Spherulitic (*c*-axis) growth for terrestrial (Mauna Kea, Hawaii) and martian hematite "blueberries"

D.C. GOLDEN[1] D.W. MING[2] AND R.V. MORRIS[3]

[1] ESCG, JE23, NASA-JSC, Houston; d.c.golden@nasa.gov
[2] ARES, NASA-JSC; douglas.w.ming@nasa.gov
[3] ARES, NASA-JSC; richard.v.morris@nasa.gov

The scientific basis for slection of Meridiani Planum for the Mars Exploration Rover (MER) Opportunity landing site centered on the detection of high concentrations of gray hematite (αFe_2O_3) by the thermal emission spectrometer (TES) on board Mars Global Surveyor [1]. Hematite concentratrions were considered a possible indicator for aqueous processes. Observations made by Opportunity show that the hematite in Meridiani Planum is present as spherules ("blueberries") and their fragments [2]. The internal structure of hematite is not discernible at the resolution limit (~30 μm/pixel) of the Opportunity's microscopic imager (MI) [3]. A terrestrial analog for martian hematite spherules are spherules from hydrothermally altered and sulfate rich tephra from the summit region of Mauna Kea volcano, Hawaii [4]. The objective of this study is to determine the crystal growth fabric of the Mauna Kea hematite spherules using transmission electron microscopy (TEM) techniques and to relate that crystalline fabric to the observed TES signature of Meridiani Planum "blueberries"

TEM analysis of Mauna Kea sphrules exhibited a radial growth pattern consisting of "fibrous" hematite with the *c*-axis of hematite particles aligned along the elongation direction of the hematite fibers. The individual fibers appear to be made of coalesced nanoparticles of hematite arranged with their *c*-axis oriented radially to form a spherical structure. Lattice fringe images suggest long-range order across particles and along fibers.

According to interpretation of thermal emission spectra for Meridiani Planum hematite, the absence of a band at ~390 cm^{-1} implies a geometry where *c*-axis emission dominates [1, 5]. Because *c*-face is perpendicular to the *c*-axis, this is precisely the geometry for the Mauna Kea spherules because the *c*-axis is aligned parallel to the radial growth direction. Therefore, we conclude as a working hypothesis that the martian spherules also have a radial, *c*-axis growth pattern on a scale that is too small to be detected by MER MI (Model B of [5]). Furthermore, by analogy with the Mauna Kea spherules [4], the martian blueberries could have formed during hydrothermal alteration of basaltic precursors under acid-sulfate conditions.

References:

[1] Christensen, P.R., et al. (2000) *JGR*, 05, 9623-9642.
[2] Squires, S.W., et al. (2004) *Science*, 306, 1698-1703.
[3] Herkenoff, K.E. et al., (2004) *Science*, 306:1727-1730.
[4] Morris, R.V., et al. (2005) *EPSL*, 240, 168-178.
[5] Glotch, T.D., et al. (2006) *Icarus*, 181, 408-418.