

New Mexico Geological Society

Downloaded from: <https://nmgs.nmt.edu/publications/guidebooks/23>



Marcou in east-central New Mexico

Ronald K. DeFord

1972, pp. 65-71. <https://doi.org/10.56577/FFC-23.65>

in:

East-Central New Mexico, Kelley, V. C.; Trauger, F. D.; [eds.], New Mexico Geological Society 23rd Annual Fall Field Conference Guidebook, 236 p. <https://doi.org/10.56577/FFC-23>

This is one of many related papers that were included in the 1972 NMGS Fall Field Conference Guidebook.

Annual NMGS Fall Field Conference Guidebooks

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual [Fall Field Conference](#) that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

Free Downloads

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only *research papers* are available for download. *Road logs*, *mini-papers*, and other selected content are available only in print for recent guidebooks.

Copyright Information

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.

This page is intentionally left blank to maintain order of facing pages.

MARCOU IN EAST-CENTRAL NEW MEXICO

by

RONALD K. DeFORD

Professor Emeritus, The University of Texas at Austin

INTRODUCTION

Jules Marcou was born on 20 April 1824 in Salins, Department of Jura, France, 30 miles northeast of the mountains that gave their name to the department and to the Jurassic System. He studied in Salins, Besançon, and Paris and published three mathematical papers before he was twenty. On account of ill health occasioned by intense application to mathematics, he returned to Salins in the spring of 1844.

"By the advice of his family physician, Dr. Germain, he made long excursions on foot into the country around his native city, and in order to give objective interest to these walks collected and studied plants with such energy that the knowledge obtained was of use to him in his subsequent work. Dr. Germain was in his leisure hours an enthusiastic collector of fossils, and possessed a considerable series of these which he had gathered himself. The interest excited in Marcou's mind by talks with Dr. Germain over his collection, and by tramps in company with him to deposits of organic remains in the strata of the Jura, gradually turned his attention from botany to the more exciting and absorbing pursuit of geology. The astonishingly active and original mind possessed by young Marcou, however, soon got beyond the stage of the development reached by his teacher, and he speedily repaid his assistance by greatly increasing the value of his collections through his work in arranging, describing, and naming the specimens. In consequence of his rising reputation Marcou was visited by Thurmann, then one of the most prominent of Swiss geologists, and also by Louis Agassiz. Both of these men, especially the latter, had great influence upon his subsequent career. It was largely owing to their encouragement that he offered for publication, in 1845, his first geological work, 'Recherches Géologiques sur le Jura Salinois.'" (Hyatt, 1899.)



Jules Marcou

The excellency of this work brought Marcou the chair of Professor of Mineralogy at the College of Sorbonne in Paris in 1846. Subsequently he was appointed Travelling Geologist, and he chose North America as his field of exploration, chiefly because Agassiz was in the United States. In 1850 Marcou married Jane Belknap of Boston, and in 1853 he published his compiled "Geological map of the United States and the British provinces of North America." It was rigorously criticized in the American Journal of Science (1854). Remarkably, this map shows that he inferred the cover of the Llano Estacado to be "Tertiary and Quaternary" like that on the High Plains of Nebraska (later Colorado-Wyoming-Nebraska) and in contrast with the fallacious "Jurassic" that he reported after he had seen the Llano.

In the early spring of 1853 Congress passed a bill authorizing Jefferson Davis, the Secretary of War, to send out several expeditions to find the best railway route to the Pacific coast. As a result of publishing his map, Marcou was appointed Geologist and Mining Engineer, and Joseph Henry, the American Faraday, Secretary of the Smithsonian Institution, persuaded him to accept. He chose to accompany the expedition led by Lieutenant A. W. Whipple along the 35th parallel from the Mississippi River at the mouth of the Arkansas to Los Angeles, California. U.S. Highway 66 now follows this route.

