PRELIMINARY RESULTS FROM A COMPARISON BETWEEN THE EXOMARS PANCAM EMULATOR AND TERRESTRIAL LASER SCANS OF ICELANDIC MEGARIPPLES

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Introduction: ESA's ExoMars *Rosalind Franklin* rover (ERFR) is slated to launch in 2028 and arrive at Oxia Planum, Mars, in 2030. The main astrobiological mission to sample aqueous-altered Noachian-aged terrain for evidence of biosignatures [1] is supported by the PanCam camera instrument. PanCam is a camera suite of high resolution and wide-angle cameras that will capture images in 2- and 3D in the visible and near-infrared (NIR) [2].

In addition to supporting the nominal mission, PanCam will be used to characterize the geology and geomorphology of the landing site and landscape elements during its traverses. In so doing, the aeolian environment of Oxia Planum will be scrutinized for rover traversability, characterization of aeolian features, and changes to the landscape.

Project Overview: In anticipation of the nominal mission, work is underway to develop imaging techniques and to test the operating parameters of PanCam in terrestrial settings with the Aberystwyth University PanCam Emulator (AUPE). Specifically, we aim to validate data quality at mission critical distances (i.e. at 20 m for reconnaissance, 5-7 m for 'context imaging', and 2 m to achieve science objectives) against terrestrial laser scanner (TLS) scans of megaripples around Lake Askja, Iceland. The megaripples found here are superficially similar to transverse aeolian ridges (TARs) found throughout the rover's landing site [3].

Site and Megaripple Description: The area around the Lake Askja caldera (Fig. 1) is typified by a cold climate, snow cover, cool summertime temperatures and is covered by active aeolian sandsheets of volcaniclastic sediments [4]. The region lacks long-term wind monitoring, but researchers have noted strong winds affecting the area. The megaripples in the region have been described by [4] and, along with our surface morphology observations (summarized here) and trenching to observe internal architecture (see Banham et al., this conference). Megaripples are found in topographic depressions, surrounded by flat areas blanketed by pebble-size angular scoria. The stoss (windward) slope of megaripples were found to have a compacted layer of centimetre- to decimetre-scale poorly sorted pumice. The crest of the megaripples were primarily centimetre-scale scoria clasts. The stoss (lee-side) slope supported well-sorted centimetre-scale pumice clasts.

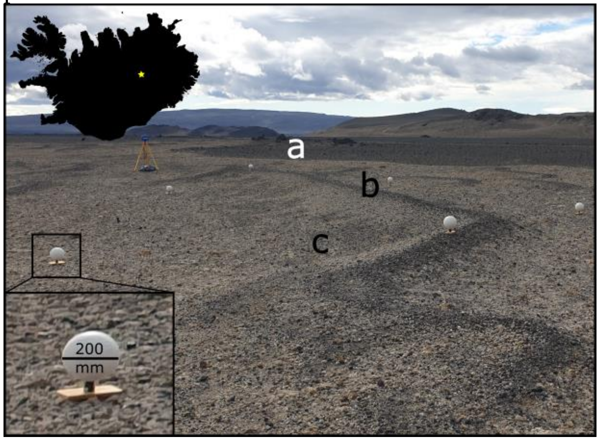

Fig 1. A ripple site in Iceland (denoted by yellow star on map). (a) An elevated flat area covered in angular pebble-sized scoria. The stoss of the megaripple, seen here in the local topographic depression, is comprised of a compacted layer of larger (cm to dm-scale) poorly sorted pumice. The crest of the megaripple (b), is comprised of centimetre-scale dark and black scoria clasts. (c) The lee slope supports well-sorted cm-scale pumice. A fixed-point sphere (diameter of 200 mm), used during TLS scans, is exemplified here, and acts as scale for the scene.

Instrumentation Description: *AUPE:* AUPE (Fig. 2) is an automated emulator for PanCam, allowing for experimentation in field and laboratory settings in preparation for ExoMars' nominal mission. Developed at Aberystwyth University in Wales using commercial, off the shelf hardware (COTS), AUPE emulates key properties of PanCam, including native image resolution, field of view, (stereo) geometry, and multispectral filter characteristics. To achieve this, AUPE houses two wide-angle cameras (WACs) and one narrow-angle high-resolution camera (HRC) mounted on an optical bench which can pan and tilt. These achromatic lenses can capture images in the visible and NIR. Cameras to emulate the ERFR Navigational Cameras (NavCam) are also mounted on the AUPE optical bench and capture panchromatic monochrome images.

