

ART. VII.—*Mineralogical Notes* ; by WILLIAM P. BLAKE.

1. *Thenardite, Mirabilite, Glauberite, Halite and associates, of the Verde Valley, Arizona Territory.*

THE deposits of sulphate of soda of the valley of the Verde river near the military post of Camp Verde have long been known, and extensively quarried, by the rancheros of the region as a substitute for salt for cattle and horses. The occurrence of thenardite in Arizona was first made known to science by the late Prof. B. Silliman, in 1881,* but he had not visited the locality and it has not been described. A recent visit to the place, and a somewhat hurried and superficial examination, enabled me, however, to collect and identify other allied species in association with the thenardite, and a peculiar pseudomorph of carbonate of lime after glauberite.

The deposits of the thenardite and the associated minerals are of considerable magnitude, covering several acres in extent, and reach a thickness of some fifty or sixty feet or more. They appear as a series of rounded hills with sides covered with a snow-white efflorescence and a greenish-colored and yellow clay at the bottom and top, partially covering the saline beds from view.

* This Jour., xxii, 204, 1881.

These beds are doubtless remnants of a much more extended deposit which occupied a local lake-like depression, or basin, probably at the close of the great volcanic era during which most of the mountain valleys of central Arizona were filled up by sediments and then overlaid by successive streams of lava. Sedimentary beds of volcanic origin remain throughout the Verde valley and its chief tributaries, and in the region of Camp Verde are deeply eroded, but rest on the uneven floor of ancient pre-Silurian slates standing on edge. High above the deposits of the valley, vertical cliffs of hard lava mark the edges of extended mesas of *malpais*, under which all the other formations are hidden and protected. But the excavations in the banks of the sulphate of soda are insignificant in comparison with the magnitude of the beds, and have failed to show, conclusively, any bottom or top, or to reveal the true relations of the beds to the surrounding formations. Whether or not they are members of the volcanic series or of a later and more local origin is yet uncertain.

Thenardite.—This salt constitutes the bulk of the deposits. It is a coarsely crystalline mass, so compact and firm that it can be broken out only by drilling and blasting with powder. It varies in its purity. Some portions are more or less contaminated with a greenish colored clay, but it is obtained also in large masses nearly colorless and transparent, with a slight yellowish tint, but seldom showing crystalline forms.

Mirabilite.—The hydrous sulphate of soda occurs in close association with the thenardite and appears to penetrate its mass in veins, but may prove to be an overlying bed. It is this species which, by its rapid efflorescence when exposed to the air, covers the whole deposit with a white powder and a thick crust through which the quarrymen must cut before they reach the solid banks of the anhydrous sulphate.

Halite.—Rock salt in beautifully transparent masses is sparingly disseminated in portions of the great beds. These crystalline masses, so far as observed, do not exceed an inch or two in thickness and no evidence of the existence of any separate workable beds could be seen. It is irregularly disseminated in the sulphate. Some masses exhibit beautiful blue tints of color, like those seen in the salt of the Tyrol and of Stassfurt. Good fragments for optical and thermal experiments could be obtained here.

Glauberite.—This anhydrous sulphate of lime and soda is an interesting associate of the other species. It occurs chiefly near what appears to be the base of the deposits, in a compact green clay. It is in clear, transparent, colorless crystals, generally in thin rhombs, lozenge-shaped, with the plane angles of 80° and 100° , and from half an inch to an inch or more broad

and one-eighth to one-quarter of an inch in thickness. The prismatic planes I, I , are generally nearly obliterated, or are absent, through the great development of the hemi-octahedral planes -1 , replacing the obtuse terminal edges. The terminal plane, O , is chiefly developed and this with the broad planes replacing the obtuse edges gives to some of the crystals the appearance of rhombohedrons of the minus series. The general habit of the crystals is similar to those from Westeregeln near Stassfurt described by Zepharovich;* with the predominating pyramid -1 , occur also the pyramids $-\frac{1}{3}$, $-\frac{1}{2}$ and either $-\frac{2}{3}$ or $-\frac{4}{5}$; traces of a pyramid on the acute edges have also been noted. There is evidence that the crystals vary greatly in size and in their habit in different parts of the deposits. They occur also in the midst of portions of the solid thenardite as inclusions, and in one instance a small crystal was found in the midst of a transparent mass of halite. Close inspection of the transparent tabular crystals from the green clay reveals the presence of crystalline cavities with fluid inclusions made evident by the movement of small bubbles. When heated the decrepitation is violent.

Carbonate of lime pseudomorphs.—Where the lower bed containing the bulk of the glauberite crops out at the surface and has become oxidized and dried, the glauberite disappears and is replaced by carbonate of lime in an amorphous condition but having the exact form of the glauberite crystals, whose matrix they have filled. These pseudomorphs are firm, compact and dense, but are without cleavage or interior crystalline structure. Color, cream-yellow. They weather out in great numbers and show that the glauberite must occur in a great variety of sizes and forms of aggregation, in some places in rosettes and in others in crystals two or three inches long.

2. Bournonite in Arizona.

Bournonite occurs sparingly at the Boggs Mine, Big Bug District, Yavapai County, Arizona Territory, associated with pyrite, zinc blende, galenite and copper pyrites. The crystals are brilliant and characteristic, with interesting modifications not yet studied and compared. This is believed to be the first announcement of the occurrence of this species in the United States. I am indebted to Fred. E. Murray, Esq., superintendent of the mine, for specimens.

* Sitzungsber. Akad. Wien, vol. lxi, 1874.