

D' SOUTHWEST ← 340 mi (547 km) along the line of section or 277 mi (446 km) end point to end point → NORTHEAST

INTRODUCTION

Sedimentary rocks of Cretaceous age along Transect D-D' in eastern Arizona, northern New Mexico, southern Colorado, and western Oklahoma consist mainly of sandstone, siltstone, shale, limestone, and bentonite. They accumulated as sediments in continental, nearshore marine, and offshore marine environments on the eastern margin of a north-trending epicontinental sea. The rocks record intermittent deposition and erosion as well as regional and local subsidence and uplift possibly beginning in Aptian time (about 112-65.4 Ma). Most of the Lower Cretaceous (Berthiaum through Aptian, 142-112 Ma) in this transect is represented by a basal unconformity. The Cretaceous rocks and unconformities along the transect are depicted on the attached lithostratigraphic cross sections (sheets 1 and 2); one extending from the Mogollon Rim in eastern Arizona to Pagosa Springs in southwestern Colorado and the other from Pagosa Springs, Colorado, to the Mancos Shale in northeastern Colorado. The same rocks and unconformities are also represented on the attached chronostratigraphic profile (sheet 3), which was prepared mainly from surface and subsurface data shown on the lithostratigraphic cross sections.

This compilation is the third in a series that was prepared for the Western Interior Cretaceous (WIK) Project of the Global Stratigraphic Geology Program (GSGP), established by the International Union of Geological Sciences. WIK was identified early as a GSGP research project with the goal of extending our understanding of the history of the earth, surficial processes, the evolution of life, and the biotic influences on earth processes through global-scale research on sediments, sedimentary rocks, and the associated organisms and their remains. A specific goal of WIK has been to create a publicly available database from which to reconstruct and interpret the depositional history of the Cretaceous in the interior of western North America. The database would allow comparisons of the Cretaceous Western Interior Basin with other basins of the interior of western North America. The database would allow comparisons of the Cretaceous Western Interior Basin with other basins of the interior of western North America. The database would allow comparisons of the Cretaceous Western Interior Basin with other basins of the interior of western North America.

The regional cross sections, A-A', B-B', and D-D', vary slightly in format and scale because of the differences of the regional coordinates and because of the specific geologic requirements of each region. Correlations of stratigraphic units along the transects were based mainly on conodont-bearing beds of bentonite and marine fossils in the sequences. The datum used in the lithostratigraphic cross sections for transects A-A' and B-B' was derived from the stratigraphic location of the upper Campanian mudlak Baculites fossils. For the lithostratigraphic cross section of transect D-D', Molenaar (Dyman and others, 1994) explained that "A variable datum was used in constructing the lithostratigraphic cross section. In general, the highest marker bed or horizon in a particular area that was considered to have been nearly horizontal at the time of deposition was used. For example, in the southwestern part of the transect, either the Towells Tongue of Dakota Sandstone or the Rio Salado Tongue of Mancos Shale was used because most of the overlying strata had been removed by erosion.

Further northeast where a younger strata is preserved, a higher marker bed was used, such as the base of the Pecosado Tongue of Mancos Shale or an inter in the San Juan Tongue of the Mancos Shale and so on." The numerical ages of the strata shown on the chronostratigraphic cross sections were determined from the radiometric studies of bentonites by Obradovich (1993) and the identification of associated fossils.

The cross sections for Transect D-D' were compiled by the late C.M. Molenaar from stratigraphic information that he and other earth-scientists developed during many years of field and subsurface studies in the southwestern United States. They are based on published and unpublished information as follows: from Wülfe (1959) data for the Zuni basin and the southern flank of the San Juan basin were derived from the work of Hook and others (1983) and Molenaar (1983) data for the subsurface Mancos Shale in the San Juan basin were supplied by Molenaar and Baird (1992); and data for the panhandle of Oklahoma and northeastern New Mexico area were obtained partly from a publication by Holbrook (1992). Stratigraphic nomenclature proposed for the area of Pagosa Springs by Leskie and others (1997), the Mancos Shale and Cortez Member of the Mancos Shale, is used here and noted on Sheet 1. Correlations from Pagosa Springs through the Raton basin are mostly the interpretations of Molenaar.

