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UPPER TRIASSIC PLANTS OF CANON DEL COBRE NEW MEXICO

by

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INTRODUCTION

The Upper Triassic rocks of Carlon del Cobre, New Mexico, contain a small but significant flora which has been known to the scientific world since 1859. The flora is significant because it was the first Upper Triassic flora to be discovered in the Southwest that contains leaves (Ash, 1972b). It remained the only such flora until Upper Triassic leaves were discovered in Utah in the 1920's and in Arizona in the 1930's. In addition, the flora in Canon del Cobre is useful for determining the base of the Triassic sequence in the area and for correlating those strata with the classic Chinle sequence in Arizona. Most of the information on the flora is contained in a few obscure publications that are out of print and difficult to obtain. The purpose of this note is to bring attention to this little known flora.

The assistance of Dr. and Mrs. Carson Mark of Los Alamos, New Mexico, with some of my field work in Carlon del Cobre is acknowledged with thanks. Also I am grateful to Dr. Herman Becker of the New York Botanical Garden for loaning me the specimens collected in Canon del Cobre by J. S. Newberry, and to Dr. Francis Hueber of the Smithsonian Institution for the fossils collected there by J. W. Powell and F. H. Knowlton. This research is supported by the Earth Sciences Section, National Science Foundation, Grant GA-25620.

Canon del Cobre (also called El Cobre Canyon) is a short, rugged, nearly inaccessible box canyon that extends northward from a point about three miles northwest of Abiquiu, New Mexico (Fig. 1). The canyon is about five miles long and has a maximum width of two miles. In many places the steep canyon walls may be 500-700 feet high (Fig. 2). Canon del Cobre is drained by Arroyo del Cobre, a minor intermittent tributary of the Rio Chama. At present the only road into Canon del Cobre follows the channel of Arroyo del Cobre for about three miles. At that point the road shifts out of the Arroyo to higher ground and after about one mile the road passes into Canon del Cobre through a notch called El Puertecito. The road continues northward to a spring near the middle of the canyon.

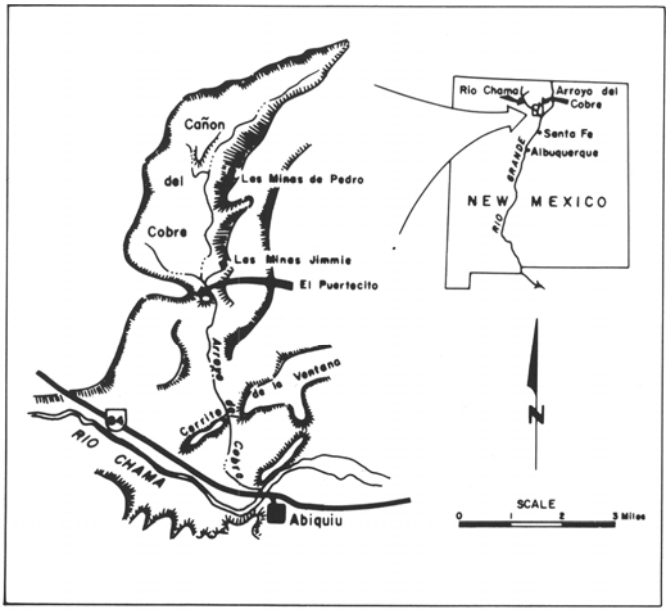

Figure 1. Index map showing the location of Cañon del Cobre, New Mexico.

LOCALITIES

Upper Triassic plants occur at two localities in Cañon del Cobre. Each locality is associated with a separate group of abandoned copper mines. Both groups of mines are on the east wall of Canon del Cobre and both are in the same bed of yellow, coarse grained, conglomeratic sandstone. The northernmost group, Las Minas de Pedro (Figs. 1 and 2), are about 400 feet above the floor of Canon del Cobre. These mines are in poor condition, but they obviously were once very extensive, judging by the large mass of tailings on the cliff face below them and the number of associated adits. About 8 to 10 adits are still visible and there is evidence of several more. The visible adits have caved or are partially filled with debris. Some of the adits with timber supports can be entered for a short distance. These mines have been assigned U.S. Geological Survey fossil plant locality number 10144.

