POSSIBLE FAULT CONTROL OF HYDROGEN ION CONCENTRATIONS NEAR SCHIAPARELLI CRATER, MARS. J. R. Clevy and S. A. Kattenhorn, Department of Geological Sciences, University of Idaho, Moscow, ID 83844-3022. (clev2739@uidaho.edu, simkat@uidaho.edu)

Introduction: Epithermal neutron flux maps of the equatorial region near Schiaparelli Crater in Mars' eastern hemisphere indicate hydrogen ion concentrations in the shallow subsurface [1]. Published maps of these hydrogen concentrations [2] reveal anomalous linear concentrations of hydrogen with a northeast to southwest trend (Fig. 1). The width and trend of these linear anomalies matches the width and trend of the graben between Scylla Scopulus and Charybdis Scopulus further to the south, west of Hellas Basin.

These concentrations are believed to indicate locations of subsurface water ice. As such, the flux maps pinpoint locations where quantities of water may intermittently exist today or where liquid water may have pooled in the past. The possibility of life existing on Mars, either in the distant past or at present, depends on the availability of liquid water.

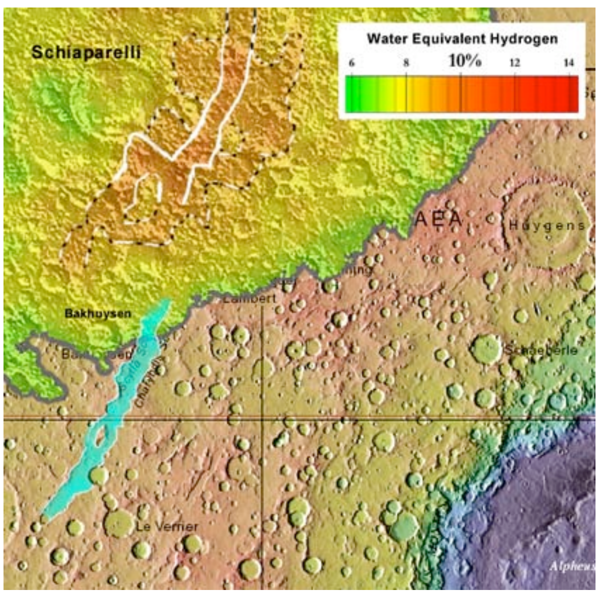

Figure 1. Hydrogen ion concentrations (*top left part of map*) superimposed on a DEM map of the region northwest of the Hellas Basin. Linear anomalies (*solid white outlines*) east of Schiaparelli display a similar width and orientation to the Scylla-Charybdis graben (*cyan shading*). Dark orange (*dashed outline*) indicates that water equivalent hydrogen comprises just over 10% of the subsurface material.

Scylla and Charybdis Scopuli: The designator Scopulus intimates a lobate or irregular fault scarp [3]. The closest terrestrial analogs – thrust faults – are not commonly seen in pairs with a dropped valley between them. Scylla and Charybdis face each other across a wide, relatively smooth-bottomed valley (Fig. 2b).

Additionally, any irregularity in the Scylla and Charybdis scarp faces can be attributed to their status as very old faults in a heavily cratered terrain. Crater impacts along the fault walls remove semicircular chunks that, may have appeared as irregular scarps in Viking photos.

A preliminary investigation of slope steepness from MOLA-generated DEMs indicates that both Scylla and Charybdis exhibit fault planes with angles steeper than 55° (Fig. 2b). Such high angles are more akin to normal faults on Earth. This geometry reinforces our assumption that the valley is a graben.

Similar, smaller grabens are also visible in the area of Le Verrier Crater (Fig. 1). These smaller grabens may indicate younger fault complexes, and indeed, the scarps show less degradation from impact cratering.

Hydrogen Anomalies: Chemically or physically bound hydrogen within a meter of the Martian surface has been mapped using neutron spectroscopy [1]. The Neutron Spectrometer, part of the Gamma-Ray Spectrometer on board Mars Odyssey, is able to detect thermal, epithermal and fast neutron fluxes. Each of these have specific energy ranges with epithermal neutron energy ranging from 0.4 – 500 keV. This band is the most sensitive for hydrogen mapping purposes. Regions with high hydrogen concentrations have a low epithermal energy flux.

Linear anomalies in hydrogen ion concentrations in the equatorial region east of Schiaparelli Crater indicate a hydrogen water equivalent of just over 10 percent. The linear features do not appear to be artefacts of data scaling, but rather suggest heterogeneous dispersion of hydrogen.

