PYTi-NiCr SIGNATURES IN THE COLUMBIA HILLS ARE PRESENT IN CERTAIN MARTIAN METEORITES. B.C. Clark[1], R. Gellert[2], D.W. Ming[3], R.V. Morris[3], D.W. Mittlefehldt[3], S.W. Squyres[4], A. Yen[5] and the Atherna Science Team. [1]Lockheed Martin, POB 179, Denver, CO 80201, Benton.c.clark@LMCO.com; [2]Univ. of Guelph, Canada; [3]NASA Johnson Space Center, TX; [4]Cornell University, Ithaca, NY; [5]Jet Propulsion Laboratory, Pasadena, CA.

Introduction: Uniquely high levels of phosphorus and titanium were observed in several samples [1-3] by the APXS x-ray fluorescence measurements as the MER Spirit rover climbed Husband Hill (Columbia Hills, Gusev crater, Mars). A careful study of many such samples and their geochemical variability has revealed additional elements in this pattern, and that the derived multi-element signature is also unambiguously manifested in several martian meteorites.

The Signature in Husband Hills Samples: The Wishstone and Watchtower classes of rocks [2-3] both contain elevated P and Ti, with Wishstone being the first type specimen encountered, prior to midway up Husband Hill. Samples in this class can contain >5 % P_2O_5 and up to 3 % TiO_2. It was also noticed early-on that these materials are very low in Cr. Independence class samples have also been reported to contain high P and Ti [4]. Comparisons are shown in Figure 1. Several new samples, including some at the summit and beyond but not yet allocated to classes, also contain these enhancements.

An unexpected occurrence of yttrium at a detectable level led to a search for Y in other samples. It is found that the Y correlates positively with P, Figure 2, a common geochemical occurrence. It was also found that for these low-Cr materials, the Ni is often also lower (<100 ppm) than typical and correlates linearly with the Cr. We have therefore identified an association of high P, Y and Ti, coupled with low Ni and Cr. In addition, these materials tend to have less Fe, less Mg and more K than other martian samples.

The Signature in Martian Meteorites: Although lower by about a factor of 2 in P_2O_5 content, the martian meteorite QUE 94201 not only exhibits high P, as noted by [3, 5, and others], but all the characteristics of the PYTi-NiCr signature, compared to classical SNCs (see element tabulations by Lodders [8]). The same is true of the Los Angeles meteorite and for lithology B of EETA79001 (but not lithology A). Figure 3 compares P, Ti and Cr contents of these and other martian meteorites. Other elements expected to be at higher levels, from meteorite analyses, include Al and especially Ga and some heavy REE.

Implications: Connections between classes of rocks at Husband Hill, and most importantly the analogous samples available for study on Earth, have important potential consequences for further study.

Multiple classes at Husband Hill contain the signature. Not only do the 3 classes given above and additional classes under investigation contain this signature, but so also do some soils. The white material composed of a ferric sulfate [3] is admixed with one such soil, although perhaps because of the scuffing process which brought it to the surface.

Stratigraphic aids. The Adirondack, Clovis and Peace classes of rock at Husband Hill do not show this signature. This is not surprising for Adirondack class, whose loci are in the plains, or for Clovis samples, which are found within the distinct map unit of West Spur. The two Peace class samples, however, were found as an apparent outcrop at a location between Wishstone and Watchtower, yet are their PYTi-NiCr as well as Mg, Fe and K levels are so chemically opposite the larger class that they may be erratics, or the Wishstone float samples may have translocated.

Primary igneous processes. A major question since discovering the high P and Ti in Husband Hill is its origin. These rocks have been subjected to various levels of aqueous alteration [3,2], and the ready mobilization of martian phosphate at moderately low pH [6] opens the possibility of phosphate enrichment. However, the occurrence of this signature in selected martian meteorites, whose relationships indicate an igneous differentiation sequence [7], is strong indication that the PYTi-NiCr signature in Husband Hills likewise is of igneous origin. As pointed out by Ming et al. [3], the higher P/Ti ratio for some Husband Hills rocks may be evidence of P enrichment by subsequent alteration (cf. also Fig. 1 with Fig. 2).

Petrogenetic commonality. These results attest to a genetic relationship between the many classes of rock which show this signature. Degrees of alteration vary dramatically, but these different classes of rock appear to derive from a continuous sequence of original source material that predates aqueous alteration.

References: [1] Gellert et al., *JGR* 2006, in press. [2] Squyres et al., *JGR*, 2006, in press. [3] Ming et al., *JGR*, 2006, in press. [4] Clark et al., *AGU*, San Francisco, Dec. 2005. [5] Kring, D.A., Workshop on Unmixing the SNCs (2002). LPI 6005. [6] Dreibus et al., LPSC XXVII (1996) 323. [7] Rubin et al., Geology 28 (2000) 1011-1014. [8] Lodders, K., *Meteorit. Planet. Sci. 33* (1998) A183-A190.

Fig. 1. P, Ti and Cr in selected samples, Husband Hills.

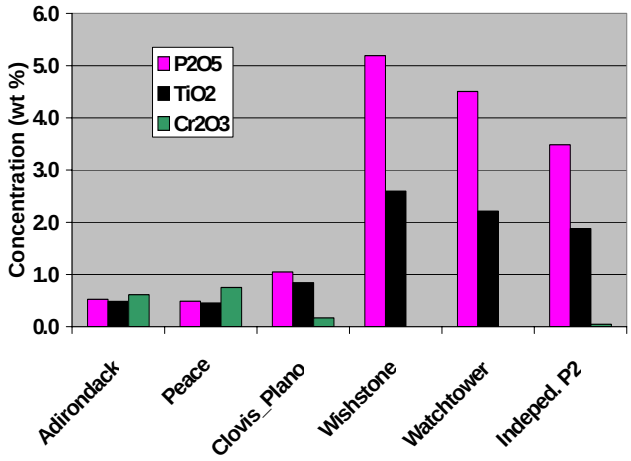

Fig. 2. Y and P are correlated in P-rich martian samples.

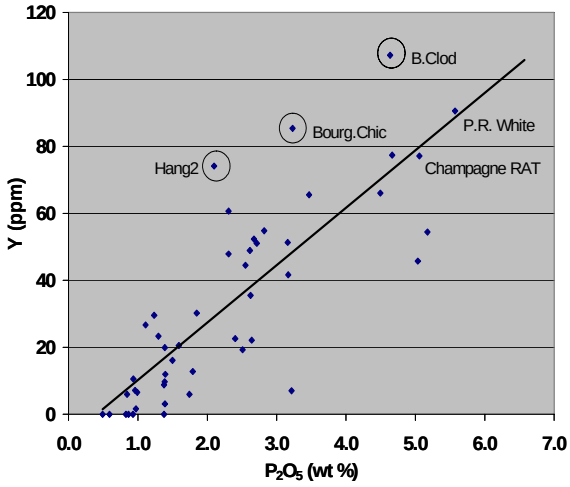

Fig. 3. P, Ti and Cr in martian meteorites