The distance along Transect D-D' is about 615 mi (990 km). The distance between the ends of the cross section, along an east-northeast-trending straight line, is about 450 mi (720 km). On cross sections D-D' and D'D' (sheets 1 and 2), the horizontal scale is about 1 inch = 7.8 miles (1 centimeter = 4.9 kilometers) and the vertical scale is about 1 inch = 360 feet (1 centimeter = 31.2 meters). On chronostratigraphic cross section D-D' (Sheet 3), the horizontal scale is about 1 inch = 15.8 miles (1 centimeter = 10 kilometers) and the vertical scale is about 1 inch = 1.6 million years (1 centimeter = 0.03 million years).

The Cretaceous rocks of Transect D-D' are shown on the lithostratigraphic and chronostratigraphic cross sections as formations, members, tongues, lentils, and beds. Rock types of continental origin were not differentiated on the cross sections by the late senior author, probably because the contrasting strata were too thin to be depicted at the scale of the cross sections. Rocks of marine origin are classified as sandstone, shale, and siltstone, and carbonate rocks; these lithologic units commonly include lesser amounts of other rock types. The strata of this transect were described at more than 21 outcrops and from 14 boroholes. At many localities along the transect, outcropping marine beds yielded mollusk fossils, mainly ammonites and nautilus, that were compared to the Cretaceous Western Interior ammonite zones (Cobban and others, 1994) to determine relative ages of the strata. Radiometric ages of Cretaceous bentonites in the Western Interior (Obradovich, 1993) have been used to establish precise ages for many of the fossil zones.

The Cretaceous strata along Transect D-D' were described and named by Molenaar (1983) and others (1997), and they were modified by Molenaar and others (1997) to reflect east-northeast from northwestern Utah to south-central South Dakota. The Cretaceous strata are conformably overlain by rocks of Tertiary age. Nearly in eastern Arizona and in western New Mexico, Cretaceous siliclastic rocks of continental and nearshore-marine origin are common. Most of these strata in the San Juan Basin, northern New Mexico and in western Oklahoma, are composed mostly of siliclastic and carbonate rocks that were deposited in offshore-marine environments. They are conformably overlain by Tertiary beds. Cretaceous strata in this area, from the top of the Cenomanian Dakota Sandstone to the top of the Campanian Trinidad Sandstone, are about 3,500 ft (1,050 m) thick.

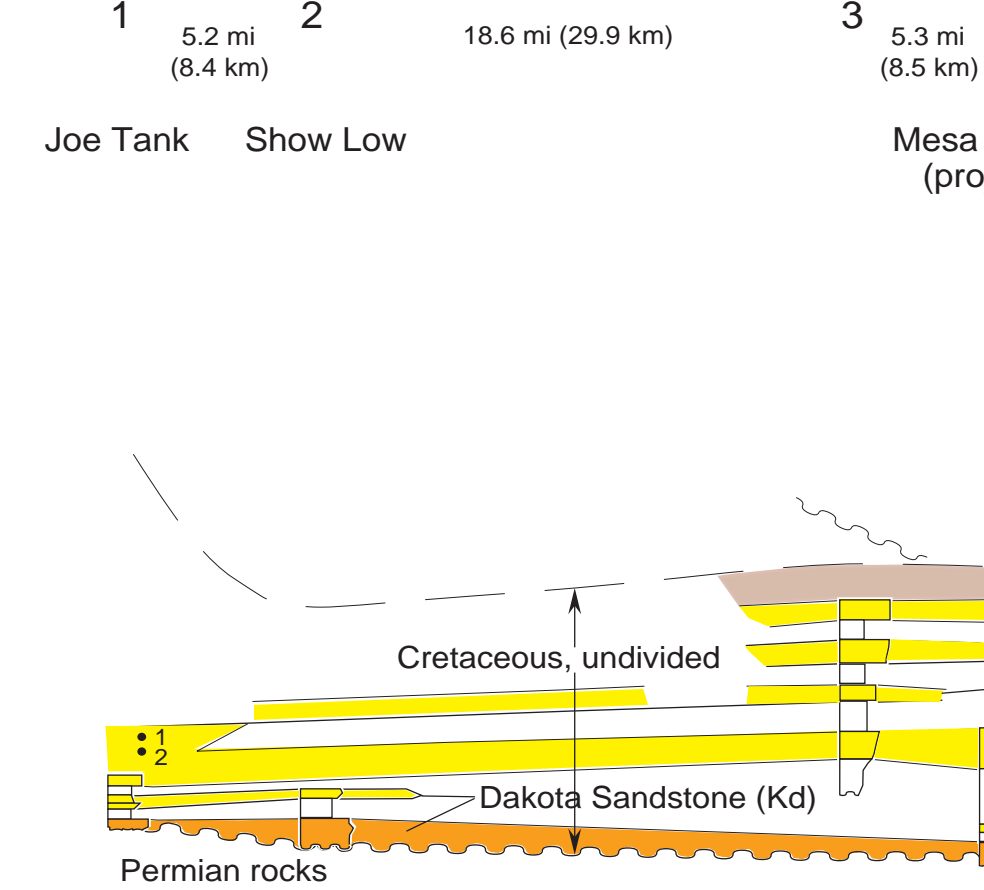
These cross sections were initially digitized and printed with the guidance of W.S. Larson, J.R. Boker, and M.E. Henry of the U.S. Geological Survey, whose selfless contributions to the preparation of these illustrations are much appreciated. Reviews of this report by T.S. Dyman, J.E. Fassett, J.L. Ridgley, D.J. Nichols, and K.L. Varner provided references to the stratigraphic, sea, and drilling that are gratefully acknowledged. The following list of references for the stratigraphy of Cretaceous rocks in the region of Transect D-D' is not comprehensive. It includes citations only for those publications apparently used by Molenaar in constructing the cross sections and cited in this text. The cross sections, originally prepared by Molenaar, were revised and supplemented by Merewether after Molenaar's death.

