A PORTRAIT OF A MAFIC-COMPOSITION MEGARIPPLE: INSIGHTS TO THE INTERNAL ARCHITECTURE OF EXTRA-TERRESTRIAL MEGARIPPLES? S.G. Banham[1], P.A Carling[2], E.A. Favero[3], M.R Balme[3], [1]Imperial College London, UK (s.banham@ic.ac.uk), [2]University of Southampton, UK, [3]Open University, Milton Keynes, UK.

Introduction: Large aeolian bedforms are ubiquitous features on the surface of Mars. Investigation of these features from orbit have yielded information about their distribution, orientation, and morphology, but nothing about their internal structure and mode of migration. Robotic platforms – such as MSL or MER – have literally only scratched the surface of these bedforms, yielding some information on the near-surface grainsize, but nothing about the internal architecture [1]. Furthermore, where rovers have investigated aeolian bedforms particles on the surface have average grainsizes of 130 µm for active dunes and ripples [2] and TARs have a mean grainsize of 1-2 mm [1].

While performing morphometric analysis of large ripples in Iceland as part of a project to validate Aberystwyth University PanCam Emulator (AUPE)[3], trenching was performed across several megaripples. These megaripples were unusual in they were composed of predominantly volcanic detritus – pumice and scoria. The formation of the ripples from "exotic" materials provide an insight to how dunes may develop on other planetary bodies where volcanic detritus are abundant on the surface.

Here we provide an initial qualitative description of the megaripple morphology and their internal architecture and suggest a mechanism for migration.

Field Site & background: The broader study area lies south-east of the Askja caldera (65.039°N, 16.579°W) and is characterized by a mixture of active sand sheets and recent basaltic lava flows. Active sand sheets are common in this area, covering an area of ~270 km^2 with sand cover varying from isolated near recent lava flows to total in open flat areas [4]. Sediment for sand sheets is largely derived from the proglacial margin of the Dyngjujökull glacier to the west, and lava flows to the north [4]. Sediment forming the megaripples are volcaniclastic and is thought to be derived from one of the major eruptions of Askja, seven of which have occurred since 1875 [5]. Additionally, Holocene eruptions are recorded to have generated significant quantities of pumice and ash [6].

The ripple chosen for trenching in this study is the ripple described by Favaro et al. (this conference), which focuses on the 3D reconstruction of the ripple using terrestrial laser scans and AUPE reconstructions.

Ripple Planform Morphology: Figure 1 shows the morphology and surface composition of the megaripple. Areas adjacent to the ripple – here termed "inter-ripple" – were flat with little topography and were composed of pebble-size angular scoria. Test pits dug into interdune areas exposed poorly-sorted mafic materials consisting of basaltic sand through to scoria cobbles. The megaripple had a wavelength of ~8 m (from stoss to lee toe), an amplitude of 35 cm, and a sinuous crestline. The stoss side was oriented toward the west with an angle of ~6°, while the lee slope's average angle was 12°, and was oriented east.

