Reports

Anomalous Erosional Topography in Victoria Land, Antarctica

Abstract. *An area of some 18 square kilometers at the head of Wright Dry Valley displays an erosional terrain of unique characteristics—a labyrinthine complex of erratic, interconnecting channels cut to depths of more than 100 meters in bedrock. It is interpreted as a result of catastrophic fluvial erosion, probably analogous to that which produced the Channeled Scabland of eastern Washington, though on a greatly reduced areal scale.*

At the head of Wright Dry Valley (160°50′S, 77°33′E), and immediately in front of Upper Wright Glacier, an area of approximately 18 km^2 is characterized by a type of erosional topography entirely unlike that found elsewhere in the region, and with few known counterparts elsewhere in the world (Fig. 1). Brief mention of this area has been made previously (*1*), but without comment on its significance. Below I present a preliminary description and interpretation.

The area is dominated by a labyrinthine network of erratic, interconnecting channels deeply trenched in the strongly jointed rock of a thick dolerite sill. The individual channels, or channel segments, differ widely in their characteristics. A few are relatively straight, but many are curved, angulate, or irregular in ground plan, with margins notched or scalloped locally. Width ranges from less than 100 m to more than 300 m, and depth from a few tens of meters to more than 100 m; both differ irregularly lengthwise along the same channel, and sidewise from one channel to another. However, there is a general increase in size down-valley. Where the walls are relatively deep, the upper walls are generally steep, with ragged cliffs controlled by jointed rock. The channels pass down over talus and rubble to debris-mantled, U-shaped troughs, in which patterned ground occurs locally. Where the channels are relatively shallow, cliffs may be lacking, with rubbly slopes all the way up. Lengthwise, the troughs are extremely irregular, with no continuous or systematic gradient. Reversals and abrupt changes of gradients are common, and although walls of channels are continuous, bottoms are often interrupted by inclosed depressions. Some channels are open at both ends, with hanging relations to their neighbors, while others head, gradually to abruptly, in the surrounding rock platform.

The inclosed depressions in and contiguous with the channels are of particular interest. Some are more or less equidimensional, but most are elongate, being variously linear, arcuate, or angulate. Various gradations occur from individual basins through connected basins to chains of basins forming channels. Some of the larger basins are completely rimmed by bedrock, with measured closure up to 75 m; closures of more than 20 m are common. Slopes in transverse profile are mostly steep to cliffed, and in some places are asymmetric; lengthwise they are more moderate, and the 8° measured in one basin is more or less representative. Diversity in size and form of the basins is considerable, and few if any correspond to what might be termed a specific morphologic type.

Trends of the individual channels, with their associated basins, are notably divergent, and some are oblique or even transverse to the axis of the valley. Interconnections are unsystematic, and cross connections are numerous. Discordances of gradient and differences in elevation at junctions are common, and angles and directions of junction are erratic. The overall pattern is somewhat suggestive of a tortuously distorted anastamosing stream pattern entrenched in bedrock, with smooth curves replaced by discordances and angularities.

Interchannel areas are characterized by island-like knobs, buttes, tables, and minor ridges of bedrock rising to rudely accordant levels. Diversity in size and shape are marked. Rounded rock basins up to an estimated 10 m in depth and a few tens of meters in width occur at places on the flatter, upper surfaces, and resemble oversized potholes. Intensive mechanical weathering, however, has effaced any original erosional markings; fresh, unweathered rock is absent.

Down-valley from the labyrinthine area, on granitic rock which underlies the igneous sill (*2*), the channels merge and drop down into the two forks of Wright Valley, with their more normal erosional topography. The anomalous topography is confined to the doleritic rock, and appears to be conditioned by its jointing.

Up-valley, the channeled terrain passes under the ice of Upper Wright Glacier, to continue for an undetermined distance. The glacier heads at an icefall some 7 km back, and approximately 400 m high, leading up to the polar ice cap.

The origin of the labyrinthine tract is problematical. It cannot be regarded as a typical product of normal erosional agencies, but rather requires some explanation of an extraordinary nature. Occurrence in a glaciated valley, and proximity to an ice front, immediately suggest the possibility of glacial erosion, working in some bizarre fashion. This, in fact, was suggested for another area with comparable terrain (*3*), but was unsubstantiated, and has never been accepted. In the area considered here, none of the individual landforms within the channeled area, with possibly a few minor exceptions adjacent to the ice front, are identifiable as distinctively glacial, and the ensemble is even more difficult to attribute to that process; no analogs of demonstrably glacial origin are found in the literature. The typical linearity and parallelism of glacially grooved landscape (*4*) are lacking, and the characteristic rounding and "streamlining" of contours, and the systematic asymmetry of slopes produced by other forms of glacial erosion are nowhere recognizable. The channels are too small to have sustained individual ice tongues of erosional effectiveness, and are of the wrong shape, pattern, and orientation to have favored effective transmission of motion from an overlying valley glacier to ice bodies which filled them. This applies particularly to the channels highly oblique to the direction of glacial advance; any ice filling

