

doc. 0286

1967

UNITED STATES
DEPARTMENT OF THE INTERIOR

DI-6

APPROVED DECEMBER 1961

doc. 0286

Field Notes
Summer 1967

(Northern Colo. _____ 1 to 9

Fox Hills Fm.

- 7841 Loc. 1 Big Draw, secs A+B _____ 1
- 7841 Loc 2 Whipple Canyon _____ 7
- 7841 Loc 3 Lisle Ranch _____ 8
- Loc 4 Miscell. N.E. Colo. _____ 9

Type Fox Hills _____ 10

7748 New localities on improved "roller concrete road" - new Rt 63 segment betw. Rt 20 (old Rts) + Little Eagle.

~~Loc 301~~

- Loc. 301 _____ 10
- Loc. 302 _____
- Loc. 17, new cut _____
- Loc. 303 _____

Loc. 74 _____ 12

Loc 304 _____ 12-14

Lance Creek _____ 15

7132 Loc 101 - measured section
[not Type Fox Hills project #]

" 100 _____ 34

" 108 _____ 34

7865 N of Belle Fourche (w/Cobban) _____ 38

~~Pierre Sh~~
Cantile Sh

Karl M. Waage
Peabody Museum
Yale Univ.

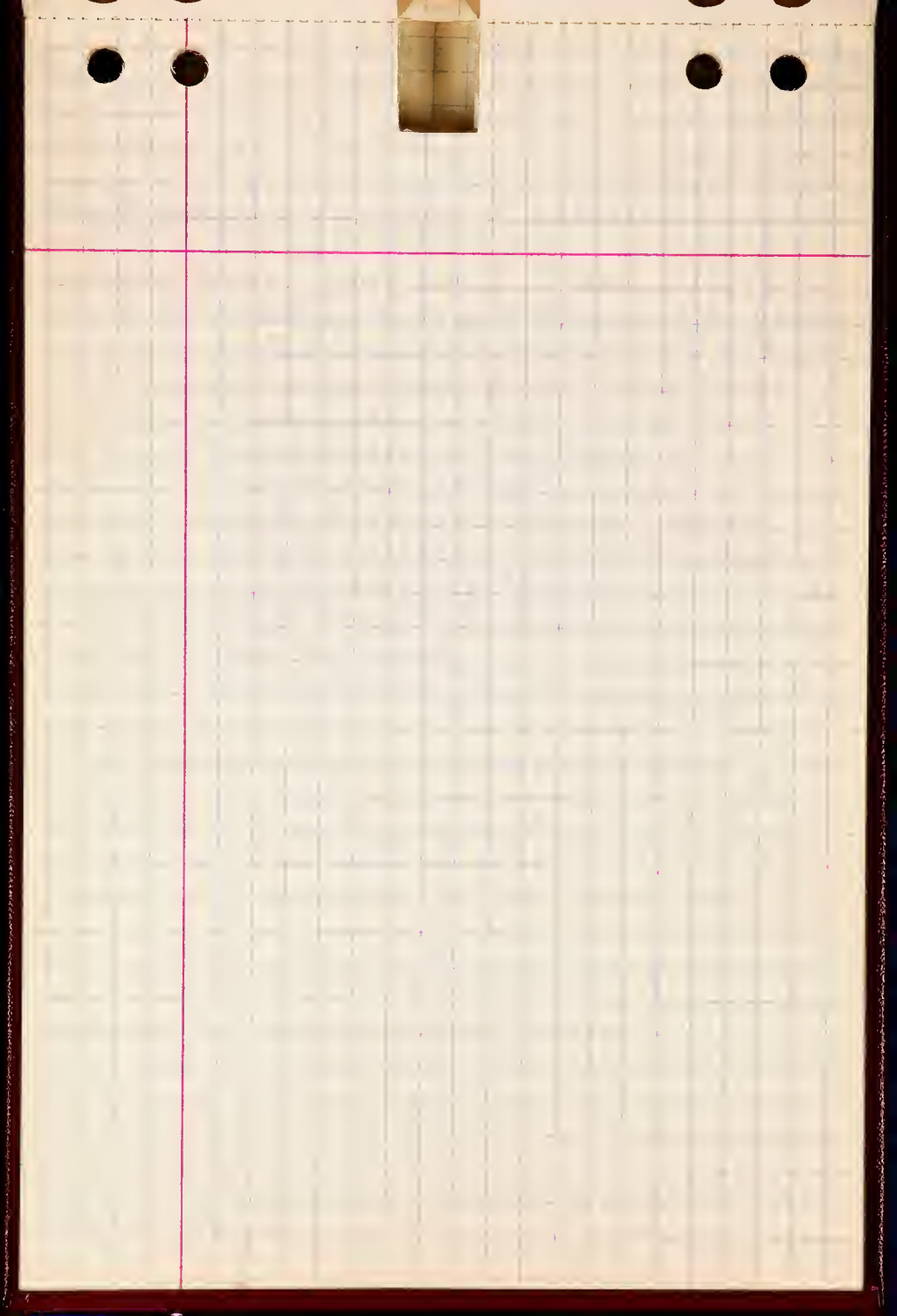
10/11/71

Howard Rollin
Route 1
Weldona, Colo. 80653

Send him:
Otoliths
Fox Hills specimens
Spedons paper

Field Notes





Field Notes

Northeastern Colorado Fox Hills

Locality NECO 1. West wall of Wildcat Creek in vicinity of Howard Rollins house. Exposures in Big Draw in $N\frac{1}{2}$ sec. 31, T. 6 N., R. 58 W., Judson Hills quadrangle NW of Fort Morgan, Colo.

Composite section based on two hand-levelled sections.

(1A), in tributary draw of Big Draw just NE of Rollins house. In about center $SW\frac{1}{4}$, $NE\frac{1}{4}$, sec. 31.

(1B) Head of Big Draw in center $S\frac{1}{2}$, $NW\frac{1}{4}$, sec. 31.

$$\begin{array}{r} 5.6 \\ 4 \\ \hline 22.4 \end{array}$$

$$\begin{array}{r} 5.0 \\ 6 \\ \hline 57.6 \\ 2.6 \\ \hline 35.0 \end{array}$$

$$\begin{array}{r} 5.0 \\ 5 \\ \hline 28.0 \end{array}$$

- 25
- 35
- 30
- 19
- 17
- 14
- 22
- 162

Section 1A. Draw east Rollin's house

Unit 1

25 ± to ?
(22.4 mcs)

Sand, vfg, lite orangish brown weath., massive (1.0 m cross bedded) with huge scattered conc. masses, crumbly gray weathering, some conc. in rd. concs. Rare pockets fossils, and few scattered Elisoceras? in sand. Collection # 1 Big Draw from these. Ophiomorpha present in concs

C3179

Unit 2A

35.6

Interbedded, dk gray shale, & vfg sand local. mottled. Shale predominates. Weathers to light brownish gray

Unit 2B

30.4

As above but sand predom. in upper, increasingly thicker layers (0.4 to 1.0) as well as thin concs. in upper 4.0 shale concs chiefly as partings. Lamination more pronounced. Locally small x-lam concs in sand layers. Some large Nuculas in sand - scattered. Lamination is more irreg. thin - lam. concs. made of thin laminae with sand in shale.

D5873

Unit 3

10.0 to ?

Sand, tabular x-lam to irreg, x-lam yellowish orange weath. Numerous

Gross cat

1

5 2

10 2

rusty brown. weath. irreg oval concs.
up to 5' long diam, and also platy
ledges conc. ss. Local clusters
fossils, incl. Cardium speciosum
Small Mucula +
Ophiomorpha

Section 1B

Unit 1
19.0

Measuring up from base of sand.
Sand, vfg, tabular x-lam in lower
4 or 5 feet, becoming massive, irreg.
x-lam above. Weathers yellowish
orange. Zone of concretizing ss.
between 5 + 10 feet above base.
Locally intraformational cgl at top
conc layer - Fossils. - Also fossils in
shale in local rare lenses. Coll #2.

C3180

Ophiomorpha common. Belonitella, Nucula,
Mactra, Tancredia, Lunstra etc

Unit 2A
16.8

Mostly covered, to layer small
sandy gray weathering concs.
Rare Mucula. Sp. 2 mos. situ irreg.
thin interbedded shale at top of unit. ss
in next

Unit 2B
13.8

Gray silt. to sandy shale ~~ss~~
interbedded bands. Irreg. thin
beds, x-lam loc. fairly thin. \pm

24
100



inch zu. No visible fossils but Rollin reports local shell layers.

Unit 3
22.4

Sand, tabular beds x-lamin sh ptngs
+ thin beds lower 18 ft; above
this sand current-bedded etc. in
yellowish to green rocks.

