Reports

Sorted Patterned Ground: New Appalachian Localities South of the Glacial Border

Abstract. *Sorted stripes, nets, and polygons in the Appalachians of Pennsylvania, West Virginia, and Virginia display patterns and stone orientations visibly similar to those of ground patterned under current cold climates. Larger forms appear inactive or fossil and may provide data on the paleoclimate and slope stability.*

Sorted patterned ground (*1*) is a nongenetic group term for features displaying a sorting between stones and fines; various forms may be classified geometrically as circles, nets, polygons, steps, and stripes. Much but not all patterned ground originates in cold-climate regions; careful work, including surface and subsurface measurements of orientation, is required for clear demonstration of this genesis (*2*). Specific processes in formation of patterned ground are complex and incompletely understood. Although current climatic conditions in the area discussed (Fig. 1) are insufficiently severe to produce large cold-climate forms, there is evidence that, during Pleistocene cold phases, the climate was cooler south of the margins of the ice sheets (*3*). If ground conditions were sufficiently severe, with frost action, fossils of such forms might be expected as evidence of a former periglacial climate (*4*). However, previously reported Appalachian occurrences of clearly developed sorted patterned ground are rarer (*5*) than in edaphically favorable sites in regions of currently cold climate (*6*). Not reported here are certain large-scale block fields (*7*) which are not strictly classified as sorted patterned ground.

There are several types of sorted patterned ground at relatively high elevations in the Appalachians of Pennsylvania, West Virginia, and Virginia (Fig. 1): sorted stripes, sorted nets, and sorted polygons (*1*). Stones in the patterns derive from rock units now either under or upslope from the features; they are relatively resistant to weathering. Orthoquartzite beds in Tuscarora Sandstone, Pocono Formation, and the Pottsville Group provide common materials, as do some rhyolitic rocks of the Mount Rogers Volcanic Group. Larger forms having surface-pattern diameters of about 1 m or more display surface evidence of an inactive or fossil nature. Apparently undisturbed growth of vegetation, including forest cover, is characteristic of these sites; stones are disintegrated in place without separation of constituent fragments, lichens of 10 cm or more in diameter grow on exposed areas of rock, and the upper and lower portions of blocks are differently weathered.

Sorted stripes (*1*) of rock fragments commonly display a straight-line surface pattern, but sinuous and anastamosing forms also are common (Fig. 2a). Slope angles commonly are 7 to 13 deg, although a maximum of 18 deg occurs on Whitetop Mountain, Virginia (Fig. 1). The long-axis dimension of stones in the pattern varies; in a stripe sampled on Whitetop Mountain the mean stone length is 55 cm; in the area of Cold Knob Mountain, West Virginia (Fig. 1), the length averages 80 cm. The width of stony stripes ranges from less than

