John C. Moore ... oration, Rochester, N. Y. Binder and ho... leaves Patent...
Form 180 Blue
2646

Consolidated Coal Co. Lake Creek Mine

Consolidated Coal Co. Buckhorn # 2

Bell & Zoller Coal Co. Buckhorn # 2 (1951)

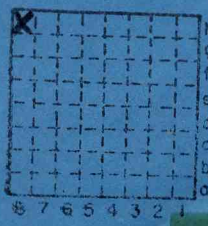
Bell & Zoller Coal Co. Zeigler # 4 (1/8/60)

Zeigler Coal Co. Mine # 4 (7/1/71)

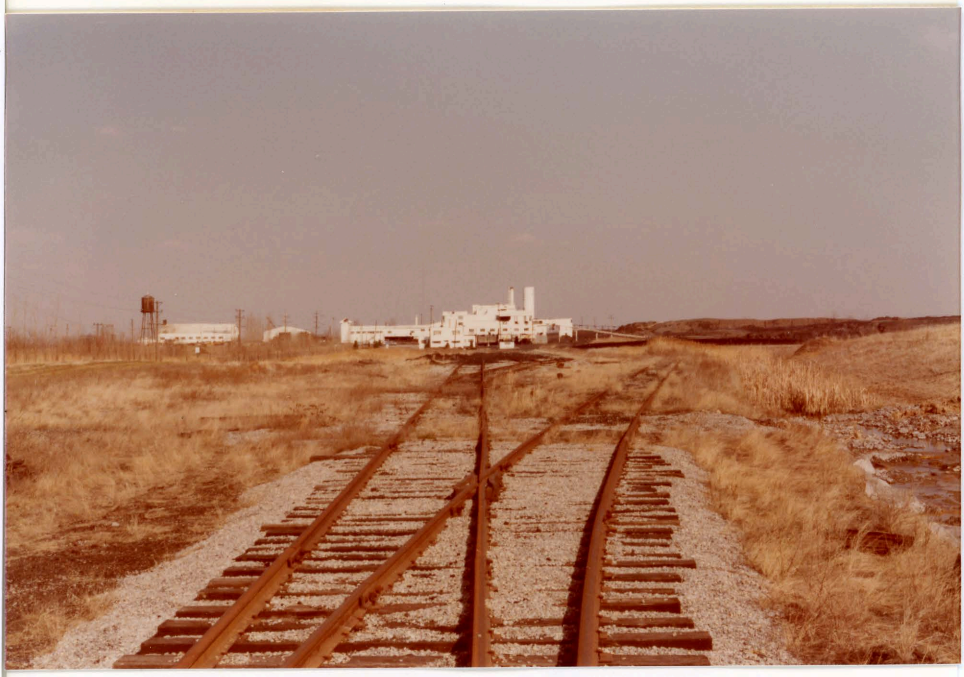
ZEIGLER COAL CO.
MINE # 4

Mine Index No. ~~0216~~ 0662
County No. 1604
Coal Report No. S-83

WILLIAMSON COUNTY



John C. Moore Corporation, Rochester, N.Y. 14604
MOORE'S MODERN METHODS
FORM 180 W



Tipple of Zeigler No. 4 - recently abandoned. John Nelson, March 1981.

m_45_001.tif

Mine originally operated by: (1)

Date 1944, July — Consolidated Coal Co — Lake Creek

Original name or number:

Illinois Coal Report p.

LATER OPERATORS

	Date	Operator	Name or No.
2	1950	Consol Coal Co.	"Buckhorn No. 2"
3	1951	Bell & Zoller Coal Co.	Buckhorn
4	1960	" " " " "	~~Zeigler 4~~ Zeigler 4
5	1965	Bell & Zoller Coal Co.	#4
6			
7			
8			
9			
10			
11			
12			
13			
14			

OK 1946

40'S 640'E of NW corner NW NW (1948)

*Also owners #See ownership sheet

Railroad, Wagon, Strip, Idle, Abandoned slope

IDENTIFICATION

County No. 160 4

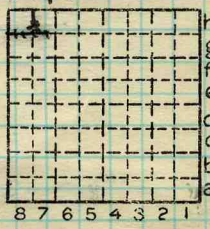
Coal Report No. S83

Quad. West Frankfort (1948)

County Williamson

Coal No. □6

7-8'



Sec. 16

T. 8 S.

R. 3 E. W.

Index No. 0216 H3

COAL MINE OPERATOR

(68020—1500—11-38) 2

Jo[illegible] C. Moore Corpor[illegible]n, Rochester, N. Y. Binder and holes in le[illegible] Patented. FORM [illegible]992 A

MOORE'S MODERN METHODS

(Sheets) COAL PRODUCTION (Sheet)

Period Mo.	Day	Year	Mo.	Day	Year	Tons	
7	1	1944	12	31	1944	34	277
1	1	1945	12	31	1945	308	842
					1946	449	716
					1947	530	891
					1948	628	849
					49	486	295
					50	546	063
					51	611	678
					'52	776	968
					53	738	244
					1954	858	224
					1955	810	003
					1956	880	437
					1957	757	081
					1958	869	142
					1959	1 062	384
					1960	1 074	567
					1961	1 107	627
					1962	1 088	999
					1963	1 067	831
					1964	1 097	177
					1965	1 150	226
					1966	1 073	150
					1967	1 270	193

SUMMARIES

No. to No.

Railroad, Wagon, Strip, Idle, Abandoned Slope

Sec. 16

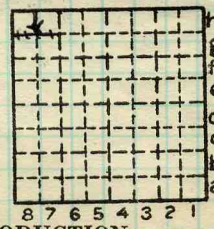
IDENTIFICATION

County No. 604 Coal No. □

Coal Report No. S-83

Quad. West Frankfort

County Williamson



T. 8 N. S.

R. 3 E. W.

Index No. 0216 H8

COAL MINE—PRODUCTION

ILLINOIS GEOLOGICAL SURVEY, URBANA

(2732—2M—7-41)

(Sheets) COAL PRODUCTION (Sheet)

Period Mo. Day Year	Period Mo. Day Year	Tons
	1968	1 062 493
	1969	1 087 395
	1970	1 069 234
	1971	843 440
	1972	652 959
	1973	423 211
	1974	578 071
	1975	595 063
	1976	507 701
	1977	404 897
	1978	266 291
	1979	274 062
	1980	200 306

Abandoned August 1980.

SUMMARIES

No.		No.			
1950	to 1971 (INC)		20	902	556

Railroad, Wagon, Strip, Idle, Abandoned Slope

Sec. 16

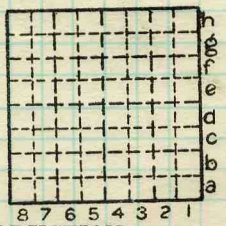
IDENTIFICATION

County No. 1604 Coal No.

Coal Report No. S-83 ☐

Quad. West Frankfort

County Williamson



T. 9 N. S.

R. 3 E. W.

Index No. 0216 48

COAL MINE—PRODUCTION

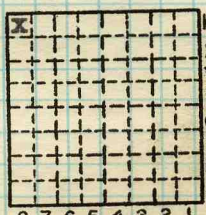
ILLINOIS GEOLOGICAL SURVEY, URBANA

(2732—2M—7-41)

0	- 21½	Coal, normally banded and bright with thin pyrite facings on bedding planes.
21½	- 21-7/8	Pyrite
21-7/8	- 23¾	Coal, normally banded and bright
23¾	- 24¼	shale, dark gray and coaly
24¼	- 40	Coal, normally banded and bright with some vertical pyrite facings
40	- 65	Coal, normally banded and bright with thick bands of vitrinite up to ½" thick
65	- 66-3/8	Coal, normally banded and bright with thin mineralised fusain bands
66-3/8	- 67	shale, dark gray to black with thin coal streaks
67	- 72	Coal, normally banded and bright
72	- 77¼	Coal normally banded and bright
77¼	- 77½	Fusain
77½	- 83¼	Coal, with thick bands of vitrain up to 1" thick

BELL & ZOLLER COAL CO
BUCKHORN MINE #2
14th. Rm. off 13S off 10E
By GMW Date 1952
Quad. Part
County WILLIAMSON

Sample # 1



Sec. 16
T. 08 N. S.
R. 03 E. W.
Index No.

BELL & ZOLLER COAL CO — Sample # 1
BUCKHORN MINE #2
14th. Room off 13S off 10E

continued

83¼	- 84¼	shale, dark gray, carbonaceous, with thin coaly streaks
84¼	- 90	Coal, normally banded and bright with a band of vitrain 1½" thick
90	-106	Coal, normally banded and bright.

0	- 12½	Coal, normally banded and bright
12½	- 14	Coal, quite pyritic
14	- 36	Coal, normally banded and bright with some vertical pyrite faces.
36	- 37	Fusain
37	- 48	Coal, normally banded and bright
48	- 48½	Fusain
48½	- 52	Coal, quite pyritic
52	- 56¼	Coal, normally banded and bright
56¼	- 56-5/8	Fusain
56-5/8	- 60½	Coal, normally banded and bright
60½	- 61	Coal, bony
61	- 66	Coal, normally banded and bright with several thin bony streaks
66	- 67	Coal bony

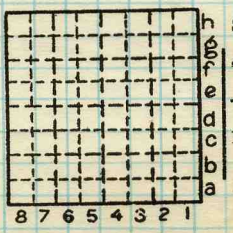
BELL & ZOLLER COAL CO
BUCKHORN MINE # 2
Crosscut between 13S and 13A

Sample #2

By GMW Date 1952

Quad. Part

County WILLIAMSON



Sec. 16
T. 08 N. S.
R. 03 E. W.
Index No.

(87469—10M—10-49) ILLINOIS GEOLOGICAL SURVEY, URBANA

BELL & ZOLLER COAL CO Sample # 2
BUCKHORN MINE # 2
Crosscut between 13S and 13A

continued

67	- 82	Coal, mormally banded with several thi fusain bands
82	- 83	Blue band, pyritic, not included in xx sample
83	-103	Coal, normally banded and bright

Central
Press Clipping Service
INDIANAPOLIS INDIANA

Carbondale, Ill. Free Press
Friday, January 8, 1960

at the Walker Funeral Home, Sparta, burial in Marissa Cemetery; a Masonic service will be at 7:30 p. m. today at the funeral home.

BELL & ZOLLER CHANGES BUCKHORN MINE NAME

The name of the Bell and Zoller Coal Co. mine three miles east of Johnston City has been changed from Buckhorn to Zeigler 4, according to Roland Wilson, Johnston City, vice-president in charge of operations.

The reason, Wilson said, is that originally all Bell and Zoller coal was mined in Zeigler and change is to standardize mine names. The company operates another mine, Zeigler 3, near Zeigler.

Commercial bakeries were in existence as early as the 6th Century B. C.

Williamson 16-85-3E

Strata	Thickness	Top	Bottom
Sample # 1 Bell & Zoller #4			
955' in June 11, 1963			
35th N, of main W. Gluskoter & Baker			
Main N.		Top down--	
600' S,			
720' W, cent. sec. 5			
T. 8S. R. 3E.		From	To
Total thickness = 83"			
Some coal left on bottom			
Coal, normally bright banded with calcite and pyrite on vertical right fractures. Also, few thin pyrite stringers.		0	14
Boney coal		14	14½
Coal, normally bright banded; abundant calcite on vertical fracture. Few thin fusain lenses.		14½	44
Coal, normally bright banded with frequent soft and also mineralized fusain beds. Abundant calcite as above		44	72
Blue band, extremely thin and variable, absent within a few feet laterally. Omitted from sample		72	72½
Coal, normally bright banded, hard.		72½	83

Strata	Thickness	Top	Bottom
Sample #2 Bell & Zoller #4			
+885' June 11, 1963			
4th S. entry Gluskoter & Baker			
off Main West			
Main N.			
40'W. 40'S., N. center. Sec. 8, T. 8S, R. 3E.		Top down	
Total thickness = 83"		From	To
Coal, normally bright banded; sparse calcite on vertical fractures, few thin pyrite bands.		0	19½
Shale; variable thickness along face.		19½	20
Coal, normally bright banded; pyrite and calcite on vertical fracture.		20	22½
Boney coal.		22½	23½
Coal, normally bright banded; few thin soft fusain lenses. Secondary minerals sparse.		23½	83

Note:
- -Blue band at base of sample, better than 1' left below it.
- -Gray shale roof.
- -Face very wet.

Sample #3 Bell & Zoller #4

At mouth of 2 room, 3rd E., 1st S., Main W. off the main N. 470'N., 970'W. S.E. cor., Sec.5, T.8S, R. 3E.

June 11, 1963
Gluskoter & Baker

Top Down

Total thickness = 84'

Strata	Thickness	From	To
Coal, normally bright banded; pyrite lenses, 1/16" to 1/8" thick at 12" and 18".		0	20
Boney coal.		20	21
Coal, normally bright banded; minor amounts of calcite and pyrite on vertical fractures. Many thin (less than 1/8") fusain bands, mostly soft.		21	63
Boney coal and vitrain alternated in bands up to 3/8" thick.		63	65½
Shale.		65'	66¼
Dull Coal banded with vitrain.		66¼	73½
Blue band.		73½	74¾
Coal; dull boney bands similar to 1' section above blue band. Banded with bright coal. A few prominent fusain bands.		73¾	83
Shale.		83	83¾
Coal, normally bright banded.		83¾	84

Note:
- Over 1' of coal left at bottom.
- Face exposed for few weeks. Was cleaned off prior to sample
- Shale at bottom, blue band and shale 8" above blue band. All omitted from sample.

COUNTY

ZEIGLER COAL CO. MINE # 4 JOHNSTON CITY, WILLIAMSON COUNTY, ILLINOIS

Visit by Heinz Damberger, H.-F. Krausse, and John Nelson, 7/17/74. Reconnaissance visit for Herrin (No. 6) Coal Roof Study. Damberger and Krausse notes follow. John Nelson did not take notes.

Not all photos taken are included here. For the rest, please see Roof Study Photo Notebook (in Confidential Room).

