MSL TITANIUM OBSERVATION TRAY MEASUREMENTS WITH APXS. J.A. Berger[1] (jeffaberger@me.com), P.L. King[1-3], R. Gellert[2], J.L. Campbell[2], N. Boyd[2], I. Pradler[2], G.M. Perrett[2], and the APXS and MSL Science Teams. [1]Univ of New Mexico, Albuquerque, NM; [2]Univ of Guelph, Guelph, ON; [3]Australian National Univ, Canberra, Australia.

Introduction: Mounted on the front of the MSL rover, Curiosity, is a titanium observation tray (o-tray), upon which portions from drilled and scooped Martian samples may be delivered for analyses by rover cameras and the alpha-particle X-ray spectrometer (APXS) [1]. The o-tray is an important tool to assess possible fractionation from in-situ samples to the sieved (<150μm or <1mm) portions delivered to SAM and CheMin. Titanium metal was selected because it has the lowest response for APXS [2-3]; APXS-invisible materials that are non-conductive (e.g., Teflon) could not be used due to engineering concerns. The principal considerations for interpreting the APXS spectra from the o-tray are: 1) attenuation of the Ti signal through the sample can be used as a measure for overall sample coverage and 2) the sample signal depends on sample thickness and therefore possibly on particle size. Additional background from the Ti will introduce higher uncertainties for smaller samples. We evaluate here the first APXS measurements of the o-tray on Mars and present lab measurements of particulates on substrates made from the same Ti metal. We then present a strategy for utilizing the o-tray for MSL.

O-tray measurements with APXS on Mars: *Rocknest soil sample:* On Sol96, scooped and sieved (<150 μm) soil from the Rocknest drift [4] was analyzed by APXS on the o-tray (Fig.1) with ~2cm standoff. Some of the sample moved out of the APXS field of view (FOV) when the sampling subsystem caused vibration of the o-tray. The spectrum of soil on the o-tray exhibits a prominent Ti peak and elevated background over <5 keV (Fig.2), stemming from incomplete charge collection of the Ti peak in the detector.

The peak areas of the soil sample on the o-tray are directly comparable to those of the in-situ soil target (Fig.2). Peak area ratios are ~1/3 across the spectrum relative to the bulk sample (Fig.3), suggesting that ~1/3 of the APXS FOV contains sample. This is consistent with MAHLI images which show that roughly 25% of the ~4cm FOV (larger than in-contact FOV due to 2cm standoff) is covered by the soil. On the o-tray, the Ca, Mn, and Fe signals drop with increasing atomic number (*Z*), indicating that a fraction of the grains are smaller than the typical APXS sampling depth [3]. Slightly elevated S and Cl, with a S/Cl ratio similar to that found on MER [2], could indicate a small enrichment of these two elements in the <150 μm portion delivered to the o-tray.

Figure 1: Stretched MAHLI image of o-tray with Rocknest soil sample. The red hue on the right side of the o-tray is caused by fine dust, seen elsewhere on the rover and likely deposited on landing [e.g., 5].

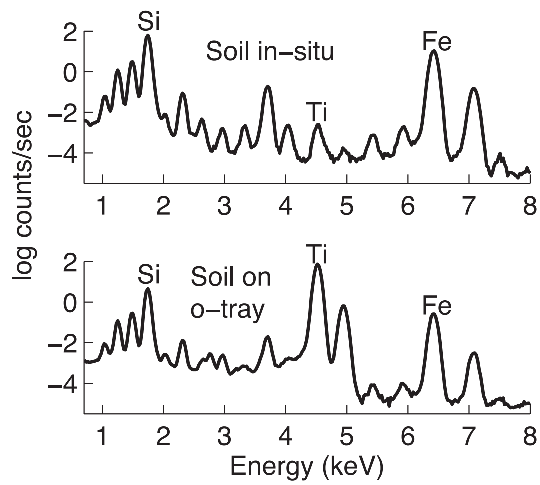

Figure 2: APXS spectra of Rocknest soils in-situ (target Portage) and on the o-tray.

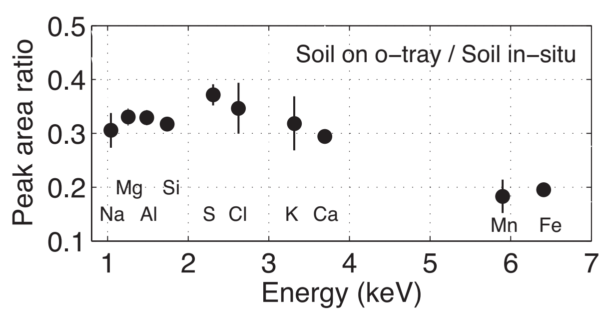

Figure 3: Peak area ratios of Rocknest soils in-situ (target Portage) and on the o-tray. Ratio = soil o-tray/soil in-situ. Bars show error in precision.

Laboratory o-tray measurements with APXS: To test the APXS response to samples on a Ti metal substrate, particulates of the basalt of Broken Tank (BT2) [6-7] were dusted uniformly over pieces of Ti substrate (courtesy of R. Anderson at JPL) and measured with the FEU APXS. BT2 is also used for the APXS calibration target [5-7].

