



Triassic rocks of northwestern New Mexico and southwestern Colorado

Sherman A. Wengerd

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TRIASSIC ROCKS OF NORTHWESTERN NEW MEXICO AND SOUTHWESTERN COLORADO

By Sherman A. Wengerd
University of New Mexico

Regional Setting

Triassic rocks of the "Four Corner" area thicken westward and southwestward from the Uncompahgre highland in southwestern Colorado and north-central New Mexico. No Triassic rocks are present on the higher parts of the Uncompahgre highland, and the lithology of conglomerate lentils in Chinle, Shinarump, and Dolores strata indicate that the highland area was a prominent source of sediments during most of Triassic time (See map).

In early Triassic time, the Cordilleran seaway to the west, in western Utah and Nevada, was the site of marine Moenkopi deposition comprising gray shale and limestone. Continental clastic sediments were being supplied to the Moenkopi sea from the Uncompahgre highland on the east, hence the inter-fingering of continental clastics and marine limestone is a common feature of Moenkopi strata in central Utah (Stokes 1949, p. 79). Toward the end of Moenkopi time, virtually the entire area was subjected to subaerial erosion which is now evident in the form of local discordance between Shinarump and Moenkopi strata, particularly in southeastern Utah and northeastern Arizona.

Lithofacies and isopachous data now indicate that the Shinarump conglomerate is an extremely widespread clastic formation lying unconformably upon the Moenkopi formation, but grading eastward and upward into Chinle shale of late Triassic age. This gradation has led to the inference that the Shinarump conglomerate is, with the Chinle shale, of late Triassic age. The widespread post-Moenkopi peneplanation, and differential erosion of the Moenkopi beds in response to variable uplift in the "Four Corner" area probably occurred in middle Triassic time (Stokes 1949, p. 79). Deposition of Shinarump pediment gravels probably began in certain areas as early as mid-Triassic time. Variations in thickness, coarseness, and sorting of Shinarump sediments are a function of differential uplift on the Uncompahgre highland, variations in rainfall, condition of the post-Moenkopi pediment slope, and durability of the supplying terranes to the east and northeast. The Shinarump conglomerate, typically a pediment gravel in a large area west of the Uncompahgre Uplift, is better developed as a poorly sorted, gritty sandstone southwest of the Uncompahgre Uplift, in northwestern New Mexico. This difference of lithology, and lack of sufficient deep drilling in the San

Juan Basin, coupled with conflicting vertebrate faunal evidence from shales beneath the Agua Zarca-Poleo sandstone complex in New Mexico, have to date precluded final correlation of the basal Upper Triassic sandstone beds in New Mexico with the type Shinarump beds of Arizona and Utah.

Throughout late Triassic time, Chinle shale and sandstone were deposited over broad, westward-sloping, swampy, alluvial plains, by alluviating streams which debouched into the California sea in Nevada. Volcanic activity, probably far to the northwest, added bentonite to Chinle strata. Thickness and fineness of grain of Chinle strata, and lack of sharp local discordances (with the exception of cross bedding and channelling) indicate the gentle continuous subsidence of this subaerial alluvial plain throughout late Triassic time in the "Four Corner" area.

Formation Descriptions

(Arranged alphabetically for ease of reference)

Agua Zarca sandstone. Upper Triassic (?) reddish-buff to light-gray conglomeratic sandstone, with some siltstone and silty shale, probably equivalent to the Shinarump conglomerate. Named after Agua Zarca Creek, west of Coyote, Rio Arriba County, north-central New Mexico, by Wood and Northrop in 1946. 0-380 feet thick.

Chinle formation. Upper Triassic, red, purple, lavender, and green shale, chocolate-colored sandy shale, red shaly sandstone, and bluish-gray limestone conglomerate lenses. Contains abundant bone "scrap" and petrified wood. Named after Chinle in the Chinle Valley, Apache County, northeastern Arizona by Gregory in 1915. 0-1400 feet thick.

Correo sandstone member of the Chinle shale. Upper Triassic, dark-brown to reddish-buff, massive, cross-bedded sandstone. Named after Correo, south edge of Mesa Gigante, Valencia County, New Mexico, by Kelley and Wood in 1946. 0-120 feet thick.