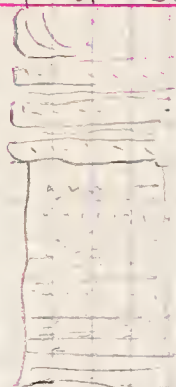
Grass Point

Field Notes

Summary of Big Draw section

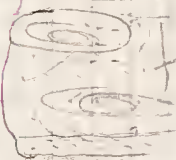
160' ±

SS C



Mucula (sub)

SS B

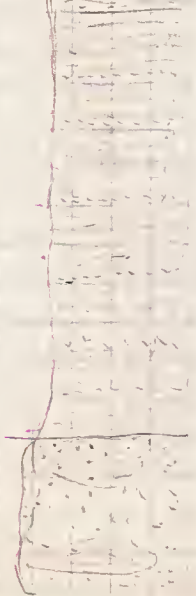


Tenebrion, Nucula, Luritia

Aphromorpha C3180
 Varied. Mactra, Cardium, Tenebrion
 Oyster frags, shark teeth + reptils

Large Nucules D5873

SS A



Ophiomorpha
 Local pockets fossil
 Cardium, Discaulus (in & too)
 also Oxymura
 Sapphires, etc C3179

Field Notes



Fossil assemblages in Big Draw.

All are secondary-current bed deposits with possible exception of some of the clusters in the A sand. Even these have broken shells common.

A sand:— Cardium dominant, Clisocolus (if that's what the big shell is) 2 subdominant. Both occur loose in sand as well as in clusters. Deuteliu also common. Oxytoma in local clusters. Scaphites have definite Lance Creek look to them. Got 2 fragmental ones. Only ammonoids found are in this sand.

C3179

B sand:— Ophiomorpha more common than in A. Cardium present but Clisocolus rare or absent. Shell between A + B sands has large Nuculas, locally well preserved — a different sp. than in B sand. B sand has biggest fauna.

Trochodites in, also Mactra — neither seen in A. Abundant small Nucula.

Shell bed top of B sand with oyster etc. is litter on surface of Cretaceous — Lisle Canyon (Loc. 3) indicates from ss C. 6

C3180

Field Notes



Lac. 2 Whipple Canyon - Chiefly in W $\frac{1}{4}$, SW $\frac{1}{4}$, NW $\frac{1}{4}$
sec. 25, T6N, R59W Judson Hills guzd.

B sand 30-35' thick. Intermittent shell
beds at top in transition to overlying
shale. Many Ophiomorpha, Crinoids,
Terebratula, Nucula, Lunata? Eospira large
Deutellium. Collection from wide draw
running S in W $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$.

As in Big Draw the B sand only
fossiliferous in upper part where
shale interbeds begin to appear.
Slabby conc. masses also have
local shell layers on surfaces.
Essentially same fauna. Very
large, Deutellium conspicuous. Terebratula
most common bivalve locally.
Numerous Ophiomorpha, Codium
is present but not common. Shark
teeth as usual.

D5874

Upper shale appears somewhat
thicker here than in big draw, has
some punky concretions in lower
part. Saw no fossils.

C sand at top here, no fossils
found in it.

End of



Loc 3 Clarence Lisle property, Draw in
about center N $\frac{1}{2}$, NE $\frac{1}{4}$, sec. 28, T. 6 N.,
R. 59 W., Judson Hills Quad.

Chiefly C sand and beds above it, has
basal contact. Skeleton section follows

Top of shale unit
C sand

19.0 \pm Sand, massive, cross-laminated, some
small cones. Sand is vfg, becomes
turbid & lam. in lower 2 or 3 ft.
At top in upper 5 to 8' I masses
conc. sand, relatively flat tops
hold approx level

18.0 \pm Sand as above. At top conc. sand
slabs with conspicuously ripple-
mold upper surface. Scattered
conc. masses. Between 6 and 12
feet from base one or more
layers of oyster cgl, shark + rept,
teeth, Crossostrea little else, water-worn
shells + vertebrae.

Total C sand = 37.0 \pm

5.5 \pm Shale and sand. Bright blue-gray shale
with sandy interbeds grading to gray
sand.

28.0 - ? Sand, massive brownish to light gray, 8
white at top. Opinion up to 15' \pm . Locally
conc. ss 2' 11-14' from base. Cap of gravel.

Faint handwritten text at the top edge of the page.



[no quad]

Loc 4 Sunken Lake road just S. of "T" with road to Cornish on Marquette-Weld Co. line; E. Side Coal Bank Draw

Local ledge - *Crossostrea* - *Anomia* bed. Rare *Corbicula* - flat variety about 3/4" long. Underlain by dk gray shale.

From Loc 4 West to Crow Creek see "Lorraine" in road cuts; Fox Hills exposures poor to nonexistent. No chance of any significant study.

Wildcat Mound south of Milliken. - about 100 feet of Fox Hills sand exposed. Oyster cgl layers at top locally. Not worth a section.

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TYPE FOX HILLS

Survey of new (Little Eagle) segment of F.S.D. 63

(old "roller-coaster road")

Approx. 1000 to 1400 feet N of S line of sec's 16 + 17 along their mutual boundary, or just under 1 3/4 mi N of turnoff to Johnson Bros. study, an ^{old} segment SD at 63, sec's 16 + 17, T 19 N, R. 27 E

Cut exposing brown layers of ^{concrete}

POAZ = A4700

Trail City down through sandy POAZ interval into LGAZ

UNAZ =

A4699

layers. May get to LNAZ in gullies draining cut to N.

Good glauconite sand in jets + loose. Fossilif. cones abundant.

Little Eagle SE Quad

LOC. 302

Center ~~of~~ section line between sec's 16 + 17, 2 miles N of turnoff to Johnson Bros.

LGAZ in lower part of cut. (E of rd)

LGAT =

A4701

to top of POAZ. glauconitic sand

Some upper nicolleti cones.

UNAZ =

A4702 +
A4703

Collected. Plenty of LGAZ.

Loc 17 uncut - continues old 17 about 400' to south.

Loc #3 - Old Loc. 17 enlarged by new cut.

Starts top of rise in Protocardia

sand with glauconite sand, highly fossiliferous.

UNAZ cones scattered in zone

6 to 10' thick; at least 2 layers

base of LNAZ. Well developed LNAZ

zone of cones loc. by with large

Gervillia masses in basal layer.

Good lower jarosite. Elk Blute in

gullies. Shallow - lying cones locally

Some small burrows subhorizontal



Fairly numerous rich concs of several
layers, washing out of road fill +
fill in gully, to N. Gully is
site where we collected from
construction in 1946 - POAZ
and UNAZ collections

Loc. 303
~~Loc #4~~

Old loc. 18 enlarged by new
cut. New road swings W off section
line N from 18.

Lower Di. Nic. well exposed.

Also LGAZ

LNAZ has "Gerrulliz" type concs
in usual jackets in lower layer
within 3' jarosite. Some single
Gerrulliz, or zinnwulfite; or even
claw. Some barren. At same
layer local big gerrulliz concs.
Usual Di. nic 8 to 10' above jarosite

^W
1/2 mile NNW old Loc. 18 in NE cor.
Sec. 8, T19N R27E, Carson Co. ~~At~~
Cut on new segment SD 63, Little
Eagle Quad.

LNAZ = A4704, A4705 + A4707

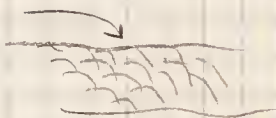
LGAZ = A4706



Locality 74 - and vicinity.

- ① Amphitheatre channel. Corbicula distrib. in current-bedded shingle and more sparsely in intervening sandy beds in which spec. with valves attached common. Fresh samples of latter show Corbs in excellent state preservation.

[C0473] Theyer's jaws from bed^{of} scattered corbs about 18" above shingle bed at base channel. Shingle bed locally cross-laminated



Charcoal common throughout the shingle beds. Crossostrea shells assoc with channel are markedly thinner than those of most Colgate beds - several show attachment to stalks.

- (2) Traverse along lower Hell Creek from our section at 74 NW to center of sec. 29. Includes part Loc. 74 and 304 (see next p.).

Unio's locally common to abundant. Not only in or at base of lower Colgate-like sand lenses, but also in sandy silty clays between them. Lower beds



A 4715

intermittent in zone into 12 feet above basal lignitic shale. Fauna otherwise as all vertebrate including Myledaphis, dinosaur bones + teeth (Gomosaur) crocs, turtles, presumed cheepsosaurs, also much water worn charcoal — sampled to be tested, the usual wood and plant frags.

Locally lower lignitic shale is absent — Colgate — Bullhead — like beds in with Coville association at close to Unio horizon. Relationships obscure. (probably fault)

Unio sand includes clay pellets, plant frags etc on fresh cut. Unios commonly both valves, some aligned — hinges down.

Loc 304

Includes that part of Iron Lightning bedlands north of the E-W bluff of Well Creek in west rim of bedlands in NE cor. sec 32 (actually NE $\frac{1}{4}$ NE $\frac{1}{4}$; E $\frac{1}{2}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$; most of N $\frac{1}{2}$, SE $\frac{1}{4}$ NE $\frac{1}{4}$; and NE cor SW $\frac{1}{4}$ NE $\frac{1}{4}$) and SE part sec. 29 (actually SE $\frac{1}{4}$; and part E $\frac{1}{2}$ SW $\frac{1}{4}$) T14N, R19E, Red Elm NE Quad. Ziebach Co. So. Dak.

