TOOLS OF SURVEYORS AID SHALE STUDY

By EUGENE S. RICHARDSON, Jr.
CURATOR OF FOSSIL INVERTEBRATES

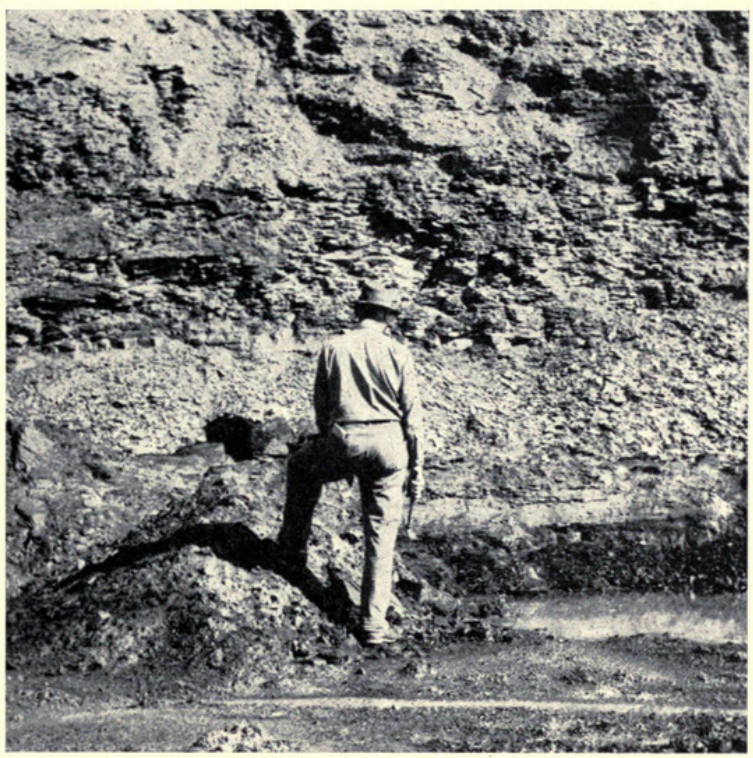
WE HAVE TOLD, in past issues of the BULLETIN, of some of the discoveries of Coal Age fossils in and near the Mecca Quarry (named for an Indiana town nearby) excavated by the Department of Geology. On this site Dr. Rainer Zangerl, Curator of Fossil Reptiles, and I have found more than 65,000 fossils and fossil fragments, whose position and orientation we have charted on a large number of scale drawings of the quarry. We have told, too, how we spent several weeks in the Mississippi River delta country exploring the *flotant* terrain in search of a modern counterpart of the living conditions of the animals of 240 million years ago that became the Mecca fossils. But that is not the end of the Mecca story.

For that matter, it will take several years of study to come to the end of the research opened up in that one small quarry of 20 square meters. There are many primitive vertebrate fossils of completely unknown types that must be assiduously prepared and studied and described. There are also many problems concerned with the geographic extent of the living conditions that gave rise to the black shales and the many well-preserved fossils that we have recovered. It is that group of problems that occupies us in the 1957 field season.

As explained in a BULLETIN article (November, 1956) Pennsylvanian living conditions at the quarry site were such as could only occur in a narrowly circumscribed area. It was not a broad open sea with uniform environment extending over hundreds of square miles; it was not a broad swamp covering several states; nor was it a shoreline hundreds or thousands of miles long with uniform environment for life all along the strand. Rather, these peculiar animals lived in a restricted basin of shallow water, probably cut off from the open sea by a series of bars or shallows, yet sufficiently open to it so that marine shellfish could get in. The surface of the water was probably covered with a thick mat of floating vegetation whose rapid decay provided the organic matter that gives the black shale its color.

CHECKING IN FIELD

Having proposed to ourselves this rough outline of the ancient local geography, we had to check it in the field. That meant examining nearby outcrops of the same rocks and studying the differences in lithology (rock composition) and fossils. We have done some of this in the recent years of studying the quarry problem and are continuing that part of the program this season. We attempted at first to follow the standard practice of correlating beds exposed in nearby places by comparing the elevations above sea level at which we find the outcrops. Because the Pennsylvanian (Coal Age) rocks appear to be very nearly level in most exposures, it is a handy assumption that they actually are level and that therefore, if a certain bed appears on the surface of the ground at 550 feet above sea level in one creek valley, it will also appear at 550 feet above sea level in the next valley, a half mile away. But actually this is not so, as detailed mapping soon shows.



