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CARBONIC COLUMN OF RIO GRANDE REGION.

BY CHARLES R. KEYES.

The character of the later Paleozoic succession in southwestern United States has radically modified our general ideas regarding carbonic history in America. As directly bearing upon this subject the Carbonic rocks of the New Mexican region are of exceptional interest. The Rio Grande section, if it may be so designated, is serially the most complete in the country. It is of great thickness. It contains many elements wholly unknown elsewhere on the continent. It furnishes full data with which to close the already prolix debate on the exact age and stratigraphic position of the uppermost Paleozoic beds of Kansas and other parts of the country. It is particularly important at this time as connecting the succession of the Mississippi province with that of the Far West. By contrast it emphasizes the insignificance of our eastern Carbonic representatives.

It was recently shown\* that while few estimates on the maximum measurement of the Carbonic rocks of the Southwest ventured above 2,000 feet there really existed of these sediments in New Mexico the enormous thickness of more than 6,000 feet.

Although there have been many notes published on the Carbonic rocks of the Southwest there has never been any serious attempt to correlate the results of the various disconnected observations. Only lately have investigations of broad character made reasonably exact geologic correlation in the region possible. While it is, perhaps, as yet premature to venture beyond the provincial series in the detailed consideration of the Carbonic formations of the Rio Grande region, there are certain terranal names which have long been locally applied that may be used. Some of them were not, possibly, so exactly defined as they should have been originally; but this fact could hardly be a valid excuse for the proposal of new names on no better grounds than the old ones and the use of some of these old names in entirely different senses. From such course only confusion can come.

In its latest and most complete form the standard Carbonic section of the Rio Grande region, or of New Mexico, may be indicated as follows:

\*Journal of Geology, Vol. XIV, p. 147, 1906.

GENERAL RIO GRANDE SECTION OF CARBONIC TERRANES.

Time Divisions		Provincial Series	Formations	Rocks
CARBONIC PERIOD.	LATE	Cimarronian	Moencople	Shales
			Pecos	Sandstones Shales
		Guadalupan	Capitan	Limestones
			Eddy	Sandstones
	MID	Maderan	Bernalillo	Shales
			Hueco (upper)	Limestones
			Oscuro	Limestones
		Manzanan	Mosca	Limestones
			Coyote	Sandstones
			Montosa	Limestones
	Ladronesian	Sandia	Shales	
		Alamito	Shales	
EARLY	Socorran	Sierra	Limestones	
		Lake Valley	Limestones	
		Grande	Limestones	

The presence of marked planes of unconformity between all of the several serial divisions is especially significant. It points to still other unknown and important representatives to make the American section complete. How great are the terranal representatives of these intervals can at present only be surmised. In northern New Mexico the unconformity plane between the Maderan and Cimarronian series is known, 200 miles to the southward, to be represented by over 3,000 feet of sediments. The remnants of the true coal-bearing series, corresponding to the lower productive coal measures of the Mississippi valley is believed to have been once of great thickness and extent. Under similar conditions an erosion interval north of the Ozark dome at the base of the Des Moines series is known to be represented farther south in central Arkansas by sediments the thickness of which is more than 10,000 feet.\* In the Southwest the depositional equivalents of the Carbonic unconformities may equal or even greatly exceed in thickness that of the present known section.

The Socorran series corresponds in a general way to the lower part of the original Mississippian series of Missouri and Illinois. The Ladronesian, Manzanan, and Maderan series might be included in the world-wide Pennsylvanian division of the United States Geological Survey. The Guadalupan and Cimarronian series have no representation in the East; and the latter in the Mississippi valley only in western Kansas.

Three important subdivisions of the Socorran series have thus far been recognized.† These find their best development in the vicinity of Lake Valley, in southwestern New Mexico. There are good reasons for believing that other formations of this series exist nearby. These formations are the Grande, Lake

\*The heavy lines indicate planes of unconformity. The Eddy sandstones may more properly belong to the Maderan possibly co-extensive with the Bernalillo shales and sandstones; there are reasons for believing that marked line of unconformity exists at the base of the Capitan limestone. All of the unconformities represent erosion epochs, except that between the Maderan and Manzanan which is apparently an overlap. There are several planes of unconformity in the Maderan section.

\*Bull. Geol. Soc. America, Vol. XII, pp. 173-196, 1901.

†Trans. American Insti. Min. Engin., Vol. XXXIX, 1908.