Good exposure of Unio bed in hard zone of principal draw crossing it to



sharp change in rim to E-W to
form sharp promontory just S of
contour sec. 29. (~~SW 1/4~~ ~~NE 1/4~~ ~~SE 1/4~~
~~sec 29.~~) approx in SE cor, NE 1/4
SW 1/4 sec. 29. (Coll. A 4716)



LANCE CREEK AREA

Loc. 101. Measured sections

Vert
+
L
D
constant

(A) Lower part: Begins in draw about 1/4 mile east of N. Prong Crazy Woman Cr. N30 W ^{direction} dip, strike N60 E, dip 17°

Unit 1
-3°, 27'
plus 4.0 ft
down from
top conc ledge
where meas.
began

Sand, vfg, silty and clayey, mixed, weathers crumbly light gray to slightly yellowish gray outcrop. Clay in pellets and chips-or streaks. From 3.0-4.0 ft concretization and ledge showing irreg. bedding? if any, much very small burrowing traces loc, very few large one ll bedding.

7+4 = 11 ft

At top, similar conc. sand. with, yellow to gray crumbly with some vb calcified flint masses. Small burrowing, irreg, discontinuous. Between conc layers sed. more sandy upward.

No fossils - no recog. Ophiolite in the sun.

Unit 2
+6°, 38'

(15')

Sand, vfg, clay blebs loc. and, more apparently, clay burrow fillings. Weathers light gray yellowish rzst. Predom. mixed, crops as massive rounded oc. Bedding locally marked by a few loc layers or partings clay and more extensive layers with small



irreg. dk gray clay frags which ~~prob~~
represent thoroughly bored clay parting.
At top is discontinuous large
cones ~~layer~~ similar to layers in
unit 1. Cores, dk gray calcic sand. Cores
show small scale mixing some litter
burrows
Sand shows larger Ophio burrows
barely detectable but outlined loc.
in clay. Other burrows also shown
by clay

Unit 3

Sand, as below.

Top at loc. from clay parting +
crumbly cones.

+8° 48'

D=17°

(20')

4.0 from top ± another crumbly cone
zone with cores. Between this
and base irreg spread numerous
small + large crumbly type cores
Some with hidden parts.

A4723

Collection #1 from sand (8.0 ± 0.2 m)
cones in this lower interval.

Unit 4

D=17°

+1°, 36'

(11')

Sand, as below but weathering the typical
yellowish-orange of massive Fox Hills sands.
Also more prominent are irreg layers + lenses
of discontin. clay lumps, fisher pellets.
Some obviously assoc. with burrowing.
also local peppering of fa pellets



possibly secondary. At top of this unit large ^{hard} conc. masses + crumbly jackets + concs. in upper 2 to 4'. These have usual evid. small burrowing. Some larger subparallel burrows, none Ophioid recognizable.

Unit 5

+13°, 48'

(24')

Sand 26 below, some bedding marked loc. by clay. Also prominent blks clay and pellet-forms in sand. Latter may be Ophiomorphic but ~~was doubt~~ ~~+~~ Fossils not unlike Ophi. but why clay pellet walls? ~~and rather~~ ~~typical?~~; also some pellet streaks lacking form, but may be compression texture.

Interval has scattered small cones one contained large Gervillia. Also very large cones in discon. layer in upper 5' (up to 4.0) diam.) one has many Veniella humilis.

Clay-rimmed burrows appear both pelletoid + non pelletoid type.

At top is platy sand conc layer numerous irreg bedding trails. Some vertical ± burrows, becomes irreg bedded downwards only platy in spots.



Unit 6. Sand as below. Zones of hard RB with
cones at top and 10 to 12 ft from top
softer cones scattered below. Locally
in sand are Ventella, 2 flat Δ clam
(Cyprinacea?), small Ino (fibrous?)
Also found 1 spindle-tube filling solidified
(Coll. 2) cones have abundant good
Ventella locally esp. layer 10-12 from
top.

+20°, 48'

A4724

(29)

In this interval pellet structures esp.
abundant. Resemblance of most to Ophio
is strong. Sand also locally pelletal

pic 1
pic 3 etc

Top. Conc layer markedly irreg.
has crumbly parts but mostly solid.
Fe-speckled conc sand. Here marks
top of massive-burrowed sands

discontinuity

Unit 7
Sand, forming in tubular sets a few
inches to a foot + thick, cross lam.
X lams locally marked by heavy M
accumulations. Locally soft, more
commonly indurated, clay pellet
lenses few, laminated with sand
partings, channelled, trail out into
pellet layers.

+27°, 25'

pic 2

(17')

In basal 3 or 4 ft a few Ophio
like pellet forms. Chiefly devoid of
burrowing a few thin lenses silt
and clay with hor. 3. burrows



Capped by 6" to 1' conc. sand which has irreg. contact with set beneath. bottom shows trails loc. is of lg lam to ripple lam. sand. Loc. vert burrows indet. Some impressions ophid on underside.

Rippled surface loc. an exp. current ind. loc. from NNE

Loc. in sand inclusions in layers + blebs of porcellanite.

Unit 8
+21°, 25°

Sandy, as below. Conc. laminated sand. Layer about in middle. sand at top mid layer locally shot with fusiform holes which weather out to funnel-like holes on outcrop.

(15')
Upper layer rippled + commonly capped by conspicuous current ripples.

Soft beds between at top sand + clay with 11 lam. more conspicuous than in unit 7 but locally x-lam. Most of this interval obscured Burrowing chiefly in 2 conc layers apparently.



Loc 101 (B) Crop just E N. prong Old Woman Cr.
Dir. Dip N35E., dip 20°

Beginning top conc. layer \approx to top
unit 7, sec. A.

(E)

Unit 1

Largely covered into \approx unit 8 sec B.

+20° 43'

(About 10.0 to 11.5 from base loc.
conc. ledge small occ. festoons of
ripple struct.)

(28')

Sandstone, vfg, thinly bedded to lam
and interbed with gray shale thin
partings + layers up to 1/2 inch
Bedding details obscure. Scattered
local cones - compressed and up
to 1.0 long diam (on bedding) which
only slightly cone-ized + part on
bedding. Also some calcitic
conc ledges locally. One
4.0 from base capping ledge
is ripple marked.

Bedding loc. irregular, shales in
small thin lenses - some sh.
blebs.

Capped by persistent conc ledge
locally platy, is ripple mtd



locally with interference type concretion
on top crossed by trails, ledge with
variety of burrows, including
inclined pencil diam; U-shaped pencil diam
(may be L-shaped?), spindle burrows (few)
Bedding from lam, to ripple lam. sets.

Unit 2.

+20 20'

(13')

Chiefly covered but as below with
yellowish orange sand + sh partings
Top is local conc masses R. columnar
platy thin lam. sand

Unit 3

-3° 36'

(11')

Sand, yellowish orange becoming
more massive, looking due to loss
of most of shale interbeds,
Tabular units thicker, still low L
X lam., vfg

Local conc masses form ledges
most are discontinuous but
appear replaced with irreg
bottoms in the ss.

One about 4.0 from base has
Ophi network on surface;
commonly then are ripple and

Unit 4

+14° 44'

(25')

As in unit 3 but a few more
shale ^{lower} _{1/2} some contorted
beds sand loc. conc. sized also



lower 1/2; up 1/2 local sh' plngs
but sude. than lower locally.
Numerous local conc bedded
ripple (bed) with fossils, some
burrows, but not as plentiful
as lower unit

Unit 5
+4', 43'

(17')

Sand, appears massive, color
change to light gray begins this
interval though orange tint.
Still thin bed, X lam but visible
chiefly in concs, which are
either grayish slabby or hard
RB. Irreg distrib for most
part. Thin bedded top
interval fairly continuous.

Unit 6
-11', 50'
(8')

Sand, obscured in slope - numerous
RB conc layers + gray.
Obscured.

Unit 7
-20', 50'
(add 3' of
unit 8
to this)

(15')
* 3'

Sandst, massive with grayish
some Ophio in basal 3ft as
clay pebbles + fossils.
Very obscure bedding is
low angle X lam ~~partly~~
Cap thin conc. rippled ss
irreg shallow channel incision
in sand.



Unit 8

+22°, 39'

21'

*

Observed, locally massive yellow stained sand.

Capped by prominent continuous ledge hard grey ss 3 or more ft thick (locally pinacles thin x bed sand) - ~~pro~~ conc-ized up into Unit 9.

Lower 3.0 to 1.0 ft of cap is full of "spindle" burrows.

Unit 9

less ft

Dip. D. N. 30° E

Dip 18°

-8°, 50'

9'

A4726 ↓

To base of Ostrea Corbicula bed.

Sandstone, massive upper with thin sand x bedded, fq., loc. conc-ized in lower part, surface above with yellow + orange stain.

Ostrea Anomia-Corbicula bed is local lens 18 shale + sand - pinches out E+W in gray white sand. At May have where 8.0 ft of 18 sand + sandy sh. Shell bed current deposited with some Corbis both valves



Loc 101

Section (A) continued by offsetting along layer with interference ripples (top of unit 8) to first small branch on E side of gully to W.