Structural Control: While the hydrogen in this equatorial region is thought to exist as water ice in the subsurface [1], it is equally possible that the concentrations indicate stable hydrate minerals [4]. The segregation into linear features suggests that one time the hydrogen was capable of fluid movement and subsequent compartmentalization. The linear ion concentrations mimic the width and orientation of the Scylla-Charybdis graben suggesting structural control of the hydrogen.

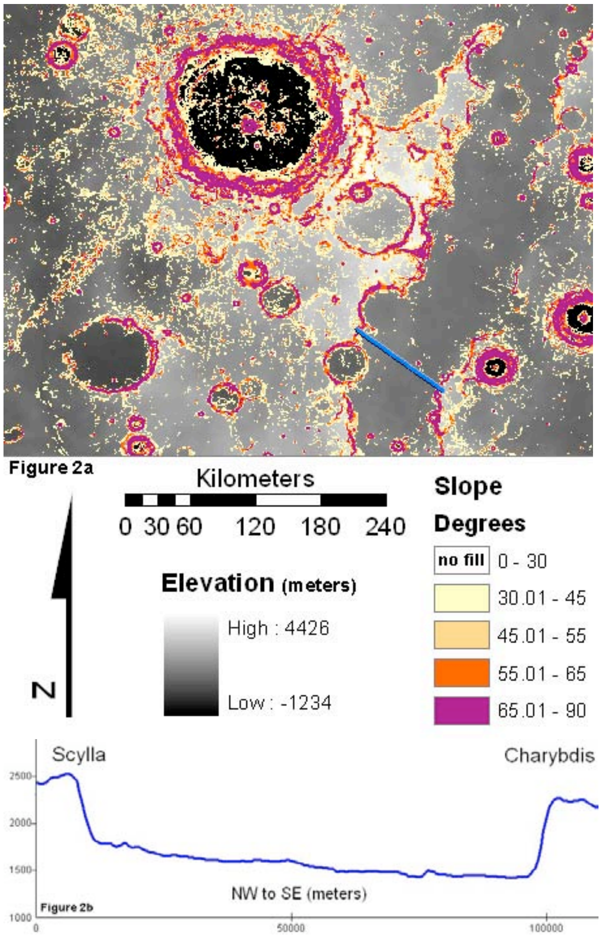

Figure 2. (a) Slope map overlying DEM highlights fault scarps and crater walls. (b) A profile across a non-cratered segment displays a normal fault geometry.

Interaction between faults and fluids are still not perfectly understood [5]. While the role of faults in fluid migration is undeniable, the permeability of a given fault varies in space and time. Highly permeable damage zones surrounding a low permeability fault core are widely accepted model features [6]. Such fault cores would allow fluids to collect inside grabens with the fault traces constraining the width of the fluid-rich zone.

The marsquakes related to the Scylla-Charybdis faulting could have contributed to the location of the hydrogen concentrations as well. From terrestrial studies of hydrologic disturbances due to earthquake rupture we see changes in water level in monitored wells, sometimes thousands of miles from the epicenter [7]. Sudden drops or rises as well as visible oscillations of groundwater levels have been commonly documented, as well as migration of fluids away from epicentral regions [9].

Discussion: Neither Scylla nor Charybdis noticeably rupture the surface near the linear anomalies. This is not unusual as faults can propagate upward from the seismogenic zone. Existing fault traces can also become covered in sediments, masking their location. As with surface-breaking faults, subsurface faults should also act as a barrier creating a confined channel within the width of the graben. Furthermore, grabens may have acted as topographic controls on surface water accumulation in the past. This apparent structural control of hydrogen implies that at one time the hydrogen was not locked up in ice or hydrate minerals and was able to behave fluidly, filling the graben between the two normal faults to create the linear anomalies we see in the epithermal flux maps. Other low latitude epithermal hydrogen ion anomalies were mapped in the area surrounding Gusev Crater where Mars Exploration Robot Spirit found indications of past water alteration [8].

References: [1] Feldman, W.C. et al. (2002) *Science* 297, 75-78. [2] Boynton, W.V. et al. (2002) *Science* 297, 81-85. [3] USGS (2004) *Gazetteer of Planetary Nomenclature*, http://planetarynames.wr.usgs.gov/jsp/append5.jsp. [4] Elphic, R.C. et al. (2004) LPSC XXXV, Abstract #2011. [5] Fairly, J.P. et al. (2003) *Geophys. Res. Lett.* 30, 5.1-5.4. [6] Caine, J.S. et al. (1996) Geology 24, 1025-1028. [7] USGS (2003) *Fact Sheet 096-03*. [8] Gellert, R. et al. (2004) *Science* 305, 829-832. [9] Kattenhorn, S.A. (2002) *Eos, Trans. AGU* 83, F1368.

Acknowledgements: This work was supported by the NASA Idaho Space Grant Consortium