This was the only visit to Zeigler # 4 made in connection with the roof study.

ZEIGLER COAL CO. MINE NO. 4, JOHNSTON CITY, WILLIAMSON COUNTY, ILL.

Visit by Heinz Damberger, H.-F. Krausse, and John Nelson 7/17/74. Notes by Heinz Damberger. Reconnassaince visit for Herrin (No. 6) Coal Roof Study.

Photo #1: 1st S. Panel off SE off Main North; 2000' from S.L., 600' from W.L. Sect. 10, 8S-3E. Shale lense in coal seam with small displacement in west (Right side of picture). View looking south. Strike of fault in picture 135-140/W (see H.F.K. notes).

Photo #2: About 2-4" top layer of coal taking off (sic) into roof shale and causing roof falls. Loc. in 1st SE Panel one crosscut inby overcast, 1st S. off Main East. 2200' from S.L., 450' from W.L., Sect 10. Looking on a 220-degree heading.

#3: 3rd Main East Entry, crosscut between 3rd and 4th of the face (sic) 220' S, 1400' E of center, Sec 10, looking on a 30-degree heading. Slip in roof, polished, slickensided; roof problem immediately after mining (before bolting). Trends about N 45 W with striations.

Note: Heinz shows a diagram indicating the slip trends 045 (N 45 E) and dips 45 to NW. This is being typed two years after visit and after Heinz has left the Survey. See original field notes included here. Heinz did not believe in making legible notes and getting them typed promptly. C.J.N.

#4: 4th Main East. Roof fall connected with fault trending 140, dipping SW. View looking N. See HFK for further notes. Location on map: Crosscut # 100, between 3rd and 4th East, 200' S, 1100' E of center, Sect. 10.

Photos 5 and 6: Two crosscuts inby rock hopper, 1800' W, 1800' S of center Sect. 9. Shows irregularities at top of seam and stringers taking off, causing roof problems. Also shows structure of shale in this area near bottom, with synaresis etc. Views looking NW.

Photo #7: First roof bolts in the world, put in about 30 years ago, directly above rock hopper. 1800' W, 1700' S of center Sect. 9.

Note: The company man claimed these are the oldest roof bolts ever used in a coal mine, but many other mines claim to have been the first to have used this system of roof control. C.J.N.

Photo #8: 2nd Main West two crosscuts inby the coal hopper. Edge of "channel" looking appr. S. 1200' from S.L., 400' from W.L., Sect. 9.

Photo #9: Map of Zeigler #4
Photo # 10: Ruined
Photo # 11: John Nelson and H.-F. Krausse looking at map
Photos 12, 12A, 13A: Zeigler #4 Map

Note: Many of these photos are lost and not available. Some of them can be seen in the photo notebooks of the Herrin (No. 6) Coal Roof Study. These notes were typed by John Nelson on 5/13/76, after Heinz had left the Survey.

PHOTO 2

mn_45-002.tif

PHOTO # 5

MN-45-003.tif

Zeigler #4, 7/17/74, #6

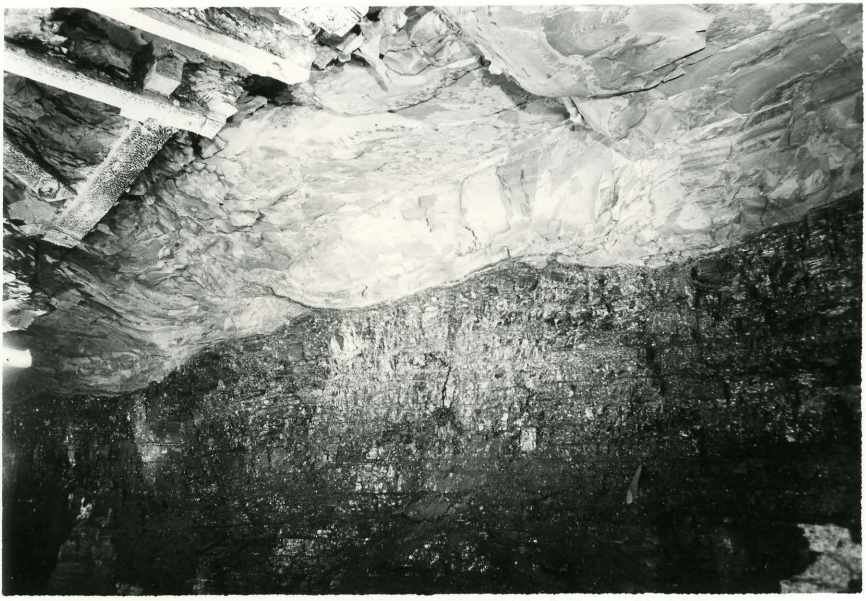


PHOTO # 6

MN-45-004.HP

Zeigler #4, 7/17/74, #7

PHOTO # 7

Zeigler #4, 7/17/74
#8

PHOTO # 8

mn_45_006.ftp

Same day, same mine, notes & sketch by H.-F. Krausse

Drawing of roll (over) with notes in illegible German.

Photo II is a "horseback" in roof which strikes 70. Other horseback has 20 strike. Normal cleat strike (?) 145.

Photo IV fault small 143/62 NE Striations pitch (??) 50 cause of roof fall.

The rest is illegible and in German.

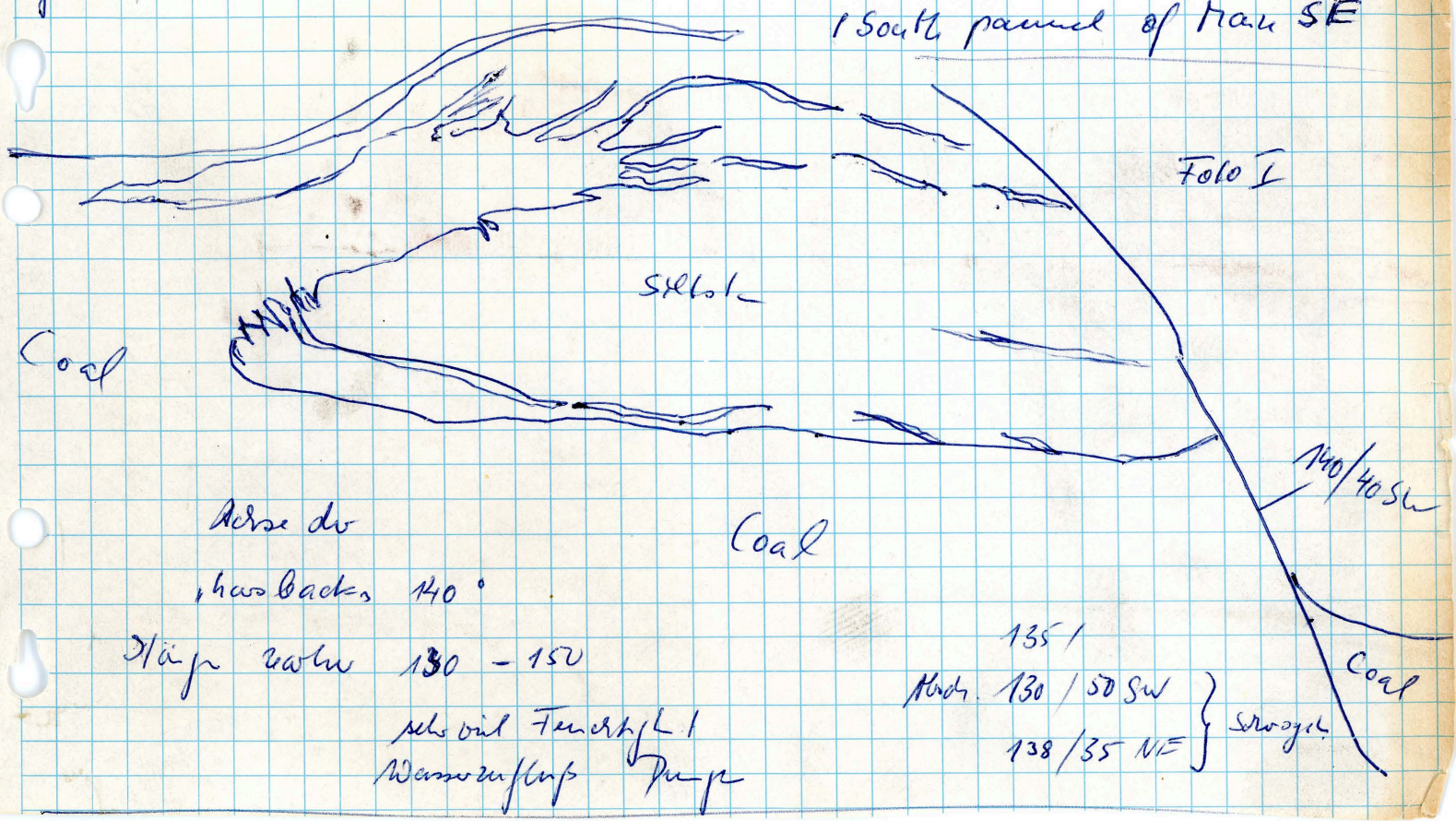

South panel of Haus SE
Fold I
Shale
Coal
Coal
140/40 SW
Coal
135 /
Kluft 130 / 50 SW
138 / 35 NE
schwach
Achse der
„Haus Back" 140°
Streichrichtung 130 - 150
sehr viel Feuchtigkeit
Wasserzufluss

Foto II is from a „hasback" in roof which strikes 70° / other hasback 20° strike

Normaldeal slr 145

Photo IV fault small 143/62 N/E ~~Lia~~ Strike pitch 50° caused roof/fall

Große Klüfte in Hgd. vor alle nahe Störungen aber auch sonst. 70° + 150° strike

Strei 70°-90° Einfall leicht Richtg.

~~Remarks: Luftkanal Abb. ...~~

ZEIGLER COAL CO. MINE NO. 4 STUDY OF COTTAGE GROVE FAULT SYSTEM

In 1976 a detailed study of faulting at Zeigler No. 4 was begun. Notes, sketches, and photos from this study are stored in a separate book, and field maps are kept in folder 10-3-9.

ZEIGLER COAL CO. MINE NO. 4 WILLIAMSON COUNTY, ILL.

Feb. 10, 1977 John Nelson and H.-F. Krausse

This is a one-day reconnaisance visit of the faulted areas we hope to map in greater detail later. Our guide is Larry Harp, surveyor.

The mine now operates only 3 working sections, all conventional. Ray Columbo (Chief Eng.) and George Little claim the coal is too hard for continuous miners, and they say production rates with conventional are as good or better than that obtained with continuous miners in older parts of this mine. Both rippers and borers were formerly used. Zeigler #4 no longer pulls the pillars because they do not own the surface in the new part of the mine. Pillaring formerly was done both on the double-barrel room style used by Old Ben, and by simple punching of square blocks.

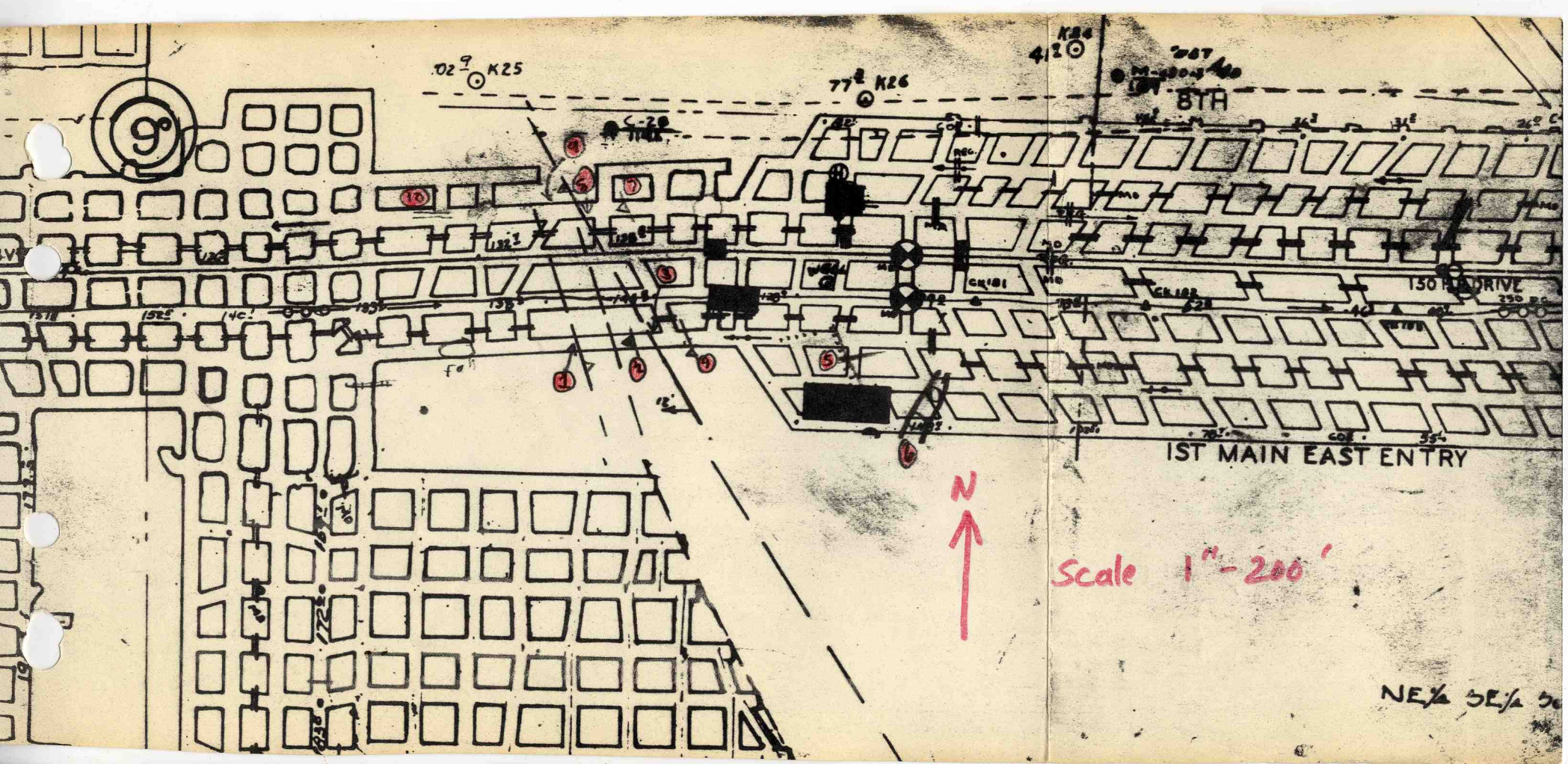
Shooting is done with Air-dox. Seven or eight faces are worked sequentially in a section so that loading is nearly continuous. There are about 15 men on a section, and the mine works three production shifts. Total payroll for three shifts is about 260 men.