Dip 21°, N 27 E

UNIT 9

+1° 50'

(191)

Sand, vfg, with yellowish orange, beds up to 10" thick to four inch with within beds & partings dk gray shale, and some ^{lt} gray laminated silts. Sand beds 12 in to X 12 in. Low beds may be very low. L & X beds though where conc-ized some appear true laminae

(NOTE Dk gray shales are actually org rich silts with little clay.)

Conspicuous feature where sandst. exposed is thin bedding.

Local conc-ized sand intermittent, layered. Both sand & conc loc with spindle burrows.

At top is local platy conc layer, intermittent - prob discont. ripple marked.

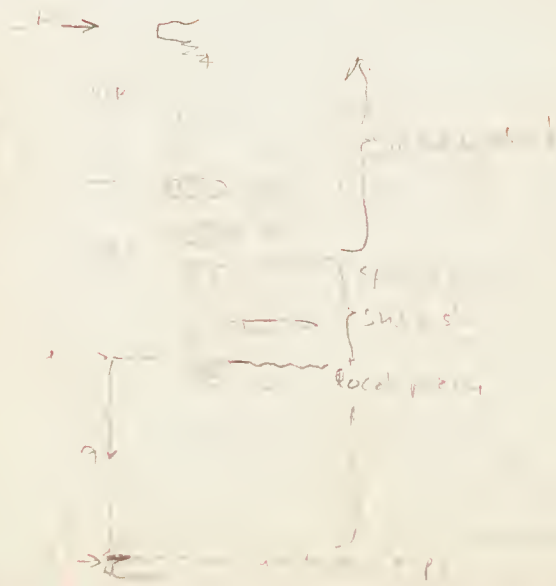
UNIT 10

~~26° 47'~~

26° 47'

(341)

This unit in halves at layer large discontinuous concs - actually 2 5 to 6 zone - double row with top at about 1/2 of interval.



— change to grid with reverse of

'A4725'

10A - As below, with 1.5' ± zone spindle borings about 2' beneath lowermost of double conc layers. At this point section goes to sand, and rest of 10A is like 10B (see above)

10B. Sand, vfy as below except bedding less evident due to disappearance clay partings. Bedding still tabular x lam through. Clay locally in discont. blebs and in pellet zones - flat ovoid pellets. At top fairly persistent conc sand & few clay layers under the sand of conc layer ripple mark. loc. in transition type common. No burrows in 10B evident but trails & some Ophio-like on top.

UNIT II

+15°, 34'

20

Sand as below few shaly ptngs in lower 2', few shale inclusions. Slabby conc layer thin, sand sheets base 5 to 6' from top has intermittent cones between which sand has shale plugs abundant (could be common still same relationship? With conc layers, whether new depo & working?)

At top a fairly persistent gray weath. ss ledge that has pellet form weath surface common. ~~the~~ Question



whether this has any signif. In layer
5-6' below get some edges of
conc. masses. suspect all secondary,
no trace pellets in sand though
more widely diffuse Fe specks.

UNIT 12
+140, 50'

Sand, as below but loosing yellowish
orange color, becoming grayish white
with yellow to orange stained zones.
Sand vfg to fg, massive,
bedding obscure.

29'

In mid. unit ripp-bedded conc. layer 10"±
platy type

About 3' from base zone loc. OB with
sand concs + 1st void, rze Op
present - laterally goes into interb.
sand + shale - or clay block zone,
locally with porcellanitic stuff.

* This layer locally marks sharp
color change in sand - may be
significant horizon

Top of unit is 1.0± intermittent conc
layer with loc. RB thin-bedded conc
ledges. As in many, ledges -
some clay layers + pleb zones.
Just beneath.

↑
4
= top unit &
course

↑
13 - 1 =

Unit 13
+19, 28'

18

Sandstone, with light gray rounded
massive chert with faint subll
to x lamination. Fine grd.

Beginning ± 8.0 ft ^{base} has Ophio in sand
marked by clay-pellet outlines
also loc. conc with Ophio tubes
with to holes.

About 1 or 2' above mid of unit sand
gives way to silt clay with spindle
burrows and clayey sand with
0.4 conc sand exp. - This unit about
1.8 thick. Then more silt clay with
tubes + 6 to 8" conc exp.

Caps gray conc ss - clay pellet zones
Vert burrows incl. Ophio, sparsely -
most vert burrows prob.
upper end of spindles

Unit 14
(Dip 20°, N 35° E
+25°, 53')

37

Sand, as below, light gray with
loc. bright yellow stain. Faint
lam x lam visible, fq, some
Ophio in pellet forms.

Lower 4' irreg concige-sand
continuous with ledge top of
Unit 13. Has "cannonball"
concs wrapped in ledgy material.
Top v. local conc platy bed some trace

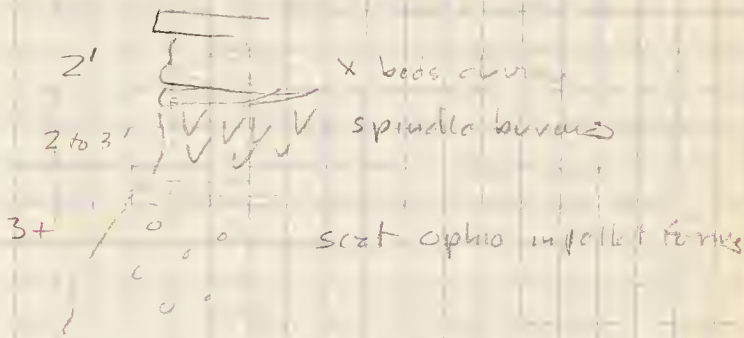


Unit 15

Sandstone as below.

+2°, 50'
(measured
at N60E)

About 5' from base thin, persistent
conc. layer. Sand under as follows



Above to marker 15, same as
massive fine, x lens, well sorting
local conc masses.

Unit 16

+15°, 41'
(meas. at
N60E)

Same as life gray sand interval.
conc layers below. to
persistent conc. platy ledge

at top of bluff, head of draw
Ledge with scat ophi - gray platy layers
Note 15-16 intervals include horizon
Oyster - Corbic zone sec B zone
all sand here.

B

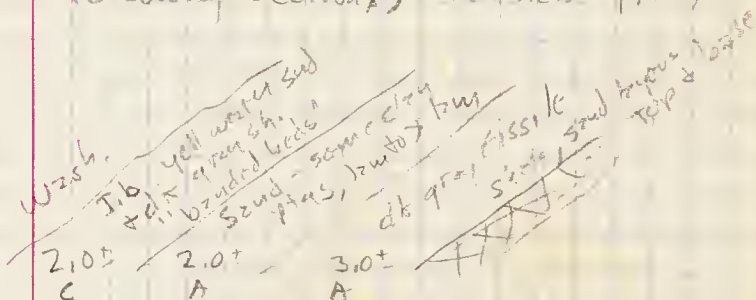
A

LOC. 101 Section (C) Head of draw behind ridge trending E from N. prong OW creek

Beginning at top conc. ledge traced across from top of Section (A) - i.e., top UNIT 16

UNIT 1

Chiefly obscured by wash, but top underhanging ledge with interturbance ripples and some surface trails. Overlain by following sections, thickness approx



Over C, massive white sands begin as in units 2 + 3, with at most 2'

Unit 2

Sand, massive rounded crop tabular x lam with considerable festooning in tab beds. Freely spaced gray log-like cones. Sand is chiefly fq, may be some mg ls.



- Unit 3 Sand as above.
- Unit 4 lower 3.5' ft is lignitic shale + gray shale with thin sand layers at base. Above this appears to be soft brownish yellow sand to cap, but chiefly covered cap is RB platy conc ledges intermittent.
- Units 5 } Include sand unit. Another mass of like gray one similar to one in units 2 + 3. Poorly exposed at this place. At top zone large VB concs. (top 10)
- Unit 6 Sand (as seen in gully w of scatter) chiefly fg., gently to locally sharply turned & low, still generally tabular.
- Unit 7
- Unit 8
- Unit 9
- Unit 10



Loc. 101, Section D: - Shall bed draw.

Beginning at top sandstone with
Corbiculae' h₂sh.

(Corbiculae sand is about 3' thick).
dip 20°, N27°E

Unit 1

+11°, 48'

To conc layer \approx top unit 10 Sec C.

Lower part (below 17' from top)

silty fissile shale abundant
plant frags, loc. almost a lignitic
sh. One thin sand sect. Corbiculae
in upper part.

Upper 17' includes basal
sand with Corb. about 1.5 ft thick

Then 2.0' shale, then greenish sand
zone IB sand + sh 3.0' then
sand to top. Sand of trans has
sect. Corbiculae. Cap of flat oval
concs.

Unit 2

+10°, 40'

About 10' sand at base, then 0.5

liq. shale, 4.0' shale beginning

gray sandy, about 5.0' sand

at top. Top thin plat liq. sand



Unit 3

+6°, 46'

Alternating liq. sh., liq. shale + sand
Approximation of detail

- .5 to .6 conc. - shaly RB F₂ zone ^{7 Vfg}
to silt sand
burrows
in sh.
- .8 - Sand
- .8 - Liq sh.
- 4.0± Sand shaly at base + top
- 3.0± Liq shale minor liq.
- ↑ 1.8± Sand
- 4.0± liq. sh. + liq. shale
- 1.8 Sand, white, vert burrows or roots
- 6' liq. base, bot - sh becoming sandy top
sand thin beds + lam.

