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TITLE: Discovery of Carbonate-Rich Outcrops in the Gusev Crater Columbia Hills by the MER Rover Spirit

PRESENTATION TYPE: Assigned by Committee (Oral or Poster)

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ABSTRACT BODY: The chemical composition, global abundance, distribution, and formation pathways of carbonates are central to understanding aqueous processes, climate, and habitability of early Mars. The Mars Exploration Rover (MER) Spirit analyzed a series of olivine-rich outcrops while descending from the summit region of Husband Hill into the Inner Basin of the Columbia Hills of Gusev Crater to the eastern edge of the El Dorado ripple field in late 2005. Reanalysis of Spirit's mineralogical data from the Moessbauer Spectrometer (MB) and the Miniature Thermal Emission Spectrometer (Mini-TES) and chemical data from the Alpha Particle X-Ray Spectrometer (APXS) in 2010, coupled with new laboratory data for carbonate-bearing samples, lead to identification of carbonate in one of the outcrops (Comanche) [Morris, R.V., et al., Science, 329, 421-424]. The carbonate is rich in magnesium and iron (Mg₆₂Sd₂₅Cc₁₁Rh₂, assuming all Ca and Mn is associated with the carbonate) and is a major component of the Comanche outcrops (16 to 34 wt.%). The mineralogical, chemical, and abundance data are constrained in multiple, mutually consistent ways by the MER analyses. For example, a low-Ca carbonate is required by the MB and APXS data and is consistent with Mini-TES data. Three spectral features attributable to fundamental infrared vibrational modes of low-Ca carbonate are present in the Mini-TES spectra of Comanche outcrops. The average composition of Comanche carbonate approximates the average composition of the carbonate globules in Martian meteorite ALH 84001. Analogy with ALH 84001, terrestrial, and synthetic carbonate globules suggests that Comanche carbonate precipitated from aqueous solutions under hydrothermal conditions at near neutral pH in association with volcanic activity during the Noachian era. Comanche outcrop morphology suggests they are remnants of a larger carbonate-bearing formation that evolved in ultramafic rock and then preferentially eroded by a combination of aeolian abrasion and chemical decomposition by exposure to acid-sulfate vapors/solutions. The high carbonate concentration in the Comanche outcrops supports climate models involving a CO₂ greenhouse gas on a wet and warm early Mars and subsequent sequestering of at least part of that atmosphere in carbonate minerals.

KEYWORDS: [6225] PLANETARY SCIENCES: SOLAR SYSTEM OBJECTS / Mars, [5410] PLANETARY SCIENCES: SOLID SURFACE PLANETS / Composition, [3672] MINERALOGY AND PETROLOGY / Planetary mineralogy and petrology, [1060] GEOCHEMISTRY / Planetary geochemistry.

(No Table Selected)

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Additional Details

Previously Presented Material: 90% published in Science Magazine.

0% previously presented.

Scheduling Request: Please schedule my paper before presentation by Steve Ruff entitled: Mini-TES observations of Comanche carbonate and its distribution.