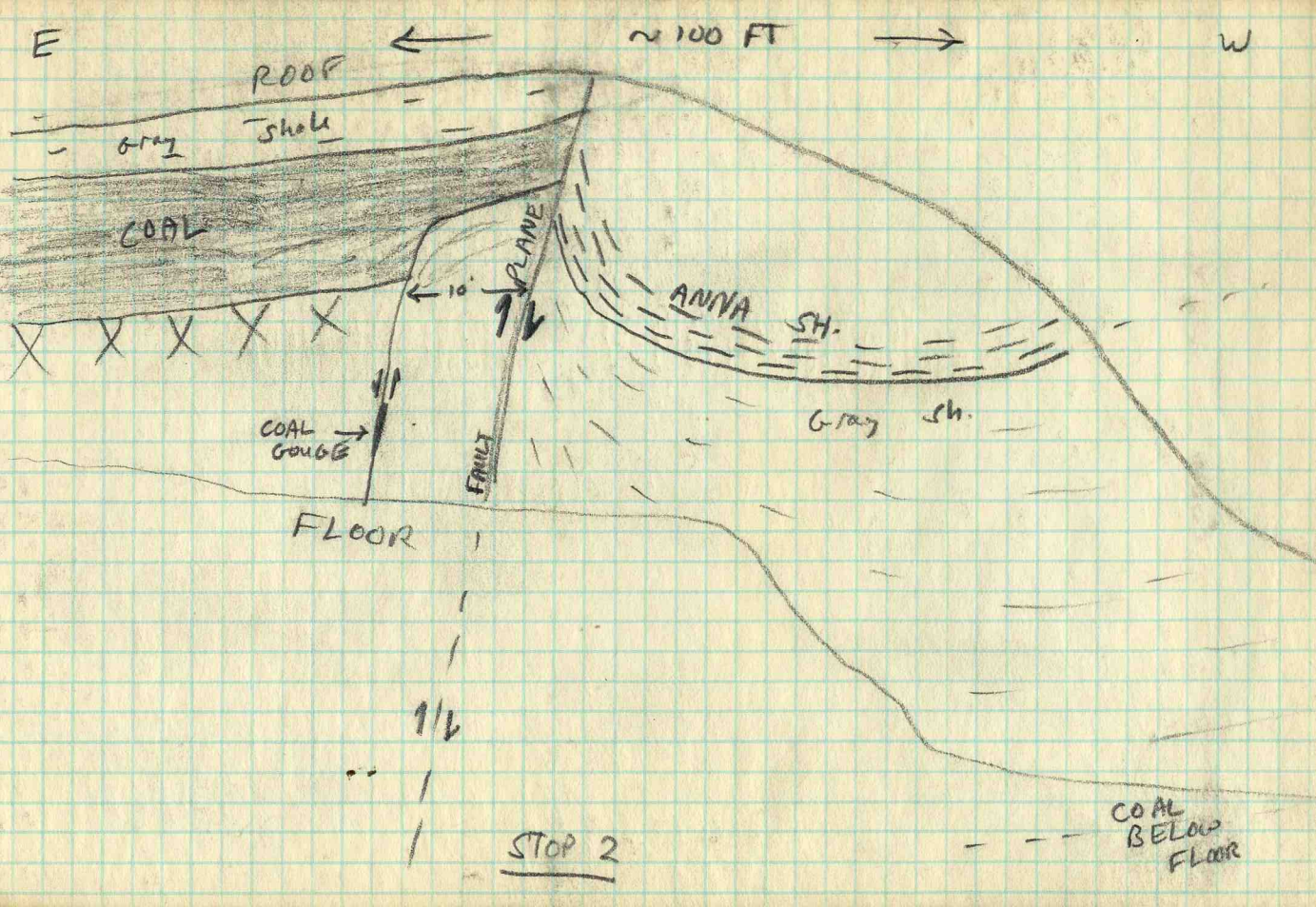
The first area examined is the main fault zone on the steep hill in the 1st Main East. The coal pitches steeply in a northeasterly direction for several hundred feet either side of the fault area.

Numbers refer to locations on field map (included)

(1) Entry graded in roof; coal not exposed. Faults cross entry approximately as shown on company map, but cannot tell amount of displacement.

(2) Main fault area. Company map not accurate here. Pattern appears highly complicated. Throw looks more like 30 feet than the 12 feet indicated by company. The easternmost fault plane is a reverse fault dipping steeply to the NE. The bottom of the coal on the


9
K25
K26
8TH
150 HP DRIVE
1ST MAIN EAST ENTRY
N
Scale 1"-200'
NE¼ SE¼ Sec


E
~100 FT
W
ROOF
gray shale
COAL
10'
PLANE
ANNA SH.
gray sh.
COAL GOUGE
FAULT
FLOOR
COAL BELOW FLOOR
STOP 2

hanging wall is about opposite the Brereton Limestone on the footwall (west). The NE block is not much disturbed up to the fault plane, but the rock west of the fault is sharply drag-folded and gouged.

On the north rib an angular block of coal 5' X 1' is dragged downward along the main fault plane. Gouge zone seems to widen downward.

Anna/Energy Shale contact is sharp. Roughly 15 ft. of gray shale.

Sketch (over) generalized view of south rib.

(3) Slickensided striations on bedding plane in Energy Shale about 0.25' above top of coal. Striations trend 007° and the bedding surface dips 9 to the north.

(4) Normal fault trending 165/65° W with 5.5' displacement at the top of the coal. Fault is offset about 20 feet by horizontal movement along bedding plane. Striations on bedding plane trend about 015° indicating that the actual movement was greater than 20 feet (direction of movement was not at right angles to the fault.) The upper part of the coal seam moved to the southwest relative to the lower part of the seam. A second horizontal offset of about one foot is seen in the roof just above the top of the coal.

Diagram (over) indicates that the horizontal displacement along the bedding plane is about 40 feet, and that the upper part of the coal moved "uphill" relative to the lower part of the coal. This is the same sense of movement observed in the 6th North of Freeman Orient # 4 near the large reverse fault.

West of the fault the horizontal movement took place at the coal- roof contact and there is a 1-2" thick zone of crushed coal along this surface. The lower few inches of the roof shale also are crushed and disturbed. In the "middle block" of the fault there is a zone of crushing up to a foot thick, with large clay lenses and rotated blocks of coal. East of the fault the crushed zone is generally less than an inch thick, but it is visible for several hundred feet.

W E

STOP 3

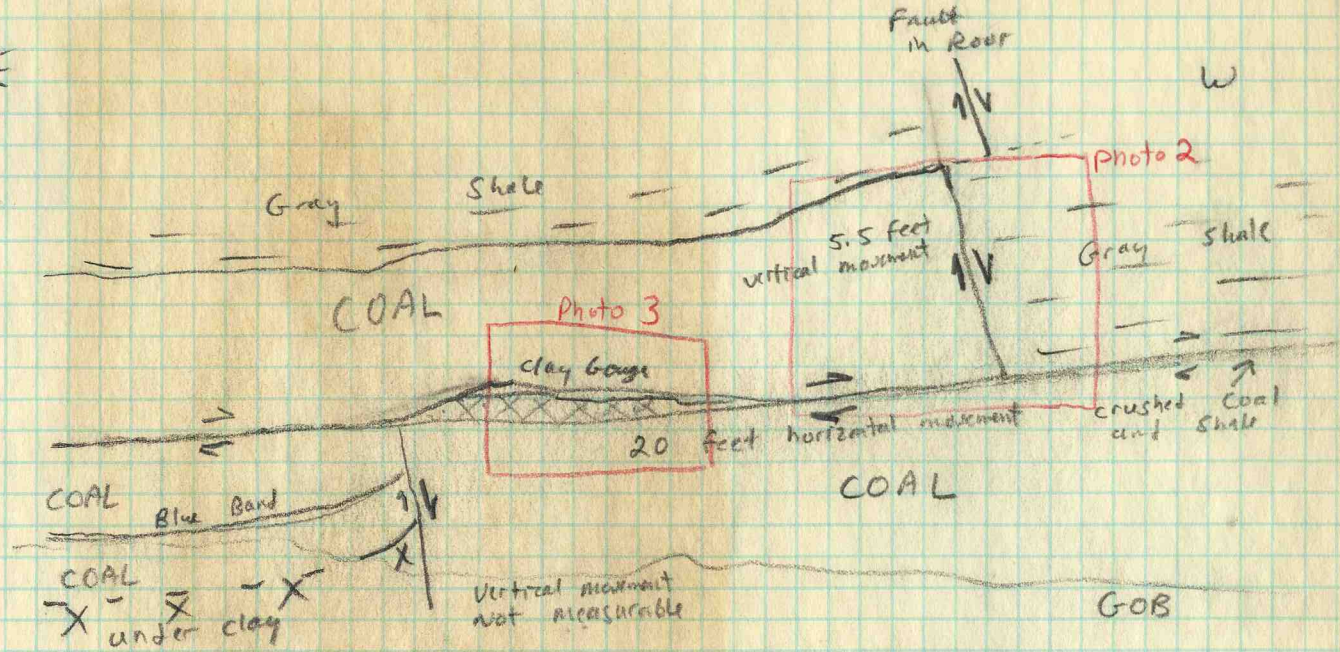
Slickensides on bedding surface in roof shale. Striations trend N 7 E and the beds dip approx. 8-10 to north. Shale apparently has moved ~~south~~ north ward relative to coal. ~~(= uphill !!)?~~

Fanning appearance of striations is due to wide-angle lens on camera. Actually the striations are parallel.

Neg. ~~#~~ Photo 5, north rib from 6 feet, B, fll.

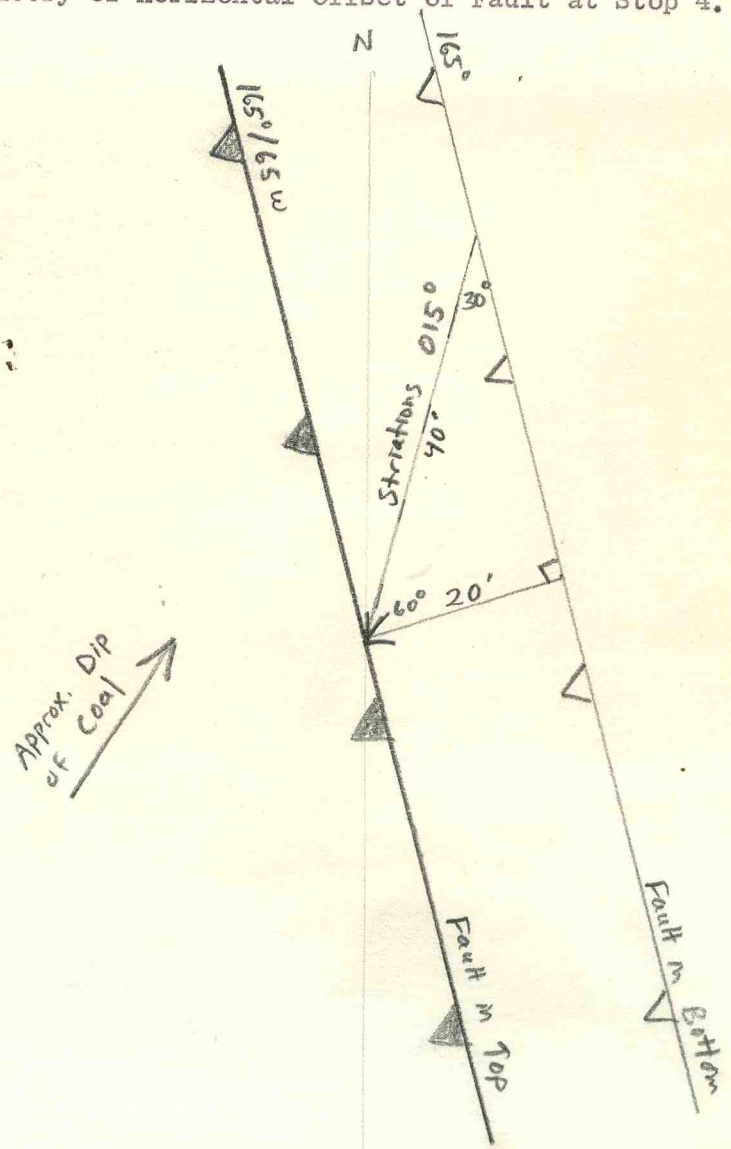
Neg 4 also of same site

ms_45-007.tif



Stop 4- Generalized View South Rib.

Geometry of Horizontal Offset of Fault at Stop 4.



(5) Fault with about 0.1' throw, down to west, at roof line. Fault continues across roof as a series of "en echelon" fractures. Horizontal displacement at top of coal is about 1 foot (measured in the plane of the rib). Striations trend roughly N-S along this surface of movement. Fault dies out about 3 feet down in the coal.

Prominent east-west fractures in roof shale. Some of these are faults with very small displacement and they intersect the N-S faults. Cannot tell which set is older. The E-W fractures are much more intense than usual jointing in Energy Shale. Suspect they are related to the tectonic movement.

(6) Large roll, 5 feet deep at the lowest point, on the north rib. Riders on both sides show the usual folded, deformed shale between rider and main seam. Middle part of roll on north rib is a large wedge of undeformed shale whose bedding lies nearly horizontal. This wedge is down-dropped along slip planes forming a graben. Multiple roll fronts are seen.