PIONEER EXPLORATION

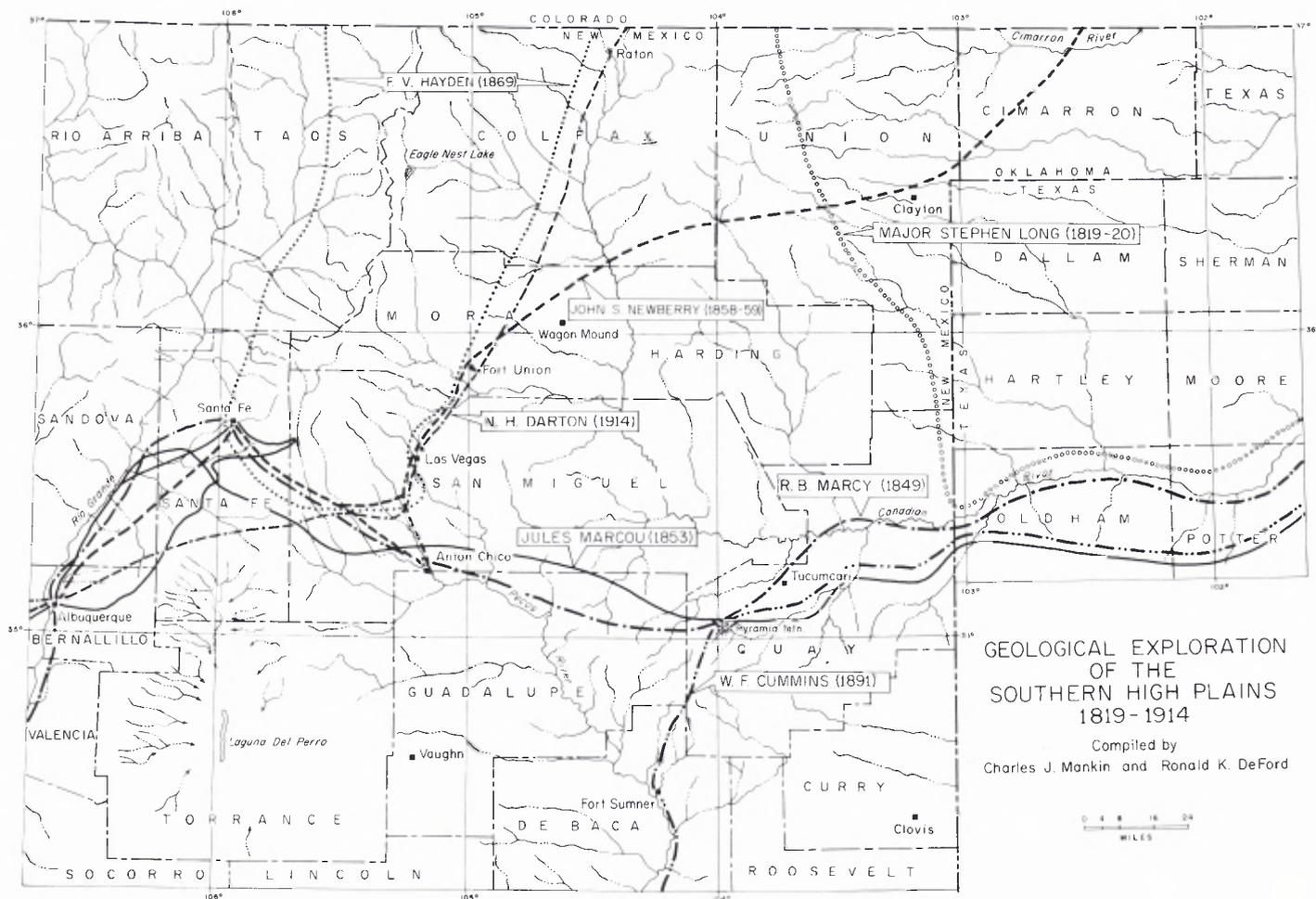
During the early exploration of the West, Tucumcari was a crossroads. Of the surveys that traversed northeastern New Mexico, seven "stand as exceptional" according to Mankin (1958, p. 16-17); and three of them paused at Pyramid Mountain southwest of Tucumcari or passed nearby:

1. Major Stephen H. Long, 1819-1820. A party that included Thomas Say, paleontologist, crossed northeastern New Mexico (Merrill, 1924, p. 69-70).
2. Captain R. B. Marcy in 1849 (Marcy, 1850).
3. Lieutenant A. W. Whipple and Jules Marcou, in 1853.
4. J. S. Newberry (1861; 1876) in northeastern New Mexico, 1858 and 1859.
5. F. V. Hayden in 1869, eastern side of Sangre de Cristo Range.
6. W. F. Cummins in 1891.
7. N. H. Darton in 1914 along the Santa Fe Railroad.

MARCY 1852

The second Marcy expedition explored the Red River in the summer of 1852. The party under the command of Captain Marcy (1853) included George Shumard (1853). They reached the eastern edge of the Llano Estacado in the Texas Panhandle 130 miles east of Tucumcari but did not continue into New Mexico. Shumard (p. 190-191) described "horizontal layers of drift" on the Llano, but Hitchcock (1853), p. 175), President of Amherst College, doubted

"whether this formation be the same which we denominate drift in New England—the joint result of water and ice, for no example has as yet been found of drift agency as far south as



Texas . . . and I have been led to suspect that what Dr. Shumard calls drift may be only a newer portion of the tertiary strata."

PYRAMID MOUNTAIN

On the 19th of September 1853 Lieut. Whipple's wagon train crossed from Texas into New Mexico, where it was greeted by the first norther. On the 22d, wrote Whipple (1856, p. 39),

"One isolated hill, detached from the Llano, stood nearly in our path, and, from its peculiar shape, was named Pyramid. One side was nearly perpendicular and all the strata of the Staked Plain were lain bare . . . Mr. Marcou and others prepared to mount its summit while the train moved on." Marcou (1858, p. 17-18) recalled that, "A better locality for geological explorations is seldom met with; but unhappily the situation is very inaccessible, in the middle of the country over which the Comanche Indians range; exploration without a strong escort is very dangerous; and at that time the expedition was progressing rapidly towards the west. Hurried by the fatigue of men and animals, we were looking for the valley of the Rio Grande del Norte to recruit our strength and forget the hardships and privations of the prairies. Obligated to confine myself to single excursion, I chose . . . Pyramid Mount . . . I give below the section as I observed it in a short examination of only four hours duration."

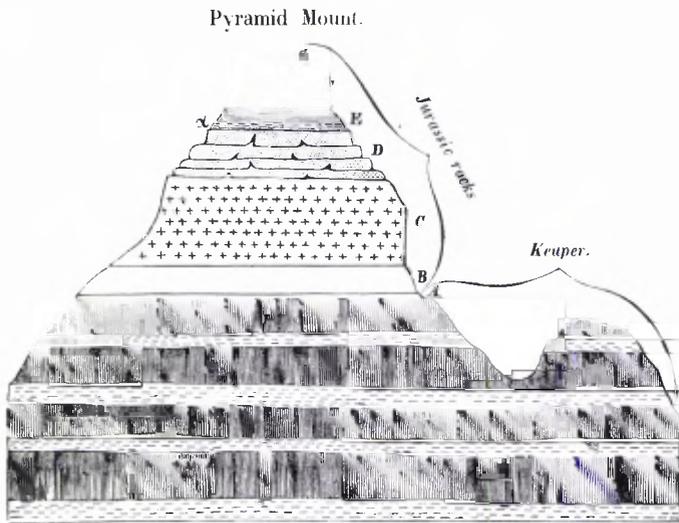
CORRELATION

At this point our story becomes a study in correlation. Marcou correlated the lower part of the Pyramid Mountain

section, up to the top of Bed A, with the Keuper of the Upper Triassic Series of Europe. His correlation has stood the test of time. How did he manage it? He called it Keuper because it looked like Keuper.