Selected REFERENCES

Aubrey, W.M., 1988, The Enclinal Canyon Member, a new member of the Upper Cretaceous Dakota Sandstone in the southwestern San Juan basin, New Mexico, U.S. Geological Survey Bulletin 1633-C, p. 57-69.
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EXPLANATION
x Outcrop section
• Borehole
0 50 100 Miles
0 50 100 Kilometers

INDEX MAP SHOWING LOCATION OF CROSS SECTIONS



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EXPLANATION
Formation or member contact
Contact that rises (uniformly or abruptly) in stratigraphic position
Contact, position is uncertain
Unconformity - Queried where uncertain
SP Spontaneous-potential curve
GR Gamma-ray curve
R Resistivity curve
KB Kelly logging
[proj] Projected position of macrofossil from nearest outcrop

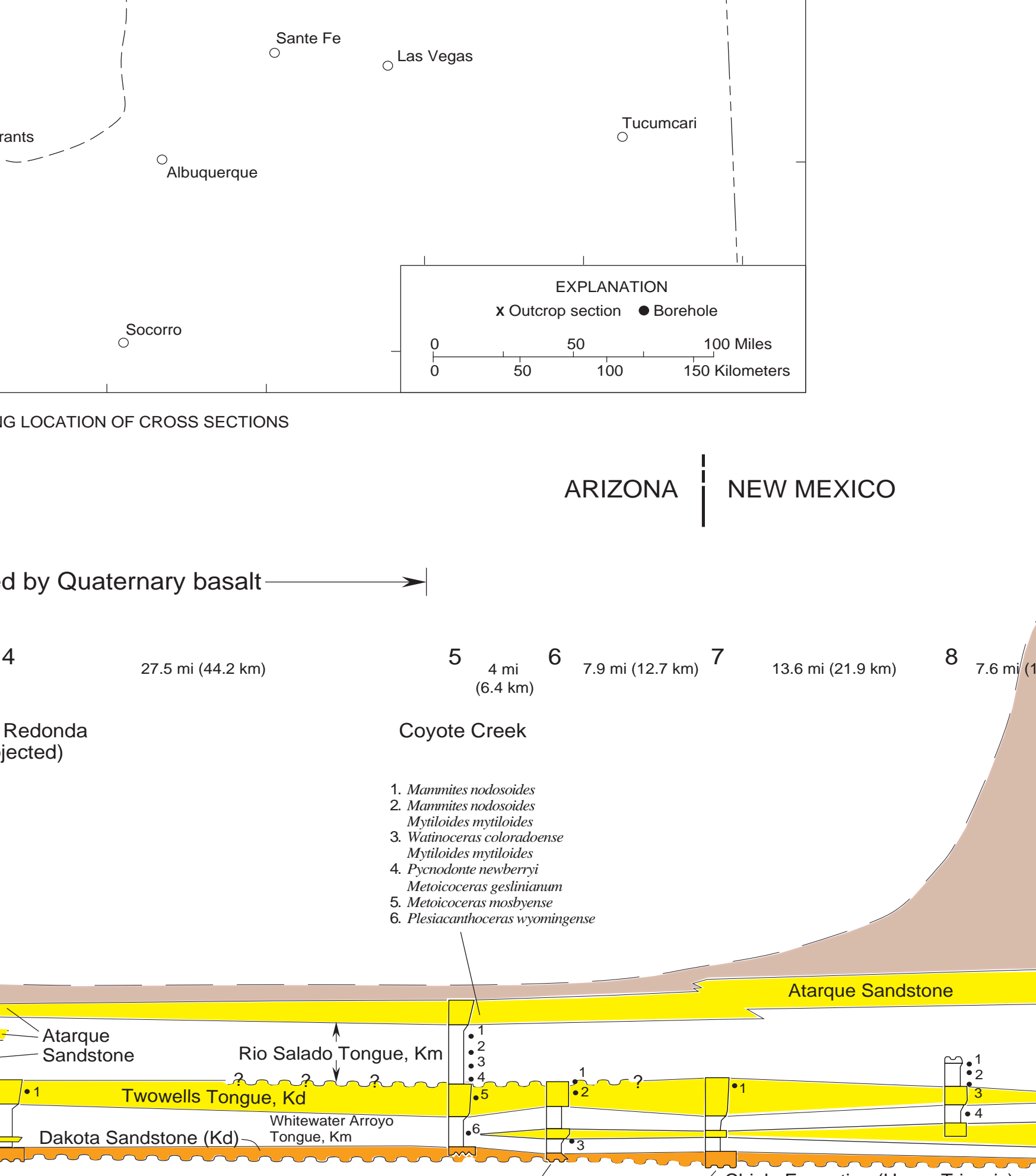
MEASURED SECTIONS (column magnified 2x)
upper coarse Sandstone
upper medium Sandstone
upper fine Sandstone
lower fine Sandstone
upper very fine Sandstone
lower very fine Sandstone