(7) Same feature as at Stop 4 (vertical fault offset by horizontal movement). Here there are several planes of horizontal movement either in opposite directions or, more likely, different amounts of movement in the same direction. Also a prominent S-shaped flexure is seen in the coal on the north rib just east of the fault. West of the fault several small NNW-trending fractures in the Energy Shale are seen to be offset along bedding planes in the shale. Amount and direction of movements not determined here.

(8) Main fault in north entry. Entry is graded level across the fault hiding many of its features. The coal seam is sharply dragged downward east of the fault and disappears into the floor about 10 feet from the fault plane. About 10 feet west of the fault is flat-lying Anna Shale and Brereton Limestone. Base of Brer-

W

E

STOP 7

Flexure in coal seam with clay band folded into a tight "S" shape. Intensity of flexure increases downward. Pulverized coal along axis of flexure (pen).

Neg.# = Photo 8, north rib from 3 feet, 1/30, f18.

m_45.008 HP

W

E

STOP 7

Nearly vertical normal fault displaced by several stages of horizontal bedding-plane movement. Flexure (previous photo) lies a few feet to the right, out of the picture.

Neg.# = Photo 9, north rib from 8 feet, B, f8.
(#10 similar)

mm_95.009.flp

eton is faulted opposite top of coal. The fault gouge zone is at least 5 feet wide but cannot see enough to definitely state direction of dip of fault plane. The drag in the coal indicates a reverse fault.

(9) Entry graded in Energy Shale, leaving Anna and Brereton roof. Anna Shale sharply overlies Energy and in places is only a few inches thick. Layers dip gently to east and no large faults are present. Many small faults are present; some trend 070-080° intersecting the dominant NW trend.

Water and gas bubbling out of rock near stopping.

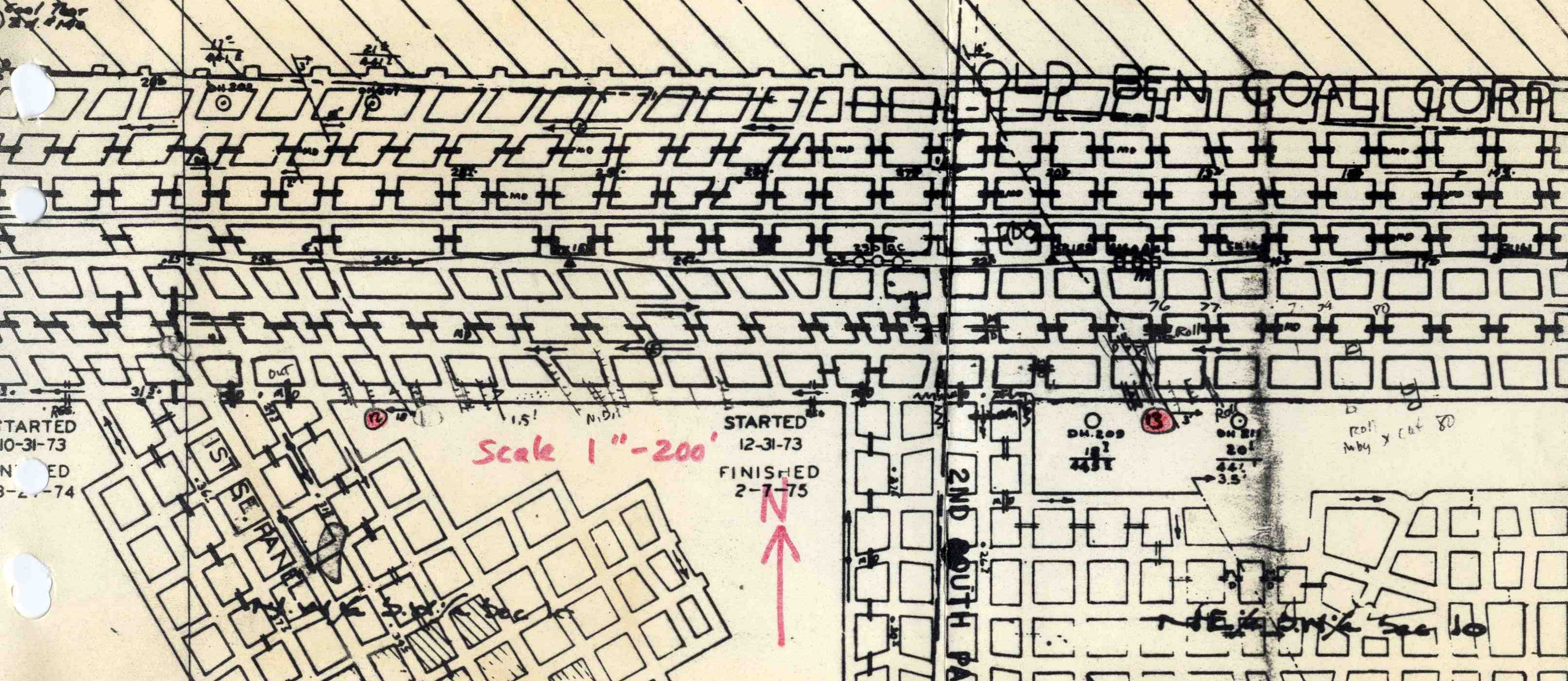
Very striking pattern of faults at Energy/Anna contact north of stopping (see photos). Anna Shale has apparently been dragged far down along the fault planes. One block of what appears to be crushed slickensided Anna Shale lies 8-10 feet below its normal position on a fault with about one foot of displacement and this block connects to a smeared-out streak of black along the fault plane. This kind of downdrop cannot be explained in terms of simple normal faulting.

(10) Entry in Energy Shale. Well-developed east-west fractures. Cannot determine displacement and see no slickensides, but the rock is intensely broken along the fractures; almost a breccia. Roof falls along the fractures. The whole area is very bad top with much water. No N-S or NW-trending faults or fractures.

Appears that the entry was mined along the coal but subsequent roof falls filled it above coal level, and entry was graded along the top of the fallen rock. This is unfortunate for us because faulting patterns are hard to discern in uniform shale.

Faults Between 1st and 2nd South Panels.

(No Stop 11)


OLD BEN COAL CORP
STARTED
12-31-73
FINISHED
2-7-75
Scale 1"-200'
N
1ST SE. PANEL
2ND SOUTH PA
OUT
DH.209
DH 211

(12) Fault area on Mains just inby 1st South Panel. Company map shows one fault, down 18" to west. In actuality there is a wide zone of faulting extending nearly to the 2nd South. In general they are high-angle (60-80°) normal faults which cut the entire coal seam. No evidence of horizontal movement. Coal seam lies essentially level.

The largest fault is the 18-incher shown on company map. It trends 150/90° and the slickensides are inclined 42° to the northwest indicating nearly equal components of vertical and strike-slip movement. A small inclined fault intersecting the large one also shows inclined slickensides. The west block moved down and to the north.

The roof is gray shale with small rolls and detached coal riders.

Some faults cause roof trouble in the crosscuts, which were driven nearly parallel to the faults. Faulting dies out near 2nd South but severe floor heave is present along the mouth of the panel. In places the floor is up more than 2 feet and contains large open fissures. Roof and rib conditions not too bad.

(13) Complexly faulted area. This zone much narrower than that at Stop 12, but much more intense faulting. The largest fault is the 3-footer plotted by the company. Many smaller faults, both normal and reverse, are also present. Some of these trace to flexures in coal and shale. Most but not all faults reach the floor. In many places opposite-dipping faults intersect and either offset each other or merge into complexly fractured areas. The first impression is that the reverse faults are later than, and offset, the normal faults, but more study is needed.

No signs of horizontal bedding-plane movement except very locally on a small scale along flexures and reverse faults.

Several rolls to the east of the faulted area run roughly parallel to the faults. Mapping is needed to see if this is a general trend.

The faulting appears to be increasing to the north as a 2-foot reverse fault appears just west of the 3-foot normal fault.

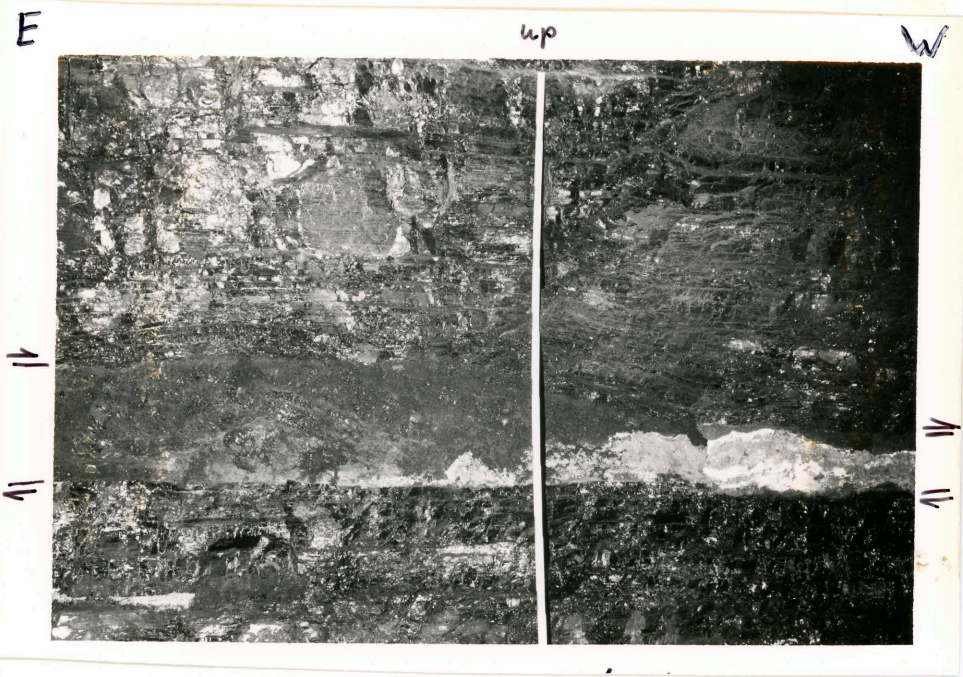
STOP 4

High-angle normal fault displaced by horizontal movement along bedding plane in coal. The upper block moved to the west (right) relative to the lower block. Note dull, fractured appearance of coal in upper block as compared to shiny coal with uninterrupted layering in lower block.

Photos by H.-F. Krausse using Nikonos underwater camera with 35 mm lens and Bauer electronic flash unit. Photo 2- south rib from 12 feet, B, f5.6-8.

Neg.#

mn_45_010.tif



STOP 4

Pulverized coal and clay found along zone of horizontal shearing. Zone is up to one foot thick. Upper half of coal seam moved to west (right).

Neg.# = Photo 3, south rib from about 3 feet, B, f8-11.

mm-45-011.tif

W

E

STOP 7

Overall view of north rib showing normal fault offset by horizontal movement along bedding planes. Sharp flexure in coal to lower right; unfortunately Fred's thumb got in the way. See Photos 8 and 9.

Neg. # = Photo 10, 15 feet, B, f 5.6

mm_45.012.tif

W

E

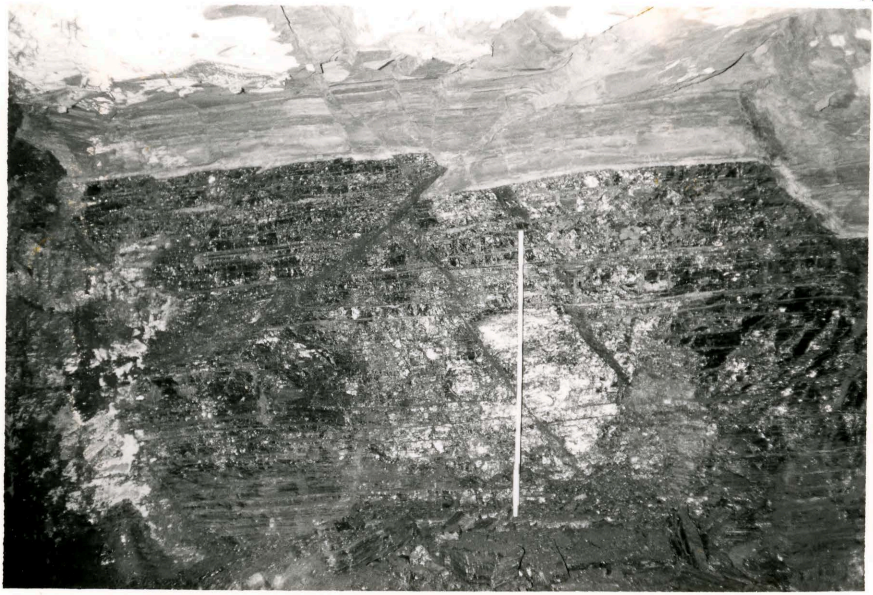
STOP 9

Complicated faulting of Anna Shale (dark, top) and Energy Shale (light, bottom). Both normal and reverse faults are present, and the shale is strongly folded and fractured. Note Anna Shale dragged sharply downward along faults at upper right.

Neg. # = Photo 11, north rib from 16-18 feet, B, f 2.5

mn_45.013.tif

E W



STOP 13

Small normal and reverse faults displacing the upper part of the coal seam and the roof shale. Coal is cut by numerous inclined fractures with little or no displacement.

Neg. # = Photo 12, south rib from 13 feet, B, f 2.5-4.

mn_45.014.tif

Photos 1 and 2

Faulted normal fault in Herrin (No. 6) Coal and Energy Shale Members (a) Normal fault displacing top of coal 5.5 feet (about 2 m) and trending 165/65W (b) Second fault is parallel to bedding (ss) in coal, very low ang l shear plane, which is situated on top of coal seam (right) and between top and bottom coal-benches (left). The displacement of the normal fault (a) was measured 20 feet (about 6 m). The fault zone parallel to bedding contains a layer of crushed and pulverized coal and locally "squeezed"-in clay material (? from the blue land?) Striations of slippage on the ss-parallel shear plane strike N15°E and plunge about 11°N. Lower bench of coal (below shear plane = footwall-bench) has slipped, "downhill".) Location: Zeigler # 4 mine, 1st main east, at main fault zone on "steep hill" to NE. (comp. also photos 9 and 10). Photo H.-F.K. 02-10-77

Photo 3

Fault zone ± parallel to bedding (ss) planes within the Herrin (No. 6) coal. Zone is "filled" with crushed and pulverized coal and a clay gouge in places. The deformed as "crushed" zone is generally 2 cm (1 inch) or less but in places up to a max. of 30 cm (1 foot) thick; and can be traced for 100m or more (several hundred feet). Location: Zeigler #4 mine, 1st main east, at main fault zone on "steephill" to NE. Photo H.-F.K. 02-10-77.