It was the right thing to do, though it be biostratigraphic heresy to say so. Humboldt wrote somewhere that in South America the plants are different, the animals are different, everything is different, even the stars are different, only the rocks are the same. And, in the U.S.S.R. during the International Geological Congress in 1937, on the outcrop or gazing out the train window, I was impressed to see how much the Carboniferous looks like Pennsylvanian and how closely the Cretaceous resembles Cretaceous; and the Permian that was described in well logs and guidebooks has all the earmarks of subsurface Permian. Since continental drift has become fashionable, these comments may not seem so farfetched as they once did. Lester King's remark that one can correlate almost bed for bed from Africa to South America is an exaggeration, but there is great resemblance between the two Permo-Triassic terranes.

It is true that Marcou also correlated the Permian redbeds and gypsum of Oklahoma as Triassic. This correlation seems less wide of the mark when we consider that a Triassic age was advocated as late as the 1930's (Roth, 1932). Marcou's map and cross section (1858) correctly showed that the northern Llano Estacado rests on Triassic ("Terrain du nouveau Grès rouge").



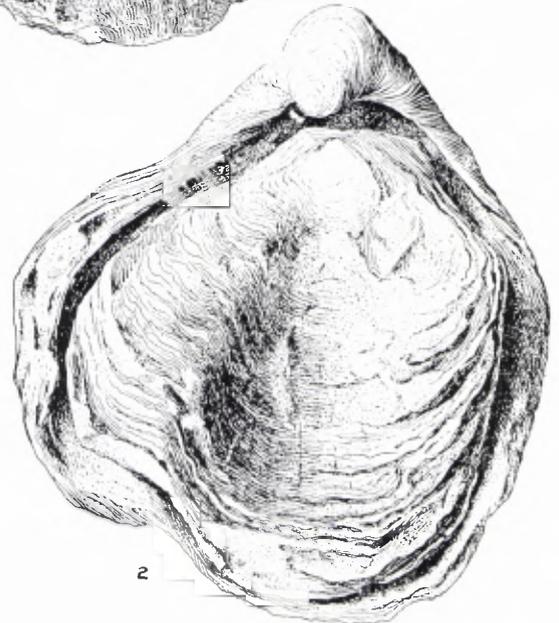
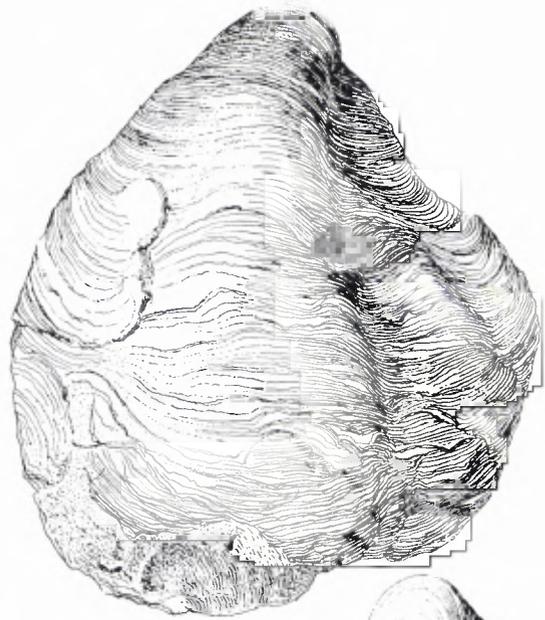
Pyramid Mountain Section by Marcou (1858, p. 18).

G. White limestone	2 feet
F. Yellow calcareous sandstone	50
E. Blue clay	30
α. zone of <i>Gryphaea dilatata</i> var. <i>Tucumcarii</i> and <i>Ostrea Marshii</i>	
D. White sandstone	25
C. Yellow sandstone	80
B. White sandstone	8
A. Grayish blue clay	1
Variegated marls, red, green, and white	200

Marcou (1858) correlated the upper part of the section, beds B through G, with parts of the Jurassic System of Europe. He claimed (p. 19) the identity of his *Gryphaea tucumcarii* from bed E "with the *Gryphaea dilatata* (Plate IV., fig. 1., 1a, 1b, 2. and 3.) of the *Oxfordian* group of England and France," and he wrote that "in the same zone with the *Gryphaea*, I found two specimens of a valve of *Ostrea Marshii* (Plate IV., fig. 4.) a very characteristic fossil of the *Lower Oolite* of England, France and Germany." We now place his beds B, C, and D in the Upper Jurassic Series and beds E and F in the Lower Cretaceous Series. His *Ostrea* is now called *Lopha marcoui* (Adkins, 1928, p. 103; Stenzel, 1971, p. N1157) and his fossiliferous zone is correlated with "the Kiamichi, or at the highest, the basal Duck Creek formation" (Adkins, 1927, p. 56) at the middle of the Albian Stage.

Marcou (1858, map) did perpetrate one indefensible correlation, misusing paleontology. Having assigned a Jurassic age to the fossils on the side of the Pyramid Mountain, he extended this age assignment to include the whole top of Llano Estacado, which he had not properly observed. Worse than that: he then assigned to the Jurassic all the High Plains farther north, reversing the sound paleogeographic correlation that he had made in 1853, when he had placed the High Plains from Texas to Nebraska in the "Tertiary and Quaternary."

*The description of Bed F originally in English as "Yellow limestone" is misleading; Marcou's field notes (Blake 1856a, p. 138) have "un grès à pate calcaire, jaune et brillant." (Cf. Cummins, 1892, p. 202.)



