THE ROLE OF PRE-EXISTING TOPOGRAPHY IN MODULATING WIDTHS, DEPTS AND CHANNEL STRUCTURE. Yuan Chen [1,2,3], James. W. Head[3], Lionel Wilson[4], Mikhail A Kreslavsky[5], Jianjun Liu[1,2], Xin Ren[1], Hongbo Zhang[1], Chunlai Li[1, 2], [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 [4]Lancaster Environment Centre, Lancaster University, Lancaster LA1 4YQ UK. [5]Earth and Planetary Sciences, UCSC, Santa Cruz, CA 95064 USA. Contact: cheny@nao.cas.cn.

Introduction: Volcanism is the most important endogenic process on the Moon. Individual mare lava flows on the Moon have been recognized from lunar orbiter images ever since the Apollo era [1-5]. The morphological dimensions of lava flows are usually employed to infer the rheologic properties of magmas in planetary sciences [3, 4, 6-8], which can help significantly in researching planetary volcanism in lieu of igneous rock samples. Previously we documented the morphological and topographical features of an Eratosthenian lava flow within Mare Imbrium [9]. The individual lava flow which crosses a series of wrinkle ridges and overflows two basaltic units (U20 to U1 then U20 in [10]) is more likely to originate from the Euler source region in SW Mare Imbrium (**Fig. 1**). In this study, we mapped the results of the eruption and emplacement process of the individual lava flow, and assessed how the observed effects can improve our understanding of our models of tectonic topography formation and lava flow emplacement and cooling behavior.

Results and Discussions: We analyzed a specific lava flow that displays strong interactions with local relief and wrinkle ridges (**Fig. 2**). In our previous abstract [9], we suggested that pre-existing relief can greatly influence the lava flow. Using crater size-frequency distribution method, we estimated the age of the lava flow to be ~3.03 (+0.17/-0.28) Ga, which is in good agreement with 3.0–3.6 Ga of U1&U20 [10].

We first focused on two most notable features: the deep central channel and an absence of central channel in the later flow process. A deep central channel is present in the first stage of the lava flow and at some locations the channel is deeper than the deposited lava (**Fig. 2de**). This indicates that during the initial emplacement of the flow thermal erosion took place, and by implication turbulence was present, at least as far as TP21, about 200 km from the inferred vent. We find that between TP2 and TP12, where the lava is flowing over U20, the average amount of erosion is ~1.7 ± 1.5 m, whereas between TP12 and TP, where the lava flows over U1, the average erosion is ~3.2 ± 2.6 m. Using estimates of lunar regolith formation rates of 1.2 m/Ga [11] and 1.3-3.7 m/Ga [12], the 0.6 Ga interval between the emplacements of U1 and U20 would have led to the formation of 0.7-2.2 m of regolith. The difference between our estimates of the amounts of erosion of the older and younger surfaces is ~1.5 m, entirely consistent with this. We infer that the turbulent flow began to erode the substrate as it crossed U20; on reaching U1 it quickly stripped away ~1.5 m of regolith and then began to erode the more coherent U1 lava that was exposed. In both parts of the flow ~1.7 m of bedrock was removed. Erosion no longer occurred after the flow crossed back onto U20, implying that turbulence ceased at this location.

Since we infer that the lava leaving the vent was turbulent, we first find its velocity using a near-vent flow thickness of 10 m and a viscosity of 0.24 Pas, appropriate to a high-Ti Eratosthenian basalt erupted at its liquidus temperature [13]. This leads to a velocity of 2.12 ms^{-1} [14] which implies an erupted volume flux of $\sim 2\times10^5$ m^3 s^{-1}, well within the range predicted for mare lava flows by [14]. When approaching the location of lava after ~200 km, the lava velocity is estimated to be 0.97 m s^{-1}; finally, the flow advance velocity at the terminus must be zero. Assuming a continuous variation of the advance velocity with distance from the vent we can find the time that the flow front would have reached a given distance. Where ponding was taking place, the advance rate would have been reduced in inverse proportion to the width of the pond being created, and taking account of this we give the implied times after the start of the eruption that the flow front reached key locations in Table 1. The implied duration of the eruption is ~4.6 days. Note that this is probably an underestimate, because the eruption rate almost certainly decreased with time [14], and so the emplacement of the distal part of the flow would have taken place more slowly than the velocities we have assumed imply.

Based on the observations of lava (**Fig. 2c**), we found that some ridges did not exist at the time of the lava flow; while some were at a very early stage of development, the height of early-aged R2 is ~20-25 m vs. 200 m at present. The present lava flow morphological features must have experienced long and multiple modifications by regional tectonic activity, including

Table 1. Times of arrival of the lava flow front at specific locations along the flow (with a slope of sin α= 0.0004).