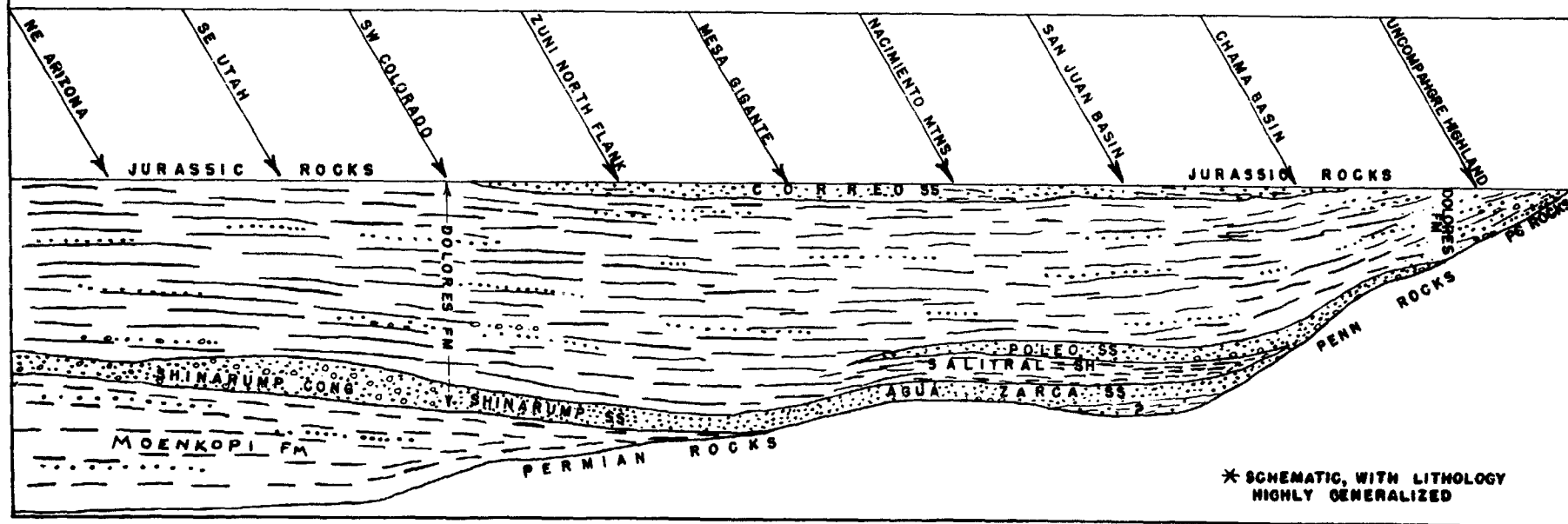
Dolores formation. Upper Triassic and possibly in part Jurassic, red to brown quartzose sandstone and conglomerate with red shale and limestone conglomerate containing abundant vertebrate bones. Named after the Dolores River, eastern San Miguel County, Colorado, by Cross in 1899. 0-600 feet thick.

Moenkopi formation. Lower Triassic, chocolate-brown to reddish-brown sandy sandstone, shale, and sandstone. Named after Moenkopi, but for exposures in the Little Colorado Valley, Coconino County, north-central Arizona, by Ward in 1901. Redefined by Baker and Reeside in 1929. 0-500 feet thick (up to 1450 feet thick in Utah).

TRIASSIC CORRELATIONS

AGE	ARIZONA	UTAH	COLORADO	N E W M E X I C O					
	NORTHEAST	SOUTHEAST	SOUTHWEST	ZUNI NORTH FLANK	MESA GIGANTA	NACIMIENTO MTNS	SAN JUAN BASIN	CHAMA BASIN	UNCOMPAGRE HIGHLAND
UPPER TRIASSIC	CHINLE FM	CHINLE FM	DOLORES FM CHINLE FM	CORREO SS CHINLE SH.	CORREO SS CHINLE SH.	CHINLE FM CORREO SS CHINLE SH POLEO SS GENORITO SS LENTIL SALITRAL SH	CORREO SS? CHINLE SH POLEO SS? SALITRAL SH?	CHINLE SH POLEO SS	DOLORES FM ABSENT
UPPER (?) TRIASSIC	SHINARUMP SS & CONG	SHINARUMP CONG	SHINARUMP SS	SHINARUMP SS	AGUA ZARCA SS(?)	AGUA ZARCA SS	AGUA ZARCA SS (E) OR SHINARUMP SS (W)	THIN AGUA ZARCA SS (MAY BE PRESENT)	ABSENT
LOWER TRIASSIC	MOENKOPI FM	MOENKOPI FM	MOENKOPI FM	QUESTIONABLE MOENKOPI SH	ABSENT	ABSENT	MOENKOPI SH (MAY BE PRESENT)	ABSENT	ABSENT

