**BULLIALDUS CRATER: CORRELATIONS BETWEEN KREEP AND LOCAL MINERALOGY.** Rachel L. Klima (Rachel.Klima@jhuapl.edu)[1], David Lawrence[1], Joshua T. S. Cahill[1] and Justin Hagerty[2]. [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA; [2]USGS Astrogeology Science Center, Flagstaff, AZ, USA.

**Introduction:** The central peak of Bullialdus Crater has long been recognized as being dominated by a strong noritic signature (e.g., 1,2,3). Results of spectral fits to the central peak of Bullialdus suggest a relatively high Mg# in the low-Ca pyroxenes (4), within the range of values observed for Mg-suite lunar samples (e.g., 5). Centered at -20.7°, 337.5° in Mare Nubium, Bullialdus Crater lies within the high-thorium Procellarum KREEP Terrane (e.g., 6). In fact, based on orbital gamma-ray data, Bullialdus is the location of a clear Thorium enhancement, which is important because Th commonly serves as a proxy for detecting KREEP-rich materials on the lunar surface (7). Using data from the Moon Mineralogy Mapper ($M^3$), we examine the mineralogy excavated by Bullialdus crater as well as that of the surroundings to determine whether the Th content can be linked to a specific lithology or mineral.

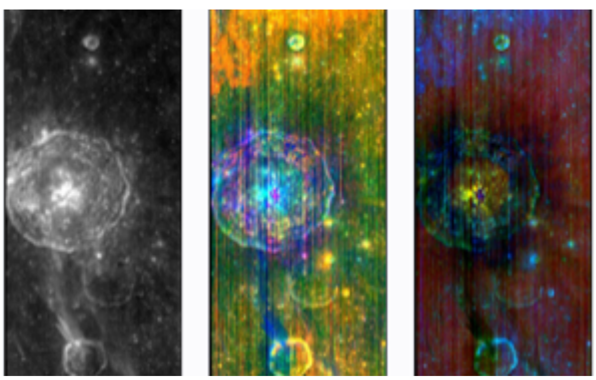

**Fig. 1.** Mineral diversity in Bullialdus crater. (A) 0.75 µm albedo map. (B) Mafic mineralogy depicted using an RGB composite of R=integrated 1 µm band depth; G=integrated 2 µm band depth, B=reflectance at 1.5 µm. In this color scheme, fresh material appears bright, with deep blue generally indicating feldspathic material, red indicating an enhancement in olivine, and orange and yellow indicating pyroxenes. Low-Ca pyroxene often appears as cyan, due to the overall brightness and narrow 1 µm band. (C) Pyroxene diversity depicted using an RGB composite of R=1.9 µm band depth, G=integrated 2 µm band depth, B=integrated 1um band depth. This color scheme highlights low-Ca pyroxene as yellow, and fresh high-Ca pyroxene as cyan. Anorthositic material and highly weathered material appear as black.

**Bullialdus Region Mineralogy:** Bullialdus crater and the local mineralogy are shown in Fig. 1, and representative spectra from Bullialdus and the surrounding region are shown in Fig. 2. Strong pyroxene bands indicative of a noritic composition dominate the central peak. Anorthositic material, excavated by Bullialdus, is exposed in the crater rim and proximal ejecta (Fig. 1). Portions of the walls exhibit a gabbroic signature, potentially enhanced in olivine. Fresh craters in Mare Nubium exhibit a typical basaltic spectral signature, while both mare and highland soils in the region are generally featureless.

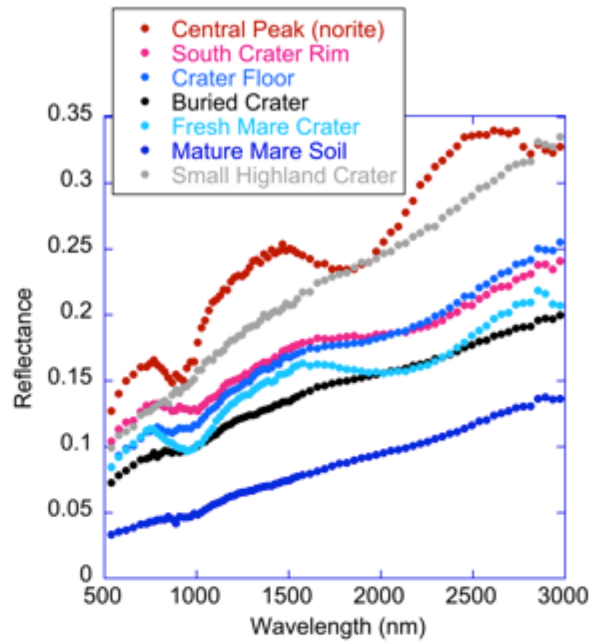


**Fig. 2.** Representative spectra from within and around Bullialdus crater.

**Bullialdus Region Thorium Content and KREEP:** Shown in Fig. 3 is the devonvolved Lunar Prospector thorium content around Bullialdus crater. There is a clear enhancement directly centered on Bullialdus crater, and additional hotspots located around several craters to the east and northeast of Bullialdus. These hotspots appear to relate to local mineralogy, with thorium enhancements corresponding to regions exhibiting noritic and anorthositic spectral signatures (Fig. 4).

