PROBABLE EOCENE GLACIAL DEPOSITS IN THE FORT APACHE REGION, ARIZONA.*

BY

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When the writer wrote his article on the Fort Apache Region, Arizona, much uncemented gravel and boulders was found capping the mesas and underlying the lava flows. These deposits he placed in the Tertiary and Quaternary. In his section on Canyon creek, Arizona, from the source of that stream to its confluence with Salt river, he gives 125 feet of coarse, uncemented gravel, of gneiss and quartzite boulders, capping the clastic rocks. Gilbert's section at the crossing of Canyon creek also gives 20 feet, coarse uncemented gravel of quartzite and gneiss boulders.** Some of the writer's other sections in that region are here copied in whole or in part to show the existence of this material in various parts of the reservations, as follows***:

Section in Seven Mile Hill canyon, five miles southeast of Fort Apache, Arizona.

		Feet
1.	Basalt	200
2.	Volcanic ashes	10
3.	Strata of mostly unlithified sand and clays	40
4.	Shale, light colored, sandy	4
5.	Conglomerate rock, the cement being volcanic ash. The pebbles and cobble stones of this series being quartzite, granite, andesyte, rhyplyte, limestone of the Palaeozoic era, etc., (no cobblestones or pebbles of the basaltic type were found in this conglomerate).	60
6.	Strata of partly lithified coarse grained, reddish to light brown sandstone, composed of angular and rounded grains of granite, rhyolyte, etc. In this series the rhyolyte-trachyte particles predominate.	200
7.	Red gypsiferous shales with sandstone and limestone of the Carboniferous age .....600 to	1100
		1614

Section along East wall of Cherry Creek Canyon, Arizona, seven miles north of Salt River, near Mr. James Hinton's house.

		Feet
1.	Light to dark brown rhyolyte	30
2.	Conglomerate rock	80
3.	Tufa conglomerate and agglomerate	20

*For references on this region the reader is referred to the following: Gilbert, G. K., and Marvin, A. R., U. S. Geogr. Sur. west of the 100th Meredian, Vol. iii, and special references as follows: Gilbert, pp. 163, 164, 165, 526-528; Marvine, pp. 221-223.

Loew, Oscar, *ibid.*, pp. 587, 642.

Reagan, Albert B., Geology of the Fort Apache Region in Arizona, Am. Geologist, Nov., 1903, pp. 265-308, 2 maps, 1 plate.

**Gilbert, *ibid.* p. 164; Reagan, loc. cit., p. 270.

***Reagan, *ibid.* pp. 270-275.

4.	Light gray sandstone	10
5.	Rhyolyte	30
6.	Gray sandstone and conglomerate	100
7.	Fine grained, gray to brown sandstone, composed of ground up Archean and Palaeozoic rocks, granite, rhyolites, diabases, etc.	40
	Total—apparently all Tertiary	210

Section South of White river, three miles west of Fort Apache.

		Feet
1.	Basalt	200
2.	Unlithified volcanic ashes	10
3.	Loose strata of slightly lithified clays and sands	40
4.	Carboniferous, red gypsiferous shales with sand stone and limestone ....600 to	1000
		1250

Generalized Section on the Government trail from Ellison's to Canyon creek.

		Feet
1.	Adobe	8
2.	Loose cobble stones and pebbles	1
3.	Yellow clay interstratified with loose sand	4
4.	Cobble stone stratum	1
5.	Light yellow to pink, lithified, stratified rock, composed of fine grains of Archean and Tonto rocks	10
6.	Dark brown, partly lithified sandstone	1
7.	Yellow to brown and pink, cross-beded sandstone	10
8.	Conglomerate series	20
9.	Porphyry, gneiss and granite rocks (intrusive)	100
10.	Tonto sandstone and shales (Cambrian)	500
11.	Archean (?) hornblende biotite granite, olivine diabase and hornblende diorite	500
	Total	1155

Section on Carrixo Creek (after Gilbert).*

		Feet
1.	Coarse gravel composed of vitreous sandstone, quartzite, and gneiss boulders	50
2-7.	Clastic rocks	1370
	Total	1420

*Gilbert, *loc. cit*; Reagan, *ibid.*, p. 274.

