
Email: lckah@utk.edu

R.E. Kronyak
University of Tennessee
1412 Circle Drive
Department of Earth & Planetary Sciences
Knoxville, TN 37996-1410
Email: rkronyak@vols.utk.edu
Student? Y

D. W. Ming
NASA Johnson Space Center
Astromaterials Research and Exploration Science
Houston, TX 77058
Phone Number: (281) 483-5839
Email: douglas.w.ming@nasa.gov
Student? N

J.P. Grotzinger
California Institute of Technology
1200 E. California Blvd
Geological and Planetary Sciences
Pasadena, CA 91125
Phone Number: (626) 395-6123
Email: grotz@gps.caltech.edu
Student? N

J. Schieber
Indiana University
1001 East 10th Street
Department of Geological Sciences
Bloomington, IN 47405
Phone Number: N/A
Email: jschiebe@indiana.edu
Student? N
D.Y. Sumner
University of California
Geology
Davis, CA 95616
**Phone Number:** 530-752-5353
**Fax Number:** 530-752-0591
**Email:** dysumner@ucdavis.edu
**Student?** N

K.S. Edgett
Malin Space Science Systems
P.O. Box 90148
San Diego, CA 92191-0148
**Phone Number:** 858-552-2650
**Email:** edgett@msss.com