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AN ANALYSIS OF THE DAKOTA SANDSTONE IN THE VICINITY OF LAS VEGAS, NEW MEXICO AND EASTWARD TO THE CANADIAN RIVER VALLEY

by

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ENVIRONMENTAL FRAMEWORK, GEOLOGIC HISTORY, AND COMPOSITION

The age of the sandstone body subjacent to the Graneros Shale and superjacent to the Morrison Formation has been a matter of controversy among geologists who have worked in the unit in the Creston Range and along the margins of the Las Vegas Plateau. The request for a paper regarding the Dakota Sandstone for inclusion in the guidebook prompted a study of the "unit" in several localities (Fig. 1) along the northwest

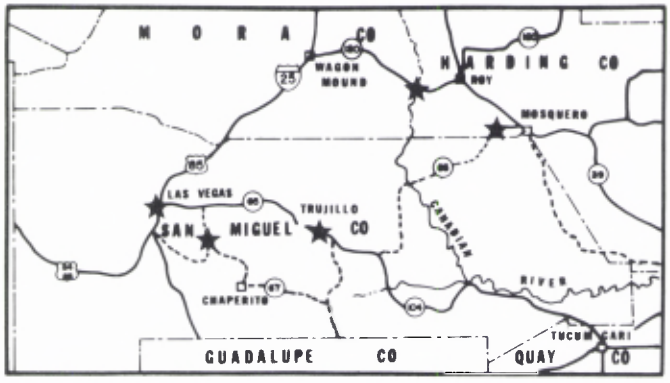

Figure 1. Localities included in Survey of Dakota Sandstone.

margin of the conference area. Specifically, sections were examined at three localities in the Creston Range near Las Vegas, New Mexico, one locality northwest of Chaperito on New Mexico highway number 67., one in the canyon of the Canadian River between Wagon Mound and Roy, New Mexico, one in the road cut at Trujilbo, and at one west of Mosquero.

Thickness of the Dakota Sandstone in the Creston Hogback ranges from 112 feet at Romeroville to 118 feet at Montezuma. Measurements were not taken at other localities, but thicknesses appeared to be similar to those in the Creston Range.

The Dakota consists of a lower alluvial interval, constituting 65-85 percent of the total section, and an upper transitional and marine interval consisting of coastal marsh, lagoon-bay, intertidal and shoreline-strike sandstone deposits. Approximately the lower two-thirds of the unit consists of a braided alluvial sheet, possibly part of a piedmont plain, that sloped toward the east and contains quartzose sandstone, conglomeratic sandstone and lenses of conglomerate. Sandstone is cemented by silica overgrowths on quartz grains. Pebbles of the conglomeratic fraction consist mainly of replacement chert derived from older carbonate rocks. Original carbonate structures are well preserved in most chert pebbles. Chert in the conglomerate is similar to varieties observed in the Devonian (Espiritu Santo), Mississippian (Terrero), and the Pennsylvanian (Madera) formations which are exposed to the west.

Within the alluvial interval a thicker braided alluvial sheet is succeeded by a thinner meander-belt sequence which consists of swampy floodplain and channel sandstone deposits. At all localities except Kearney Gap, in the Creston Range, the meander-belt deposits are succeeded by coastal marsh (carbonaceous silty shale), lagoon-bay (bioturbated silt and shale), and either a thin reworked zone of sandstone from 2 to 5 feet thick or shoreline-strike sandstone bodies ranging in thickness from 12 to 47 feet.

Conglomeratic sandstone of the lower braided alluvial interval records deposition by streams with relatively steep gradients compared to those of the subjacent Morrison Formation and the superjacent floodplain deposits. The steepened gradients probably reflect early Laramide tectonic activity to the west. The upward succession of braided alluvial (piedmont plain) deposits to swampy meander-belt deposits is commonly recorded in the geologic record and reflects progressive headward erosion of drainage basins following uplift. Thus higher piedmont plains become succeeded in time by lower gradient coastal plains. The area then became submerged by the early Late-Cretaceous sea that inundated much of the western interior of North America.

