Iron-rich carbonates as the potential source of evolved CO₂ detected by the Sample Analysis at Mars (SAM) instrument in Gale Crater.


The Sample Analysis at Mars (SAM) instrument detected at least 4 distinct CO₂ release during the pyrolysis of a sample scooped from the Rocknest (RN) eolian deposit. The highest peak CO₂ release temperature (478-502°C) has been attributed to either a Fe-rich carbonate or nanophase Mg-carbonate. The objective of this experimental study was to evaluate the thermal evolved gas analysis (T/EGA) characteristics of a series of terrestrial Fe-rich carbonates under analog SAM operating conditions to compare with the RN CO₂ releases. Natural Fe-rich carbonates (<53μm) with varying Fe amounts (Fe₀.₆₆X₀.₃₄ to Fe₀.₉₉X₀.₀₁CO₃, where X refers to Mg and/or Mn) were selected for T/EGA. The carbonates were heated from 25 to 715°C (35°C min⁻¹) and evolved CO₂ was measured as a function of temperature. The highest Fe containing carbonates (e.g., Fe₀.₉₉X₀.₀₁CO₃) yielded CO₂ peak temperatures between 466-487°C, which is consistent with the high temperature RN CO₂ release. The lower Fe-bearing carbonates (e.g., Fe₀.₆₆X₀.₃₄CO₃) did not have peak CO₂ release temperatures that matched the RN peak CO₂ temperatures; however, their entire CO₂ releases did occur within RN temperature range of the high temperature CO₂ release. Results from this laboratory analog analysis demonstrate that the high temperature RN CO₂ release is consistent with Fe-rich carbonate (~0.7 to 1 wt.% FeCO₃). The similar RN geochemistry with other materials in Gale Crater and elsewhere on Mars (e.g., Gusev Crater, Meridiani) suggests that up to 1 wt. % Fe-rich carbonate may occur throughout the Gale Crater region and could be widespread on Mars. The Rocknest Fe-carbonate may have formed from the interaction of reduced Fe phases (e.g., Fe²⁺-bearing olivine) with atmospheric CO₂ and transient water. Alternatively, the Rocknest Fe-carbonate could be derived by eolian processes that have eroded distally exposed deep crustal material that possesses Fe-carbonate that may have formed through metamorphic and/or metasomatic processes.