KANSAS GEOLOGICAL SURVEY
OPEN-FILE REPORT 86-24

The Oread Formation in Northwestern Kansas from the
Skelly #1 Bartosovsky Well, Sec. 9, T. 1S, R. 34W,
Rawlins County, Kansas

by

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INTRODUCTION

The exposures of the Shawnee Group (Virgilian) of eastern Kansas can be correlated with equivalent strata over 300 miles (500 km) into the subsurface of northwestern Kansas based on sample, core, and wireline log correlations. The purpose of this paper is to describe the Plattsmouth, Heebner, and Leavenworth members of the Oread Formation from two cores in northwestern Kansas and to contrast this with the outcrop section. Furthermore, comments are made on features observed in the cores relating to petroleum reservoir development. The distant positions of the outcrop and cored sites resulted in notable differences in depositional environment, the development of diagenetic fabrics, and ultimately, hydrocarbon accumulation and production. The Virgilian shelf was extremely broad across the western Midcontinent including Kansas, southern Nebraska, and eastern Colorado (Rascoe and Adler, 1983). The shelf apparently sloped gradually southward to the margin of the Anadarko basin (Watney, 1985). Deltaic sedimentation during the Late Pennsylvanian affected the shelf in southeastern Kansas, but not northwestern Kansas where rainfall amounts and land area were insufficient to produce substantial deltas (Rascoe and Adler, 1983; Heckel, 1980).

The Oread Formation was continuously cored in the Skelly #1 Bartosovsky well located in Section 9, Township 1S, Range 34W, in

Rawlins County, Kansas. The well is the discovery test for the seven million barrel Cahoj field. All members of the Oread Limestone are present at this location with the exception of the Toronto Limestone (#1). Those intervals focused on in this study include the middle (#2) and upper limestone (#3) members (Leavenworth and Plattsmouth, respectively) and the intervening core shale (Heebner). The lowermost portion of the Heumader Shale is also described. Limited comments are made about chips of core made available from the Plattsmouth Limestone from a well in Graham County. These cores are located on the map in Figure 1.

The Shawnee Group is not a regionally prolific producing interval of oil and gas production, which also is true of the overlying Wabaunsee Group of Virgilian age. Figure 1 depicts the distribution of oil and gas production from the Shawnee Group, namely Topeka, Oread and Toronto limestones (Newell et al., in review). In contrast, carbonate rocks of the underlying Lansing and Kansas City groups, also Upper Pennsylvanian in age, serve as reservoirs in many more well completions in western Kansas. No satisfactory reason has been presented as yet to explain these stratigraphic differences in reservoir development and petroleum accumulation. The reason may be related to differences in composition between the Virgilian and Missourian strata or diagenesis that has affected them.

The #1 Bartosovsky well had an initial potential of 3000 BOPD from the LKC, but with no production from the Oread. However, in Rawlins County the Berthos field (disc. date 1982) in Sec. 8-1S-36 and Brumm East (disc. 1982) in Sec. 17-2S-36W produce oil from the Shawnee. In Graham County, Shawnee production is more frequent, but by no means abundant: Alda (disc. 1944), Ambrose (disc. 1969), Cooper (disc. 1949), Elrick (disc. 1955), Ray (disc. 1940), and Worcester field (disc. 1951). Lansing is producing in all of these fields except for the Brumm East which has pay in the Marmaton.

CORE DESCRIPTION

Figure 2 includes the core description of the #1 Bartosovsky based on binocular microscopic examination and traces of the gamma ray and neutron logs at the same scale as the description. The original log with a depth scale of 1" = 20 ft. was digitized and expanded to 1" = 2 ft. or 10X the original. Thus some caution must be given to the use of the expanded log trace. The logging form is a modification of the form proposed by Boyles, Scott, and Rine (1986). The porosity classification is that of Choquette and Pray (1970). The core was previously described in a publication by Harbaugh and Davie (1964). Observations differ somewhat due to application of new textural descriptions and staining techniques developed since the last description.

Smaller scale versions of the wireline logs for the Bartosovsky and the well in Graham County are found in Figures 3 and 4.

Leavenworth Limestone Member

The Leavenworth Limestone Member can be divided into an upper lime mudstone unit (3930-3927.8') and a lower ooid grainstone unit (3931.8-3930').

The lower unit is dominated by ooids, but also contains 5-10% skeletal grains, the most notable of which are large (3+ cm) coiled gastropods. The unit also contains about 3% fine quartz silt. The rock is partially cemented by equant calcite spar.

Porosity has a maximum value of 16% based on core analyses. The majority of this porosity is oomoldic but there are significant fossil moldic and intra-/interparticle porosity components. Fossil moldic and intraparticle porosity is best developed in large gastropods. Much of the porosity has been reduced by coarsely-crystalline ferroan dolomite. The entire ooid grainstone unit shows moderate to heavy oil staining. Core analyses indicate approximately 45% residual oil saturation.

The upper unit is a dense, brown lime mudstone. Fossils are sparse and consist almost solely of fusulinids. Subvertical fracture pores appear to be solution enlarged and are also filled with coarsely crystalline ferroan dolomite. In places, these fracture pores are surrounded by an aureole of extant microporosity which is oil stained. Perhaps 2% inter- and intraparticle porosity has developed in and around fusulinid tests. Sutured stylolites are present at various intervals throughout the unit but are concentrated in a swarm at the base of this lime mudstone interval. These stylolites generally have amplitudes <5mm and commonly <1mm. Argillaceous material is concentrated in this swarm along with fusulinid tests which have undergone compaction. Hydrocarbon residues are present in all pore types and along stylolites.

The Leavenworth Limestone Member is essentially unchanged from its appearance and composition in the outcrop so many miles distant. The interval represents a deepening of the marine water ranging from shoal-water, energetic conditions to a quiet, open-marine environment. This is typical of transgression which characterizes the "middle" (#2) limestone. Transgression appeared to be rapid, covering a large area of the shelf as suggested by its thin, widespread but rather uniform nature of the unit.

Heebner Shale Member

The Heebner shale can be divided into a lower dark gray shale (3927.8-3927.6') and an upper calcareous siltstone. The dark gray shale is volumetrically minor but contains abundant, small brachiopods. The calcareous siltstone facies contains a few scattered brachiopod fragments and is burrow mottled throughout most of its thickness. Burrows are small and are distorted considerably by compaction. Small, discontinuous, sub-vertical, scalloped fractures suggest soft sediment deformation occurred in this silty interval. Thin lenses of silt appear to be cross laminated.

While no quantitative data is available, the clay content appears to be high. In spite of the fact that the black shale facies typical of the Heebner is not developed here, the lower siltstone interval produces a strong deflection of the gamma-ray log. The log, however, is not calibrated. Nevertheless, the deflection of the GR such as this has made the Heebner a popular marker bed throughout much of Kansas. The gamma radiation steadily declines moving upwards through the Heebner and continues to fall, albeit more gradually through the overlying Plattsmouth. The dramatic increase in gamma radiation through the Leavenworth in response to the "hot" superjacent Heebner results in a lack of precision for picking the top of this limestone.

The Heebner Shale is much siltier in this core than in the outcrop area in eastern Kansas and the transition into the overlying Plattsmouth occurs over a larger vertical distance in the core. The silty shale is fossiliferous, but the obvious megafossils are only small brachiopods suggesting some form of stressed marine environment. The microfossils such as conodonts have not been examined to further define depositional conditions. Poorly preserved ripple-cross laminations (?) in the upper part of the shale suggest occasional bottom currents which may or may not require shallow water conditions. The thin, clay-rich interval at the base of the shale which contains brachiopod shale fragments is thought to represent maximum transgression, a process initiated during accumulation of the Leavenworth Limestone.