REGIONAL STRATIGRAPHIC SECTION



THICKNESS OF TRIASSIC ROCKS NORTHWESTERN NEW MEXICO — SOUTHWESTERN COLORADO

LEGEND

● SURFACE OR SUBSURFACE SECTIONS WITH THICKNESS IN FEET.

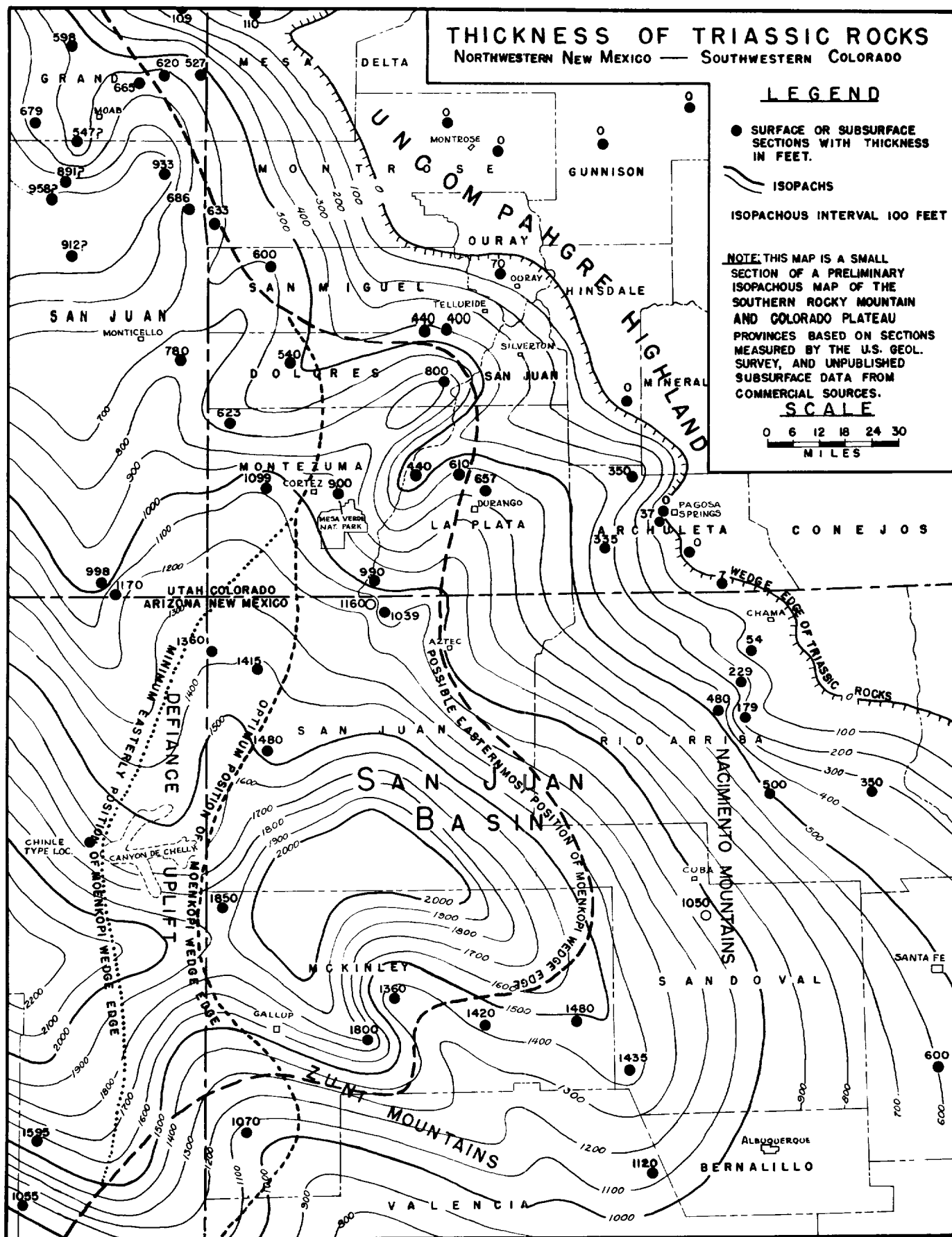
ISOPACHS

ISOPACHOUS INTERVAL 100 FEET

NOTE: THIS MAP IS A SMALL SECTION OF A PRELIMINARY ISOPACHOUS MAP OF THE SOUTHERN ROCKY MOUNTAIN AND COLORADO PLATEAU PROVINCES BASED ON SECTIONS MEASURED BY THE U.S. GEOL. SURVEY, AND UNPUBLISHED SUBSURFACE DATA FROM COMMERCIAL SOURCES.

SCALE

0 6 12 18 24 30
MILES



Poleo sandstone member of the Chinle shale.
Upper Triassic, gray to buff massive sandstone.
Named for Mesa Poleo, eastern Rio Arriba County,
New Mexico, by von Huene in 1911. 0-115 feet
thick.

Salitral shale member of the Chinle shale.
Upper Triassic, varicolored shale with limestone
concretions. Named after Salitral Creek, west of
Coyote, Rio Arriba County, New Mexico, by Wood
and Northrop in 1946. 0-105 feet thick.

Senorito sandstone lentil of the Chinle shale.
Equivalent to Agua Zarca sandstone. Named for
Senorito Canyon, Nacimiento Mountains, western
Sandoval County, New Mexico, by Renick in 1931.

Shinarump conglomerate. Upper Triassic (?),
gray to buff coarse-grained sandstone and conglomer-
ate containing abundant petrified wood. Named after
the Shinarump Cliffs, south of the Vermilion Cliffs
in southern Kane County, Utah, by Gilbert in 1875.
0-200 feet thick where identified as Shinarump.

Correlations

The Problem

Study of the Triassic rocks in the southwestern
United States is complicated by the following condi-
tions:

1. Sedimentational variations caused by contin-
ental conditions of deposition and geographic
differences in the amount of rainfall during
Triassic time.
2. Highly variable sources of Triassic sedi-
ments controlled in part by:
 - A. Irregular uplift and differential rock
terraces in the source areas (Cross
1899) (Cross and Spencer 1905) (Cross
and Larsen 1913).
 - B. Irregular ancient topographic spurs
and reentrants on the west and south-
west flank of the Uncompahgre Uplift
(See Isopachous map).
3. Conflicting paleontologic evidence based on
fresh water invertebrates, vertebrate bones,
and plants, as well as conflicting interpre-
tations of faunal evidence in relation to
lithologic characteristics (Baker and Ree-
side 1929) (Bates 1942) (Colbert 1948 and
1950) (Darton 1910, 1925, and 1928) (Eckel
1949) (Fontaine and Knowlton 1890) (Greg-
ory 1913 and 1917) (Heaton 1933 and 1939)
(von Huene 1911, 1915, and 1926) (Northrop
1950) (Reeside 1929) (Renick 1931) (Stokes
1949) (Smith 1914) (Winchester 1933) (Wood,
et al. 1948).

4. Geographic position of the San Juan Basin,
with few deep well data in an area of criti-
cal sedimentational change in Shinarump
strata, and eastward disappearance of Moen-
kopi strata (Kelley and Wood 1946) (Wood
and Northrop 1946) (Read, et al. 1949).

In view of these difficulties, a short summary is
presented for each area where Triassic rocks have
been studied in some detail. Arizona and Utah
Triassic stratigraphy is not discussed here owing to
the relatively fewer Triassic problems where Trias-
sic beds are thicker and more continuously exposed.

