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OCCURRENCES OF PALEOZOIC CARBONACEOUS DEPOSITS IN THE MOGOLLON RIM REGION

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The Mogollon Rim is a southwest-facing escarpment extending for many miles in a northwest-southeast direction in central Arizona. Approximately five miles northwest of Pine, Arizona, the Rim is transected by a wide, steep-walled gorge called Fossil Canyon, the name being derived from carbonate-encrusted sycamore leaves found in springs in the canyon bottom.

In June of 1956, a visit was made to a copper prospect on the southeast side of Fossil Canyon. Access was by foot only and the trip down into the canyon was over nearly flat-lying red beds of the Pennsylvanian-Permian Supai formation. Gray shaley zones were encountered that contained small bits of coaly material. Farther along several small patches of coal bloom were noted.

The copper prospect, located approximately ¼ mile northeast of the coal bloom area, consists of a small pit exposing carbonaceous trash in a gray mudstone. Malachite halos and some azurite are present in the carbonaceous trash zone.

During the Fall of 1959, an Arizona public utility proposed to build a coal-powered generating plant in New Mexico, a steel plant was envisioned for Clarkdale, Arizona, and several companies were actively engaged in iron-ore exploration within Arizona. Under this impetus, a more extensive investigation of the coaly horizon in Fossil Canyon seemed warranted.

Samples taken in October 1959 contained visible traces of copper. In view of the deleterious effects of small quantities of copper on certain uses of coal, analyses were made. Whole-sample content was less than 2 percent copper, whereas the ash remaining from combustion tests yielded 8 percent copper. Microscopic study of the gray-colored ash showed the presence of small, rounded blebs of metallic copper. Subsequent analyses on other samples of coaly material ranged to a low of 0.18 percent copper.

The copper values of the first samples taken left some question as to whether the land, located in the National Forest, should be prospected under lode claim laws, or whether coal-prospecting permit applications would suffice. It was decided to use lode claim laws for ingress and egress while coal prospecting permit applications were being processed.

Stratigraphic evidence suggested that the horizon containing the coaly material was either Pennsylvanian or Permian in age. A search of the literature indicated that the westernmost known outcrop of Paleozoic coal in the United States, (Dumble, 1902), is located in the Chiricahua Mountains of southeastern Arizona where it is believed to crop out near longitude 109 degrees 10 minutes west. The Fossil Creek material crops out near 111 degrees 33 minutes west.

Ransome (1916), in a description of the Supai formation in the Fossil Canyon area, mentioned the occurrence of a "very impure lignite, reported to be in places 20 inches thick — and is said by prospectors to be accompanied by some native copper." Ransome also stated that the lignitic bed occurred just under a limestone conglomerate about 12 feet thick containing limestone pebbles as much as 2 inches in diameter.

Prior to excavation work during the winter of 1959-60, the following generalized section was measured on the southeast side of Fossil Canyon:

Lithology	Thickness (feet)
Conglomerate, limestone pebble, lime-cemented	12.0
Shale, light gray	5.0
Coaly zone	1.3
Shale, light gray	10.0
Coaly zone	1.0
Shale, light gray	13.0
Coaly zone	0.5
Shale, light gray	15.0

It is interesting to note that there are three horizons of carbonaceous material each separated by light-colored shales, and all below a limestone-pebble conglomerate. It seems almost certain that the "lignitic" horizon of Ransome is included in this partial section.

The carbonaceous zone, being relatively incompetent, does not yield good outcrops. Tracing of the zone during the excavation phase was hindered by a widespread cover of slope wash. Excavation revealed that the unit is not everywhere continuous because it is cut out, at least locally, by red sandstone and shale. To the northeast in Fossil Canyon, a calcareous sandstone occupies the stratigraphic position of the carbonaceous zone.