ABBREVIATIONS FOR STRATIGRAPHIC UNITS
Kk Kirtland Shale
Kl Lewis Shale
Kch Cliff House Sandstone
Kpl Point Lookout Sandstone

FEET METERS
0 100 200
0 50 100 Kilometers

SCALE
Vertical exaggeration about 160 x
Horizontal scale excludes width of well-log column

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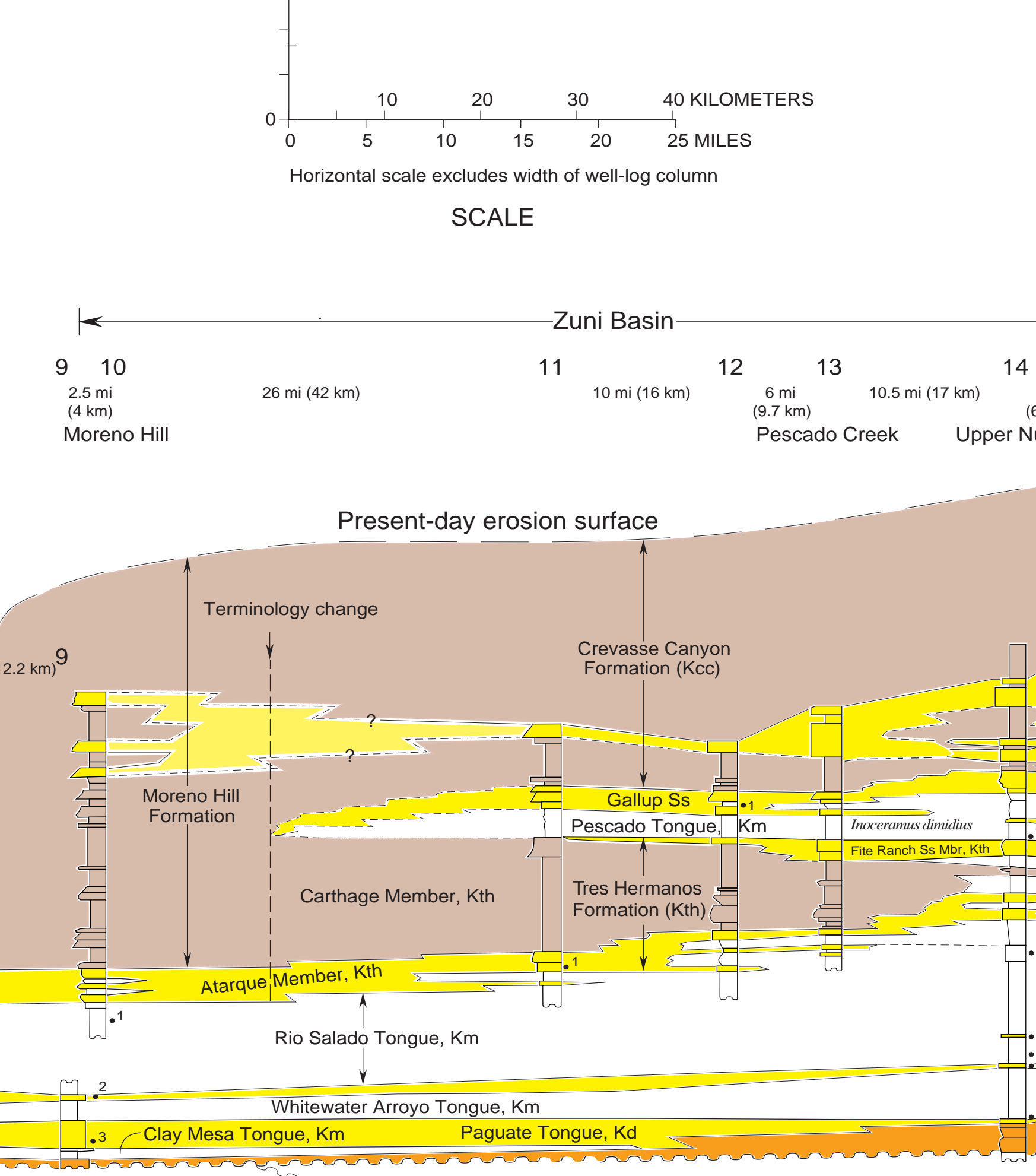
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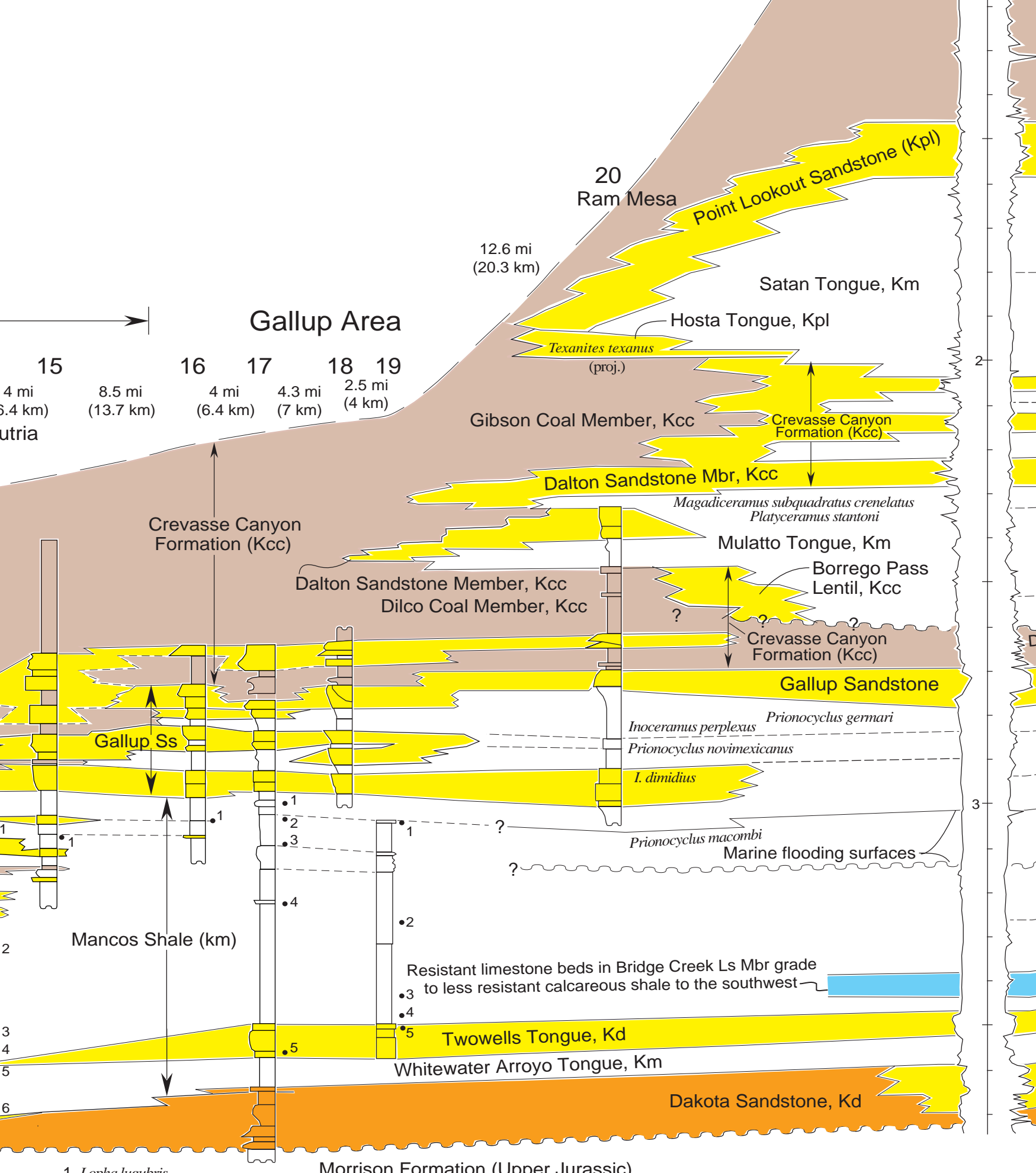
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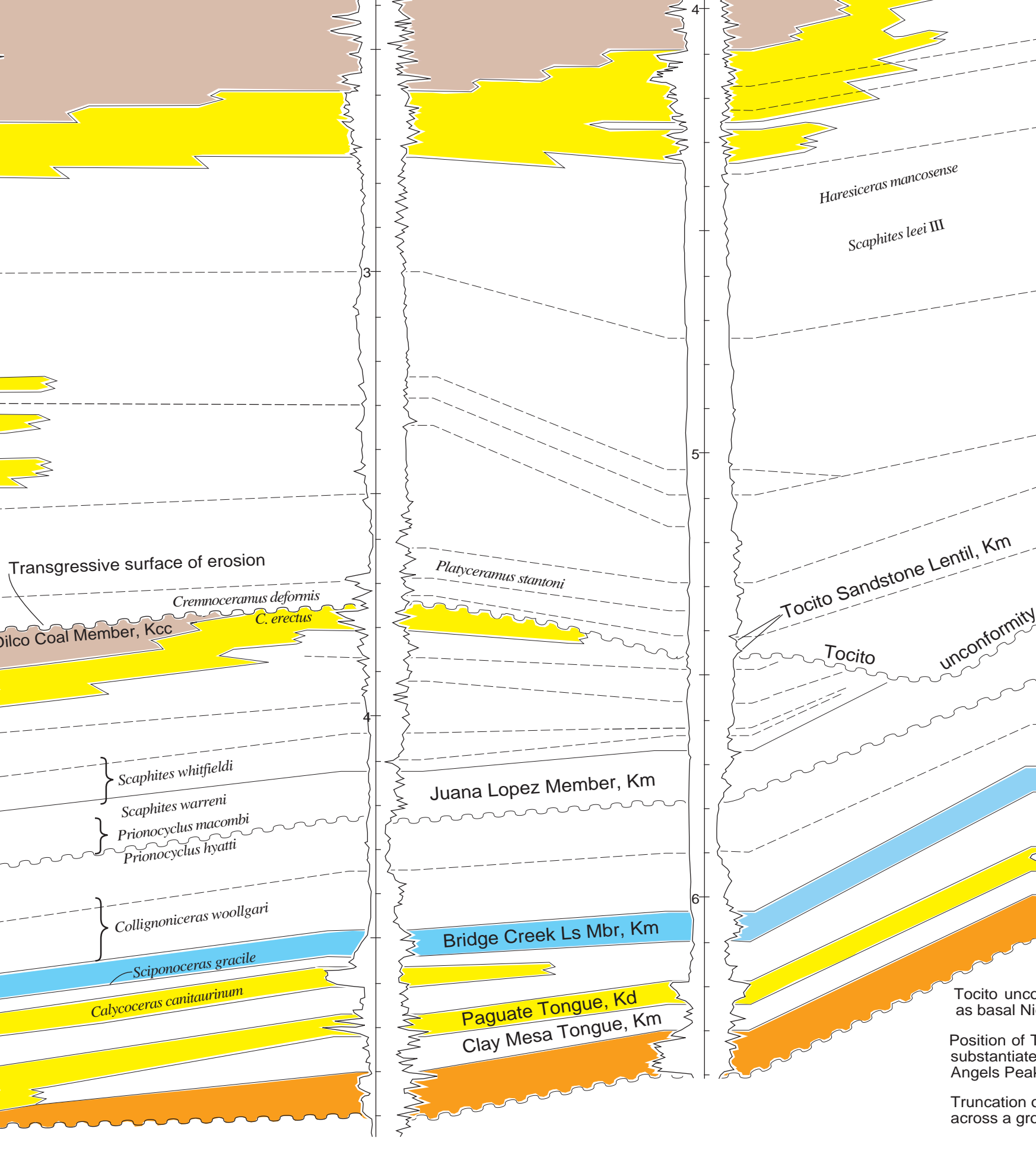