(20)

Unit 4

0°, 49'

As in Unit 3

- 0.3 conc. sand, platy
- 4.0± Sand, clay + clay sand, clay platy ls. ^{sub frags}
- 1.8 Liq sh
- .5 Sand
- 2.0 Liq shale
- ↑ 1.0± Sand
- 2.5± Sandy clay base grading to gray clay with sand ^{concs}
- 5.5 liq sh, liq, + sandy sh.
- 2.5 Vfg like gray sand. (all H.C. sand -
are vfg.)

(17)

Laterally (East) capping conc layer
thickens to 1.3± has brown
with slabs bright orange concret.



Unit 5

-15.5° 52'

(5')

Sand & clayey in lower 1/5 which has small flint sili. cones.) vfg, powdery light tanish gray with local yellow to O stain some local shaly conc sand irreg x lam. Upper 5' becomes clayey sand.

Unit 6

+12° 35'

(19')

Basal 11' is liq sh. Upper part begins sandbody described under Unit 7-8

Unit 7

-7° 52'

Unit 8

(12')

} Sand, massive, fg, weathers yellowish orange. Bedding irreg to contorted x lam, lenses & stringers clay pellet-cgl ferruginized clay lumps conc masses with festoon x bedding

To grass roots in gully.



- Loc 100
- ① Spindle-burrow bed (same horizon as in Unit 10A of Sec. A) is up to 4' thick locally - probably more
 - ② Some nodules (Coll.) at contact of massive-thinbedded sands, but not a well defined layer as at Gunn Ranch.
 - ③ Ophiomorpha either more common in "white" sands or more obvious.
 - ④ Massive yellow overlying sands appear thicker.
 - ⑤ Banded beds 25' between 1st + 2nd white sands

Loc 108

Bluffs of "banded beds" lying about on axis of Antihills syncline. Not certain of relationship to "white" sands - could be above.

On main bluff nearest road a conc. layer approx 25' below the capping sand contains small Ophiomorpha.

This only fossil except bone fragment. BB's, however, have abundant microfossil pellets.



which suggest absence of fossils
due to reducing conditions.



Northern Black Hills

CASTLE ROCK

Oligocene WR cap on > 200 feet of lower Hell Creek. Draw on NW side of butte has best section - down to Fox Hills or what I would call Fox Hills: a tabular x-lam sand some clay patches possibly containing Ophio but indef. Grades down to banded bed lithology which has a few beds sand up to 2' thick that weather yellowish.

Top "FH" sand is light gray yellowish cast, much yellow - jarosite-like crud in upper part. At top rootlets in sand. Capped by liq shale + lignite along irregular contact (photo). Above this Hell Creek succession with alternating shale-lignite units and channel sands - about 60' up bentonitic clays come in. The Hell Cr. - W.R. contact obscure on butte side.

Does not look like any place for finding lower FH anywhere S or E or W of Castle Rock - in vicinity. Suspect best place at Haystack Butte.

This section of Hell Creek should be measured. It may tie in with the Bohnead lithofacies. One horizon



of sand-lumps overlain by bentonitic
clay was particularly suggestive. No
traces of fossils found anywhere in
the section.



Ascending - Coburns Cynthio section

Top of Greenhorn (Coll fish root + jaw)

Pool Cr.
Members
81'

Lower dk shale (\approx Fairport) thin, calc
concs \pm 12' (C. woodruffi), noncalc.
Upper gr. shale with ironstones (\approx Blue Hill)
12 beds in lower part *Spirifer cynthianus*
body chamber cherts, *Calliope hypothy*
Fish-lobster layer also (I. howellns Inc)
which is phos nodules layer - see spec.

Turner Study
Members
271'

Basal chert pebble sand with shark teeth,
pseudodont teeth (sample)
Lower part with calc sandy layers -
S. warreni, *Prionocylus McCambi*,
I. dimidiata (Coll.)
L med. part - *I. perplexus*, *P. wyomingensis*
S. whitfieldi - in big O-X. weather
concs.
U med - corall bed *S. nigricollensis* (Coll.)

U Light silts - underly grass slopes.
concs at top *S. nigricollensis*

Sage Branch
Members
300+

Gray shale sept. concs. - unfoss
(Don thinks \approx Fort Hayes)
But \approx base of Fort Hayes









SECT A

8

DIP = 21° , DIP N 27° E
 V = +1° , 50' ✓

9

+26° 47' ✓

10

+15° 34' ✓

11

+14° 50' ✓

12

+19° 28' ✓

13

DIP = 20° , DIP N 35° E
 +2.5° 53' ✓

14

+2° 20' }

measured
 at N 60° E

15

+15° 41' }

16

SECT B

doc 0286

1 Interf ripple
 DIP = 22° N 30° E

2

-1° 50'

3

+11° 50'

4

+8° 54'

bottom lignite

5

+17° 35'

6

-1° 50'

7

-1° 50'

8

+20° 17'

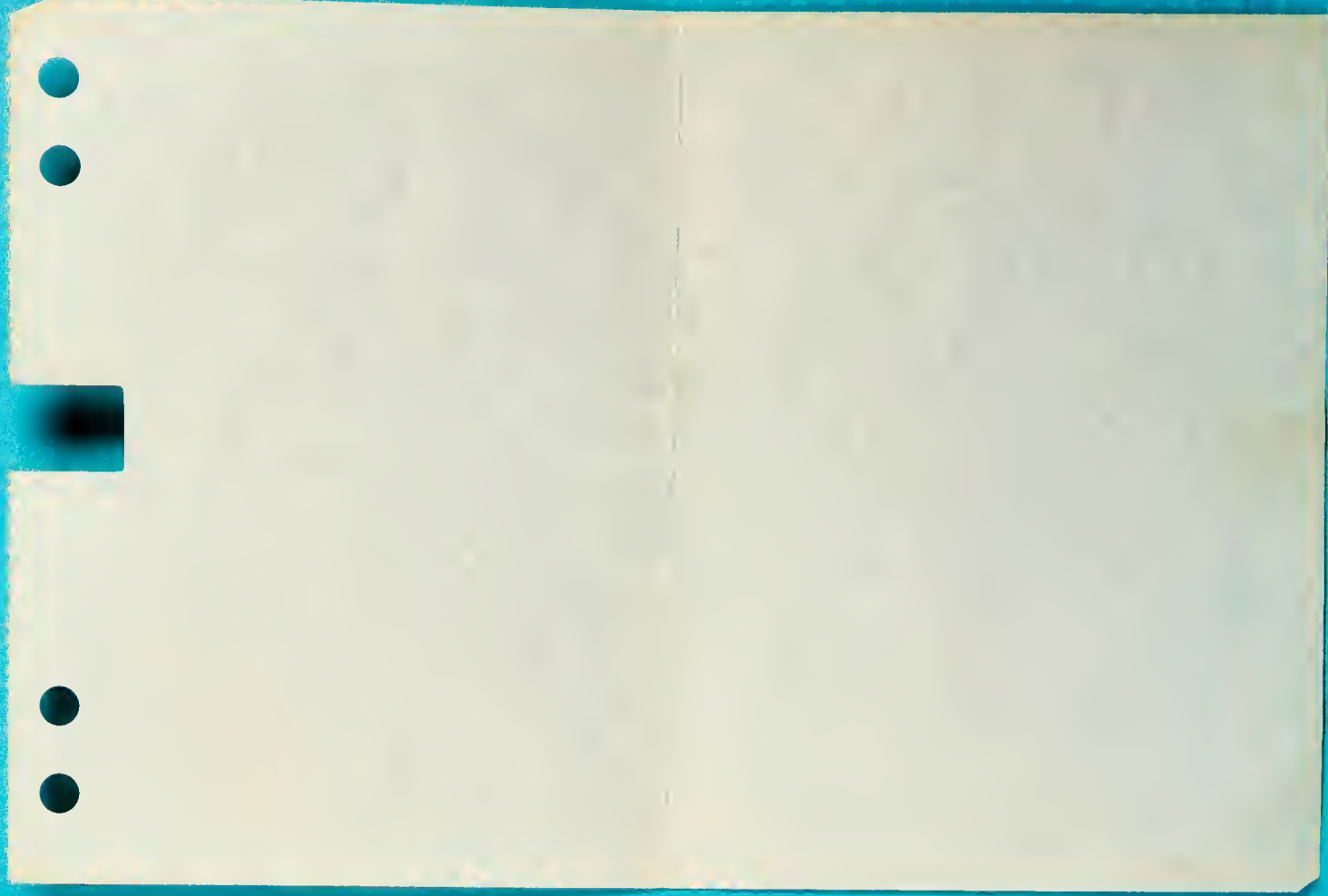
9

Top ss
 -10° 47'

10

-20° 30'