The second group of mines, Las Minas Jimmie, are about two miles south of Las Minas de Pedro (Fig. 1) and are about 150 feet above the floor of Canon del Cobre. They were never very extensive, as only 4 or .5 adits are visible and the tailings are poorly developed. Most tunnels are very short, and none are timbered. This group of mines seems to be relatively young in comparison to Las Minas de Pedro. These mines have been assigned U.S. Geological Survey Fossil Plant locality number 10145.

STRATIGRAPHIC SETTING

About 400 feet of red sandstone and siltstone beds are exposed in the east wall of Canon del Cobre near Las Minas de Pedro (Fig. 2). The beds form a steep irregular slope and represent the upper part of the Cutler Formation of Early Permian age, which is about 1400 feet thick in this area (Budding, Pitrat, and Smith, 1960). An erosional unconformity, which has only a few feet of relief, occurs at the top of the Cutler.

The Cutler Formation is overlain by the Agua Zarca Sandstone Member of the Chinle Formation, which has a lower thick (30 ft.), cliff-forming, gray to yellowish, coarse-grained sandstone unit that is conglomeratic in places and contains thin shale breaks. Small blebs and stringers of malachite and azurite commonly encrust or replace wood in the sandstone. Leaves collected from this unit are definitely of Late Triassic age. The basal sandstone unit is overlain by a slope-forming sequence of about 100 feet of interbedded grayish sandstone and shale which have also been assigned to the Agua Zarca but may be the Salitral Shale Tongue of the Chinle.

Above the Agua Zarca is a 60-foot thick bed of cross-bedded, yellowish, conglomeratic sandstone which has been

