

**Article IV.—THE WASHAKIE, A VOLCANIC ASH FORMATION.**

BY W. J. SINCLAIR.

It was at first supposed by King and Marsh that the Middle Eocene deposits of Wyoming in the Washakie and Bridger Basins were contemporaneous or nearly so. Osborn in 1881 pointed out faunistic differences. Analysis of the fauna has finally led: (1) to a faunistic correlation of the lower Washakie with the upper Bridger; (2) to placing the upper Washakie as subsequent to the Bridger. The petrographic examination of the Washakie rocks, based on specimens collected by the American Museum Expedition of 1906, affords valuable evidence for the separation of the Washakie from the Bridger as a distinct formation. The Bridger rocks, as recently ascertained,<sup>1</sup> are composed of rhyolitic ash interstratified with shell marls and thin lignitic bands of lacustrine and swamp origin respectively, while the ash composing the mass of the formation has been distributed, apparently, by both wind and running water.

The Washakie rocks are also volcanic in origin, resembling the Bridger tuffs macroscopically but differing from them in being more basic as shown by the presence of soda-lime instead of potash feldspars. As they are all quite soft more satisfactory results have been obtained by examining them microscopically in powder form than by the usual method of sectioning. They may be described as tuff sandstones, white and green fine-grained tuffs, green and purplish clays and feldspar conglomerates.<sup>2</sup>

## LOWER WASHAKIE.

1.—*Tuff sandstones.* The basal brown sandstone of the Washakie (Washakie A) may be taken as a good example of rocks of this type. It is composed of rock fragments, mineral grains and pumice. The former comprise small water-worn pebbles of soft tuff, more angular tuff fragments, and small grains of a black rock with opaque inclusions (probably magnetite) and aggregate polarization when crushed and the transparent portions of the resulting powder examined between crossed nicols. Plagioclase with the optical properties of oligoclase-andesine is exceedingly abundant in clear

<sup>1</sup> Sinclair, W. J. Volcanic ash in the Bridger beds of Wyoming. Bull. Am. Mus., Vol. XXII, Article XV, pp. 273-280, 1906.

<sup>2</sup> These observations are based on a series of Washakie rocks from the type locality east of Green River, Wyoming, collected by Mr. Walter Granger of the American Museum Expedition of 1906.

angular grains. Green hornblende is next in abundance and brown biotite, sometimes in foils of hexagonal outline, is present in smaller quantity. Carbonate of lime frequently acts as the cementing substance. A few grains of garnet and zircon are present in some of the sandstones. Pumice occurs abundantly in cottony masses scoriaceous in texture and either isotropic or showing aggregate polarization, with numerous inclusions of small, black, opaque, magnetic grains. Some of the pumice grains are red externally. No quartz has been found.

#### UPPER WASHAKIE.

2. *Tuffs*. These are white and pale green rocks containing the same minerals as the sandstones but in a finer state of subdivision and with pumice predominating. The grains of the latter are almost always devitrified, giving aggregate polarization. Plagioclase feldspars (oligoclase-andesine), hornblende, augite and biotite are among the minerals recognized. No quartz has been identified. Carbonate of lime may be present or absent. Some of the white tuffs show anastomosing root canals conspicuous against the white background by a slight yellow stain. The greenish tuffs usually crumble readily when wet but do not become plastic, while the white tuffs are more resistant, do not crumble and are unaffected by dilute acid.

3. *Clays*. The Washakie clays are greenish and purplish in color, slightly plastic when wet and, when examined microscopically are seen to be composed of exceedingly fine-grained irresolvable material with aggregate polarization.

4. *Feldspar conglomerates*. These are very peculiar rocks composed of small cleavage blocks of plagioclase (oligoclase-andesine) in a matrix of fine, angular feldspar fragments, biotite, hornblende and pumice. The matrix and many of the feldspar grains are of a pale greenish color. More or less calcareous cementation is present. The larger fragments of feldspar have the corners rounded off and are very slightly kaolinized. No quartz has been found in this conglomerate where it should be expected to occur if quartz is a constituent mineral of the Washakie rocks, as the conglomerate is evidently a natural concentrate.

#### *Summary.*

The difference in petrographic character between the Bridger and Washakie has an important bearing on the problem of correlation in time.

The Bridger rocks are rhyolite tuffs containing glassy sanidine while the Washakie rocks are andesitic with soda-lime feldspar. From the absence

of agglomerates and the fine-grained character of much of the ash it seems probable that it was transported mainly by the wind, and as the prevailing winds are at present from the west and had probably the same direction in Tertiary time, the centers of eruption should be located somewhere in the west or southwest. The absence of agglomerates does not favor the idea of local contemporaneous vents discharging rhyolitic and andesitic ash respectively and the great thickness and uniform petrographic character of each formation is opposed to the conception of rapid variation in the chemical composition of the ash at a single center of eruption. Assuming contemporaneous deposition from two centers of eruption it seems probable, in view of the comparatively short distance separating the areas occupied by the two formations (about 50 miles)<sup>1</sup> that some intermixture of the two types of ash should be found, but the conspicuous absence of plagioclase feldspar from all the Bridger tuffs and its presence in all those of the Washakie shows that this has not occurred. The lithologic evidence, therefore, does not favor the idea of contemporaneity for any part of the Bridger or Washakie.

The faunistic evidence of contemporaneity of the Lower Washakie and Upper Bridger is therefore in contradiction to the lithological evidence.

PRINCETON UNIVERSITY,  
December, 1908.

---

<sup>1</sup> Estimate based on map of Fortieth Parallel Survey.

