Characteristics and Development of an Autochtonous Blockfield, Western Dronning Maud Land, Antarctica

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Introduction:

Blockfields are relatively well documented in the Mid-Latitudes, but not in the Antarctic. They are suggested to originate either by frost action[1] or by cryogenic activity that follows "pre-preparation" by chemical weathering in warm, humid environments[2].

An autochthonous blockfield on the Northern Buttress of the Vesleskarvet nunatak in Western Droning Maud Land, Antarctica **(Fig. 1)** was studied to document its characteristics and to investigate its origin.

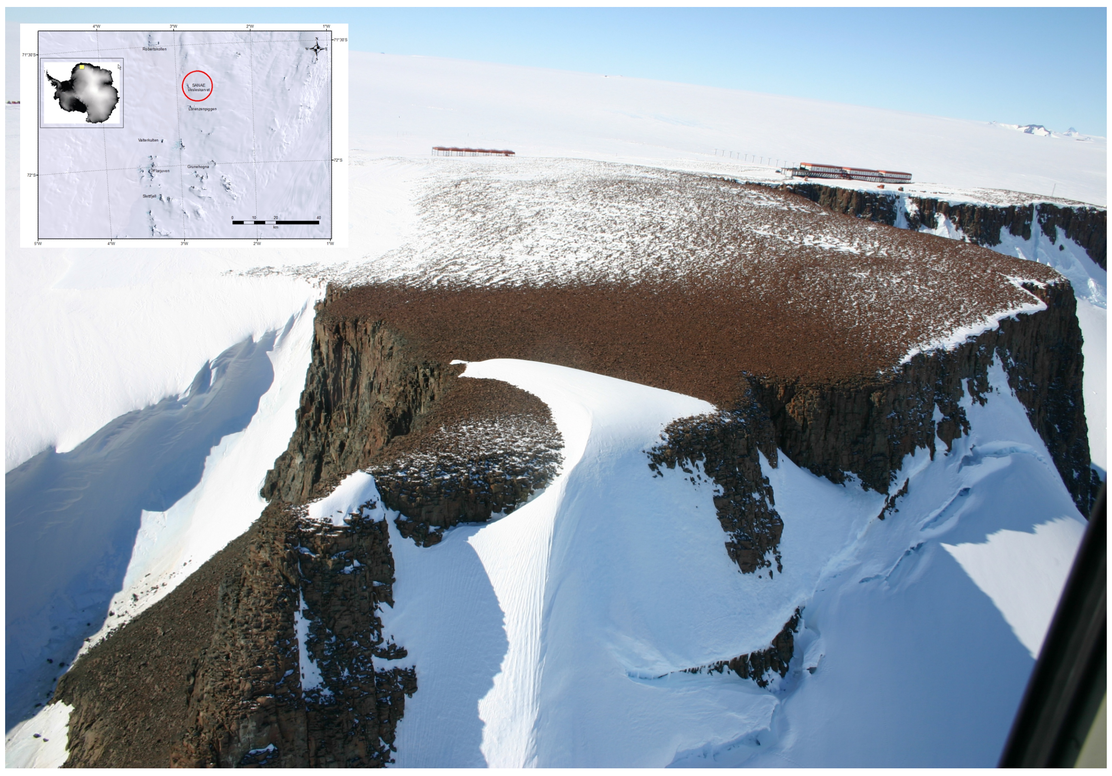

Figure 1:
Northern Buttress of Vesleskarvet, Western Droning Maud Land, Antarctica

Setting:

- The blockfield is located on a Precambrian dolerite (diorite) sill in a permafrost environment with an active layer that is currently 16cm deep.
- Initial fracturing by dilatation, following glacial retreat, has produced the blocks that comprise the blockfield **(Fig. 2)**.
- Initial jointing is largely rectangular in north-south and east-west directions **(Fig. 3).**