The greater concentration of silt at this site compared to eastern Kansas suggests closer proximity to a source of either water- or wind-borne sediments. The occurrence of anhydrite nodules in the outside shales of the Missourian strata in Hitchcock County, Nebraska, the commonly oxidized state of this shale, and the occurrence of equivalent evaporites in Nebraska and Wyoming suggest more arid conditions in northwestern Kansas than to the east and conditions suited for aeolian transport (Watney, 1980; Heckel, 1980; Prather, 1985). Moreover, Rascoe and Adler (1983) suggest a positive landmass in west-central Nebraska, perhaps serving as a local source for terrigenous clastics.

Plattsmouth Limestone Member

The Plattsmouth Limestone Member can be divided into a lower calcareous siltstone/argillaceous limestone unit (3922-3884.8') and an upper unit which consists of silty lime mudstone, wackestone, and packstone, with relatively little clay (3884.8-3876'). As seen in the description, as the clay content drops the gamma ray curve falls and the neutron counts increase, indicating a cleaner carbonate rock upwards in the sequence.

Lower Unit

The lower unit contains a sparse fauna of brachiopods, many of which are articulated, and crinoid columnals. Burrow mottling is common but has been modified by compaction. The unit has a high clay content which decreases upward. The clay content was a critical factor in the diagenetic history and resulting diagenetic fabrics. Dissolution of calcium carbonate and compaction of the unit were prevalent, apparently encouraged by the presence of the clay. Microstylolite swarms, indicative of the processes of dissolution and compaction (Wanless, 1979) are ubiquitous in this interval and apparently initiated along zones of high clay content. The presence of quartz silt in the lower Plattsmouth may contribute to the formation of these microstylolites. Sutured stylolites are not present. Very thinly-bedded to nodular chert is common throughout the lower unit. These nodules contain 30-40% ferroan dolomite which is present as unzoned 10-40 micron rhombs, a component sparsely present in the surrounding carbonate matrix. In most cases, microstylolites drape around the chert nodules, indicating that the nodules formed before compaction. Chert nodules in the upper portion of the lower unit, however, enclose microstylolites. This suggests that the formation of microstylolites and dolomitic chert nodules were penecontemporaneous processes.

Near the top of this lower argillaceous interval at 3889.5 feet a thin zone of radioactive chert is present. The chert replaces micrite and shell fragments and is not associated with microstylolites. A large nodule stained by iron oxides contains an irregular outer ring of very fine, dark flecks and blebs which appears to be the source of the elevated gamma radiation at this level as indicated with Geiger counter metering. This material could possibly be a phosphate mineral (P. Berendsen, personal communication) although no chemical or X-ray analyses have been made.

Variable amounts (generally less than 10%) of fine rhombic dolomite are present in the limestone adjacent to microstylolite seams and dolomitic chert nodules. The formation of dolomite and chert in relation to microstylolite formation has been the subject of much debate (Wanless, 1979, 1982, Pratt, 1982, McHargue and Price, 1982; Narkiewicz, 1983; Price and McHargue, 1983). With the exception of minor fractures, porosity is essentially lacking in the lower unit.

The space created by dissolution of the carbonate was apparently eliminated by compaction. The smooth, wavy nature of most microstylolites and the smooth-edged drapes or sags of micrite between some of the chert nodules suggest that the sediment was perhaps somewhat soft when these events took place.

Upper Unit

The upper unit of the Plattsmouth consists of slightly dolomitic mudstones, wackestones, and packstones which are relatively clean with respect to clay, but do contain up to 5% quartz silt. Bioclasts include brachiopod fragments, crinoid columnals, fusulinids, and a few bryozoans. Microstylolite formation in the upper unit was apparently hindered by grain-supported fabrics and the lack of clay. Consequently, sutured stylolites are more common.

Core analyses indicate a maximum of 10% porosity in the interval from 3880' to 3874' and a maximum of 4 md of permeability. Pore types include subequal amounts of solution-enlarged moldic, interparticle, and channel pores, all of which have been partially reduced by coarsely crystalline, ferroan dolomite. Vertical fracture pores account for only a very small portion of the total porosity, but probably contribute significantly to the permeability. Moderate to heavy hydrocarbon residues are present in the upper 5' of the unit, containing the greatest concentration of grains. The gamma radiation is at its lowest value through most of this interval suggesting that this is the cleanest (low clay) carbonate rock confirmed by the core. The neutron counts decrease toward the top of this interval in response to increased porosity development. Core analyses indicate a maximum of 36% oil saturation.

The Plattsmouth Limestone Member represents an shallowing-upward interval ranging from thick, low energy, subtidal-marine, silty and argillaceous wackestones capped by a thin deposit of bioclastic packstone. The lower surface of the packstone (3880.6') is erosional with semi-angular clasts of the underlying wackestone in the base of the packstone. The wackestone appears to have been at least partially lithified as burrow-like cavities and vugs near and connected to the erosional surface are filled or partially filled with bioclastic debris. The character of the overlying shale suggests that it is non-marine and that emergent conditions occurred during or immediately after its accumulation late in the process of regression. This earlier lithification event prior to packstone accumulation associated with possible dissolution suggests even earlier emergence, perhaps under supratidal conditions. The packstone may represent an influx of grains associated with rapid flooding such as a storm event versus accumulation as an offshore bar.

Heumader Shale Member

The Plattsmouth Limestone Member is overlain by a 3' interval of green, calcareous shale, the lowermost portion of the Heumader Shale, which contains in-situ breccia, clay-filled fissures, and possibly, caliche nodules. These features suggest subaerial exposure at the end of the regressive phase. This shale is 23 feet thick here containing siltstone and fine calcareous sandstone. One and a half feet of Kereford Limestone, a #4 limestone, overlie this shale completing the Oread megacyclothem.

DISCUSSION OF POROSITY DEVELOPMENT

Subaerial exposure suggested by the structures in the Heumader Shale would have subjected the underlying limestones to hostile meteoric waters, resulting in oomoldic and fossil moldic porosity development (Watney and Ebanks, 1978). While percolation of undersaturated waters led to void formation and preservation in the upper clean carbonate rock interval, the lower interval was unaffected altogether or, when porosity was formed, it was eliminated by soft-sediment deformation and compaction encouraged by the higher clay. The scalloped fractures lower in the section support some form of soft sediment deformation. Thus, the elevated clay content may have inhibited the carbonate from early lithification in turn, reducing the chances for preservation of secondary porosity in the lower Plattsmouth Limestone Member. There does appear to be more clay and silt in this core than that present along most of the outcrop.

The diagenetic model proposed by Heckel (1983), suggests that the lower, transgressive limestone (i.e., Leavenworth) would be protected from downward-percolating meteoric waters by the black core-shale, which would act as an aquiclude. Because of the lack of the black shale facies here, the Leavenworth Limestone was subjected to a greater opportunity for more intense meteoric diagenesis, which greatly enhanced its potential as a petroleum reservoir. The porosity that is present in the Leavenworth may be early and needs further study. Late stage dissolution may also have been a contributing factor to porosity development in both the Leavenworth and the Plattsmouth, but petrographic and geochemical studies of cements and relationship of these to pore space are not yet available.

