THE GEOLOGY OF MASSANUTTEN MOUNTAIN IN VIRGINIA

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IN

VIRGINIA.

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BY

ARTHUR COE SPENCER.

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INTRODUCTION.

The object of this paper is to present the lithology, sequence and structure of the formations occurring in Massanutten Mountain, Virginia, and from their study to indicate in so far as is possible, the processes and conditions under which the sediments were deposited, and those by which they have reached their present attitude and distribution[1].

In Appalachian Virginia there are recognized three marked topographic belts: the Blue Ridge, the Great Valley and the Alleghany mountains.

The rocks of the Blue Ridge are largely pre-Cambrian eruptives, but along its western slope sandstones and shales are exposed, which have been determined on fossil evidence to belong to the Lower Cambrian. These formations are followed by a massive limestone which is characteristic of the Great Valley, and this in turn by the remainder of the Paleozoic section in the Alleghany mountains to the west. In the Alleghany region folding of the Appalachian type is apparent in the repeated outcrop of certain resistant strata, which have given rise to a system of parallel linear ridges with a common N. E. and S. W. trend. The whole region has been long subject to erosion and its present physiography serves well to illustrate the intimate dependence of topographic form upon stratigraphy and structure. For example the position of the wide valley has been determined by the presence of the broad belt of soluble limestone, while the limiting mountain ranges and occasional valley ridges are higher because their component rocks have offered greater resistance to erosion by solution.

Especially marked throughout the region is the prevalence of horizontal crest lines; and the fact that the summits of the ridges

1. To Mr. Bailey Willis at whose suggestion and under whose direction this study of Massanutten Mountain was undertaken and to Mr. C. W. Hayes and Mr. M. R. Campbell who have made helpful criticisms, the author wishes to express his obligation and appreciation.

are of approximately the same height indicates an old baselevel surface—the *Alleghany peneplain*. The presence of a few low monadnocks above this general surface, which is in all probability to be correlated with the Cretaceous peneplain of Professor Davis, shows how far toward completion baseleveling had progressed before the initiation of a new cycle of erosion by elevation of the land. The floor of the Great Valley represents a later period of baseleveling of sufficient duration for the complete reduction of the limestone and shale formations without sensibly affecting the areas of more resistant rock. Into this *Shenandoah peneplain* the modern drainage has eroded its channels to a depth of 200 feet or more.

Massanutten Mountain owes its preservation to a deep sag in the long central syncline of the Great Valley by which a heavy sandstone stratum has been brought below the level of the Alleghany peneplain. Subsequent erosion has excavated the double valley of the Shenandoah on either side, and left the mountain as a residual mass dividing the Great Valley.

More sharply defined, the Massanutten area occupies the territory bounded by the two parallel branches of the Shenandoah river between the latitude of Strasburg and that of Harrisonburg, Virginia. The area is about forty-five miles long and from six to eight miles wide.

The mountain is a system of parallel ridges which coalesce at intervals to form a chain-like series of enclosed basins. If the mountain be divided into a southern and a northern part at the New Market gap, South Massanutten is found to comprise three links of the basin-chain while the fourth, known as the Fort or Fort Valley, occupies the central part of North Massanutten throughout its length of twenty-five miles.

While the mountain has, in common with the surrounding topographic features, a general northeast and southwest trend there is a slight change in direction at the New Market gap, the axis of the southern part running N. 30° E. and that of the northern part making an angle with the meridian ten degrees greater.

Comprising in its component strata the greater part of the middle Paleozoic section and isolated as it is by broad bands of the Shenandoah or Valley limestone the area forms a geologic unit and has been so considered in the discussion which follows.

STRATIGRAPHY.

THE SHENANDOAH LIMESTONE[1]. The lowest horizon within the Massanutten area is the Shenandoah limestone. While the formation is typically a heavily bedded, noncrystalline, dolomitic limestone, shaly beds are by no means rare in its lower portion. Prominent intercalations of sandstone are also found near the middle of the series and are known to be particularly well developed along the eastern side of the Shenandoah valley[2]. Similar beds of rather coarse yellow sandstone are to be seen west of Massanutten Mountain in a railroad cutting between Edinburg and Mt. Jackson. Mr. Keith has made the suggestion that these beds are probably the stratigraphic expression of the disturbance of environment which is otherwise recognized by a difference in the faunas of the middle and upper portions of the limestone series.

Above the sandstone there are limestones containing extensive beds of chert, and above these, the uppermost member, about 200 feet in thickness, consists of very dark, compact limestone becoming thinner bedded and alternating with shale to which it at last gives place.

Though fossils are by no means common in the lower portion of the formation, Mr. Walcott has succeeded in determining their age as lower and middle Cambrian[3], while the upper part is Ordovician and has long been recognized as in part equivalent to the Trenton limestone of New York.

The thickness of the Shenandoah formation has been variously

1. The names here employed for the different formations of the Massanutten area are those adopted by the U. S. Geological Survey. See a paper entitled Notes on the Stratigraphy of a portion of Central Appalachian Virginia, N. H. Darton, Am. Geol., vol. X., pp 10—18.

2. A. Keith: Harpers Ferry Folio, U. S. Geol. Survey, 1894.

3. C. D. Walcott: A. J. S. 1892, vol. xliv, pp. 53 and 478.

estimated at from 2500—3500 feet. The sandy horizon is said to be about 1500 feet below the top of the formation[1].

THE MARTINSBURG SHALE. There is no sharp break between the Shenandoah limestones and the Martinsburg shale which follows it. Above the transition beds of alternating limestone and shale the lowest deposits are fine argillaceous shales which, when fresh, are of a dark drab color, but upon weathering become more or less ochreous. These pass upward into calcareous shales which are frequently micaceous and often show ripple marks and current bedding, the latter, however, on a very small scale. Occurring with these shales there are bands of a somewhat coarser rock which the microscope shows to be made up principally of angular grains of quartz, with fragments and splinters of some substance which behaves in polarized light as a fine crystalline aggregate. Some calcite and a few mica flakes are always present, and in one thin section, a few grains of striated feldspar were observed. An exceptionally coarse specimen contained small lamellar particles, apparently fragments from a very fine grained black shale. The crystalline aggregate resists both hot and cold hydrochloric acid and is very hard. Comparison with chert from the Shenandoah limestone leaves little doubt that it is also chert of like derivation. In this rock the size of the grains is quite uniform, with a maximum diameter of about 0.5 mm.

Throughout the Massanutten area these beds are easily distinguished by their olive color, peculiar texture and somewhat prominent outcrops. They mark the only horizon within the series which can be definitely recognized.

In a railroad cutting near the bridge where the Strasburg branch of the Richmond and Danville R. R. crosses the North Fork, the beds which overlie those last described are found to be very fine grained carbonaceous shales. Other good exposures of this member are to be seen at the bridge over North Fork east of Woodstock, and again on the east side of the mountain on the New Market-Luray road. This shale merges into a more calcareous shale which is somewhat fossiliferous, and sometimes carries occasional thin beds of hard earthy limestone. The in-

1. N. H. Darton: Staunton Folio, U. S. Geol. Survey, 1894.