Organic Matter Preserved in Mudstones of a 3-Billion-Year-Old Lake Deposit in Gale Crater, Mars

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In situ analyses of lake-deposited mudstones of the Murray formation at Pahrump Hills, Gale crater, Mars show the presence of aliphatic, aromatic, and sulfur-bearing organic gases upon heating to 500-860˚C, as detected by the Sample Analysis at Mars (SAM) instrument suite on the Mars Science Laboratory's (MSL's) Curiosity rover. Organic-sulfur compounds, including thiophenes, dimethylsulfide and thiols were identified by gas chromatography-mass spectrometry (GCMS) and observed in evolved gas analyses (EGA). Other aromatic and aliphatic hydrocarbon components were also indicated by EGA. The distributions of organic molecules observed were specific to samples and cannot be from SAM's instrument background. The temperatures these organic volatiles were released is consistent with the pyrolytic cleavage of organic fragments from large molecules (macromolecules) indigenous to the mudstones. Some portion may also be derived from the thermal release of organics entrained within minerals.

The release of organic-sulfur compounds occurs at high temperatures in the SAM oven; thus, these compounds are most likely derived from sulfurized organics in the sediments and are not an artifact of sulfurization reactions in the oven. On Earth, sulfurization is a key process that facilitates organic matter preservation over geological time-scales by transforming individual organic molecules into recalcitrant macromolecules. Organic matter at the base of the Murray formation probably underwent sulfurization prior to deposition or during early diagenesis. Multiple factors likely contribute to the organic preservation in the Gale crater mudstones, however, sulfurization may be largely responsible for the greater abundance and the molecular diversity observed in the lower Murray formation.

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