

MARTIAN (?) CALCITE AND GYPSUM IN SHERGOTTITE EETA79001

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Introduction. Glass in EETA79001 that contains trapped Mars-like atmospheric gases was shown previously [1] to also contain trapped, oxidized (sulfate) sulfur and traces of sulfur- and chlorine-bearing aluminosilicates, consistent with a Martian origin. We report here further discovery of two varieties of Ca-carbonate and one of Ca-sulfate that reinforce the case for origin of EETA79001 on Mars. **Analyses.** Nine new samples from widely separated locations in the meteorite, including glass (Lith-C) from both igneous lithologic units (Lith-A, -B), were examined by scanning electron microscopy (SEM) and energy-dispersive X-ray spectrometry (EDS; incl. light elements). Grains of the most abundant carbonate deposit (sample 239) were also subjected to X-ray diffraction (XRD) using a Gandolfi camera. Based on preliminary SEM/EDS results [2], carbonate from 239 was subdivided for volatile-element and stable-isotopic analyses by others. **Results.** In sample 234 (Lith-C from same glass pocket as earlier sample 180 [1] and well-known sample 27 that contains Mars-like trapped gases), carbonate and sulfate occur both separately and together as 10-20- μ m-sized grains that are intimately associated with glass and quench-crystallized pyroxene. The sulfate (major elements Ca, S, and O) is inferred to be gypsum from its prismatic to acicular crystals that display monoclinic forms. At least two gypsum grains are enclosed and crystallographically oriented in pyroxene whereas a third appears captured in a random orientation. In addition, a cluster of gypsum needles occupy a smooth glass vesicle. Most carbonate grains (major elements Ca, C, and O) occur as anhedral, rounded disks although one occurrence comprises a more massive vug filling. Absence of recognizable crystal forms preclude identification of the carbonate by morphology. In all cases, carbonate grains are highly fractured, suggestive of thermal or mechanical stress, whereas most gypsum crystals are remarkably unblemished.

In sample 239, calcite (identified by XRD) predominates as mostly massive and granular druse on a Lith-A/C host but with a few areas of 1-5- μ m-sized radiating-acicular crystals. Laser pyrolysis of several spots [3] produced substantial CO₂ but little or no H₂O or other volatiles. Sample 239 came from near the center of the meteorite where it apparently filled voids around a large glassy vug [4]. Lith-A surrounding the 239 deposit is ostensibly free of rust and not connected to the exterior of the meteorite by any obvious fractures. Two separate, smaller vugs nearby exhibited less conspicuous but similar drusy deposits.

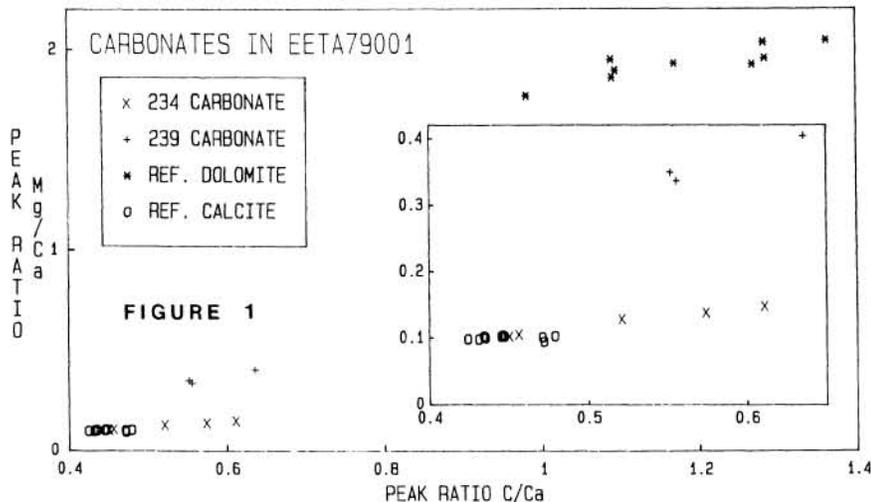
Clay-mineraloid weathering products that are common in Antarctic stony meteorites [5] occur in fusion crust on Lith-A and in glass from Lith-B (all of which occurs near the meteorite's exterior) but not in samples 180, 234, or 239.

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Semi-quantitative EDS data (peak ratios without Z-A-F corrections; Fig. 1) support textural indications that carbonates in 234 might be paragenetically distinct from those in 239. Compared with independent reference standards (calcite USNM-136321, dolomite USNM-10057 [6]), carbonates in 234 do not contain Mg or P above background levels whereas calcite in 239 contains Mg at 3-4 times background and P at twice the background level for reference calcite. Either carbonate precipitation in 239 involved a more saline fluid or the carbonates in 234 lost Mg and P after precipitation. **Are the Salts Martian or Antarctic?** Obviously, great care must be taken not to confuse products of Antarctic weathering with those of pre-terrestrial aqueous alteration. Observations made to date generally support pre-terrestrial origin for the carbonate and sulfate in sample 234; the case for carbonate in 239 remains less clear. Absence of common clay mineraloids and rust from samples 234 and 239 argue against significant Antarctic weathering. Although nesquehonite, $MgCO_3 \cdot 3H_2O$, is known as a terrestrial weathering product in Antarctic meteorites, Ca-carbonate has not been previously reported. The case for gypsum in 234 is complicated by occurrence of gypsum in weathered exteriors of many Antarctic meteorites. The textural context of gypsum in 234, however, is different from that in weathered fusion crusts and would be consistent with origin of the occluded sulfate in 180 glass [1] by assimilation of Martian gypsum by shock-produced Lith-C melt. Likewise, CO_2 trapped in Lith-C [7] might have originated, in part, by assimilation of Martian calcite. Salt grains in samples 234 and 239 would then be Martian relics that survived as a consequence of the heterogeneous and disequilibrium nature of the shock process.

Alternatively, if some or all of the salts are Antarctic in origin, then trace-element and isotopic analysts of EETA79001 (and other Antarctic meteorites) must take stringent precautions to ensure that their data and interpretations are not affected by artifacts of Antarctic weathering. Carbon and oxygen isotopic measurements on calcite from sample 239 (in progress) should help resolve an Antarctic from Martian origin for the salts.



References:

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