Investigation of sorted patterned ground on Tindastóll, Northern Iceland using 'structure from motion' photogrammetry

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Summary

This award facilitated an important part of the Ph.D. project being conducted by Alex Barrett. It allowed what was originally conceived as a remote sensing project to be extended to include the surveying of sorted patterned ground in the field in Northern Iceland, a project which has proved to be an extremely valuable addition to the overall research program.

Research facilitated by this grant

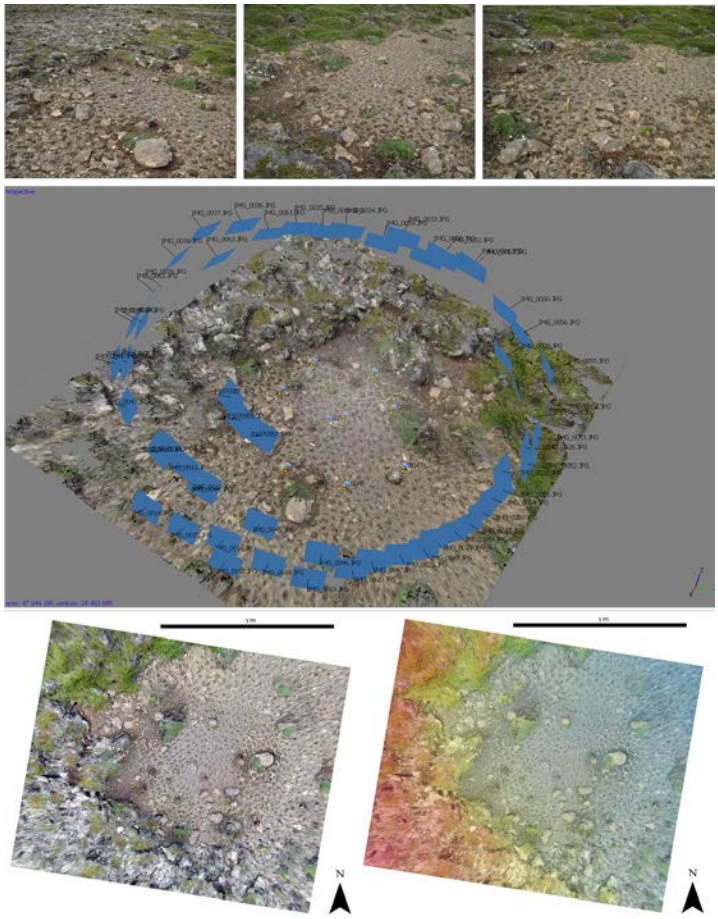
The aim of this investigation was to use *structure from motion* (SfM) photogrammetry techniques (e.g. Westoby et al., 2012) to produce Digital Elevation Models (DEMs) of small scale patterned ground in the field. This allowed us to compare the morphology of these sorted polygons with equivalent measurements of larger scale features made the previous year using air photographs and airborne LIDAR. These observations were then used to test the hypothesis that similar features observed in satellite images of the martian surface might be formed through the same mechanism.

It was necessary to precisely georeference the photographic data that was used to construct the DEMs. The locations of a number of ground control points to be made using differential GPS. Once a three dimensional model had been constructed, the positions of the ground control points could be specified to add scale information to the model. This made it possible for various time intensive measurements that would normally be made in the field to be measured quickly and efficiently within a Geographic Information System (GIS).

In total, 31 sites were surveyed and the models produced from this dataset allowed the morphology of 96 sorted polygons to be categorised. These measurements would have taken a prohibitively long time had they been made in the field, but acquisition of the photographs was quick and easy, taking less than half an hour for each site. Consequently, far more sites could be surveyed over the same period of field time, and a wider variety of features could be examined in this part of this study.

Outcomes

The main output of this project is expected to be the Ph.D. thesis of Alex Barrett, although the data will be retained by the Open University's planetary environment's research group and will have other applications beyond the end of this project. Peer reviewed publications are expected in 2015. The results will likely form part of a conference presentation within the next year, although precise plans have not yet been made.



Building a 3D model using Structure from Motion, Photographs are taken from multiple angles and then points within them are matched to create a model of the site.

Analysis is still ongoing, but provisional results have produced a variety of useful characterisation parameters which can be used to test whether the martian features have the same morphology. For example the elongation of a sorted polygon, defined by the ratio between its long and short axes, was found to increase with slope as suggested by previous studies such as Kessler and Werner, (2003).

Quantifying the variation in polygon elongation with slope provides a metric to assess at what range of gradients features of a certain elongation would be expected to develop. Consequently this can be used to test whether martian features seem to follow the same pattern. Measurements of how clast size varies with circle diameter at a variety of scales can be used in a similar manner. In the martian data, only the largest features are visible, and these are frequently far larger than terrestrial analogues. If the relationship between clast and circle size holds true between centimetre and metre scale features on earth, then the same would be expected to be true for multiple metre scale features in the martian data too, once variations in gravity are taken into account.

References

Kessler, M.A., Werner, B.T., 2003. Self-organization of sorted patterned ground. Science 299, 380–3. doi:10.1126/science.1077309

Westoby, M.J., Brasington, J., Glasser, N.F., Hambrey, M.J., Reynolds, J.M., 2012. “Structure-from-Motion” photogrammetry: A low-cost, effective tool for geoscience applications. Geomorphology 179, 300–314. doi:10.1016/j.geomorph.2012.08.021