**Bullialdus Crater and Hydroxyl**: In addition to providing a window into the complex petrology of the lunar crust, Bullialdus Crater may also provide insight into the distribution of native lunar volatiles. Multiple lunar data sets have demonstrated that some lunar surface materials exhibit a 2.8 – 3.0 µm absorption band, indicative of a hydroxyl or water component (e.g., 8, 9,10). An increasing number of studies are also revealing that the lunar mantle may have contained more water than originally assumed (11, 12, 13) and some of this increased water may be related to KREEP materials (14). Observations of the central peak of Bullialdus Crater indicate that the pyroxenes exhibit a distinctive 2.8 µm band that is significantly stronger than the immediate surroundings, possibly indicating the presence of a hydroxyl component, as illustrated in Fig. 5. The hydroxyl signature persists through multiple viewing geometries and illumination conditions.

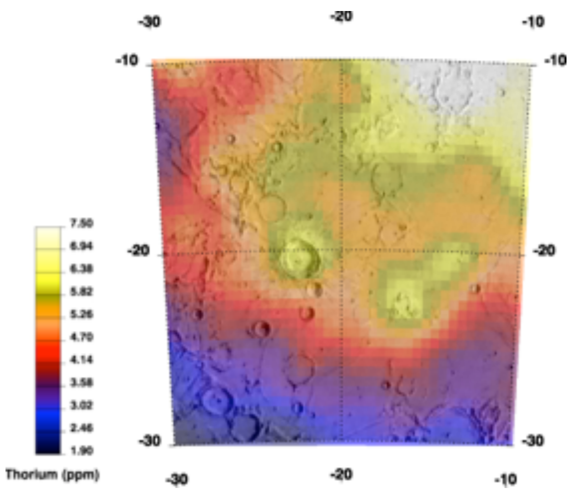


**Fig. 3.** Lunar Prospector thorium, deconvolved and overlain on the regional topography.

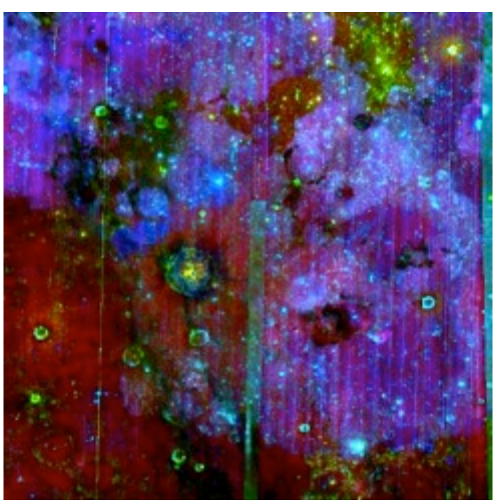

**Fig. 4.** Pyroxene diversity map for the same region depicted in Fig. 3. Color composite is the same as in Fig. 1C.

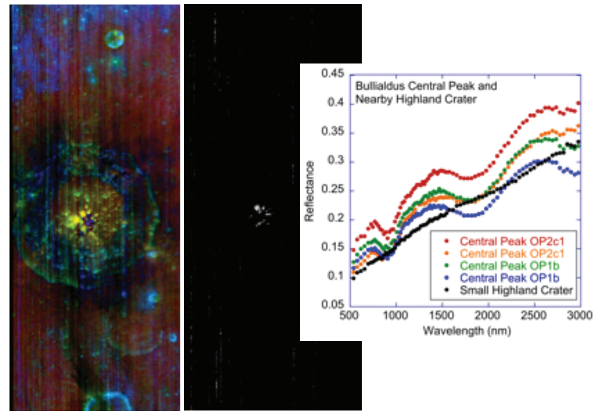


**Fig. 5.** Bullialdus crater pyroxenes (left) and 2.8 µm band depth (middle). Example spectra for the central peak taken during different optical periods with different illumination and viewing geometry are provided. A small, fresh highland crater from a similar latitude is provided for comparison.

We will explore the geology in and around Bullialdus in more detail, examining relationships between lithology, thorium content, and hydroxylated material. In particular, we investigate the specific compositions and spectral properties of the pyroxenes in these exposures to determine whether they can provide further information about the source region and distribution and character of KREEP on the lunar nearside.

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**References:** [1] C. M. Pieters, 1991, GRL 18, 2129. [2] S. Tompkins et al., 1994, Icarus 110, 261. [3] J. T. Cahill and P. G. Lucey, 2007, JGR 112, E10007, doi:10.1029/2006JE002868. [4] Klima et al., 2011, JGR 116, E00G06, doi:10.1029/2010JE003719. [5] Papike et al., 1998, in Planetary Materials, 5-1. [6] B. L. Jolliff et al., 2000, JGR 105, 4197. [7] D. J. Lawrence et al., 2003, JGR 108, 5102. [8] R. N. Clark, 2009, Science 326, 562. [9] C. M. Pieters et al., 2009, Science 326, 568. [10] J. M. Sunshine et al., 2009, Science 326, 565. [11] A. E. Saal et al., 2008, Nature 454, 192. [12] F. M. McCubbin et al., 2010, PNAS 107, 11223. [13] E. H. Hauri et al., 2011, Science 333, 213.[14] A. E. Saal et al., 2011, "A Wet vs. Dry Moon" workshop.