Brown red conc dip slope



SECT B

DIP = 20°
" N35°E

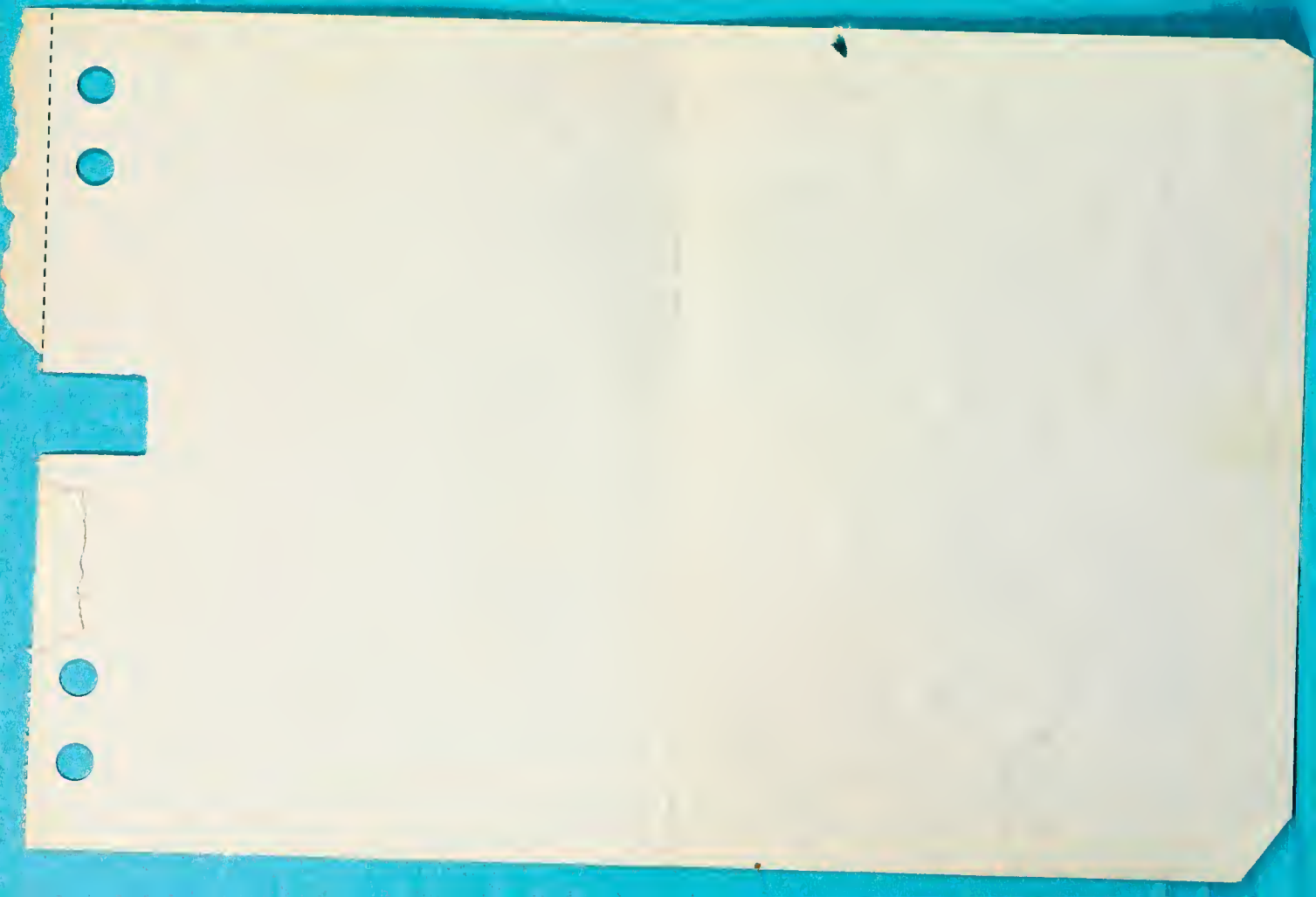
1		
2	+20°	43'
3	+20°	20'
4	-3°	36'
5	+14°	44'
6	+4°	43'
7	-11°	50'
8	-2°	50'
9	+22°	39'
	-8°	50'

DIP = 18°
" N30°E

10 Bottom Corbicula - Ostrea

doc. 0286

3	Shaly	D = 17°	V = +1°	36'
4	big discont. cones		V = +13°	48'
5	top lower sh.		V = +20°	48'
6	top discont cones		V = +27°	25'
7	top cont 1/2 - 1' cone		V = +21°	25'
8	top uppled semiscont cones			



SECT D

doc. 0286

1 TOP lobriula bed
 dip = 20° N 27° E
 + 11° 48'

2

+ 10° 40'

3 base 1st lignite
 + 6° 46'

4 top 6" red sh.
 00 49'

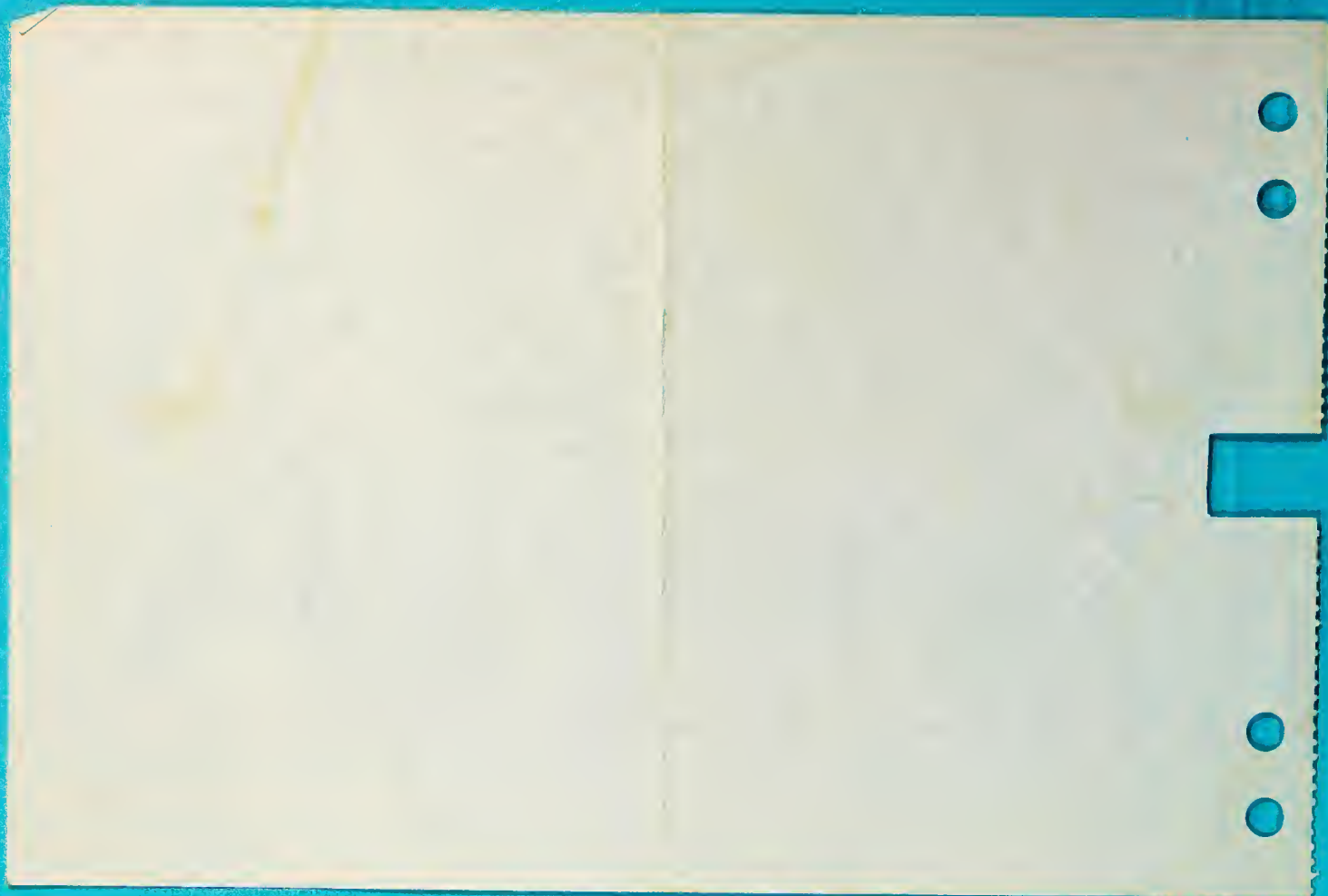
5

- 15.5° 52'

6. Base lignite
 + 12° 35'

7 Top X bed conc zone
 - 7° 52'

8





1971

doc. 0177

UNITED STATES
DEPARTMENT OF THE INTERIOR
DI-6

APPROVED DECEMBER 1941

Karl M. Waage, 1971

doc. 0177

7048

Type Fox Hills

30

2

7132

Lance Creek - Redbird area

112

4

doc. 0197

Summer 1971 with Charles Byers

Karl M Waage 1971

1000
11

Type For Hills

Locality 30

Levelled up to key beds of measured section in Bull.