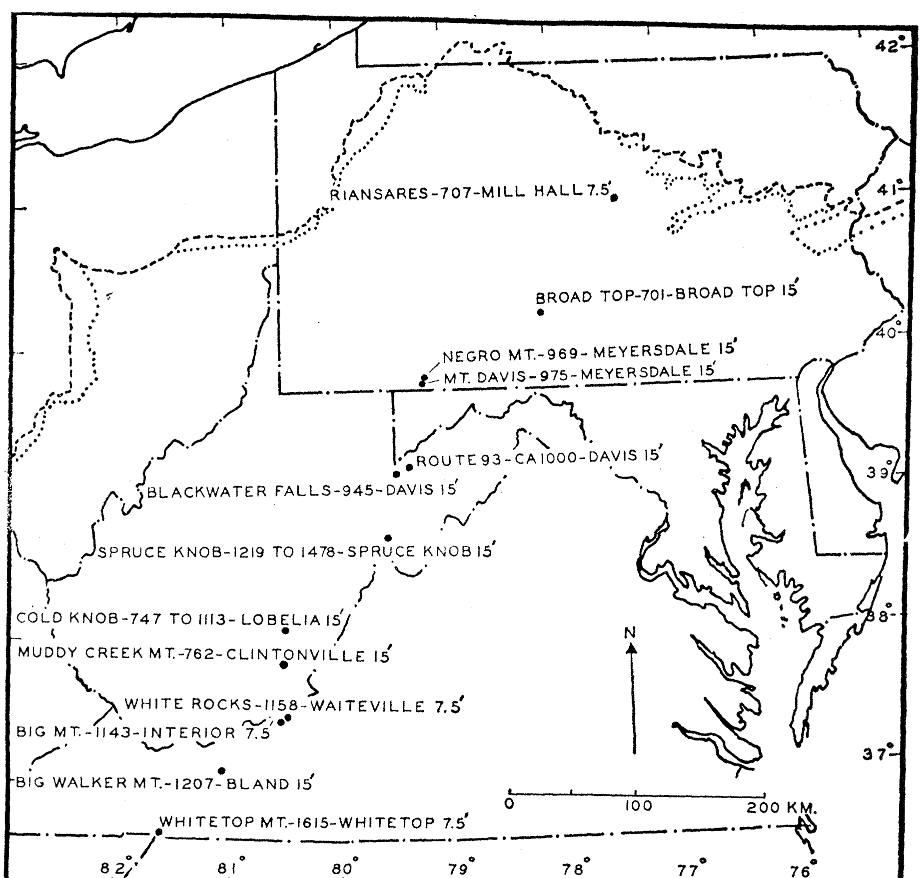

Fig. 1. Areas of sorted patterned ground. Following each name are elevation (m) and title and series description of the topographic map. (Dashed line) Wisconsinan glacial border; (dotted line) Illinoian glacial border.

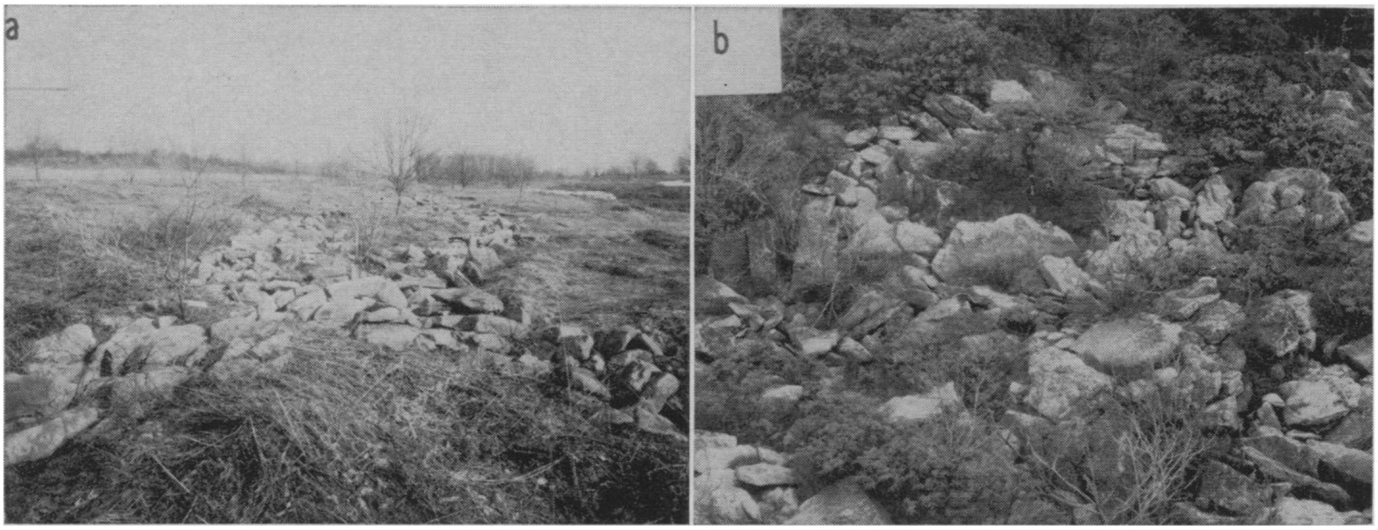

Fig. 2. Note shovels measuring 1.1 m. (a) Sorted stripes in Blackwater Falls State Park, West Virginia, 7 April 1968. (b) Sorted polygon viewed from Negro Mountain Fire Tower, Pennsylvania, 21 December 1967.

1 to 6 m. Individual stripes extend for 5 to 30 m, and can often be traced upslope directly to shattered outcrops. Stripes are oriented perpendicular to topographic contours, often trending at right angles to the strike of bedding in sedimentary rock units into which they grade in the upslope direction. Many stripes occur on ridge crests and in shallow divides where their origin cannot reasonably be attributed to fluvial action alone. Large areas are covered by sorted stripes on Big Mountain and Big Walker Mountain (Virginia), Spruce Knob (West Virginia), and Broad Top (Pennsylvania) (Fig. 1). Smaller areas are commonly covered by these features; the area of Muddy Creek Mountain, West Virginia (Fig. 1), is an example. In all localities cited, orientation of tabular stones in the stripes is visibly clear, with fragments on edge and parallel to the stripe borders (Fig. 2a). Such alignment of rock fragments is a common characteristic of this type of sorted patterned ground (*1*).