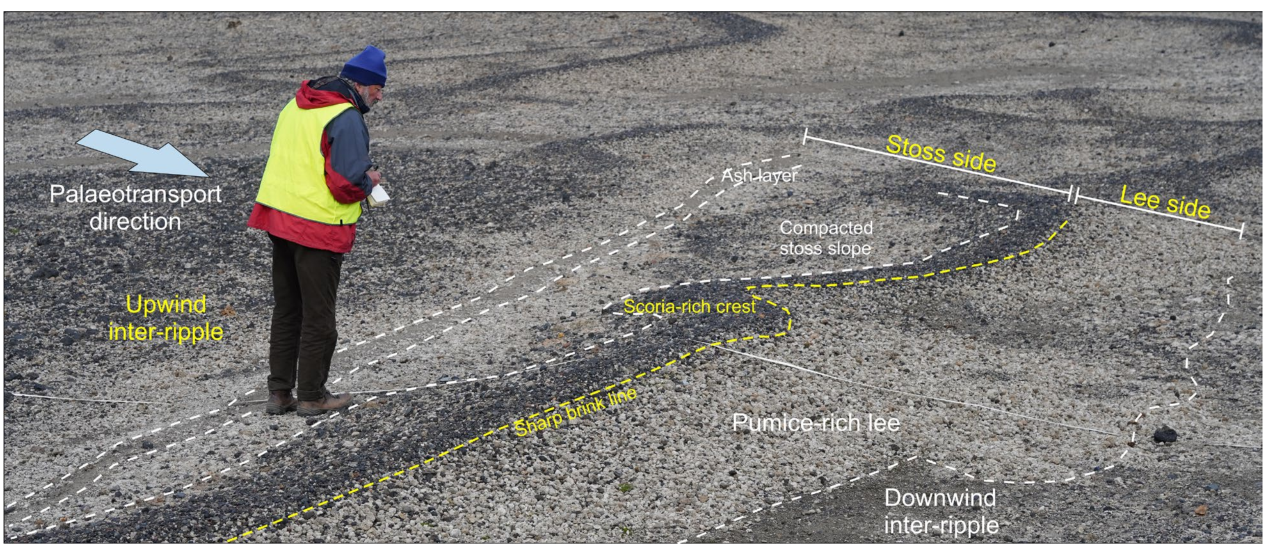

Figure 1: Megaripple surface morphology

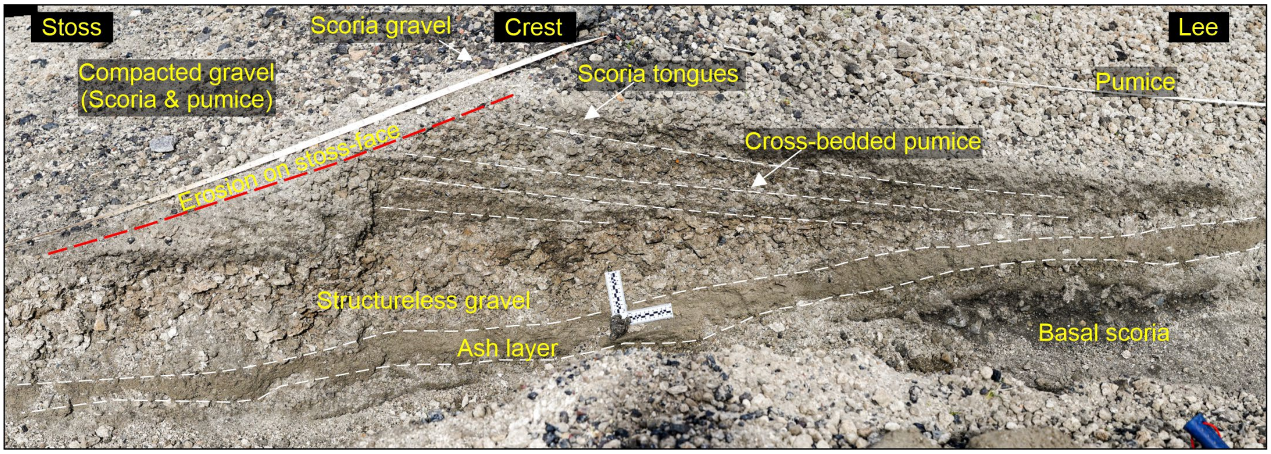

Figure 2: Internal architecture of a megaripple (Scale bar = 10cm x 10cm).

The surface mineral composition varied along the surface transect across the megaripple. Here, the upwind margin of the megaripple was defined by a fine-grain ash layer which was tan in color. Generally, it was well sorted with few larger cm-size particles.

The bulk of the stoss slope was covered with a compacted and wind-winnowed layer of pumice and scoria. The surface was relatively smooth, with no large particles exposed on the surface. Cobble-size pumice particles (20-30cm diameter) were later excavated from the surface, which were embedded within a compacted matrix of sand and gravel.

Toward the ripple crest, there is a systematic increase in the proportion of black-colored scoria granules and gravel particles. At the crest, scoria is the dominant surface material, which forms an armored layer. At the lee slope brink, there is a sharp transition from scoria gravel to pumice.

The lee slope of the ripple is surfaced by large loose and dry pumice particles, which were readily mobilized. The average grainsize is small to medium-size pebbles, and is moderately well-sorted. The layer of loose and dry scoria was approximately three grains thick. At the toe of the lee slope, a damp ash layer was exposed.

Internal Architecture of the megaripple: The megaripple was trenched perpendicular to the crest line, exposing the internal architecture shown in figure 2. The base of the trench exposed similar sediment mafic sands to scoria cobbles observed in the "inter-ripple" test pit. Overlying the basal scoria, was the 10-15 cm thick ash layer, which contained 5% angular scoria particles. The ash layer underlaid the entirety of the megaripple and was exposed at the upwind and downwind margins. This layer retained moisture and was occasionally cemented.

A layer of poorly sorted structureless pumice overlaid the ash layer, composed of friable particles ranging from granules to large pebble sized clasts. These particles were undergoing chemical weathering and were mechanically weak.

A thin layer of sand ~5 cm thick was present above the structureless gravel beneath the stoss side, but pinched out beneath the crest.

The megaripple bedform itself was composed of gravel, and had a maximum height of 35 cm. Texturally, it was composed of mixed angular scoria and pumice. Crudely developed cross-bedding with dips angles of 10-12° were highlighted by variations in the drying rate and subtle changes of grainsize that formed recessive layers. The cross-beds were parallel to the lee face and were truncated on the upwind side by the eroding stoss face. Each cross-stratum was approximately 1-2 grains thick – 1-2 cm. Adjacent to the crest, some cross-beds contained tongues of abundant scoria pebbles derived from the ripple brink.

Conclusions: This study highlights that aeolian megaripples with recognizable morphology and internal architecture can form from coarse-grain epiclastic volcanic sediments. From orbital and surface observations, apparently ubiquitous bedforms may have unusual internal mineralogy and grainsize distributions.

Acknowledgments: UK Space Agency is thanked for funding this research (Grants ST/T002913/1, ST/V001965/1 and ST/R001413/1). Support from Ferðafélag Akureyrar and Landsbjörg ICE-SAR was greatly appreciated.

References:

[1] Zimbelman, J.R., at al., (2020), JGR-P, [2] Ewing, R.C., et al., (2017), JGR-P, [3] Gunn, M.D., 2014 Spectral imaging for Mars exploration, Aberystwyth, [4] Mountney, N.P., et al., (2009), Sedimentology, [5] Brown, G.C., et al., (1991), Geol., [6] Sparks, R.S.J., et al., (1981), Phl.Trans. Royal Soc. London, A.