**COMPARISON OF THREE HYDROGEN DISTRIBUTIONS AT THE EQUATOR OF MARS.** O. Gasnault[1], S. Maurice[1], C. d'Uston[1], W.C. Feldman[2] and W.V. Boynton[3], [1]Observatoire Midi-Pyrénées (CESR, 9 av. C. Roche, 31400 Toulouse, France – Olivier.Gasnault@cesr.fr), [2]Los Alamos National Laboratory (ISR1, P.O. Box 1663, MS D466, Los Alamos, NM 87545), [3]University of Arizona (LPL, 1629 E. University Blvd., Tucson, AZ 85721).

**Introduction:** Onboard Mars Odyssey, the neutron spectrometers and the gamma-ray spectrometer are sensitive to hydrogen abundance in the Martian soil [1]. From the Neutron Spectrometer two maps of hydrogen distribution have been derived: one using the fast neutron counting rate, and one using the epithermal neutrons [2]. From the Gamma-Ray sensor Head one map is made with the 2.223 MeV gamma-ray line [3]. These maps are not totally independent since the epithermal neutrons result from the moderation of the fast neutrons, and the 2.223 MeV line is the product of a neutron capture by a nuclei of hydrogen. For convenience, these maps are turned into water-equivalent hydrogen (WEH) distributions although the nature of the hydrogen as water is not established in the equatorward regions that we are studying here [4].

**Observations:** Between -40 and +40° latitude, the WEH distributions reveal some quantitative differences between them (gamma, fast neutrons, epithermal neutrons). Qualitatively, the maps look alike, and they linearly correlate to each other:

$$WEH(fast) = 0.73 * WEH(gamma) + 0.02$$
$$= 0.68 * WEH(epithermal) + 0.01$$

where WEH are weight fractions. The respective factors of correlation are 0.84 and 0.96. The differences between the three WEH distributions might be explained by:

1. soil composition variations: while the counting rates for epithermal neutrons and for the 2.223 MeV gamma-ray line are essentially independent of the composition, it has been shown that the fast neutron flux varies as the average soil atomic mass [5];
2. burial depth variations of H-rich materials: assuming a two-layers model, where the top surface is depleted in hydrogen and the buried layer is much richer in hydrogen, the three measurements have slightly different sensitivity with depth [6];
3. a wrong assumption: either the hydrogen content of the top surface is not equal to the assumed 2% WEH, or there are more than two layers [7].

**Methods:** We certainly have more parameters than independent measurements, but we may try to put some constrains on the three main parameters that have been cited above. We investigated at regional scale the three measurements of the WEH distribution, i.e. in circles of about 10° in radius. In each of these 10°-radius regions we derive the linear correlation between two of the three WEH distributions, and we extract the slope, the offset, and the correlation factor of that linear relationship.

**Results:** The slope of these correlations is the parameter that varies the most across the surface, while the offset is almost constant and close to 0. However we discovered that the slope and the offset are not totally independent: when one increases, the other decreases.

This technique works well when comparing WEH(epithermal) and WEH(fast) for which the slope parameter varies from 0.2 (e.g. in Arabia Terra) to 1.4 (e.g. west of Elysium) as shown in Figure 1. On the contrary the linear correlation seems to break more often with WEH(gamma), and the correlation coefficient is frequently less than 0.8 (Figure 2).

**Discussion:** This study shows that for a given value of WEH(fast) at the surface of Mars, a range of different values are found for WEH(epithermal) and WEH(gamma). The only places where the variance between the three datasets is minimal are the borders between H-rich and H-poor regions. In these regions the variation of H-content is important enough to mute all the other parameters (composition, burial depth, number of layers). These regions are characterized by:

$$WEH(fast) = 0.045 \pm 0.005$$
$$\Leftrightarrow WEH(epithermal) = 0.055 \pm 0.005$$
$$\Leftrightarrow WEH(gamma) = 0.040 \pm 0.005$$

In the regions where the WEH abundance is high, we found relatively small slopes. According to the simulations this might be explained by increasing H-content in the deepest layer at the same time than increasing burial depth of that layer. Nearby Arabia Terra, the increasing values of Fe-content from the highlands to the lowlands in the North might also change the fast neutron flux. The increase of burial depth can also explain why the linear relationship is lost between the gamma-ray and the neutron measurements if they are not sensitive to the same thickness of soil.