Section North from near Camp Apache (Fort Apache) (after Gilbert)).**

		Feet
1.	Basalt and basalt gravel	70
2.	Pale pink slightly coherent, massive sand and gravel resting unconformably on No. 3............................	520
3-6.	Clastic rocks	1670
	Total	2260

It is quite possible from the data at hand that the deposits have accumulated in Seven-mile Hill section and in the Salt River and Hinton regions and in many other places in the area, covered by this paper throughout the Tertiary and may have begun even earlier. A part of the series which the writer had originally designated "Tertiary", principally in the sections mentioned above, begins with a consolidated, coarse conglomerate stratum, beneath which are strata of partly lithified sands, clays and gravels reaching a thickness of nearly a thousand feet in thickness in some places. The formation is found, for the most part, in the ancient canyons of the region. Conformably on the formation above designated "Tertiary", in this paper and in my original report on the region, are hundreds of feet of unconsolidated gravels and clays and occasionally volcanic ashes. This series covered the entire region, excepting possibly the Ellison dome, so that the lava flows which closed the Quaternary, flowed over a plain. Since then much has been removed so that now it is patchy, except where it is protected by superimposed lava. It now fills the valleys of the Pinal and Apache mountain districts; the volcanic and plutonic rocks projecting above it as peaks and mountains. The middle Cherry creek valley and the Tonto basin, as well as the Ellison flat, are covered with it. It covers the Mogollon mesa together with its southern prolongations, including the Cibicu divide, to a thickness of from five hundred to a thousand feet in many places. It is the surface rock of much of the Kelley butte country, and extends beneath the lava of the Nantan Plateau as far as visited.

At the time the writer studied the region, he believed that these deposits were due to a stage of ponding, as a result of differential uplift and lava flows, since he found no glacial striae; but since his study of the glaciation in the San Juan mountains in Colorado and the Deep Creek region, Utah, he has been compelled to change his views and conclude that the deposits in question are of glacial origin and probably in part due to laking, as a result of glaciation and volcanic disturbances. This view is also born out by the fact that the Cibicu divide and the Mogollon mesa, which are both heavily covered with this drift, are higher than the surrounding country and show no evidence of a laking stage.

The deposits, clays, sands, gravels, and boulders of schist, quartzite, gneiss, carboniferous rocks, vitreous Tonto sandstone, diorite, trachyte, rhyolite, and Archean rocks, indicate different development centers for the

**Gilbert, *ibid.*, p. 165.

glaciers that swept over the region. The materials of the Seven-Mile Hill deposits and those beneath the lava flows of the Nantan plateau indicate that the glaciers came from the White Mountains to the eastward. This is also indicated by the dip of the clays and sands. But the deposits of the Cibicu divide indicate by their composition that they came from the west and northwest (and possibly from the southwest), as do also the Hinton and Salt river deposits the latter being composed of quartzites, gneiss, vitreous Tonto sandstone, Archean and Palaeozoic rocks, and biotite granite, all of which are exposed in the upper Canyon creek region, the Ellison dome and the Tonto basin, and south of Salt river along the western face of the Plateau. It is also quite probable that some of the debris came from the mountains to the northward.

From the inadequate data at hand it would seem that at least the deposits below the partly consolidated conglomerate series are Tertiary, extending to the early Tertiary, as Gilbert, Marvin, and the writer concluded when examining the region, and that the remainder are Quaternary, as was also then concluded. This being the case, as the facts at hand seem to indicate, we would, therefore, have had glaciation here in the early Tertiary, probably in the Eocene period, repeated again in the Quaternary. Laking in consequence of blocking lava flows and faulting probably played their parts as did also the subsequent development of drainage, which is, in part, inverted and, in part, diverted.

The finding of glacial material forming the opening series of the Eocene in many parts of the world brings again to the fore with emphasis the fact that glacial epochs have occurred at the beginning (or the close) of each great era of geologic time. This raises the question again, Why do geologic eras close? Is there not a cosmic cause? And as the writer has suggested in previous publications,* may not these changes both in climate and in the readjusting and rebuilding of the earth's crust be due to results brought about by our solar system having reached one or the other terminus of the great elipse around which it is whirling with its company of planets, meteors, planetoids, secondary planets, and comets, much as our extreme yearly seasons are caused by similar positions of the earth with reference to the path it travels around the sun and to the inclination of its axis.

*Regan, Albert B., The Glacial Epoch, Trans. Acad. Sci. of Kansas, Vol. XXVI, 1913, pp. 70-83; Sunspot, Vol. 1, No. 11, January, 1916, pp. 13-30.