THE GEOLOGICAL SURVEY OF WYOMING

DANIEL N. MILLER, JR., State Geologist

THE PHOSPHORIA AND GOOSE EGG FORMATIONS IN WYOMING

by
DONALD W. LANE

PRELIMINARY REPORT NO. 12

BOX 3008 UNIVERSITY STATION
LARAMIE, WYOMING 82071
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CONTENTS

Cover photograph

Vugular porosity in pelletoid Phosphoria dolomite.
Location of core is from 8,250 feet, Pan American's Cottonwood Creek Unit, No. 25, Washakie County, Wyoming.

ILLUSTRATIONS

THE PHOSPHORIA AND GOOSE EGG FORMATIONS IN WYOMING

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Introduction

The Phosphoria Formation and the Permian portion of the Goose Egg Formation are essentially time equivalent stratigraphic units which record the history of sedimentation in two adjacent but very different depositional basins in Wyoming. The time equivalent relationship between the two formations has been recognized for many years, but the physical relationships between individual members of the formations have not been properly documented. The purpose of this preliminary study is to demonstrate, primarily through the use of subsurface information, how the two stratigraphic sequences actually relate to each other in a physical sense.

A series of cross sections and maps of my interpretation accompany this short report. Figure 1 shows the areas of Phosphoria outcrop and subcrop.

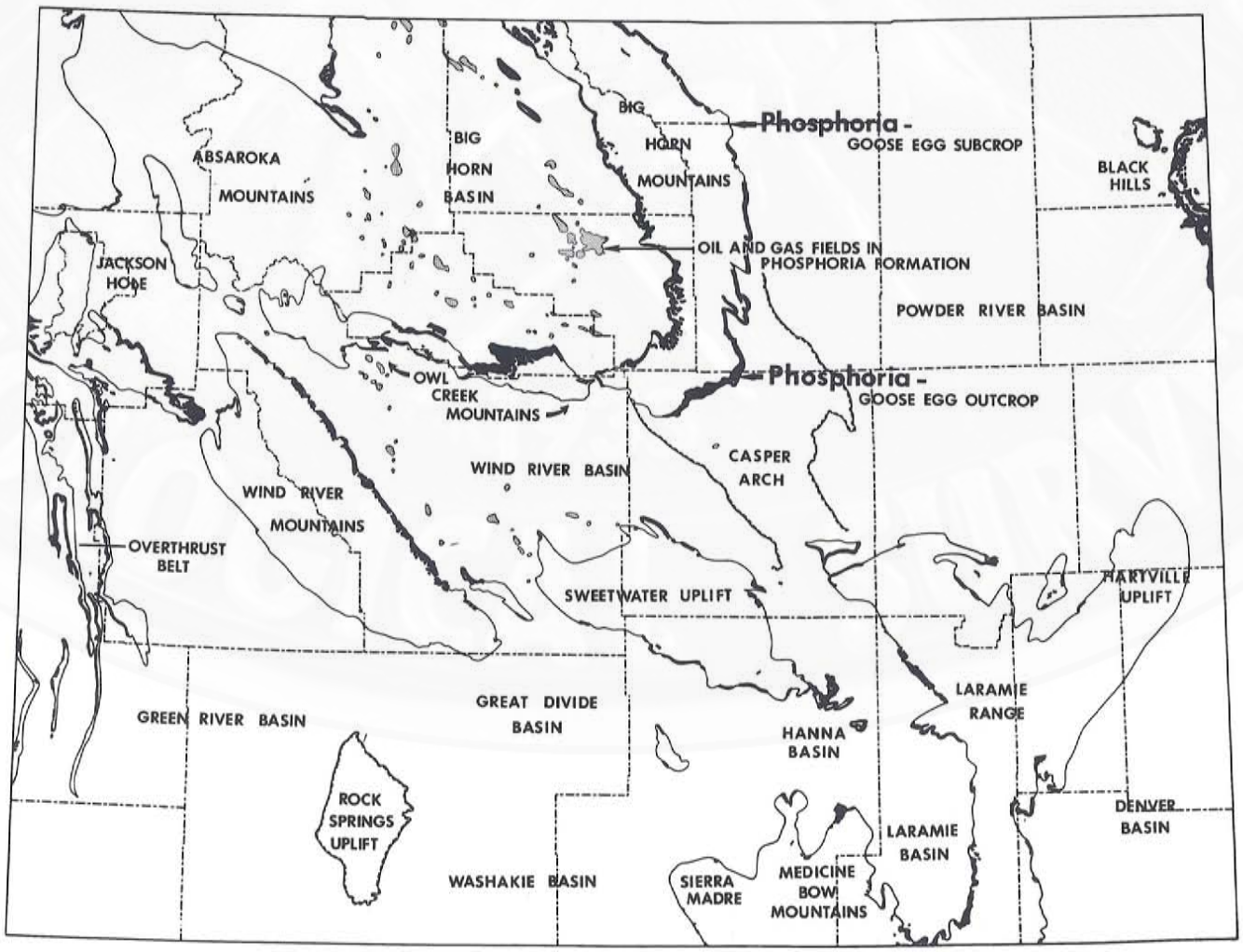


Figure 1. Areas of Phosphoria Formation outcrop and subcrop.

Area and Method of Study

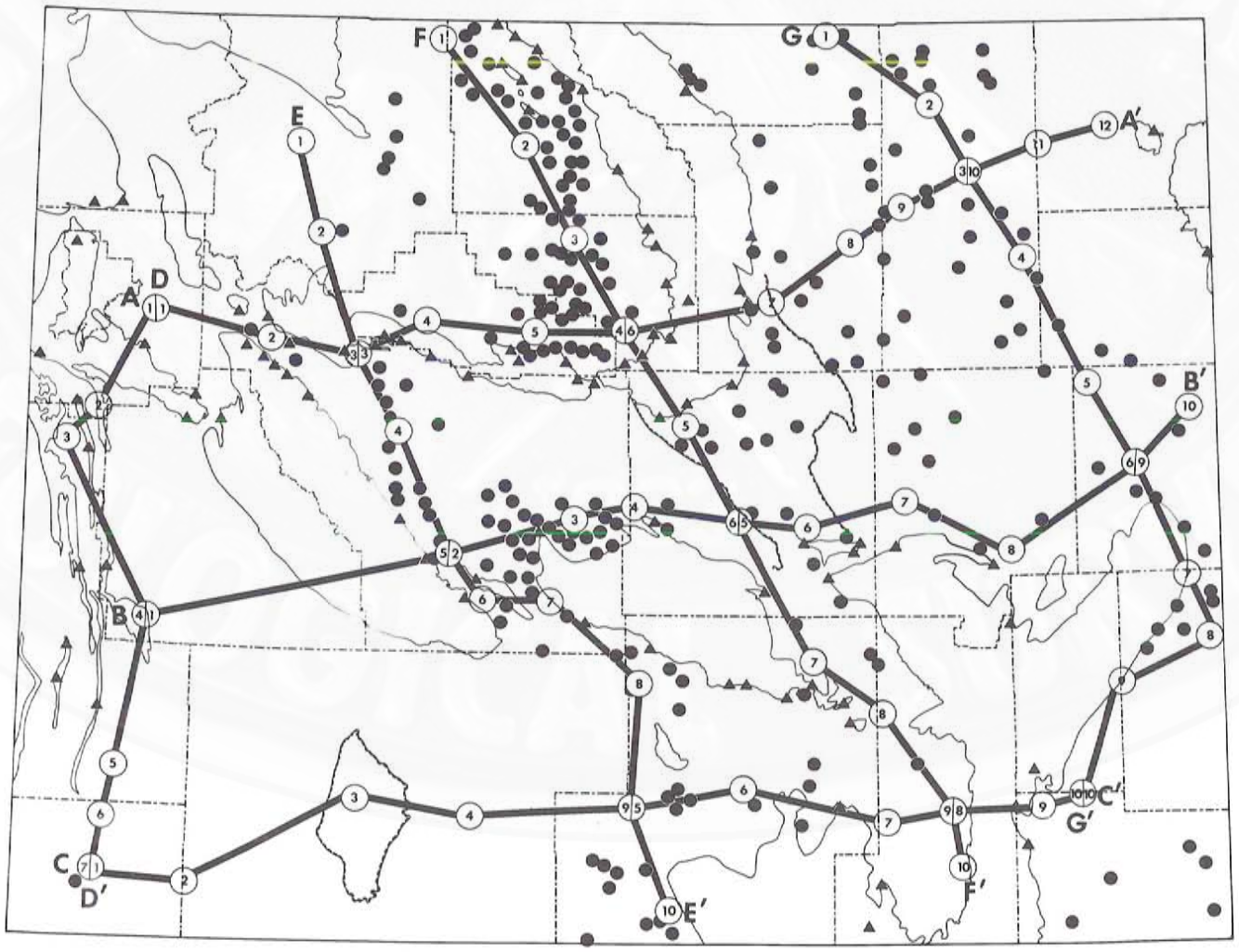
The intent of this report is to provide a regional stratigraphic framework based principally on subsurface gamma ray logs. Therefore, it is most definitive for those parts of Wyoming where subsurface control is most dense. Figure 2 shows the location of the surface and subsurface control used, along with the lines of seven regional cross-sections.

History of Nomenclature

Many of the published and unpublished works in the reference list provide a background for understanding the nomenclature. This brief summary will cover only points of particular significance.

The Phosphoria Formation is the name originally applied to a section in southeast Idaho consisting basically of phosphorite, dark shale, and chert. The name was later applied by petroleum geologists to an equivalent section of fossiliferous carbonate rock and light gray and green shale in the Rocky Mountains and has been in general use ever since. The U. S. Geological Survey has since formally named this carbonate and shale section the Park City Formation, after the Park City mining district of northeast Utah.

During the same time, members of the Goose Egg Formation were being named at localities in central and eastern Wyoming and western South Dakota, although the name Goose Egg itself was not introduced formally until 1956 (Burk and Thomas). The stratigraphic chart, Figure 3, shows the nomenclature relationship as is generally used today by industry, with my preferred modifications (Dinwoody, Sybille, Satanka) shown in white. The term "Phosphoria Formation" as used in this paper is synonymous with the Park City Formation as defined by the U. S. Geological Survey.



INDEX TO CROSS-SECTIONS AND CONTROL POINTS

● WELL CONTROL ▲OUTCROP (8) CROSS-SECTION WELL

CROSS-SECTION

Figure 2

Suggested Changes in Nomenclature

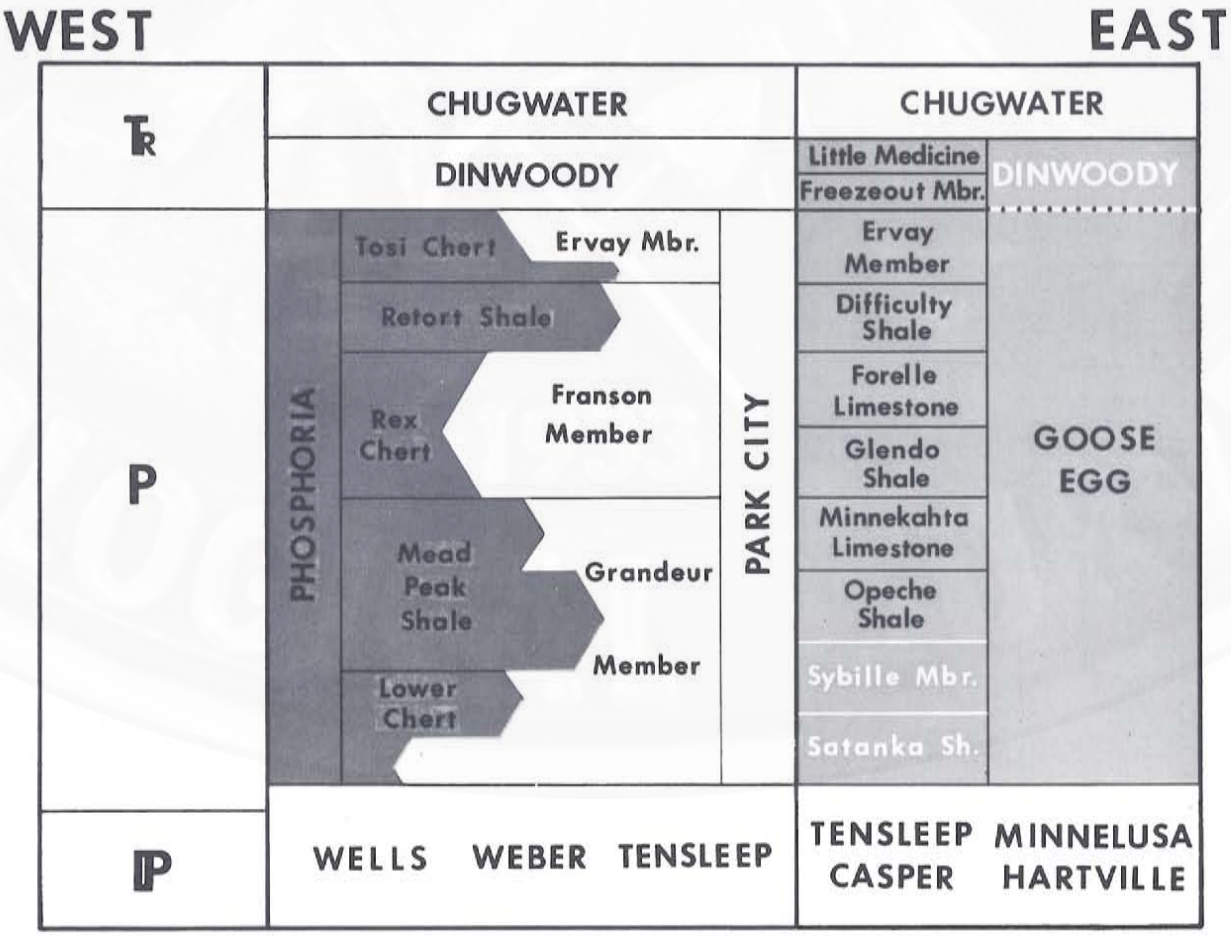
The Triassic part of the Goose Egg (Little Medicine Tongue and Freezeout Shale) should be considered as members of the Dinwoody Formation and disassociated from the Permian portion of the Goose Egg. Also, there is a persistent, unnamed carbonate-evaporite bed below the Minnekahta for which I propose the name "Sybille", a name once used but discarded. The name Sybille originally referred to what is now known as the Minnekahta. The red-bed unit below the Sybille is named Satanka, a term already in use, but redefined herein to show the continuity that exists.