Beginning with spot sample low in T.C.

CWB Sample 1

5.6

CWB Sample 2

4.2

5.8 ← CWB # 3

2.3 ← CWB # 4

Concretion (barren - grey silt type)

5.7 ← CWB # 5

5.0 ← CWB # 6

Top of CMC mass in gully - Conc jacket ?

8.0 Silty cl. scat shells, *Limopsis* begins at least 5.0 from base. (Barren hard ls concretions

CWB # 7 at 5.5 *Gervillia + Limop*, rare,

CWB # 8 at 8.0 in it - at 5.5

6.6 Top local C+C layer (about 0.3) in gully

CWB # 9 is 2.0 down from C+C layer

5.6 To top fairly persist layer ivy flth. ls concs - like sepsoid concs - CWB # 10 at top

7.0 To top layer void ls concs - *Proterodisc* layer. CWB # 11 - 3.0 above this conc layer

} Scat
small
concs

} scat
shells
14
metr

Karl M Waage 1971

57
46

12.3 Silty clay with jarositic blebs + layers beginning about 5.5 from base, CWB#12 5.5 ± from base

5.1 Silty clay with jarosite as above. Top this measurement marks top jarositic zone. Base of unit on fairly persistent jarositic layer

6.8 To top brown conc layer. CWB#13 just above base. Interval lacks jarosite + brown stain

1971



Red Bird Area.

Loc. 112, at S.E. end gravel-capped Mass
on Sharon Springs + basal Milton Members,
NW 1/4 Sec. 20 T38N R61W, Niobrara Co.,
Wyoming. (= "Pfeifer Peak")

Measured sections not corrected for
the $\pm 30^\circ$ dip. See Colburn's Red Bird
section for better thickness data

$$\begin{array}{r} 5.6 \\ - 4.0 \\ \hline 1.6 \\ \hline 7.6 \end{array}$$

$$\begin{array}{r} 7 \quad 5.0 \\ \hline 39 \quad 2 \\ 2 \quad 5 \\ \hline 4 \quad 7 \end{array}$$

loc 112

① Section of Shanon Springs + Lower Milton Members of Pierre. E of Redbird on SE cor. gravel capped Mesz in NW $\frac{1}{4}$, Sec. 20 T. 38 N, R. 61 W, Niobrara Co, Wyo

10.4 From top Ardmore bentonite to ^{top of} the "5" bentonite at base of the buttress zone

41.7 to "4" bentonite above buttress zone.

25.0 To "2" bentonite (about .8 - double ^{from 1} $\frac{1}{2}$)

7.0 To "1" bentonite

14.5 To bentonite streak, may be discontinuous slabby red-brown with conc masses.
 Start of
 Milton
 → start about 4' above base - scattered thruout. At top, local LS concs some with conc-in-conc just under bentonite streak

37.6 To top layer large sept. ls concs. (Small scaphite imbr.) The red platy conc masses. Calc ^{sept} begins to come in about 20 feet above base. Shale changes to more blocky, less fissile very gradually upward in this interval.

Section begins just N of Mule Creek cut off on Ardmore bentonite at base of bluff.

15
2

4
15
7

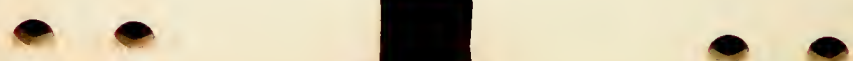
- (2) Starting base of 0.5 to 6 blue bentonite base of butress zone.
- 0.5 Bentonite - light bluish gray
- (1) 20.6 Shale, papery, gray + \downarrow zoned stringous to oil bentonite streak at top.
#1 - 4' from base, #2, 8' from base #3, 1' from top
- (2) 5.6 Shale as below, with flat ovoid cones light gray + yellowish gray ls. about 2 to 4 foot interval above base.
- (3) 0.4 Bentonite
- (4) 18.0 Shale, papery, gray + Fe brucites, bones + fish scattered throughout. Oil streak bentonite at top, and 4.4 + 6.0 from base, #4 - 1' from base, #5 - 9' from base, #6 - 3.2 ft from top.
- (5) 7.0+ Shale, papery, gray, locally flat-ovoid gray w/ls ls cones weathering out in interval. Bentonite streaks 0.4 above base and at about 3, 4, + 6. approx.
- (6) 0.6 Bentonite + shale with local concave cones
0.2 bent. at base + 0.1 - at top
Loc. Thin masses concave-cone yellow-orange weather crusts.

1881



- (2) cont.
- (7) 7.0 Shale, still with few Fe-oxyp
 breccilites, papony. Loc grey flat sandstone
 #7-3.2 from base.
- (8) 0.2 Bentonites, loc. with hard Fe stained
 layers in top of #7 below it.
- (9) 14.0 Shale, papony, with scattered red
 brown weath platy to shly conc
 masses, some breccilite flattened
 frags. A few ls. (weath yellow gray)
 concs with conc in upper 3 ft
 but most of these start in
 base #10 #8 = 3.8 from base, #9 = 3.2 from
 top.
- (10) 25.0 Shale (see below). At base first widespread
 layer large flat conc and platy
 red and, locally, septarian ls conc
 masses. - this ± 1' loc. with
 concs protruding into (9) below.
 Locally capped by thin bentonite
 streak. Above basal conc layer
 scattered similar masses, without
 obvious persistent layers though
 may be widespread concs in zone
 about 12-15 above base. At top,
 seems to be fairly persistent,
 dominantly septarian concs
 qyp wrapping, moderate (1/2' dia)
- #10 - 9.2 from
 base
- #11 - 16 from
 base
- #12 - 20.6 from
 base

1871



to very large flat ovoids.

Shale goes from porous at base
to fishy, lighter, chunkier at top

(11) 6.0±

Shale, somewhat brownish? shale, weathers
to checked outcrop some thin
fissile under it. Zone large ls sept
cones in upper foot, locally platy
type, much assoc. gypsum.

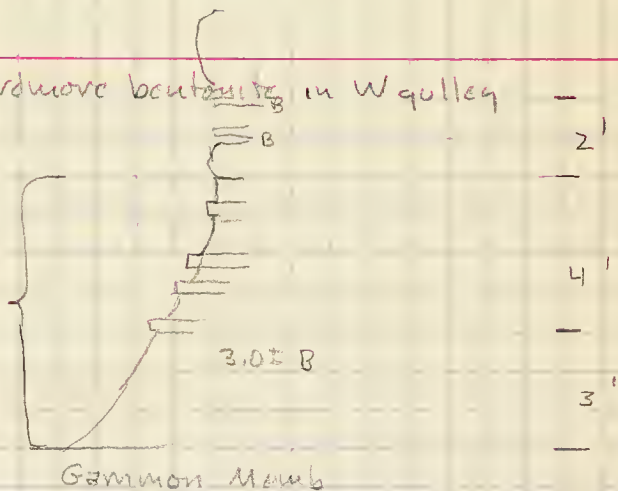
8



③

Ardmore bentonite in W gulley

Taken as
Ardmore bed.



Base Ardmore Bentonite

- | | | |
|---|-----|---|
| ① | 3.0 | Bentonite. |
| ② | 4.0 | Intubedded bentonite + tough shale |
| ③ | 2.0 | Shale with 0.1 layers bentonite middle + top. |
| ④ | 7.0 | Shale, dk gray papery, bentonite thin layers about 1.4 above base 0.8 from top + at top much jarosite + quartzum #15-1.5 from top |
| ⑤ | 6.0 | Shale as below |
| ⑥ | 1.2 | Bentonite |



- ⑦ 15, 3
- #14 - 316 to 4
3/4 sec 10250
- #13 - 610 from
top
- ⑧ 0.5

Shale, papery, gyp + Fe brow + vert.
 This zone has small scale slump
 + jointing structure. May be off same
 but not sure! (Breviliat bands - include fish head
 + picture)
 Bentonite (some as at base section 2)

Pictures
 at Loc.
 in Sec. 20

- ✓ 5. Charlie at sample hole in Sharon Springs
- ✓ 6. Gully in upper Sharon Springs with
 concretions lower Mitten coming in
 at top.
- 7. Thin bentonite in Sharon Spgs, conc mass
 in background. Note outcrop
 expression of bentonite
- 8.] Top + side views of concretion
- 9.] Jacket on concretion. Lower
 Mitten? top Sharon Spgs? (first
 persistent conc layer)
- 10.] Septarian ls conc with gypsum jacket
 Lower Mitten member.
- 11. Septarian conc mass in Lower Mitten
 Black Hills in background.
- 12, 13, 14 Fish in lower Sharon Springs ^{Unit 7} Sec 3
- 15 16 17 Ardmore bentonite bed.



④ From top Niobrara to base Ardmore bentonite
west gully just up about 60 ft from culvert

① 2.0 to ? Niobrara. Dark shale with calc specs,
weathers brownish to bluish gray,
calcareous. (CWB # KN₁ from 0.5 to 1.0 above top
CWB # KN₂ " 1.0 to 2.0 "
At top is 0.5 of brownish weather
shale with gypsum partings, mostly
non-calcareous, black stain on bedding

Gannon Memb. Pierre

② 0.2 Bentonite streak in rusty weather
shale.

