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Comparison of Periglacial Block Fields and Talus Slopes in South-Central Pennsylvania and Northern Maryland

Abstract

Relict periglacial boulder fields, or block fields, are scattered across south-central Pennsylvania and northern Maryland (e.g. Potter and Moss, 1968; Denn et al 2018). This pilot study uses a combination of digital analyses using Google Earth Pro and fieldwork to investigate block fields at different scales. Fieldwork focused on two block fields, which were compared with fieldwork conducted on two talus slopes. The block fields studied were Raven Rock Hollow in Maryland and River of Rocks at Hawk Mountain in Pennsylvania, and the talus slopes were located at Catoctin Mountain, Maryland and Waggoner's Gap, Pennsylvania. The importance of geomorphic processes on formation of block fields compared to talus slopes was examined as part of this pilot study.

Keywords

periglacial, boulder, Pennsylvania, Maryland, Laurentide Ice sheet, talus slopes

Disciplines

Environmental Sciences | Other Life Sciences

Comments

Poster presented at the North East Geological Society of America meeting in Portland, ME, March 2019.

Comparison of Periglacial and Erosive Block Fields in South Central Pennsylvania and Northern Maryland

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Introduction

Relict periglacial boulder fields, or block fields, are scattered across south-central Pennsylvania and northern Maryland (e.g. Potter and Moss, 1968; Denn et al 2018). This pilot study uses a combination of digital analyses using Google Earth Pro and fieldwork to investigate block fields at different scales. Fieldwork focused on two block fields, which were compared with fieldwork conducted on two talus slopes. The block fields studied were Raven Rock Hollow in Maryland and River of Rocks at Hawk Mountain in Pennsylvania, and the talus slopes were located at Catoctin Mountain, Maryland and Waggoner’s Gap, Pennsylvania. The importance of geomorphic processes on formation of block fields compared to talus slopes was examined as part of this pilot study.

Research Questions

The purpose of this study was to determine the orientation, size, and slope of block fields in Pennsylvania and Maryland. We have two primary research questions: Does the area of block fields increase as distance to the former Laurentide Ice Sheet margin decrease? What is the difference in size and arrangement (orientation) of boulders in block fields compared to talus slopes in Pennsylvania and Maryland?

Study Area

We chose two block fields at different latitudes with two different bedrock types . Hawk Mountain boulder field consists of sandstone from the Shawangunk Formation (Silurian period) (Miles and Whitfield 2001). Waggoner’s Gap Talus Slope contains sandstone from the Tuscarora Formation (Silurian period) (Miles and Whitfield 2001). Raven Rock Hollow and Thurmont Vista at Catoctin Mountain are both Precambrian to Cambrian (541-485 MYA) quartzite, meta-rhyolite, and phyllite(Cleaves et al. 1968) . These sites were chosen in an attempt to eliminate error associated with age and lithologic differences that might otherwise impact results. We hypothesize that talus slopes will have a stronger fabric than block fields. We also hypothesize that the area of block fields will increase approaching the LGM ice margin.

Field sites identified in Google Earth Pro

Bedrock type identified in Google Earth Pro. The main focus was on the light green Tuscarora formation of the Valley and Ridge Province.

A Thurmont Vista Talus Slope

B Raven Rock Hollow Block Field

C Waggoner’s Gap Talus Slope

D Hawk Mountain Block Field

Study area in South Central Pennsylvania and Northern Maryland, (A) Thurmont Vista at Catoctin Mountain Talus Slope, (B) Raven Rock Hollow Block Field, (C) Hawk Mountain Block Field, (D) Waggoner’s Gap Talus Slope.

Methods

Field Work

At each location, boulders were measured along transects perpendicular to the long axis of the block field. Rocks that were small enough to be easily moved were excluded due to human disturbance. The length of the long axis of each rock was measured. The orientation and angle parallel to the length of the long axis of each boulder were measured using a Brunton compass. The angle perpendicular to the long axis was also taken using a Brunton Compass.

Computer Analysis

Google Earth Pro Methods

Google Earth Pro was used to identify aerial extent and elevation of block fields in Pennsylvania and northern Maryland. Length and area was calculated using the measure tool.