I regard the Ervay, Forelle, Minnekahta, and Sybille as members of the Goose Egg Formation, and not as eastward-extending tongues of the Phosphoria. This difference is more than just a matter of semantics; it is both physically incorrect and genetically misleading to imply that the Phosphoria sea once extended into eastern Wyoming. It did not. These members are thickest in eastern Wyoming and are less well defined to the west. The Minnekahta and Forelle actually grade westward into shale.

Also, it is difficult to understand from subsurface control why the name Ervay is still used in the typical Phosphoria (Park City) area of western and central Wyoming. As presently used in the literature, it appears to have been incorrectly correlated into this area initially. Finally, I have redefined the "Ervay" (originally defined as a 6-foot limestone bed) on the basis of log character to include a thicker and more readily definable stratigraphic unit which is restricted to eastern Wyoming.

Physical Stratigraphy (Cross-Sections)

Eight cross-sections are designed to illustrate my interpretation of the physical stratigraphy and lithofacies of the Phosphoria and Goose Egg Formations. One is a diagramatic cross-section (Figure 4); three are east-west gamma ray log correlation sections (Figures 5-7); and four are north-south gamma-ray log correlation sections



STRATIGRAPHIC NOMENCLATURE CHART

(figures 8-11).

My interpretation of the physical stratigraphy and lithofacies and the suggested nomenclature changes result from three important observations:

(1) The evidence at hand strongly suggests a large positive area of exposed Tensleep-Minnelusa-Casper-Hartville-Weber in northern and central Wyoming long before the earliest Phosphoria-Goose Egg deposition. The Phosphoria-Goose Egg seas slowly transgressed onto and over this older surface from all sides, eventually covering it with progressively younger deposits. In Wyoming, the oldest stratigraphic units are present on the south, southeast, and southwest sides of the high. At the most northerly control points in the state only the youngest Permian sediments cover the exposed Tensleep-Minnelusa surface.

(2) Two sizeable areas of salt deposition existed during Goose Egg time: one in the Powder River Basin, and the other in the Denver-Julesburg Basin.

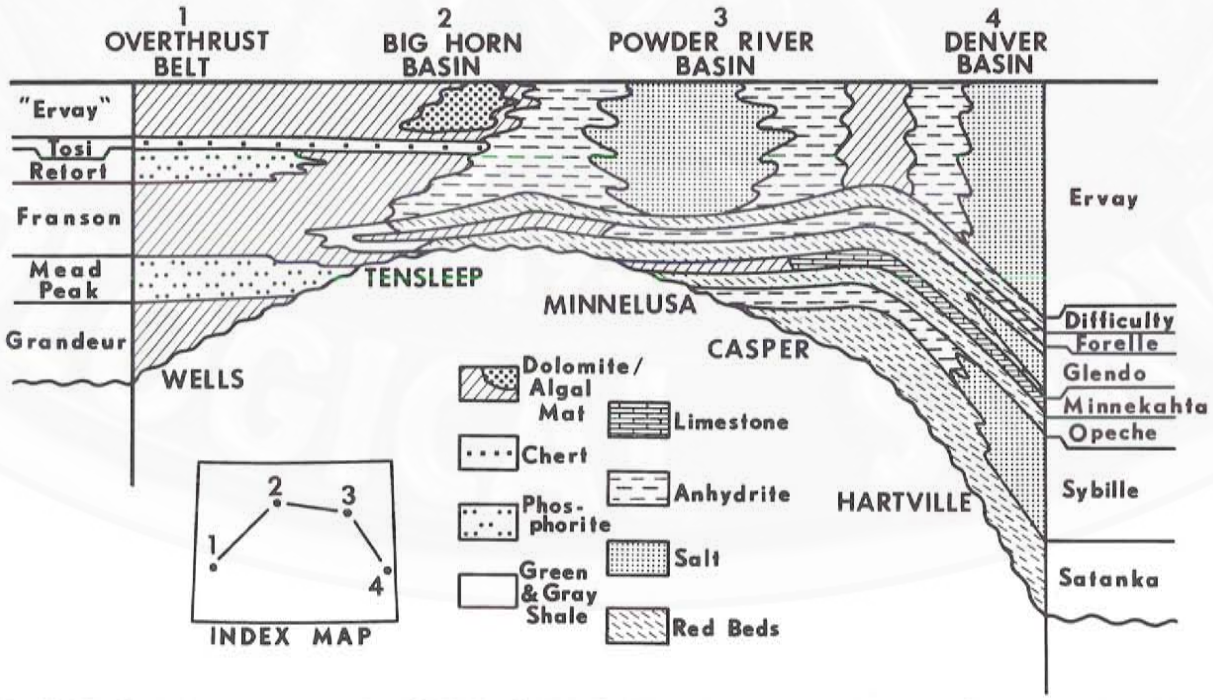
(3) Cross-section D-D' shows that the gamma ray logs of the carbonate-phosphorite sections of western Wyoming correlate more readily due to their similarity of character, and show a more consistent thickness for the section than the multitude of published measured surface sections would lead on to believe. Correlation of the logs gives a distinct impression of depositional continuity and stratigraphic uniformity.

An algal mat facies is indicated on the cross-sections (Figures 5, 6, 7, 9, and 10) by a diagonal stripe pattern. This rock type occurs in the upper half of the youngest unnamed member of the Phosphoria Formation. Its geographic extent is indicated on Figure 19.

Lithologically, it is vugular pelletal dolomite with a distinct but somewhat irregular lamination. Pelletal carbonate particles were trapped by a non-calcareous algal mat layer in a supratidal position. In most samples and cores of this rock, most of the vugs have been filled by anhydrite or sparry dolomite. Good outcrops of this facies occur northeast of Lovell in the northeastern Big Horn Basin, Little Sheep Mountain and Sheep Mountain in the Big Horn Basin, north of Lysite in the northern Wind River Basin, and at Conant Creek Anticline in the southwest Wind River Basin.

Lithofacies (Maps)

The following lithofacies maps of the eight members of the Goose Egg Formation (Figure 12 through 19) are based almost entirely on log



DIAGRAMMATIC STRATIGRAPHIC CROSS-SECTION PHOSPHORIA - GOOSE EGG PERMIAN ROCKS

Figure 4

interpretation. The maps show my interpretation of the geographic extent of each member, presumbaly established by the original shorelines. By following the depositional limits from the oldest (unit 1, Figure 12) to the youngest (unit 8, Figure 19), one can see how the Phosphoria-Goose Egg seas transgressed in a regular manner over the older eroded surface. The two seas merged, progressing northward to what was then the highest topographic point in the northern Big Horn Basin.

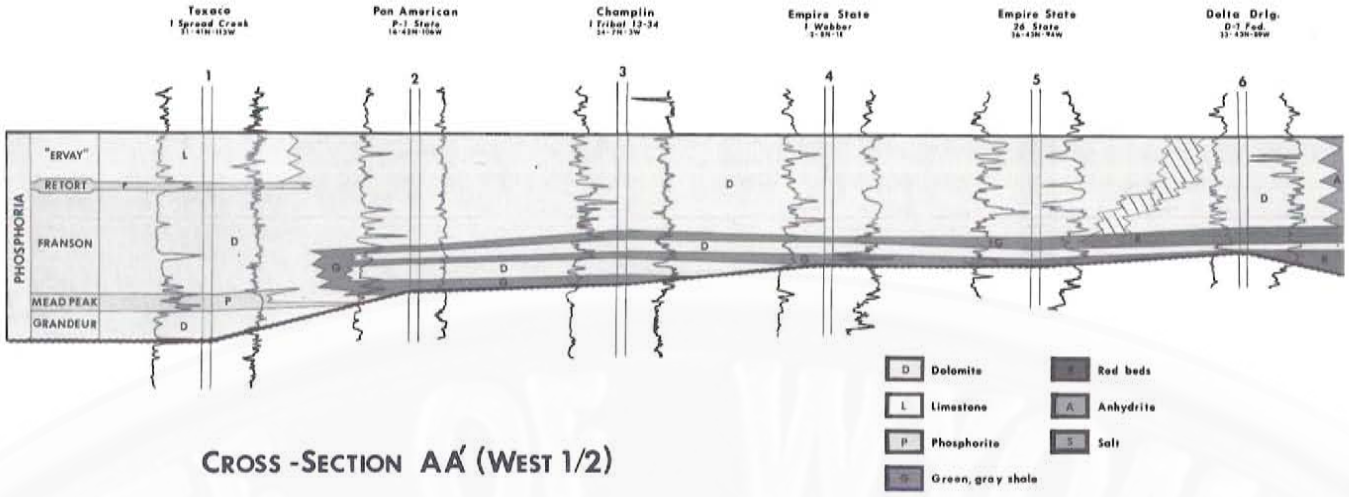
The algal mat facies previously described lies along the Phosphoria side of the boundary between Phosphoria and Goose Egg rocks. The position of the facies appears on the lithofacies map of unit 8 (Figure 19).

The extent of salt deposits in the Powder River Basin is defined reasonably well by existing control. The salt deposits in the Denver-Julesburg Basin are poorly defined and penetrated by only a few wells. Subsurface control in Nebraska is incomplete.

In the most general sense, the Goose Egg deposits of Wyoming were deposited around the northwest margin of a large evaporite basin centered farther east in the midcontinent area. The Phosphoria Formation of Wyoming is a marine sequence that was deposited on the shallow eastern shelf of a north-south trough through Idaho and Utah. In between was a more positive area, at least in north central Wyoming, that influenced the position of the shore lines and controlled the regional depositional strike and lithofacies of the deposits.

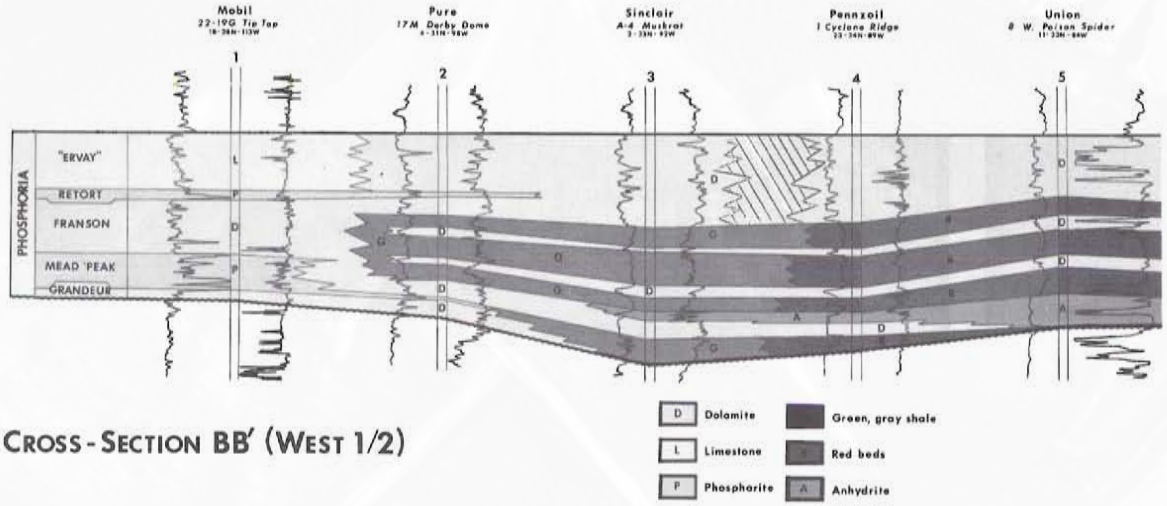
The final map (Figure 20), a "worms eye view", shows which members of the Goose Egg (and its equivalent Phosphoria section) lie directly on the underlying eroded Tensleep surface.

Again, the significance of the interpretation is much more than a matter of semantics and nomenclature. Correlating physical stratigraphic relationships reveals conditions relevant to the entrapment of oil and gas that hopefully will aid future exploration.



