MORPHOLOGY AND PHYSICAL PROPERTIES OF ORIENTALE LIGHT PLAINS AND ASSOCIATED FLOW FEATURES ON THE MOON. H. M. Meyer[1], J. D. Stopar[1], S. S. Bhiravarasu[1], B. W. Denevi[2], and M.S. Robinson[3], [1]Lunar and Planetary Institute, USRA, 3600 Bay Area Blvd., Houston, TX 77058 (meyer@lpi.usra.edu), [2]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, [3]Arizona State University, Tempe, AZ 85287.

Introduction: Light plains are relatively flat to gently rolling deposits exhibiting an albedo comparable to the highlands in which they are typically found [1]. They have been interpreted as fluidized basin ejecta [1], melt-rich basin ejecta [2-3], ejecta from basin secondary impacts [4], and overlapping ejecta deposits from several impact events [5]. Previously, light plains within ~4 radii of the Orientale basin were mapped to the 100 m scale and interpreted as primarily the result of the basin-forming impact, though the exact mechanism of formation remained unclear [6]. Common morphologic indicators of fluidized flow in geologic materials include lobate margins and channels with levees [7]. Landforms with flow indicators can be used to constrain the dynamics of emplacement and the physical properties of the materials being emplaced [e.g., 7]. This work identifies light plains associated with Orientale (e.g., Fig. 1a-f) that exhibit flow features (e.g., Fig. 1h) and characterizes their physical properties and variations in morphology in order to distinguish between the hypothesized origins as dry debris or melt-rich deposits.

Data and Methods: Beginning with the light plains mapped by [6], we identify light plains deposits exhibiting flow indicators including lobate margins, leveed straight-edge deposits, remnant channels, and ridges. To do this, we used moderate-to-high incidence images from the Terrain Camera on SELENE (~10 m/pixel) [8], the Lunar Reconnaissance Orbiter Camera (LROC) Wide Angle Camera (WAC) (~100 m/pixel), and the LROC Narrow Angle Camera (NAC) (~50 cm/pixel) [9] to accentuate the morphology of flow indicators. These images were also used to assess the relative density of craters on the flow features and terrain they embay. LROC WAC [10] and NAC topography [11] were used for topographic context, scarp slopes, and flow dimensions at the ~300 m and 2-5 m scales, respectively. To quantitatively compare the block abundance of the flows to the surrounding highlands and basin continuous ejecta, we used a Diviner Rock Abundance (RA) map (128 ppd) [12]. Arecibo 70-cm CPR data [13] and Mini-RF 12.6-cm *m-chi* decomposition maps [14-15] differentiated the physical properties of the flows with respect to the light plains, background highlands, and reference features such as Orientale's melt sheet, ejecta, and landslides.

Observations and Interpretations: Flow feature morphology (e.g., Fig. 1h) varies based primarily on underlying topography and distance from the basin. Broad flow features and sheet-like light plains with flow features are common within ~2 radii of the basin, and smaller, branching flows are found >2 radii from the rim. Deposits with flow features become thinner (from >200 m thick to 10s of m thick) and narrower (from 10s of km across to a few km) with increasing distance from the basin rim. Some near-basin flow features have lobate margins exceeding 30° in slope, but the deposits themselves occur on underlying slopes <10° (average highland slopes are 8.9°-11.1° over a 15 m baseline [11]). More distal flow features display lower slopes along their lobate margins (<7°), but blocks are often still visible at the meter scale along those margins.

Enhanced 70-cm CPR (Fig. 1c), volume scattering (Fig. 1e, yellow), RA (Fig. 1d), crater retention relative to surrounding terrain suggest a coherent layer of material beneath the regolith including the flows themselves and the light plains from which they originate. Though RA reflects only the uppermost surface, for a surface >3 billion years old to display enhanced RA relative to surfaces of comparable age, the blocks must be replenished from the subsurface. These properties are comparable to those of Orientale's melt sheet and are distinctly elevated above the continuous ejecta, background highlands, and landslides of comparable age.

The Phocylides deposit (Fig. 1) is located to the southeast of the Orientale basin (54.91°S 295.18°E) in a region covered by Arecibo 70-cm radar data, which is limited to the eastern portion of Orientale. This is an example of a light plains deposit exhibiting flow features. This sheet-like deposit displays a straight southwestern margin, but along the northeastern margin, lobate flow features emanate from the light plains and into a nearby topographic low. The Phocylides deposit is part of a larger, high CPR (70-cm) "streak" correlated with light plains that extends away from Orientale and across the South Pole. It has been interpreted as impact melt from Orientale based on interpretation of both 70-cm and 12.6-cm radar data combined with morphology and geologic context [2-3,16]. This "streak" suggests significant outward momentum during deposition (radial to the basin, overriding topography ~100-200 m high in Phocylides region). Subsequent flow occurred downslope into local topographic lows. A smaller scale example of this type of multistage flow at Giordano Bruno suggests that exterior melt deposits can continue to flow on the order of days to weeks after initial emplacement [17]. Flow features are found as far as ~1800 km (nearly 4