At the places where the WEH abundance is low, such as west of Elysium, that difference is probably due to composition variations (for instance in iron). However there is no systematic relation between the iron content and the slope variations between

WEH(fast) and WEH(epithermal). In particular calculations show that it is possible to get slopes greater than 1 when both the composition and the WEH abundance vary simultaneously.

We will continue to study these various measurements of the hydrogen content and their regional variations. A systematic comparison with numerical calculations might help to sort out which parameters are varying: H-content, composition (Fe-content), burial depth… Having a better understanding of the role of each of these parameters should help in determining the nature of the hydrogen in the Martian surface.

**References:**

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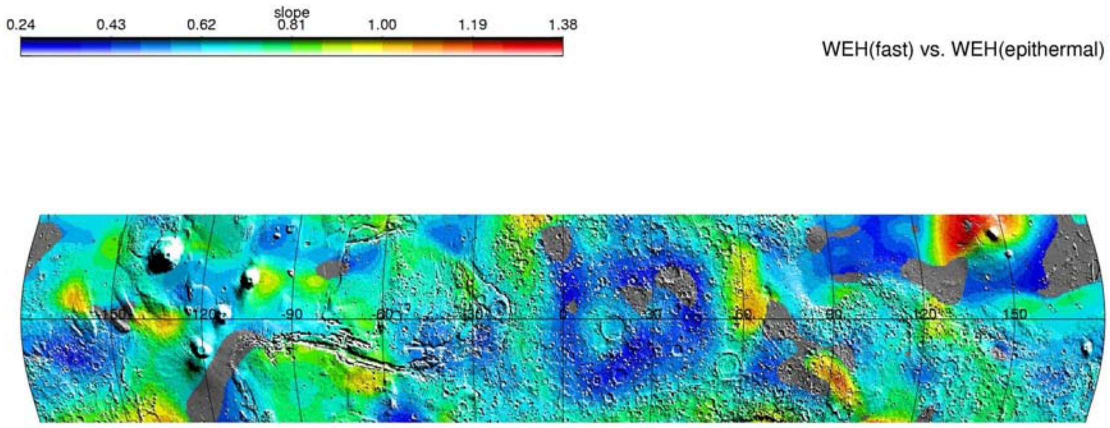


**Figure 1:** Map of the slope of the linear relationship between WEH(fast) and WEH(epithermal) when the correlation factor is better or equal to 0.8. The calculation is made in 10$^{o}$-radius circles, and the result is affected to the central pixel.

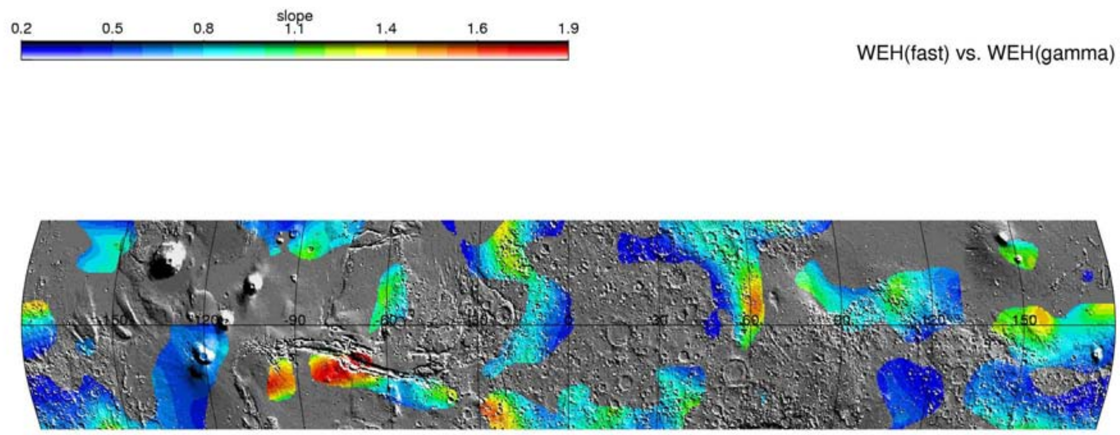


**Figure 2:** Map of the slope of the linear relationship between WEH(fast) and WEH(gamma) when the correlation factor is better or equal to 0.8.