GRAHAM COUNTY CORE

Figure 4 depicts the gamma ray neutron resistivity logs for the Graham County well. Only chips of the core are available from the Plattsmouth between 3403 and 3368. The strong gamma ray deflection occurs at the location of the Heebner Shale Member. The oil-filled, porous interval occurs between the depths of 3380 to 3373. The binocular examination of the chips indicates a skeletal packstone/grainstone interval with fossil-moldic porosity, possibly solution-enlarged interparticle porosity, and vugs, all with heavy oil staining. Immediately below the porous zone at 3383.4, the chip sample indicates a packstone/wackestone fabric which is non-porous.

Immediately above the porous interval at 3369.1 is an ooid grainstone which appears to be overcompacted. Some of the interparticle porosity is reduced by cement. The low resistivity and neutron response combined with an intermediate gamma ray level between 3368-65 feet, superjacent to the porous zone, suggests a shale or very shaley carbonate rock. This shaley interval is probably equivalent to the Heumader Shale Member of the Oread, albeit a thin one, and the overlying limestone between 3375 and 3357, the Kereford Limestone Member.

The Kereford is a super limestone (#4) and its relative thinness and the lack of a radioactive shale between it and the underlying Plattsmouth suggest this correlation. The shoal-water conditions at the top of the Plattsmouth, the oolite and grainstone and interval of porosity development, and underlying fossiliferous micritic carbonate rock suggest a shallowing upward (regressive or #3) limestone unit. The porous interval is an excellent petroleum reservoir, restricted to the cleaner (low gamma ray), grain-supported carbonate rock of the Plattsmouth. Again it is probably the presence of the cleaner carbonate which reacted as a rigid unit during the dissolution event preserving the new void space.

CONCLUSION

The clean, shale-free carbonates commonly have a grain-support fabric or contain abundant phylloid algae (Watney, 1979; Ebanks and Watney, 1985). The clay minerals are either winnowed out by currents leading to the accumulation of coarser grains or are sparse in the non-turbid water environment which apparently was required for the proliferation of phylloid algae. These clean carbonates then respond as more rigid units to diagenesis where pores created during selective dissolution are preserved and which later may become sites for mesogenetic enlargement and oil accumulation. The regressive carbonate rocks, the upper (#3) limestones, are the favored sites for this diagenesis suggesting that processes related to early infiltration of freshwater which apparently issued down from the tops of these sequences are most important.

ACKNOWLEDGMENTS

Appreciation is extended to Lea Ann Millikan for word processing drafts of the manuscript, Jennifer Sims for computer graphics of wireline log information, and to Stephen Wai Leung Cheng for generation of Shawnee oil and gas production map from Well History Control System of Petroleum Information, Inc.

