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Comparison of the Mars Odyssey GRS results with geological mapping at the Cerberus Plains

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The neutron signals estimated by the Mars Odyssey Neutron Spectrometer do not correlate particularly well with the geological maps except in the Cerberus plains. A recent volcanic unit within this region corresponds to a local maximum of neutron emission in all three ranges of energy: thermal, epithermal and fast. Such maxima constrain the chemical composition of the near-surface material. Practically, having a strong fast neutron signal means that the material is rich in neutron producers (for instance Fe and Ti). Having a high thermal neutron signal means that the material is deprived from strong neutron absorbers (for instance Cl or Mn). Although it is impossible to directly infer the concentration in the individual elements with the neutron currents only, the measured ratio provide constraints on the chemical composition of the near-surface material. The ratio of fast to thermal neutron currents is correlated to the macroscopic absorption cross section for unlayered material. The region of the Cerberus plains exhibits a very low fast to thermal neutron currents ratio signifying a low macroscopic absorption cross section.

The Gamma Subsystem provides a direct measure of the abundances of Cl, Fe, Si, K, H and Th under the assumption that the composition is constant with depth. We estimate the macroscopic absorption cross section of the Martian superficial material that is consistent with these abundances. The macroscopic absorption cross section estimated with the Gamma Subsystem is not correlated to the same geomorphic unit than the Neutron Spectrometer and is quite high. The Cerberus plains have a high abundance

of chlorine. However, because of the large response function of the instrument, the signal at Cerberus can either result from the contamination by the neighboring Cl-rich region Medusae Fossae or from the actual composition at Cerberus. Consequently to the high absorption ability of chlorine, the GRS GS data predict a high absorption cross section at Cerberus.

The Cerberus Plains have been suggested to consist of flood lavas and plains style volcanism. The consistency of these hypotheses with the GRS results is studied via the macroscopic absorption cross section of terrestrial analogues. Columbia Plateau flood basalts and Snake River plains basalts have been identified as possible terrestrial analogues of the Cerberus Plains. These basalts have very low Cl and SO_2 contents. Consequently, they have very low macroscopic absorption cross sections, which is consistent with the low absorbing material detected by the Neutron Spectrometer. However the Cerberus Plains may not consist entirely of basalt because its low thermal inertia has been interpreted to result from a thin layer of soil covering the bedrock. Soils are richer in chlorine in comparison to rocks, suggesting that the composition of the region has vertical layering. This may explain the apparent discrepancy between interpretations of the neutron and gamma rays data sets, which both assumed the absence of layering initially. In conclusion we interpret the GRS observations by the presence of heterogeneous materials in the region of Cerberus and variations of the chlorine content in the close subsurface over a large area.

To validate the proposed geological scheme, we simulate the emission of neutron currents with the use of GEANT. GEANT is a code that simulates the transport of particles through matter. We use a model of martian material made of two layers. Chlorine being identified as the key chemical element in neutron absorption, different chlorine abundances are tested in this model. We thus estimate the behavior of neutron currents confronted to chlorine layering.