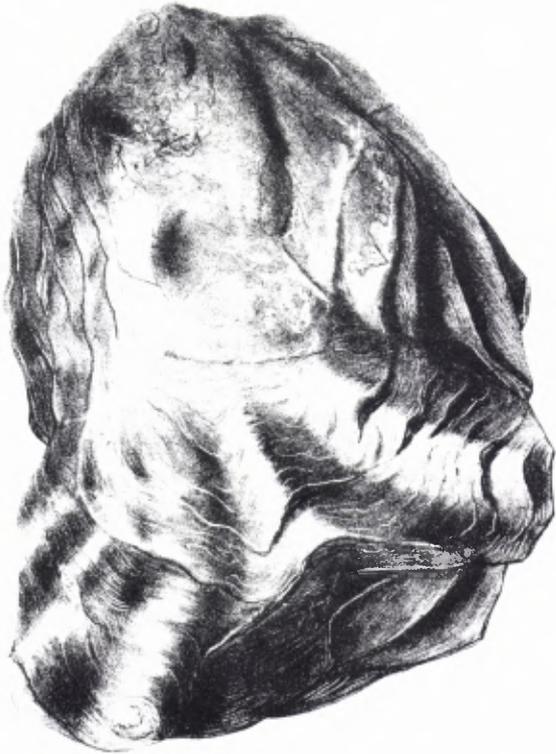
"*Gryphaea corrugata* Say, var. *tucumcarii*. From *Tucumcari Mesa*. Collected by Prof. Alpheus Hyatt" (Hill and Vaughan, 1898, pl. 14). This is *Texi-gryphaea tucumcarii* of Stenzel (1971, p. N1114). 0.87 natural size.

POLITICS

After 1853 correlation became polemical, complicated by politics, prejudice, and temperament. If Jefferson Davis had not been so high-handed, the sequel might have been different.

On 26 March 1854 the Whipple expedition arrived in Los Angeles, and Marcou returned from California via the Isthmus of Panama, as he recounted in 1858 (p. 1-3):

"I was attacked by sickness of a serious nature, quite frequent in that unhealthy climate, a chronic diarrhoea; and on my arrival at Washington, the 1st June 1854, I stated my desire to pass the winter in Europe on account of my health, which had been much injured by the fatigues and exposures of this long journey across a wilderness. The American government made no objection to this project of a voyage to Europe, on the contrary I was told that I should be better prepared to make a complete and



Lopha marcoui (Böse), natural size. The upper is Marcou's figure of "*Ostrea Marshii*" from "bed α of clay . . . at Pyramid Mount" (1858, p. 44; pl. 4, fig. 4). The lower is Böse's figure of "*Ostrea (Alectryonia) Marcoui*, n. sp. . . . Valva derecha, lado interior . . . probablemente idéntica con la que Marcou describió como *O. Marshi*" from "Cerro de Muleros . . . 5-6 kms. al N.W. de Ciudad Juárez, Estado de Chihuahua" (Böse, 1910, p. 105; lam. 16, fig. 1).

detailed report, having at my command the resources of European Science. Captain Whipple only asked me to make a geological *Résumé* for the octavo edition, and I did so notwithstanding the state of complete prostration to which I was then reduced by my malady."

"Having packed all my collections, books and other effects, and taken and paid my passage and that of my family consisting of four persons, on the Cunard Steamer *Niagara*; I was leaving my residence in Boston at nine o'clock in the morning the 27th September in order to embark, the steamer leaving the Wharf at East-Boston at noon, when I received letters from Captains Whipple and Pope containing orders from the Secretary of War to remain in the United States, or to give up my notes."

"The orders contained in these letters took me completely by surprise; I was no longer free to obey either of the alternatives they offered. I had two days before embarked twenty boxes containing my collections, books and other effects, and it was materially impossible to land them again and open them to look for the specimens and notes belonging to the government; especially as these specimens and note-books were scattered in several boxes and mixed with specimens and notes that belonged to me. It only remained for me to resign, which I did and embarked for Europe.

"On arriving at Salins I found a letter from Washington, which threatened, in case I did not at once relinquish the specimens and note-books belonging to the Government, to prosecute me in conformity with a treaty of extradition lately concluded between the United States and France. I might have taken my chance in a lawsuit with the American Government, but I preferred to give up every thing, indignant at such treatment, and I replied that I would place in one box all the specimens and notes that the Secretary of War demanded, and would give them up to any responsible person who could give me a receipt in due form, which would release me from all subsequent claim on the part of Mr. Jefferson Davis."

The delivery took place on 28 February 1855. W. P. Blake, government geologist who had been with Marcou on Lt. Whipple's expedition along the 35th parallel, received the specimens. He then gave them to Hall. In 1856 (p. 99) Hall classified *Gryphaea Tucumcarii* as a synonym of *G. Pitcheri* Morton (*pitcheri* is now called *corrugata*; see Adkins, 1928, p. 107). In 1857 (p. 136) Hall averred that Marcou's specimens of *G. Tucumcarii* "present no features . . . which can serve to distinguish them from *Gryphaea Pitcheri*," but modern paleontologists have corroborated Marcou, recognizing *tucumcarii* as a distinct species (Adkins, 1928, p. 107; Stenzel, 1971, p. N1114).

HALL'S CORRELATIONS

Meanwhile back on the High Plains in the summer of 1853 Hayden and Meek were employed by James Hall to collect fossils along the Missouri River in Nebraska (now Nebraska and South and North Dakota). Hall and Meek (1855) described the invertebrate fossils and published (p. 405) the following "Section of the Members of the Cretaceous Formation as observed on the Missouri River and thence Westward to the Mauvaises Terres." The names and revised thickness in parentheses were added in 1862 (Meek and Hayden, p. 419).

Eocene Tertiary Formation: Clays, sandstones, etc., containing remains of Mammalia. 25 to 250 ft.