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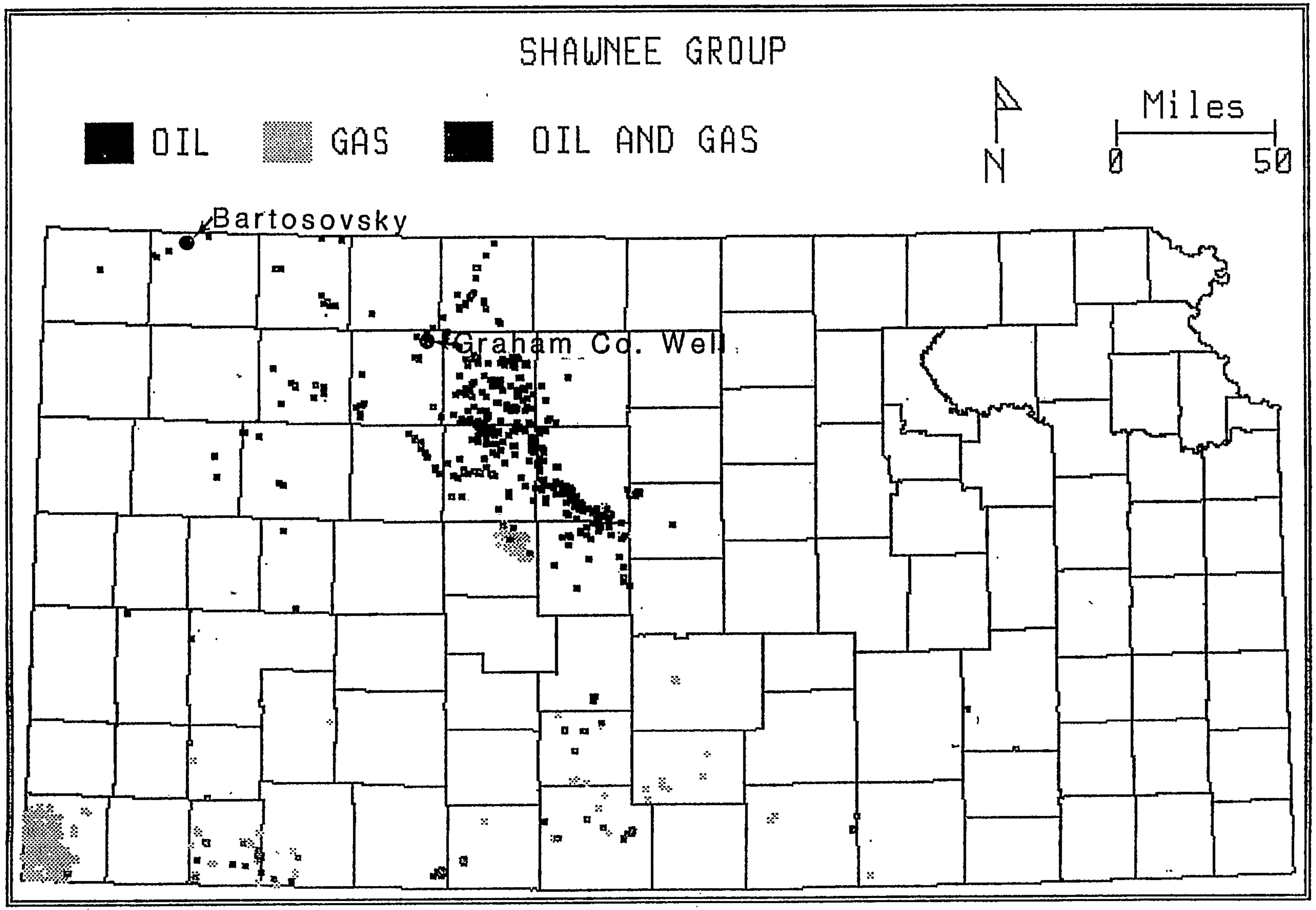
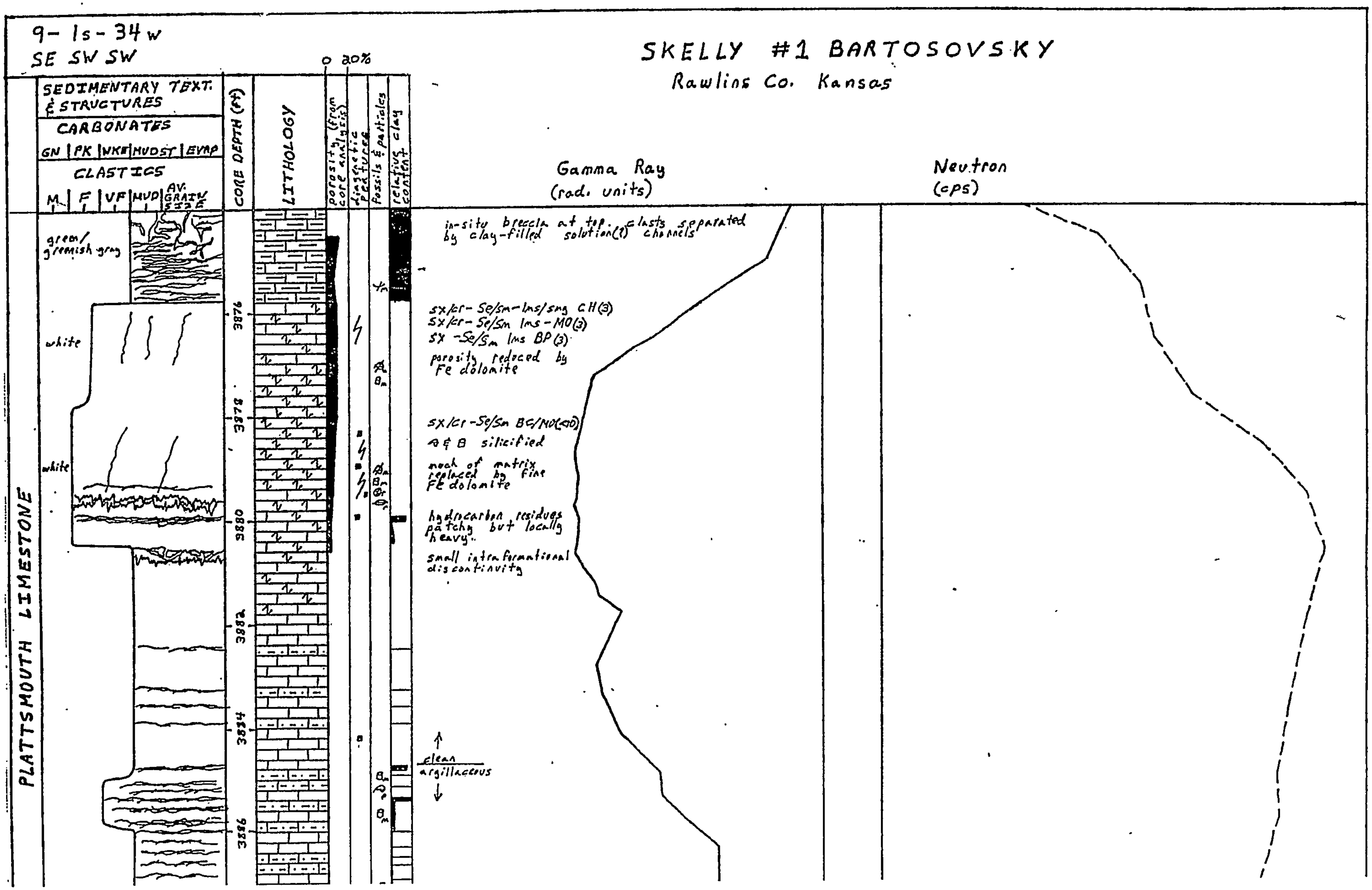
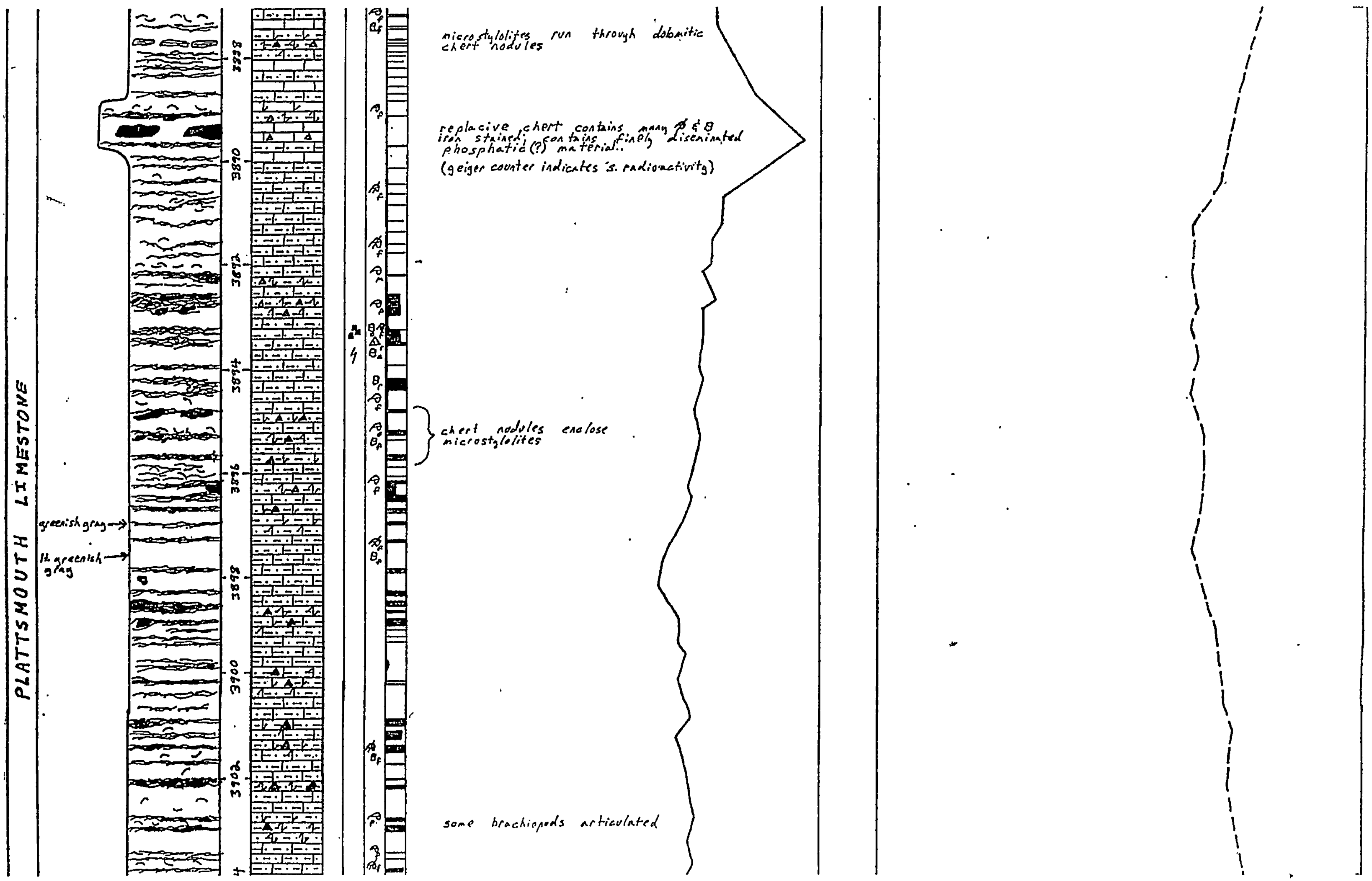