Coaly materials exposed in excavations were severely oxidized (Fig. 1). However, a sample of the least-oxidized material available was found to yield slightly more than 10,000 B.T.U.'s per pound, suggesting a bituminous rank. The carbonaceous zone crops out again on the

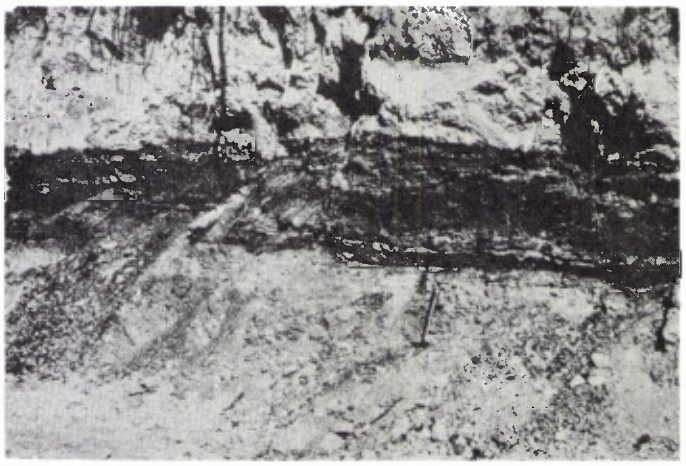

Figure 1. Excavated face of coal-bearing zone, Fossil Creek Canyon.

northwest side of Fossil Canyon about 1 ½ miles north of the area discussed above. There are two seams or horizons separated by about 15 feet of mudstone. This zone can be traced laterally for at least 900 feet. Small pieces of malachite and azurite, associated with gypsum, weather out of the coal bloom. Both ends of the outcrop are covered by alluvium.

Twenty-four miles east of Pine, a unit containing carbonaceous material is exposed near the base of the Mogollon Rim at Promontory Butte. In the late 1950's a uranium company drilled several holes and drove a short adit into the base of this unit. One coaly seam was encountered in the larger carbonaceous zone. Drill logs indicate a spotty content of copper carbonates, whereas, megascopic quantities of chalcopyrite, chalcocite, sphalerite, and black uranium minerals are exposed in the adit.

Approximately twenty miles south of Holbrook, Arizona two deep holes were drilled at least 7 miles apart: Union-Continental Oil, Aztec Land & Cattle Co., No. 1; and Union-Continental Oil, New Mexico and Arizona Land Co. No. 1. In both of these holes, core descriptions mention "abundant carbonized wood" associated with carbonaceous to lignitic materials and pyrite, all in light- to dark-gray and black shale. The carbonaceous zone in each of these two holes is thought to represent a single, equivalent stratigraphic horizon.

A legitimate question, although admittedly impossible to answer now, is whether or not these widely separated carbonaceous zones are closely related in time. The question can be approached only in a most general way. Because of a lack of basic stratigraphic data relating to the occurrence at Promontory Butte, it will be dropped from the discussion to follow.

Two stratigraphic reference points are common to both Fossil Creek Canyon and the deep exploration holes southwest of Holbrook: (1) the top of the Mississippian Redwall limestone, and (2) the Permian Fort Apache limestone member of the Supai formation. These stratigraphic markers are separated by 1650 and 2050 feet of sediments at Fossil Creek and the wells, respectively (Huddle & Dobrovolny, 1945).

An accurate measurement of the position of the coaly zone at Fossil Creek Canyon with respect to either of these stratigraphic markers has not been made. Huddle & Dobrovolny did not mention this zone, and Ransome, using a barometer, estimated its position to be about 800 feet below a 20-foot limestone (presumed to be the Ft Apache). Field mapping on the Turret Peak quadrangle