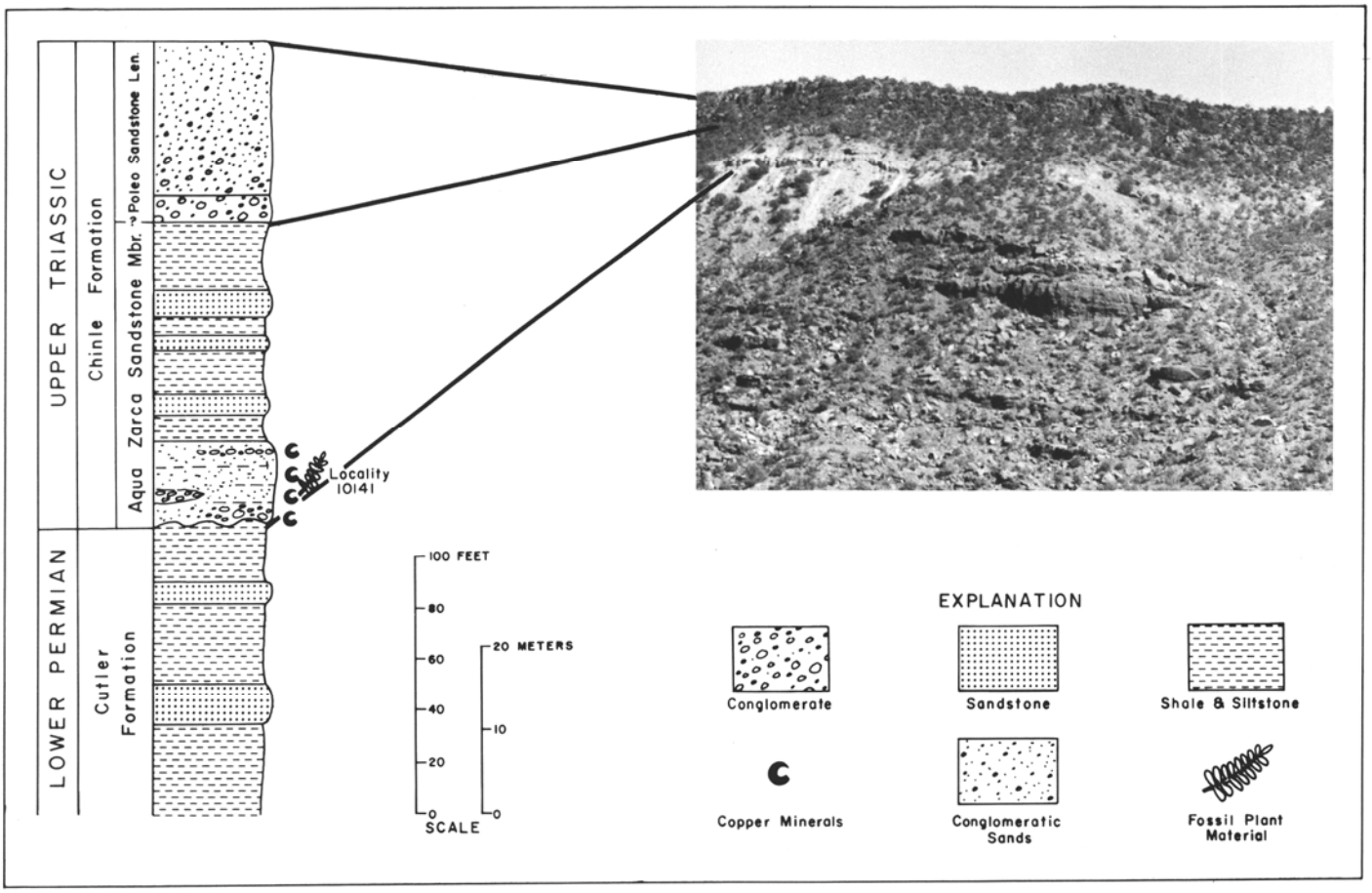

Figure 2. Stratigraphic section and photograph of the east wall of Cañon del Cobre at Las Minas de Pedro. The mines are in the thick ledge near the top of the cliff in the base of the Agua Zarca Sandstone Member of the Chinle Formation.

assigned to the Poleo Sandstone Lentil of the Chinle. The bed forms a fairly prominent cliff at the top of the walls of the walls of Carlon del Cobre. A slight angular unconformity has been recognized at the base of this bed in Carlon del Cobre (Budding, Pitrat and Smith, 1960).

The assignment of strata in Carlon del Cobre by Budding, Pitrat and Smith (1960) differs from that discussed above. They assigned to the Cutler all the strata below the angular unconformity at the base of the unit referred to above as the Poleo Sandstone Lentil. That unit was assigned by them to the Agua Zarca. Their interpretation is obviously in error because it places the bed of sandstone containing Upper Triassic plants (here referred to the Agua Zarca) in the Lower Permian. As a result of the error by Budding, Pitrat and Smith (1960), the contact between Permian and Triassic rocks on the map published by Smith and others (1961) is about 100 feet too high, at least in Carlon del Cobre.

DISCOVERY AND COLLECTION OF THE CANON DEL COBRE FLORA

The Upper Triassic flora in Cañon del Cobre became known to scientists mainly through the efforts of Dr. John S. Newberry, who discovered them while working with the Macomb expedition in 1859. During July of that year, while the expedition was in Abiquiu, New Mexico, Newberry learned of the old copper mines a few miles to the northwest. On July 17 he visited the mines with A. H. Pfeiffer, the local Indian agent, and discovered that the roof shales at the mine contain many leaf impressions. He also noted petrified wood in the associated beds of sandstone. Some of the leaves were collected and eventually described by him (Newberry, 1876). Several of these leaves are in the collections of the New York Botanical Garden, but some of the illustrated specimens have been lost, according to H. F. Becker of the New York Botanical Garden.

Newberry's notes on his journey into Canon del Cobre are rather interesting and worth repeating because they accurately describe the area. He (Newberry, 1876, p. 68-69) reported the following:

> July 17.—Started this morning, with Mr. Pfeiffer and several members of our party, for the copper mines, situated some nine miles north of Abiquiu. As we rose from the valley, we were gratified by the most charming view we had yet beheld in New Mexico. The alluvial bottom-lands covered with groves of vivid green cottonwoods, alternating with fields of wheat and corn, interspersed among which were the white-washed adobe houses of the residents, each with its walled corral, its garden, and its clumps of apricot-trees, formed a scene of fertility and rural beauty rare enough in a country whose sterility is proverbial. Above the valley rose the frowning battlements of the trap mesas, which sweep around the foot of the valleys, and the rough and rocky slopes stretching up to their lofty and picturesque summits. In another direction were above, the peculiar outline of Abiquiu Peak, and below, the rocky gate from which the river issues.
>
> Leaving the Chama, we passed up the eroded valley of an intermittent tributary [Arroyo del Cobre] . This is excavated