SHAWNEE GROUP
OIL
GAS
OIL AND GAS
N
Miles
0
50
Bartosovsky
Graham Co. Well

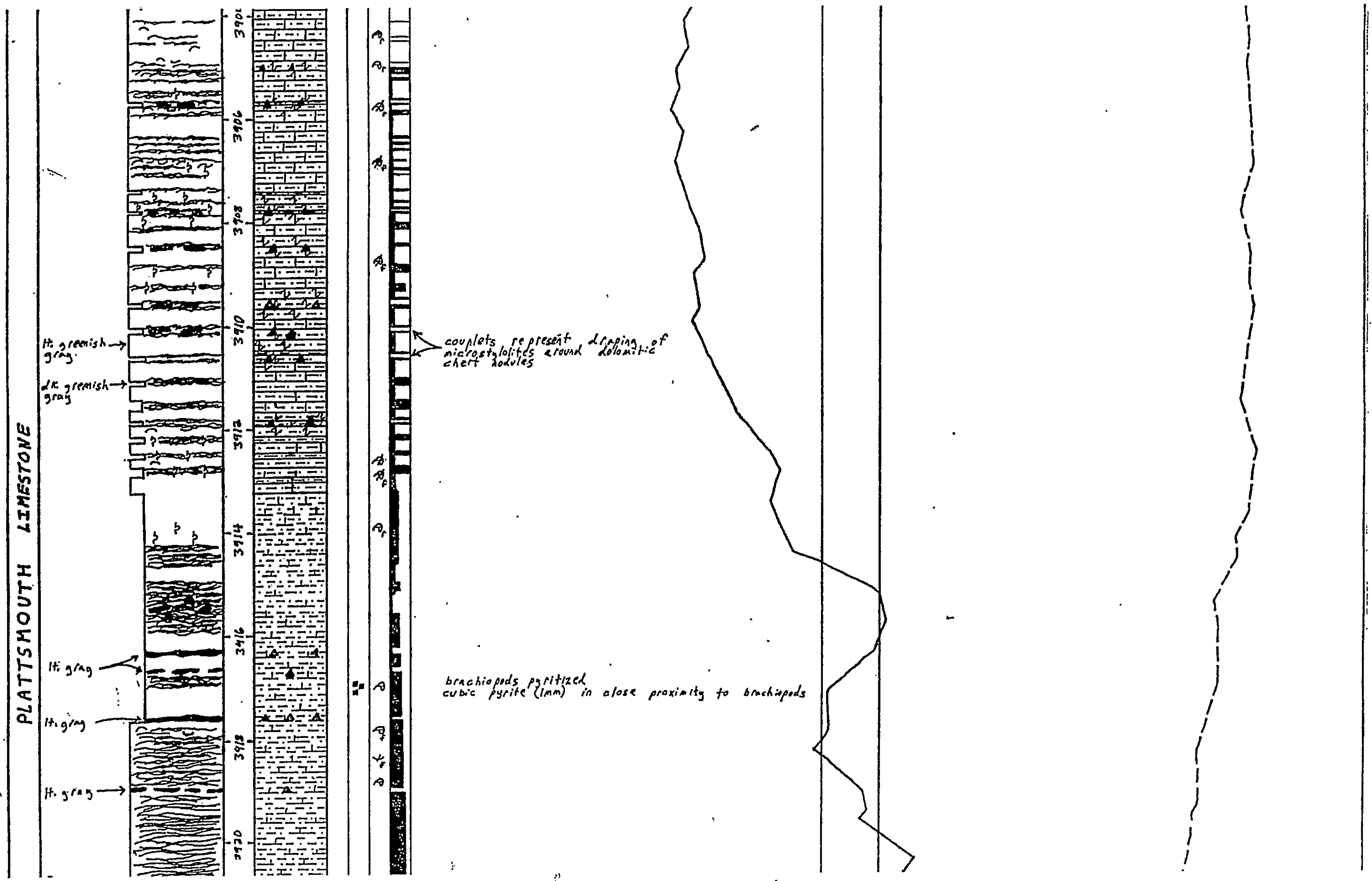
Figure 1

Figure 2


9-1s-34w
SE SW SW
SKELLY #1 BARTOSOVSKY
Rawlins Co. Kansas
SEDIMENTARY TEXT. & STRUCTURES
CARBONATES
GN | PK | WKE | MUDST | EVAP
CLASTICS
M | F | VF | MUD | AV. GRAIN SIZE
CORE DEPTH (ft)
LITHOLOGY
0 20%
porosity (from core analysis)
diagenetic features
fossils & particles
relative clay content
Gamma Ray
(rad. units)
Neutron
(cps)
PLATTSMOUTH LIMESTONE
green/ greenish gray
white
white
3876
3878
3880
3882
3884
3886
in-situ breccia at top. clasts separated by clay-filled solution(?) channels
sx/cr-Se/sm-lms/smg CH(3)
sx/cr-Se/Sm lms-MO(3)
SX-Se/Sm lms BP(3)
porosity reduced by Fe dolomite
sx/cr-Se/Sm BC/MO(<10)
silicified
much of matrix replaced by fine Fe dolomite
hydrocarbon residues patchy but locally heavy.
small intraformational discontinuity
clean
argillaceous



PLATTSMOUTH LIMESTONE
greenish gray
lt. greenish gray
3888
3890
3892
3894
3896
3898
3900
3902
microstylolites run through dolomitic chert nodules
replacive chert contains many ꝑ & B iron stained; contains finely disseminated phosphatic (?) material.
(geiger counter indicates 's. radioactivity)
chert nodules enclose microstylolites
some brachiopods articulated



PLATTSMOUTH LIMESTONE
lt. greenish gray
dk. greenish gray
lt. gray
lt. gray
lt. gray
3904
3906
3908
3910
3912
3914
3916
3918
3920
couplets represent draping of microstylolites around dolomitic chert nodules
brachiopods pyritized
cubic pyrite (1mm) in close proximity to brachiopods