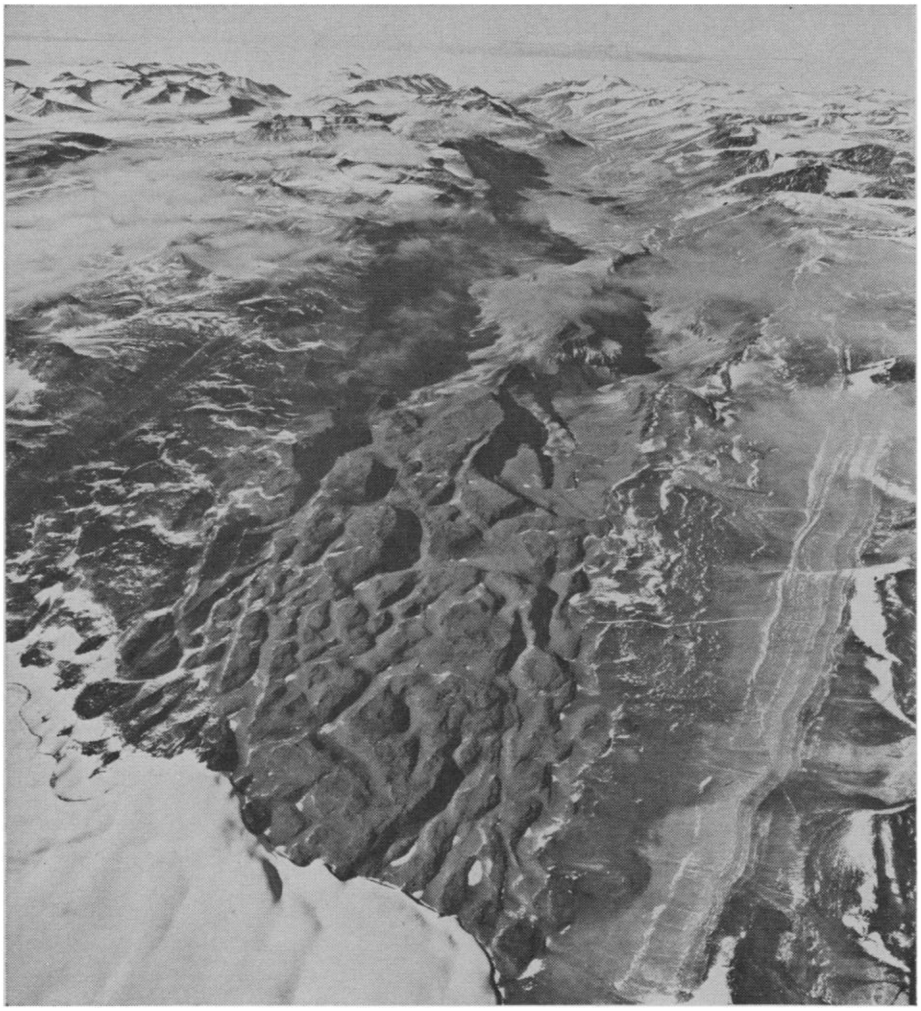

Fig. 1. View eastward over Wright Dry Valley, Victoria Land, Antarctica, from an altitude of approximately 6000 m, at a point over the Upper Wright Glacier. The margin of the glacier is in the foreground, with an area of anomalous labyrinthine topography just beyond it. McMurdo Sound and Ross Island are in the background. [U.S. Navy for U.S. Geological Survey]

them under glacial cover must have been essentially stagnant, with the main body of the glacier shearing across their tops. North of the channeled area, however, on a moderately sloping shelf with the same bedrock, and leading up to bordering cliffs, the topographic aspect is different, and does suggest effects of glacial plucking. If similar topography once extended over the now-channeled area, it might have played a part in the localization of channels.

If glacial erosion be rejected as the primary cause of channeling, fluvial erosion remains as the one alternative. Certainly the landforms are not the usual products of stream erosion working under ordinary conditions. However, except perhaps for scale, the forms and patterns seem less unlike those of fluvial erosion than those of any other process. And analogs, although comparatively rare, do exist. Individual landforms of the labyrinthine area are more or less matched, on a somewhat reduced scale, by those of the Dalles stretch of the Columbia River (*5*). And the labyrinthine terrain as a whole finds counterparts, without reduction in scale, at many places in the Channeled Scabland of eastern Washington, demonstrably sculptured by catastrophic fluvial erosion under an exceptional combination of conditions (*6*), over a much greater area. There is thus ample precedent for attributing the labyrinthine terrain complex of Wright Valley to fluvial erosion, and neither precedent nor logical basis for interpreting it in any other way.

If fluvial erosion be accepted as the preferred hypothesis of origin, it could have worked only by plucking on a massive scale, with kolk (*7*) or vortex action in a dominant role, exploiting zones of structural weakness in the rock. To produce inclosed rock basins of the size observed, depth of water must have been great and velocity very high; as in the case of the Washington Scabland, this presumably would have involved simultaneous flooding of all or most of the channels, and temporary inundation of areas between them. A great volume of water was necessary.

The source of the water is unknown. In Washington, the flood waters have been traced back to an ice-dammed lake of great depth and extent, catastrophically drained. For Wright Valley, relevant evidence is concealed by the ice cap. However, accelerated general melting of the ice cap, during an interglacial stage, provides the best explanation; this implies the development, or uncovering, of a drainage basin of such size and configuration as to collect the meltwater from a broad area and channel it through a single outlet. Recurrent impounding and sudden release of water in such a basin, as by formation and subsequent breaching of an ice dam, would have been particularly effective in supplying the required volume of water.

The implications of the above interpretation are far-reaching. Inferred conditions for producing the requisite water supply suggest more extensive deglaciation than has been generally considered for the region, and have a bearing on broader questions as to the Pleistocene history of the Antarctic ice cap and related problems. It is hoped that the foregoing discussion may stimulate the continuing search for new data related to these questions, leading perhaps to more definitive interpretations than are possible here.

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References and Notes

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8. Work carried out under National Science Foundation grant GA-21.

10 February 1965