THE ARISTARCHUS PLATEAU LARGE IGNEOUS PROVINCE: THE CASE FOR BI-MODAL VOLCANISM. M. Zanetti¹, B. L. Jolliff², K. Shirley³, T. D. Glotch⁴, J.J. Haggerty⁴, A. L. Gullikson⁴ ¹University of Western Ontario, Department of Earth Science, 1151 Richmond St., London, Canada; ²Washington University in St Louis, MO; ³Stony Brook University, Dept. of Geoscience, Stony Brook, NY; ⁴USGS Astrogeology Center, Flagstaff, AZ. (Michael.Zanetti@uwo.ca).

Introduction: Combining detailed morphologic mapping, using Lunar Reconnaissance Orbiter Camera (LROC) imagery, with compositional datasets including WAC – color, Diviner, Clementine spectral reflectance (CSR), Lunar Prospector Gamma Ray Spectrometer (LP-GRS), and interpretations from the Chandryaan-1 Moon Mineralogical Mapper (M³) and Clementine ultraviolet and visible light spectroscopy (UVVIS) research, we have characterized the interior and ejecta blanket of Aristarchus Crater, as well as regions within the southwestern portions of the Aristarchus Plateau.

We find that silicic regions observed in LRO- Diviner data covering the Aristarchus crater floor and ejecta (first reported by [1, 2]) are well correlated with low FeO content and high Th abundance, possibly indicating the excavation of an evolved hypabyssal intrusion or platon, as suggested by [3-6]. We identify compositional anomalies on the plateau near Herodotus Crater, Väisälä Crater, and the Cobra Head volcanic vent which share the same composition as evolved excavated units in Aristarchus ejecta. Silicic material in Cobra Head suggests formation in part as a silicic dome, despite being the source region of Vallis Schröteri, a prominent basaltic sinuous rille. We infer that the southern portion of Aristarchus Plateau may have formed due to Si-rich intrusions and bi-modal volcanism [6].

Datasets: FeO: Based on Clementine-derived FeO abundance maps (Fig. 1a, Fig. 2) [7], the central peak of Aristarchus has lowest FeO content (~4 wt %), with areas of the crater floor and ejecta ranging from 4 to 11 wt %. Areas of the surrounding mare, and the northeastern ejecta of the crater have FeO contents of >18 wt %.

CF position: Diviner channels centered at 7.81, 8.25 and 8.55 μm are designed to characterize the Christiansen feature (CF) (Fig. 1b; Fig. 2), an infrared emissivity maximum feature that is sensitive to silicate polymerization [1, 2]. Low CF positions are found in the crater floor, central peak, and in the southwest ejecta. Additional occurrences on the SE plateau are found at red arrows in Fig. 1.

KREEP signatures: Lunar Prospector GRS elemental abundance data for thorium (Th) and potassium (K) [8-10] (not pictured) show that Th (measured abundance >12 ppm, modeled abundance >15 ppm [10]) is concentrated as a hot spot roughly centered on Aristarchus Crater, with elevated K concentrations (~3300 ppm) roughly centered west of Aristarchus Crater [8].

Spectral Signatures: WAC color ratio maps [11, 12] (Fig. 1c) provide information about unit maturity and mineralogic similarity, and are analysed in conjunction with multi- and hyper-spectral unit maps from Clementine UVVIS [13, 14] and M³ parameter maps [15].

Figure 1: A) Clementine FeO map; B) Diviner Christiansen Feature (CF) position map; C) LRO-WAC Color Ratio map (composite R:689/321, G:415, B: 321/689). Red arrows point to features on the Aristarchus Plateau that share similarities in all datasets.
**Plausible Rock Types:** The combination of low FeO (<11 wt%), short CF position (<7.9 μm), high Th (>11 ppm), high K (3300 ppm), high albedo materials with no mafic component in the central peak [15], and spectrally indistinct materials (SW ejecta; [15, 16]) are inferred to represent highly evolved alkali-rich differentiates related to a KREEP-rich near-surface intrusion [3-6]. Possible rock types associated with this region include alkali anorthosite, alkali norite, monzogabbro, granite, and their extrusive equivalents.

**Anomalous Regions on the Plateau:** We interpret anomalous areas on the plateau (Fig. 1, 2, red arrows) to represent separate outcrop occurrences of the silica-rich rocks that are present in Aristarchus ejecta. This interpretation implies that crater floor-like units are areally widespread in the southeastern plateau region, either as a coherent layer beneath a cover of Imbrium ejecta and/or dark mantle deposits [17]; or as discrete subsurface intrusions. The morphology of the Cobra Head is a prominent topographic high, and it is the source of Vallis Schröteri, the largest basaltic sinuous rille on the Moon. However, the steep sides of the volcano (relative to other basaltic volcanoes on the Moon, such as the shield-like Hortensius domes), and numerous nearby mounds of presumably constructional volcanism (suggested as cinder cones by [18]), suggest that the topography may be related to processes other than basaltic volcanism. Silicic volcanic structures on the Moon such as the Gruithuisen domes [19] and the Compton-Belkovich volcanic complex [20], share morphologic similarities with the Cobra Head volcano, with volcanic constructs that include steep topography and strong compositional anomalies seen in Diviner CF. Additionally, Väisälä Crater is perched on what may be a constructional mound. If the units exposed in the Aristarchus Crater floor and southwest ejecta make up a large component of the plateau material in the southern part of the Aristarchus Plateau, then an origin of these units as extrusive volcanics, rather than intrusive plutonic rocks, may also be possible. The CF positions indicating Si-rich compositions (i.e., rhyolite/granite) are also consistent with obsidian [1], which may have contributed to the construction of Cobra Head.

**Possible sources:** Two models for fractionating silica-rich material from the parent melt are silicate-liquid immiscibility (SLI) [20, 21] and partial melting associated with basaltic underplating [9, 21]. While SLI occurs at the microscopic scale, the main issues with the SLI model are whether it ever occurred at the scales necessary for widespread emplacement of evolved materials (e.g., Gruithuisen Domes), and that high field strength elements such as Th, which is enriched in lunar silicic rocks, are observed experimentally to partition into Fe-rich liquid, not silicic liquid. With the basaltic underplating & partial melt model, KREEP-rich rocks (which are abundant in the plateau region) are heated, causing partial melting and intrusion of silicic magma into overlying rocks [e.g., 3,4,6,9,21]. This model fits with bi-modal volcanism, which could allow for both the emplacement of evolved silicic materials similar to our inferred compositions (and accounting for the morphologic construction of Cobra Head and other sites), and for the effusive eruption of the basaltic melt.

**Figure 2:** A) Graph of Diviner CF Position vs Clementine FeO content for all pixels in the scene (Figs. 1a, b). Red box denotes values <11 wt% FeO and shorter than 8 μm CF position. B) Location of pixels with low FeO and silicic CF Positions. Note strong correlation with Aristarchus Crater floor and ejecta deposits and similar composition regions on the SE Aristarchus Plateau. This same region is also correlated with high Th and K concentrations measured by LP-GRS (not shown).