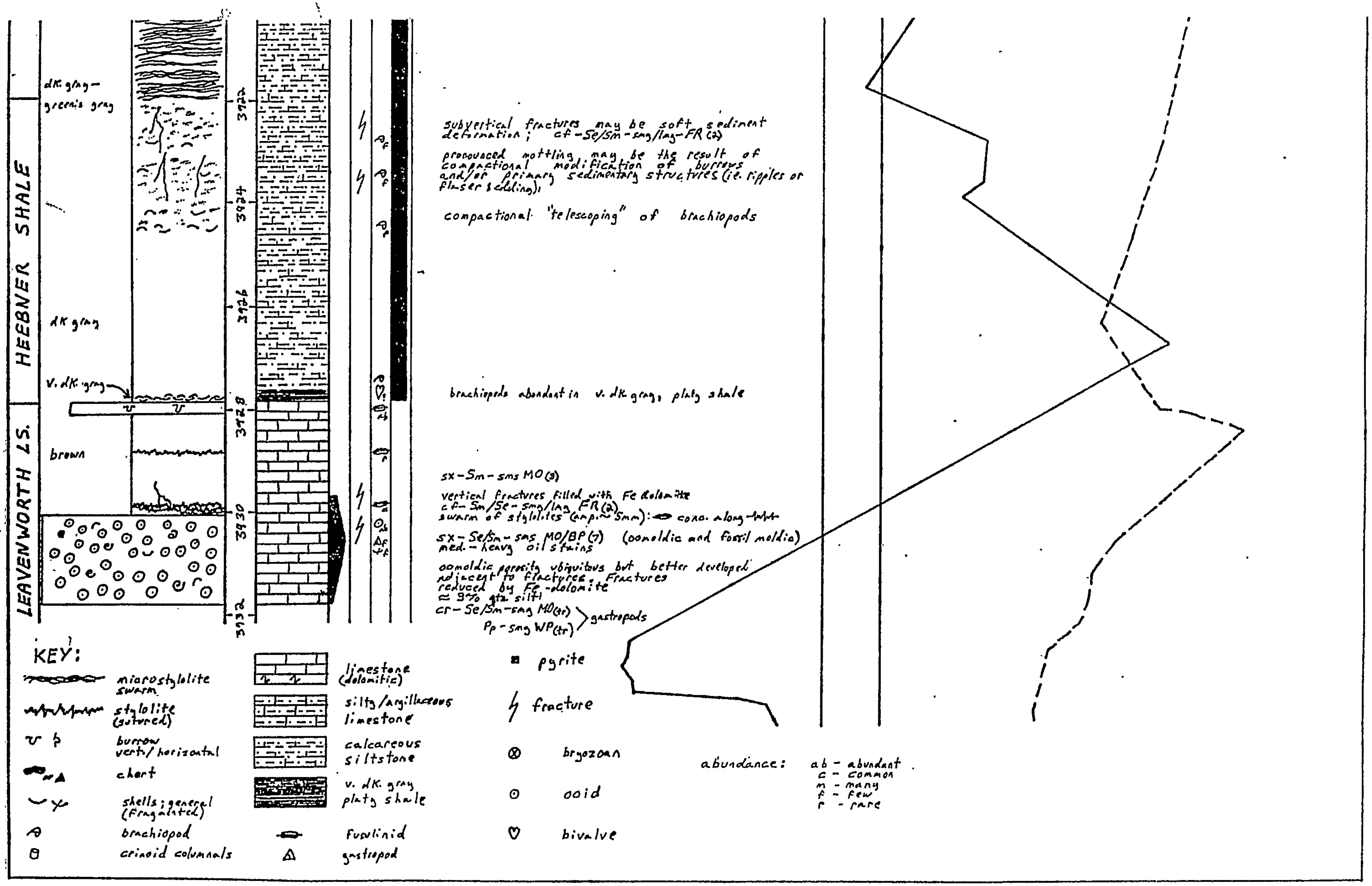

HEEBNER SHALE
LEAVENWORTH LS.
dk. gray - greenis gray
dk gray
v. dk. gray
brown
3922
3924
3926
3928
3930
3932
subvertical fractures may be soft sediment deformation; cf-Se/Sm-sng/lag-FR (2)
pronounced mottling may be the result of compactional modification of burrows and/or primary sedimentary structures (i.e. ripples or flaser bedding).
compactional "telescoping" of brachiopods
brachiopods abundant in v. dk. gray, platy shale
sx-Sm-sms MO(3)
vertical fractures filled with Fe dolomite
cf-Sm/Se-sng/lag FR(2)
swarm of stylolites (amp.~5mm): conc. along
sx-Se/Sm-sms MO/BP(7) (oomoldic and fossil moldic)
med.-heavy oil stains
oomoldic porosity ubiquitous but better developed adjacent to fractures. Fractures reduced by Fe-dolomite
≈ 9% qtz silt
cr-Se/Sm-sng MO(tr)
Pp-sng WP(tr)
gastropods
KEY:
microstylolite swarm
stylolite (sutured)
burrow vert/horizontal
chert
shells; general (Fragmented)
brachiopod
crinoid columnals
limestone (dolomitic)
silty/argillaceous limestone
calcareous siltstone
v. dk. gray platy shale
fusulinid
gastropod
pyrite
fracture
bryozoan
ooid
bivalve
abundance: ab - abundant
c - common
m - many
f - few
r - rare

Figure 3

#1 Bartosovsky

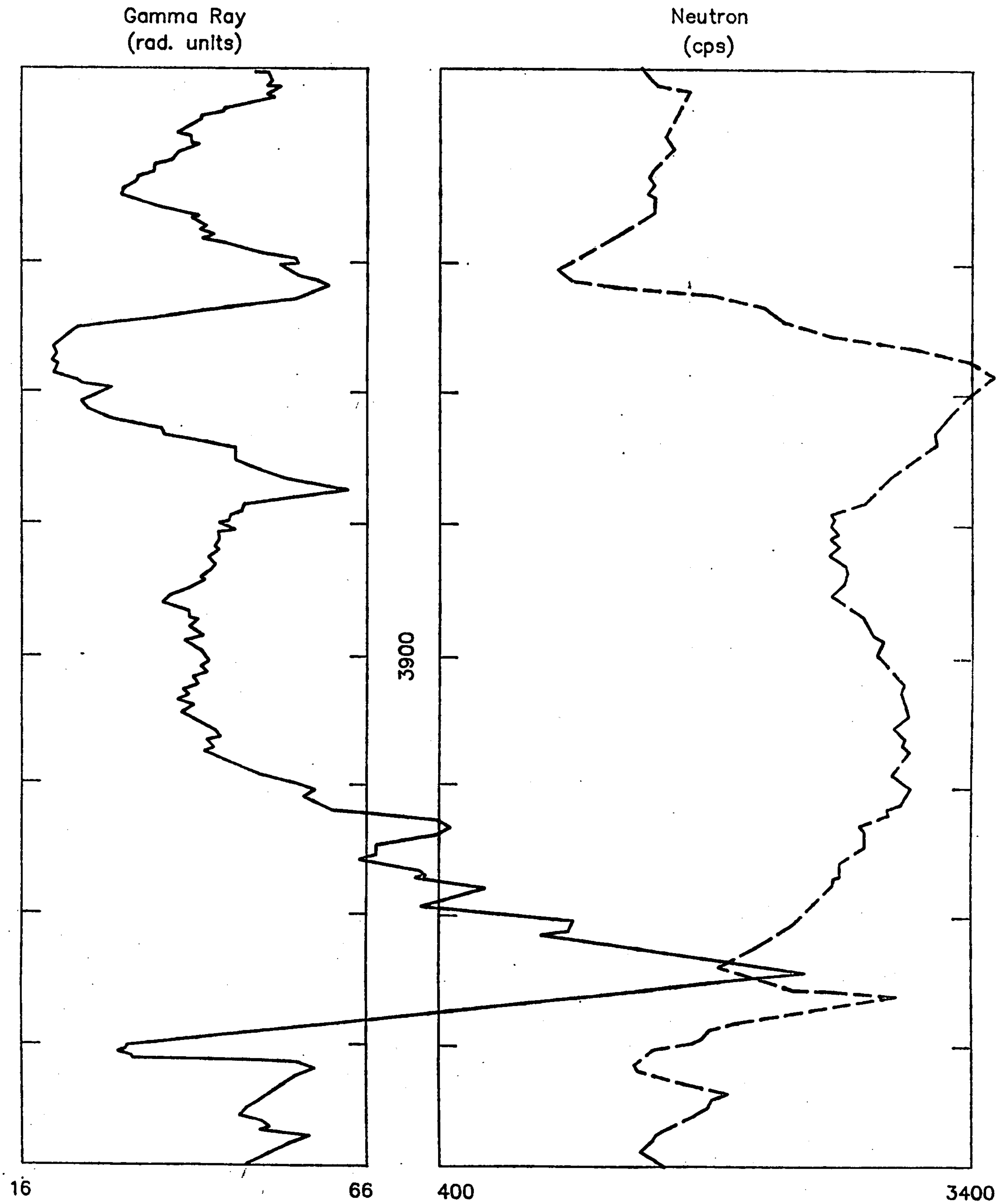
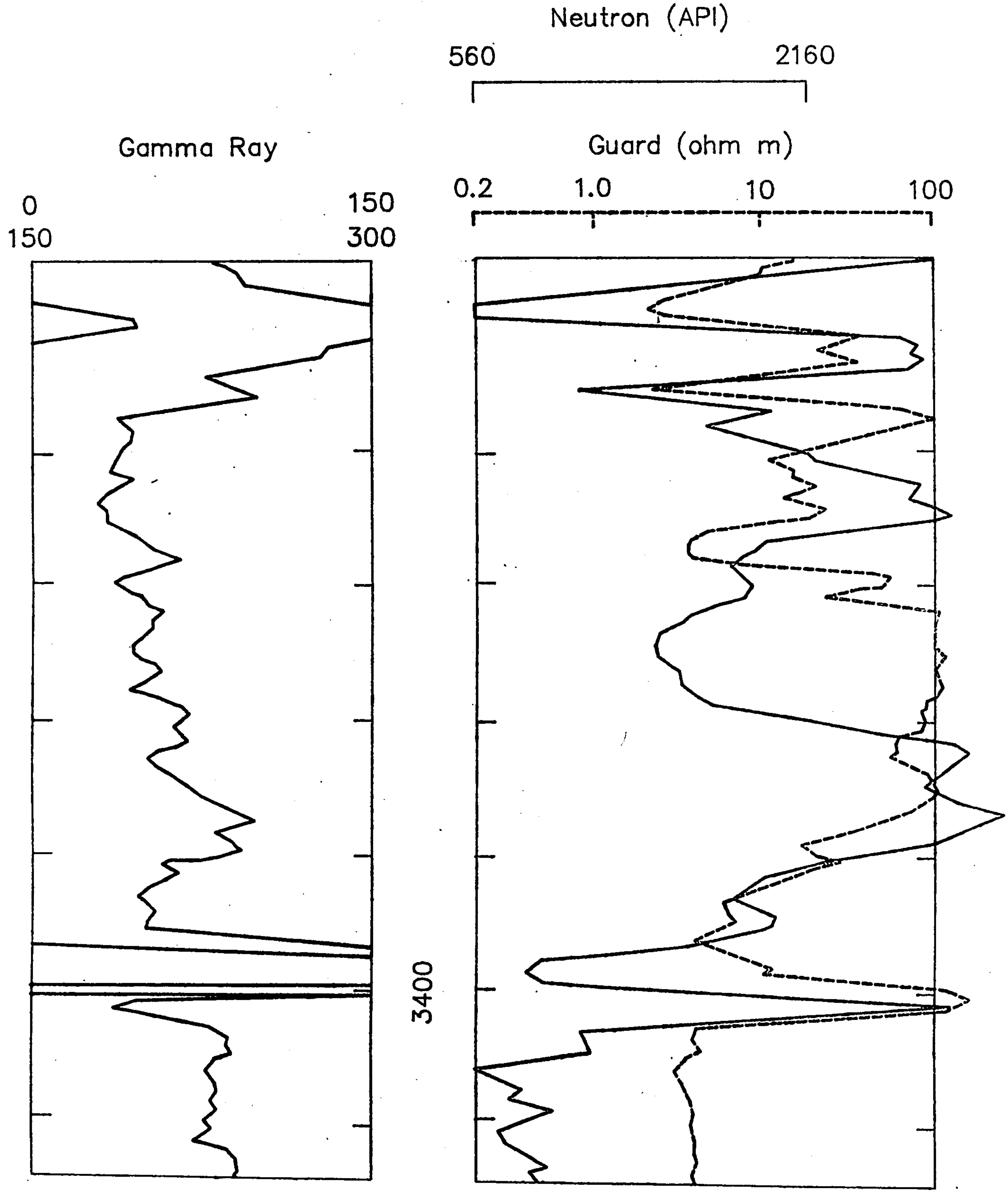


