SULFURIC ACID ALL OVER EARLY MARS? H. Wänke[1], W.V. Boynton[2], J. Brückner[1], G. Dreibus[1], G. J. Taylor[3], L. Evans[4], B. Janes[2], J. Keller[2], K. Kerry[2], R. Starr[5], and the GRS Team, [1]Max-Planck-Institut für Chemie, J. J. Becher Weg 27, D-55128 Mainz, Germany, e-mail: waenke@mpch-mainz.mpg.de, [2]Lunar and Planetary Laboratory, Univ. of Arizona, Tucson, AZ, USA, [3]Hawaii Inst. of Geophysics and Planetology, Honolulu, HI, [4]Computer Sciences Corp., Lanham, MD, [5]Dept. of Physics, Catholic Univ. of America, Washington, DC.

The Gamma-Ray Spectrometer (GRS) of the 2001 Mars Odyssey Mission [1] yielded global maps of the Martian surface chemical composition. In the following, we will discuss three observations of general interest we have made studying these maps.

Observation 1: The abundance of Si in the Tharsis regions turns out to be very low (Figs. 1, 2). It is not easy to understand why the area around the Tharsis Montes volcanoes should be so low in Si. The average Si concentrations in basaltic shergottites (Martian meteorites) is 23.0 weight %. The highly fractionated K-rich basalts analyzed by the Pathfinder rover have 24.2 % Si [2]; primitive basalts in Gusev crater 21.2 % Si [3]. The simple explanation of less Si due to a higher proportion of olivine does not work because we should than see an increase in Fe, which we don't see. In fact Fe is low there, too (Fig. 3, 4). That is why we believe that the depression of Si as well as of Fe is a dilution effect. Rieder et al. [4] observed with the Alpha Particle X-ray Spectrometer on board the rover Opportunity in the outcrops at Meridiani Planum, which are mostly covered with dust layers, a mean content of 9.2 weight % S coupled with a Si depletion of down to 17 weight %.

The observed Si depression at the Tharsis region amounts to about 20 %. It could be speculated that this might also be due to high abundance of sulfates, although the mechanism for the high sulfate abundance at Meridiani Planum and Tharsis are certainly different.

We know that Mars contains considerable amounts of FeS [6]. Although today, most of the FeS resides in the Martian core, a certain fraction has remained in the mantle. The solubility of FeS in silicate melts is a strong function of the FeO content. The Martian mantle contains about 18 % FeO in comparison to 7.6 % FeO of the Earth's mantle corresponding to a factor of 3.5 more FeS. Hence, the high abundance of S in the Martian crust is actually to be expected.

The chlorine map (Fig. 5) shows high concentrations in the Tharsis regions and west of it a significant enhancement, which may point to volcanic exhalation from the Tharsis volcanoes together with SO_2. Preliminary S data on large regions, obtained by GRS measurements, show a correlation with Cl abundances, hence, it could be expected that the S concentration is also high in the Tharsis regions.

The most recent GRS regional data of Tharsis Montes do not show S concentrations sufficiently high to account for Si depression. However, dilution seems to be the major reason for the Si depression as it is paralleled by low Fe.

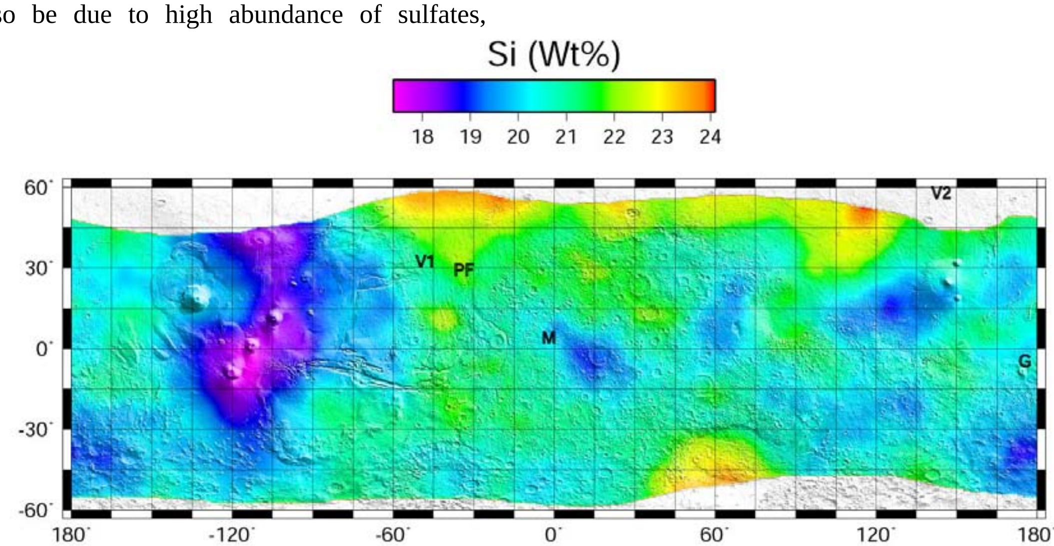

Fig. 1 GRS silicon concentration map of Martian surface

It is interesting to note that rover Spirit just found with the APXS an so far unknown type of volcanic rock, which is high in Na (4.5 wt. %), Al (8.0 %), P (2.3 %), and Ti (1.5 %) [7]. Hence, several elements might add up for the dilution effect.