③ 2.6 Shale, weathers gray with rusty zones
CWB # KG 1 in lower foot, KG 1.5
is in top foot

④ 0.5 Bentonite

⑤ 9.0+ Shale Pt gray fissile to streak
bentonite + jarosite. (CWB # KG 1.75
3 feet above base
slump?)

⑥ 9.5 from streak jarosite to base Ardmore
may be section missrag.
CWB # KG 2 4.5 to 5. Below Ardmore



Red Bird section, Traverse A -

(Picture 18 looking down dip to Fox Hills from Mitten - Red Bird contact - CWB middle dist.)

Collections in Upper Mitten from cones & flint of weathered cones, chiefly in upper half of upper Mitten.

Pictures -

Concretion layer in Red Bird sitting

2 of Pine ridge breccias, one with CWB

Aug 3 - A I whitfieldi concretions in lower part of unnamed membs.

Also B, C

D, Fox Hills - Pierre contact Traverse A.

E, F. - Contact of 2nd & 3rd units up in FH bioturbate - nonbioturbate as in Wessel contact.

G, H - Views E over Traverse A at Red Bird from Fox Hills and

J view W to Upper Fox Hills from lower FH

K Fox Hills cone zones from in TL 20.



The Fox Hills fauna is 26 at Lance Cr.

Protocardia

Tellina

Bryozoa

Venusta

Dentalium

Yoldia

"Inoceramus" fragilis

Sphaeroides

Haploscaphites

~~Duroscaphites~~

gastropods.

7.

7.



From base Audubon to samples in SP

- 13.5 Sample[#]2 0.5 to 0.8 from top.
Sample[#]1 hard ledge shale on to Audubon 3.5 to 4
2 base base
- 5.3 Sample[#]3 upper 0.5
- 8.4 Bentonite 0.2 at top
Sample[#]4 about 0.3 to 0.8 above Bentonite



Measuring from base Ardmore

4.0 To ledge above Ardmore. Sample #1 3.2 to 4.0

14.0 Sample #2 13.0 to 14.0

8.6 Sample #3 upper .6

10.2 To base thin bentonite

X 0.2 Bentonite

0.6 Sample 4

Offset ground corner to S.

Measuring up from X bentonite

4.0 To plate orange-yellow sand layer,
Sample 5 is 1 foot beneath this
layer

5.0 To soil top of butte:



Measuring from ^{top} 2nd bentonite down in Gannett
to base of Ardmore -

14.0

Sample Gannett 1 about 1 foot below
Ardmore to 2 ft below

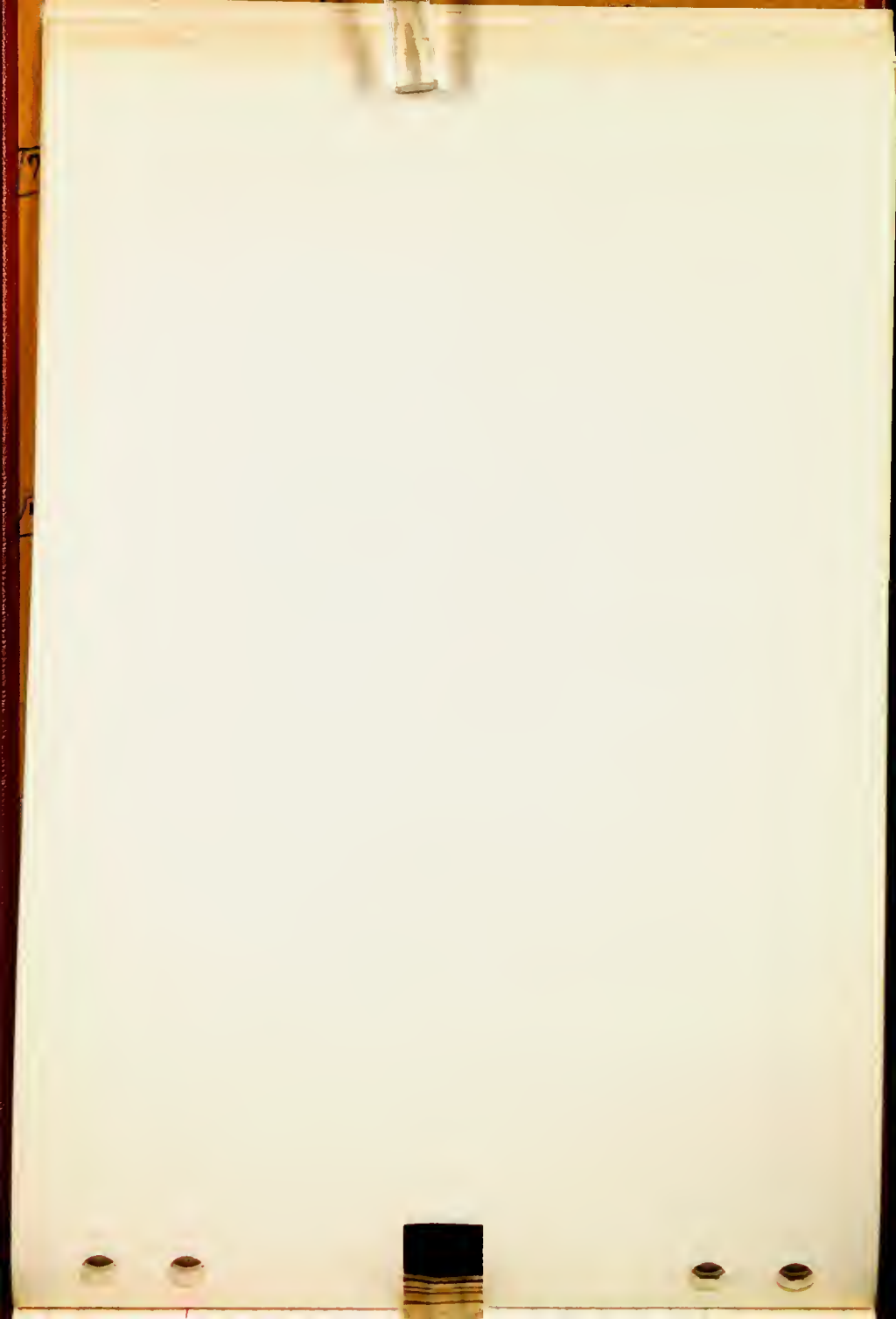
Sample Gannett 2 about 1 ft below
2nd bentonite

0.7 Bentonite

Measuring down from Ardmore

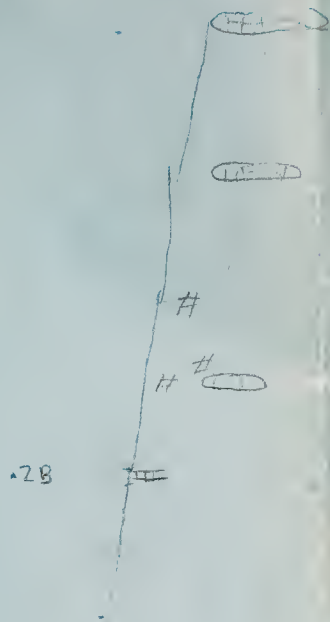
16.0 to base thin bent. Gannett #3 is
just below this.

18.0 below Ardmore 2 thin bed calc
shale Gannett 4

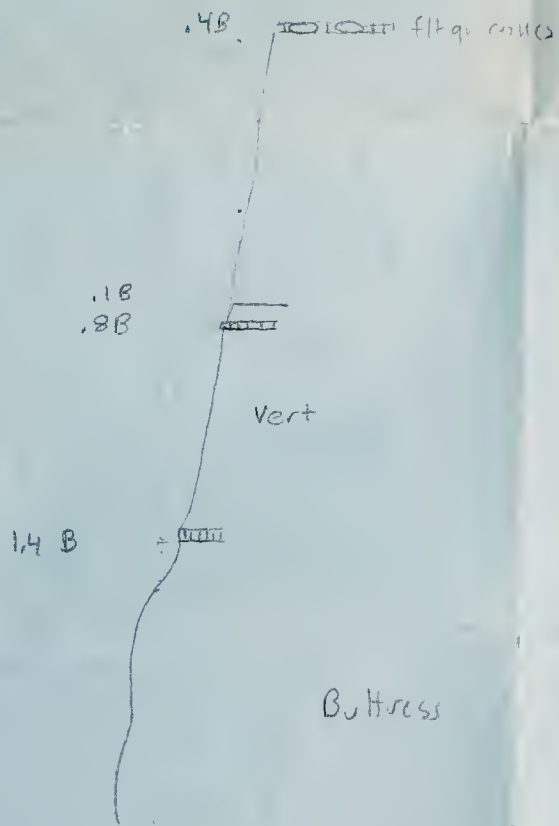
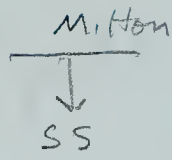








Cobbins



Butress

Ardmore

[loc. 112]

(Note many sections on Red Bus road at Pfisher Post)

doc. 0177

doc 0177