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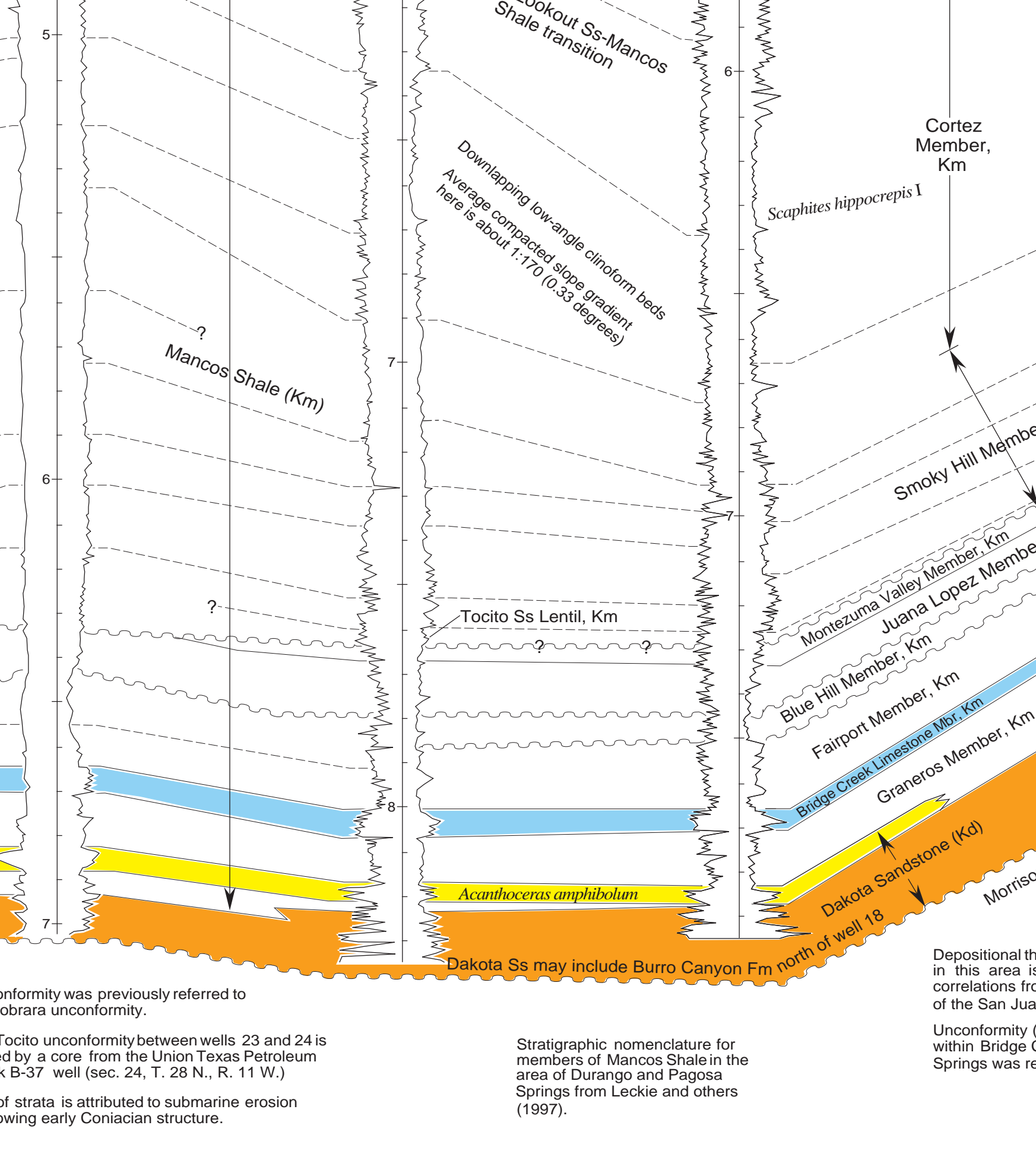
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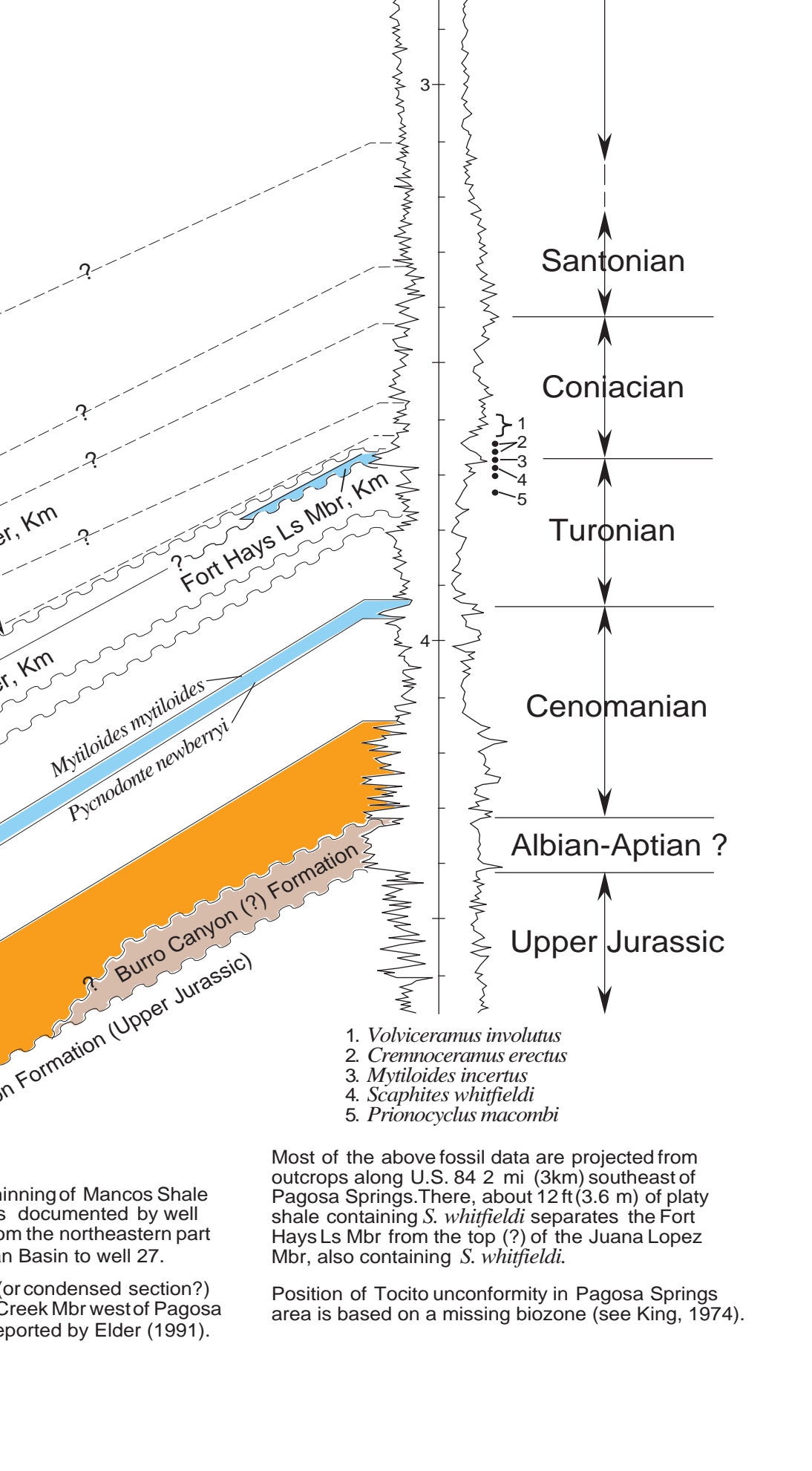
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SECTION D-D', EAST-CENTRAL ARIZONA TO PAGOSA SPRINGS, COLORADO REGIONAL STRATIGRAPHIC CROSS SECTIONS OF CRETACEOUS ROCKS FROM EAST-CENTRAL ARIZONA TO THE OKLAHOMA PANHANDLE

By C.M. Molenaar, W.A. Cobban, E.A. Merewether, C.L. Pillmore, D.G. Wolfe, and J.M. Holbrook

Manuscript approved for publication November 1, 2001. Any use of trade names in this publication is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey. This map was produced on request, directly from digital files on an electronic plate. For sale by U.S. Geological Survey Information Services, Box 2428, Federal Center, Denver, CO 80225. 980-486-6225