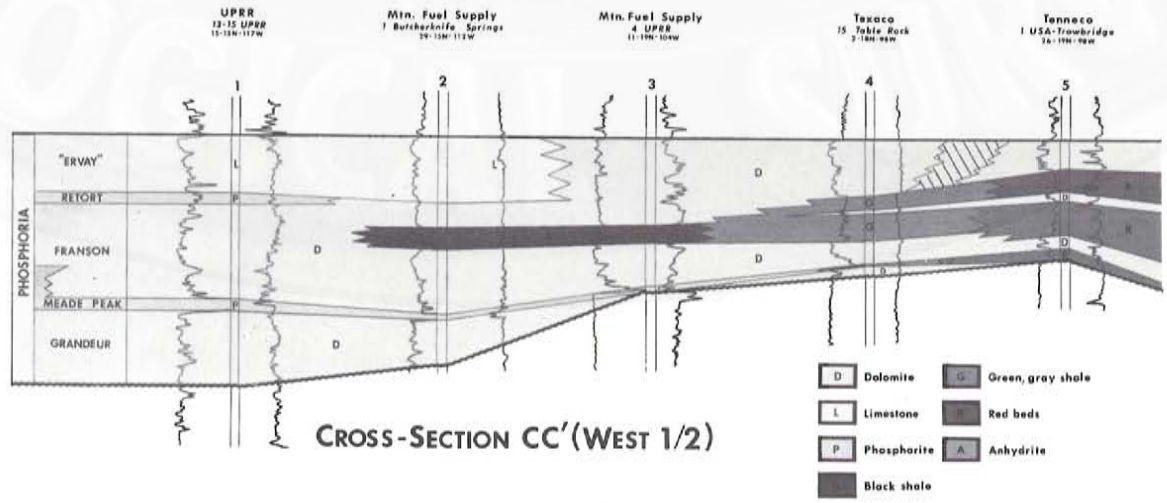
CROSS-SECTION AA' (WEST 1/2)

Figure 5



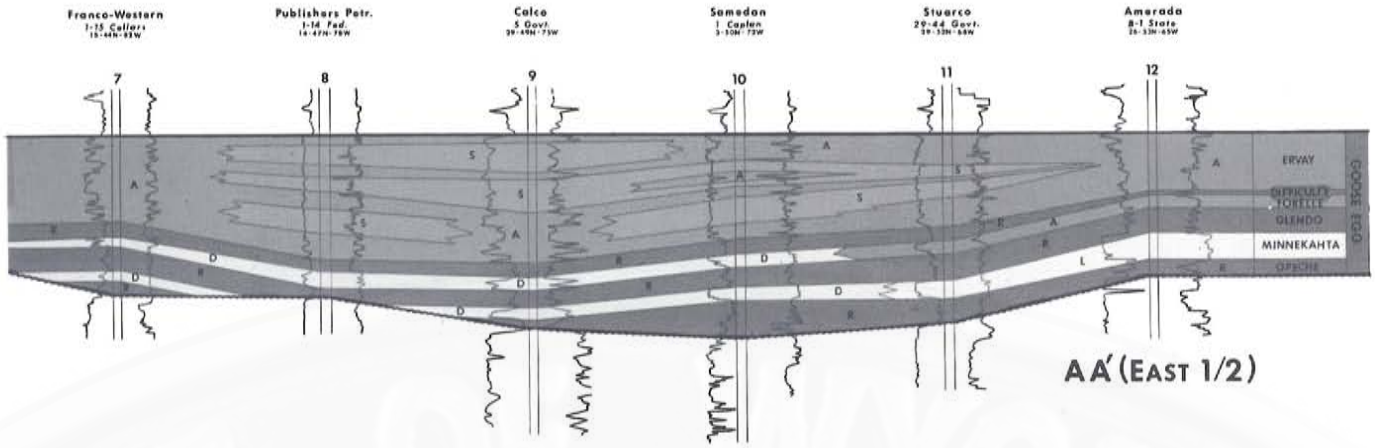
CROSS-SECTION BB' (WEST 1/2)

Figure 6

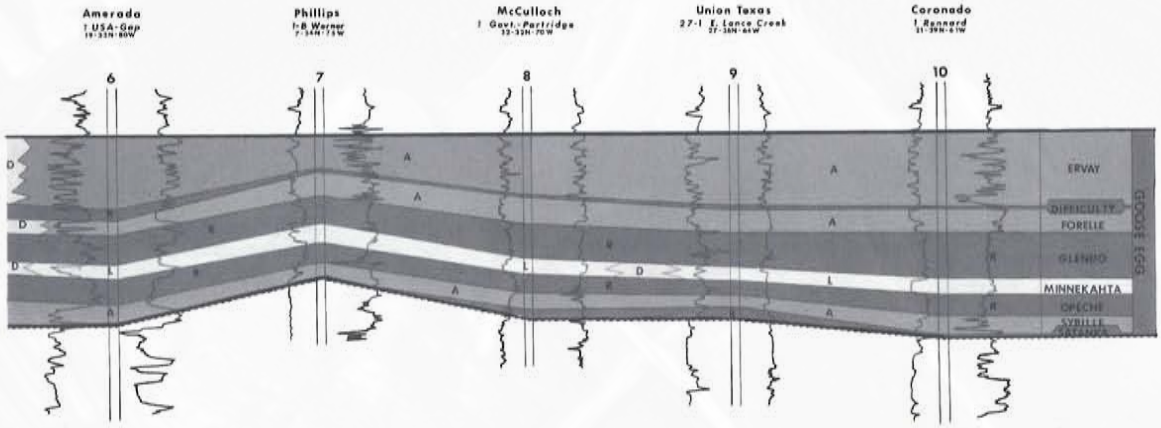


CROSS-SECTION CC'(WEST 1/2)

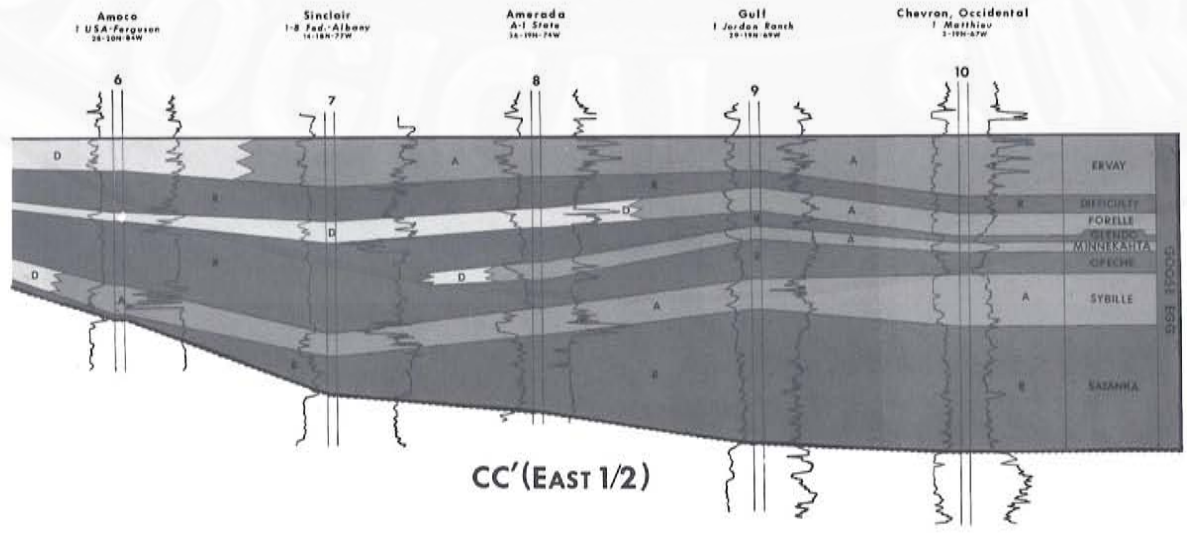
Figure 7



AA′ (EAST 1/2)



BB′ (EAST 1/2)



CC′ (EAST 1/2)

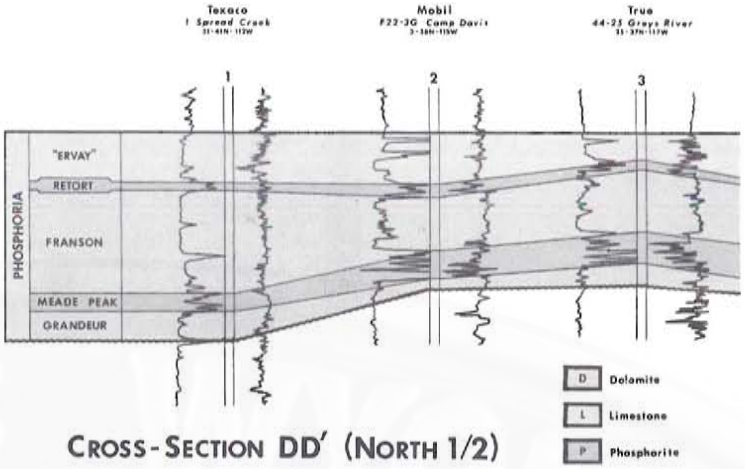


Figure 8

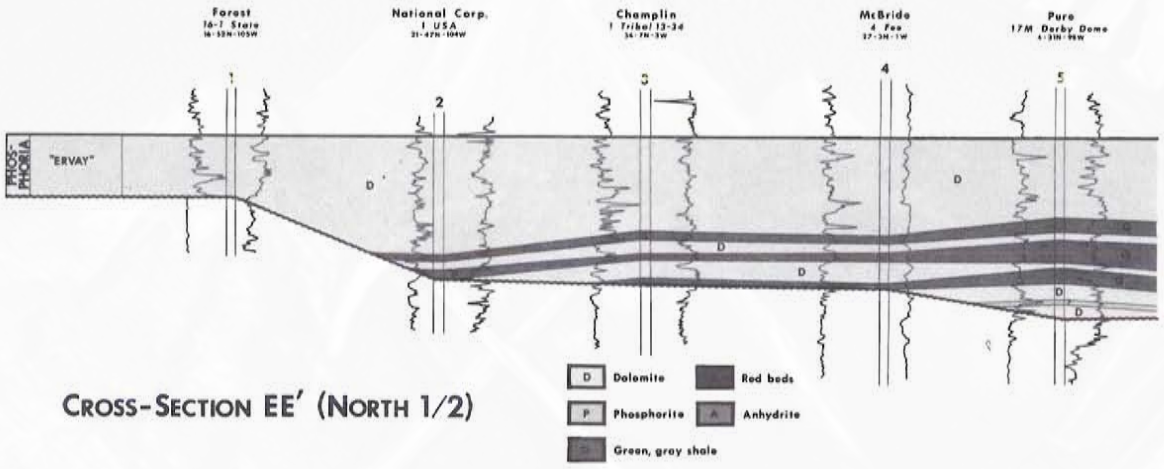


Figure 9

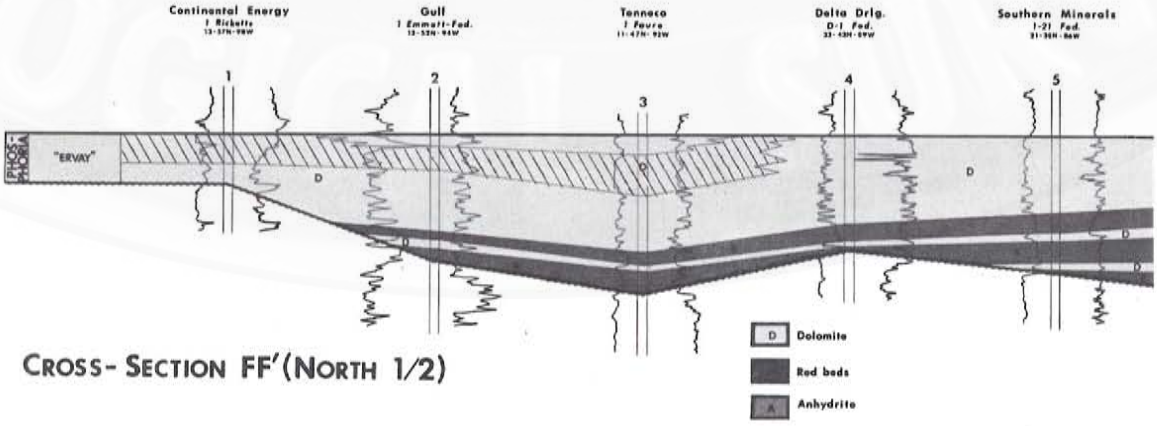
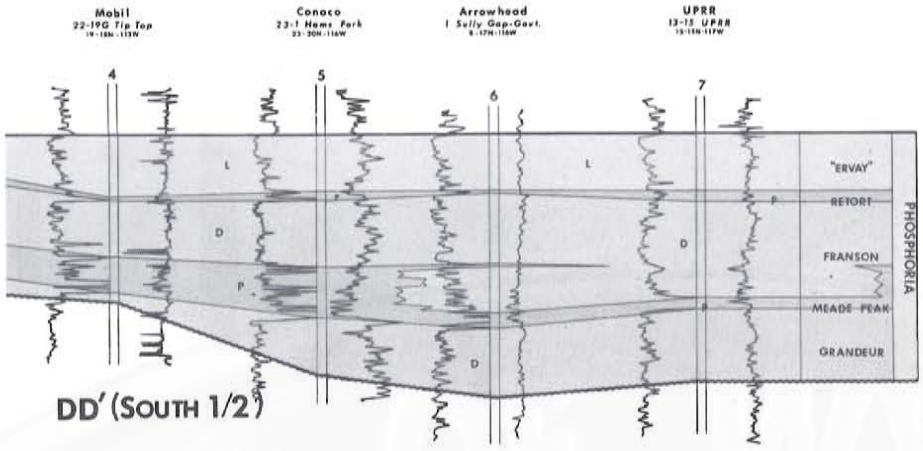
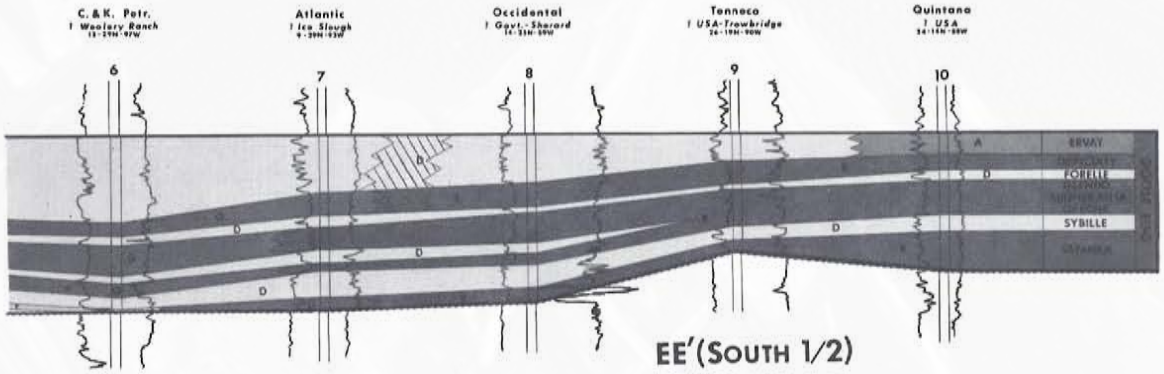


