SOURCE REGIONS OF YOUNG LAVA FLOWS IN SOUTHWEST MARE IMBRIUM: CHARACTERIZATION OF THE EULER AND LAMBERT REGIONS. Y. Chen[1, 2, 3], J.W. Head[3], C. L. Li[1], J. J. Liu[1], X. Ren[1], [1]Key Laboratory of Lunar and Deep Space Exploration, National Astronomical Observatories, Chinese Academy of Sciences, Beijing, China, [2]University of Chinese Academy of Sciences, Beijing, China, [3]Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, RI 02912, USA. Contact: cheny@nao.cas.cn.

Introduction: Recent advances in the analyses of the generation, ascent, intrusion, and eruption of basaltic magma on the Moon [1-3] have related quantitative models with observed volcanic features and provided new insights into the nature of eruption mechanism responsible for their formation. Variations in specific physical parameters, such as eruption flux and volatile content will result in distinctive styles of eruption, and lava viscosities, cooling behavior and preexisting topography will affect the emplacement processes, all leading to distinctive landforms. Among the most distinctive, extensive and youngest volcanic lunar landforms are the finger-like lobate lava flows emanating from the SW margins of Mare Imbrium [4]. These lava flows are sufficiently distinct morphologically and spectrally to measure lengths and thicknesses [4,5] and to estimate the subflow topographic slopes [1]. The largest flow length described [4] was 1200 km. Wilson and Head [2] took as values representative of such flows a thickness of 20 m and width of 20 km; using a length of 1200 km, they calculated an emplacement time of ~69 hours and a volume flux feeding the 20 km wide flow to be 1.9×10^6 m^3 s^{-1}. Flow motion was fully turbulent and it was concluded [2] that mare lava flows having thicknesses of at least ~10 m were emplaced in eruptions having volume eruption rates of at least 10^4 and more commonly 10^5–10^6 m^3 s^{-1}. Flows in the latter part of this range are very unlikely to be cooling limited and are therefore volume limited, erupting at 10^5–10^6 m^3 s^{-1} until the supply of magma to the vent was exhausted. A supply-limited origin for the young Imbrium flows is supported by their morphology, which shows little evidence for the types of breakouts expected in cooling limited flows [1; Fig. 12b]. The volume of magma in the above 1200 km-long flow is ~500 km^3, consistent with the ~1000 km^3 upper end of the single dike volume range predicted [2].

Recently, four stages in lava flow emplacement were identified [3], with very specific deposits and landforms associated with each. Typically, late-stages (Stage 4) of fissure eruptions develop a final phase that can bury features and stages developed earlier in the eruption. The goal of this analysis is to continue to characterize [6] the range of volcanic features in the two southwest Mare Imbrium young lava flow source regions, Euler and Lambert, in order to cast light on the diversity of volcanic processes operating there and to assess the implications for variations in the nature of these source regions.

Euler Source region: The vicinity of the crater Euler was regarded as one source area of Eratosthenian-aged basalts within Mare Imbrium by tracing long lava flows and investigating morphologic features [4-6], even though the exact vents were difficult to identify because they appear to have been buried by their own flows or destroyed by later impacts. The volcanic landforms around Euler, which are regarded as forming from dikes erupting onto the surface, exhibit radial dike-like patterns outward along the center line of Imbrium basin [6].

Lambert Source Region: The region of crater Lambert was suggested as another possible source area. The recent geologic survey systematically studied tectonic features of Lambert source region and determined the tectonic history of the area [6]. Here we report on the analysis of volcanic landforms; using a variety of datasets, such as low-illumination LROC WAC, SLDEM data, and detrended topography data [7], we undertook a detailed study of volcanic features around Lambert to assess their eruption conditions and compare with the Euler region.

The volcanic features in this region are mostly distributed in the south and east of Lambert crater (Fig. 1). Rilles are the most prominent volcanic structures in the Lambert region. The longest rille, about 100–300 m in width, extends to about 150 km from the SW to the East of Lambert (Fig. 1). Previous investigation [6] regarded the entire rille length as two separate rilles apparently due to a later lava accumulation and impact obscuration. However, the detrended map (Fig. 2) which has removed the regional slope [7] reveals a buried rille channel connecting the separate pieces previously mapped.

