MARSLAB AT THE NEVADA TEST SITE: ROVER SEARCH FOR SUBSURFACE HYDROTHERMAL ACTIVITY EXPOSED BY SMALL CRATERS. L. E. Kirkland[1,2], K. C. Herr[2], P. M. Adams[2], L. B. Prothro[3], and B.M. Allen. [1]Lunar&Planetary Institute, Houston; [2]The Aerospace Corp., laurel.e.kirkland@aero.org, kenneth.c.herr@aero.org, paul.m.adams@aero.org, [2]Bechtel Nevada, prothrlb@nv.doe.gov, allenbm@nv.doe.gov.

Introduction: Hydrothermal alteration products that correlate with ejecta from small craters (less than ~100 m deep) could flag near-surface hydrothermal activity. An accompanying abstract [1] discusses potential airborne (Mars satellite analog) routes to discover such sites, based on testing from explosion craters at the Nevada Test Site (NTS). Here we report correlated ground-based studies that use rover-analog, thermal infrared imaging spectroscopy.

A primary goal of the airborne study is to determine routes to discovery of hydrothermal activity on Mars. The goals of the ground-based study are: (1) determine which materials and textures cause the observed airborne signatures, and which materials are imperceptible; (2) compare the airborne results to detailed geologic maps; and (3) develop lessons-learned for Mars.

Craters and coatings: Abstract [1] has information on the craters, coating formation, the NTS, and MarsLab instruments. Fine-grained, white coatings of calcite [2] and opal occur on the ejecta basalt, especially at joints (Fig.1), and also on the cinders (Fig.2). The coatings are indicators of hydrologic activity. Coating thickness ranged from thin (Fig.1) to more substantial material (Fig.3). Visually, the thin calcite and opal coatings appeared very similar.

Data: The 2003 rover MiniTES measures thermal infrared, hyperspectral images similar to the MarsLab instruments RamVan and Tonka [1]. We positioned RamVan on the Danny Boy crater south rim (Fig.4), and measured hyperspectral images (Fig.5) of the interior (Fig.6), rim, and ejecta in April, 2004.

Results and upcoming work: *(1) Causes of spectral variability.* The RamVan scenes recorded considerable spectral variability. However, geologic studies of the sites concluded that the basalt composition is fairly uniform, although the vesicularity varies with depth [2,3,4]. If the basalt composition is uniform, then potential causes of the spectral variability include coatings (mainly opal, calcite, glass melt (Fig.6), desert varnish, aeolian), and particle size and texture effects [5,6]. Onsite correlation of the RamVan spectra with targets is needed to determine the true cause(s) and thereby develop accurate interpretation methods.

(2) Pixel size. SEBASS measures 2 m/pixel, vs. ~0.2 to 1 m/pixel for RamVan, which translates from 100 to 4 RamVan pixels per SEBASS pixel, respectively. Thus RamVan is likely to map greater spectral variability, which adds both complexity and information.

(3) Viewing angle matters. Overhead measurements typically view straight down, while rovers generally are side-looking. The two perspectives can view different materials. For example, for a scene such as Fig.1, the rover perspective sees the boulder sides. Debris between the boulders (e.g., Fig.6 inset, right) is less visible, and can differ compositionally (e.g., dust vs. rocks on Mars). SEBASS sees boulder tops and material between the boulders. The tops of boulders can weather or be coated differently, e.g., preferential dust deposition on boulder tops. The instruments may record different results because they see different materials, even for the same pixel size and location.

(4) Variability with location. The airborne SEBASS spectra show that Buckboard 12 and Danny Boy exhibit some differences in spectral signatures, in spite of their close proximity (~400 m separation). The meaning for geologic interpretations needs to be unraveled. We did not measure RamVan data of Buckboard 12, and future work will fill in that gap.

(5) Geologic maps. Correlation of spectral results with new and existing geologic maps (e.g., Fig.8) will compare results. Systematic comparison with well-developed techniques is necessary to advance interpretation accuracy and confidence.

