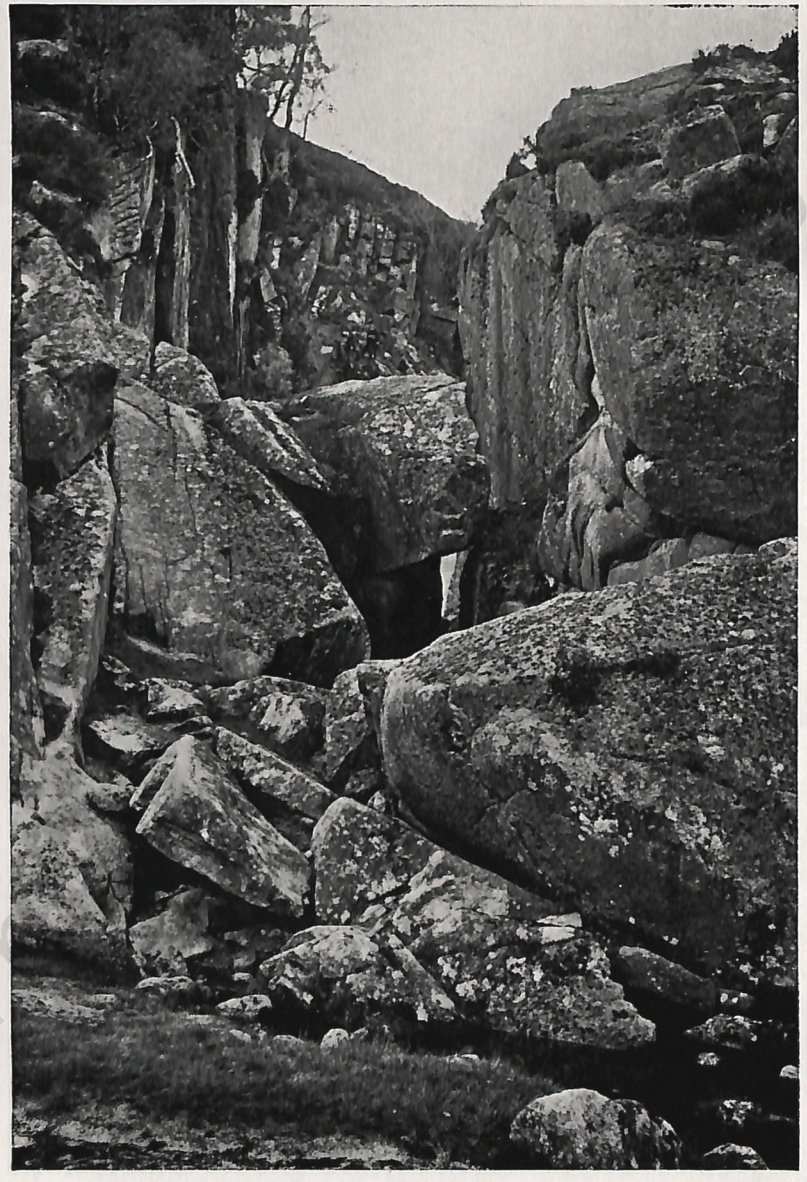

Photo by *G. W. Wilson.*

THE VAT (EXTERIOR).

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THE VAT.

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The Vat, near Cambus o' May, is the most remarkable natural phenomenon on Deeside; indeed, so far as I know, there is nothing in this country quite comparable with it. Any attempt hitherto made to explain its origin has ignored that of the gorge in which it lies; an adequate explanation must account for the one as well as for the other.*

Approach to the Vat is usually made from the point where the road from Cambus o' May to Logie-Coldstone crosses the Burn o' Vat. For some distance nothing remarkable is encountered; but, after following the tiny stream for a few hundred yards, one enters a large hollow or cirque, rock-walled all round. On the north and south sides, however, the living rock is much obscured by scree. The east side of the cirque is breached by the stream; while a broad, shallow hollow, evidently the result of erosion by running water, indents its western rim. In the floor of this hollow two channels have been cut. The more northerly is shallow and opens out on the top of the

* The true explanation is hinted at by me in "The Physical Geology of the Dee Valley," 1912; but in that work the space necessary for a detailed account of the Vat was not available.

cirque wall; the more southerly is the narrow gorge, 42 feet deep, that gashes the western wall of the cirque from top to bottom; in it lies the Vat. The cirque looks so like the pot-hole found below every waterfall (*e.g.*, at Linn of Muick) that one is surprised to find in it no boiling pool, but only a streamlet meandering over a grass-covered, marshy floor.