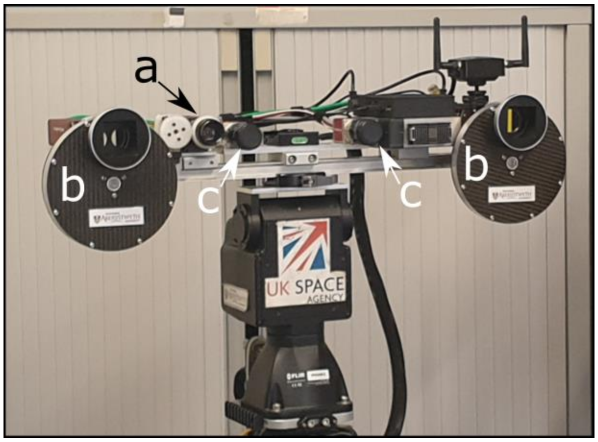

Fig 2. AUPE emulates the operation of ERFR's PanCam camera using COTS hardware. It captures visible and NIR images using (a) HRC and (b) WAC cameras, and panchromatic monochrome images with (c) NavCam cameras.

TLS. A Faro Focus x330 TLS was used to capture 3D data of aeolian features in the study area. The TLS has a maximum horizonal accuracy of 2 mm and can image features between 0.6 and 330 m. This proved beneficial for the study of an individual ripple, as well as the architecture of the ripple field it was found in.

Differential GPS: An EMLID Reach RS+ differential GPS (dGPS) was used to pinpoint the locations of the TLS and AUPE at the start of each instrument's survey with millimetre accuracy in both the horizontal and vertical. These data were used to ground-truth the TLS data, creating a 'real world' 3D model by which AUPE models could be compared against.

Methodology and Instrumentation Deployment: After identifying a suitable ripple, we deployed six fix-point spheres upwind, downwind, and atop the ripple crest (inset, Fig.1). These spheres were used for orthorectifying multiple TLS scans in post-processing. We then set out to collect TLS scans of the ripple at multiple orientations.

AUPE images were collected in 'batches'. First, AUPE collected a reference frame of the ripples orthogonal to the crestline at 20 m with the fix-point spheres in the frame (Batch 1). Then, the spheres were removed, and a combination of WAC, NavCam, and HRC images were captured (Batch 2). Batches of images at 7 m (Batch 3) and 2 m (Batch 4) were similarly acquired. These distances were chosen to emulate a possible "reconnaissance-investigation-study" sequence during the nominal mission.

Post Processing: TLS scans were registered in Faro Scene and edited in CloudCompare (Fig. 3a). They were then brought in as 2.5 D raster surfaces in ESRI's ArcGIS Pro 2.9 for further analysis. AUPE images were processed (Fig. 3b) using Aberystwyth University's radiometric pipeline and the PRoViP geometric pipeline developed by Joanneum Research (JR) [5].

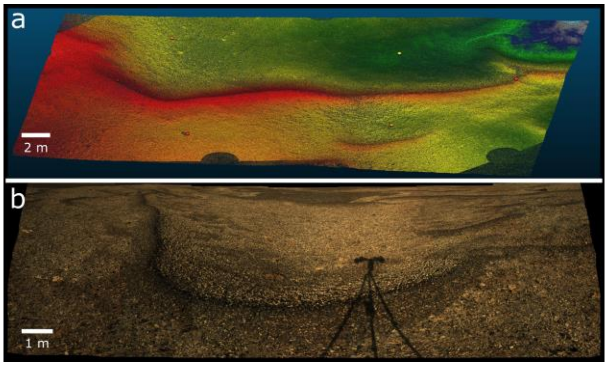

Fig 3. Comparison between (a) TLS topographic data (from low elevation in blue to high elevation in red) analyzed in CloudCompare and (b) data processed in RGB using Aberystwyth University's radiometric pipeline and JR's PRoViP geometric pipeline.

Current State of Investigation: Post-processing of TLS and AUPE data (Fig. 3) is ongoing. Preliminary data suggests AUPE images of grainsize and ripple architecture taken at 7 m and 2 m, when compared to TLS scans, suffer from only sub-cm errors. Work is ongoing to statistically assess these errors, so to quantify the fidelity of the image assessment. Assessment of errors associated with reconnaissance-level images (20 m from the ripple) is underway. We look forward to sharing our results and interpretations at LPSC.

Acknowledgments: We gratefully acknowledge UK Space Agency (UK SA) funding (ST/T002913/1, ST/ V001965/1 and ST/R001413/1 to MRB and EAF and ST/T002883/1 to MG).

References: [1] Vago et al. (2017) *Astrobiology*, 17, 6-7. [2] Coates et al. (2017) *Astrobiology*, 17, 6-7. [3] Favaro et al. (2021) *JRG-P*, 121, 4. [4] Mountney N.P. et al. (2004) Sed. Geology, 166, 3, 223–244. [5] Traxler et al. (2022), *3D Digital Geological Models: From Terrestrial Outcrops to Planetary Surfaces*, 33-55.