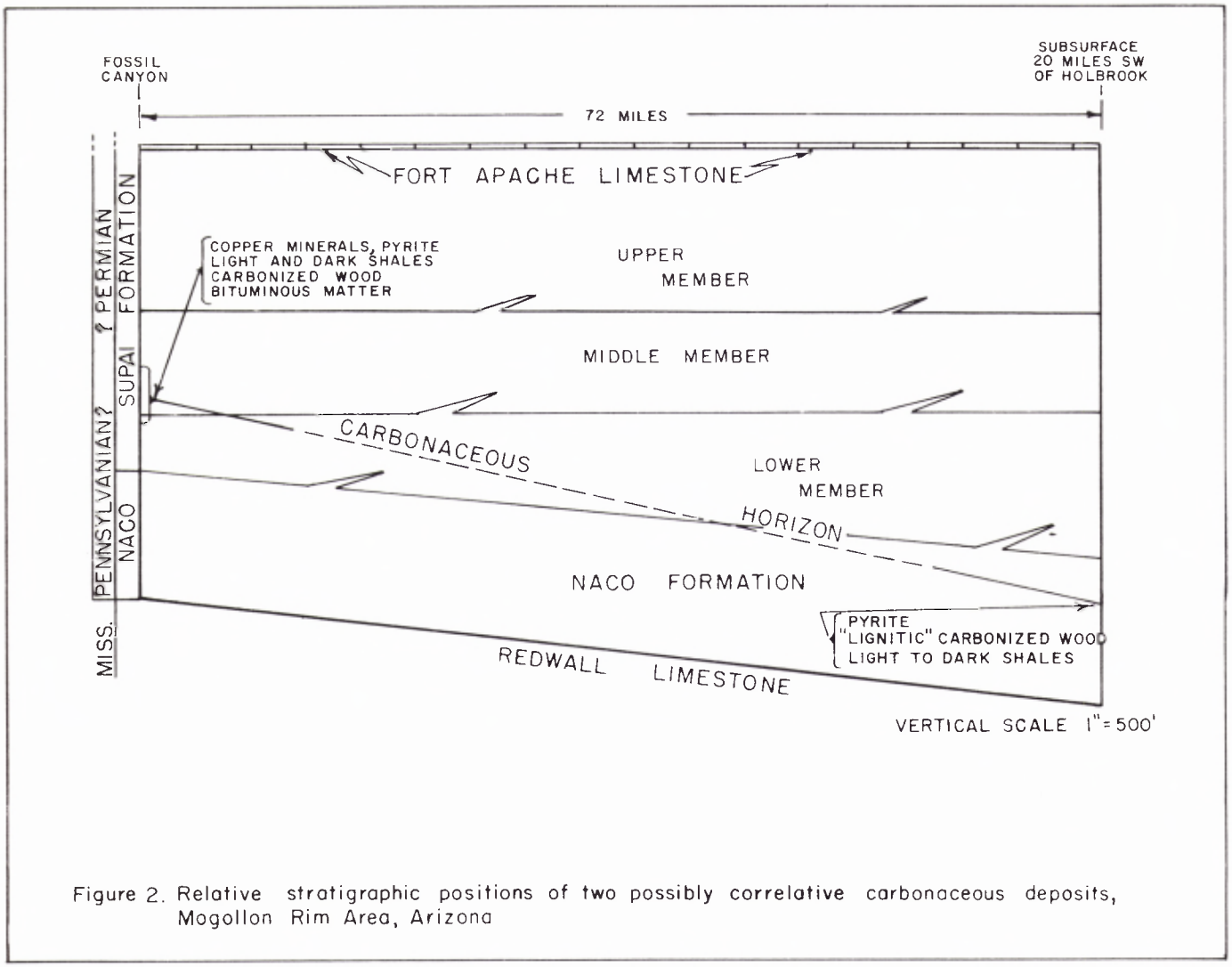

Figure 2. Relative stratigraphic positions of two possibly correlative carbonaceous deposits, Mogollon Rim Area, Arizona

topographic sheet suggests that about 1,000 feet separate the coaly zone from the Ft. Apache limestone. Assuming the stratigraphic position of the zone to be between 800 and 1,000 feet below the Ft. Apache Limestone, and 650-850 feet above the Redwall limestone, places it either in the lower part of the middle member of the Supai or the uppermost part of the lower member as defined by Huddle & Dobrovolny. It seems certain that it is not in the Naco formation as these authors define the Naco at Fossil Canyon. In the wells southwest of Holbrook, the carbonaceous zone is 1650 feet below the Ft. Apache limestone and 400 feet above the Redwall limestone. Here, the carbonaceous zone is in the top of the Naco formation as defined by Huddle & Dobrovolny. However, most workers agree that contacts between the Naco and lower member of the Supai, and between the lower and middle members of the Supai are arbitrary, and that they cross time lines, (See Winters, this guidebook). The extent to which they cross time lines can be solved only by establishing a time-marker zone within the sequence. Thus far such a marker has not been delineated. Whether or not local occurrences of horizons in which coaly or carbonaceous accumulations are known represent a single time horizon will be learned only after considerably more drilling and outcrop data are gathered. Figure 2 shows the zone at two localities plotted against the lithologic subdivisions of the Supai formation made by Huddle & Dobrovolny.

The coaly zone in Fossil Canyon occurs in an unfossiliferous part of the stratigraphic section. Pollen and spore work, now being done on samples from the shales and carbonaceous beds, may contribute significantly to our understanding of the type of vegetation then existent, and may provide data that will allow for added discussion of the Pennsylvanian-Permian time boundary in Fossil Creek Canyon.

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