OXYGEN FUGACITY OF THE MARTIAN BASALTS FROM ANALYSIS OF Fe-Ti OXIDES: IMPLICATIONS FOR MANTLE-CRUST INTERACTION ON MARS. C. D. K. Herd and J. J. Papike. Institute of Meteoritics, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM, 87131, herdc@unm.edu.

Synopsis: The oxygen fugacity of the basaltic martian meteorites has been calculated from thermodynamic models involving spinel-ilmenite equilibria. The wide range of estimates, from near the IW buffer to near QFM, may be explained by mixing of mantle-derived melts with oxidized material in the martian crust. Possible oxidized crustal end-members are considered.

Analytical Method and Results: Spinel-ilmenite pairs in the martian basalts were analyzed for Fe, Ti, Cr, Mg, Al, and Mn using the electron microprobe. Oxygen was also analyzed in spinel, following the technique of [1]. This permitted an assessment of non-stoichiometry, by adjusting ferric/ferrous ratios using the negative charges from measured oxygen, and calculating the cation sum. Spinel in all of the martian basalts except QUE 94201 were found to be stoichiometric (cation sum = 3) within error. Spinel in QUE 94201 has undergone oxyexsolution, and now contains lamellae of ilmenite.

Implications for Mantle-Crust Interaction on Mars: Studies of Rb-Sr and Sm-Nd systematics of martian meteorites indicate that QUE 94201 has the lowest I and highest initial \( \varepsilon_{Nd} \) isotopic composition and hence is the most mantle-like [2]. It is also the most reduced. The other martian basalts are progressively more enriched in radiogenic Sr and depleted in radiogenic Nd, suggesting mixing between mantle and a crustal (or magma ocean trapped-liquid) component [2,3]. The inferred involvement of the “crust-like” component correlates with oxygen fugacity (Fig. 1). Figure 1 is a plot of initial \( \varepsilon_{Nd} \) versus oxygen fugacity (from QUIlF) for the martian basalts. The predicted \( \varepsilon_{Nd} \) value for Los Angeles, based on the equation of the line-of-best-fit, is –6.1. Likewise, we predict an I value of 0.7218. The nature of the oxidized second component is unknown, but it may be trapped liquid, an oxidized crustal lithology, oxidized alteration products, water, or a combination. Although the mechanism is as yet poorly understood, it can be concluded that the source of the basalts, the martian upper mantle, is reduced, around IW (~ QFM – 4), and the martian crust is significantly more oxidized, around QFM.

Fig. 1.