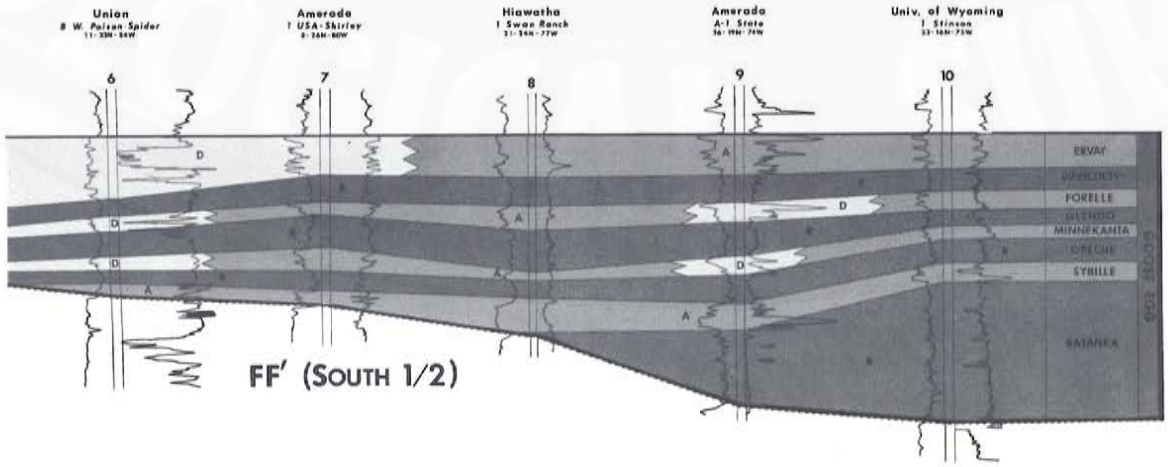
Figure 10



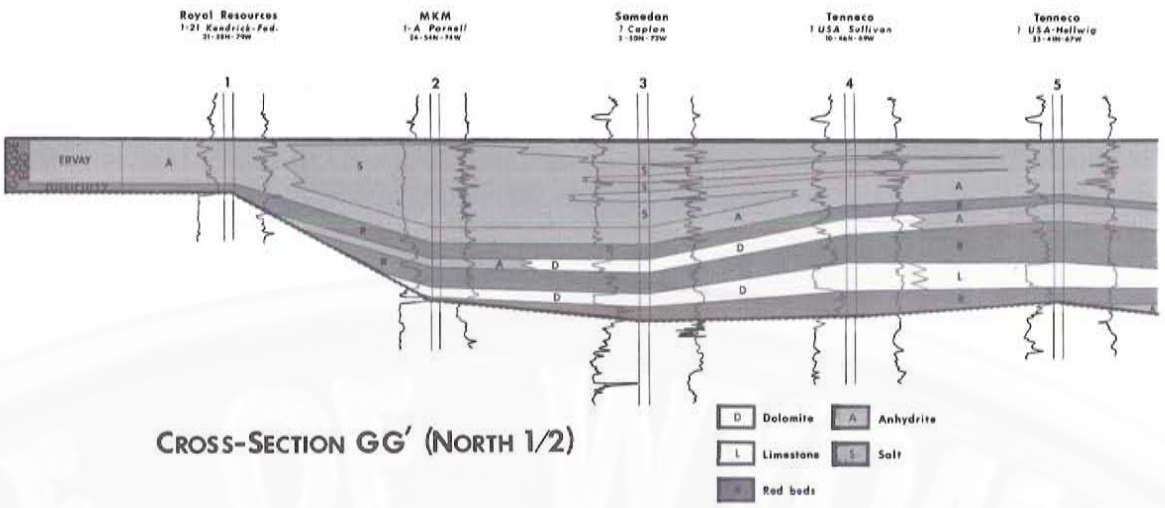
DD′ (SOUTH 1/2)



EE′(SOUTH 1/2)

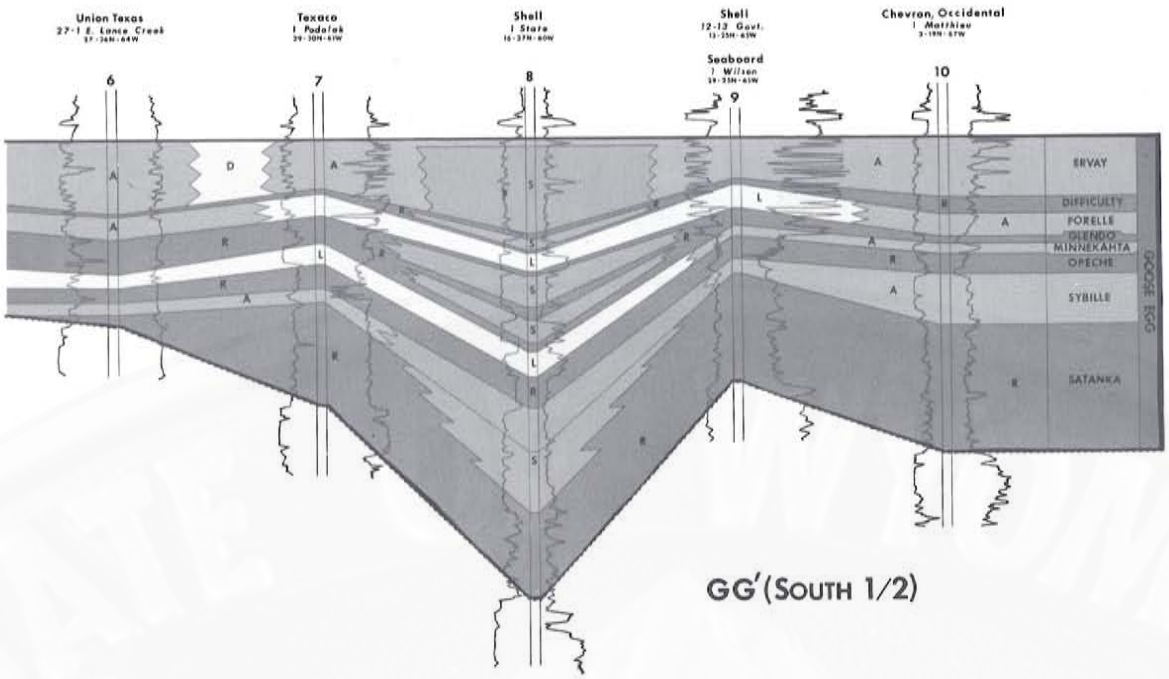


FF′ (SOUTH 1/2)

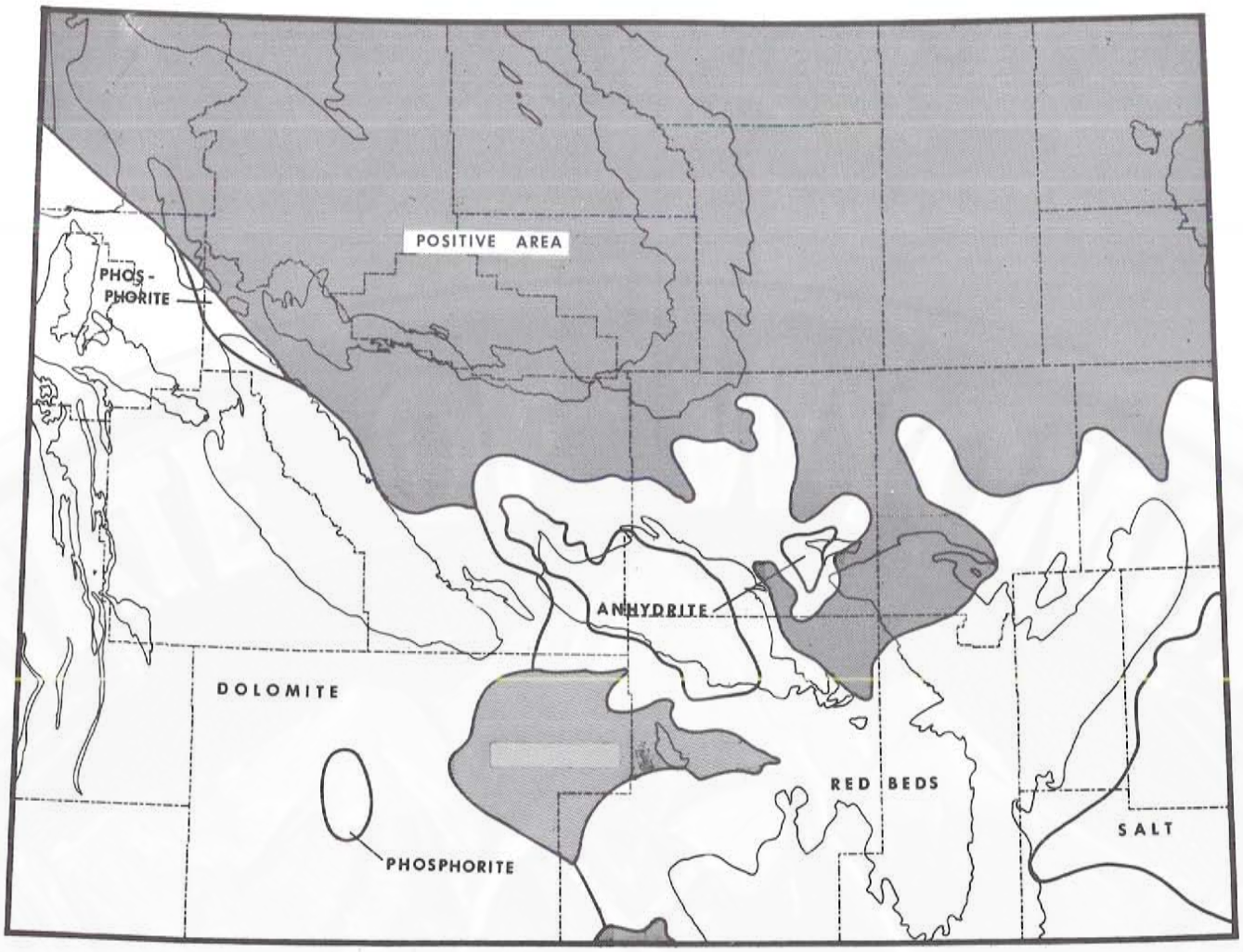


CROSS-SECTION GG′ (NORTH 1/2)

Figure 11

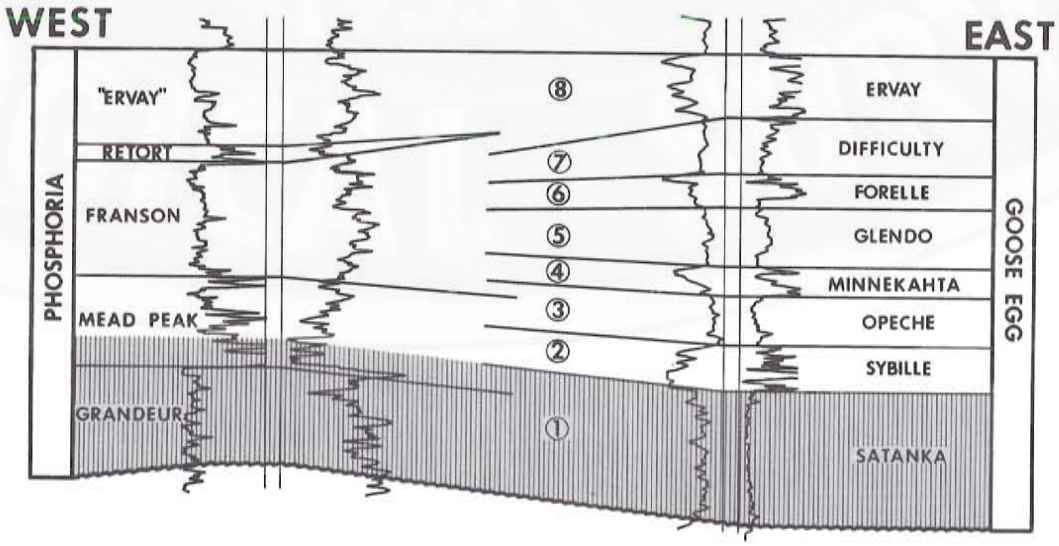

Union Texas
27-1 E. Lance Creek
Texaco
1 Podolak
Shell
1 State
Shell
12-13 Govt.
Seaboard
1 Wilson
Chevron, Occidental
1 Matthieu
6
7
8
9
10
ERVAY
DIFFICULTY
FORELLE
OLENDO
MINNEKAHTA
OPECHE
SYBILLE
SATANKA
GOOSE EGG

