HIGHEST SPATIAL RESOLUTION NEW HORIZONS LEISA SPECTRAL-IMAGING SCAN OF PLUTO.

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Observation: The Linear Etalon Imaging Spectral Array (LEISA) component of New Horizons' Ralph instrument [1] provides spectral coverage from 1.25 to 2.5 µm, at a resolving power ($\lambda/\Delta\lambda$) of 240. LEISA's spectral dispersion is provided by a wedge filter affixed to the detector so as to give each column of the array a unique wavelength. By scanning the array across the scene in the wavelength-dispersion direction while recording a series of images, each part of the scene is eventually imaged in each wavelength, enabling a multi-spectral image cube to be assembled.

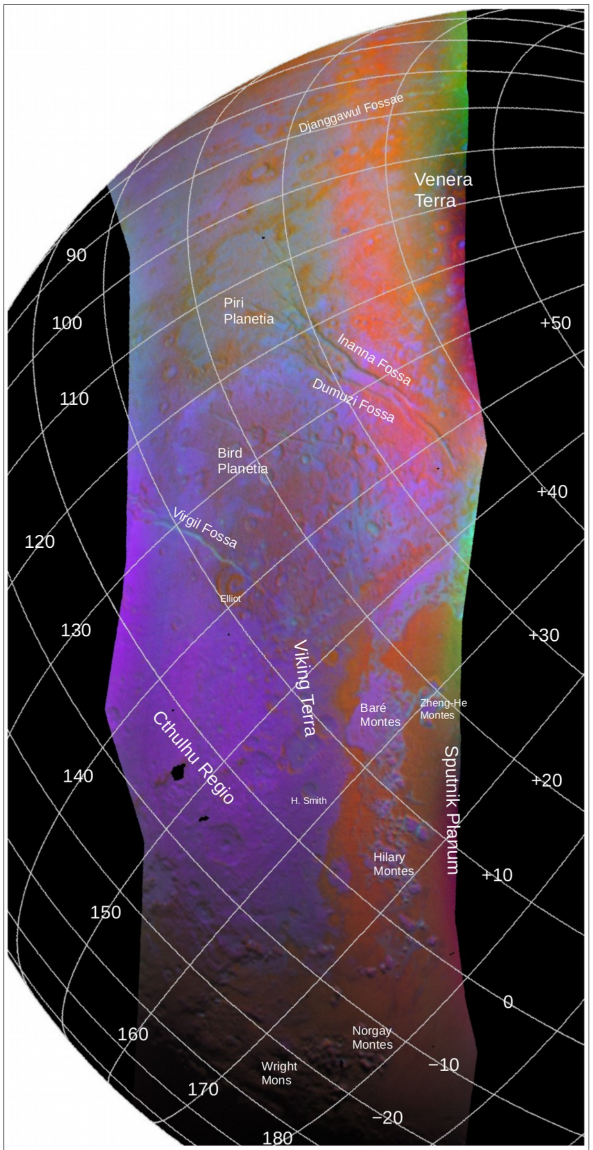

Fig. 1. False color image of the P_LEISA_HIRES scan constructed from the first few principal components computed from LEISA data. All feature names are informal.

The highest spatial resolution LEISA observation of Pluto, at about ~3 km/pixel was obtained by New Horizons at around 10:56 UT 2015 July 14, from a range of 47,000 km. As shown in Fig. 1, the scan ran diagonally from the sunlit limb at mid-northern latitudes, southeast across the mountainous contact region between the large, dark, reddish expanse of Cthulhu Regio[1] and the extremely bright and volatile ice-rich Sputnik Planum. These features are so large and conspicuous that their existence had already been known from Earth-based observations, enabling the encounter sequence to be designed to reveal more about them.

Results: Maps of Pluto's various ices species were constructed from the LEISA observation by computing integrated areas, band depth ratios, or correlations with template spectra as described in [2]. These maps (e.g., Fig. 2) trace specific materials across Pluto's surface in a qualitative sense. More quantitative abundance maps await pixel-by-pixel analysis of the individual spectra, using radiative transfer models to account for multiple scattering and particle size effects, a computationally expensive process (see [3]).

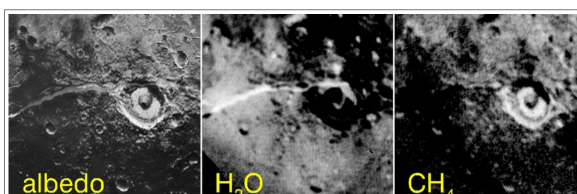

Fig. 2. Compositional maps of a 300 km wide region around Elliot crater and Virgil Fossa. North is up.

