PASSIVATION OF METAL OXIDATION BY IRON OXIDE PRODUCTION IN ORDINARY CHONDRITES WEATHERED IN A MARS ANALOG ENVIRONMENT.

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Introduction: The degree of reduced iron-nickel (kamacite and taenite) alteration in meteorites found by current and future rovers on Mars can serve as a marker for the assessment of paleoclimatic trends on the planet [1, 2]. A similar method of climatic assessment has been applied to terrestrial meteorite weathering [3]. Metal alteration will be “passivated” in a hot desert environment when the production of iron oxides and oxyhydroxides becomes arrested by the tensile strength of the surrounding rock mass as void spaces are filled [4]. We report evidence of similar behavior in OC from Mars-analogous Antarctica [5], suggesting that the magnitude of metal alteration on Mars may be asymptotic to “plateau” values specific for each meteorite type.

Methods: Two separate modal analyses were performed on each of 19 weathering category C OC from Allan Hills and Lewis Cliff, Antarctica. The first utilized a petrographic count of 500 points per sample to differentiate opaques (consisting mainly of reduced metal grains) from stained and unstained phase abundances. In this count, stained areas included all types of secondary oxide visible in thin section. The second count used 500 points per sample to differentiate opaques from crystalline, opaque-pseudomorphic limonites (OPL) and volumetrically less significant non-OPL oxide stain phases. All point counts used medium-power objectives and the condenser apparatus. The first modal count was performed by making manual adjustments of the mechanical stage, while the second employed an automatic stage-advancing unit.

Results: In an attempt to identify any trends in the production of secondary minerals (particularly OPL), the stain component of the iron oxides was separated from the total oxide fraction and included with the unstained silicates fraction. This held constant the sum of all formerly transparent areas, whether stained or unstained, and regardless of the stain intensity. With little or no void space for OPL products to grow into, OPL replacement of reduced metal primary phases is isovolumetric [e.g. 6]. Ternary plots of volumetric modal abundances with OPL, opaques, and silicates (stained and unstained) as end members, show a clear, linear trend for 18 of the samples. We interpret this trend to indicate a state of pressure equilibrium (passivation) within each meteorite where the stress produced by the growing minerals is in balance with the tensile strength of the rock itself. Non-isovolumetric metal alteration can occur only if fractures and void spaces are enlarged, or new fractures created to expose unweathered surfaces to the environment. Therefore, this metastable state of affairs is adjusted each time the meteorite is broken until equilibrium can be reestablished.

References: [1] Ashley J. A. and Wright S. P. 2004. LPSC *XXXV*, #1750. [2] Ashley et al. 2007. LPSC *XXXVIII*, #2264. [3] Bland P. A. et al. 1996. Geochimica et Cosmochimica Acta 60, No. 11: 2053-2059. [4] Bland P. A. et al. 1998. Meteoritics and Planetary Science 33: 127-129. [5] Wentworth et al. 2005. *Icarus* 174:382-395. [6] Buchwald V. F. and Clarke R. S., Jr. 1989. American Mineralogist 74: 656-667.