SEDIMENTARY STRUCTURES, PALEOGRAPHY, AND CLIMATE

Large and small scour-and-fill structures are abundantly represented in the lower Dakota braided alluvial complex. Vertical sequences of sedimentary structures record flood stages or periods of high discharge characterized by initial scours followed by deposition during falling flood stage or lower phases of discharge.

A commonly represented sequence includes a lower interval of coarse material which is massively to crudely layered, an interval of coarse, parallel-laminated sand or large truncated-ripple cross-bedding with foresets up to three feet high, fine, parallel laminations or small current-ripple crossbedding, and parallel sand-silt-clay laminae. A layer of mud commonly blanketed much of the channel at the end of the falling flood stage of deposition. Each flood unit commonly exhibits clay chips and pebbles at the base, derived from the mud deposited at the end of the previous falling flood stage, and grain size decreased upward within each interval.

Channel sandstone of the meander belt overlying the braided alluvial sheet display structures similar to those of the

braided stream deposits, but commonly contain point bar structures. Meander-belt deposits consist chiefly of carbonaceous silt and silty shale deposited on floodplains.

Throughout the study area analyses of current flow patterns in the lower alluvial interval of the Dakota reveals a consistent regional slope toward the east-southeast. The interpretation of this regional slope is reinforced by the presence of pebbles and cobbles consisting of replacement chert derived from Devonian, Mississippian and Pennsylvanian carbonate deposits and from Precambrian metamorphic rocks from a westerly source area. The fact that replacement chert (but no limestone) pebbles were transported from a westerly source suggests prolonged chemical weathering and solution of carbonate rocks under humid or subhumid climatic conditions.

The upper portion of the upper Dakota transitional and marine sandstone beds display well developed vertically to subvertically oriented burrows made by worms, pelecypods and crustaceans that lived in the intertidal zone. Grain size in marine sandstones increases upward.

Flat- to round-crested oscillatory ripples commonly form on present beaches and intertidal flats by partial erosion of initially sharp-crested wave ripples when the tide ebbs. Such ripples are oriented parallel to shorelines. Flat and round-crested ripples are commonly present in the upper transitional to marine sandstones of the upper Dakota interval and indicate a shoreline strike of N. 0-17° E. Large truncation ripples in the upper Dakota marine sandstones reflect deposition by longshore currents that flowed parallel to subparallel to the shoreline. Throughout the study area a consistent longshore current pattern was observed in the upper Dakota with the predominate direction being S. 0-25 W. with minor 180 degree reversals. The inferred shoreline strike is also perpendicular to the regional slope delineated from analyses of paleocurrent flow data in the lower alluvial interval.

The abundance of carbonaceous silty shale and plant remains in the upper portion of the Dakota suggests that the climate at the depositional site, like that of the westerly source area, was humid to subhumid.

The sandstone sequence above the Morrison Formation in the Creston Range, in the walls of the canyon of the Canadian River between Wagon Mound and Roy, New Mexico, in the rim of the escarpment along the Las Vegas to Chaperito highway, and in the escarpment at Trujillo, New Mexico are internally conformable and appear to grade upward into the Graneros Shale. Accordingly, the writers assigned these beds to the Dakota Sandstone. Superficially similar sandstones which crop out in the escarpment south of San Jon, New Mexico (Stop 5, first day) in the scattered outcrops near Campana, New Mexico (vicinity of Stop 2), in the escarpment west of Mosquero, and at David Hill are considered to be Mesa Rica Sandstone (or Purgatoire). The question, "What is Dakota and what is Mesa Rica?" poses an interesting problem the solution of which is not yet at hand. The final answer will involve extremely detailed study of the area between Mosquero and the Canadian River. Tentative conclusions are based upon the following criteria:

1. The Tucumcari Shale contains an abundant marine fauna which assigns the unit to the Lower Washita (Duck Creek). The lower portion of the overlying Mesa Rica Sandstone likewise contains marine fossils of Lower Washita age.
2. The uppermost beds of the Mesa Rica Sandstone are bioturbated. These beds are in seemingly conformable sequence with the fossiliferous lower portion. On the other hand, the braided alluvial plain deposits of the lower portion of the Dakota Sandstone are of undoubted terrestrial origin.
3. At Stop No. 2, and at the Tixier Ranch, the shale bed which overlies the lower thick-bedded sandstone of the Mesa Rica is marine and contains fragments of *Gryphaea tucumcarii* and *Pervinquieria* both of which occur in the Tucumcari Shale south of San Jon. Silt and clay beds of the meander belt portion of the Dakota (middle Dakota) contain carbonaceous materials and numerous fragments of fossil plants. This unit is of terrestrial origin. Sandstone beds which overlie the fossiliferous shale at Stop No. 2 and the post-Pajarito sandstone in the section south of San Jon are of terrestrial origin. Sandstone bodies which overlie the meander belt sequence of the middle Dakota are bioturbated and contain fragments of various marine pelecypods, gastropods, and sponges. Accordingly, the uppermost beds of the Dakota Sandstone are of marine origin.

In the opinions of the writers, no caprock sandstone seen during the first day of the field conference is Dakota Sandstone; rather, it is Mesa Rica Sandstone, Cheyenne Sandstone, or Purgatoire. Furthermore, the lower portion of this sandstone is of marine origin; the upper part is non-marine. Tentative age assignment for this unit is Lower Washita (Duck Creek and possibly Fort Worth).

Lateral relationships between the Dakota Sandstone and the Mesa Rica Sandstone are not yet known, but detailed paleontologic study of sections westward from Mosquero toward the Canadian River and toward the section at Trujillo should provide answers.

CONCLUSIONS

1. In the vicinity of Las Vegas, New Mexico and eastward to the Canadian River Canyon the Dakota Sandstone represents an internally conformable succession recording deposition, upward from the base, in the following envirnonments: 1) a lower braided alluvial (piedmont) plain on which quartzose sandstones, conglomeratic sandstones and conglomerates accumulated; 2) a meander belt characterized by channel sandstones and floodplain deposits consisting of carbonaceous silt and shale; 3) an upper transitional to marine interval representing accumulation in coastal marshes, lagoons or bays, intertidal flats and shoreline-strike sandstone bodies deposited by littoral drift and longshore currents.

2. Coarse conglomeratic sandstone and conglomerate of the lower Dakota piedmont plain probably reflect a response to early Laramide tectonic activity to the west.

3. The relatively thin upper transitional and marine interval of the Dakota and the superjacent Graneros Shale records a classical widespread transgression of the expanding Gulfian sea over the western interior of North America.

4. Analysis of paleocurrent flow data from the lower alluvial interval of the Dakota reveals a regional slope toward the east-southeast. Pebbles in the conglomerate fraction consist principally of replacement chert derived from Devonian (Espiritu Santo), Mississippian (Terrero), and Pennsylvanian (Madera) carbonate formations which were exposed to the west. Pebbles eroded from Precambrian metamorphic rocks also indicate a westerly source area. Orientation of flat- to round-crested wave ripples, which formed parallel to the shoreline on beaches and tidal flats, reflects a shoreline trend of N. 0°-17° E. over the area. Analysis of paleocurrent patterns in

upper Dakota marine sandstone records deposition by longshore currents flowing parallel or subparallel to the shoreline.

5. Abundance of pebbles of replacement chert derived from carbonates in the lower alluvial Dakota and the absence of limestone pebbles suggests that the source area to the west was characterized by a humid to subhumid climate. The presence of highly carbonaceous silts and shales and abundant carbonized plant remains in the upper portion of the Dakota indicates that the climate at the depositional site also was humid to subhumid.

6. There is no reason to suppose that the sandstone mapped as the Dakota Sandstone in the Las Vegas area, and eastward to the Canadian River Canyon, has been improperly classified. It represents an internally conformable sequence which grades upward into the Graneros Shale.

7. The sandstone beds which crop out in the high escarpments of the field conference area probably are not Dakota Sandstone. Rather, they should be assigned to the Mesa Rica, the Cheyenne, or to the Purgatoire. Future studies of the area between Mosquero and the canyon of the Canadian River should provide information on lateral relationships between the Dakota Sandstone and the sandstones of Lower Washita age.