Southwestern Colorado

Cross first described Triassic rocks in the
Telluride area and named the red sandstone, grit,
conglomerate, and shale the Dolores formation
(1899). He measured 1550⁺ feet of Triassic beds
and noted that the coarse sediments were derived
from Algonkian and Paleozoic rocks of the San Juan
continental area (Cross 1899, p. 2). Later study of
vertebrate and plant fossils showed the Triassic beds
to be only 400 feet thick, his earlier measurements
having included Permian beds (Cross and Spencer
1905). Owing to the nearness of this area to the
major sources for Triassic sediments, subdivision
of the Dolores section was not attempted; in fact,
Jurassic sandstone beds were included. Later work
on the Animas Canyon section and other nearby
Triassic exposures indicated a late Triassic age for
these strata.

Eckel's lithologic descriptions and stratigraphic
position of the beds suggest, however, that the basal
sandstone and shale section totaling 273 feet in
Animas Canyon, Colorado, may be equivalent to the
Poleo sandstone, Salitral shale, and Agua Zarca
sandstone in the Nacimiento Mountains as described
by Wood and Northrop (1946). As it will be shown
later in this report that the Agua Zarca sandstone is
probably equivalent to the Shinarump sandstone, it
is very likely that close lithologic study will prove
the existence of Shinarump equivalents in the Animas
Canyon section.

Moenkopi strata were encountered in a deep well
drilled on the McElmo anticline in Montezuma County
and in other wells in southwestern Colorado, but
correlative strata are absent east of Durango. It is
possible that certain sections now called Dolores
formation may contain Chinle, Shinarump, and Moen-
kopi equivalents.

Triassic rocks in southwestern Colorado are
overlain by Jurassic sandstone beds of the Glen Can-
yon and San Rafael groups, and underlain by Cutler
strata of Permian age.

Zuni Mountains, New Mexico

Darton's early work on the red beds of New Mexico indicated that Shinarump and Moenkopi beds were present in the Zuni Mountain area (1928). Later work by Baker and Reeside (1929) and Reiche in 1942 cast doubt on the existence of Moenkopi beds in north-western New Mexico based on rates of thinning in eastern Arizona, and the presence of abundant sili-cified wood in purple shale beneath a 100-foot white sandstone at the approximate stratigraphic position of the Shinarump sandstone (Bates 1942, p. 45). Despite this meager unsupported evidence, no valid Upper Triassic fossils have been found in the purple shale beneath the white sandstone. Regional corre-lations, lithologic examination, and isopachous study of each formation carried into New Mexico from Ari-zona and Utah, suggest strongly that Shinarump and Moenkopi beds are present off the northwest plunge of the Zuni anticline, and possibly throughout a great part of the deeper San Juan Basin. Additional evi-dence is presented by Kelley and Wood in the dis-covery of a thick Shinarump section in Mesa Lucero, southeast of the Zuni Mountains (1946). The drilling of additional wells in the basin will aid in solving this problem of whether Moenkopi beds are present in the San Juan Basin and the possibility of the Shina-rump sandstone being directly correlative with the Agua Zarca sandstone in the Nacimiento Mountains. Triassic rocks in the Zuni area are overlain by Win-gate strata of Jurassic age, and underlain by San Andres strata of Permian age.

Archuleta Area, Colorado

The name "Dolores" as applied by Cross to Triassic beds in southwestern Colorado has been carried into Archuleta County where the classical tripartite division of the Triassic system cannot be applied. Surface sections in Piedra Canyon and sub-surface sections in wells drilled in Archuleta Canyon vary greatly in thickness and lithology (Wood, Kelley, and McAlpin 1948) (Read, et al. 1949). The Dolores formation is believed to be of late Triassic age, but possibly includes some Jurassic beds. Where the formation is very thin, the lithology appears similar to that of the Poleo and basal Agua Zarca sections in the Nacimiento Mountains to the south. Typical Chinle shale is generally present in the Triassic section only where it is thicker than 200 feet. This facies change is probably controlled by nearness to the source of Triassic sediments as represented by the Triassic wedge-edge on the flank of the Uncompahgre Uplift. It is notable that the Triassic clastics in the area appear to be largely Permian debris in contrast to Triassic coarse clastics of Paleozoic and pre-Cambrian origin which are present in Utah and Arizona, great distances from the Uncompahgre highland.

Dolores beds lie on rocks ranging from Permian to pre-Cambrian age, on the southwest flank of the

Uncompahgre highland. These strata are overlain by Entrada sandstone of Jurassic age which formerly extended over a great part of the nearby highland area.