GG' (SOUTH 1/2)

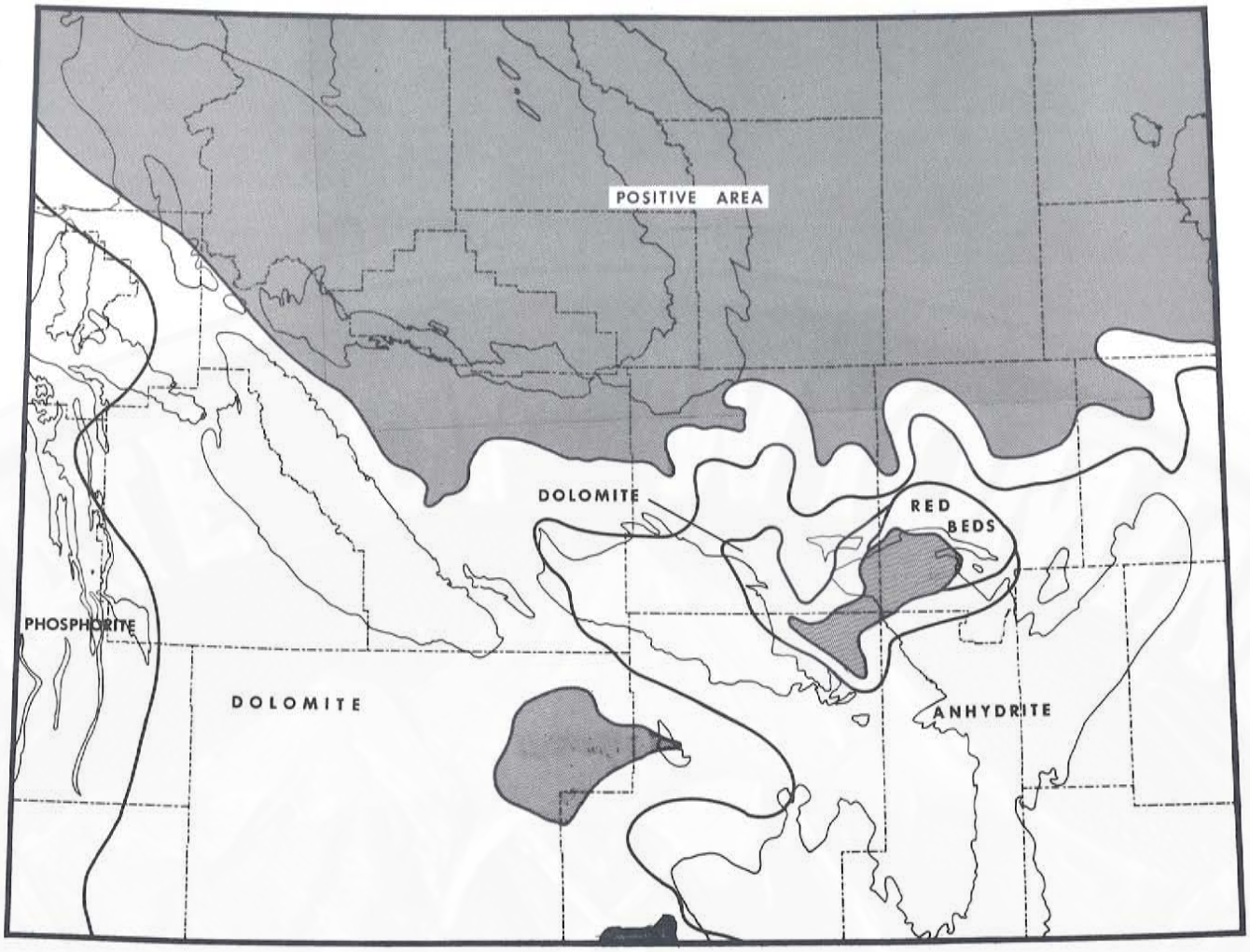


FACIES MAP OF UNIT 1

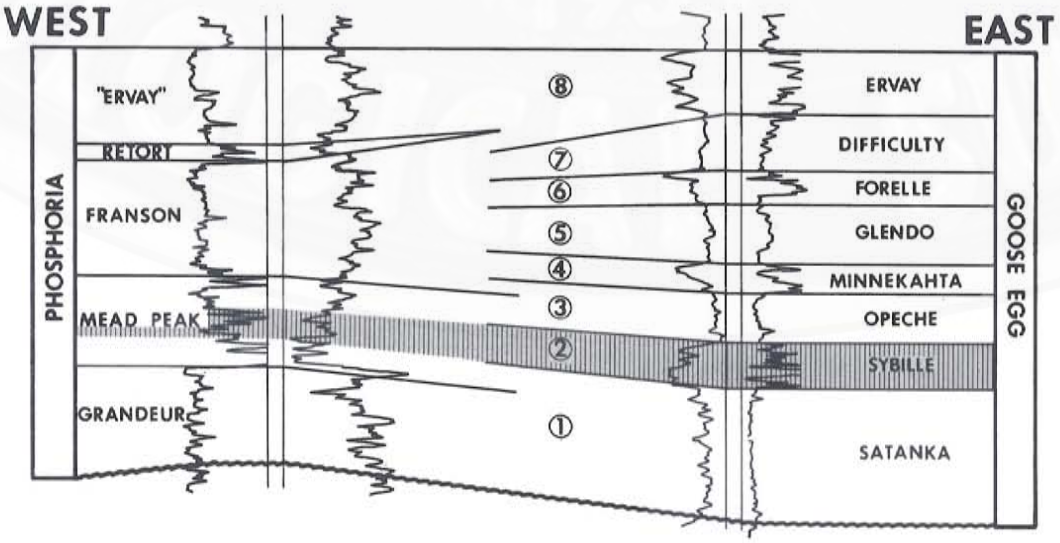
Figure 12



INTERVAL SHOWN ON FACIES MAP OF UNIT 1

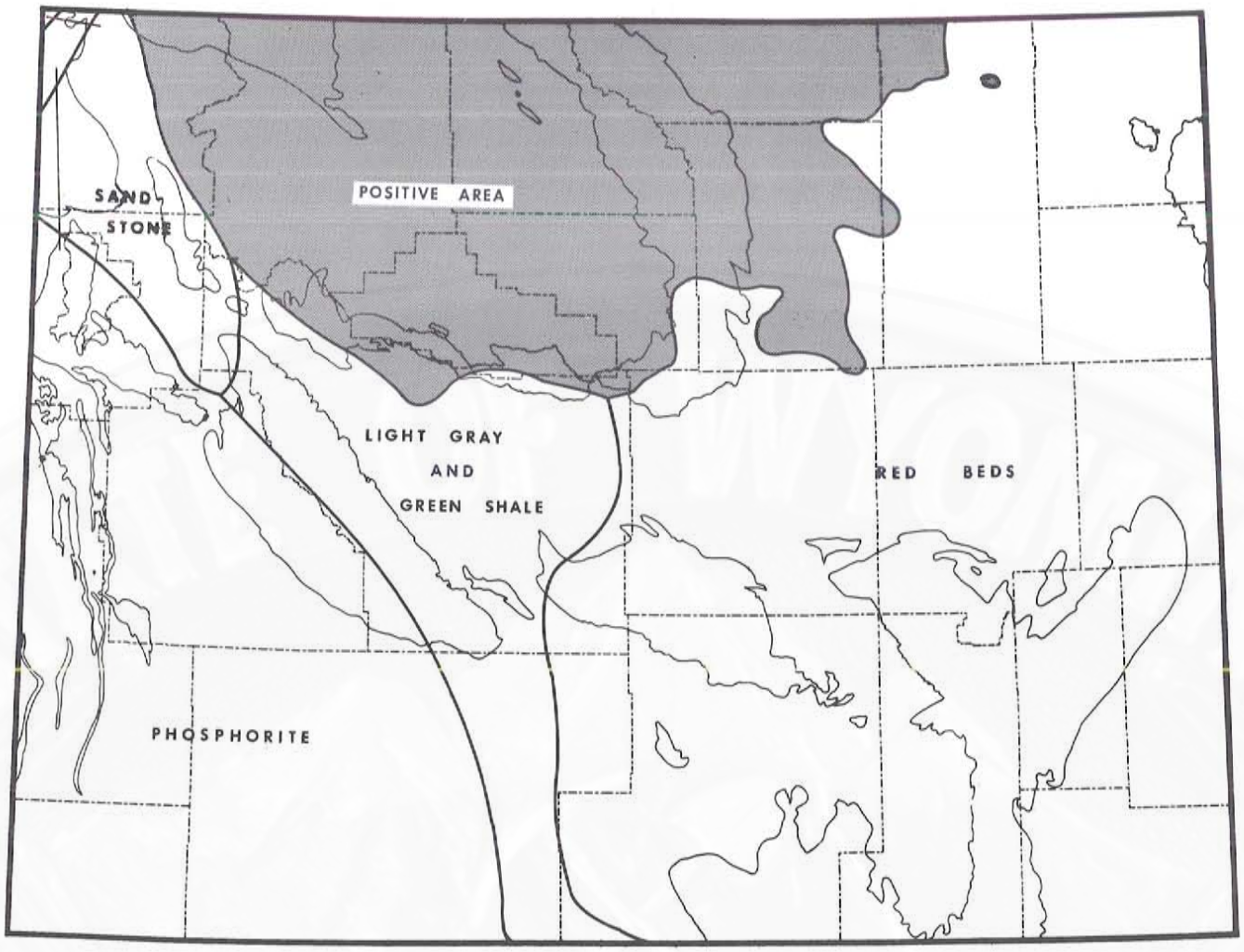


FACIES MAP OF UNIT 2



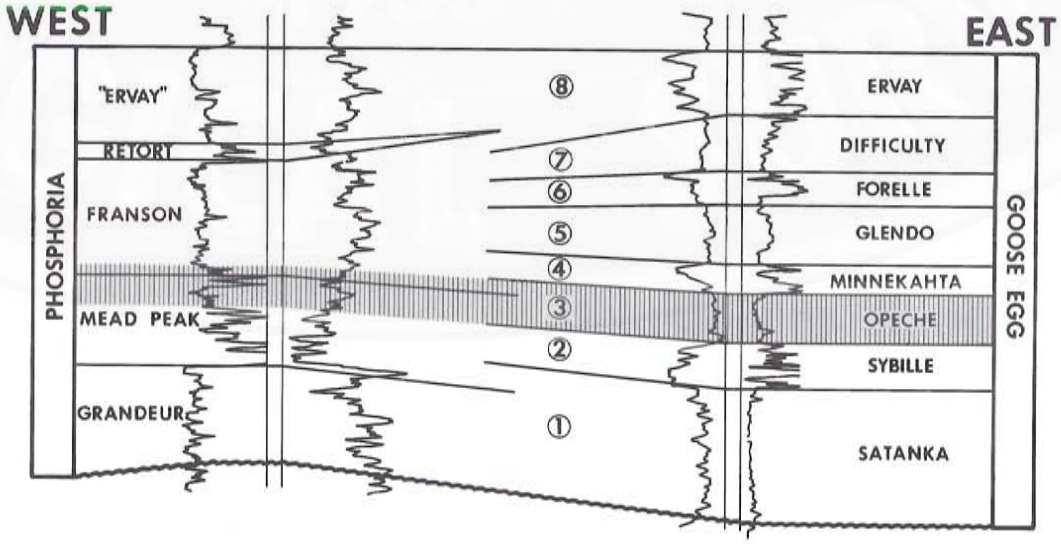