> in the Triassic series, and its sides exhibit bands of brilliant color, red, orange, blue, white, etc., as vivid as could be drawn from an artist's color-box. In some localities, the red sandstones—usually soft and fine-grained—are replaced by coarse conglomerates or masses of cemented bowlders, generally of large size ... Ascending the arroyo, toward its head, we found the strata rising rapidly toward the north, and cut through so as to expose the *saliferous* sandstoned= Moenkopi Formation] —the lowest member of the Trias—in sections of at least 200 feet. The group here consists of thick-bedded, chocolate sandstones, like those of New Jersey and the Connecticut Valley, except that here and there they showed large patches of white, interstratified with green and brown shales. Here, as on the Little Colorado, this formation contains much saline matter, as shown by numerous salt springs and a white saline efflorescence on the surfaces of the rock itself. The Cobre is situated in the face of the cliffs, bordering an eroded valley(Arroy del Cobre) drained into the Ghama below Abiquiu. These cliffs are composed at base of the saliferous sandstones and interstratified marls, some 250 feet in thickness; above these blood red marls and calcareous sandstones, 200 feet thick; the whole crowned by coarse yellow sandstones, having a thickness of about 150 feet.... The copper occurs in the base of the yellow sandstones just above the marls. To reach the most important of the ancient mines of this vicinity, we climbed up the face of the southern cliffs of the valley, over the red sandstones and marls, till we reached the coarse yellow sandstones which overlie them. Here we found an entrance, five by six feet in dimensions, which led to a series of galleries, having a combined length of perhaps a hundred yards. The work exhibits considerable skill in the use of tools, and a familiarity with the business of mining. The roof is carefully braced where weak, and old galleries are closed by well-laid walls of masonry. From the style in which the excavation is done, and from the perfect preservation of the woodwork, I attribute this and other similar mines in this region to the earlier Spanish explorers. The rock which contains the ore is very coarse, frequently a conglomerate, with bands of light-gray clay. The copper is distributed with considerable uniformity through a layer four or five feet in thickness. It occurs in the form of sulphide of copper and iron, (erubescite,) and green carbonate, replacing trunks of trees and fragments of wood, and in concretions and botyroidal masses scattered among the pebbles of quartz, or as minute points of carbonate specking [sic] the shales. It has evidently been deposited from solution, investing and replacing the wood precisely as the sulphide of iron is prone to do.
>
> The most interesting incident of our visit to this coppermine was the discovery in the shale roof-stone of thousands of impressions of plants, of which abundant specimens were procured. They are mostly cycadaceous—Otozamites and *Pterozamites—with* a few conifers *(Brachyphyllum* and *Voltzia?).* The species are probably new, and will not afford the means of determining with precision the age of the stratum containing them, but the discovery is of great geological interest, as showing the wide distribution of the cycadaceous flora of the Triassic and Jurassic epochs, and gives additional confirmation of the generalization of Brongniart, who characterized this epoch in the botanical history of the world as the reign of Gymnosperms.

The description given by Newberry suggests that the mines he visited are those called Las Minas de Pedro. The 150 foot thick sequence of coarse yellow sandstone which he saw at the top of the canyon is herein assigned to the Agua Zarca Sandstone Member and Poleo Sandstone Lentil of the Chinle. The 250 feet of saliferous sandstone and interstratified marls and the 200 feet of blood-red marls and calcareous sandstones below the yellow sandstone sequence are herein assigned to the Cutler Formation.

Elsewhere in his report, Newberry (1876) described and illustrated two new species of cycadophytes, *Otozamites macombii* and *Zamites occidentalis,* from Cafion del Cobre. In addition he identified and illustrated some coniferous foliage and a coniferous cone. Two of his plates showing some of these fossils are reproduced here (Figs. 3 and 4).

In 1886 Major John W. Powell, who was then the Director of the U.S. Geological Survey, visited some of the Carlon del Cobre copper mines and collected plant fossils. A few years later in 1889 the paleobotanist, F. H. Knowlton also collected in the canyon.

The wood and leaves in the Powell and Knowlton collections were collected from what Knowlton (in Fontaine and Knowlton, 1890) called the old copper mines. They apparently came from the same bed of sandstone from which Newberry had collected in 1859; however, they apparently were obtained from a different mine. Knowlton reported that the mines consisted of just three adits only one of which was branched, and that none of the tunnels were very long nor timbered. This contrasts with the extensive mines visited and described by Newberry. I believe that the wood and leaves described by Knowlton in 1890 came from Las Minas Jimmie in the southern part of Cañon del Cobre.