Figure 4

Graham County well



Skelly #1 Bartosovsky
9-1s-34w

Selected Core Samples from the Oread Limestone

The following set of samples have been selected to show typical lithologies and features of interest. Many of these features are discussed in, "The Oread Formation in Northwestern Kansas",which is included in the guidebook. Figure 2 from that article is reproduced on the adjacent poster. The depths marked on the samples correspond to the depths shown in Figure 2 and are marked on the poster.

Some of the samples have been stained with Alizarin Red (stains calcite red) and potassium ferricyanide (stains iron-bearing carbonates blue). Thus, red areas are calcite, blue areas are ferroan dolomite, and purple areas are ferroan calcite. Certain features have been labeled on the cores and are indicated in parenthesis ().

Plattsmouth Limestone Member

(1) 3875/3876 - dolomitic packstone

Note:
- solution enlarged channel (CH), moldic (MO), and interparticle (BP) porosity
- ferroan dolomite (FeDol) (stained blue) reducing channel and vug porosity
- rhombic non-ferroan dolomite (unstained) in matrix
- hydrocarbon residues

(2) 3876/3877 - packstone

Note: - patchy, solution enlarged (?) interparticle (BP), moldic (MO) and vug (V) porosity.

- ferroan dolomite (FeDol) reducing some vug porosity

- hydrocarbon residues

(3) 3879-3880 - packstone

Note: - complex mosaic of sutured stylolites may have originated along microstylolites, preceeded by soft sediment deformation, resulting in the disturbed fabric

(4) 3880 - packstone/wackestone

Note: - intraformational discontinuity separates packstone (above) from wackestone (below)

- the surface of the wackestone has been heavily bored (B) and infilled with the overlying packstone

- sub-angular clasts (C) of wackestone overlie the discontinuity

(5a)&(5b) 3882.5 - lime mudstone

Note: - be sure to look at both core halves

- non-sutured solution seams (microstylolites ?) enriched in clay and skeletal grains, pass laterally into sutured stylolites

- microfaults (arrows) may have developed while the sediment was relatively soft, and were enhanced by development of sutured stylolites

(6) 3885 - wackestone; typical

- contains brachiopods, many of which are silicified or pyritized, and crinoid columnals which are commonly silicified

- microstylolite swarms are abundant

(7) 3887.5 - argillaceous lime-mudstone

Note:
- sparse fauna of small brachiopods and crinoids
- cm-sized dolomitic chert nodules contain small (10-40 micron) rhombs of ferroan dolomite (stained blue)
- Figure A (attached) is a cartoon depiction of the sequence of events producing the interrelationship of chert nodules and microstylolites seen here.

(8) 3889.5 - skeletal wackestone

Note:
- sparse fauna of small brachiopod and crinoid columnals
- dolomitic chert nodules contain small (10- 40micron) rhombs of ferroan dolomite (stained blue)
- the zone of dark blebs in the large nodule may be a phosphate mineral. This zone is slightly radioactive (confirmed by Geiger counter) and is probably responsible for the small gamma-ray kick at this horizon. Note that the zone is darker along its outer portion on the top of the nodule and not on the bottom of the nodule.
- ever-present microstylolites can be seen between the chert nodules and at the base of the sample; unstained areas within the microstylolite swarms are mostly silt and clay

(9) 3893 - argillaceous lime-mudstone

Note:
- dense swarm of microstylolites, typical of interval

(10) 3910.5 - silty lime-mudstone

Note:
- dolomitic chert nodules contain 40-60% ferroan dolomite (stained blue), present as 10-40 micron rhombs (confirmed by thin-section petrography)
- microstylolite swarms appear to drape around the chert nodules, suggesting that the chert nodules formed before the microstylolites
- lime mudstone between the chert nodules contains traces of microscopic, rhombic, non-ferroan dolomite

(11) 3914 - silty lime-mudstone

Note: - sparse fauna, mostly small brachiopods

- burrow mottling

Heebner Shale Member

(12) 3922.25 - calcareous siltstone

Note: - pronounced mottling may be the result of compactional modification of primary sedimentary structures (ie. ripples or flaser beds) or burrows

(13) 3923 - calcareous siltstone

Note: - mottling may be the result of compactional modificaton of primary sedimentary structures (ie. ripples or flaser beds) and/or burrows

- fractures may be the result of soft sediment deformation

Leavenworth Limestone Member

(14) 3929-3930 - lime mudstone

Note: - subvertical solution enlarged (?) fractures are reduced by ferroan calcite (FeC) (stained purple) and occluded by ferroan dolomite (FeDol) (stained blue)