INTERVAL SHOWN ON FACIES MAP OF UNIT 2

Figure 13



FACIES MAP OF UNIT 3

Figure 14



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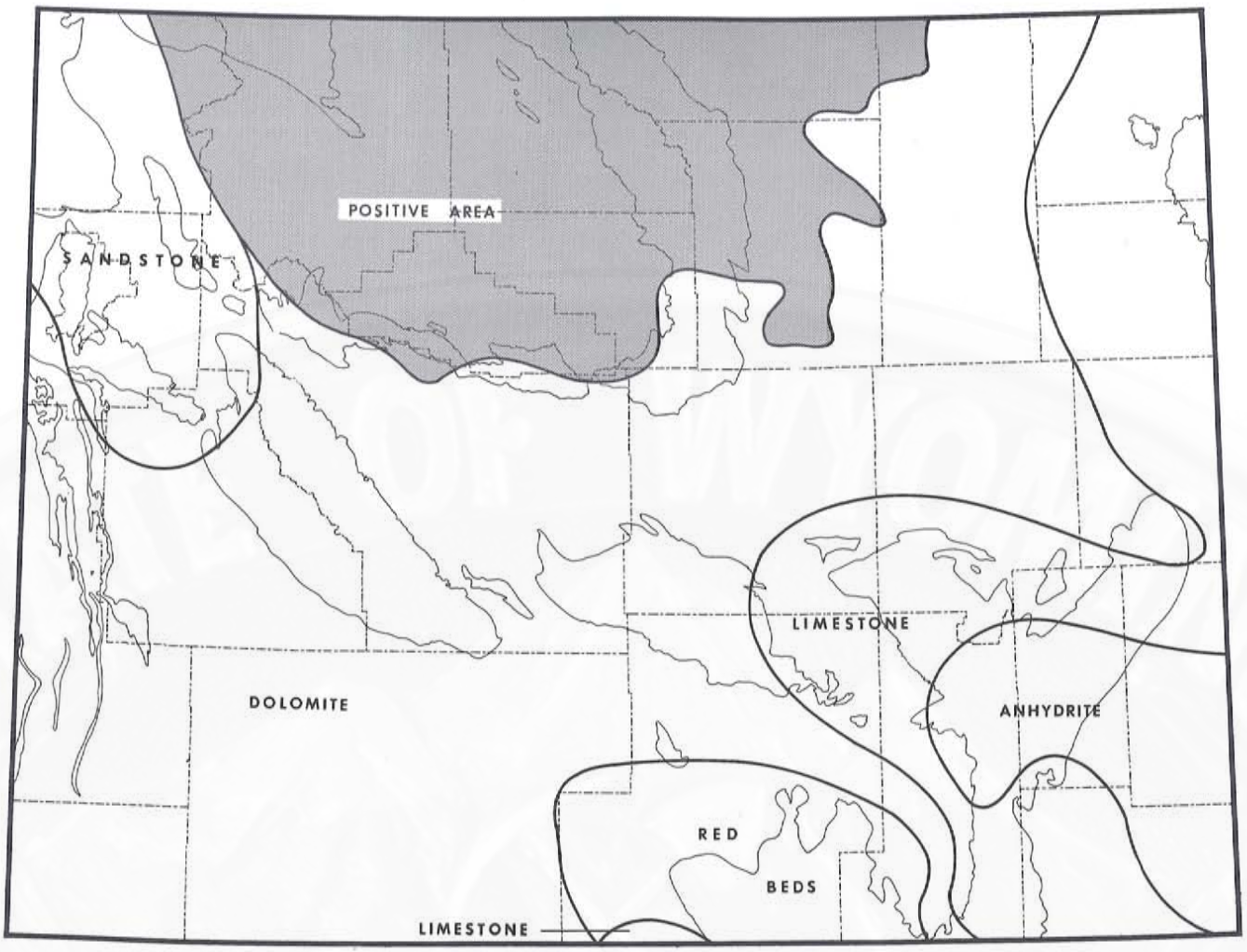
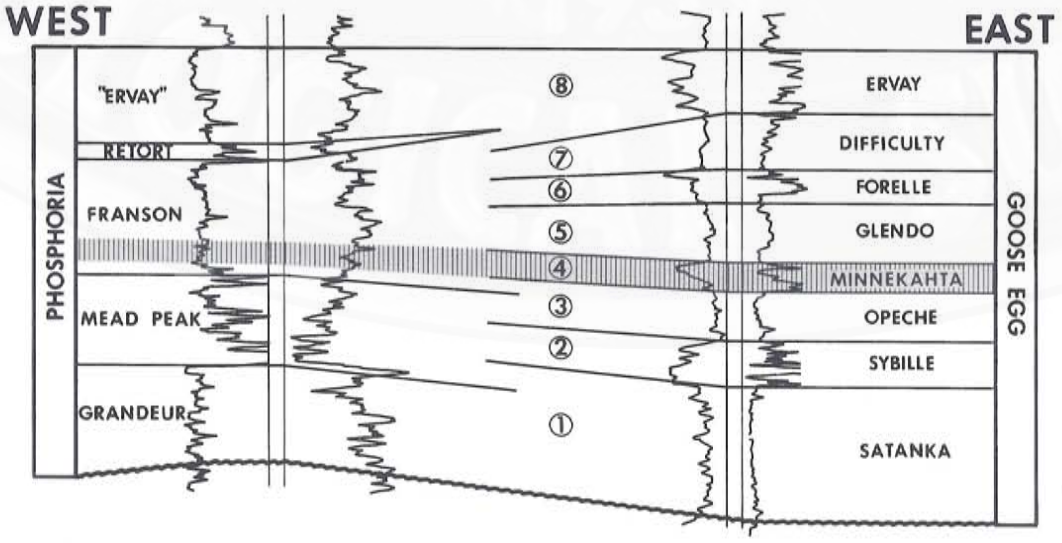
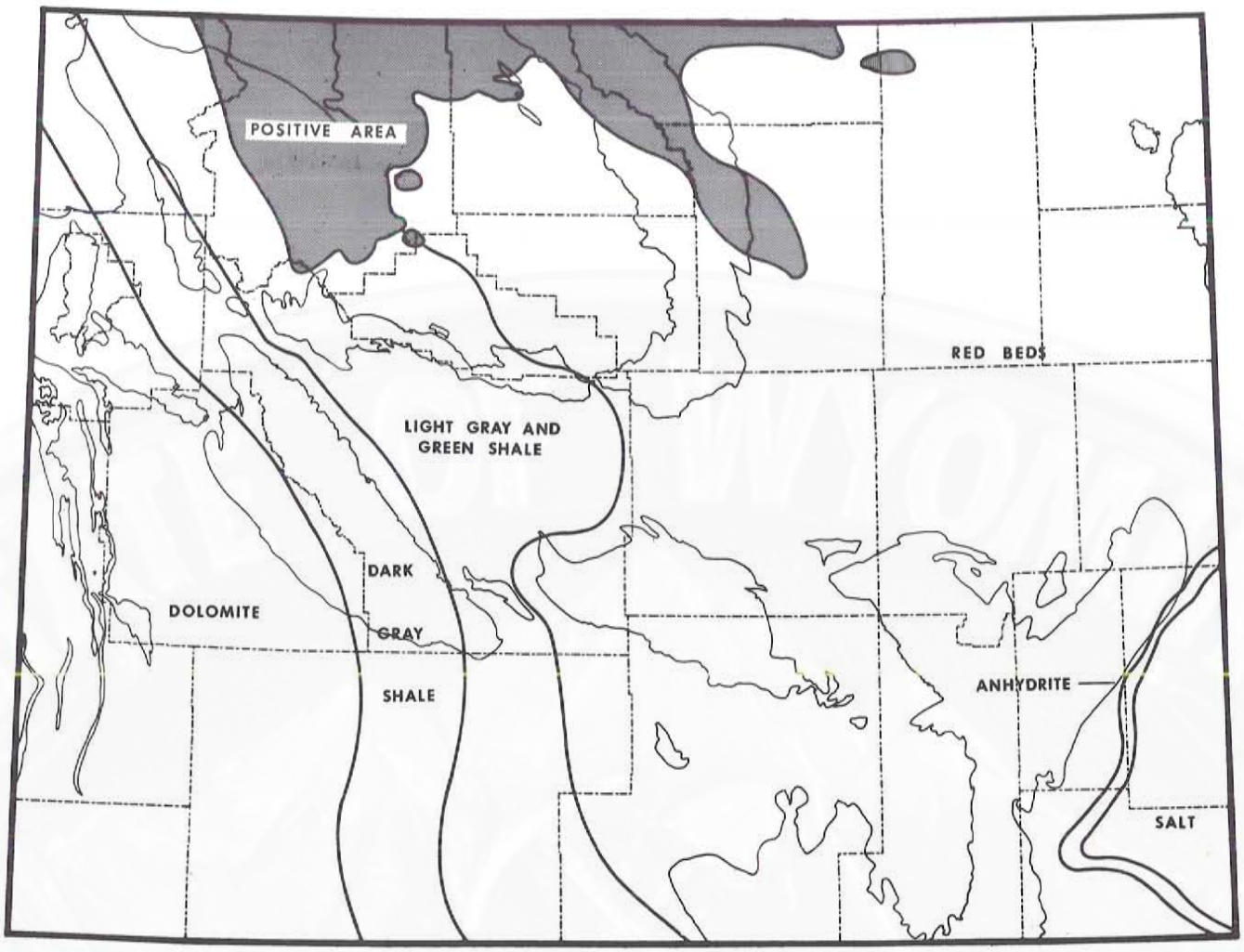