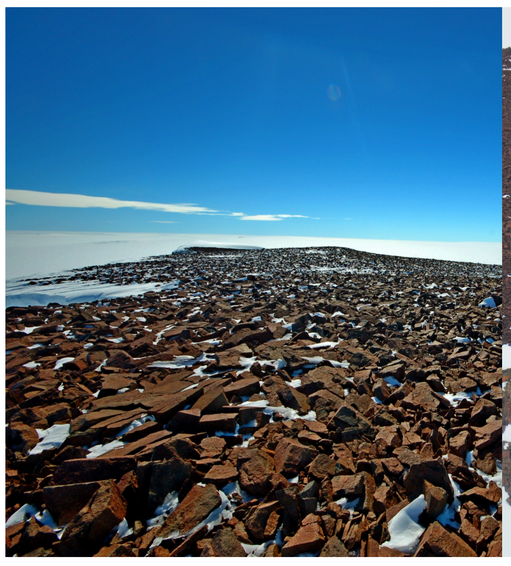

Figure 2:
Blocks on Vesleskarvet

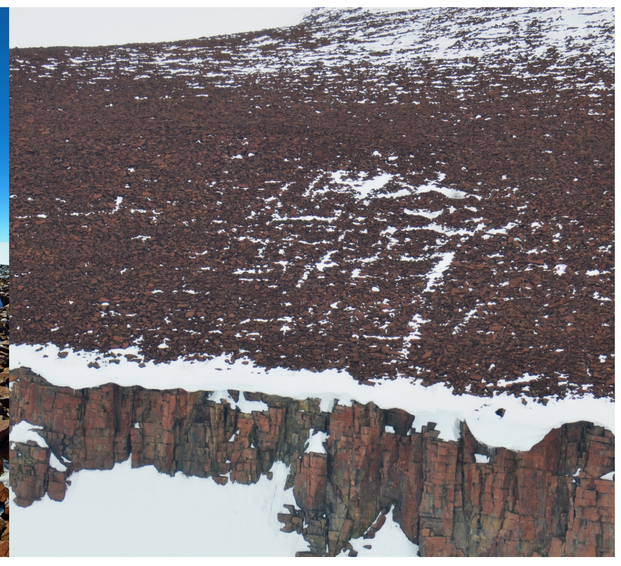

Figure 3:
Jointing on the northern Buttress of Vesleskarvet

Field Methods:

Over 300 individual blocks were sampled on the Northern Buttress of Vesleskarvet along predefined transects. The following was undertaken:

- Dimensions and orientations of each face were measured.
- The characteristics of each block and their facets were noted.
- Data loggers were used to determine the ground thermal environment.
- An Equotip and Schmidt Hammer were used to measure rock hardness and, hence, relative weathering.
- Rebound values were mapped and interpolated over the extent of the study area.
- Additional data were collected to note the spatial distribution of lichen so that any relationships that existed between lichen growth and rock weathering could be determined.

Findings:

- Orientation of block long axes was random, except where the slope angle was steeper (**Fig. 4**).
- Large areas showed ice supported blocks (**Fig. 5&6**).
- Well-developed case hardening and patination are indicative of a substantial period weathering subsequent to initial bedrock fracturing (**Fig. 7**).
- No statistically significant differences were found in rock hardness measurements on different aspects of individual rocks sampled (**Fig. 8**).
- Rock hardness differences over the entire nunatak reflect the variability in aerial exposure and moisture conditions brought about by the spatial and temporal distribution of snow cover (**Fig. 9**).
- Lichen coverage was most prolific where the rock was softer and exposed for longest.

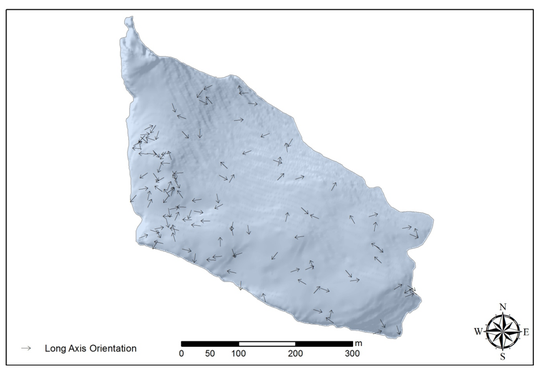

Figure 4:
Long axis orientation of blocks on the Northern Buttress, Vesleskarvet.

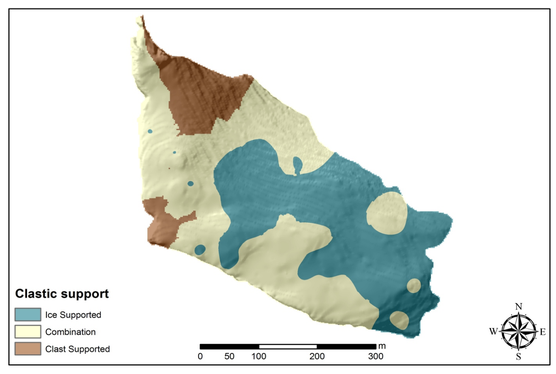

Figure 5:
Clastic support of blocks on the Northern Buttress, Vesleskarvet.

Figure 6:
Ice supported blocks, Vesleskarvet.

Figure 7:
Patinas on block surfaces, Vesleskarvet.