Statistical Analysis

SPSS and VassarStats were used for statistical analysis. Independent t-tests and correlation analyses were used to determine the statistical significance of the data and identify correlations between variables.

Results

Google Earth Pro Analyses

The size of the block fields ranges from 1,317 m² to greater than 57, 000 m². The elevation of the block fields ranges from 214 m to 559 m. Latitude ranges from 39.67 ° N to 41.14 ° N.

Orientation of boulders

Thurmont Vista

Raven Rock Hollow

Waggoner’s Gap

Hawk Mountain

Field Work Summary Statistics:

Location:	Long Axis Length (m)			Angle Parallel to Long Axis (degrees)			Angle Perpendicular to Long Axis (degrees)			Modal Orientation
	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	
Hawk Mountain	3.21	0.52	1.49	72	0	27.1	44	27	33.4	NE
Raven Rock Hollow	5	0.3	1.4	40	0	14.9	90	0	45.2	NE
Thurmont Vista	1.62	0.29	0.7	85	0	20	60	0	19.2	NW
Waggoner’s Gap	1.5	0.44	0.86	70	0	18.1	65	0	24.3	SE

An independent samples t-test shows that axis length is significantly different ($p < 0.001$) at block fields compared to talus slopes. Boulders in block fields are larger than boulders in talus slopes.

An independent samples t-test shows that perpendicular dip is significantly different ($p < 0.001$) at block fields compared to talus slopes. Boulders in block fields exhibit a larger perpendicular dip than boulders at talus slopes.

An independent samples t-test shows that there is no significant difference ($p > 0.05$) in axis length at Hawk Mountain and Raven Rock block fields. Boulder size is similar at Hawk Mountain and Raven Rock.

Correlation Analyses

There is no correlation ($p > 0.05$) between axis length and angle parallel to the long axis on talus slopes.

There is no correlation ($p > 0.05$) between axis length and angle parallel to the long axis in block fields.

Discussion

Our hypothesis of an increase in overall block field area approaching the ice margin as mapped by Sevon and Braun (1999) was not supported ($p = 0.308$). This result suggests that the temperature gradient across the study area was not large enough to cause a significant change in block field area across the study area. Talus slopes have strong fabric while the block fields do not show preferred orientations. Thurmont Vista Talus Slope at Catoctin Mountain and Waggoner’s Gap Talus Slope have a strong East-West orientation. The two block fields displayed a weak fabric with random orientations. Hawk Mountain has a slightly stronger orientation than Raven Rock, but this is likely a result of the small sample size of boulders ($n = 14$) measured at Hawk Mountain. The long axis length of the boulders and the angle parallel to the long axis of the boulders was unrelated to the orientation of the boulders at every site. Independent samples t-tests ($p < 0.05$) indicate that boulders in block fields have larger length of long axes than boulders on talus slopes suggesting that these landforms were created by different processes . This idea is corroborated by the comparison of axis length in Hawk Mountain and Raven Rock block fields ($p = 0.727$), which exhibit a statistically similar boulder size.

Despite the two block fields being composed of different bedrock formations— Shawangunk Formation (Silurian Period) (Miles and Whitfield 2001) and Weverton (Pre-Cambrian to Cambrian Period) (Cleaves et al 1968), respectively, as well as having different lithologies, the rocks still exhibit similar size. This suggests that freeze-thaw periglacial activity during the Pleistocene period was a primary component in the formation of the block field landforms. Lithology and rock age did not impact boulder size. Angle perpendicular to the long axis of boulders in block fields was also significantly larger than angles of boulders on talus slopes. Periglacial activity in block fields caused a random distribution of boulders at steep angles compared to talus slopes .

Summary and Future Work

- No significant difference in boulder size at Hawk Mountain and Raven Rock Hollow block fields.
- Boulder size is similar at the two block fields despite a bedrock age difference of ~100 million years. This similarity suggests that the freeze-thaw action experienced at both locations during the Pleistocene Era is responsible for the current rock formations.
- The two talus slopes exhibited preferred orientations, and block fields exhibited random orientations. This means that the talus slopes are strongly influenced by gravity while periglacial activity is the primary process at block fields.
- Google Earth Analyzes do not show a correlation between size of block field and distance to ice margin.
- Future work should include gathering a greater sample size from Hawk Mountain and possible additional aerial analyses using drones.

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