It is conceivable that large amounts of sulfur ended up in sulfuric acid, which formed lakes and oceans covering most of the Martian surface. On reaction with olivine, Mg and Fe and other sulfates were formed, which now are found on the Martian surface in large quantities.

Observation 2: Iron is generally low in the southern martian highland for yet unknown reasons.

Observation 3: The abundance distribution of Th. On Earth, K, U, and Th follow each other except in very special cases. The GRS maps for Mars for K and Th show a similar trend but there are deviations. Potassium shows enlarged abundances (Fig. 6) in several areas in the northern hemisphere of Mars. Thorium is also enriched in these areas (Fig. 7), but the Th enrichment covers larger areas. We believe that during magmatic fractionations Th follows K also on Mars. However, Th resides, contrary to K, mainly in phosphates that are easy soluble. They can be distributed over larger areas with running water and even more so in the presence of sulfuric acid.

References: [1] Boynton, W.V. et al. (2004), *Space Science Rev., 110*, 37-83. [2] Wänke, H. et al. (2001) *Space Science Rev., 96*, 317-330. [3] Gellert, R. et al (2004) *Science 305*, 829-832. [4] Rieder, R. et al. (2004) *Science, 306*, 1746–1749. [5] Wänke, H. and Dreibus, G. (1994) *Phil. Trans. R. Soc. Lond. A 349*, 285-293. [6] Dreibus, G. and Wänke, H. (1985) *Meteoritics 20*, 367-381. [7] Gellert, R. et al. (2005) LPSC XXXVI, LPI Houston (CD-ROM).

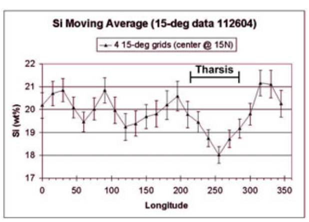

Fig. 2 Silicon concentration along a 15 degrees wide latitude band centered at +15º north.

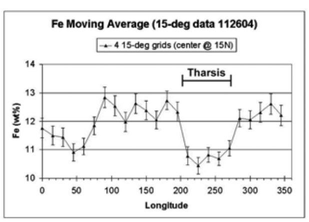

Fig. 3 Iron concentration along a 15 degrees wide latitude band centered at +15º north.

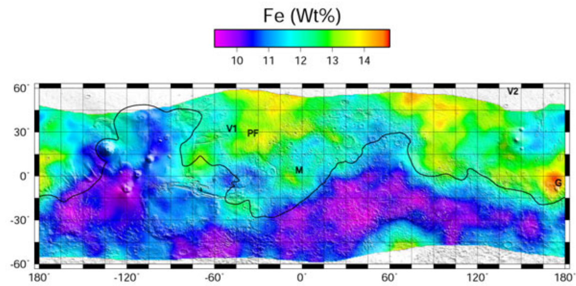

Fig. 4 GRS iron concentration map of Mars

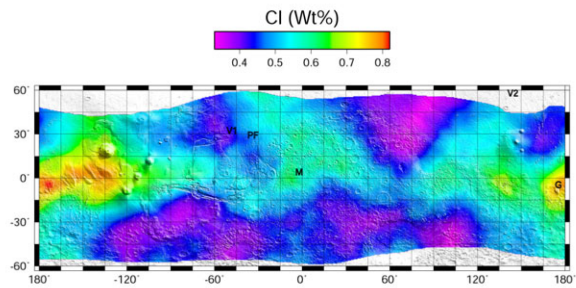

Fig. 5 GRS chlorine concentration map of Mars

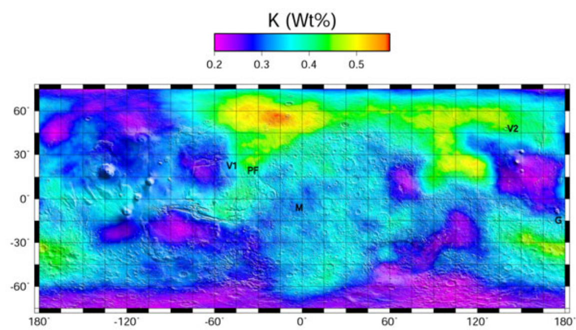

Fig. 6 GRS potassium concentration map of Mars

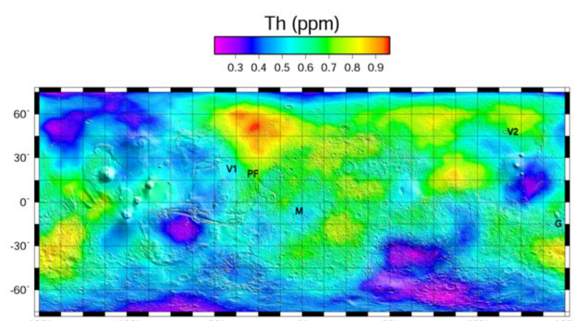

Fig. 7 GRS thorium concentration map of Mars