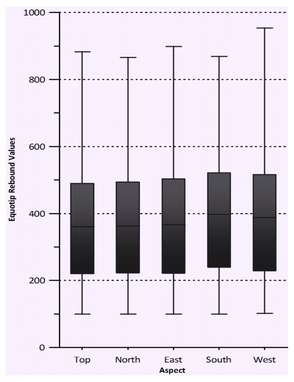

Figure 8:
Rock hardness (Equotip) for different aspects of blocks on Vesleskarvet.

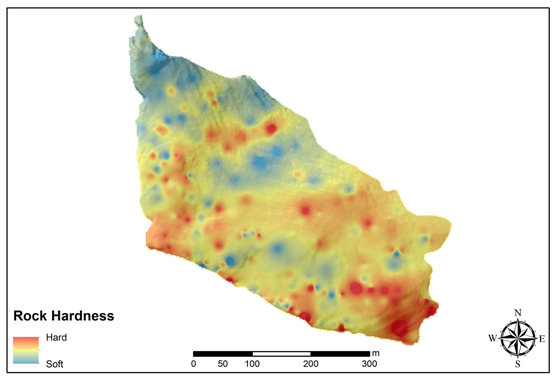

Figure 9:
Combined rock hardness values (Equotip and Schmidt Hammer) on the Northern Buttress, Vesleskarvet.

Suggested Model for the Development of the Blockfield (Fig. 10):

- Initial fracturing that produced the blocks was by dilatation, which followed glacial retreat.
- Individual blocks are separated from adjacent and underlying material by an ice matrix and are displaced from their original positions.
- Meltwater from snow-melt reaches the permafrost and freezing from above in winter causes the ice to expand and displaces the clasts to produce a random orientation of the block long axes. [3 & 4]
- Areas most exposed are suggested to have more dynamic environments that result in enhanced weathering, softer rocks and are hence better habitats for lichen growth.

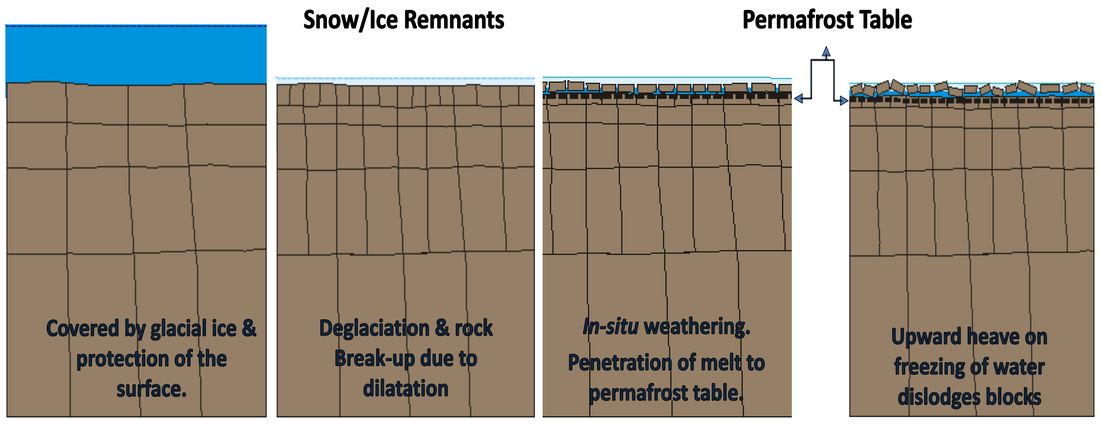

Figure 10:
Conceptual Model for Blockfield Development

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References:
1. André , M. F., Hall, K., Bertran, P. & Arocena, J. 2008. Stone runs in the Falkland Islands: Periglacial or tropical? *Geomorphology*, **95**, 524–543.
2. Rea, B. 2007. Periglacial Landforms, Rock Forms: Blockfields (Felsenmeer). *Encyclopedia of Quaternary Science*, 2225-2236.
3. Goodfellow, B.W., Fredin, O., Derron,M.-H. & Stroeven, A. P. 2009. Weathering processes and Quaternary origin of an alpine blockfield in Arctic Sweden. *Boreas,* **38**, 379–398.
4. Murton, J.B., Peterson, R. & Ozouf, J.-C. 2006. Bedrock Fracture by Ice Segregation in Cold Regions. *Science,* **314**, 1127-1129.
5. Whalley, W.B., Rea, B.R., Rainey, M.R., 2004. Weathering, blockfields, and fracture systems and the implications for long-term landscape formation: Some evidence from Lyngen and Øksfjodjøkelen areas in North Norway. *Polar Geography*, **28**, 93–119.