
# *Pennsylvanian correlations in southwestern Colorado*

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# PENNSYLVANIAN CORRELATIONS IN SOUTHWESTERN COLORADO

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## INTRODUCTION

Private research by the authors, both independently and in collaboration, has resulted in a practical subdivision of the Pennsylvanian stratal section of the entire region of the Paradox basin and its surrounding shelves. The sediment increments of Early to early Middle Pennsylvanian age are known to be bounded by widely correlative time markers regardless of the lithology of the sediment increment. Recognition of these markers requires the availability of gamma ray-neutron or sonic logs; however, they can be recognized on excellent electric logs and sample logs in many wells.

## PURPOSE

The purpose of this short paper is to extend our well-established correlations from nearby wells in the Paradox basin to the outcrop section to be examined during the field trip in the Animas Canyon north of Durango, Colorado. This section has been studied by many geologists and an historical review of the published studies was presented by Wengerd (1957).

It has been suggested by the American Stratigraphic Commission (1961) that no new names be given stratal units in regional and local society guidebooks, and we have suggested no new names; all are in articles already published. What we have done is tighten up the correlation network by shifting the names about a bit.

This short paper is thus only a preview of a formal article which may be published later in the Bulletin of the American Association of Petroleum Geologists.

## SEDIMENTATIONAL SUBDIVISION

The Lower Pennsylvanian section of the Paradox region consists of an heterogenous sequence of rock types whose detailed study on gamma ray-neutron and sample logs shows that the sequence can be subdivided into sendimentational units which have vertical individuality and great lateral persistence. Although the log character of each unit is relatively constant, it may appear expanded or compressed, reflecting changes in thickness. These sediment increments, bounded by correlative time markers, can be recognized over a wide area, greatly facilitating log correlations.

## CYCLE CORRELATION

The saline facies of the Lower Pennsylvanian consists of a sequence of cycles as described by Herman and Barkell (1957, p. 867) and later correlated by Hite (1960). Regional correlation of gamma ray-neutron logs shows the presence of 29 cycles near the middle of the basin, and suggests the possibility that five other cycles may be developed immediately above the Molas Formation in the area north of the Continental, Scorup No. 1 (T. 47 N., R. 18 W., Sec. 8, Colorado ). Stratigraphic nomenclature has not been a serious problem in this area of the basin, due in part to the ease with which salt cycles can be correlated, and in part to lack of interest in the economic potential of the area.

## STRATIGRAPHIC NOMENCLATURE

The stratigraphic nomenclature of the shelf area of the Paradox basin was acceptably simplified by a nomenclature committee of the Four Corners Geological Society ( Malin, 1958), and subsequent additions within the framework created by this committee have meshed well. Certain discrepancies in unit boundaries between the base of the Barker Creek and the top of the Molas Formation can be resolved very easily. These discrepancies are the result of projecting correlations from the area of salt deposition to the sequence along the shelf margin. These correlations show the need for adjusting formation boundaries to coincide with major breaks in cyclic deposition. Beyond these minor adjustments, any complaint of stratigraphic nomenclatural complexity resolves itself into an academic debate between the proponents of time-stratigraphic nomenclature and those favoring the rock-stratigraphic approach. A dual system is both awkward and unnecessary, and the problem may be resolved rather easily by regional correlations of wells which penetrated the Lower Pennsylvanian sequence.

## SEDIMENTARY UNITS

The cycles of the basin center area are members of certain gross units bounded by time markers which can be projected into the sequence of the shelf margin. These markers coincide with the boundaries of certain zones proposed by Malin (1958) and other workers. Any of the stratal sequences, between thin marker units, produces a distinctive log character which can be identified and mapped throughout much of the Paradox region. It has been proposed ( Szabo, 1968, p. 15) that the Paradox Formation, as used by Wengerd (1962, p. 280) be elevated to group status and that the stratigraphic units currently called "pay