We also found that the initial crater in the crater chain (Fig. 3), previously regarded as resulting from collapse or the presence of a vent above a fissure, was found instead to be of impact origin on the basis of the following evidence: 1) the presence of distinctive raised rims distinguish impact craters from volcanic craters; 2) the low points in the NW and SW crater rim permitted lava flooding which partly buried the crater.

Several domes and lava flows exist in the vicinity of southern rim of Lambert R (Fig. 4), a circular wrinkle-ridge structure was interpreted to be formed by the interaction between solidified mare lavas and preexisting topography [eg. 8]. The ridge cuts across the preexisting crater (Fig. 4c) located on a dome, which indicates that the ridge must postdate the crater and domes. The same situation is shown in Fig. 4e, where a depression/channel-like feature is cross-cut by the ridge. The sinuous boundary of the depression in Fig. 4d suggests that it was not formed by volcanic collapse; detailed inspection of its western rim in low-sun illumination images shows that it is more likely to be lava flow fronts. Flow fronts spreading in a S-N direction (indicated by red arrows) also reveal local volcanic activity. A volcanic depression and possible surrounding lava accumulation is observed in Fig. 4b.

Two newly discovered low domes have associated summit pit craters (Fig. 5). Regional profiles show their presence on a slope. Dome 1 is about ~40 km in diameter, and ~50 m in height. Dome 2 is much smaller, ~10 km in diameter and ~20 m in height. These two shields exhibit a distinctively low-angled slope on their flanks (<0.5º), which is far lower than the majority of lava shields on the Moon [9]. According to profiles drawn along pit craters in Fig.5, the geometry of them can be acquired: the irregular summit pit (~1 km wide, 8 km long) and the elongate pit (~1 km wide, 1.5 km long). The gently sloped summit crater rims of the domes and the absence of ejecta material confirm the volcanic origin of the summit pits.

To the NE of Lambert, a lava channel, up to ~10 m in depth, was revealed by using low-sun illumination image and detrended topography data (Fig. 6), providing additional evidence for lava originating around the crater Lambert and flowing to the north.

References: 1) Head, J. & Wilson, L. (2017) Icarus 283, 176. 2) Wilson, L. & Head, J. (2017) Icarus 283, 146. 3) Wilson, L. & Head, J. W. (2018) GRL 45, 5852. 4) G. Schaber (1973) PLPSC. 5) Bugiolachhi, R. & Guest, J. (2008) Icarus 197, 1. 6) Zhang, F., et al. (2016) EPSL 445, 13. 7) M. Kreslavsky et al. (2017) Icarus 283, 1387. 8) Brennan, W. (1975) The Moon, 12, 449. 9) Head, J. & Wilson, L. (1991) GRL 18, 2121.

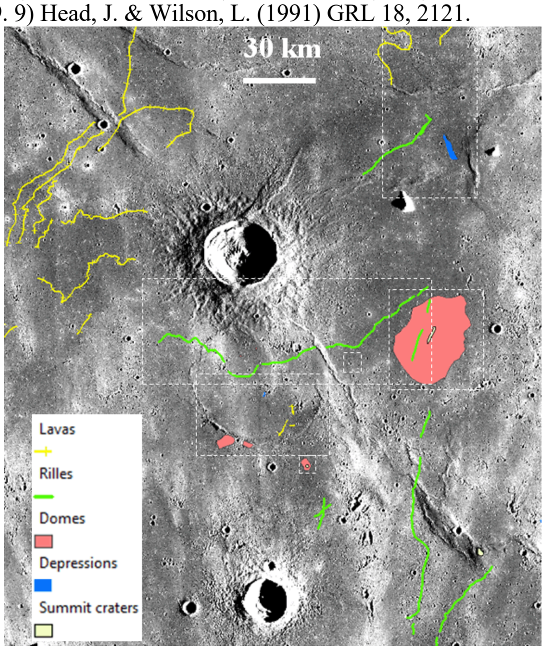

Fig. 1 Map of volcanic landforms in the vicinity of Lambert.