Cretaceous Formation:

5. Arcaceous clay passing into argillo-calcareous sandstone. 80 ft. (Fox Hills, 500 ft.)
4. Plastic clay with calcareous concretions containing numerous fossils. This is the principal fossiliferous bed of the cretaceous formation upon the Upper Missouri. 250 to 350 ft. (Fort Pierre, 700 ft.)
3. Calcareous marl, containing *Ostrea congesta*, scales of fishes, etc. 100 to 150 ft. (Niobrara, 200 ft.)

2. Clay containing few fossils. 80 ft. (Fort Benton, 800 ft.)

1. Sandstone and clay. 90 ft. (Dakota, 400 ft.)

Buff-colored magnesian limestone of the carboniferous period.

Hall (1857, p. 135), who had never been within a thousand miles of Tukumcari, further asserted that in the section of Pyramid Mountain Marcou "recognizes a series of sandstones and clays beneath limestones which are of unquestionable cretaceous age." Hall correlated Marcou's beds E, F, and G with the "Nebraska section 2 and 3" (Benton and Niobrara) and D, C, B, A, and everything below A with "section 1" (Dakota). Meek and Hayden (1857, p. 268; 1858, p. 133) stated the latter correlation more explicitly, pointing "to the conclusion that the great gypsum deposits of the south-west hold a position equivalent to No. 2, or the upper part of No. 1 of the Nebraska section."

It is now common knowledge that Marcou called the Cretaceous beds at Tukumcari "Jurassic," but Hall who called them "Cretaceous" was as far off in correlation as Marcou; if we consider the section below bed E, Hall was much farther off. Hall's map (1857) shows most of the Llano Estacado as Cretaceous correlative with Nebraska No. 2, 3, 4, 5 and all the vast redbed terrane in Texas and Oklahoma east of the Llano as Cretaceous correlative with Nebraska No. 1, but it does show a patch of Tertiary on top the Llano. Marcou (1889, p. 160) pointed out the absurdity of classifying the redbeds as Dakota.

BLAKE'S DISAPPROBATION

In May 1855 three months after surrendering his field notes and collections, Marcou (1855b) presented a new geologic map of anglo-America; it was published in the fall with a French text. In Salins in February 1856, a year after the confiscation, Marcou (1858, p. 4) received a letter from W. P. Blake, who wrote:

"Captain Humphreys Top. Engrs., in charge of the office of the United States Pacific Railroad Explorations and Surveys, has sent the geological collection made by you when with Lieutenant Whipple, and your two note-books to me, and wishes me to describe the collection and prepare a report on the geology of the line explored by Lieutenant Whipple to accompany his final report in quarto form.

"I regret that it is not in your power to perform this duty, and in consenting to undertake it, I am actuated by a desire to secure the publication of your results in connection with the official reports. It is my intention to present a translation of your notes, and your preliminary *Resume* already printed in the octavo volume, and to add a full description of your collection with such observations on it, and on the geology of the route as shall appear desirable and necessary.

"If you prefer that the preliminary *Résumé* should not appear in the final report,—its place being supplied by the translation of your notes—or if you wish to present any modification or explanation of your views, please write me and I will regard your wishes. I do not write officially, but in my private capacity, being desirous to accord you every privilege which I could desire if similarly situated."

Marcou's notebooks "were written in pencil, with abbreviations and conventional signs, and in the French language." One might ask, How would *you* feel if someone published your field notes without your permission while you were still active? Marcou would have none of it. His Gallic combativeness aroused, he battled the American stratigraphic establishment for the next forty years. He was not always objective and not always right.

Blake had been busy too. He published (1856a) the notes and a translation in parallel columns, and at the August meet-

ing of the American Association for the Advancement of Science he found fault with Marcou's new map, publishing his criticism in November (1856b). In California, where Blake had worked, his animadversions were sound; also along the Rio Grande below El Paso and along the Upper Missouri, where neither man had been, Blake made his point against Marcou's foolish extension of the "Jurassic." But Blake, who had never visited Oklahoma, Texas, or New Mexico, had nothing there to add to the views of Hall.

HEAVY ARTILLERY

Blake's derogatory review of Marcou's contribution was not an isolated incident but was linked with the criticisms of Hall, "whose opinion was law in American geology," and Dana, editor of the American Journal of Science. Their commentaries seem to have been motivated not only by disagreement but also by considerable personal dislike and a mild xenophobia. The 1854 review of Marcou's 1853 map and an 1855 article on Emmons was attributed to Hall, but the anonymous author of the latter publication wrote that "another pen than ours called attention to Marcou's poor caricature of a geological map" and "its worthlessness." "That Marcou is a comparative stranger in our country may explain his ignorance though not his presumption," he said.

In 1858 and 1859 Newberry (1861; 1876) crossed north-eastern New Mexico but hardly passed within a hundred miles of Tukumcari. He joined in the dissent. In September 1859 the American Journal of Science (v. 28) reported on pages 298-299 that Newberry had "pronounced" a paleobotanical correlation of Cretaceous leaves which contradicted that of Heer and Marcou. On pages 258-259 was a quite unrelated



Amiel Weeks Whipple



William Phipps Blake



James Hall



James Dwight Dana

quotation from Marcou, containing some dramatic remarks about late Paleozoic and Mesozoic evolution. In these Marcou quoted Quenstedt on “precursors” or “advance guards” of the Mesozoic populations. The Journal appended a priggish, bracketed statement:

[“Obs. It will be interesting to the reader to turn from Mr. Marcou’s ‘rear guards, isolated spectators’ and ‘advance guards,’ to the plain prose of facts observed by Dr. Newberry in New Mexico, on the site of our author’s assumed Jurassic beds. See p. 298.”]

Later, Newberry was called to account for the manner of his pronouncement by both Lesquereux and Heer, and Newberry acknowledged that the manner was due to “a little honest indignation,” because Marcou’s “degree of arrogance” was “difficult to bear patiently.”