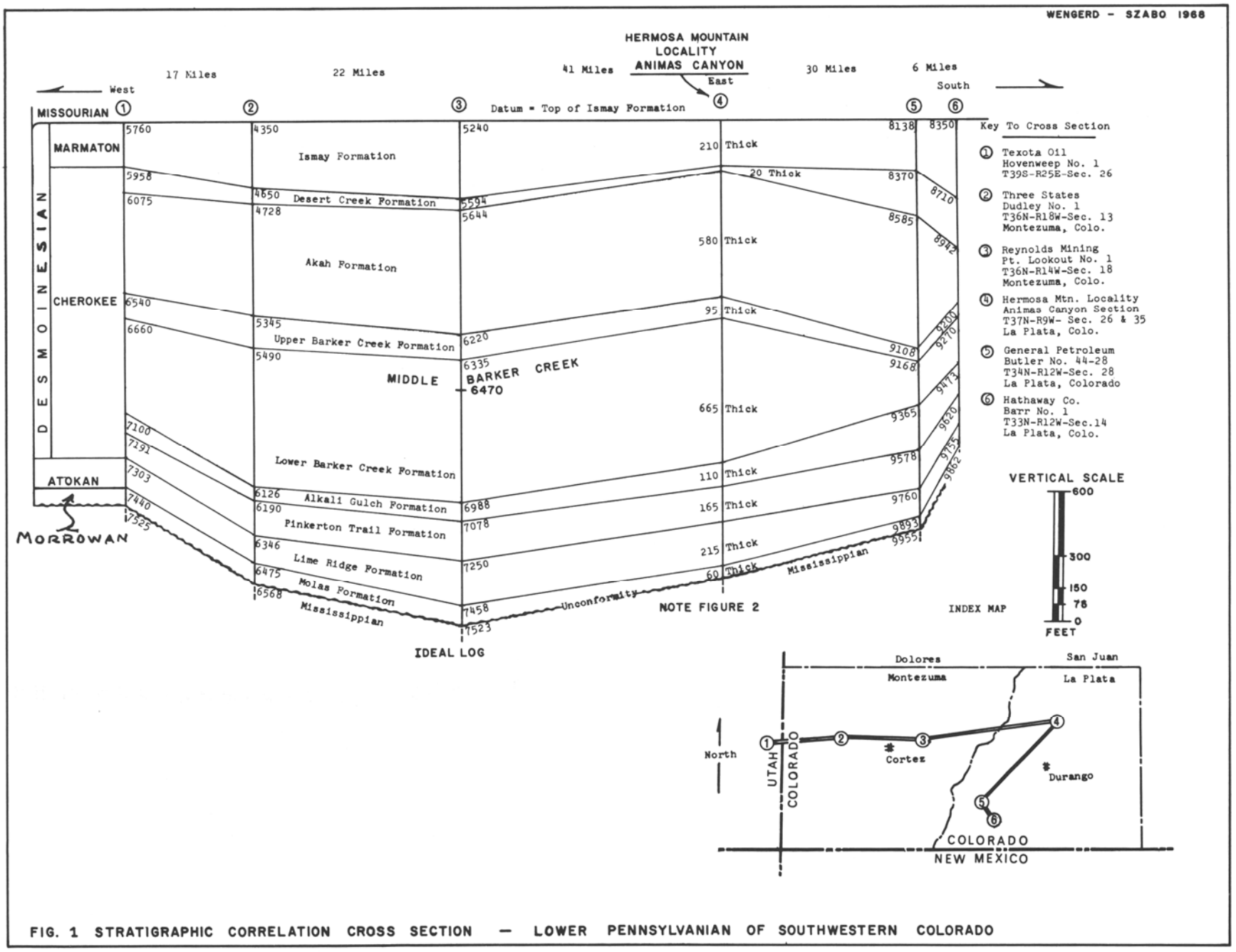



FIG. 1 STRATIGRAPHIC CORRELATION CROSS SECTION — LOWER PENNSYLVANIAN OF SOUTHWESTERN COLORADO

zones" or zones be raised to formation rank. This change is in agreement with Articles 6 and 9 in the Code of Stratigraphic Nomenclature (American Commission on Stratigraphic Nomenclature, 1961, p. 650-51) and since the proposed units are mappable formations whose boundaries coincide with the boundaries of time-stratigraphic units, the stage-substage nomenclature of Baars and others (1967, p. 401) appears to represent unnecessary terminology. A more utilitarian nomenclature is presented in Table 1.