W. M. Fontaine described briefly and illustrated a new cycadophytic species, *Zamites powelli,* based on some of the leaves collected from the old mines (in Fontaine and Knowlton, 1890). Berry (1927) transferred *Z. powelli* to the genus *Otozamites.* The fossil has since been collected from the Chinle Formation and Dockum Group at many localities in the Southwest. It is so common and abundant that it could be considered a Chinle-Dockum index fossil. The other leaves and leafy shoots which Fontaine identified are either lost or are so poorly preserved that they have been rejected (Ash, 1972a).

Knowlton studied the wood from the old mines. He concluded (in Fontaine and Knowlton, 1890) that it should be referred to *Araucarioxylon arizonicum,* a species he had described earlier from Arizona (Knowlton, 1889). Most of the petrified wood in the Upper Triassic rocks on the Colorado Plateau is now thought to represent this species (Scott, 1961).

The pith casts in the two collections are reported to have come from some new mines that were opened in 1889 in the northwestern part of the canyon. They were said to be located several hundred feet stratigraphically below the so-called old mines from which Newberry and others had collected. Thus, they would be in the Lower Permian Cutler Formation. I have not been able to find these mines.

In 1900 Lester Ward transferred the two leafy shoots and cone that Newberry (1876) had called *Pachyphyllum?* to the genus *Pagiophyllurn* since the former name was preoccupied. Ward (1900) also assigned them to a new species, *P. newberryi.* Ward neglected to describe the species; that task was undertaken by Lyman Daugherty (1941). Daugherty (1941) also compared Newberry's specimens with some from Petrified Forest National Park. A few years ago it was demonstrated (Ash, 1970) that the two suites of fossils represent two different species. Those from the Petrified Forest were redescribed as *Pagiophyllum simpsonii* and those from Cafion del Cobrc retain the name *Pagiophyllum newberryi.*

I have visited Cafion del Cobre three times and have made small collections of wood and leaves from both groups of mines. These collections confirm the presence of the species described by previous workers. I have also studied all of the leaves identified by Newberry and Fontaine that can be located at this time. A paper redescribing one of them, *Otozamites powelli,* has been submitted for publication.