The Vat is entered from the cirque by scrambling over some fallen blocks of granite—somewhat of a feat for ladies during the regime of the trouser skirt—and passing below the north-east corner of another huge fallen block that at first sight seems to bar all passage. Standing in the entrance and looking westward, the visitor sees that the burn cascades some 15 feet into the Vat, trickles across its sandy floor, and finds exit on his left. But at first he will have eyes for nothing but the Vat itself. Its floor is an almost perfect circle, 59 feet in diameter. On both sides its curved walls rise upward and inward to a height of 19 feet on the north side and of 13 feet on the south side. As far as the eye can judge or geometrical tests can be applied, the curved surfaces are found to be *parts of an almost perfect sphere.*

Above the curved surfaces just mentioned, vertical walls of granite rise 42 feet on the north side, and 60 feet on the south side above the floor of the Vat. Both walls are formed by clean-cut joint faces: but on the south wall, above the big round of the Vat proper, can be seen a considerable fragment of what appears to have been originally a cylindrical or slightly funnel-shaped shaft. From the curvature of what remains this shaft seems to have had a radius not much more than one-third of that of the huge cauldron below. The clean-cut faces, forming a great part of the walls of the Vat as we see it now, shew where portions of the walls and roof have fallen away. How deep the Vat was originally, one cannot say; but, from the outward curvature of the spherical surfaces where they meet the present floor, it may safely be judged that much more—probably very much more—lies hidden than is now

disclosed to view. Thus beneath the visitor's feet lies a cavity in the solid rock of sufficient size to accommodate all the debris that, falling from roof and sides, has marred the original symmetry of the Vat; indeed, the caving-in may have commenced while the lower, wider portion was in course of formation.

The Vat has been excavated in granite ("Newer Granite" of the Geological Survey), coarse-grained, easily disintegrated, and similar in colour and quality to the main body of the granite in the Cairngorm massif.

Granites are intersected by three sets of joints, one "horizontal,"* the other two vertical; the planes of jointing are mutually at right angles or nearly so, and cause the rock when subjected to weathering to break into cuboidal blocks. In the cliffs overlooking Glen Eunach the regular jointing produces on rock faces the effect of Cyclopean masonry. There all three sets of joints are strongly marked and very regular. But the manner in which granite reacts to weathering and erosion is frequently affected by the predominance of two or of one of the sets, as well as by the regularity with which, and the interval at which the joints are spaced, and by the angle at which they intersect (which, however, generally approximates to a right angle). Now the granite in the vicinity of the Vat is intersected by two strongly-marked sets of joint-planes—a "horizontal," dipping east at an angle of 30° to 40°, and a vertical, running nearly east and west; they are spaced at intervals of from 5 to 10 feet. The prominence of the vertical set has led to the caving-in of part of the roof of the Vat, explains the clean-cut faces above its great round, and has caused the disappearance of the greater part of the funnel-shaped shaft, of which a fragment of the south side alone remains. The north-south set of joints is faintly marked and very irregular in its course.

* So called for convenience. The angle that the "horizontal" set makes with the horizon varies.

On account of the multiplicity of lines of weakness, a closely-jointed rock, *ceteris paribus*, yields to erosion by running water much more readily than one with jointing more widely spaced. At the west end of the Vat, and right in line with the entrance passage, a belt of granite, 8 to 10 feet wide, shews close-set vertical joints, a foot and less apart; it can be traced down almost to the floor of the Vat. There is little doubt that this weak belt was once continued across the space now occupied by the Vat and through the narrow gorge connecting it with the cirque. Even a cursory examination reveals the fact that the walls of this gorge, except where the opening of joints has caused rock-falls, is water-worn from top to bottom—far above the highest flood-level of the stream that now occupies it. Towards its outer end part of a considerable pot-hole, a lesser Vat, is visible.