FACIES MAP OF UNIT 4



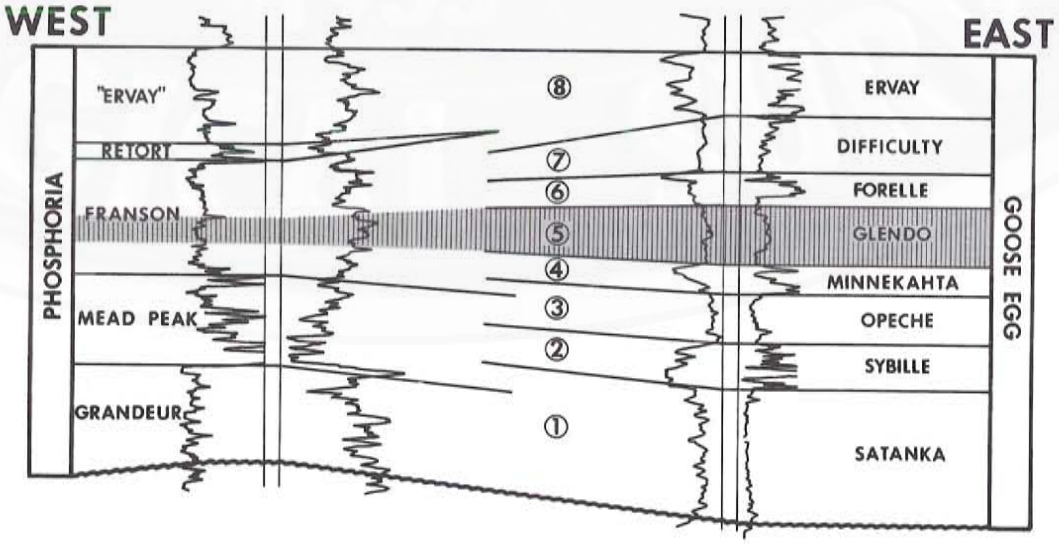
INTERVAL SHOWN ON FACIES MAP OF UNIT 4

Figure 15

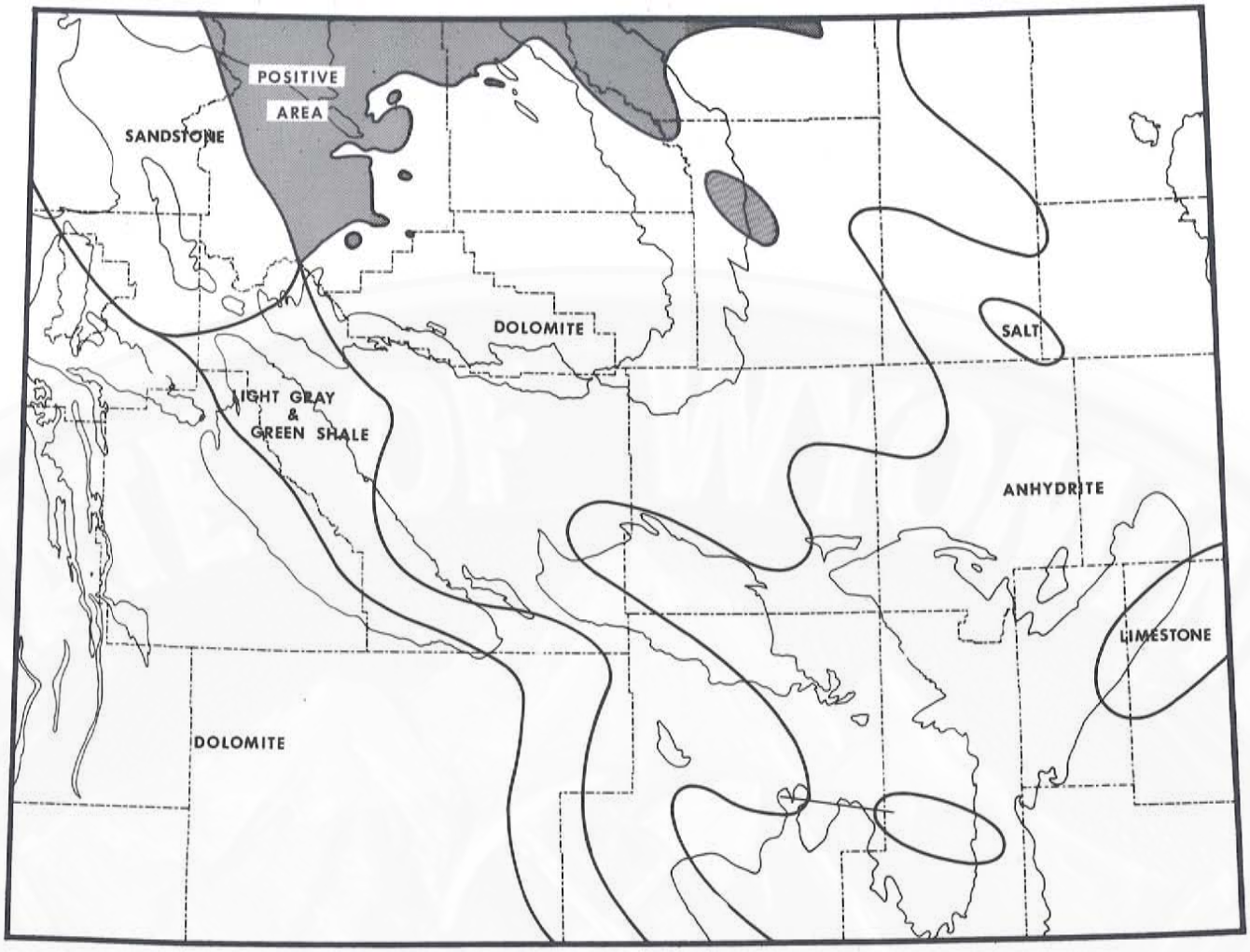


FACIES MAP OF UNIT 5

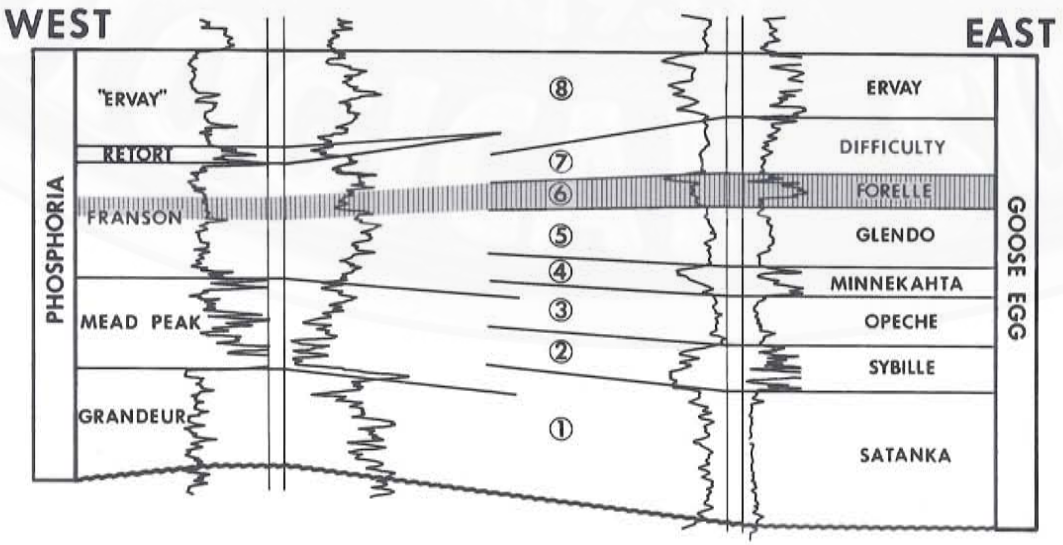
Figure 16



INTERVAL SHOWN ON FACIES MAP OF UNIT 5

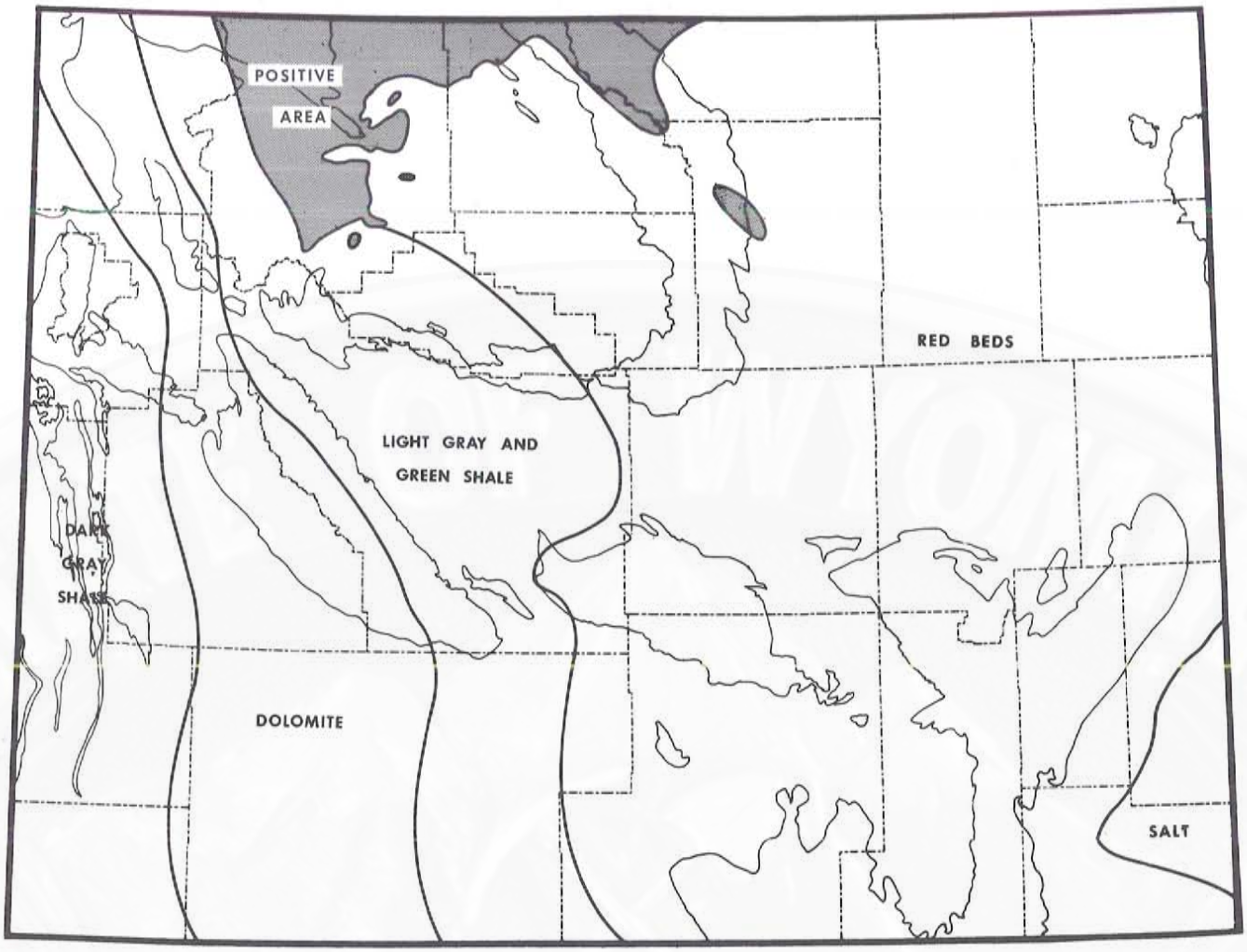


FACIES MAP OF UNIT 6



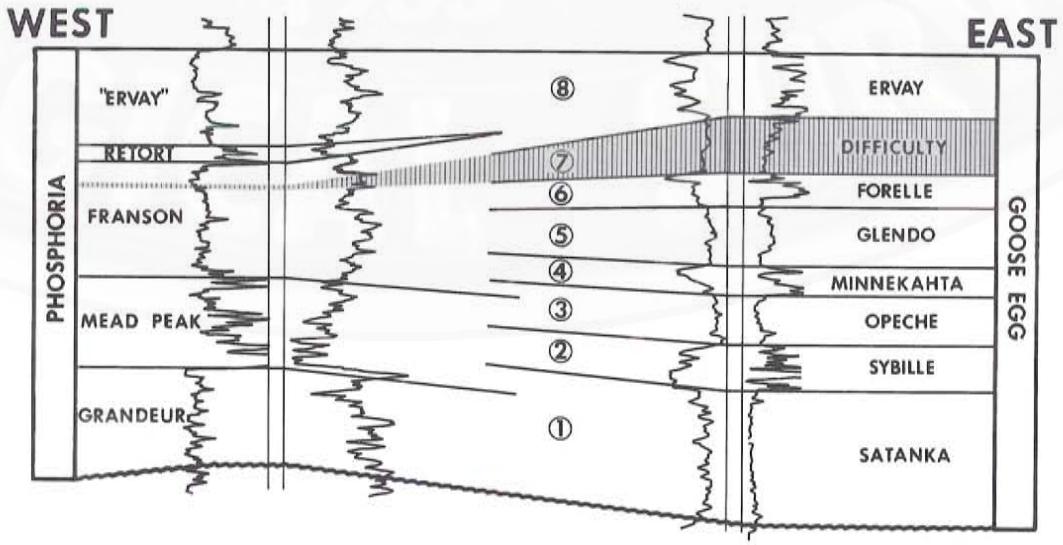
INTERVAL SHOWN ON FACIES MAP OF UNIT 6

Figure 17

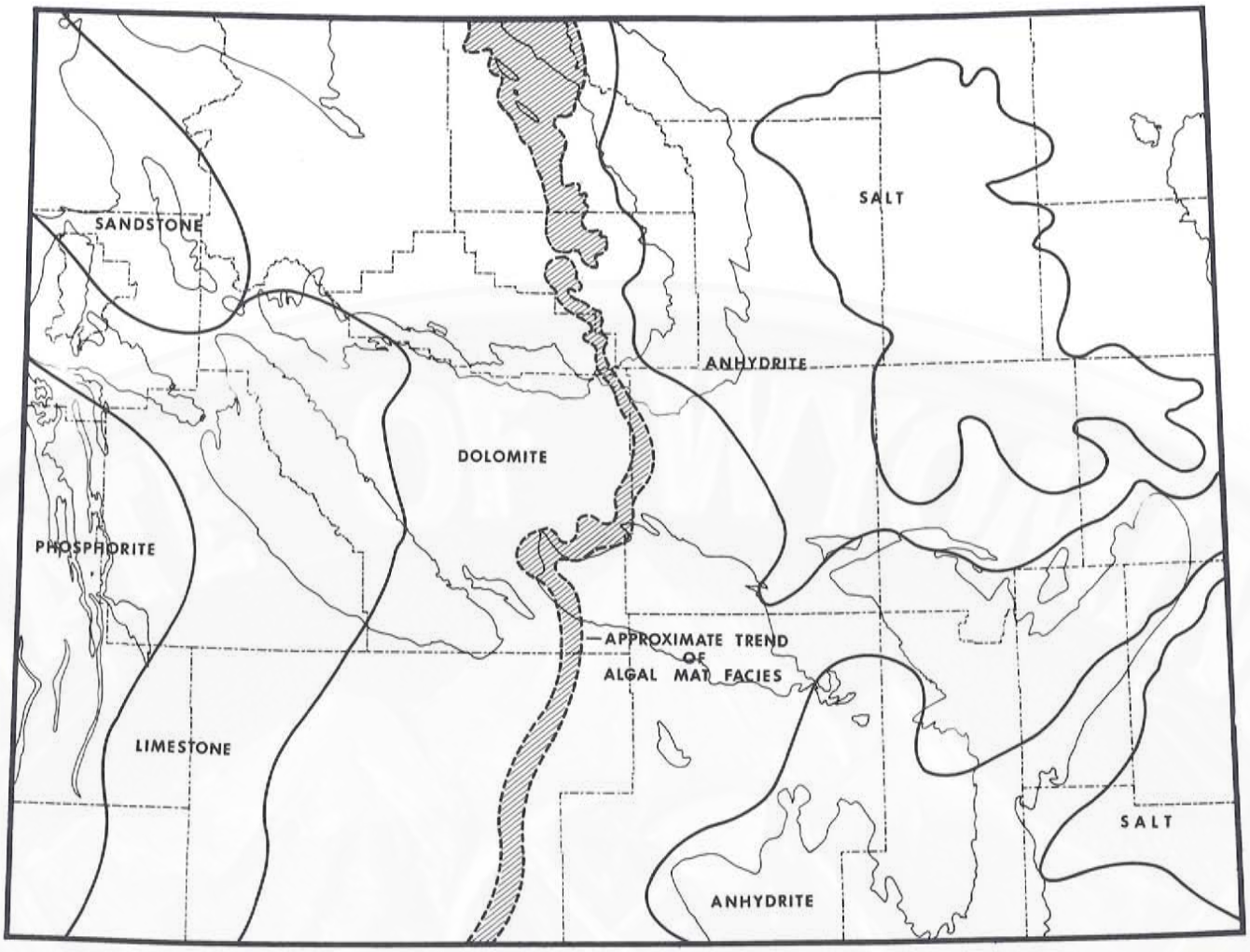


FACIES MAP OF UNIT 7

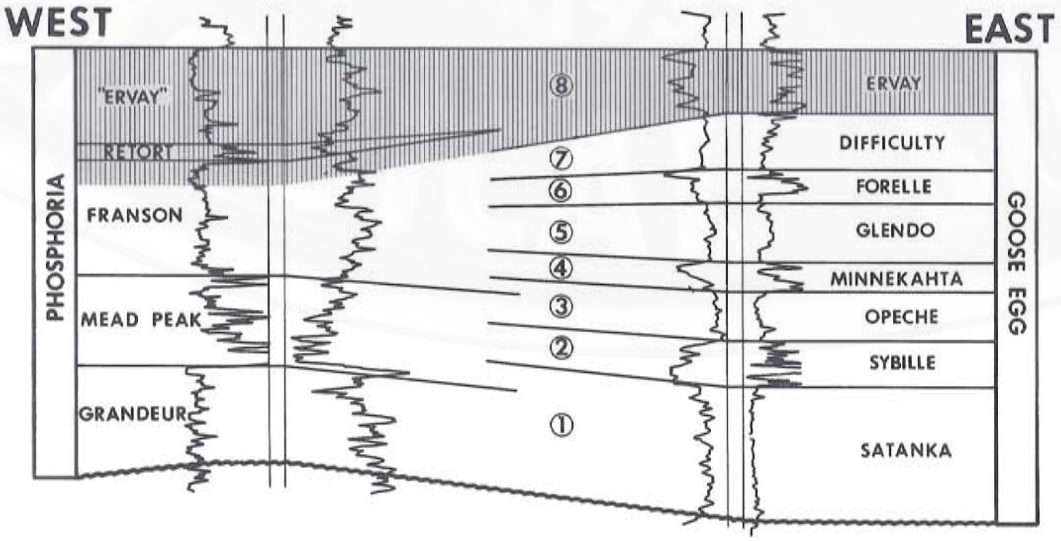
Figure 18



INTERVAL SHOWN ON FACIES MAP OF UNIT 7



FACIES MAP OF UNIT 8



INTERVAL SHOWN ON FACIES MAP OF UNIT 8

Figure 19

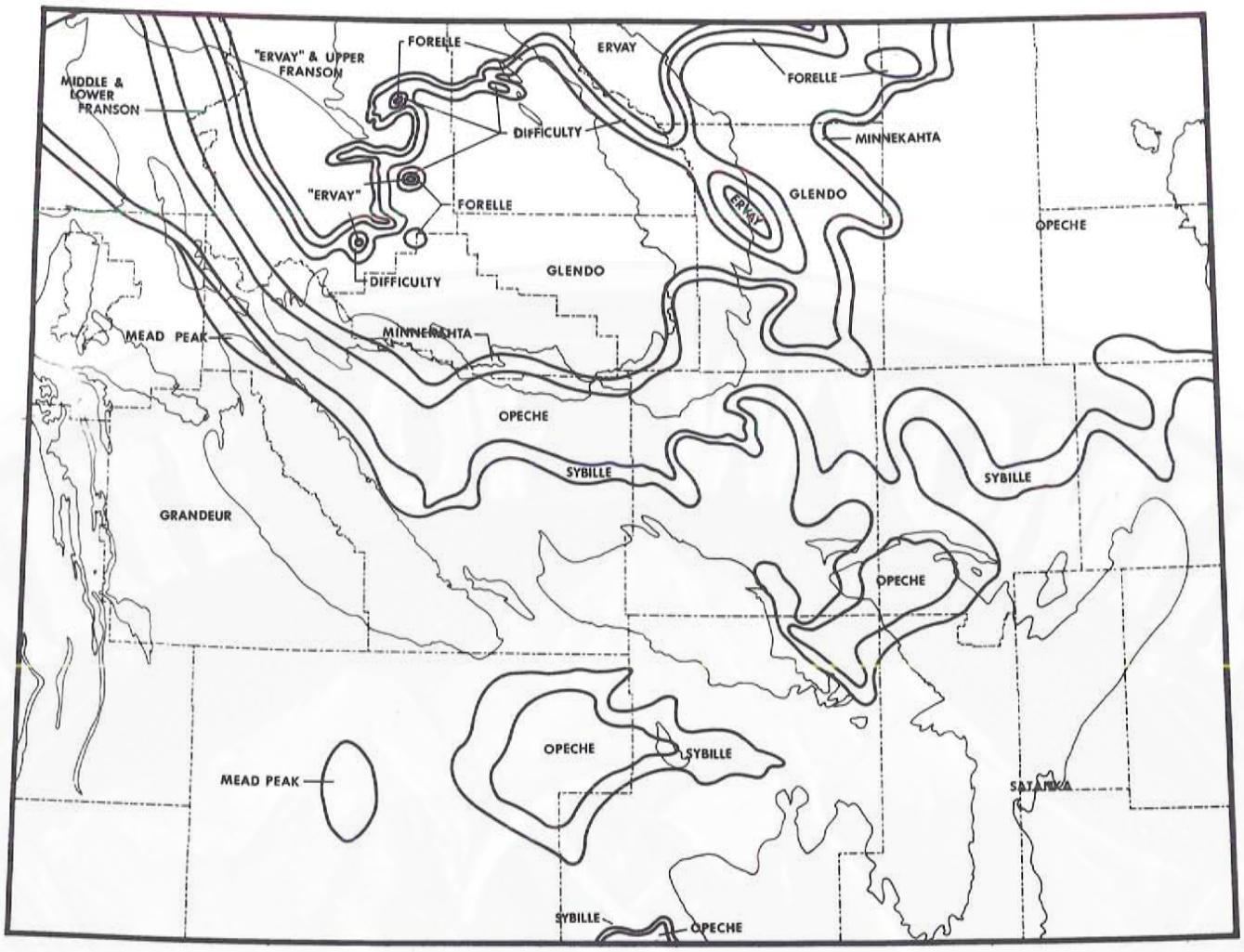


Figure 20. Worm's eye view map.

REFERENCES

Basko, Donald B., 1954, Stratigraphy of the Phosphoria Formation of northern Carbon County, Wyoming: Univ. of Wyo., unpub. M.A. thesis.

Boyd, D.W., 1958, Observations on the Phosphoris reservoir rock, Cottonwood Field, Washakie County, Wyoming: 1958 Geologic Record, Rocky Mtn. Sec., Am. Assoc. Petroleum Geologists, publ. by Petroleum Information, Denver.

Burk, C.A., and Thomas, Horace D., 1956, The Goose Egg Formation (Permo-Triassic) of eastern Wyoming: The Geol. Survey of Wyo. Rept. of Inv. no. 6, 11 p.

Campbell, Charles V., 1962, Depositional environments of Phosphoria Formation (Permian) in southeastern Bighorn basin, Wyoming: Am. Assoc. Petroleum Geologists Bull., v. 46, no. 4, p. 478-503.

Campbell, John A., 1963, Permo-Triassic red beds, northern Denver basin, in Geology of the northern Denver basin and adjacent uplifts: Rocky Mtn. Assoc. of Geologists Guidebook 14th Field Conf., p. 105-110.

Cheney, T.M., and others, 1954, Stratigraphic sections of the Phosphoria Formation in Wyoming, 1951: U.S. Geol. Survey Circular 324, 22 p.

Condit, D. Dale, 1924, Phosphate deposits in the Wind River Mountains, near Lander, Wyoming: U.S. Geol. Survey Bull. 764, 39 p.

French, James J., 1959, The Goose Egg Formation in the southern portion of the Bighorn Mountains, Wyoming: Univ. of Wyo., unpub. M.A. thesis.

Frielinghausen, Karl W., 1952, The Phosphoria Formation of southern and southeastern Big Horn Basin, Big Horn, Hot Springs, and Washakie Counties, Wyoming, in Southern Big Horn Basin, Wyoming: Wyo. Geol. Assoc. Guidebook 7th Field Conf., p. 55-57.

Gardner, Louis S., 1944, Phosphate deposits of the Teton basin area, Idaho and Wyoming: U.S. Geol. Survey Bull. 944-A, 36 p.

Gulbrandsen, R.A., 1960, Petrology of the Meade Peak Phosphatic Shale Member of the Phosphoria Formation at Coal Canyon, Wyoming: U.S. Geol. Survey Bull. 1111-C, p. 71-146.

Hale, Lyle A. (ed.), 1967, Anatomy of the western phosphate field: Intermountain Assoc. of Geologists Guidebook 15th Annual Field Conf., 287 p.

Hoyt, John H., 1963, Permo-Pennsylvanian correlations and isopach studies in the northern Denver basin, in Geology of the northern Denver basin and adjacent uplifts: Rocky Mtn. Assoc. of Geologists Guidebook 14th Field Conf., p. 68-83.

Ketterer, Walter P., and Swirczynski, R.P., 1952, Preliminary lithofacies study of the Phosphoria Formation, Big Horn Basin, Wyoming, in Southern Big Horn Basin, Wyoming: Wyo. Geol. Assoc. Guidebook 7th Field Conf., p. 53-54.

King, Ralph H., 1947, Phosphate deposits near Lander, Wyoming: The Geol. Survey of Wyo. Bull. 39, 84 p.

_____, 1957, Stratigraphy of the Phosphoria Formation in the Wind River Mountains, in Southwest Wind River Basin: Wyo. Geol. Assoc. Guidebook 12th Field Conf., p. 35-38.

Kivi, Wilho J., 1940, The stratigraphy of the Phosphoria Formation of western Wyoming, with notes on the occurrence of phosphate: Univ. of Wyo., unpub. M.A. thesis.

