Improving our understanding of the influence of iron oxides on thermal experiments looking for organic matter on Mars.
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Introduction: The payload of the Mars Science Laboratory (MSL) rover includes the Sample Analysis at Mars (SAM) instrument suite. Within SAM, powdered samples are heated from 40 to 850 °C [1]. Gases evolved from the sample are sent directly to a mass spectrometer (Evolved Gas Analysis – EGA) or for gas chromatography-mass spectrometry (GC-MS) analyses [2]. SAM data have shown evidence for organic matter [3], indicated the presence of perchlorates [1] and provided constraints on the volatile species within the X-ray amorphous component present in Gale Crater materials [4,5].

Materials sampled from the surface of Mars are made up of many different species, a proportion of which will thermally decompose within the SAM analytical range. Decomposing phases and their decomposition products have the potential to interact with one another. For example, any mineral that decomposes to release oxygen may combust and destroy organic matter it is associated with. Conducting analogous laboratory experiments to SAM can help identify some of these interactions and assess their importance in the instrument suite's ability to detect organic matter.

Organic matter on Mars: The oxidising nature of the martian surface, in combination with intense radiation, likely leads to the breakdown of organic matter into metastable organic salts, such as acetates, oxalates, mellitates and phthalates [6]. Organic salts are difficult to detect using thermal experiments, such as SAM, as their decomposition products are simple species, such as carbon dioxide, carbon monoxide and acetone [6].

Decarboxylation of organic acids has been suggested as a possible source of some of the carbon dioxide and carbon monoxide seen in SAM-EGA data [4,5,7]. Identifying how different types of organic acids and salts decompose to give carbon dioxde and carbon monoxide is therefore of great importance.

The impact of mineralogy: Sample mineralogy can directly and indirectly influence evolved gas chemistry in thermal experiments (e.g. oxychlorine phases, such as perchlorates, which are likely widespread on Mars) [1]. Any mineral that decomposes within the temperature range of a pyrolysis experiment will likely have some impact on the data produced.

Hematite and magnetite have been detected in Gale Crater rocks and sediments by the MSL Chemistry and Mineralogy (CheMin) instrument [8] and MSL's future exploration targets include Hematite Ridge, identified from orbit [9]. Thus, we seek to understand how hematite, magnetite and perchlorates interact with each other and with organic matter during SAM-like thermal experiments.

Experimental approach and preliminary data: Experiments are conducted on a laboratory analogue to the SAM instrument. Standards of hematite, magnetite, perchlorates and organic matter are mixed and studied by EGA. Iron, calcium and magnesium perchlorates, as well as different oxalate and acetate salts, are being used to explore the influence of cation variation. For example, while most oxalates show only minor variation, potassium oxalate has been found to have extremely different thermal decomposition profiles when mixed with iron, magnesium or calcium perchlorate. The addition of hematite and magnetite to each mixture, with or without perchlorate, allows the influence of the iron oxides on organic matter detection to be assessed.

Kerogen mixtures are also used to represent organic matter that has experienced less oxidative degradation. The data support interpretations of the organic matter content of regions of Gale Crater hosting iron oxides.

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