In November 1858 Dana reviewed Marcou’s “Geology of North America.” He effectively exposed some of Marcou’s mistakes and his sins of omission and some of his failures to deal fairly with fellow geologists. Dana also condemned Marcou’s map for showing the great redbed terrane of the West as Triassic on slight evidence, forgetting that Hall had shown it as Cretaceous. Dana recalled that Blake had discussed Marcou’s *Gryphaea Tucumcarii* and *Ostrea Marshii* and “pronounced them Cretaceous”; and he quoted “another able,” “excellent,” anonymous paleontologist (not Hall), who stated that *G. Tucumcarii* “is the true typical form of the Cretaceous species, *Gryphaea Pitcheri* of Morton . . . A glance at Morton’s figure . . . will satisfy anyone of its identity . . . The surface formations of the Llano Estacado, instead of being Jurassic, are Cretaceous.” Dana mentioned Marcou’s “characteristic self-complacency,” and remarked that persons selected to accompany western expeditions “are sometimes good geologists and sometimes otherwise.” He assured the reader that, despite Marcou’s taking exceptions to statements in the Journal, “We wish only to seek out the truth, that we may honor it and here register it for the use of science”; and “on no other ground than a desire to promote the interests of science have the pages of this Journal been open to the criticisms.” One might say, The editor doth protest too much. In the January 1859 issue, Agassiz came to Marcou’s defense.

EPILOGUE

In 1860 Marcou returned to the United States and for the rest of his life made his home in Cambridge. He remained convinced of the Jurassic age of his Tucumcari fossils. In his 1889 paper on the Mesozoic series of New Mexico he went over the whole ground again, adding a few later incidents but nothing really new.

R. T. Hill was the first geologist to visit Tucumcari after Marcou. He came 35 years later in August 1888 and again in April 1891. In 1889 the U.S. Geological Survey appointed Hyatt to be paleontologist in charge of the lower Mesozoic (Jura and Trias); and Hyatt spent considerable time that summer in the vicinity of Tucumcari and collected fossils there. Cummins, Geologist for Northern Texas for the Geological Survey of Texas, was there in the summer of 1891 and published (1892) an equitable account of the whole Tucumcari affair. Cummin’s paper also summarizes Hill’s conclusions. According to Marcou (1893, p. 214), I. C. Russell also visited Tucumcari during the same busy interim.

After his first visit Hill was “inclined to believe in the correctness of his [Marcou’s] position.” After Hill’s second visit he was “inclined to think the upper half of Tucumcari mesa,

New Mexico, . . . is composed, below the cap rock, of Trinity sands,” but he did not affirm whether the Trinity was Jurassic or Cretaceous.

Cummins concluded that *Gryphaea tucumcarii* “is so different in its specific characteristics from *G. Pitcheri*, Morton, that there is very little in common between them.” Nevertheless, he also collected a suite of associated fossils from the same horizon and a single dicotyledonous leaf from the sandstone of Bed G. Paleontology was his “reason for referring the Tucumcari beds to the Washita division of the Cretaceous.”

Marcou was irreconcilable. Hyatt was a gentle soul, but Hill, who was not, managed to get crosswise of both Cummins and Marcou.

How much of the section Cummins meant to include in his “Tucumcari beds” is not clear, but Cragin (1895, p. 361) subsequently wrote about “Tucumcari shales (or zone of *Gryphaea tucumcarii*).” Dobrovolny and Summerson (1946) have proposed to call this fossiliferous, basal Cretaceous layer the Tucumcari Shale Member of the Purgatoire Formation. They did not mention Pyramid Mountain but mapped instead Crazy Woman Butte in Sec. 19, T. 9 N., R. 29 E.

Hyatt studied his collections and began “a comparison between the fossils found at Tucumcari and elsewhere with European Upper Jurassic forms . . . If the work had not been interrupted by Congressional action in 1892, the comparisons would have been extended into the Cretaceous.” He reached no fixed opinion but found that an ammonite and *Gryphaea tucumcarii* both “have the characteristics of Cretacic types.” He did not find any “identical species in the European Jura.” In 1898 Hill and Vaughan (p. 20-21) quoted Hyatt’s unpublished manuscript.

Hill and Vaughan (p. 53) placed both *Gryphaea pitcheri* Morton and *G. dilatata* var. *tucumcarii* as synonyms of *G. corrugata* Say; but Adkins (1927, p. 40-41, 44, 50-51; 1928, p. 107) recognized *G. tucumcarii* as a separate species. Dobrovolny and Summerson (1946) overlooked Adkins’ work. Stenzel (1971) has placed both species in a new genus *Texigryphaea*.

REFERENCES ARRANGED CHRONOLOGICALLY

- 1850, Randolph Barnes Marcy, Report of Captain R. B. Marcy: 31st Cong., 1st Session, Senate Ex. Docs., v. 14, no. 64, Repts. of Secretary of War, p. 169-227, Serial 562.
- 1853, Randolph Barnes Marcy, Exploration of the Red River of Louisiana, in the year 1852: 32d Cong., 2d Session, Senate Ex. Doc. 54 (v. 8), Rept. of Secretary of War, x & 320 p., Serial 666, Appendix D.-Geology, p. 161-195. Reprinted as House Ex. Doc., x & 286 p., 1854, Serial 666, Appendix D.-Geology, p. 140-172.
- 1853, George Gettz Shumard, Remarks upon the general geology of the country passed over by the exploring expedition to the sources of Red River, under command of Captain R. B. Marcy, U.S.A.: in Marcy (1853), p. 179-195; reprinted in House Ex. Doc., 1854, p. 156-172, Serial 666.
- 1853, Edward Hitchcock, Notes upon the specimens of rocks and minerals collected: in Marcy (1853), p. 163-178; reprinted in House Ex. Doc., 1854, p. 140-155, Serial 666.
- 1853, Jules Marcou, Geological map of the United States and the British provinces of North America: Boston, Gould & Lincoln, c. 1:5,600,000; colored map to c. 104°W and c. 50°N. with 2 uncolored cross sections: York-Town, Va., to Ft. Laramie; Lake St. John, Canada, through Lake Erie and Nashville, Tenn., to Mobile, Ala. Text, x & 92 p., 8 pl.
- 1854, Notice of a geological map of the United States and the British provinces of North America, with explanatory text, geological sections and plates of fossils which characterize the formations, by J. Marcou: Am. Jour. Sci. & Arts (James D. Dana, ed.), 2d ser., v. 17, no. 50 (Mar.), art. 19, p. 199-206. “This article is anonymous, but its author is considered to be, without doubt, James Hall of Albany” (Marcou, 1858, p. 93).

