Endothermic peaks were observed for ankerite and calcite, magnesite, aragonite and siderite while two at 1000 mbar is indicated by a single endothermic peak for dolomite (Fig. 1). The Te and TCO2 for carbonate decomposition were lower for the 12 mbar experiments (Fig. 1). The decomposition temperatures (e.g., magnesite vs. calcite) decrease as pressure decreases. This indicates that Tc differences will decrease and thus have the potential to cause multiple peaks to merge into one peak as pressure decreases. The merging of peaks is also enhanced by peak broadening caused by greater peak areas associated with temporary CO2 accumulation caused by lower flow rate in the 12 mbar (1 sccm) experiments. These factors caused the Tc to be similar for dolomite, ankerite, and calcite at 12 mbar. The single endotherm and similar Tc for dolomite, ankerite, and calcite at 12 mbar suggests that in addition to calcite, ankerite and dolomite are plausible candidates for the high temperature carbonate endotherm observed in the Wicked Witch soil by TEGA.

Results from these laboratory studies suggest Fe-bearing carbonates, siderite, may explain the low temperature CO2 release while ankerite may explain the high temperature endotherm and associated CO2 release in the Wicked Witch soil. However, the oxidizing nature of the atmosphere as indicated by soil perchlorate [6] and the predominance of surface Fe3+ species [7] suggests that reducing conditions are not favorable for Fe3+ bearing carbonate formation. Thus, magnesite becomes the most likely candidate.
aqueous activity associated with the deposition of the mid to late Hesperian Vastitas Borealis (VB) and/or early Amazonian Scandia materials (scenario 1). Another possibility (scenario 2) is that Phoenix carbonates were emplaced through deposition of atmospheric dust containing magnesite[9], followed by thin-film water activity [10,11] that dissolved Ca-silicates and some magnesite followed by precipitation as Ca-rich carbonate that ranged from Mg-calcite to dolomite. The presence of pedogenic dolomite in olivine-bearing Hawaiian soils [12] suggests low temperature formation of dolomite is plausible in the Phoenix soils. Thermal calculations indicate that (Ca,Mg)-carbonate concentration could range from 4.5 (no Mg) to 5.4 (dolomite) wt. %.

Scenarios 1 and 2 are both viable processes that could yield MgCO₃, CaCO₃ and/or (CaMg)(CO₃)₂. Scenario 1 suggests that for carbonate deposition with the Vastitas Borealis (VB) and Scandia materials; deposition solutions were alkaline from the mid to late Hesperian and into the early Amazonian. Acid solutions may have dominated elsewhere on Mars during these time frames [13] but the VB and Scandia waters would have been alkaline. Scenario 2 indicates that pedogenic carbonate formation may be ongoing due to water thin-films sourced from the ice table below. Viking soil pH estimates (7.4-8.7) [14] suggest that soil carbonate could be buffering the Viking soil pH as in the Phoenix soil. Soil carbonates at the Phoenix and possibly the Viking Landing sites suggest that moderately alkaline soil pH may occur throughout the northern plains.

Soil carbonate persistence, in at least the northern plains, indicates that moderately alkaline soils may be more prevalent and acid deposits (e.g., Meridiani) are less extensive across Mars. Widespread and moderately alkaline soil pHs would enhance the habitability on Mars for microbial life that may have existed in the past.


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