SEARCH FOR SHORT-TERM CHANGES IN THE LUNAR SURFACE: PERMANENT ALTERATION OVER FOUR DECADES. A. P. S. Crotts[1], [1]Department of Astronomy, Columbia University, 550 West 120th St., New York, NY 10027; arlin@astro.columbia.edu.

Introduction: The comparable imaging resolutions of the *Lunar Reconnaissance Orbiter* (LRO) Camera narrow angle channel and high-resolution modes on *Lunar Orbiter III* and *V* (LO) more than 40 years ago allows one to survey large areas (~10^5 km^2) for changes down to a few meters. We are completing a systematic comparison of LROC-NAC data with LO images that have been optimally processed to eliminate cosmetic defects. The current Abstract should be considered a work in progress with new results likely by March 2011.

The candidate mechanisms for these changes are several: impacts, mass wasting (rockfall/avalanche), and possibly regolith motion associated with outgassing. The latter is strongly suggested by strong correlation [1] of transient optical changes in the surface appearance (Transient Lunar Phenomena: TLPs) with outgassing as traced by ^{222}Rn alpha particle emission. [2,3] Such erosion by outgassing may be the preferred explanation for large, recently excavated depresisons unassociated with impacts. [4] In both cases one might explore how gas released from the lunar surface might alter regolith properties possibly observable remotely. A recent model indicates that minimally explosive outgassing events would leave crater-like features ~20 m in diameter contained within photometric changes in the regolith over hundreds of meters. [5]

Comparing LO and LROC-NAC data: We have conducted much of a survey comparing areas where LROC and LO high resolution imaging overlap, especially in regions where mass wasting and/or outgassing may occur (as traced by ^{222}Rn and/or historical TLP frequency). First of all, the reader should be aware that superlative LROC-NAC has somewhat superior resolution to highest resolution LO III and V imaging, but that LO high-resolution frames are usually comparable to the point that distinctly significant features in LROC-NAC are at least marginally detectable in LO hi-res imaging. An example of a sloped talus field from both epochs is shown in Fig. 1.

To look for boulder motion, we take images that have similar illumination angles (with viewing angles almost always being sufficiently similar) and produce a rock boundary map with outlines derived from a Roberts edge-finding filtered image of the initial data. In almost all cases these boundaries agree with each other within the noise. At the resolution of these images and the likely LROC-NAC/LO-hires overlap region, one should expect to detect of order ~10^7 boulders for the complete survey. There are large parts of the surveyed area with age since last major impact of ~$10^8 - few \times 10^8$ years (Aristarchus, and ultimately Tycho, Copernicus). Over the ~42 year baseline, therefore, a few boulders may have moved. (Refer again to Fig. 1.)

The other category of feature we have detected thus far are anomalous and new bright haloes around small craters (of order tens of meter diameter). Cases exist where the region around these have brightened more than photometric function would allow, especially in cases of similar illumination angles. (See Fig. 2.)

References: [1] Crotts A.P.S. (2008) *ApJ*, 687, 692. [2] Gorenstein P. and Bjorkholm P. (1973) Science, 179, 792. [3] Lawson S.L. et al. (2005) JGR, 110, E09009. [4] Shultz P. et al. (2006) Nature, 444, 184. [5] Crotts A.P.S. and Hummels C. (2009) *ApJ*, 707, 1506.

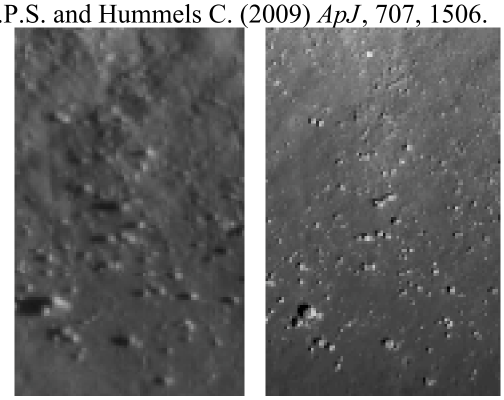

Fig. 1: images from LO V and LROC-NAC of portion of Vallis Schröteri with most inclined slope, showing 210 detected boulders. One large boulder (nearest image center) shows marginal evidence of moving about half its own width. (The field is about 180 m wide.)

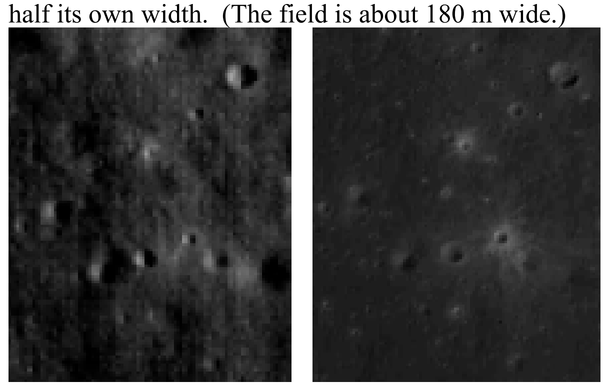

Fig. 2: images from LO V and LROC-NAC showing most prominent evidence of photometrically bright halo around crater feature (just below right of center). Because the illumination angles differ by ~50°, one sees significant changes interior to all detectable craters, but the noted change is exterior and larger than consistent with photometric function variation.