Chama Basin - Nacimiento Mountains New Mexico

The Triassic system in this area is represented by the Chinle formation which has been divided as follows:

Upper shale member 235-953 feet (?)
Poleo sandstone lentil 0-115 feet
Salitral shale tongue 0-105 feet
Agua Zarca sandstone member 90-400 feet (?)
(Wood and Northrop 1946)

The Poleo sandstone thins from Mesa Poleo south-ward, whereas the Agua Zarca sandstone thins north-ward from its thickest development near San Ysidro. What is now named Agua Zarca sandstone was called the Poleo sandstone by Renick (1931), but surface tracing of the beds proved the existence of a shale now known as the Salitral tongue. Where the Poleo sandstone is absent, the Salitral tongue cannot be differentiated from the main body of the Chinle shale (Wood and Northrop 1946).

The conglomeratic sandstone at the base of the Chinle shale in the Chama Basin is probably the Poleo sandstone as defined by von Huene in 1911, although the Salitral shale may be absent and both the Agua Zarca and Poleo sandstone may be present (See Regional Stratigraphic Section). This conclu-sion is based on thickness, and the presence of abun-dant basal conglomerate lentils in the Poleo sand-stone in the Chama Basin.

In 1922, Darton stated that the Poleo sandstone was equivalent to the Shinarump conglomerate and further, that the shale beneath the sandstone was probably Lower Triassic Moenkopi (quoted by Northrop 1950). Baker and Reeside later showed that the shale beneath the Poleo sandstone was late Triassic in age, based on vertebrate fossils (1929). This discovery led to their suggestion that the Poleo sand-stone is younger than the Shinarump conglomerate of Arizona. It may be inferred that these Upper Trias-sic fossils came from the shale called the Salitral by Wood and Northrop; which does not disprove the suggestion that the Agua Zarca sandstone (formerly called Poleo through miscorrelation by Renick in 1931) is possibly a direct time and lithologic equi-valent of the Shinarump beds present at Mesa Lucero, north flank of the Zuni Uplift, and near Chinle, west of Canyon de Chelly, Arizona.

The Chinle shale of the Ghost Ranch country (Chama Basin) contains at least six fossil zones, yielding bones of amphibians, phytosaurs, small dinosaurs, and fresh water clams (Colbert 1950). The Chinle section represents two phases of sedi-

mentation comprising a basal massive sandstone, which Colbert also suggests may be the Shinarump equivalent (1950, p. 60), and the soft varicolored shale above. Lower Triassic Moenkopi strata are absent on the outcrops along the east side of the San Juan Basin and in the Chama Basin.

Triassic rocks overlie Cutler, Yeso, and San Andres strata, and are overlain by the Wingate (Entrada) sandstone of Jurassic age, in the east and northeast sectors of the San Juan Basin.

The Triassic correlations of the "Four Corner" area, based on a survey of the literature, subsurface and surface work, and certain as yet unvalidated inferences, are shown on the correlation chart and the regional stratigraphic section.

Oil and Gas Possibilities

Triassic rocks of the San Juan Basin are entirely of non-marine origin and only slight shows of petroleum have been found.

The Byrd-Frost et al. MacIntosh No. 1 in Section 25, T 36 N, R 18 W, Montezuma County, Colorado, was completed in August, 1948, as a carbon dioxide well making between 150,000 and 500,000 cubic feet of gas per day from the Shinarump conglomerate. A dry-ice plant will shortly be in operation.

The nature of the Triassic sediments and lack of thick marine, source beds subjacent or superjacent to excellent reservoir rocks such as the Shinarump conglomerate, Agua Zarca sandstone, Poleo sandstone, and the Correo sandstone, appear to preclude Triassic oil and gas production in the San Juan Basin. Under certain special conditions of timing, fracturing, and sealing, small quantities of oil and gas may move into Triassic rocks from Pennsylvanian rocks below. In the northeastern part of the San Juan Basin, Dolores sandstone beds probably overlap Pennsylvanian marine source beds, but the timing of oil origin and migration, in relation to deposition of the potential reservoir sandstone beds appears incorrect for the formation of oil and gas pools.

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