IMAGERY AS A MULTI-SCALE INVESTIGATION TOOL DURING THE CANMARS 2016 MSR ANALOGUE MISSION. E. Godin[1], C. M. Caudill[1], G. R. Osinski[1,2], [1]Dept. of Earth Sciences / Centre for Planetary Science and Exploration, University of Western Ontario, London, ON, Canada, N6A 5B7, egodin5@uwo.ca, [2]Dept. of Physics and Astronomy, University of Western Ontario, London, ON, Canada, N6A 5B7

Introduction: Remote field investigations using rovers is challenging, one limitation and asset being the capabilities of the available image sensors. Landscape representation requires a complementary satellite image and/or an in situ panoramic capable camera and controller; remote objects of interests call for a zoom camera while close objects characterization and interpretations require a high resolution capable camera. The whole imagery suite requires a balance between capabilities and time/resource/data bandwidth budget to be shared with other instruments and rover subsystems [1]. While large features of interest imagery need modest resolution to be useful, small features such as grain size, fluvial bedding, eolian processes, veins in rocks or fine layering arrangements needed a higher resolution to be confidently interpreted [2], which was not possible for Viking instruments for instance [3].

Instr.	**Feature**	**CanMars 2016**	**Mars 2020**
MastCam	Zoom + Panos	Zoom-Cam	StereoCam
RMI [4]	Long-distance imagery	DSLR + Macro	FOV: 1.1°. Res: 4 Mpx Foc: 1.4 m → ∞
WATSON [5]	Arm-mounted wide-angle camera	DSLR + Macro	FOV : 34° Res: 13.9 µm Foc: 20.4 mm → ∞

Table 1: Optical instruments deployed on MESR and equivalent for Mars 2020. MastCam is mounted on a mast with pan-tilt capabilities; RMI (Remote Micro Imager) is long-distance capable with a narrow field of view [4]; WATSON (Wide Angle Topographic Sensor for Operations and eNgineering) is arm-mounted and can be oriented at angles not possible from the MastCam [5]. 'FOV' → 'Field of View'; 'Res' → 'Resolution', 'Foc' → 'Focus'.

In this paper we examine how the imagery instruments mounted on the CSA Mars Exploration Science Rover (MESR) [6] were used to interpret elements of the stratigraphic reconstitution during the CanMars 2016 Analogue Mission. In summary, the goals of the 2016 mission cycle focused on paleoenvironmental habitability potential and preservation of biosignatures [7]. MESR was deployed for the duration of the mission (31/10/2016 – 20/11/2016) at an undisclosed location in Utah (USA). The MESR platform was built by MacDonald, Dettwiler and Associates Ltd. (MDA). The CanMars 2016 analogue mission was a partnership between the CSA, and the Centre for Planetary Science and Exploration (CPSX) at Western as part of the NSERC CREATE project "Technologies and Techniques for Earth and Space Exploration" (http://create.uwo.ca). International participants included NASA, DLR (German Space Agency), and UKSA.

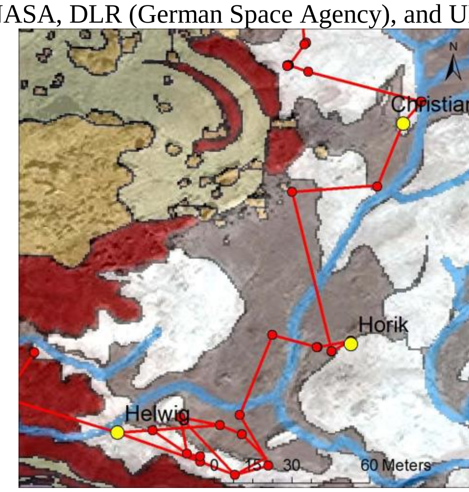

Fig. 1: Yellow dots indicate where whitish siltstones exposures (white area on the map) were observed and interpreted; the red line indicates the rover traverse and the red dots the stops during traverses.

Optical: specifications, purpose and processing: Optical instruments installed on MESR for CanMars 2016 had a MARS 2020 planned equivalent with slight specification differences (Table 1).

MastCam. MESR's MastCam can acquire 360° panoramas using its pan-tilted mounted zoom-cam. Zooms between ×1 to ×10 can be obtained. Unlike Mars 2020 MastCam, MESR MastCam is not stereo-capable.

RMI. The Remote Micro Imager (RMI) is a component of the SuperCam array [4] useful to obtain fine details at distances between 1.4 m up to a few hundred metres; its very narrow field of view and high resolution enable the possibility to acquire targeted, detailed imagery with the possibility of discerning sand-sized grains, stratae and bedding [4]. It is also a useful complement to other SuperCam components (e.g., VISIR's LIBS and Raman [5,8]), providing visual context to these scans. RMI sequencing can be ordered to obtain slightly overlapping targets that may be ultimately reprocessed as a mosaic (raster). MESR's RMI equivalent was a DSLR mounted with a macro lens.