TABLE 1

| | FORMATION | | CYCLES * | AGE | | |
|---|---|---|---|---|---|---|
| PARADOX GROUP | ISMAY | | 1 – 3 | MARMATON | DESMOINESIAN | PENNSYLVANIAN |
| | DESERT CREEK | | 4 – 5 | CHEROKEE | | |
| | AKAH | | 6 – 10 | | | |
| | BARKER CREEK | UPPER | 11 – 13 | | | |
| | | MIDDLE | 14 – 15 | | | |
| | | LOWER | 16 – 19 | | | |
| | ALKALI GULCH | | 20 – 24 | | | |
| | PINKERTON TRAIL | | 25 – 29 | | | |
| | LIME RIDGE | | 30 – 34 ? | ATOKAN | | |
| | MOLAS FACIES | | ——— | MORROWAN | | |
| | MANNING CANYON LEADVILLE | | | MISSISSIPPIAN | | |

* IN PART AFTER HITE (1960) WENGERD – SZABO 1968

## LIME RIDGE PROBLEM

The greatest single change recommended here is the substitution of the name Lime Ridge for strata of Atokan age. This time slice had been discussed as pre-Desmoinesian by Clair (1952, p. 37) and was later designated as the Lime Ridge Formation (Clair, 1958, p. 34 ) . This required restriction of the Pinkerton Trail Formation to the basal part of the Desmoinesian.

Other stratigraphers have included Atokan strata of quite different lithologic characteristics in the Pinkerton Trail (Clair, 1958, Wengerd and Matheny, 1958, Wengerd, 1962, Baars and others 1967), but Clair (1952 and 1958 ) recognized an important unconformity below which are found pre-Desmoinesian strata of greater-than-usually-recognized economic potential. These pre-Desmoinesian strata include the Pinkerton Trail Formation as first defined by Wengerd and Strickland (1954, p. 2168 ). Well-exposed sections at Pinkerton Creek Trail across the Encantado cliffs, and along the road to Rico across the Hermosa cliffs at Columbine, plus time-marker controlled correlation in Paradox wells suggest that the name "Pinkerton Trail" should be applied to cycles 25 through 29 of earliest Desmoinesian age, as recommended in this paper.

For the following reasons, we suggest that Pinkerton Trail of the original type locality be called Lime Ridge, which includes the Molas facies, and that Pinkerton Trail Formation be moved up into the basal Desmoinesian, as a valid mappable formation below the Alkali Gulch:

1. Clair (1952) set the stage by calling these beds pre-Desmoinesian.
2. Wengerd and Strickland (1954) found both Atokan and Desmoinesian fossils in pre-Paradox strata at the Hermosa Mountain locality.
3. This change agrees with Baars and others (1967) that Fusulinella is Atokan.
4. Agreement is offered with Clair who established a type locality for pre-Desmoinesian strata in the subsurface of Lime Ridge anticline on the Monument upwarp in Utah (1952) and named these strata the Lime Ridge (1958).
5. We see the validity of this adjustment to eliminate confusion in the stratigraphic nomenclature of the Paradox shelf areas.

## MOLAS FACIES

The Molas facies is a "residual soil" zone recognized in the Paradox region both north and south of the Uncompahgre upleft. In outcrops, it is recognized as far southeastward as Cedro Canyon, east of Albuquerque, New Mexico. Regional correlation of the Molas reveals that a marine shale unit laterally equivalent to the Molas is present in the subsurface near Price, Utah (Szabo, 1968, p. 23), in a part of the section originally referred to as th Manning Canyon Formation (Sadlick, 1956, p. 74) . This marine section is probably equivalent, in part, to the Belden Formation of Morrowan age in northwestern Colorado and northeastern Utah.