Photos 4 and 5

Fault plane (slikenside, shear surface with striations 07°/09° NNE) ± parallel to bedding (ss) planes in immediate roof (Energy Shale Members) of the Herrin (No. 6) Coal. Location: Zeigler #4 mine, 1st main east, at main fault zone on "steep hill" to NE. Photos H.-F.K 02-10-77.

H-F.K

Photos 7 and 8

Reverse fault with extreme drag fold in Herrin (No. 6) Coal. It is not an "upthrust", but an "underthrust" fault, becoming less and less steep leading into ± bedding parallel shear planes (comp. photos 10 and 9). Notice prominent cleats normal to ss and tilted underthrusted footwall-block. Photo is close up from parts of photo 10 (see hammer-handle in "bad spot of picture). Location: Zeigler #4 mine, 1st main east at main fault zone, on "steep hill" to NE. Photo H.-F.K. 02-10-77.

Photos 9 and 10

Multi-faulted normal fault in Herrin (No. 6) Coal and Energy Shale Members. Some shear zone as shown in photos 1 and 2. Main fault's strike and dip about 155-165/65-90oNE, displacement about 30 ± feet (10 m). Fault is accompanied by a number of ± parallel synthetic and antithetic faults 155-165/50-70SW or NE of these accompaning faults is shown in the photo, but it has been sheared into "fragments" along ± bedding parallel shear surfaces (comp. photos 2 and 8). Location: Zeigler #4 mine, 1st main east at main fault zone on "steep hill" to NE. Photo H.-F.K.

(*) with displacements at top of coal of several feet. One

Photo 11

Intensely and complexely deformed faulted and fault-folded shale about Herrin (No. 6) Coal. Section of Members: Brereton Limestone (upper left medimum gray material) Anna Shale (dark gray shales with fold structures)
Energy Shale (light gray shale at bottom of picture)
Herrin (No. 6) Coal (not shown in photo)
All material has been deformed as well ductily as brittly. Anna Shale fragments have been found within fault zones (see black streaks in fissures below center of ruler) This indicates or even proves that the faults are collapse fractures, open in the stage of forming and sometime later, after pieces of

sediments from above had fallen in, closed again, locally even showing compressional features. Location: Zeigler #4 mine, 1st main east, fault zone on "steep hill" to NE. Photo H.-F.K. 02-10-77

Photos 12 and 13

Normal and reverse faults cutting bottom of Energy Shale and top of Herrin (No. 6) Coal. Some of the faults are offset in the coal by small shear planes parallel to bedding, others merge into each other in "extension zones" of intersivly fractured coal. Whether the reverse faults offset the normal faults (as visible in the photo) and are younger ~~as~~ or not, has to be proved by more detailed studies. Location: Zeigler #4 mine, 1st main east (where coal seam lies horizontally again, east of "steep hill" just inby 2nd south panel, Photo: H.-F.K. 02-10-77

Photos 14 and 15 ← may not have come out - not w. neg. set PJO.

Main fault (30 feet≈10m displacement) cutting through Canton Shale Member (left side of photo, dark gray shales bedding ± horizontal and very little deformed, with some minor low ang l. normal faults increasing the lateral extension) and a very finely laminated, firm light gray brownish siltstone, which normally covers the Canton Shale (right side). Siltstone has fallen or been dragged into fault fissur r and tilted to almost vertical position of bedding. In Photo 15 also defomred under clay and base of Herrin (No. 6) Coal is visilbe (upper right corner) Location: Old Ben #24, West South Main fault area, northern most entry, northward. Photo H.-F.K. 02-11-77

ZEIGLER COAL CO. MINE NO. 4 WILLIAMSON COUNTY

John Nelson and H.-F. Krausse 8/15/77 Notes by J.N.

Mapping main faulted area in 1st Main East. Accompanied by Larry Harp, engineer.

1.) Pervasive horizontal shearing in the coal and at coal/roof contact all along this, the return air escapeway. Effects vary from thin bedding-plane shears looking like fusain partings to complexly sheared zones up to a foot thick. Locally even larger areas in the coal seam are folded and crushed. Rapid lateral changes in magnitude of shearing; a foot-thick shear zone may die out into simple bedding plane shear within 10 feet.

Several high-angle fractures with horizontal slickensides and fluting also seen. None of these could be traced laterally any distance and none cross the coal/roof contact (they may be sheared off by bedding-plane movement). If these are true strike-slip faults, as they appear to be, the amount and direction of movement cannot be determined.

Crosscuts on both sides of escapeway are packed with "gob" and roof and ribs are very bad in escapeway. Coal seam dips rather gently to the northeast.

See H.-F.K. notes for more detailed descriptions of individual structures.

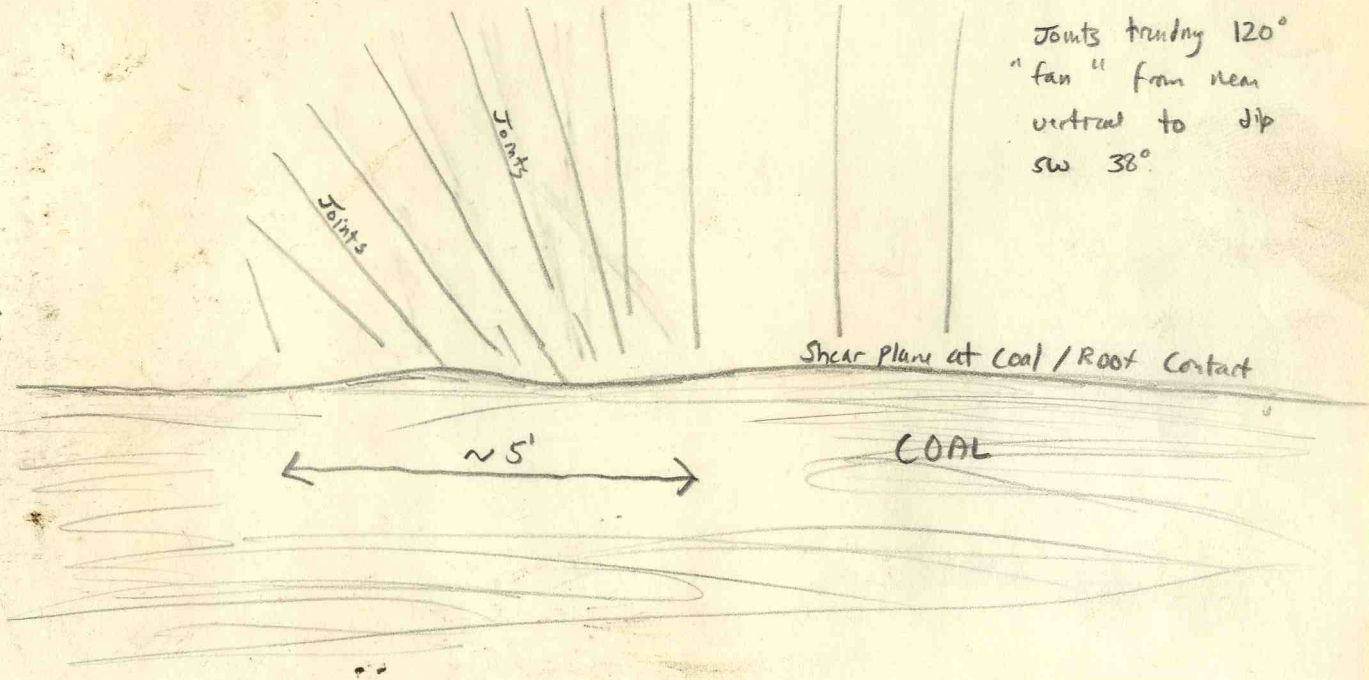
2.) Large roof fall at 3-way intersection with unusual structural features in coal and roof.

The coal on the east rib contains a series of high-angle fractures which show horizontal or nearly horizontal fluting and slickensides. These tend to curve and branch, and the coal is pulverized along them. Directional trends are 023/80° SE, 034/58° SE, and 033/88° SE.

There is a shear plane at the coal/roof contact

Stop 2

Looking SE at east rib of entry



FORM 180 W
MOORE'S MODERN METHODS

(3)

and locally this thickens to a crushed zone several inches thick. Vertical fractures do not cross this zone- they probably are truncated and displaced. Other shear planes within the coal seam are locally apparent.

About 10 feet of the gray shale roof rock is visible in the fall. It contains well-developed vertical jointing or fracturing trending 050° and 120. Locally these fractures "fan" (see sketch, over) This suggests that the fractures are tectonic and are dragged or rotated by the horizontal movements in the coal.

An examiner walking the escapeway tells me about an "override" that occured in the now-sealed Main 4th South Panel off the 1st Main East. The coal turned steeply uphill and a squeeze-like situation developed in which the roof apparently moved downhill, knocking out the stoppings sideways as it fell. The "override" stopped against a solid barrier pillar near the bottom of the grade.

If the examiner correctly described what happened the roof may have indeed slid downhill along pre-existing shear planes.

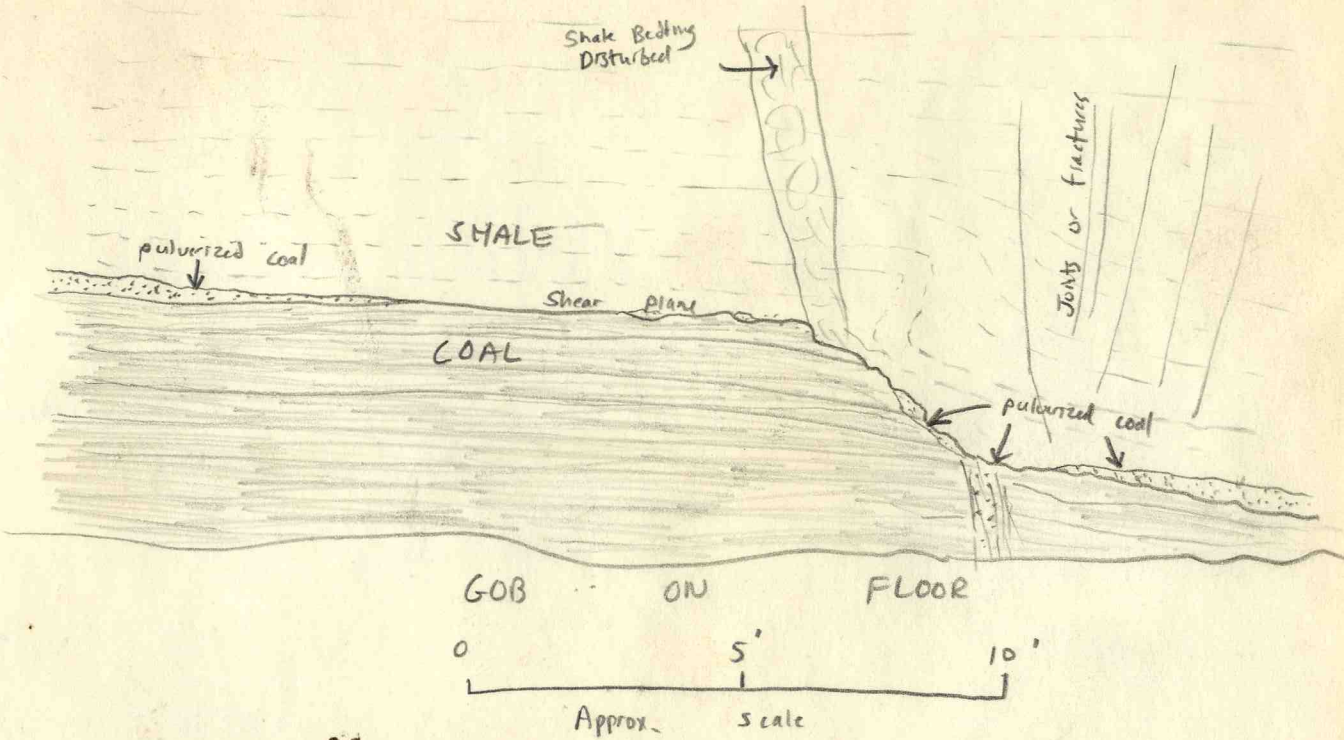
3.) Monoclinal structure in coal trending about 095 and seen on both sides of entry. Appears to become larger to west. The entry is driven part in the roof and part in the upper part of the coal seam, so the effect on the lower part of the coal cannot be seen.

As shown in sketch (over) there is a prominent horizontal shear at the top of the coal, with local zones of pulverized coal several inches thick. The lower few inches of the gray shale roof also seem to be crushed. The shear plane has been folded in the monocline. There is a steeply-dipping zone of pulverized coal and crushed shale. This appears to have been offset slightly with the lower part

Step 3 – Structure on West Rib.

S

N



(4)

FORM 180 W
MOORE'S MODERN METHODS

having moved to the north. Unfortunately not enough of the coal is exposed to tell what happens to this fracture zone downward.

This appears to be a case where a horizontal shear has been displaced by later movement. Or, perhaps more likely, vertical and horizontal movement were simultaneous.

We saw this structure earlier this year on a reconnaissance visit, but we did not recognize it for what it is.

4.) Sketch of main fault. It is a reverse fault with at least 32 feet displacement. Note strong drag on footwall. See earlier notes on this fault.

