Paleoglaciological study of Borgmassivet, Dronning Maud Land, East Antarctica, using WorldView imagery

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Abstract

Paleoglaciological reconstructions based on glacial geological and geomorphological evidence are used to test and constrain numerical models of ice sheet extent and dynamics. In MAGIC-DML ("Mapping, Measuring and Modelling Antarctic Geomorphology and Ice Change, in Dronning Maud Land") we are reconstructing the timing and pattern of ice surface elevation changes since the mid-Pliocene across western Dronning Maud Land, East Antarctica. The study area has sparse pre-existing field data and considerable ice sheet model uncertainties.

We present a remote sensing-based mapping of glacial geomorphology and structures on the ice sheet surface for a coastal-inland transect including the Ahlmannryggen-Borgmassivet-Kirwanveggen ranges, using high-resolution WorldView imagery. The primary aim of the study is to map traces of a thicker ice sheet on nunatak slopes that were formerly partly or entirely covered during ice surface maxima. Panchromatic and multispectral images were analysed in a multi-step procedure using ArcGIS, including image processing and mosaicking, visual feature recognition, and mapping. The identification of key landforms (such as till veneers and erratic boulders) required the adoption of some assumptions to differentiate, for example, till from regolith. Where patterned ground was mapped, we infer a presence of till rather than regolith because subglacial erosion is more likely to produce finer material than subaerial weathering. Very large boulders on plateau surfaces are mapped as erratics because they could not have been delivered by slope processes to local highpoints. Sediment veneers with ridges were mapped as till because the ridges are inferred to originate from reworking by ice. However, the reliability of derived paleo-ice sheet reconstructions is limited by both the necessary assumptions and the absence of crosscutting relationships between landforms. At face value, the presence of till cover and erratics above the present ice surface on some nunataks indicate thicker ice in the past. Mapping and landform interpretations will be verified during the upcoming MAGIC-DML 2017-18 field season. Additional mapping of structures on the ice sheet surface is used to (i) infer ice flow characteristics; this was possible by assessing the distribution of primarily blue ice areas, crevasse fields, and supraglacial moraines, and by analysing their connection to wind directions and ablation rates; and (ii) yield target field routes for the upcoming field season to potential

cosmogenic nuclide (CN) sampling locations. The chronology derived from CN dating will permit the delineation of ice sheet surface elevations as targets for ice sheet modelling.

Keywords: Dronning Maud Land; glacial geomorphological mapping; remote sensing; ice sheet thinning.