Fig. 2 shows H_2O and CH_4 ice maps of the region around Elliot crater and Virgil Fossa, in comparison with an albedo map based on New Horizons LORRI

1 All feature names throughout this abstract and the associated talk are informal.

images [4,5,6]. The crater is strikingly depleted in H_2O, while the fossa is rich in that material, which is non-volatile at Pluto surface temperatures. The surrounding plains also show H_2O ice absorption but less so to the north of Elliot, where the H_2O gives way to CH_4 ice. The flat floor of Elliot is very rich in CH_4, as are the north-facing portion of its inner rim and central peak.

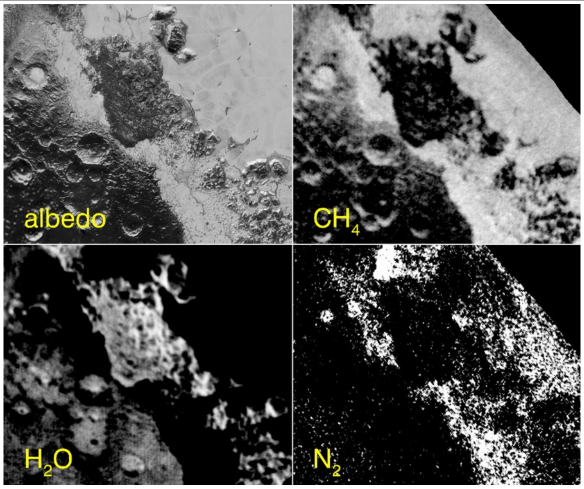

Fig. 3. Region extending from Viking Terra in eastern Cthulhu Regio at lower left to Sputnik Planum at upper right. The mountainous region at upper center is Baré Montes, with Zheng-He Montes near the top of the frame and Hilary Montes at lower right. Each pane is 350 km tall and north is up.

Another interesting region appears in Fig. 3, with maps of albedo, H_2O, CH_4, and highly volatile N_2 ice. In dark Cthulhu Regio at lower left, H_2O ice has a patchy distribution, and there is little or no N_2 ice. CH_4 occurs there, but mostly just on north-facing slopes. No H_2O is seen in Sputnik Planum, but that area is rich in both N_2 and CH_4. Interestingly, the N_2 ice absorption in Sputnik does not appear to be spatially uniform (unfortunately this is a noisier map owing to the weakness of the N_2 absorption band at 2.15 μm). A region just north of Baré Montes shows particularly strong N_2 absorption. An unnamed crater with a bright floor stands out at upper left. The bright floor material looks similar to Sputnik Planum, rich in both CH_4 and N_2.

Despite its low visible wavelength albedo, Baré Montes shows reasonably strong H_2O ice absorption and little CH_4 or N_2. H_2O ice was expected in mountainous regions, since the more volatile ices are too ductile for large, enduring edifices to be built of them. But its distribution in the various mountain ranges in this region is curious, tending to be associated with south-facing slopes. It appears to be masked by CH_4 ice on north-facing slopes.

At mid-northern latitudes, as in Fig. 4, the distributions of CH_4 and H_2O ices often appear anti-correlated. Many craters show bright rims with strong CH_4 absorption, while their dark floors show H_2O absorption. A possible explanation for this CH_4 distribution is that it preferentially condenses from the atmosphere on topographic highs and regions with high albedos.

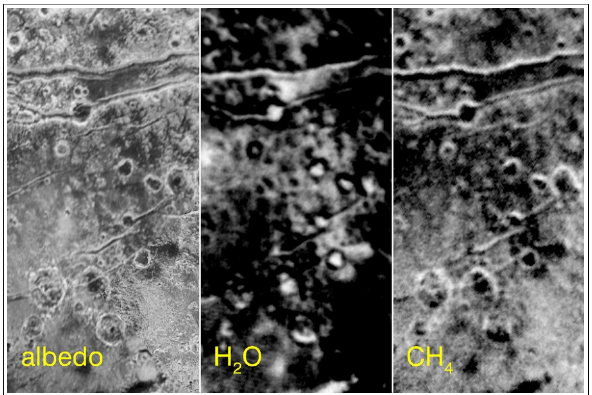

Fig. 4. Region extending from Bird Planitia north to Dumuzi and Inanna Fossae. Each pane is 400 km tall and north is up.

This co-occurrence of H_2O absorption with visually dark regions is seen widely across Pluto, with Baré Montes and Cthulhu Regio providing good examples in Fig. 3. It is unclear whether the H_2O plus tholins responsible for darkening the crater floors actually accumulate there (perhaps arriving as wind-blown dust), or are generally representative of Pluto's subsurface materials but are seen to outcrop only in regions such as crater floors where they are least likely to become coated by volatile ices, owing to the local thermal environment.

References: [1] Reuter et al. (2008) SSR, 140, 129-154. [2] Grundy et al. (2016) Science, submitted. [3] Protopapa et al. (2016) this conference. [4] Cheng et al. (2008) SSR, 140, 189-215. [5] Stern et al. (2015) Science, 350, 292. [6] Moore et al. (2016) Science, submitted.