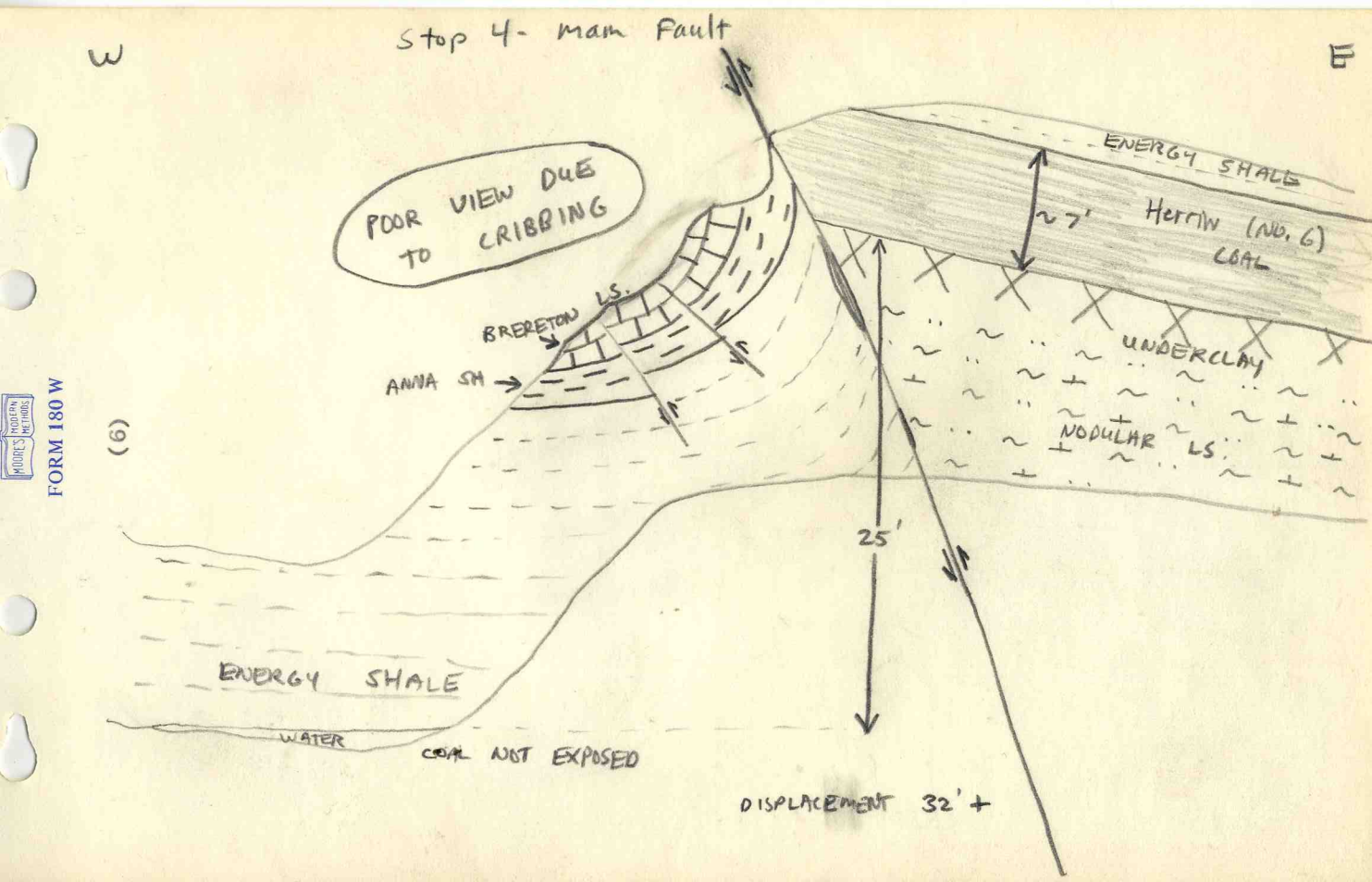
5.) Entry driven in Energy Shale (roof of coal). Top of coal not visible and shale lacks marker beds.

Numerous high-angle fractures trending 150. Some of these definitely displace the rock, but cannot determine how much or in what direction. Sideritic bands are definitely offset. The shale is locally intensely fractured and crushed by movement.

Note also closely-spaced vertical joints or fractures trending 080-100. These have curving planes. Probably they are related to faulting.

6.) Top of coal seam exposed near floor of entry. Apparent horizontal shear plane at coal/roof interface. The contact is very irregular with the upper inch or two of the coal pulverized and the lower inch or so of the roof shale altered to a sticky claylike material. At one place striations trending 040-041/8 NE are seen on a bedding plane 0.1' below top of seam.

7.) Very persistant fault of small displacement trending about 140/90. On the north rib it is offset by horizontal movement at the coal/roof contact. The coal apparently moved 1.1' to the NE relative to the roof. The coal dips steeply to the



FORM 180 W
MOORE'S WESTERN NOTEBOOKS

northeast in this area. Striations in the roof trend 150. Not sure if this is the plane of displacement.

The vertical fault is easily traced across the roof to the southeast. It is made up of a series of closely-spaced "enechelon" fractures.

Persistant 090° jointing also present in the roof.

8.) Large roll affected by both vertical and horizontal shearing. The roll is roughly 20 feet wide and trends NE-SW. At its deepest point it cuts 2-3' into the coal. It has large, splayed-out coal "riders" on both sides and smaller "riders" and detached coal stringers in the central area. Large compactional slips form a graben near the center of the roll.

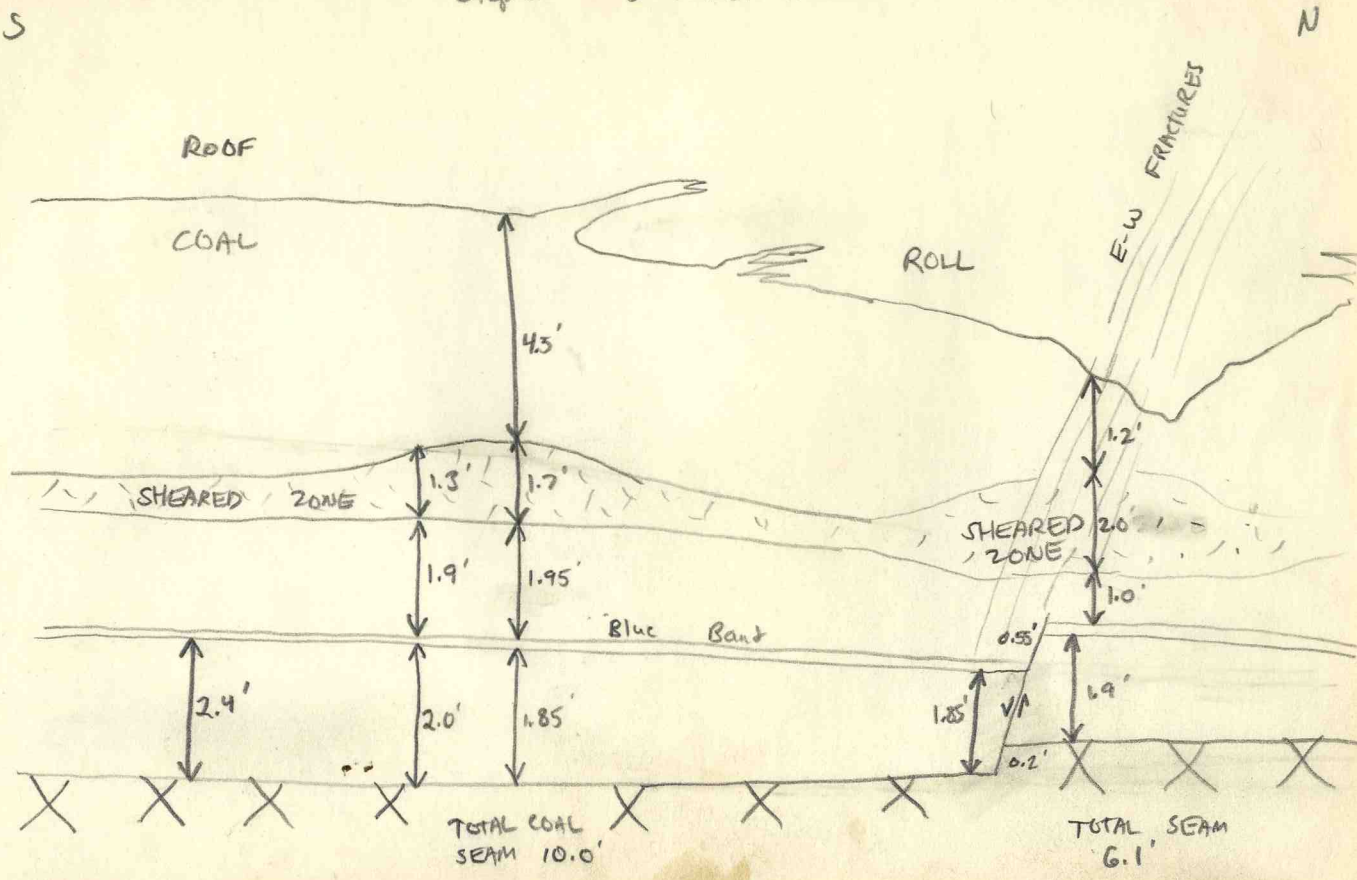
The vertical fractures trend about 080° and cut near the center of the roll on the west rib of the crosscut. The coal and roof appear to be sheared but displacement, if any, is very small. It is difficult to distinguish here between compactional and tectonic effects.

There is locally intense shearing along bedding planes in the coal with crushed zones or lenses up to 2 feet thick and many feet long. The main zone of horizontal shearing is near the middle of the coal seam but some shearing may have occured closer to the floor.

The structure is so complex here that we have much trouble deciphering it. We cannot determine the order of structural events, though it appears nearly certain that the roll is a sedimentary/compactional feature older than the vertical and horizontal shearing.

Rib rash is severe in this area of steeply dipping coal. No major roof falls, but there is much loose rock along the ribs, especially on the downhill side of entries.

Stop 8- West Rib of Crosscut



FORM 180 W (8)
MOORE'S MODERN METHODS

Continue mapping fault area 9/16/77.

9.) Persistent 080° fractures in roof. Fractures are vertical or steeply dipping, parallel or "en echelon". Most look like ordinary joints but in places they are more closely-spaced and shear both coal and roof. These have vertical slickensides and some have small displacement (an inch or so).

Continued horizontal shearing in middle and mid-lower part of coal seam. Mostly this shows as simple bedding-plane shears, but there are local thicker zones of crushed coal.

10.) Coal seam gradually levelling off to northeast, and effects or vertical and horizontal shearing are dying out. Roof fractures are short and discontinuous. The coal appears locally somewhat fractured and the cleat is inclined, but no shear surfaces are seen.

The roof is slabby medium-dark gray shale with abundant carbonaceous plant debris on bedding planes.

11.) At east edge of map area the coal dips gently northeast. The area is remarkably free of structural disturbance, either tectonic or soft-sediment. Very discontinuous east to southeast-trending fractures in the roof, and occasional bands or zones of crushed-appearing coal (possibly fusain) are all that can be seen. The roof shale looks very uniform and contact to coal is even and regular. Both roof and ribs are stable, with very little rashing.

12.) Note slight water seep on south rib midway in coal seam, with bands of crushed coal or fusain. Possibly the result of horizontal shearing.

13.) Probable horizontal shear zone 0.1-0.2' thick, with pulverized coal, 4.0' below top of coal seam. Coal dips steeply NE. Roof lacks definite jointing or faulting.

14.) Shear plane trending 140/85° NE with both horizontal and vertical slickensides. This appears to die out downward in the coal and it ends abruptly at the top of the coal where it may be cut off by horizontal movement.

Perhaps some or all of the apparent strike-slip faults we see began as vertical fractures and later became planes of horizontal movement, simultaneously with the bedding-plane shearing.

15.) Entry driven in Energy Shale west of main fault, with Anna and Brereton Limestone at roof level. See notes of earlier visit to this place.

As noted on earlier visit this area is complexly faulted and some of the faults show very peculiar drag and squeeze.

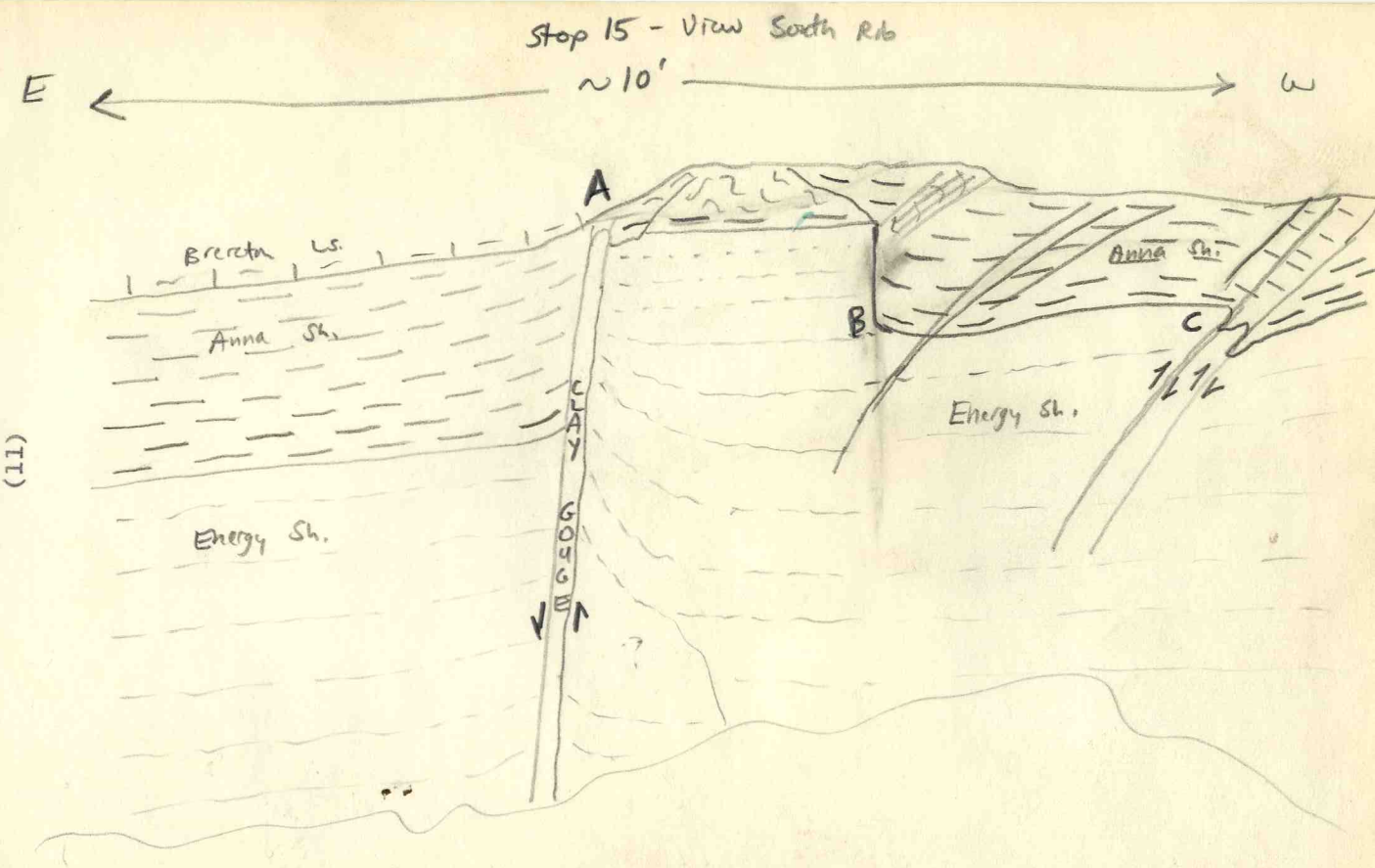
Sketch (over) shows faulting along part of the south rib. Note strongly upturned bedding in the Energy Shale west of Fault "A". With normal drag we would expect this shale to be folded downward. Either we have a fault that has reversed direction of movement, or (much more likely I think) there has been horizontal movement squeezing rock layers up against the fault plane.