NATURE PROVIDES GAUGE

Museum scientist studies a vertical-wall exposure of the rocks lying above the Mecca quarry shales. Only in such vertical exposures can the true thicknesses of these beds of rock be determined. This one is in the wall of a fire-clay pit of the Clay City Pipe Company near Montezuma, Indiana.

Since proper correlation of beds is fundamental to tracing the rocks formed at the same time, we have in several instances made detailed maps, using standard surveyors' instruments, as a guide in tracing the exposures. At the same time, these maps show us the sequences of rock types exposed in the several gullies and hillsides that we have mapped. Using the assumption that the beds are fairly flat-lying, at least over short distances, we were at first satisfied to determine the elevations of the successive beds seen in a given gully and then to arrive at the thickness of a bed by subtracting the elevation of its bottom from the elevation of its top. However, as we

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SOUTHWEST EXPEDITION BREAKS NEW TRAILS

By PAUL S. MARTIN
CHIEF CURATOR OF ANTHROPOLOGY

MEMBERS of the 1957 Southwest Archaeological Expedition look forward to the present season with high hope and eagerness. Digging is to be done in an area that has been "surveyed" by archaeologists but in which little or no systematic excavation has ever been carried on.

The area to be worked lies in a triangle that is approximately bounded by Springerville, Show Low, and St. Johns, Arizona, and includes the headwaters of the Little Colorado River in east-central Arizona. The base camp is near the town of Vernon. Dr. John B. Rinaldo, Assistant Curator of Archaeology, will accompany me on the expedition, Roland Strassburger, of Winnetka, Illinois, is expedition photographer, and other personnel will join the expedition in the field.

SUMMARY OF PAST RESEARCH

Before explaining why this area was chosen for continuing our research a brief summary of what we accomplished in New Mexico during the fifteen seasons we worked there will place our present tasks and queries in clearer perspective.

We found that the Mogollon Indians had inhabited the Pine Lawn Reserve area in New Mexico continuously for about 3,800 years (2500 B.C. to A.D. 1300) or perhaps even longer. At first they depended more on wild plants for subsistence than on corn and beans, but later this situation was reversed. They lived in earliest times in caves or flimsy shelters, cooked in baskets, hunted with a throwing stick and spears, and used tools that were serviceable but rough. Later they built pit-houses and surface pueblos, made pottery and cooked in it, improved their techniques of basket making, weaving, and producing tools of bone and stone.

In short, we have traced the development of a civilization from an early primitive level to a more advanced one. Every phase of Mogollon life showed progress and improvement.

UNEXPLAINED EVACUATION

But, suddenly, at about A.D. 1300, these people abandoned a forested mountainous area, a region that today seems attractive to *us*, at least, and moved out. Why they moved on is unknown and what became of them is uncertain. But we know that some of our Pine Lawn Mogollon Indians moved

north and west into the country drained by the Little Colorado River in Arizona.

The area in Arizona in which we shall conduct research for the next several seasons was chosen because it was the one that was most likely to yield answers to some of our questions: (1) What happened to the Mogollon Indians of the Pine Lawn area after they moved to a different region? (2) Did these people make a successful adjustment in their new homeland? (3) Did they remain there or did they pass out of existence completely? (4) If they did not perish, what eventually became of them and can they be identified with any known contemporary group of Indians such as the Hopi or the Zuni Indians? (5) Were the Mogollon Indians the first settlers of the area drained by the Little Colorado River or, if not, who preceded them and what is their history?

These are but a few of the questions that are going through our minds as we start our westward trek. If we obtain even a partial answer to any one of them, we shall be fortunate indeed; for archaeological problems are easy to formulate but sometimes difficult or impossible to solve. I think it is easy to see that these problems give impetus and zest to the expedition. Further, we shall be working in a district that is, in an archaeological sense, virtually untouched.

SHALE STUDY—

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accumulated more and more information from more and more gullies, we found notable discrepancies in both elevations and thicknesses derived in this way. Further, we found the same discrepancies in studying old reports of this area, some published soon after the Civil War. We wanted to be able to use many of these reports because they were based on exposures that are now, in many cases, covered by building, by soil-slides, or by changes in stream courses. Yet, as we have studied the rocks and the old reports, we have with regret had to discard much information that looked at first as though it would be useful, and we have come to realize that elevations of beds and also thicknesses have only a local significance.