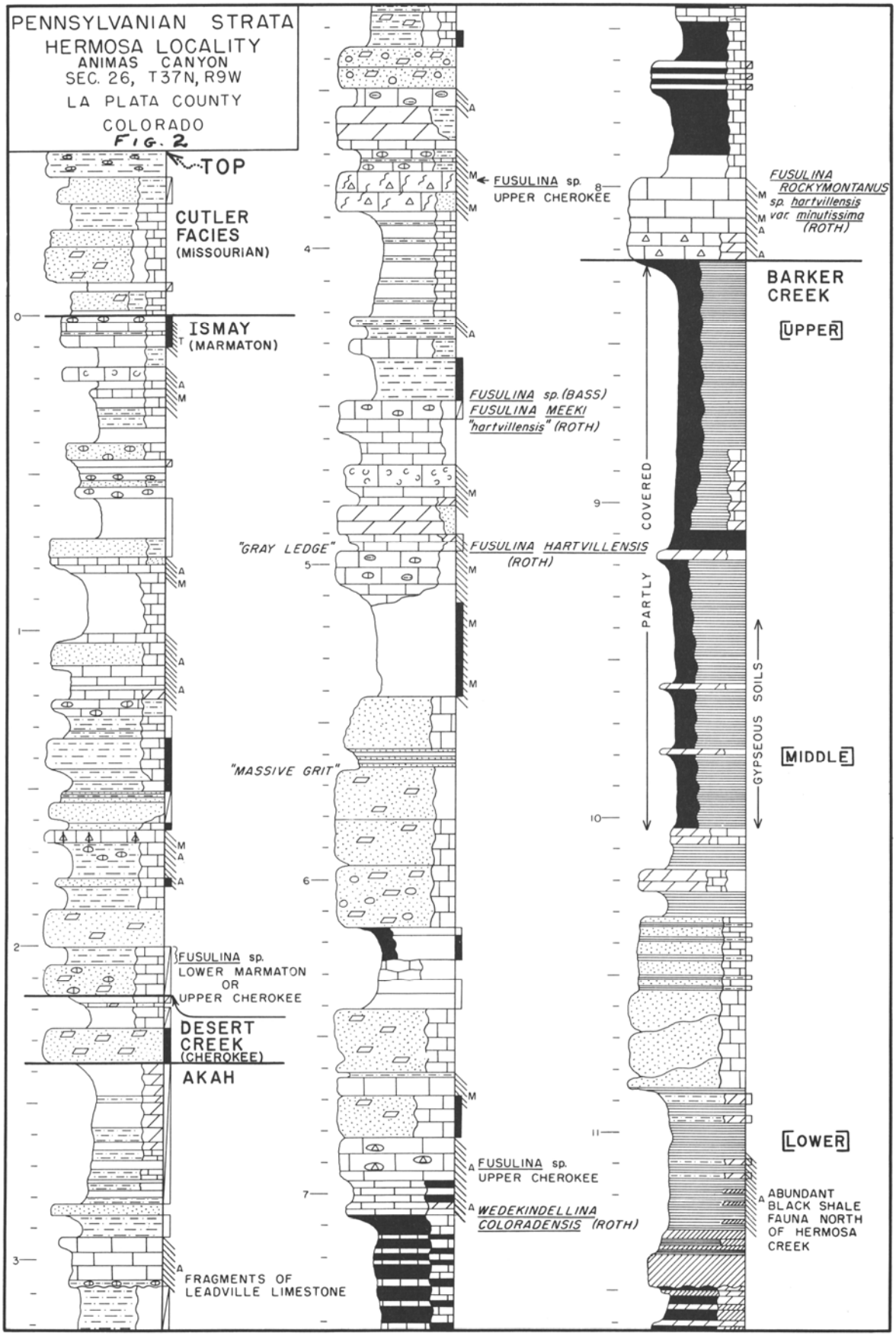
## MAPPABLE FORMATIONS

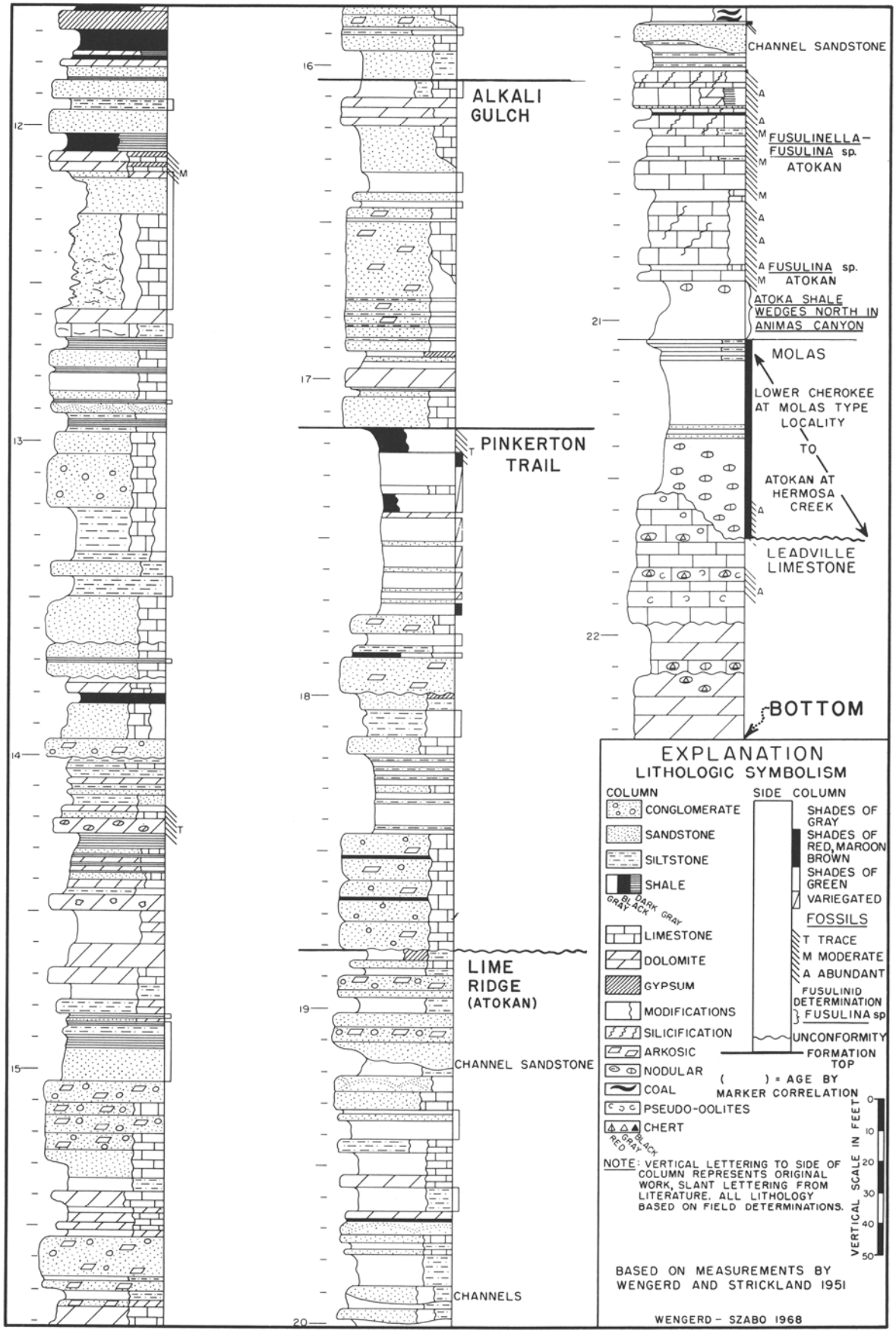
Use of the proposed stratigraphic nomenclature in the Paradox region permits the mapping of units of formational rank bounded by time-stratigraphic surfaces. The nomenclature is also compatible with fusulinid zonations proposed by Baars and others (1967, p. 402) if Lime Ridge is substituted for Pinkerton Trail in the Fusulinella zone. Correlation of selected logs in southwestern Colorado, using the proposed nomenclature, is presented in Figure 1. The Reynolds, Point Lookout No. 1, T. 36N., R. 14 W., Sec. 18, Montezuma County, Colorado, is considered to be an ideal (but not necessarily typical) log for the study of these proposed formation tops in this area.

## HERMOSA MOUNTAIN SECTION

The position of subsurface formation intercepts has been projected to the surface section measured at the Hermosa Mountain locality by Wengerd and Strickland (1954, p. 2162-2175) . The projected position of these tops is shown in Figure 2 in this paper.

Between 1957 and 1958, correlation of the Animas Canyon section of Pennsylvanian strata evolved in response to more finite subdivision of equivalent beds in the subsurface as more wells were drilled, and as more names were added to define the stratal section (Wengerd, 1957, Wengerd and Matheny, 1958, Wengerd, 1962) . Figure 2 shows the latest specific correlations with names applied which have been published previously. The time-markers utilized are adequately controlled by fusulinid determinations from the