The original depth of the gorge, like that of the Vat, cannot be determined; for its water-worn sides disappear downwards beneath an accumulation of fallen blocks. The largest of these—that under which the visitor passes on entering—shews a water-worn surface on one side, and can be assigned to its original position on the north wall of the gorge. Were it and others restored to their proper places, the gorge would have a fairly uniform width* of from 8 to 10 feet—*just the width of the belt of closely-jointed granite.* At present the distance between the solid rock-walls varies from 9 to 20 feet.

Except for its gigantic size, the Vat is exactly similar to the pot-holes formed in the rocky beds of swiftly-flowing streams by the continual whirling round of stones and sand in hollows and cracks. A stone becomes lodged in some crevice; the rush of water is unable to remove it, but keeps turning it round and round. The stone, supplied by the river with sand, acts like a lapidary's wheel, and cuts into the surrounding rock. In time it is itself worn away, but other stones get

* Except for the small pot-hole mentioned above.

caught, and take up and help on the work ; the pot-hole is slowly enlarged. In this way all pot-holes, large and small, have been hollowed out. There is, however, no record of a pot-hole that combines the size and regularity of shape possessed by the Vat.

Now it is perfectly clear that, in the formation of this stupendous pot-hole, the stream that now flows through it can have had no share whatever ; the Burn o' Vat, in fact, has done its little best to obliterate the work of an infinitely more powerful predecessor by spreading a tiny contribution of sand and gravel over the floor of the Vat. Can we prove the existence of an infinitely more powerful predecessor? And can we shew that there was a likelihood of that predecessor's finding at this particular point in its bed conditions favourable for the production of a pot-hole? If these questions can be answered in the affirmative, we may safely claim to have given a satisfactory explanation of the origin of the Vat.

Of the hundreds of people who visit this locality every summer not one in a thousand traces the burn up through the gorge that leads to the col between Culblean and Cnoc Dubh. Anyone who does so will have ample proof of the former presence of an infinitely more powerful stream than that which now dodges around big boulders at the bottom of a steep-sided, rock-walled gorge, in some places close on 100 feet deep. Viewed in relation to the gorge it occupies, the Burn o' Vat is a palpable misfit : it resembles an infant masquerading in its father's shoes. There is, indeed, no doubt that the Burn o' Vat, since it first began to flow, has cut down more than 100 feet : the valley on the bottom of which the gorge has been eroded is principally its work. But its drainage area must always have been limited, its volume small, and the rate of vertical erosion consequently extremely slow—so slow that, as fast as the stream deepened its bed, the valley walls were weathered back into gentle slopes. The rock-gorge, which has considerable width as well as depth, is evidence of a stream of large volume and

great erosive power. A smaller stream acting for a long time might have done the same amount of vertical erosion, but its valley sides could not meanwhile have continued to shew the almost perpendicular walls of living rock we here see.

As an example of the erosive power of running water, by which alone it could have been produced, the gorge is quite as striking as the Vat itself: the stream that was competent to cut the one was competent to cut the other.

If any further proof were needed that the Burn o' Vat has not carved the gorge we are considering, it is to be found in the fact that the gorge is continued beyond the point where the stream enters it. The upper end of the gorge forms a notch or wind-gap, devoid of drainage, on the col; and can have been formed by no existing stream.

To understand how the Vat and the gorge in which it lies were produced, we must consider the conditions that obtained during the Great Ice Age.

At one time the whole of Scotland was swathed in snow and ice; but at a later period, under somewhat milder climatic conditions, the valleys in the higher grounds were occupied by glaciers, while the lower parts of the country, especially towards the east coast, were free of ice. The front of the Dee Valley Glacier, at one stage in its retreat, rested against the west face of the Cnoc Dubh ridge, which, jutting southward towards Cambus o' May, lay right across the general line of ice-movement. The northern edge of the glacier rested on the flanks of Culblean, and between it and the frost-riven rock-slopes above a lateral moraine accumulated. Fragments detached from the hillside and others thrown off by the ice contributed to the formation of this moraine. But the moraine, which may be traced from the mouth of the Culsten Burn behind Tomnakiest to the col at the head of the Vat gorge, forms a gently sloping, comparatively smooth-topped terrace, not much like the ordinary conception of a moraine. Along both

Photo by *J. Mathieson.*

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sides of a glacier, particularly near its termination, course in summer streams of water derived from the melting of the glacier ice and of the winter snows on the slopes above. By these the rubbish lodged at the edge of the ice is washed and sorted. If the glacier stand for a long time at the same level against the valley wall, it may even happen that the solid rock abutting on the ice is cut into by these lateral streams (as has happened here above Cambus quarries); the moraine, too, may be so washed and levelled as to resemble a river terrace more than a moraine.