We have observed similar wrong-way drag, apparently due to compression (lateral) in the 6th North off the 2nd SE Mains at Freeman Orient # 4.

Structure "B" in the sketch at first appears to be a simple normal fault, but on close inspection I could not trace a fault plane either above or below the Anna/Energy Shale contact. Possibly there is a fault plane, disguised by weathering. But I think this is a fault displaced by horizontal shearing and/or folded.

At "C" is a series of small reverse faults with "wrong-way" drag or tilting of beds on either side, again perhaps due to later horizontal movement.

Some bedding surfaces in the Anna Shale and at the Anna/Energy contact are polished and at one place N-S striations were observed at the Anna/Brer-



FORM 180 W
(11)
MOORE'S MOUNTAIN METHODS

MOORE'S MODERN METHODS
FORM 180 W

eton contact. These lithologic contacts would be expected to make good surfaces for horizontal movement.

Additional complication is added by the presence of two directions of faulting. See Note 16. We did not previously recognize the east-west faults in this area.

Roof and ribs are loose and dangerous, hindering detailed study of this area.

16.) See sketch map (over). Two directions of faulting, intersecting and apparently displacing each other.

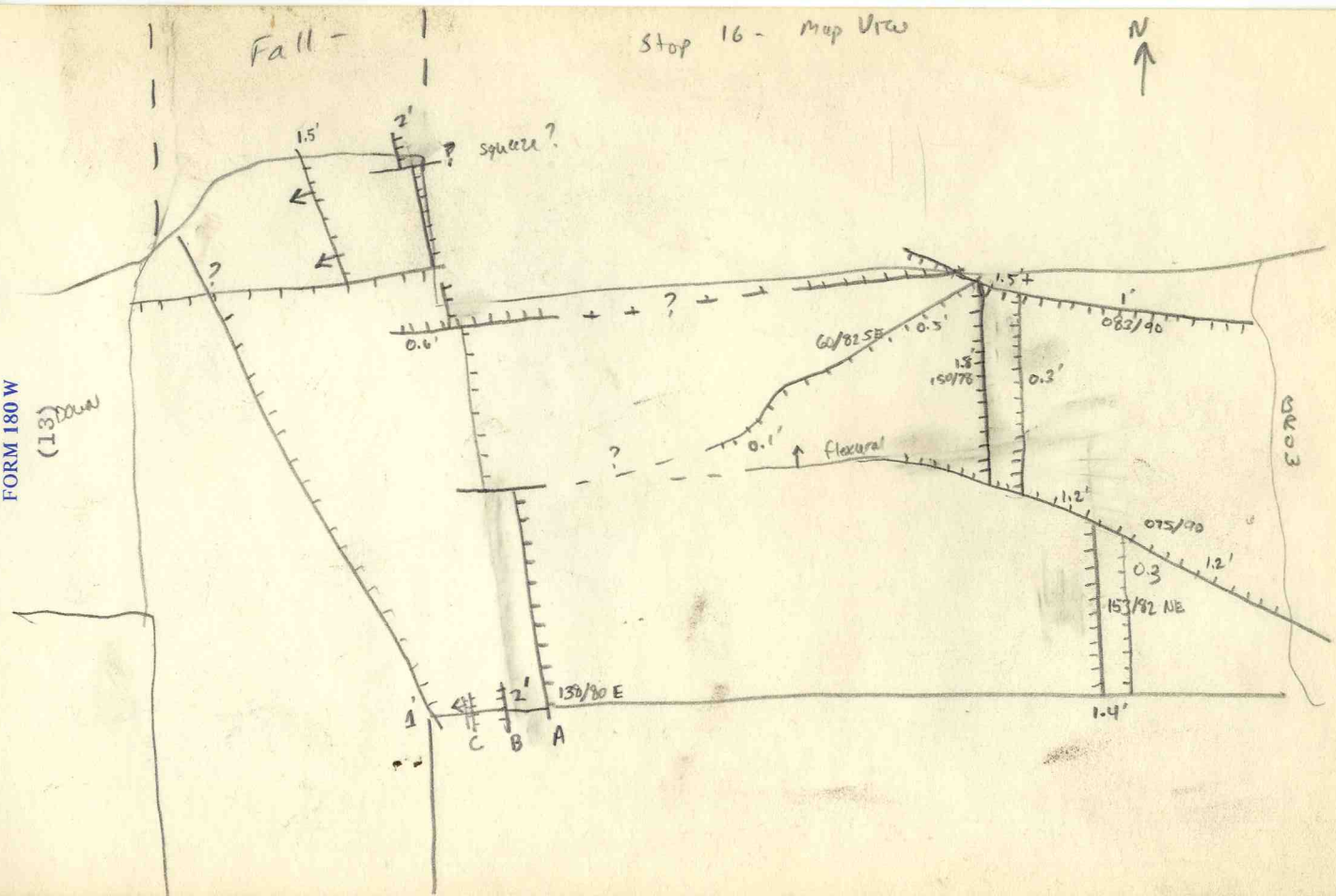
In most of the area shown in the sketch map the roof is formed by the base of the Brereton Limestone withsome clinging Anna Shale. The ribs are formed by Anna and Energy Shale. Faults trending about 150°, roughly parallel with the big reverse fault just to the east, are quite apparent.

But there is a second set of high-angle faults trending about 080°, roughly at right angles to the main set. These intersect the 150° faults and appear to displace them with left-lateral movement.

We are running out of time for this visit, and will have to return to continue study of this fascinating area.

My first impression is that the 150° faults formed first, parallel with the big 32' reverse fault and the folding of the coal. A second set of vertical fractures more or less at right angles to the main faults probably formed at this time also. These 080° fractures are seen through most of the mapping area.

Later the area was subjected to horizontal shearing, either as a result of renewed tectonic movement or gravity sliding. This produced horizontal shears on bedding planes and also strike-slip movement along the pre-existing 080° vertical fractures.



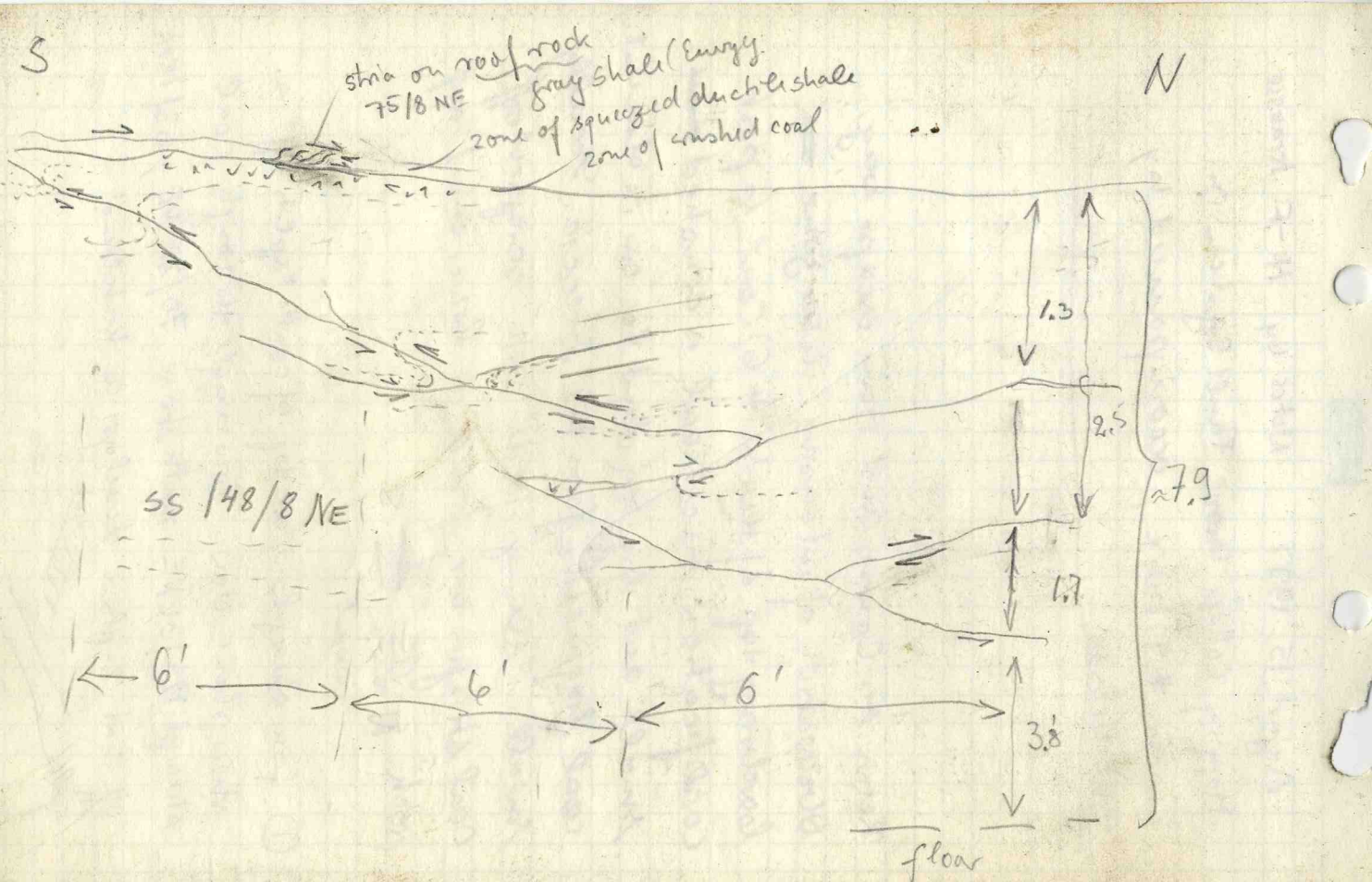
FORM 180 W
MOORE'S MODERN METHODS

August 15 1977 Notes by H.-F. Krausse

Mapping Collage Grove Fault System in Ziegler #4 mine, accompanied by J.W. Nelson

Return Air Course and main escape way. Observation of intensive shear zone ~~in~~ bordering top of Herrin (#6) Coal is post coalfication since coal is crushed ~~and~~ small and big ~~pa~~ (dent to cm in diameter) coal fragments form the breccia. Locally small "slump folds" with scraped off coal stringers are found in lowermost roof rock.

① from shear plane at top of coal "split off" a shear plane down low angle through coal shear pl 125/31 NE with striae 70/22 NE; 63/18 NE off that s-plane develops a kinkband


S
N
striae on roof rock
75/8 NE
gray shale (Emgy.
zone of squeezed dark shale
zone of crushed coal
1.3
2.5
≈7.9
1.7
SS 148/8 NE
6'
6'
6'
3.8
floor

Zeigler #4

(1) see map!