Sorted nets and sorted polygons (*1*) have borders of stones commonly surrounding finer material, and are distinguished from each other by shape in plan view. Polygonal patterns are usually discernible (Fig. 2b), although sorted nets occur lacking clearly defined sides. Observed sites are on slopes inclined at 7 deg or less; in several localities of greater slope, these features become transitional to sorted stripes. The long-axis mean dimension of stones in the borders of polygons is variable: in one border near Negro Mountain Fire Tower (Fig. 1) it is 97 cm; in two localities in the Spruce Knob area (Fig. 1), lengths average 31 and 35 cm. Mesh (*8*) diameters range from 2 to 12 m; the largest forms known are on Mount Davis and near Negro Mountain Fire Tower, Pennsylvania (Fig. 1), where mesh diameters of 8 to 12 m are common (Fig. 2b). Forms several meters in diameter occur near Risansares Mountain Lookout Tower in Pennsylvania, in the areas of Spruce Knob and Route 93 in West Virginia, and near White Rocks in Virginia (Fig. 1). Miniature sorted polygonal patterns up to 30 cm in diameter occur in bare areas on Whitetop Mountain, Virginia (Fig. 1), and may represent active features; and there is evidence of similar small-scale forms on other high mountain sites in the region.

On all reported sites, tabular stones in the mesh borders are commonly on edge and oriented parallel to the borders (Fig. 2b); similar orientations are reported from other areas of patterned ground (*1*).

Appalachian areas of patterned ground south of the glacial border exhibit surface characteristics visibly identical with those found on ground patterned under current cold climates above the tree line; they may be inactive or fossil forms of this type. If so, the Appalachian features constitute a valuable record of climatic change and subsequent slope stability. They may also indicate treeless conditions at the time of formation, as reported active areas of ground, patterned under cold climates, essentially lack forest cover (*5*). However, I warn against premature conclusions before more data on subsurface characteristics, modifying effects of differential preservation, and regional distribution of features become available. All occurrences are not necessarily contemporary, and ages must be determined at selected sites before research results will be useful in detailed reconstruction of paleoclimates. Other kinds of indicators of climate (*3*) should provide corroboration.

G. MICHAEL CLARK

Department of Geology,
University of Tennessee,
Knoxville 37916

References and Notes

1. A. L. Washburn, *Geol. Soc. Amer. Bull.* **67**, 823 (1956).
2. G. Lundqvist, *Geograf. Ann.* **31**, 335 (1948).
3. For findings by two different disciplinary approaches: H. T. U. Smith, *Geol. Soc. Amer. Bull.* **60**, 1485 (1949); D. L. Whitehead, in *The Quaternary of the United States*, H. E. Wright, Jr., and D. G. Frey, Eds. (Princeton Univ. Press, Princeton, N.J., 1965), pp. 417–32.
4. Cold climates in which frost action is a dominant process, possibly accompanied by slope mass movements and wind action; see R. F. Black, *Biul. Peryglacjalny* No. 15, p. 329 (1966).
5. C. S. Denny, *Ohio J. Sci.* **51**, 116 (1951); *U.S. Geol. Surv. Profess. Paper 288* (1956); A. Rapp, in *L'Évolution des Versants* (Union Géograph. Intern., Liége, 1966), pp. 229-44.
6. A. Rapp, in *L'Évolution des Versants* (Union Géograph. Intern., Liége, 1966), p. 237.
7. N. Potter, Jr., and J. H. Moss, *Geol. Soc. Amer. Bull.* **79**, 255 (1968); W. D. Sevon, *Penna. Acad. Sci. Proc.* **40**, 90 (1967); H. T. U. Smith, *Amer. J. Sci.* **251**, 625 (1953); ——— and A. P. Smith, *Geol. Soc. Amer. Bull.* **56**, 1198 (1945).
8. The unit component of patterned ground, as a circle, polygon, or intermediate form (*1*).
9. Supported by a Faculty Research Grant from the University of Tennessee. I thank J. M. Dennison (University of North Carolina), O. C. Kopp (University of Tennessee), and S. E. White (Ohio State University) for constructive comments.

1 May 1968