From various causes (which need not be detailed here) the flow of water in the case we are considering seems to have been particularly copious. When it reached the col between Culblean and Cnoc Dubh, it did not turn southward along the west flank of the latter hill, but coursed over the col, struck into the bed of the Burn o' Vat, and proceeded to erode the great gorge. At the east end of the cirque a waterfall was initiated. This fall cut back, as waterfalls do, into the solid rock, gradually increased in height (owing to the surface of the granite rising towards the west), and formed a huge pot-hole at its base—the cirque.

On and some distance back from the lip of the fall the stream found a line of weakness, the narrow belt of close-jointed granite, where vertical erosion proceeded at a greater rate than elsewhere. As the channel on the weak belt was gradually deepened, more and more of the water flowed along it, and the rate of erosion was still further increased. Boulders carried into this narrow passage and whirled round and round by the tumultuous current would be likely to form pot-holes.* This tendency would be increased by the angle at which the

* The tendency of a strong current in a narrow channel to eddy and form pot-holes is beautifully exemplified at the Linn of Dee. The Linn, too, is an example of a narrow gorge cut in what was formerly the lip of a broad waterfall, as at the Vat; but the two cases are due to entirely different causes.

water entered the channel excavated in the weak belt, for it may be observed that the latter crosses obliquely the line of the gorge where it enters the Vat. At the precise point, therefore, where we should expect the formation of a strong eddy, and possibly of a pot-hole, we find the Vat.

The narrow upper portion of the Vat, of which only a part of one side remains, widens downward. This is probably due to increasing flow of water as the channel in which it lay was deepened ; and the sudden increase in diameter shewn in the lower part of the Vat probably marks the time when practically the whole flow began to pass along this route. The formation of the pot-hole began in the weak belt ; but, as it gradually increased in size, it invaded the more resistant granite on both sides.

I think it may now be claimed that we have proved (1) the existence of a powerful stream quite capable of having produced the observed phenomena ; (2) the presence in its bed, at a particular point, of conditions specially favourable to pot-holing ; and that we have given an adequate explanation of the origin of the Vat.

The *size* of the Vat is a result of the great volume of water poured over the col every summer, and of the strong eddy produced as described above ; the *regularity of its shape* is no doubt due to the homogeneous nature of the rock (apart from the relatively narrow belt of close-jointed material) on which the water operated.

The *preservation* of the Vat is to be attributed to the cutting off (by the recession of the Dee Valley Glacier) of the stream of meltwater before it had time to destroy the symmetrical result of its previous work. There is no doubt that pot-holes of similar size and regularity have been formed at favourable points in the beds of strong-flowing streams ; but these streams have continued to occupy their channels, and persistent attack upon their beds has removed many of the most striking results of past erosion. In the caving-in of the roof of the Vat and in the fallen blocks that cumber its outlet, we see

the result of a process that would have gone on much more rapidly, had the same volume of water as formed Vat and gorge continued to pass through them, undercutting their walls and causing repeated rock-falls.

It may be added that there is in nature no more powerful eroding agent than a copious stream of water descending with torrential velocity, and charged with boulders and sharp sand washed out of the moraines of a glacier.

I may also say that, every time I visit the neighbourhood of the Vat, I come more and more clearly to realise that the most stupendous example of the erosive power of running water to be seen hereabouts is not the Vat but the great gorge above it or the cirque, similar in origin but so vastly superior in magnitude to its more bizarre neighbour.

Gorges like that of the Burn o' Vat, formed by the discharge of meltwater from glacier or ice-sheet, are known as "overflow channels." They are particularly abundant on Deeside: fifteen, large and small, can be counted within easy walking distance of Dinnet Station. But nowhere can a more splendid example be seen than that just described.