Valley and Sierra limestones. The Lake Valley limestone, carrying the typical fauna of the Lower Burlington limestone was originally fully described by Springer.† Its northward extension to the Magdalena range, 100 miles away, was recently noted.§ Herrick's title\*\* "Graphic-Kelly lime," for a part of this formation, that has crept into geologic literature during the past year was not intended to have exact geologic definition but merely local mining significance, referring to mines of that name. The Grande limestone appears to contain the fauna of the Chouteau limestone of Missouri. The Sierra limestone is a formation higher than any other of the Early Carbonic strata yet recognized in the Southwest. Gordon is mistaken in regarding all three of these divisions as the original Lake Valley limestone.

The only known Carbonic coal-bearing formation in the Southwest is included in the Ladronesian series. It is thought to be an extension or representative of the Arkansan series of the southern Ozark region. Being sharply delimited above and below by marked unconformity planes of erosional character it was doubtless once one of the most important formations of the region. Herrick,\* who first noted the beds, though not recognizing their true significance, referred them to the Upper Carbonic, but he subsequently was convinced that they were of earlier age. The series will doubtless be found to be wide-spread though possibly only in remnantal areas.† No one who has seen the two formations would think of correlating the beds of this series with any part of the Sandia shales. Its fauna and flora is a theme of great interest as it must be so unlike anything else in the West.

It is a matter of great surprise that the recent considerations of the beds constituting the Manzanan series should give rise to such a confusion of ideas as they have. It can only be accounted for by the cursory and incomplete character of the examinations during hasty reconnaissance work which has been the usual method in the region. The use of the term Manzanan is an attempt to preserve Herrick's title without introducing new names. To be sure, it was not at first definitely delimited, but since no other title for the beds in question has intervened there appears no good reason for abandoning the term, or for using it for a very different section having no elements in common with the first one.

As he himself has often in person explained, Professor Herrick in none of his published writings ever intended to formally propose any of the geographic names which he used provisionally. The formal proposals of the necessary geologic titles and their definition was reserved for a special memoir which I believe was well along towards completion at the time of his sad demise. The intentionally informal character of the few geographic names he use from time to time is clearly indicated in all of his writings. His term Manzano, for example, is used in a number of different senses in as many different places; one referring to the gray limestones between the red-beds and the red quartzite at the top of his Sandia shales. The title Bernalillo shales, which I had suggested for the Mid-Carbonic red-beds, was acceptable to him and would have been used by him in his final memoir.

†Am. Jour. Sci. (3), Vol. XXVII, p. 102, 1884.

§Proc. Iowa Acad. Sci., Vol. XII, pp. 169-171, 1905.

\*\*American Geologist, Vol. XXXII, p. 311, 1904.

\*Journal of Geology, Vol. XII, p. 242, 1904.

‡Eng. & Min. Jour., Vol. LXXXI, p. 1129, 1906.

If the gray and blue limestones below the Bernalillo red shales of the Sandia district (Manzanan and lower Maderan) are to be thrown together, which does not seem at all advisable, the term Magdalena Group as recently proposed\* is clearly synonymic. Richardson's title of Hueco group† covers this section exactly, and has the great advantage of being at least recognizably defined.

The Maderan series appears to be separable from the Manzanan upon the same faunal and other grounds as the Missourian and Oklahoman series in Kansas. Its development is that of a three-fold sequence. As exposed in the north, in the Sandia mountains the main limestone member is only 400 feet in thickness. Higher and higher limestone beds come in southward until a maximum measurement of 3,000 feet is attained. This superior dark limestone formation, or median member of the series, is included in the Hueco formation of Trans-Pecos Texas. If the name Hueco is to be retained as a geologic title it may advantageously be applied to the median members as representing the main body of limestone of western Texas.