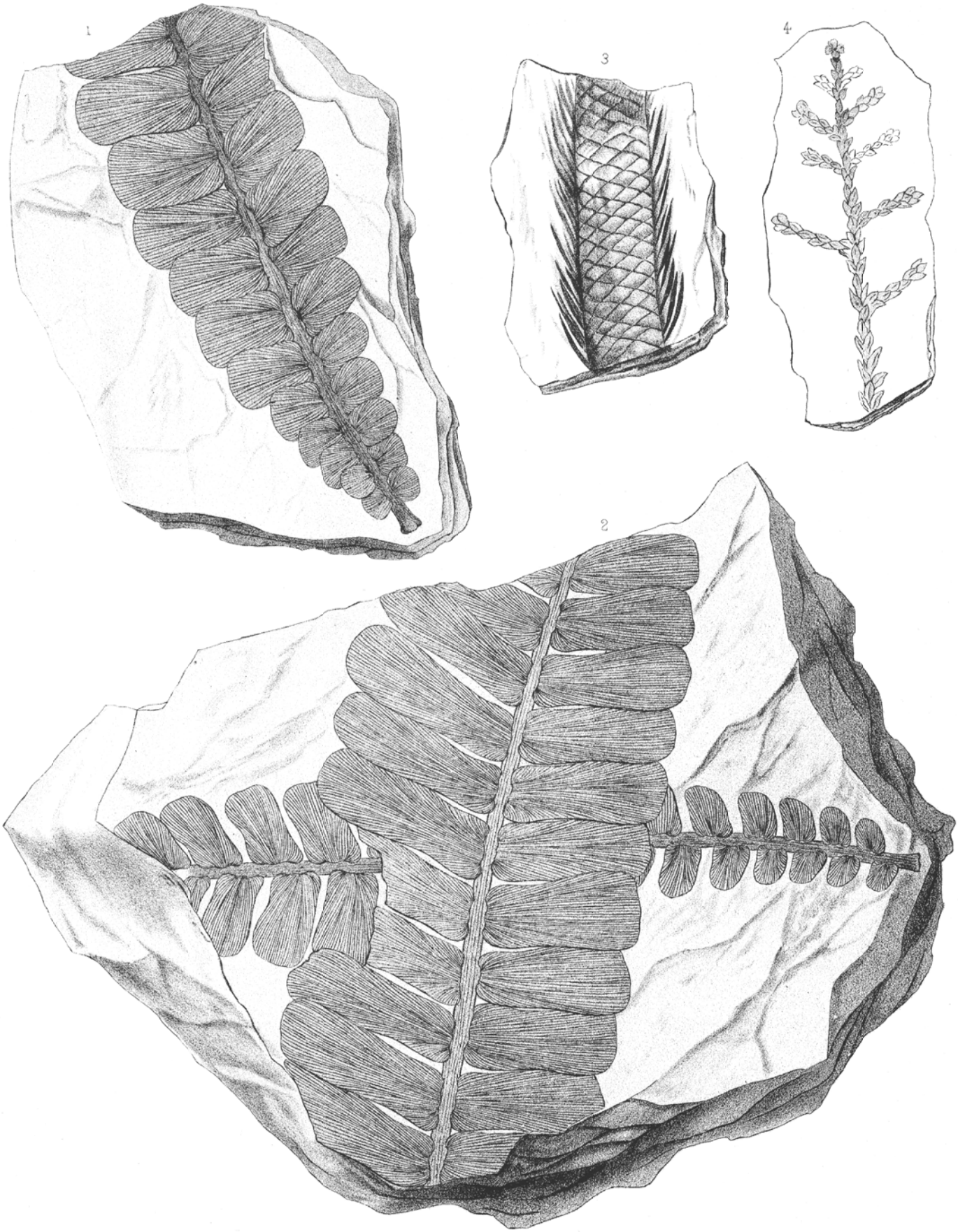

Figure 3. Newberry's (1876) plate IV showing some of the fossils from Cañon del Cobre. 1 and 2. **Otozamites Macombii** *Newberry (x1), 3. branch of a conifer (about x4), 4.* **Brachyphyllum** *sp. (x1).*