(6) Surface weathering matters. Well developed desert varnish is common on surfaces of exposed basalt on Buckboard Mesa. However, desert varnish is typically not present on basalt ejecta at the craters due to the short period of surface exposure for most of the ejecta. Because the spectral signatures differ between basalt with desert varnish and that without, compositional mapping methods as currently applied to Mars would map the two materials as having different bulk compositions. That unwelcome result illustrates a significant unknown in current mineral maps of Mars.

Figure 1: Buckboard 12 ejecta, SW side. Scrugham Peak is in the background. Arrow marks person for scale. This shows the typical blocky ejecta in the foreground, red cinder ejecta in the background, and carbonate or opal coatings. **Inset**: Opal coating on ejecta from this area. Ruler numbered divisions are in cm.

Figure 2: Buckboard 12 ejecta in the cinder-rich (north) region. The whitish material shown here does not effervesce. Inset is a close-up. Ruler numbered divisions are in cm.

Figure 3. Opal near Buckboard 12 (5Apr04).

Figure 4: Danny Boy ejecta, south rim, looking ~east. RamVan is on the Danny Boy rim, on a dirt ramp constructed for crater access. The arrow marks an example view from the spectrometer (shown in inset) that is raised above the roof.

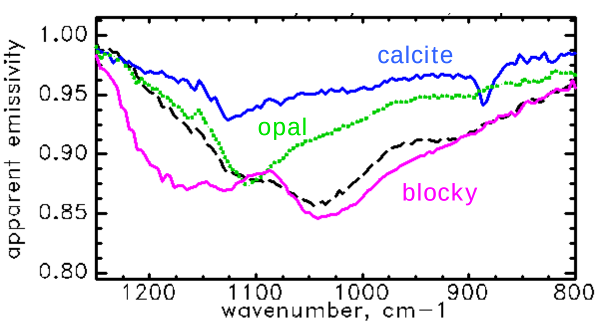

Figure 5: RamVan spectral data [8]. These spectra are from the Danny Boy southwest interior. The purple, solid trace is of blocky material. The green and blue traces match lab spectra of opal and calcite, respectively. The dashed, black trace illustrates additional spectral variety.

Figure 6: Inside Danny Boy. Inset shows a close-up of possible glass melt (arrow). The inset rock is ~1/3 m wide.

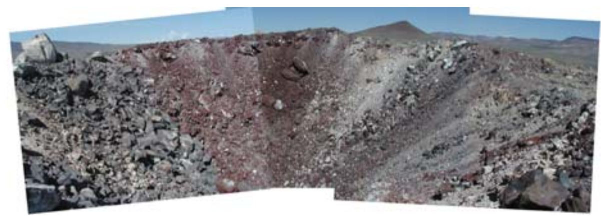

Figure 7. Inside Buckboard 12, taken from east rim looking ~NW. The whitish coatings are mainly carbonate or opal. Scrugham Peak is visible in the background, center-right.

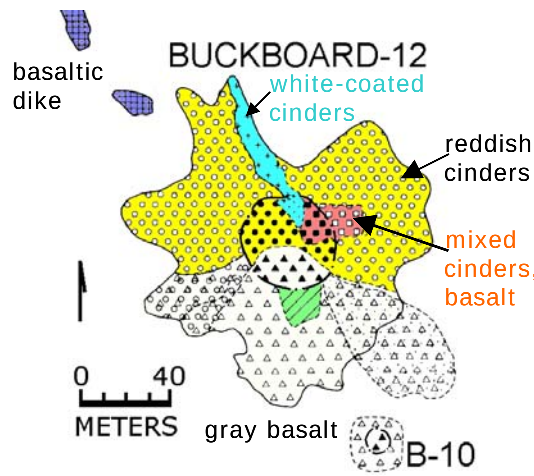

Figure 8: Buckboard 12 geologic map from [7]. "B-10" is the crater Buckboard 10. The green, hatched region is where ejecta was removed during post-cratering research.

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