FREQUENCY OF BLOCK DISPLACEMENTS AT THE NORTH POLE OF MARS BASED ON HIRISE IMAGES. L. Fanara[1,2], K. Gwinner[1], E. Hauber[1], J. Oberst[1,2], [1]Institute of Planetary Research, DLR, Rutherfordstr. 2, 12489, Berlin, Germany (lida.fanara@dlr.de), [2]Department of Geodesy and Geoinformation Science, Technical University of Berlin, Straße des 17. Juni 135, 10623, Berlin, Germany.

Introduction: The margin of the north polar cap of Mars is a region characterized by active surface processes such as avalanches and block displacements [1, 2]. Many such displacements have been captured by the High Resolution Imaging Science Experiment (HiRISE) in each year of its operation in Mars orbit. The blocks follow a path either from the North Polar Layered Deposits (NPLD) or the Basal Unit (BU) towards the foot of the steep scarps [3]. Russell et al. [4] have analysed the landslide erosion of a long scarp by manually identifying the events. We are developing an automated change detection process to obtain quantitative estimates concerning the frequency and volumetric significance of block displacements, and, ultimately, derive additional constraints to improve our understanding of the present-day evolution of the north pole.

Data: With a ground pixel size of ~0.25m, HiRISE images provide us with the only data source where even blocks less than a metre across (diameter) can be resolved. HiRISE has been imaging the margin of the north polar cap for 10 years now, with certain areas having been captured with a frequency of up to 7 times in a month.

Observations: The first site which we manually investigated is one of the most imaged and active scarps of the north pole at 83.8°N, 124.6°E (Figure 1). Its slope drops from ~60° to ~20° at the contact between the NPLD and BU while the total height of the scarp is 500-700m. We observed about one thousand displaced blocks within about 4 years' time along the 20 km scarp. Block displacements have been found along the whole scarp, either as single-block events or events involving multiple blocks. The blocks come to rest within a distance of 700m downslope as measured from the border between BU and NPLD. The diameters of the blocks vary from less than a metre to 5 metres and their average shape is ellipsoidal. However there are some exceptions with very elongated shapes and some with clear angular shapes. The source of the blocks is sometimes clearly visible, but most of the time it is hard to identify it unambiguously.

Change detection: The bottom right part of Figure 1 is a result of manual identification representing the desired change detection result which we are aiming to achieve. The detection of such small changes requires accurately co-registered images from different points in time. To this end, we ortho-rectify the images using HiRISE DTMs. Despite the good temporal coverage of the north polar steep scarps by HiRISE, only a few DTMs are currently available through PDS. Additionally there is currently no location covered by more than one DTM. With the aim of comparing overlapping DTMs of different times, we use Ames Stereo Pipeline

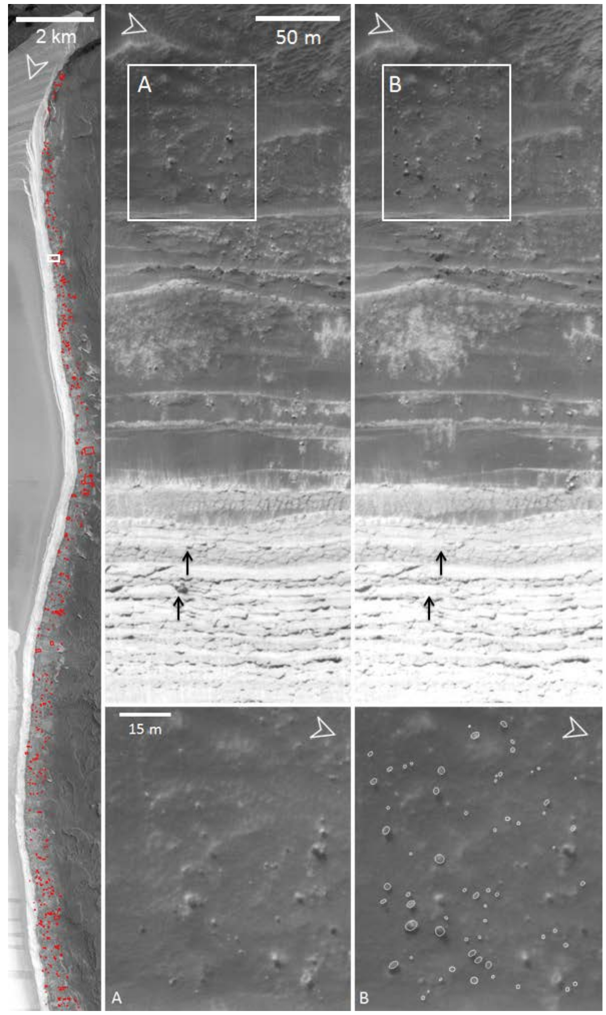

Figure 1: HiRISE images of steep north polar scarp. Left: Marked in red are block displacements that occurred within 4 years along this long steep scarp. The white rectangle is the area shown right at the top. Right top: part of the scarp with 4 years difference showing the displaced blocks and their possible source at the NPLD (black arrows). Right bottom: zoomed in part of the foot of the scarp with 4 years difference. Marked in white are the displaced blocks that we want to detect automatically.

[5] to produce them, where stereo pairs are available, and ortho-rectify the images. As we observe residual offsets between overlapping orthoimages, horizontal shift values are determined and applied to allow for best possible co-registration within a local area. The co-registered images are the inputs for the change detection.

The images are first subtracted from each other and classified using a thresholding technique, providing us with the largest differences between them. In order to distinguish between blocks and other changes we then check block candidates for consistency with a simple object model consisting of elliptical bright objects accompanied by a dark shadow. For this we apply filtering to the images to retrieve the boundaries of each block and then check whether large differences detected in the previous step are located in these regions. On this basis, the algorithm classifies whether the feature will be defined as a new block or not. In order to evaluate our results, we test our algorithm on areas where we have manually identified the displaced blocks.

Discussion: A first analysis, based on manual detection, has shown that the frequency of block displacements at an active steep north polar scarp is in the order of a couple of hundred displacements per year. To get a more accurate result and analyse the events in more detail within an extended area, we set up a systematic procedure for co-registering the images and detecting these block displacements automatically.

Our method retrieves the shapes, sizes and locations of the new blocks. Obtaining their spatial distribution and, in case their source is visible, the distance that they have travelled are important aspects for understanding their movement and the associated dynamics. Using the information on the available HiRISE temporal coverage of each region we can also narrow down the time interval within which each event occurred and investigate a possible connection to avalanches. In combination with the volumes of the events, from shadow measurements and height changes from HiRISE DTMs, the estimation of corresponding erosion rates for the north polar steep scarps becomes possible.

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