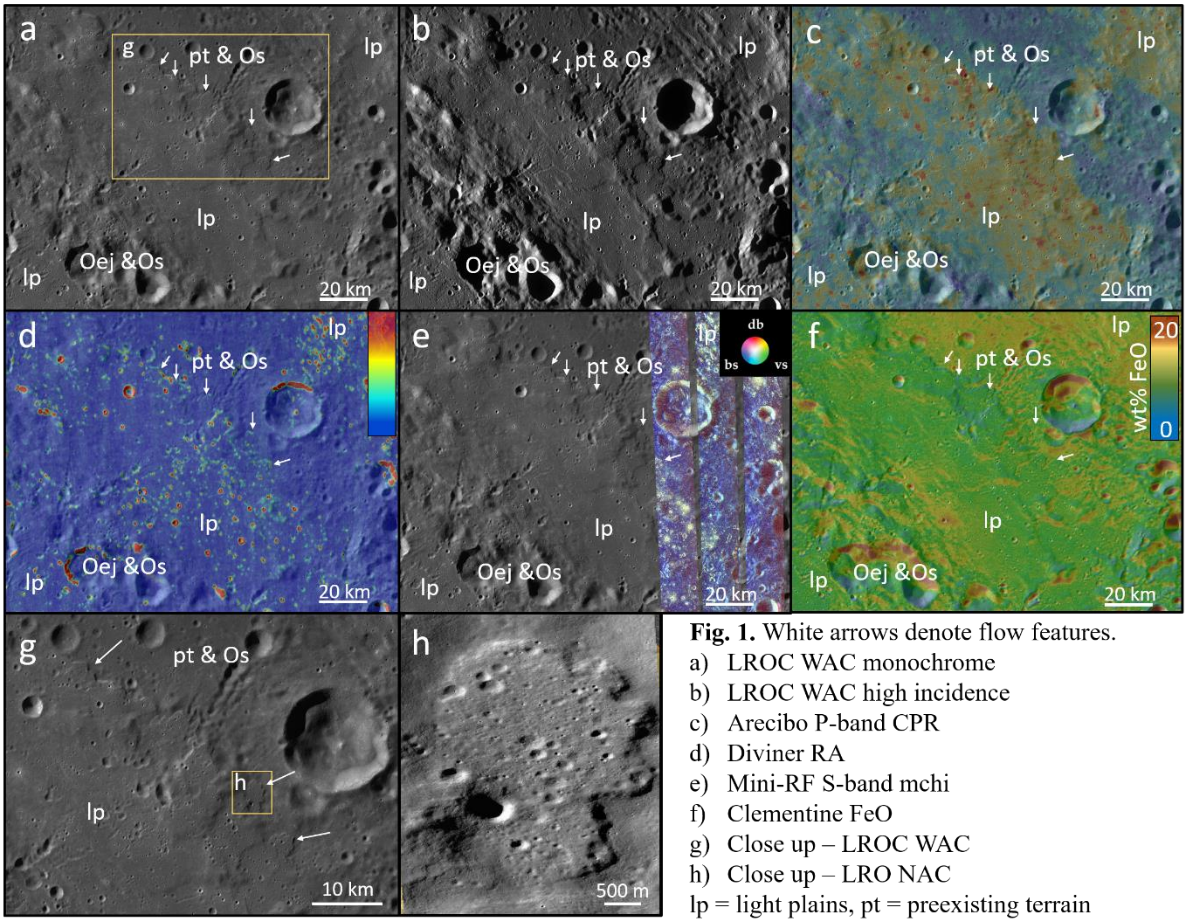

Fig. 1. White arrows denote flow features.
a) LROC WAC monochrome
b) LROC WAC high incidence
c) Arecibo P-band CPR
d) Diviner RA
e) Mini-RF S-band mchi
f) Clementine FeO
g) Close up – LROC WAC
h) Close up – LRO NAC
lp = light plains, pt = preexisting terrain
Oej = Orientale ejecta, Os = Orientale secondaries

radii) from the Orientale basin rim. Previous work identified melt flows at ~0.5-4 radii from crater rims [18-20]. As such, Orientale's flow features are consistent with the distances at which coherent melt typically occurs.

Conclusions: We interpret the majority of the flow features associated with Orientale light plains as impact melt (at least in significant part) that was ballistically emplaced and subject to flow controlled by both momentum and local topography. The combined lobate form, physical properties, and apparent strength of these deposits and flow features after >3 billion years argue against an origin as dry fluidized debris exclusively. Extrapolating from these results, the common occurrence of flow features among Orientale light plains implies that most basin light plains within ~2 radii of the rim likely contain significant melt. This work suggests that significant quantities of impact melt were emplaced beyond the continuous ejecta of the basin and flowed upon impacting the surface. This interpretation has important implications for the basin formation process in terms of melt production, heat retention, and transport.

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