WATSON. The Wide Angle Topographic Sensor for Operations and eNgineering (WATSON) is a component of the SHERLOC array [5]. It is an arm-mounted, wide field of view and high resolution camera, which may be used as a microscope or to obtain near distance images. Arm-mounted instruments can be raised to stand higher than the MastCam and can be oriented in angles not possible for other instruments. Sand-sized grains can be readily distinguished and discriminated against finer grain matrix background on images. Similar to the RMI, WATSON acquisitions can be programed to overly each other to build mosaics. Further, due to the capability of the arm to maneuver laterally on a plan, images can be obtained side by side normal to the target as stereo-images, which can be later processed as detailed 3D view of surfaces. MESR's WATSON was a DSLR mounted with a macro lens.

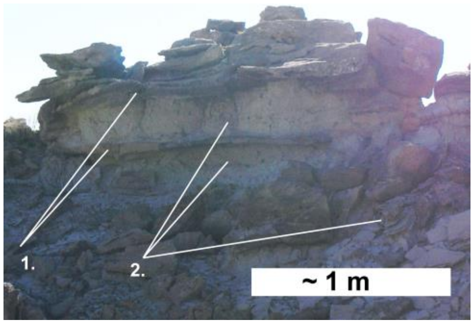

Fig. 2: Zoom image of Horik (Fig. 1). "1" refers to two sandstone layers delimiting a possible interbed; "2" denotes the white siltstone unit, from which a well-preserved fragment detached as seen on Fig. 3.

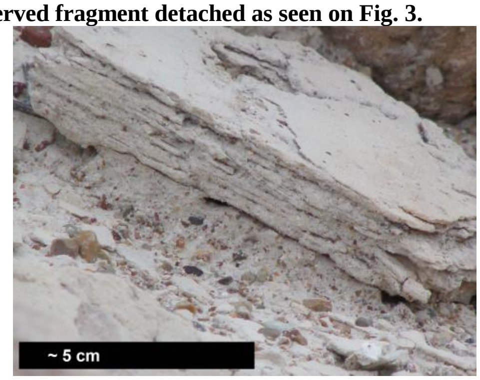

Fig. 3: RMI of the siltstone recently detached from *in situ* formation Horik (Fig. 2, point 2). Layers are a few mm thick. Subrounded gravel is mixed in the silty fine white matrix. Brown-pink gravel was interpreted as felsic.

Model for the base unit: The base of the stratigraphic column was, simultaneously, the most accessible layer for MESR and where the preservation of very fine depositional layers were the best preserved. Sandstone outcrops a few m^2 in area, and light-coloured deposits (Fig. 1 in white) generally characterize the base of the stratigraphic column in the study area, and is the lowest accessible layer. The sandstone outcrop, Horic, (Fig. 1, Fig. 2) seems to have preserved the stratigraphy of the underlying whitish siltstone mixed with bright-coloured, subrounded, low sphericity gravel (Fig. 3) in successive siltstones-sandstone interbedding (Fig. 2). Similar siltstone facies was found at Helwig and Christian (Fig. 1) [9].

The white unit on the geologic map was interpreted as this siltstone facies; the brownish-coloured surface bordering the small stream crossing the site north to south was interpreted as recent alluvial deposits covering the aforementioned siltstone. One interpretation is that the sandstone outcrop covering subsequent siltstones/sandstone interbedding was eroded for most of the site except for Horik, leaving exposed siltstones.

Implications and conclusions: Satellite, panoramas, zooms, RMI's and WATSON imagery often at multiple outcrops were required to interpret the depositional dynamic of the base layer for the site. From the distribution of the white mantle, up to a specific site where layering was preserved, scale needed to be adjusted to best address the obvious assumptions. Sharply defined siltstones to sandstone layering imply changing depositional environment, with corresponding swift change in energy in regard to the paleo-stream dynamics. MESR's optics were not equipped with systematic size scaling tools. Based on camera specification it was possible to deduce the size of the image but often images were obtained at an angle that was not perpendicular to the target, thus reducing the scale precision. Images obtained from rover tracks in sediments or from a borehole were useful to caliber dimensions, but were not always available. Optics were cheap in time, energy and bandwidth to use, meaning an abundance of reasonable quality images helped to overcome the lack of systematic scale. A constant and reliable scale is definitely a must for rovers optics.

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References: [1] Cross M. et al. (2016) *LPS XLVII*, Abstract #1581. [2] Squyres S. W. et al. (2004) *Science*, 306, 1709-1714. [3] Harrison T. et al. (2016) *LPS XLVII*, Abstract #1250. [4] Gasnault O. et al. (2015) *LPS XLVI*, Abstract #2990. [5] Novak K.S. (2015) *ICES XLV*, Abstract #134. [6] Osinski G. R. et al. (2016) *LPS XLVII*, Abstract #2616. [7] Osinski G. R. et al. (2017) *LPS XLVIII*, this conference. [8] Mittelholz A. et al. (2016) *LPS XLVII*, Abstract #1578. [9] Caudill C.M. et al. (2017) *LPS XLVIII*, this conference.