Location	Distance from the vent /km	Arrival time /hours
start of LP1	162	27.8
end of LP1	176	35
start of LP2	183	36.7
end of LP2	194	44.8
start of LP3	201	46.8
end of LP3	218	57.7
start of LP4	258	74.2
end of LP4	272	87.2
end of flow	286	111.2

ridge uplift, basin loading and so on. Finally, we summarized the paleo-geological emplacement process (divided into eight phases, **Fig. 3**) of the Imbrium flow.

Conclusions: We found that: 1) the geometry and morphologic features of the lava flow can be significantly affected by pre-existing topography. 2) Morphological features demonstrated a complex tectonic history, indicating that several early low wrinkle ridges must predate the studied lava flow. 3) The existence and disappearance of lava channel/levee structure are relevant to the lava properties, especially in turbulent/laminar modes. 4) The lava flow was possibly accomplished in less than five days, occurring in the very early period of the regional wrinkle ridge formation. This lava flow history provides new insight into the interplay of regional volcanism and tectonism and late-stage lunar thermal evolution.

Acknowledgments: The work described in this paper was partly funded by the UCSA joint PhD Training Program (YC), the National Natural Science Foundation of China (11941002) (HZ), and Beijing Municipal Science and Technology Commission (Z1911000043 19001) (JL). The work was partly funded by NASA Data Analysis Program(LDAP: 80NSSC19K1382) (JH and MK) and the Lunar Reconnaissance Orbiter Lunar Orbiting Laser Altimeter Team (80NSSC19 K0605) (JH). The LROC data used are available at the LRO Archive (http://wms.lroc.asu.edu/lroc/). The SLDEM2015 data are archived in PDS node (http://imbrium.mit.edu/DATA/ SLDEM2015/).

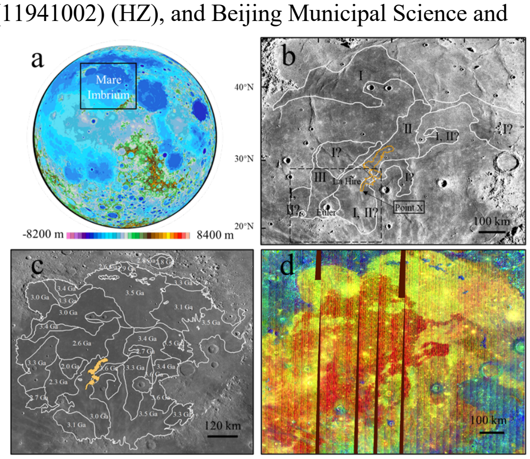

Fig.1 Geologic background of Mare Imbrium. (All in equidistant cylindrical projection).

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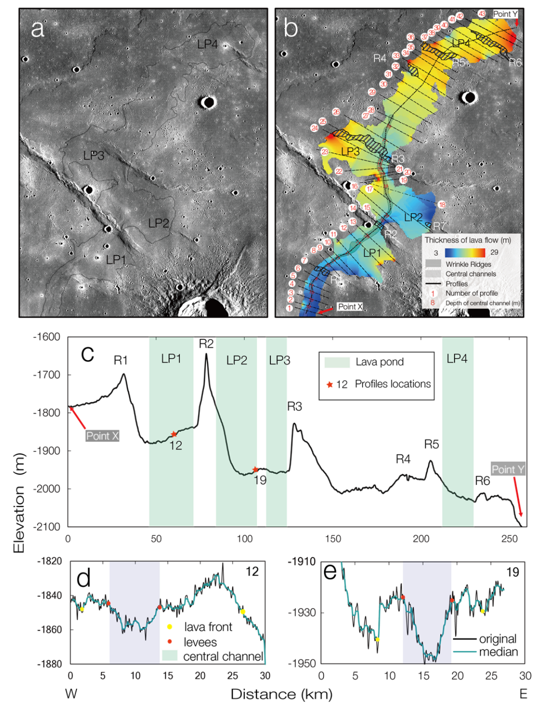

Fig 2. Detailed topographic analysis of lava geometry.

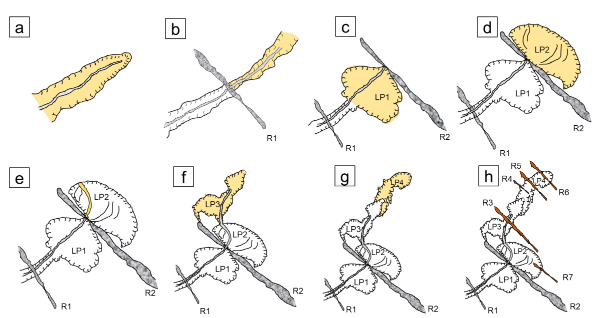

Fig 3. Paleo-geological sketch map of the studied lava.