



PITTED COBBLES OF NORTHWESTERN OKLAHOMA

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Much of northwestern Oklahoma seems to have been formerly covered by Tertiary sands and gravels; and in the far west extensive Tertiary deposits still hide the Permian Red Beds. But eastward these deposits become thin and patchy, and in the main zone of Permian deposits are represented by pebble-sprinkled areas only a few acres in extent, on the higher lands.

In the easternmost areas the pebbles are well rounded, and composed of rocks most resistant to weathering; chiefly quartz and quartzite, with occasional fragments of opaline silica and petrified wood. The average size of the pebbles is less than two inches in dimensions and most of them are about the size of marbles. To the west and northwest the stones are larger, they are not so well rounded, and pebbles of granite and porphyry become common. In the vicinity of Medicine Lodge, Kansas, pebbles of these materials are abundant.

Westward, beyond the area where such gravels are common, there are outliers of rocks of Lower Cretaceous age. These have been described by Bullard¹ who found, south of the outcrop of these deposits in southern Kansas, four areas in Oklahoma where there are small scattered remains of the beds.

For a few miles eastward from the exposures and outliers of Lower Cretaceous rocks, there are fragments of a characteristic yellow shell-bed, and fragments of other fossils from these deposits, in the gravel; but from the easternmost gravel patches these relatively soft fragments are absent.

¹Bullard, Fred M., Lower Cretaceous of Western Oklahoma: Oklahoma Geol. Survey Bull. 47, October, 1928.

The gravels themselves probably merge eastward and southward with more definitely Quaternary gravels.

In addition to the pebbles which make up the Tertiary and Quaternary gravels there are others, apparently of somewhat different history, to be found associated with them. These will be referred to as cobbles, to distinguish them from the ordinary pebbles of the gravels; for in average size they are larger, being from two or three inches in dimensions up to five or six inches. Nearly all of them are irregular in shape, many retaining the angular shapes of the original rock fragments, and are peculiarly pitted on all surfaces. Practically all of these cobbles consist of very hard, fine-grained gray quartzite, or of very hard, compact, coarse-grained sandstone or grits. Rarely a fragment of quartz or of opaline silica is also found pitted.

In the vicinity of Medford, these cobbles are fairly common along the bases of small breaks that border the courses of minor drainage channels. The cobbles and pebbles have apparently been left and to some extent concentrated by the removal of the finer sediments by erosion.

In many places farther southward, patches of upland gravel or merely a scattering of pebbles over areas only a few acres in extent seem to be the final remnants of the gravel beds. In most of such places a few of the pitted cobbles can be found. In some places, however, no cobbles are in evidence; whereas in a few places the cobbles are common but rounded pebbles are scarce. No cobbles have been seen by the writer, east of the eastern limit of the Permian formations.

In the easternmost localities the cobbles are not so strikingly pitted, but they are better polished. In the western localities they are notably rougher, and more deeply pitted. Some of the best specimens were found in the Harper district, and in this and other western areas they are in some instances coated with a thin film of lime carbonate. Farther west, in the gravels near Medicine Lodge, and beyond, no pitted cobbles were noticed in the Tertiary gravels; but in one locality in western Kansas, a few pebbles were found, that seemed to have incipient pitting, and in the same district a few blocks of quartzite exhibit the same condition on a larger scale.

The presence and character of the pebbles left as remnants of the Tertiary gravels have been observed by many geologists and mentioned in print by a few. In 1917 Dr. Bloesch² commented on the angular frag-

²Bloesch, Edward: Observations on Post-Permian Deposits in North-Central Oklahoma; Bulletin Southwestern Association of Petroleum Geologists, Vol. 1, pp. 136-139, 1917. Mentions of flinty or cherty material with slick surface due to wind polish, and referred to their origin, age and manner of deposition as an unsolved problem. Those to whom the writer has sent or shown specimens of the cobbles have usually dismissed them as some phenomenon of aerial weathering, presumably produced by the scouring action of wind-blown sand.

In early notes on the distribution of the cobbles, it seemed for a time that they might in some way be related to a horizon in the Permian, as they appeared to be distributed along a broad zone in the Permian area and might have been originally in one of the upper formations; and as

erosion progressed they might have been left as residuals scattered over the surface. However, no such hypothesis of their distribution would explain the present association of the cobbles with the well-rounded pebbles, nor hint at the origin of their peculiar pitting. Later, the cobbles were observed, apparently in *situ*, in a gravel at the base of the Lower Cretaceous beds. The Oklahoma and Kansas Highway No. 1 crosses this gravel about ten miles south of Coldwater, Kansas, and cobbles may be picked out of the road bank; a fair specimen being in evidence perhaps every ten or twenty yards. The road cut is only three or four feet deep, and the gravel is not much thicker and is covered by a residual soil. In some instances the cobbles are covered with a thin deposit of lime carbonate, like some of those found near Harper. They are also plentiful a few miles farther south, near the base of Avilla Hill, which forms a prominent outlier of the Lower Cretaceous beds, on the State Boundary. It and other remnants of the Lower Cretaceous have been described in detail by Bullard in his report on them. The cobbles are also fairly common in the Tertiary gravel area that extends for several miles east from Avilla Hill.

Without going further into detail, nor attempting to list various possible means to account for the pitting of the cobbles, the writer's suggestion is that the action has been one of partial solution of the very siliceous stones. Their irregular forms suggest such chemical action; for it is similar shapes that limestones, salt and other more readily soluble substances take on, during the progress of solution. It would seem that these stones have been partially dissolved by corrosive water, possibly at a time when the gravel containing them was at or near local ground-water level. Only an occasional cobble in the gravel seems to have been so affected, perhaps because the necessary conditions for considerable solution were developed only adjacent to these pebbles. Possibly the structure or texture of the stone had something to do with it, as it is the granular stones (quartzite and grits), that have been chiefly affected. Only rarely has a quartz pebble been thus attacked. That there has been some such chemical action where the Lower Cretaceous beds rest on the Permian seems to be further shown by the deposit of lime carbonate on some of the cobbles; and in a few places, notably along the east side of Avilla Hill, by the presence of many platy fragments of iron oxide in the thin gravel. This oxide seems, from the shape of many of the fragments, to have been deposited upon the pebbles, and further indicates chemical action within the gravel.

It is suggested, therefore, that the pitted cobbles have come from the basal gravel of the Lower Cretaceous deposits and that they there received their deep pitting by partial solution by alkaline ground-water. When later exposed on the surface and in some places incorporated in Tertiary gravels, they have become polished, and perhaps in some localities where long exposed on the surface, have acquired an incipient desert varnish, such as gives the gloss to many desert pebbles.

Such conditions would conform to Bullard's idea that Lower Cretaceous beds completely covered the Permian in Western Oklahoma, with a basal deposit of gravel and sand laid down directly on the Red Beds. He

believes that later erosion removed all but scattered outliers, and that Tertiary deposits were then spread over, preserving these outliers, which have been re-exposed by post-Tertiary erosion. That no pitted cobbles have been noticed east of the Permian limits, indicates that neither Cretaceous nor Tertiary deposits overlapped onto the Pennsylvanian.

Some of the pitted cobbles were probably incorporated in and transported with the Tertiary gravels; but where they are most common, with relatively few rounded pebbles, they may represent final remnants of Lower Cretaceous outliers.