- 1855, Amiel Weeks Whipple, Report of explorations for a railway route, near the thirty-fifth parallel of latitude, from the Mississippi River to the Pacific Ocean: 33d Cong., 1st Session, House Ex. Doc., v. 18, Ex. Doc. 129, pt. 2, p. 1-154, index p. i-vi, errata p. i-ii, Serial 737, 8vo.
- 1855a, Jules Marcou, Résumé of a geological reconnaissance extending from Napoleon, at the junction of the Arkansas with the Mississippi, to the Pueblo de Los Angeles, in California (Boston, July 26, 1854): Chap. 6, p. 40-48 of Whipple (1855). The text of Marcou's "Resumé" was reprinted in Serials 760 and 793, p. 165-175, see Blake (1856a).
- 1855b, Jules Marcou, Résumé explicatif d'une carte géologique des Etats-Unis et des provinces anglaises de l'Amérique du Nord, avec un profil géologique allant de la vallée du Mississippi aux côtes du Pacifique, et une planche de fossiles: Soc. Géologique de France, Bull., 2d ser., v. 12, séance du 21 Mai.
- 1855, James Hall and Fielding Bradford Meek, Descriptions of new Species of Fossils, from the Cretaceous Formations of Nebraska, with Observations upon *Baculites ovatus* and *B. compressus*, and the Progressive Development of the Septa in Baculites, Ammonites, and Scaphites: Am. Acad. Arts. & Sci., Memoirs, new ser., v. 5, pt. 2, art. 17, p. 379-411, pl. 1-8.
- 1856, Amiel Weeks Whipple, Reports of explorations for a railway route, near the thirty-fifth parallel of north latitude, from the Mississippi River to the Pacific Ocean: 33d Cong., 2d Session, Senate Ex. Doc. 78, Serial 760, House Ex. Doc. 91, Serial 793, v. 3, 4to: Extracts from Whipple (1855), p. 1-36; pt. 1, Itinerary p. i-viii & 1-36; pt. 2, Report on the topographical features and character of the country, p. 1-77; pt. 3, Report upon the Indian tribes, p. 1-127; pt. 4, Report upon the geology of the route, by W. P. Blake, p. v-xiv, 1-175. Extracts and pt. 1, Itinerary, reprinted in part in Panhandle-Plains Historical Review (Canyon, Texas), v. 44, 1971, with preface and notes by Ernest R. Archambeau correlating Whipple's route with modern landmarks.
- 1856a, William Phipps Blake, Report on the geology of the route near the thirty-fifth parallel, explored by Lieut. A. W. Whipple, Topographical Engineers, in 1853 and 1854: pt. 4 of Whipple (1856), Serial 760. No. 1. General report upon the geological collections, by Blake, p. v-xiv, 1-119, with colored lithoprint of Pyramid Mountain facing p. 25; No. 2. Résumé and field notes by Jules Marcou, original French with translation by Blake in parallel columns, with colored "Geological section from the Mississippi River to the Pacific Ocean" by Marcou; reprint of Marcou (1855), p. 165-175; colored geological map of the route and colored cross section along the route from Mississippi River to Pacific Ocean prepared by Blake from Marcou's notes and collections.
- 1856, James Hall, Descriptions and notices of the fossils collected upon the route: Chap. 9, p. 99-105, pl. 1-2, of Blake (1856a); *i.e.*, of pt. 4 of Whipple (1856), Serial 760.
- 1856b, William Phipps Blake, Review of a portion of the geological map of the United States and British provinces by Jules Marcou: Am. Jour. Sci. & Arts, 2d ser., v. 22, no. 66 (Nov.), art. 32, p. 383-388.
- 1857, William Hemsley Emory, Report on the United States and Mexican boundary survey, made under the direction of the Secretary of the Interior: 34th Congress, 1st Session, Senate Ex. Doc. No. 108, v. 1, pt. 1, xvi & 258 p.; pt. 2, viii & 174 p., Serial 861.
- 1857, James Hall, Geology and paleontology of the boundary: p. 101-165, pl. 1-21 of Emory (1857), pt. 2, with colored map illustrating the general geologic features of the country west of the Mississippi River by James Hall assisted by J. Peter Lesley, 1:6,000,000.
- 1857, Fielding Bradford Meek and Ferdinand Vandiveer Hayden, Descriptions of new Fossil Species of *Mollusca* collected by Dr. F. V. Hayden, in Nebraska Territory; together with a complete Catalogue of all the Remains of Invertebrata hitherto described and identified from the Cretaceous and Tertiary Formations of that Region; and, 1858, Descriptions of new species and genera of fossils, collected by Dr. F. V. Hayden in Nebraska Territory, under the direction of Lieut. G. K. Warren, U.S. Topographical Engineer; with some remarks on the Tertiary and Cretaceous formations of the north-west, and the parallelism with those other portions of the United States and Territories: Philadelphia, Acad. Nat. Sciences Proc., 1856, p. 265-268, and 1857, p. 117-148.
