PLUTO’S SPUTNIK PLANITIA: SPECTRAL VERSUS GEOLOGICAL SIGNATURE. F. Scipioni1, O. White1,2, C.M. Dalle Ore1,2, D.P. Cruikshank1, W.M. Grundy1, R.P. Binzel3, M.W. Buie2, J.C. Cook2, A.M. Earle2, K. Ennico2, D.E. Jennings2, C.J.A. Howett3, I.E. Linscott4, A.W. Lunsford5, J.M. Moore1, W.B. McKinnon6, C.B. Olkin7, A.H. Parker8, S. Protopapa9, D.C. Reuter3, B. Schmitt10, K.N. Singer1, J.R. Spencer3, S.A. Stern8, H.A. Weaver4, A.J. Verbič6, J. Verbiscer2, L.A. Young5, and the New Horizons GGI team. 1NASA Ames Research Center; Moffett Field, CA, 94035 (francesca.scipioni@nasa.gov); 2SETI Institute, Mountain View, CA; 3Lowell Observatory, Flagstaff AZ; 4Massachusetts Institute of Technology, Cambridge MA; 5Southwest Research Institute, Boulder, CO; 6Pinhead Institute, Telluride, CO; 7NASA Goddard Space Flight Center, Greenbelt MD; 8Stanford University, Stanford CA; 9Washington University in St. Louis, St. Louis MO; 10University of Maryland, College Park MD; 11Université Grenoble Alpes, CNRS, Grenoble, France; 12University of Virginia, Charlottesville, VA.

Introduction: In 2015 the New Horizons spacecraft encountered Pluto to unveil an icy world with a rich and complex geological history [1,2,3]. The surface of Pluto exhibits several terrain types, the most conspicuous being Sputnik Planitia* (SP). The north and central part of SP is 3-4 km depressed with respect to the surrounding mountains and has a cellular pattern [1,2]. The origin of the cells likely originated from solid-state convection of N2-ice [4], the primary surface constituent of SP. In the southern part of SP, the cells disappear, and the terrain consists of featureless plains [1,2].

A geological map of Sputnik Planitia has been produced [3] by analyzing New Horizons LOn-Range Reconnaissance Imager (LORRI) [5] observations. The map identifies 15 geological units, plus the undifferentiated Pre-Sputnik Planitia Uplands (psu) (Figure 1). The geological units were defined primarily by the texture and albedo that they present at the 386 m/pixel scale of the base map used for classification.

In this work, we consider observations of Sputnik Planitia by New Horizons’ near-infrared imaging spectrometer, LEISA [6], and we investigate whether the geological units identified by [3] are defined not only by their geomorphology, but also spectrally. The results shown here are still preliminary.

Methodology: From three high spatial resolution (ranging between ~ 6 and ~ 9 km/pixel) LEISA spectral image cubes we produced a mosaic using the Integrated Software for Imagers and Spectrometers (ISIS) routines. We then selected regions of interest on the mosaic corresponding to the Sputnik Planitia geological units identified in [3].

We consider 13 units, excluding the Impact Crater (ic), and the Bright, Pitted Uplands (bpu) units because they are exterior to SP. The units selected for the analysis are: Bright, Cellular Plains (bcp); Dark, Cellular Plains (dcp); Dark, Trough-Bounding Plains (tbp); Sparsely Pitted Plains (spp); Deeply Pitted Plains (dpp); Lightly Pitted Plains (lpp); Patchy, Pitted, Marginal Plains (pm); Dark-Pitted, Marginal Plains (dmp); Chaotic, Angular, Blocky Mountains (abm); Chaotic, Inter-Block Material (ibm); Scattered Hills (sh); Dark, Ridged Terrain (drt); Bright, Chaotic Terrain (bct). See Table 1 in [3] for a detailed description of the units.

We extract the average spectrum for each of the thirteen units, shown in Figure 2. The spectra are not normalized, or offset. The analysis shown here is qualitative, because the work is preliminary, and not complete. LEISA data were calibrated using

Figure 1: Distribution of geological units on Pluto’s Sputnik Planitia [3].

Results: In the region covered by LEISA’s low-spectral-resolution segment (1.25-2.5 μm) [6], Sputnik Planitia’s spectrum is dominated, on average, by CH4, N2, and CO absorptions [7]. CH4 has four series of broad absorptions in the region between 1.30–1.43 μm, 1.59–1.83 μm, 1.90–2.00 μm, and 2.09–2.48 μm [8]. CO and N2 absorption bands are centered at 1.58 and

* Some feature names mentioned in this paper are now formalized while others are informal
Figure 2 highlights the positions of all the dominant CH₄, N₂, and CO absorptions. All of the geological units we considered show CH₄, N₂, and CO spectral features, although they differ in spectral absorption band depth and slopes.

The unit with the flattest continuum slope is the Bright, Chaotic Terrain (bct), which refers to a small portion of terrain located north of al-Idrisi Montes. This mountain range consists of units ibm and abm, the blocky, mountainous units that extend along the eastern border of Sputnik Planitia and are separated from Cthulhu Macula by the Dark, Ridged Terrain (drt) and Dark-Pitted, Marginal Plains (dmp) units (Figure 1). Unit drt has significantly suppressed CH₄ and N₂ absorption bands, while the CO feature is not present. Absorption features become gradually deeper, and the albedo increases outward from the center of Sputnik Planitia, passing from unit ibm, to abm, and to dmp.

The cellular plains of Sputnik Planitia are split between three units: the northern margin of Sputnik Planitia is occupied by unit Dark, Trough-Bounding Plains (tbp); to the south extends unit Dark, Cellular Plains (dcp); and the center of Sputnik Planitia contains unit Bright, Cellular Plains (bcp). Units tbp and dcp are spectrally very similar, while bcp has slightly shallower CH₄ and N₂, but deeper CO absorption bands.

The average spectrum of the bcp unit is remarkably similar to that of the Sparsely Pitted Plains (spp), even though the two units occupy portions of Sputnik Planitia that are not adjacent but are separated by the pitted plains units lpp and dpp.

The same similarity is also shared by units dmp, lpp and sh. The lpp and sh units occur along the eastern margin of SP, while dmp occurs along its western edge.

The similar spectral characteristics of different geological units may be due in some cases to a relatively thin veneer of seasonal or super-seasonal ice.

**Discussion:** The preliminary analysis of the spectral characteristics of Sputnik Planitia shows that not all mapped geological units exhibit distinct geological and spectral characteristics. Terrains that appear to have different geological ages and evolutionary histories, often spatially separated, show spectra that are strikingly similar, if not almost the same.

**References:**

![Figure 2: Average spectra for thirteen of the fifteen geological units identified by [3]. Shaded regions and dashed lines show the positions of the main CH₄, N₂ and CO absorption features.](image-url)