- fractures surrounded by an aureole of extant, oil-stained microporosity

- compacted fusulinid-forams concentrated in microstylolite swarm at base of sample

(15) 3930-3931 - ooid grainstone

Note: - patchy distribution of oomoldic porosity

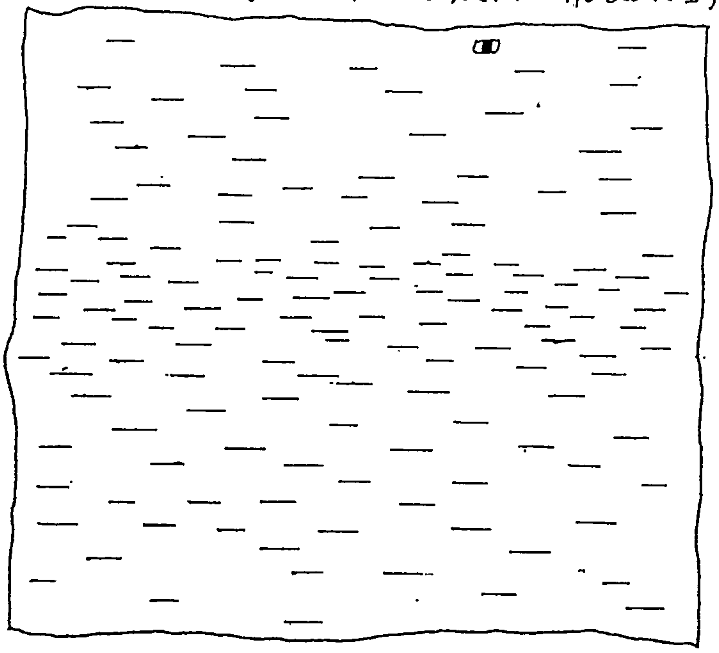
- hydrocarbon residues

(16) 3931 - ooid grainstone

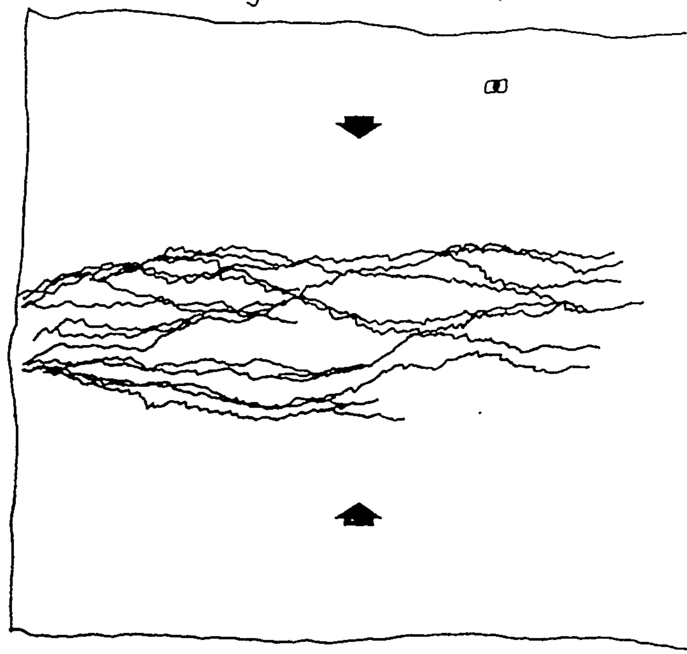
Note:

- patchy distribution of oomoldic porosity
- fossil moldic and intraparticle porosity developed in large gastropods (be sure to look at the back of the core)
- ferroan dolomite (FeDol) reducing oomoldic and fossil moldic pores

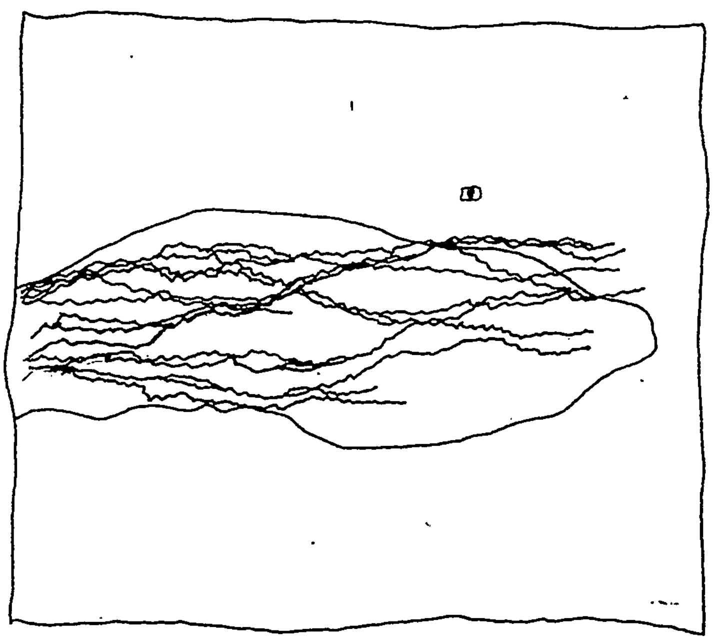
Figure A. Postulated sequence in the development of microstylolites and dolomitic chert nodules; Skelly #1 Bartosovsky, 9-1s-34w, 3887.5'



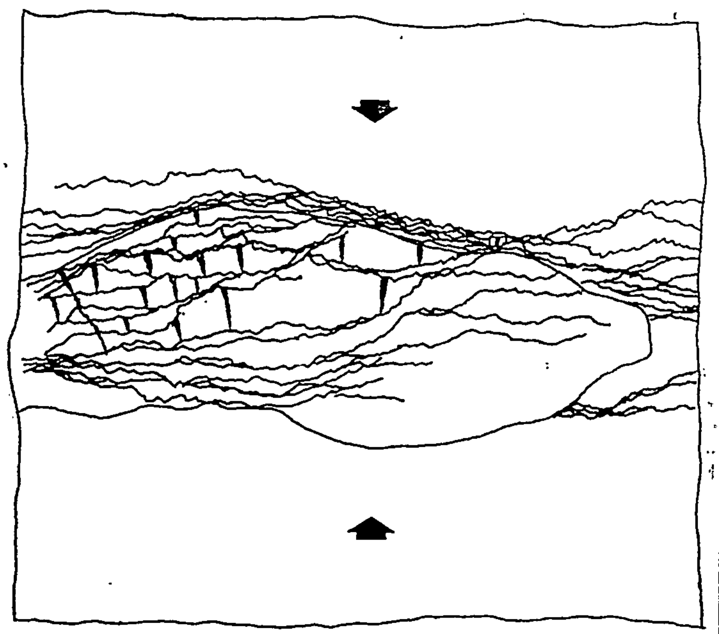
t_1 - undisturbed argillaceous lime-mudstone, subtle variations in clay content (illustrated by density of dashes) are probably depositionally controlled



t_2 - microstylolites (unsutured solution seams) are initiated along more argillaceous zones, and further concentrate silt and clay by differential compaction and dissolution of carbonate. dolomitization may be associated with this process



t_3 - silicification of lime mud and allochemical grains



t_4 - silica nodule, possibly soft, is bent slightly, producing V-shaped tension cracks at the top and compressional fractures at the base (not shown); the V-shaped fractures are filled by Fe-Dolomite at a later time; microstylolites continue to form around the nodule; note [illegible] columnal

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Open-File Report #86-24