The third and youngest member of the Maderan series is composed of shales and sandstones having a characteristic red coloration. The title Bernalillo shales has been applied to them.‡ The fact that the "Red-Beds" are not of Permian nor Jura-Trias age is not a new discovery as lately announced by Lee.§ As early as 1900 Herrick\*\* had found abundant fossils in these beds which were correlated with the so-called Permian (Permo-Carbonic) of Kansas. It must be remembered that all of this author's later references to the Permian are to this so-called Kansas Permian and not to the true Permian. About the first revision which my own preconceived notions of the region underwent when first I visited New Mexico in 1902, was that these Red-Beds of the Rio Grande region corresponded faunally to the Oklahoman series of Kansas. They were thus specifically correlated†† and their distinctness from the Kansas Red-Beds emphasized by the designation of the local title of Bernalillo shales. At the time it was thought that the upper one-third of the red-beds section might be a part of the Cimarronian series; but it was soon afterwards discovered that over this part of the region of central New Mexico both the Kansas Red-Beds and the Triassic Red-Beds were absent.\* In the section east from the Manzano mountains, down the Rio Pecos and Canadian river valleys there are thus found three great red-beds formations imposed upon one another with apparently no sharp planes of separation and belonging to three distinct geologic ages. To avoid confusion I have tried to be always very careful to apply the title Red-Beds only to this great sequence. There are in the region extensive Cretacic "red-beds," which I have always referred to as the Pink beds, or Tertiary "red-beds," and farther south great Devonian "red-beds," which I have not designated at all.

To further complicate the Red-Beds problem southward from the Sandia locality the sandy materials rapidly increase and the red coloration fades, as it does in the Red-Beds region of Kansas and Oklahoma. In the 150 miles

\*Journal of Geology, Vol. XV, p. 812, 1907.

†Univ. Texas Min. Sur., Bull. 9, p. 32, 1904.

‡Ores and Minerals, Vol. XII, p. 48, 1903; also, Rept. of Governor of New Mexico to Secretary of Interior, for 1903. p. 339, 1904.

§Journal of Geology, Vol. XV, pp. 52-58, 1907.

\*\*Journal of Geology, Vol. VIII, p. 116, 1900.

††Loc. cit., p. 339, 1904.

\*Amer. Jour. Sci. (4), Vol. XX, pp. 423-429, 1905.

which separate the Sierra Oscura and the Guadalupe range, which I have not yet been over thoroughly, a grave question arises as to what becomes of the red Bernalillo shales and sandstones. I have fancied sometimes that the 1,500 feet of Richardson's Delaware Mountain sandstone (Eddy sandstone) which immediately overlies the dark Hueco (Maderan) limestones is the southern continuation; but of this there is as yet no strong proofs.

I had also thought that I had traced the Cimarronian Red-Beds of western Kansas and northwestern Texas up the Canadian River valley and down the Pecos valley, around the great escarpment of the Llano Estacado, to the vicinity of the Guadalupe mountains where presumably they rested on the Guadalupe limestone. While on account of the extensively faulted character of the area it may take further field work in order to determine this point beyond all question there has yet appeared no valid grounds for believing that these Red-Beds underlie the Guadalupe limestones.

The existence of a dark limestone, 800 feet in thickness, above the Bernalillo shales, as urged by Lee\* and by Gordon† I very much question. There will have to be very much better testimony adduced before their ascertainment can be accepted. My own observations have been strongly to the contrary. I am quite familiar with all of the localities mentioned by both of the authors named. In every instance there seems to be very clear evidences of profound faulting which has raised, as it were, the lower limestones above the outcropping level of the red shales. In the San Filice range, east of Socorro, the fault has been tested by the drill and a displacement of nearly 1,000 feet found, yet along the faultline there is practically no bending of the strata. Similar apparent faulting back of the Sandia and Manzano ranges, where Lee states that the great upper dark limestone is missing, brings the lower limestones above the level of the same shales, in the same way as it does in the Caballos, Oscura and San-Filice ranges. Small wonder is it that Girty comments with surprise upon the similarity of the fossils which were collected for him from the limestones beneath the Bernalillo shales and the alleged limestone above.

Late Carbonic time is represented in the Rio Grande region by the great Guadalupan series of limestones, the faunas of which were early described by Shumard‡ and later by Girty§, but which have no counterparts elsewhere on the American continent. Their affinities are with the original Permian series of Russia.\*\* The other Late Carbonic representative is the true Cimarronian series of Red-Beds of Kansas, separated from the Triassic red-beds by marked unconformity††.

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\*Journal of Geology, Vol. XV, p. 54, 1907.

†Ibid., p. 816, 1907.

‡Trans. St. Louis Acad. Sci., Vol. I, p. 280, 1860.

§Univ. Texas Min. Sur., Bull. 9, p. 40, 1904.

\*\*Journal of Geology, Vol. VII, pp. 321-341, 1899.

††Am. Jour. Sci. (4), Vol. XX, pp. 423-429, 1905.