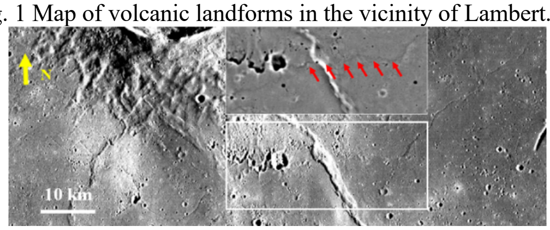

Fig. 2 A single long sinuous rille displays by low-illumination image and detrended topography image [7].

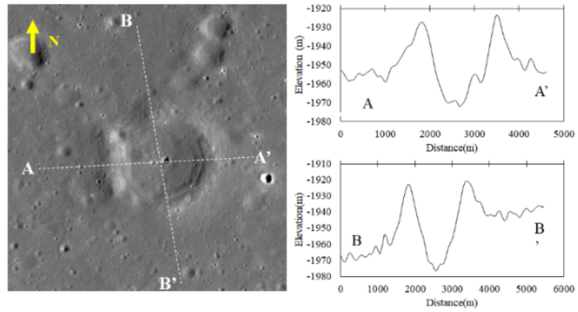

Fig. 3 Head crater in crater chain and SLDEM topo profiles.

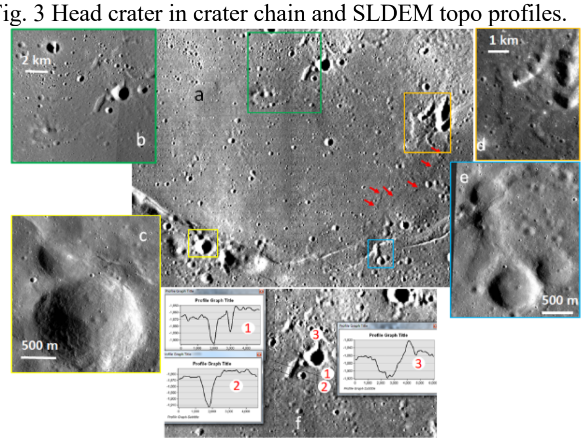

Fig. 4. Volcanic landforms in the Lambert R ring-structure.

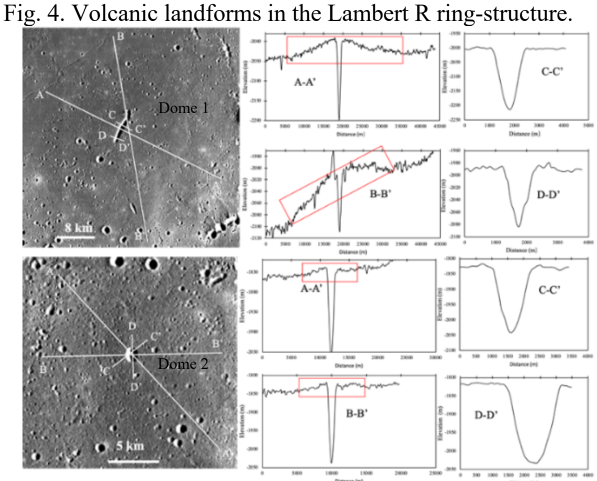

Fig. 5 Two possibe low domes associated with summit craters.

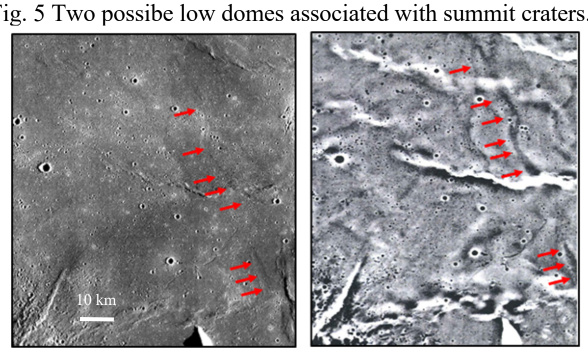

Fig. 6. Lava channel in low-sun image and detrended data [7].