Initial Results of the Mars Odyssey Neutron Spectrometer at Mars. W.C. Feldman[1], R.L. Tokar[1], T.H. Prettyman[1], W.V. Boynton[2], K.R. Moore[1], O. Gasnault[1], S.L. Lawson[1], D.J. Lawrence[1], and R.C. Elphic[1] Space and Atmospheric Sciences, Los Alamos National Laboratory, Los Alamos, NM 87545, wfeldman@lanl.gov, [2]Lunar and Planetary Laboratory, University of Arizona, Tucson.

The scientific goals of the Mars Odyssey Neutron Spectrometer (NS) are to: 1) map the distribution of H within 1 m of the surface, 2) map the seasonal variation of CO_2 ice that covers both polar caps during their respective winter seasons, 3) map the locations of basaltic and andesitic provinces on Mars, and 4) provide maps of the neutron number density and fast-neutron flux at the surface of Mars for use in converting measured gamma-ray line strengths to elemental abundances.

Mars Odyssey was launched on 7 April, 2001, the NS was operated for about 5 months during cruise to Mars, and returned data for about three orbits at Mars after orbital insertion on 24-25 Oct., 2001.

The NS sensor is a cubical block of borated plastic scintillator that is segmented into four equal volume prisms. In mapping orbit, one of the prisms will face forward into the spacecraft velocity vector, one will face backward, one will face down toward Mars, and one will face upward. Neutrons coming directly from Mars will be separated from those that are reprocessed by the spacecraft using a combination of velocity filtration (because the spacecraft in orbit about Mars travels faster than a thermal neutron) and self-shielding of one prism by the other three. Fast neutrons are separated from thermal and epithermal neutrons electronically. Details of the instrument and the Doppler filter technique for separating thermal and epithermal neutrons have been given elsewhere.[1,2] Application to the Mars Odyssey NS including a first demonstration of its operation during the fourth periapsis pass is given by Tokar et al. [3] A demonstration of the ability of the NS to measure the flux spectrum of fast neutrons was given by Feldman et al. [1] It was shown that the flux of fast neutrons generated by cosmic-ray interactions with spacecraft material is about 1/3 that expected to leak outward from Mars. It was also shown that the directional sensitivity afforded by the segmented design of NS will allow a separation of neutrons coming directly from Mars from those that leak outward from the spacecraft.

An overview of the latitude dependence of the thermal/epithermal counting rates during the fourth periapsis pass is given in Figure 1. The orbital track passed close to the north pole of Mars and reached periapsis at about 68^o north latitude at an altitude of 294 km. The portion of this track when the altitude of Mars Odyssey was less than 1000 km is shown in the left-hand panel of Figure 1. The latitude dependence of counts averaged over three 19.2 s integration periods of prisms 1, 2, 3, and 4, all corrected for altitude using the solid angle of Mars at each latitude point, is shown at the right in Figure 1. The difference in counts per 19.2 s between prism 4 (front facing) and prism 2 (back facing) is also given in Figure 1.

An overview of all prism counts shows two distinct latitude ranges; 1) poleward of 67^o north latitude, and latitudes between 27^o and 62^o N. Counts registered within the 27^o to 62^o latitude band are about twice those registered poleward of 67^o for each of the prisms. Because of the NS design and its orientation relative to Mars and the Mars Odyssey velocity vector; 1) prism 3 records mostly thermal and epithermal neutrons coming from Mars that are reprocessed by the spacecraft, 2) prisms 1 (outward facing, covered by Cd) and 2 (backward facing) record epithermal neutrons coming directly from Mars plus a small component coming from the spacecraft, and 3) the difference in counts from prism 4 (forward facing) and prism 2 (backward facing) gives the flux of thermal neutrons coming from Mars that is corrected to first order for neutrons reprocessed by the spacecraft. Inspection shows that; 1) spacecraft reprocessed thermal and epithermal neutrons are not negligible, 2) the flux of epithermal neutrons coming from a large region of Mars poleward of ~60° N latitude (abcissa angles between about 60° and 120° in Figure 1) are depressed from that coming from the more equatorial band by at least a factor of two, and 3) the flux of thermal neutrons (P4-P2) is enhanced by a factor of 2 at the more equatorial latitudes.

Although our results are preliminary, they are all consistent with a large polar terrane that is rich in hydrogen. This new result can be placed in proper context by comparing with the epithermal flux from the Moon that was measured using the Lunar Prospector NS. Whereas the full range of epithermal neutron flux from the Moon spanned 15%, that measured along the orbital track of Mars Odyssey shown in Figure 1 spanned more than a factor of 2.

References: Feldman, W.C. et al., JGR, in press (2001), Feldman, W.C. and D.M. Drake, Nucl. Instr. Meth., A245, 182-190 (1986), Tokar, R.L. et al., LPSC XXXIII, (2001).

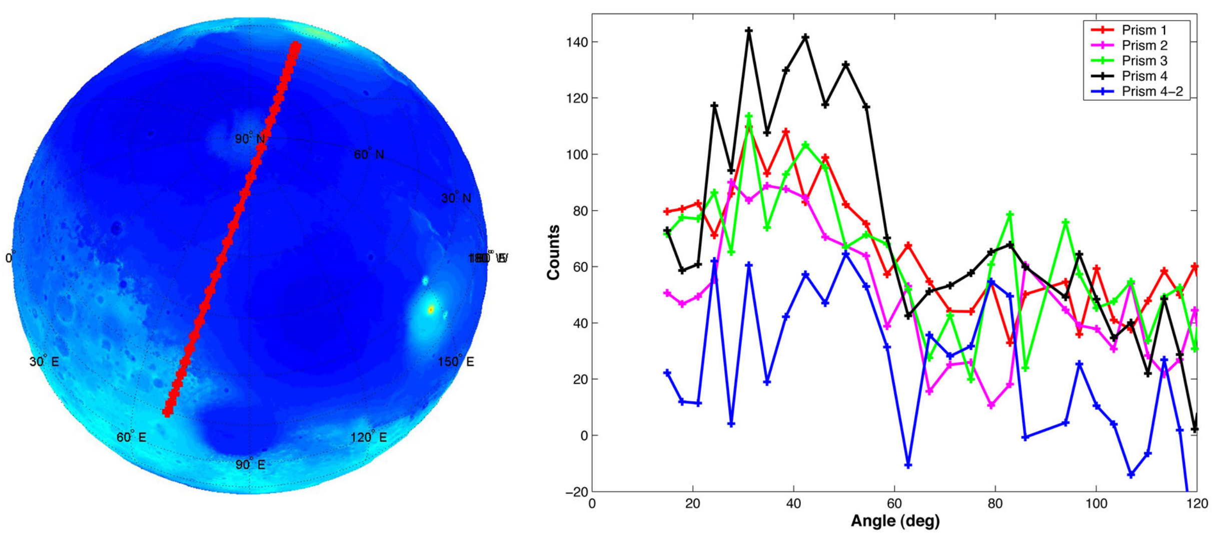

Figure 1: At the left is that portion of the fourth periapsis pass of Mars Odyssey for which its altitude is less than 1000 km. At the right is an overplot of the latitude dependence of the counts per 57.6 s integration period registered by each of the prism faces. Going from right to left, the angles on the abcissa of the right-hand panel mark the trajectory of Mars Odyssey from top to bottom shown in the left-hand panel.