Sample coverage: Relative to the uncoated Ti plate, increasing the coverage of BT2 particulates decreases the Ti signal and increases the sample signal (Fig. 4). As seen with the Martian spectra, the peak area ratios of the larger particle sizes generally decrease across the spectrum in proportion to the areal coverage of the sample (Fig. 5). This is not so for the smaller particle sizes. Attenuation of the Ti peak area follows a trend with increasing sample coverage (Fig. 6a), which is useful for estimating the overall portion size.

Particle size/thickness: The decrease in peak area ratio with increasing *Z* (Figs. 3,5) is evidence that the sample is thin with respect to the APXS sampling depth [3]. Sampling depth increases with *Z* (modeled range ~1-110 μm in Martian soil) [3], therefore the Si/Fe ratio illustrates the implications for a sample with grain sizes smaller than the sampling depth (Fig. 6b). As sample mass increases, the Si/Fe ratio decreases because the bigger sample enlarges the volume from which Fe X-rays are excited. Comparison with an "infinitely thick" sample allows us to constrain the thickness and mean grain size of sample on the o-tray. Infinitely thick samples on Mars may include in-situ targets, large portions on the o-tray, or sample dropped by CHIMRA to the ground.

O-tray and APXS strategy for MSL: We have demonstrated the potential for APXS measurements of Martian samples on the o-tray to constrain grain sizes. Further work by our group will characterize the properties of o-tray samples such that composition can be determined, which is important for understanding the samples delivered to SAM and ChemMin. We recommend the following strategies to maximize scientific return from the o-tray measurements with APXS:

- Iterate portion drop-off and APXS to obtain spectra of sample masses of ~200mg, ~400mg, ~600mg, etc.
- Measure samples on the ground when ejected by CHIMRA to obtain bulk sample spectrum.
- Periodically measure airfall dust accumulated on the o-tray, assuming CHIMRA samples are vibrated off.
- Improve targeting of the sample pile on the o-tray to maximize the sample amount.

References: [1] Campbell, JL et al. (2012) *Space Sci. Rev.* 170, 319-340. [2] Gellert, R et al. (2006) *JGR 111*, E02S05. [3] Brückner, J et al. (2008) *The Martian Surface* ed. JF Bell III, 58-101. [4] Yen et al. (2013) this conf. [5] Campbell, JL et al. (2013) this conf. [6] Burkemper, L et al. (2008) EOS Trans AGU. [7] Thompson, L et al. (2013) this conf.

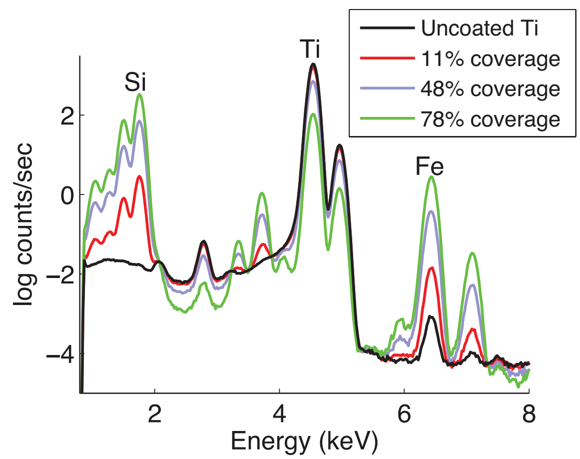

Figure 4: APXS spectra of BT2 <150 μm particulate on Ti plate.

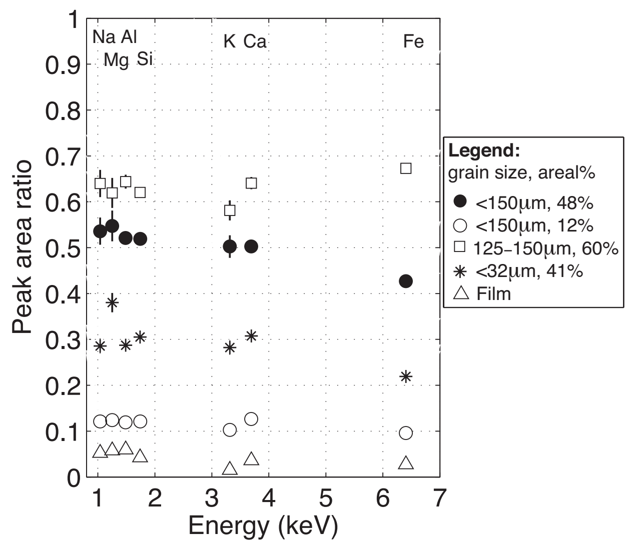

Figure 5: Peak area ratios relative to 78% coverage of the o-tray with <150 μm BT2 particulate.

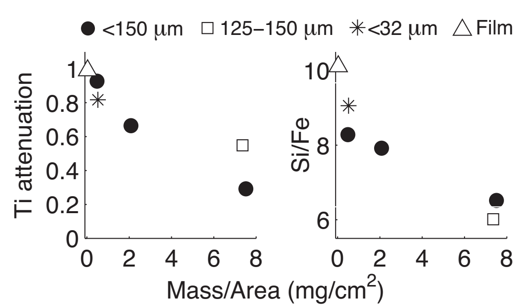

Figure 6: (A) Ti peak area decreases and (B) Si/Fe drops with increasing sample mass over the surface. Error in precision is contained within the symbols.