This was well illustrated for us in April of this year, when, in surveying a small creek valley near Mecca, we found the quarry shales exposed at three places on the sides of the valley and at a fourth in the bed of the stream. The elevations at these four points, though the outcrops lay within a radius of a few hundred feet, differed by as much as 15 feet. Obviously, then, we could not use any one of those elevations in computing the thickness of beds lying between the quarry shales and another bed, the "Staunton B," exposed in the lower course of the stream half a mile away. Obviously, also, we could not rely on any other thicknesses derived in that way by the other geologists who have worked in the area.

However, all was not negative, for we gained some positive results as well. Why, we asked ourselves, do the thicknesses and elevations vary so much? Elevations may vary because of a bed having been wrinkled by compressional earth forces. We know that there has been some activity of this sort in Indiana and Illinois. Indeed, early in May, in a creek bed near West Union, Indiana, we found a small pinched fold in the Pennsylvanian rocks showing rather intense local compression of the earth's crust. But the structural movement of the rocks thus indicated is a later feature than the rocks themselves; unless structural deformation is very severe it doesn't affect the thickness of

WADING FOR SCIENCE

Dr. Rainer Zangerl, Curator of Fossil Reptiles, adjusting the plane table used in surveying an Indiana creek valley. Because of dense vegetation, lines of sight can be found often by working right in the water of streams.

beds of rock. Is it possible that there were similar differences in elevation during the Coal Age itself? And, if so, what would cause such a thing?

POSSIBLE EXPLANATIONS

The answer seems to be that there probably were local differences in elevation while the rocks were being deposited. This is a necessary consequence of some of the rock types found in the sections. For example, in two nearby creeks we find the interval between "Staunton B" and the quarry shales differing by as much as ten feet. Now, this may be merely an apparent difference due to the difficulty inherent in measuring thicknesses by subtracting elevations. But the rocks occupying this interval supply an alternative explanation that seems very attractive. The thinner interval is occupied entirely by soft shales; the thicker interval is in part occupied by sandstone. Now, shale is formed by the squeezing and hardening of a clay mud, and sandstone is formed from a wet sand. If you have ever made mud pies you will recognize that mud holds a great deal of water; when the mud dries out it shrinks and cracks—it occupies a much smaller space. Sand castles, on the other hand, don't shrink, though they may fall apart because there is nothing to stick the grains of sand together when they dry out.

Now, if the sea bottom on top of the Staunton B had been covered with a layer of plain mud in one place and a combination of mud layers and sand layers a half mile away, forming a level bottom, the mud in the first spot would lose more volume in turning to rock than the mud and sand in the second spot, with the result that the coal deposited on top of this surface would develop a sag. Then, when the coal was submerged again, there would be a relatively deep pool in one place and a shallow one in another. Conditions such as we have postulated for the deposition of the quarry shale would be met, the animals living in the deep pool would be partially cut off from the open sea, and oceanic waves would not disturb the isolated pool.

It is still necessary for us to put this hypothesis to further tests in the field before we are entirely satisfied with it. It is just one of the facets of the problem of the black-shale fossils, but one whose place in the total picture is as important as any.

AWARD FOR BOOKMAKING WON BY MUSEUM

At the Eighth Annual Exhibition of Chicago and Midwestern Bookmaking held by the Chicago Book Clinic, Chicago Natural History Museum was presented a Certificate of Award in recognition of its entry *The King's Day*, by Mrs. Webster Plass of New York and London (BULLETIN, October 1956 and November 1956). The award, recognizing the high standards of design, printing, binding, publishing intent, and reader appeal, is particularly gratifying in view of the fact that the competition included entries from commercial publishers and carefully planned advertising brochures from many outstanding commercial organizations. The design, planning, and supervision of the publication were accomplished by Helen A. MacMinn, Associate Editor of Miscellaneous Publications on the staff of this Museum, who received a similar award from the Chicago Book Clinic in recognition of her contribution to the excellence of the publication. All phases of the work, including the photography, were done by the Museum organization with the exception of the photoengraving by Jahn and Ollier Engraving Company. The booklet was prepared for presentation to all guests of the Museum on Members' Night in October of 1956, and since that time has been on sale with other popular publications of the Museum.—C.C.G.