

erodes readily and contains a considerable amount of sand. This is the condition, not only of the main streams, but also of the tributaries so far back from the main stream that change in its bed could not possibly affect them.

From the relation of the present stream bed of the South Canadian to its previous stream beds and also to the terraces it appears that the river at present is cutting its bed downward. However it may have aggraded its bed at times in the past and may do so again in the future.

XXV. BURIED MOUNTAIN RANGES IN OKLAHOMA

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It is a well known geologic axiom that granite (used in the sense of igneous and metamorphic rock) underlies all other rocks. Granite is the most common expression, on the earth's surface, of the basal complex or earth stuff, which occupies by far the larger portion of the planet on which we live. We were taught in our student days that if we drill deep enough anywhere on the earth's surface we would encounter granite.

So, academically, we have known that granite underlies all of Oklahoma, and that if the blanket of sedimentary rocks, including the sandstones, limestones and shales, could be removed, that this granite floor would be exposed. However, until recently, we have had very little definite information as to the occurrence of this granite, and especially as to the depth beneath the surface at which it occurs in various parts of the state.

Thanks largely to the work of the oil geologists we are now learning many things heretofore unknown. The records of the thousands of deep wells drilled in Oklahoma, Kansas and Texas, have been collected, tabulated and correlated, so that we now know more about subsurface conditions in many parts of the Mid-Continent Oil Field than in almost any other part of the United States.

It is a matter of general information that there are in Oklahoma four regions of mountain uplift, namely the Wichitas and Arbuckles, entirely within the state, and the Ouachitas and Ozarks, located partly within Oklahoma and partly in some other state. The essential structure of these four mountain regions is practically the same, being in each case an elevated, truncated dome, with the sedimentaries dipping quaquaversally from the core of the mountains. In the Arbuckles, Wichitas and Ozarks erosion has removed

the sedimentaries from the axis of the mountains, exposing the granite. In the case of the Ouachitas the granite is yet covered.

We are learning these days that not all the mountains in Oklahoma are exposed on the surface. The most conspicuous example of a buried mountain range, at least the one that has attracted most attention, is the Nemaha mountains of Kansas. For many years geologists have known that there was a row of well-marked domes and anticlines, extending north and south across east central Kansas, but it was not until about 1915, when wells were drilled on these structures in the search for oil and gas, that we learned, much to our surprise, that these surface structures were superimposed on buried granite peaks. Something like 40 or 50 wells have touched granite along a definite line, and we are now in position to say that the Nemaha mountains extend from somewhere near the mouth of the Platte river in southeastern Nebraska, entirely across Kansas and into Kay county, Oklahoma, a distance of more than 250 miles. At one point near the Kansas-Nebraska line, the granite approaches to within about 550 feet of the surface, but deepens to the south, until in northern Oklahoma, it is over 4000 feet deep.

Another buried granite range is now known to extend northwest-southeast across southern Oklahoma and the Panhandle of Texas. A series of very prominent structures in the Amarillo country in the northern part of the Panhandle of Texas, have developed into a tremendous gas field. Something like 8 or 10 wells located on these structures, and at least four wells in direct line between these structures and the Wichita mountains have encountered granite. Enough data are now available to postulate a mountain range extending from near Caddo, Oklahoma, northwest along the Arbuckle-Wichita axis, and across the Panhandle of Texas, as far as the New Mexico line. To the buried part of the range located in southeastern Oklahoma and the Panhandle of Texas, the name Amarillo mountains has been applied. The entire known length of the range is about 400 miles.

A third possible buried range lies along Red River in southern Oklahoma and northern Texas, extending from the Petrelia field in Clay county, southeast for a distance of about 50 miles. At least 8 wells along this line have encountered granite.

Studies made by various men during the past several years would indicate that there is a probable buried range paralleling the Arbuckles on the south side, visible expression of which are the Preston anticline, the Criner Hills and the Haldon, Loco and Comanche domes.

Those who have made careful studies of subsurface conditions of Oklahoma are of the opinion that other buried ranges may occur in various sections of the state, particularly in the Robberson field of Garvin county, in the Cushing oil field, and in the Inola, Spavinaw region of eastern Oklahoma.

For many years we have known of an exposure of granite along Spavinaw creek east of Grand river, in Mayes county. David Dale Owen was the first geologist to mention this exposure. Drake, Snider and others who studied the granite have been inclined to consider it a dike, but it is now believed to be the summit of a buried granite ridge now being slowly uncovered by erosion.

XXVI. INDIAN PICTOGRAPHS IN THE WICHITA MOUNTAINS

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While investigating the problem of Pennsylvanian-Permian glaciation in the Wichita mountains the writer, in September, 1922, discovered some examples of Indian picture writing at the west end of Camels Back mountain, located about eleven miles southwest of Hobart. The picture writing is engraved on the very smooth or polished surface of granite exposed at the base of the mountains, and it occupies a space some six feet in width by five feet in height. The accompanying Figure 7 from a photograph made by G. W. Long, of Hobart, reveals the character of the writing.

The lines of engraving on the polished granite are variable in distinctness, but they are usually about one-half to three-quarters inches in width and one-sixteenth inch in depth. In order to secure a good photograph of the writing the engraved lines on the granite were marked with black crayon. Later the lines in the photograph were retouched for the purpose of making the half-tone engraving shown in Figure 7. Although some obscure markings on the granite are not brought out the main features of the pictographs are shown in the figure.

So far as could be learned by the writer this example of Indian writing was not known by the white men living in the region. However, the Kiowa Indians knew of it. Since the finding of this pictograph other examples have been reported to occur on smooth granite surfaces in the Devils Canon, located some 10 miles west of Camels Back. It is quite probable that further investigation