- 1858, Jules Marcou, Geology of North America with two reports on the prairies of Arkansas and Texas, and the Rocky Mountains of New Mexico, and the Sierra Nevada of California, originally made for the United States Government: Zurich, Zürcher and Furrer, 4to, viii & 144 p., 7 pl. of fossils, 3 colored maps: geologic map of U.S. and part of Canada with cross section from Fort Smith, Ark., to Los Angeles, Calif.; geologic map of part of New Mexico; Maclure's geologic map of U.S.A., 1811; and dedicatory letter to Agassiz, Feb. 1858.
- 1858, James Dwight Dana, Review of Marcou's "Geology of North America": Am. Jour. Sci. & Arts, 2d ser., v. 26, no. 78 (Nov.), art. 36, p. 323-333.
- 1859, Louis Agassiz, On Marcou's "Geology of North America": Am. Jour. Sci. & Arts, 2d ser., v. 27, no. 79 (Jan.), p. 134-137. James Dwight Dana, Reply to Prof. Agassiz on Marcou's Geology of North America: *ibid.*, p. 137-140.
- 1861, Joseph Christmas Ives, Report upon the Colorado River of the West: 36th Cong., 1st Session, Senate Ex. Doc.—House Ex. Doc. 90, Serial 1058, pt. 1, General report, p. 11-131; pt. 2, Hydrographic report, p. 1-14; pt. 3, Geological report by J. S. Newberry, p. 1-154, 3 pl.; pt. 4, Botany, p. 1-30; pt. 5, Zoology, p. 1-6; appendices, p. 1-32.
- 1861, John Strong Newberry, Geological report: in Ives (1861), pt. 3, 154 p., 3 pl.
- 1862, Fielding Bradford Meek and Ferdinand Vandiveer Hayden, Descriptions of new Lower Silurian, (Primordial), Jurassic, Cretaceous, and Tertiary fossils, collected in Nebraska, by the exploring expedition under the command of Capt. Wm. F. Reynolds, U.S. Top. Engrs.; with some remarks on the rocks from which they were obtained: Philadelphia, Acad. Nat. Sciences Proc., 1861, p. 415-447.
- 1876, John Navarre Macomb, Report of the exploring expedition from Santa Fé, New Mexico, to the junction of the Grand and Green Rivers of the Great Colorado of the West with geological report by Prof. J. S. Newberry: U.S. Army, Engineer Dept., vii & 148 p., 22 pl., map.
- 1876, John Strong Newberry, Geological report, p. 9-118; Descriptions of the Carboniferous and Triassic fossils, p. 135-148, pl. 3-8: in Macomb (1876).
- 1889, Jules Marcou, The Mesozoic series of New Mexico: Am. Geologist, v. 4, no. 3 (Sept.), p. 155-165; no. 4 (Oct.), p. 216-229.
- 1892, William Fletcher Cummins, Notes on the geology of the country west of the plains: Austin, Geol. Survey Texas, 3d Ann. Rept. 1891, p. 201-223.
- 1893, Jules Marcou, Remarks on a part of the review of the Third Texas Report: Am. Geologist, v. 11, no. 3 (Mar.), p. 212-214 (letter dated 16 Dec. 1892).
- 1895, Francis Whittemore Cragin, A study of the Belvidere beds: Am. Geologist, v. 16, no. 6 (Dec.), p. 357-385.
- 1898, Robert Thomas Hill and Thomas Wayland Vaughan, The Lower Cretaceous gryphaea of the Texas region: U.S. Geol. Surv. Bull. no. 151, 67 p., 35 pl., 55th Cong., 2d Session, House Doc. 568, Serial 3702.
- 1899, Alpheus Hyatt, Jules Marcou: Boston, Am. Acad. Arts & Sci. Proc., v. 34, no. 23 (June), p. 651-656. Hyatt studied under Agassiz and Marcou at Harvard.
- 1910, Emil Böse, Monografía geológica y paleontológica del Cerro de Muleros, cerca de Ciudad Juárez, Estado de Chihuahua, y descripción de la fauna Cretácea de la Encantada, Placer de Guadalupe, Estado de Chihuahua: Instituto Geológico de México Boletín núm. 25, 193 p., 48 pl., colored geologic map and profiles.
- 1924, George Perkins Merrill, The first hundred years of American geology: New Haven, Conn., Yale University Press, xxi & 773 p. The route of Newberry shown in northeastern New Mexico on fig. 73, p. 361, is incorrect.
- 1927, Walter Scott Adkins, The geology and mineral resources of the Fort Stockton quadrangle: Austin, Univ. Texas Bull. no. 2738 (8 Oct.), Bur. Econ. Geology, 166 p., 6 pl.; and 1928, Handbook of Texas Cretaceous fossils: Bull. no. 2838 (8 Oct.), 303 p., 37 pl.
- 1932, Robert Ingersol Roth, Evidence indicating the limits of Triassic in Kansas, Oklahoma, and Texas: Jour. Geology, v. 40, no. 8 (Nov.-Dec.), p. 688-725.
- 1946, Ernest Dobrovolny and Charles Henry Summerson, Geology of northwestern Quay County, New Mexico. Sheet 1. Geologic map and stratigraphic sections of Mesozoic rocks. Sheet 2. Text by Dobrovolny and Summerson; Subsurface geology by Robert Latimer Bates: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 62.
- 1958, Charles John Mankin, Stratigraphy and sedimentary petrology of Jurassic and pre-Graneros Cretaceous rocks, northeastern New Mexico: Austin, Univ. Texas, unpublished Ph.D. dissertation, x & 233 p.
- 1971, Henryk Bronislaw Stenzel, Oysters: Treatise on Invertebrate Paleontology, pt. N, v. 3, p. N953-N1224.