MacLachlan, James and Bieber, Alan, 1963, Permian and Pennsylvanian geology of the Hartville uplift-Alliance basin-Chadron arch area, in Geology of the northern Denver basin and adjacent uplifts: Rocky Mtn. Assoc. of Geologists Guidebook 14th Field Conf., p. 84-94.

Maughan, E.K., and Wilson, R.F., 1963, Permian and Pennsylvanian strata in southern Wyoming and northern Colorado, in Geology of the northern Denver basin and adjacent uplifts: Rocky Mtn. Assoc. of Geologists Guidebook 14th Field Conf., p. 95-104.

McCue, John J., 1953, Facies changes within the Phosphoria Formation in the southeast portion of the Big Horn basin, Wyoming: Univ. of Wyo., unpub. M.A. thesis.

McKee, E.D., Oriel, S.S., and others, 1967, Paleotectonic investigations of the Permian System in the United States: U.S. Geol. Survey Prof. Paper 515, 217 p.

_____, 1967, Paleotectonic maps of the Permian System: U.S. Geol. Survey Misc.

Geol. Inv. Map I-450, 164 p.

McKelvey, V.E., and others, 1953, Stratigraphic sections of the Phosphoria Formation in Wyoming, 1947-48: U.S. Geol. Survey Circular 210, 35 p.

_____, 1959, The Phosphoria, Park City, and Shedhorn Formations in the western phosphate field: U.S. Geol. Survey Prof. Paper 313-A, 47 p.

Momper, James A., 1963, Nomenclature, lithofacies and genesis of Permo-Pennsylvanian rocks-northern Denver Basin, in Geology of the northern Denver basin and adjacent uplifts: Rocky Mtn. Assoc. of Geologists Guidebook 14th Field Conf., p. 41-67.

Partridge, Lloyd R., 1949, The Phosphoria and Dinwoody Formations, northern Bighorn basin, Wyoming and Montana: Univ. of Wyo., unpub. M.A. thesis.

Privrasky, N.C., and others, 1958, Preliminary report on the Goose Egg and Chugwater Formations in the Powder River basin, Wyoming, in Powder River Basin: Wyo. Geol. Assoc. Guidebook 13th Field Conf., p. 48-55.

Sheldon, Richard P., and others, 1953, Stratigraphic sections of the Phosphoria Formation in Wyoming, 1949-50: U.S. Geol. Survey Circular 307, 45 p.

_____, 1954, Stratigraphic sections of the Phosphoria Formation in Wyoming, 1952, U.S. Geol. Survey Circular 325, 24 p.

Sheldon, Richard P., 1957, Physical stratigraphy of the Phosphoria Formation in northwestern Wyoming: U.S. Geol. Survey Bull. 1042-E, p. 105-185.

_____, 1963, Physical Stratigraphy and mineral resources of Permian rocks in Wyoming: U.S. Geol. Survey Prof. Paper 313-B, p. 49-273.

Tebbutt, Gordon E., 1964, Lithogenesis of a distinctive Permian carbonate fabric, Big Horn and Washakie Counties, Wyoming: Univ. of Wyo., unpub. M.S. thesis.

Thomas, Harace D., 1934, Phosphoria and Dinwoody tongues in lower Chugwater of central and southeastern Wyoming: Am. Assoc. Petroleum Geologists Bull., v. 18, no. 12, p. 1655-1697.

_____, and Krueger, Max L., 1946, Late Paleozoic and early Mesozoic stratigraphy of Uintah Mountains, Utah: Am. Assoc. Petroleum Geologists Bull., v. 30, no. 8, p. 1255-1293.

Tourtelot, Harry A., 1952, Marine and evaporite facies of Permian and Triassic strata in the southern part of the Big Horn Basin and adjacent areas, central Wyoming, in Southern Big Horn Basin, Wyoming: Wyo. Geol. Assoc. Guidebook 7th Field Conf., p. 49-52.

Weichman, Bernard E., 1958, Stratigraphy of the Phosphoria Formation in the southern portion of the Wind River Basin, Wyoming: Univ. of Wyo., unpub M.A. thesis.

Yochelson, Ellis L., 1968, Biostratigraphy of the Phosphoria, Park City, and Shedhorn Formations: U.S. Geol. Survey Prof. Paper 313-D, p. 571-660.

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