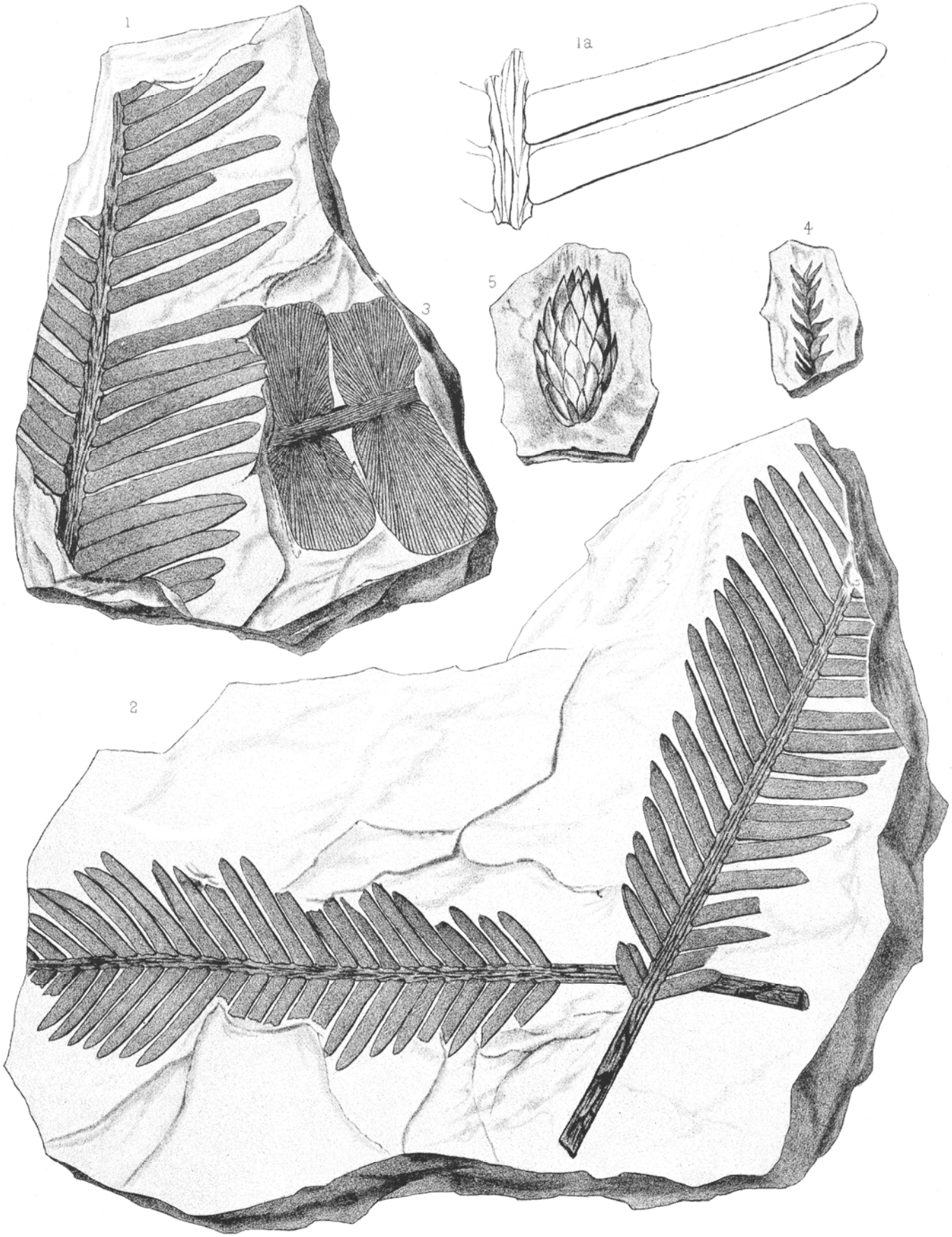

Figure 4. Newberry's (1876) plate V showing some of the fossils from Cañon del Cobre. 1, 1a, and 2. **Zamites Occidentalis** *Newberry (x1), 3.* **Otozamites Macombii** *Newberry (x1), 4. branch of the conifer* **Pagiophyllum Newberryi** *Ward ex. Daugherty (x1), 5. cone of the conifer* **P. Newberryi** *Ward ex. Daugherty (x2). Originally 4 and 5 were called* **Pachyphyllum***? by Newberry.*

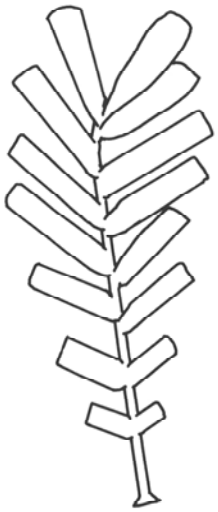

Figure 5. A sketch of **Otozamites Powelli** *(Fontaine) Berry (x1), which was originally described from Cañon del Cobre by Fontaine in 1890.*

COMPOSITION AND AGE OF THE CANON DEL COBRE FLORA

In Carlon del Cobre the Agua Zarca Sandstone Member of the Chinle Formation contains the following plant fossils:

Conifers

Brachyphyllum sp.

Pagiophyllum newberryi Ward ex. Daugherty

Arauicarioxylon arizonicum Knowlton

Cycadophytes

Otozamites macombii Newberry

O. *powelli* (Fontaine) Berry

Zamites occidentalis Newberry

Several additional conifers have been reported from Canon del Cobre (Fontaine and Knowlton, 1890), but I have been unable to confirm their presence. The specimens on which they were based have either been lost or else are in such poor condition that I have not been able to recognize them.

The ferns are conspicuous by their absence from the Canon del Cobre collections. Elsewhere in the Southwest (e.g., Fort Wingate, New Mexico) ferns are fairly common in the Chinle flora. Their apparent absence may be a result of inadequate collecting or lack of preservation of the delicate material.

The age of the Canon del Cobre flora has undergone slight refinement since it was first discovered by Newberry in 1859. Newberry (1876) recognized its Triassic age. Later Fontaine (in Fontaine and Knowlton, 1890) stated that it was Late Triassic in age, probably latest Triassic (Rhaetic). Ward (1900) determined that it was of Late Triassic age, but he did not indicate the stage. Daugherty (1941) determined that the Chinle flora probably correlated with the Keuper state (early and middle Late Triassic) in Germany. My work, which is incomplete, suggests that the Carlon del Cobre flora undoubtedly is Late Triassic in age and possibly correlates with the earliest Late Triassic (the Lettenkohle of the German Keu per).

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