**Remote Sensing of Water in the Valles Marineris Using Mars Odyssey Neutron Data.** K.R. Moore, R.L. Tokar, R.C. Elphic, D.J. Lawrence, B.L. Barraclough, and H.O. Funsten, Space and Atmospheric Sciences, Los Alamos National Laboratory, Los Alamos, NM 87545, krmoore@lanl.gov

## Introduction

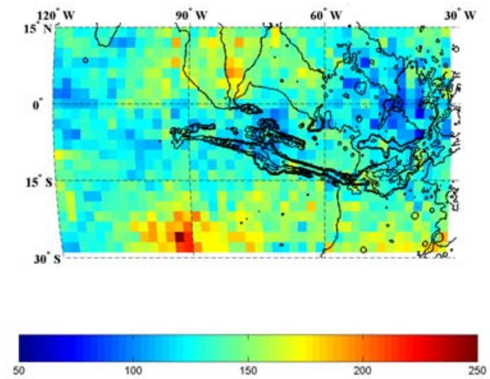
All three major regions of the Valles Marineris exhibit features that suggest the presence of groundwater at some point in Martian history. The Noctis Labyrinthus in Western Valles Marineris contains valleys that appear to have been enlarged by sapping that is possibly due to groundwater. The Ius, Ophir, and Hebes Chasmata in Central Valles Marineris exhibit landslides with deposit flows extending much further than those associated with dry terrestrial landslides. One possible explanation is the presence of water in the slide material. The chaotic terrain in Eastern Valles Marineris and the outflow channels that empty into Chryse Basin are again evidence for the presence of water [1].

The neutron spectrometer (NS) in the gamma ray spectrometer (GRS) [2] on Mars Odyssey is capable of sensing the presence of hydrogen to a depth of approximately 100 g-cm$^{-2}$ (density-depth product) by the depression of epithermal neutrons emiited from the Martian surface [3]. This study examines the GRS epithermal neutron data recorded over the Valles Marineris for signatures of hydrogen (assumed to represent water).

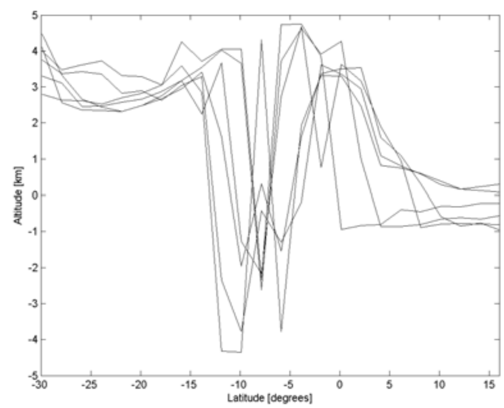
## GRS NS Data

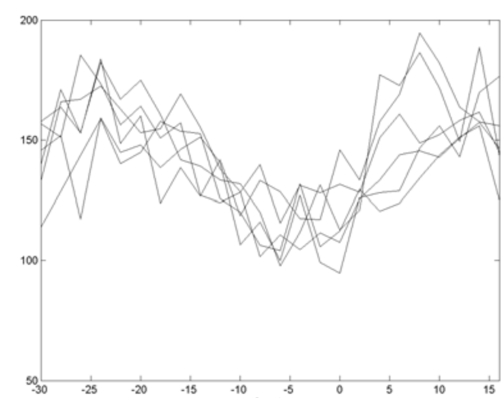
The NS employs borated plastic scintillator to detect thermal and epithermal neutrons, in addition to fast neutrons. There are four independent detector prisms that view nominally in: 1-the nadir direction, 2-the spacecraft velocity (ram) direction, 3-the zenith direction, which is toward the spacecraft and 4-opposite the spacecraft velocity. The data analyzed here are obtained by the nadir looking prism 1 which is covered with a sheet of cadmium excludes neutrons with energies below ~0.3 eV from the scintillator. Electronics discriminate against neutrons with energies above ~600 keV.

The following 2°x2° map displays the average counts from prism 1 (~19.6 s accumulation interval) recorded during the northbound orbits over the Valles Marineris region between March 20 and April 18, 2002, overlaid on MOLA topography contours. The blue regions correspond to regions of decreased epithermal neutron fluxes.




The following figures shows, respectively, the MOLA altitude contours and the average NS counts from prism 1 as a function of latitude for 2° wide longitudinal bands space every 2° in latitude from 71° to 81° W.

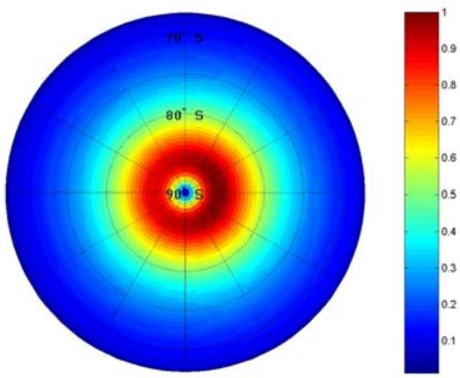


**Analysis**

There are several factors which must be considered in analysing these data. In addition to various instrumental considerations, limited spatial resolution is a significant effect. The data displayed in the figures were obtained by assigning the counts in an accumulation interval to the pixel directly below the spacecraft during the accumulation. The spacecraft traverses 1° of latitude during this interval.

The following figure shows the calculated detector footprint for prism 1 at the top of the atmosphere for a planet with a homogeneous composition. The fractional counts ΔC times the fractional area ΔA/A are plotted. The net counts C recorded by prism 1 are $C = \sum_{fov} \Delta C \cdot \Delta A / A$ , where *fov* is the field of view. The FWHM is approximately 10° of latitude but there are significant contributions to the counts at 20° from nadir. The detector footprint is clearly significant compared to the width of the canyon.




Another effect is the variation in the amount of atmosphere between the surface and the spacecraft. Increasing the atmospheric thickness causes a reduction in the observed counts. MCNPX is a Monte Carlo particle code capable of simulating this effect. Preliminary MCNPX simulations [4] indicate the observed reduction in epithermal counts over Valles Marineris is approximately what is expected from the simple increase in atmospheric thickness due to topography so this effect must be accurately estimated in order to make estimates of the hydrogen (water) in the soil.

This study is aimed at answering whether there is a believable epithermal neutron signature of hydrogen in the Valles Marineris. The analysis is accomplished by comparing the measured counts with those numerically predicted by MCNPX. The numerical predictions include the neutron production in soil with various concentrations of water, propagation of those neutrons through the atmosphere, and interaction with the instrument.

**References:**

[1] Boyce, J.M., The Smithsonian Book of Mars,112-121,2002
[2] Boynton, W.V. et al. (2002), Science, 10.1126/science.1073722
[3] Drake, D.M., W.C. Feldman and B.M. Jakosky, (1988), J. Geophys. Res., 93, B6, 6353-6368
[4] Prettyman, T.H. et al., . (2002) *LPS XXXIIII*