PENNSYLVANIAN STRATA
HERMOSA LOCALITY
ANIMAS CANYON
SEC. 26, T37N, R9W
LA PLATA COUNTY
COLORADO
FIG. 2
TOP
CUTLER FACIES (MISSOURIAN)
ISMAY (MARMATON)
FUSULINA sp. LOWER MARMATON OR UPPER CHEROKEE
DESERT CREEK (CHEROKEE)
AKAH
FRAGMENTS OF LEADVILLE LIMESTONE
"GRAY LEDGE"
"MASSIVE GRIT"
FUSULINA sp. UPPER CHEROKEE
FUSULINA sp. (BASS) FUSULINA MEEKI "hartvillensis" (ROTH)
FUSULINA HARTVILLENSIS (ROTH)
FUSULINA sp. UPPER CHEROKEE
WEDEKINDELLINA COLORADENSIS (ROTH)
FUSULINA ROCKYMONTANUS sp. hartvillensis var. minutissima (ROTH)
BARKER CREEK
COVERED
PARTLY
GYPSEOUS SOILS
ABUNDANT BLACK SHALE FAUNA NORTH OF HERMOSA CREEK
UPPER
MIDDLE
LOWER


ALKALI GULCH
PINKERTON TRAIL
LIME RIDGE (ATOKAN)
CHANNEL SANDSTONE
CHANNELS
CHANNEL SANDSTONE
FUSULINELLA–FUSULINA sp. ATOKAN
FUSULINA sp. ATOKAN
ATOKA SHALE WEDGES NORTH IN ANIMAS CANYON
MOLAS
LOWER CHEROKEE AT MOLAS TYPE LOCALITY
TO
ATOKAN AT HERMOSA CREEK
LEADVILLE LIMESTONE
BOTTOM
EXPLANATION
LITHOLOGIC SYMBOLISM
COLUMN
CONGLOMERATE
SANDSTONE
SILTSTONE
SHALE
BLACK
DARK GRAY
GRAY
LIMESTONE
DOLOMITE
GYPSUM
MODIFICATIONS
SILICIFICATION
ARKOSIC
NODULAR
COAL
PSEUDO-OOLITES
CHERT
RED
GRAY
BLACK
SIDE COLUMN
SHADES OF GRAY
SHADES OF RED, MAROON BROWN
SHADES OF GREEN
VARIEGATED
FOSSILS
T TRACE
M MODERATE
A ABUNDANT
FUSULINID DETERMINATION
FUSULINA sp
UNCONFORMITY
FORMATION TOP
( ) = AGE BY MARKER CORRELATION
NOTE: VERTICAL LETTERING TO SIDE OF COLUMN REPRESENTS ORIGINAL WORK, SLANT LETTERING FROM LITERATURE. ALL LITHOLOGY BASED ON FIELD DETERMINATIONS.
VERTICAL SCALE IN FEET
0
10
20
30
40
50
BASED ON MEASUREMENTS BY WENGERD AND STRICKLAND 1951
WENGERD – SZABO 1968

Hermosa Mountain section itself and from numerous wells in the Paradox basin.

Several striking conditions are mentioned below, without detailed explanation.

1. The lower Cutler red-beds are doubtless of Pennsylvanian age, a suggestion made by Roth, Thompson, Bass, and Wengerd in earlier publications not referenced here.
2. The Ismay is higher in the section than anyone had dared to suggest previously; clearly a function of closeness to source of terrestrial elastics from the emerging Uncompahgre uplife.
3. Most of the Ismay elastics are non-arkosic quartzose sandstones.
4. Coarse elastics of the Desert Creek through Lime Ridge Formations are predominantly arkosic granulites, believed to be from the San Luis highland to the northeast, rather than from the later Uncompahgre to the north and northwest.
5. The Desert Creek section is very thin, presaging either a slow initial rise of sea bottom to decrease sedimentational space as the Uncompahgre began to lift, or pre-Ismay erosion of a previously deposited, thicker Desert Creek.
6. If all the coarse elastics are arbitrarily deleted from the section, the stratal section is somewhat similar to that in some parts of the southwestern sedimentational slope of the Paradox basin.
7. Sandstone and granulite channels in the Lime Ridge Formation show the positive tendency of the mobile border of the San Luis uplift just prior to the ponderous subsidence of Paradox evaporite basin, wherein the predominant evaporite deposits are of Pinkerton Trail, Alkali Gulch, Barker Creek, Akah, and Desert Creek age.
8. There can be little doubt that the coarse elastics of the Paradox group are distal, high, steep-shelf equivalents of thick salt lentils; these elastic sediment incursions took place cyclically as this eastern mobile border pulsed upward, simultaneous with basinal subsidence, while salt was being deposited in the Paradox basin.

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