August 15/77

(1) Ad

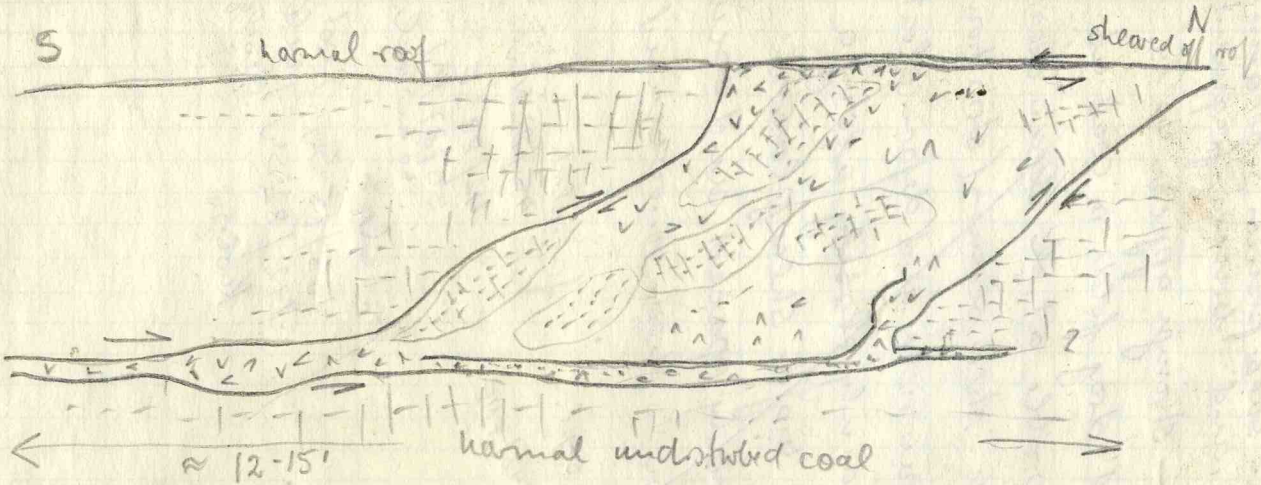
cleats are older than shear planes because they are disrupted and breccia-fragments also show cleats — strongly appears to be the "soft sediment" drag folds in coal at the shear planes visible at ~~the~~ clean cleat surfaces. At places shear planes (striations on shear planes override and deform cleats. At other places, mainly ~~closely~~ along a zone close to the major shear planes cleats are very densely spaced and occur oriented in relation to shear movement

Face cleat
45/82 NW
42/88 SE
50/87 NW
not measured

Butt cleat
135/85 SW
143/82 SW
not well developed

other cleats
170/85 NE (Kaolin)

5



Station (2) downhill over thrust of coal on coal
tilted bleder of coal "swim" in finely crushed or ~~ore~~
pulverized coal breccia. main or major shear plane
is very hard while upper portion are ~~more~~ less compacted
roof rock gray (Envoy Shale) almost undisturbed
joints 110/75 SW

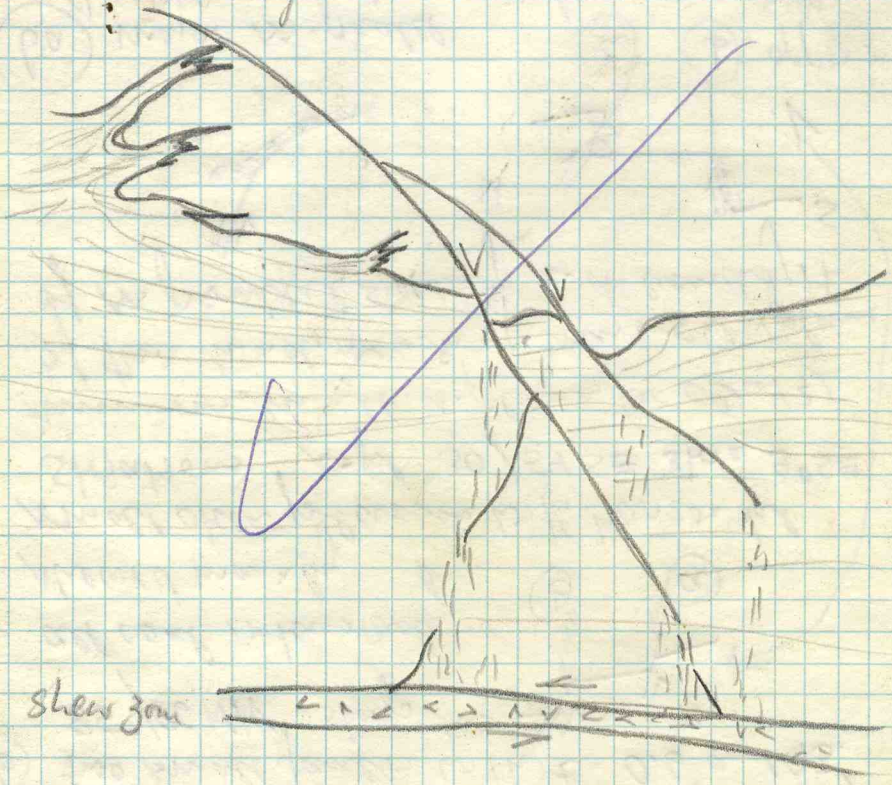
August 15/77

(3)

Shear zone is still within coal about 3.6' from top of coal and 0.3' thick crushed coal

No # "3a" on map.

Rolls trending 105° double-roll



Role and dark fault + joint board is older than the shear zone.

(5) coal seam rather inclined

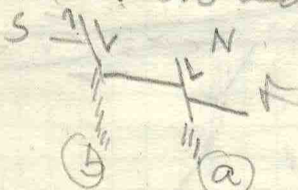
ss 100/11 NE

cleats are all tilted str 85/60 S

joints 80/49 S

(6) two small faults with t.=0.6' and 0.3'

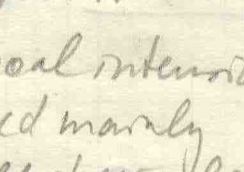
85/86 NW steep!

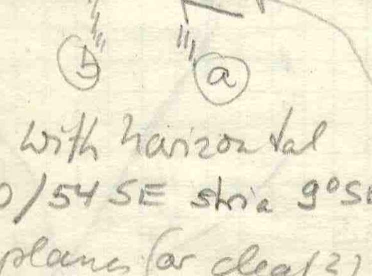


all coal intensively sheared mainly

small shear planes with horizontal striations s-pl. 30/54 SE stria 9°SE

numerous small s-planes (or cleat?) of this trend, reaching main shearplane of ss parallel shearing a.d. bending it





(6a) major ss-parallel shearplane 4.8' beneath roof of bl. gy sh.

(a) thrust due to slippage downhill is tread!

(b) opposite pillar

August 15, 1977

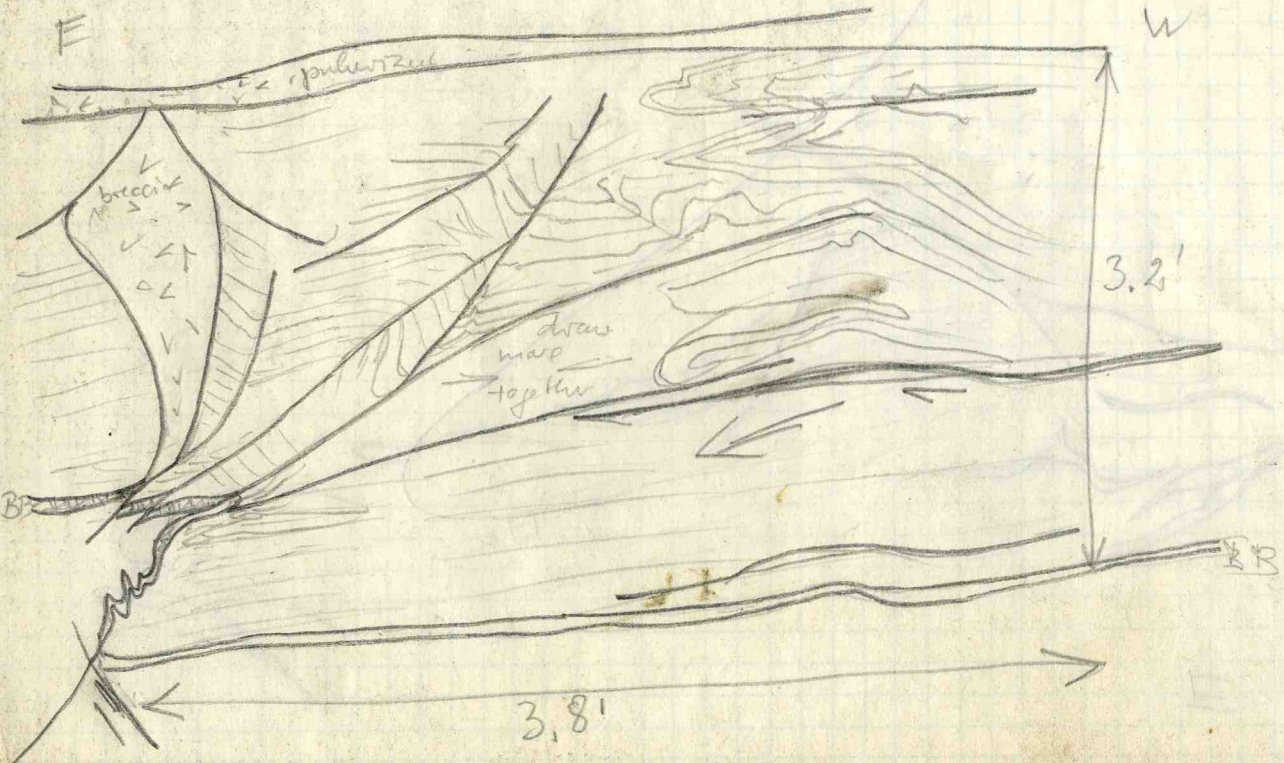
(7) by Roll

Roll and coal underneath is truncated by E-W trending minor faults

Major, ss-parallel s-plan is still there zone of 17 thickens and contains folded + pulverized coal

(7a) John has more details on measurements

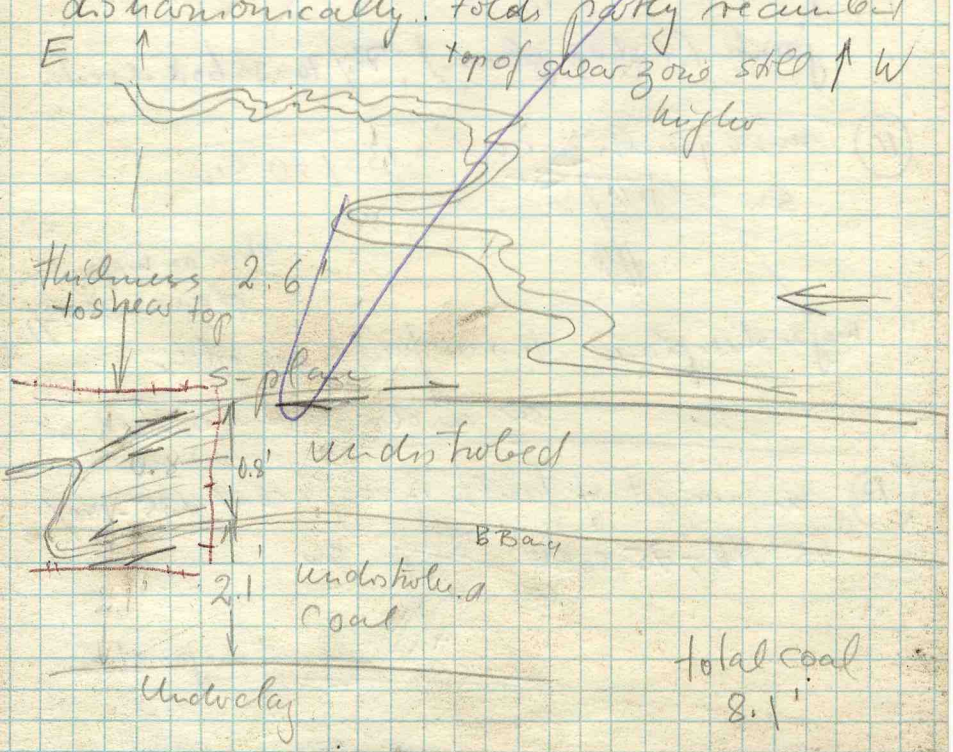
at station 8a



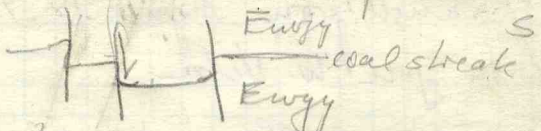
August 16, 1977

Zeigler #4 Return Main escapeway continued from August 15, 77 together with Jon W. Nelson

(8) major s-plane parallel to ss is still existing and well developed at this point coal is separated into to ten 0.5 - 1 cm laminae and folded very disharmonically. Folds pokey recumbent



(9) high angle mini-fault double - spaced with filling of altered shale (very soft) coal streaks in roof rock are off-set

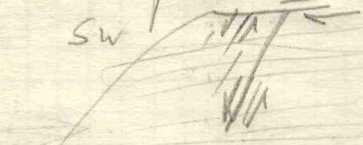


faults 78/73S
81/85S

(10) striations in the roof rock on bedding planes Li 45/14° NW

joints (+ shear plans) 78/70-90 both directions

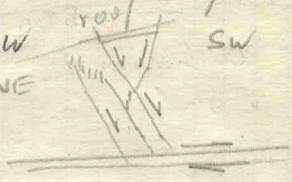
(11) minor faults in coal 135/70 SW



stria on major shear plane 38-42/12 SW

major shear plane minor faults are older or as old as major shear pl.

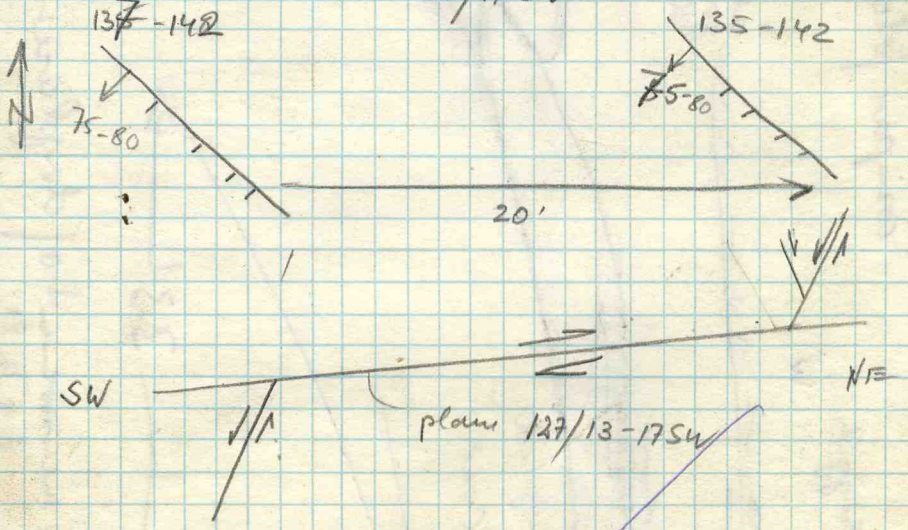
(12) minor set of faults in roof + coal 135-140/45° NE - 75-80 SW



stria on major shear pl 128/17 SE
37/17 SW

(11 and 12) on major shear plane 127/28SW minor faults have been displaced

Strie 37/17 SW



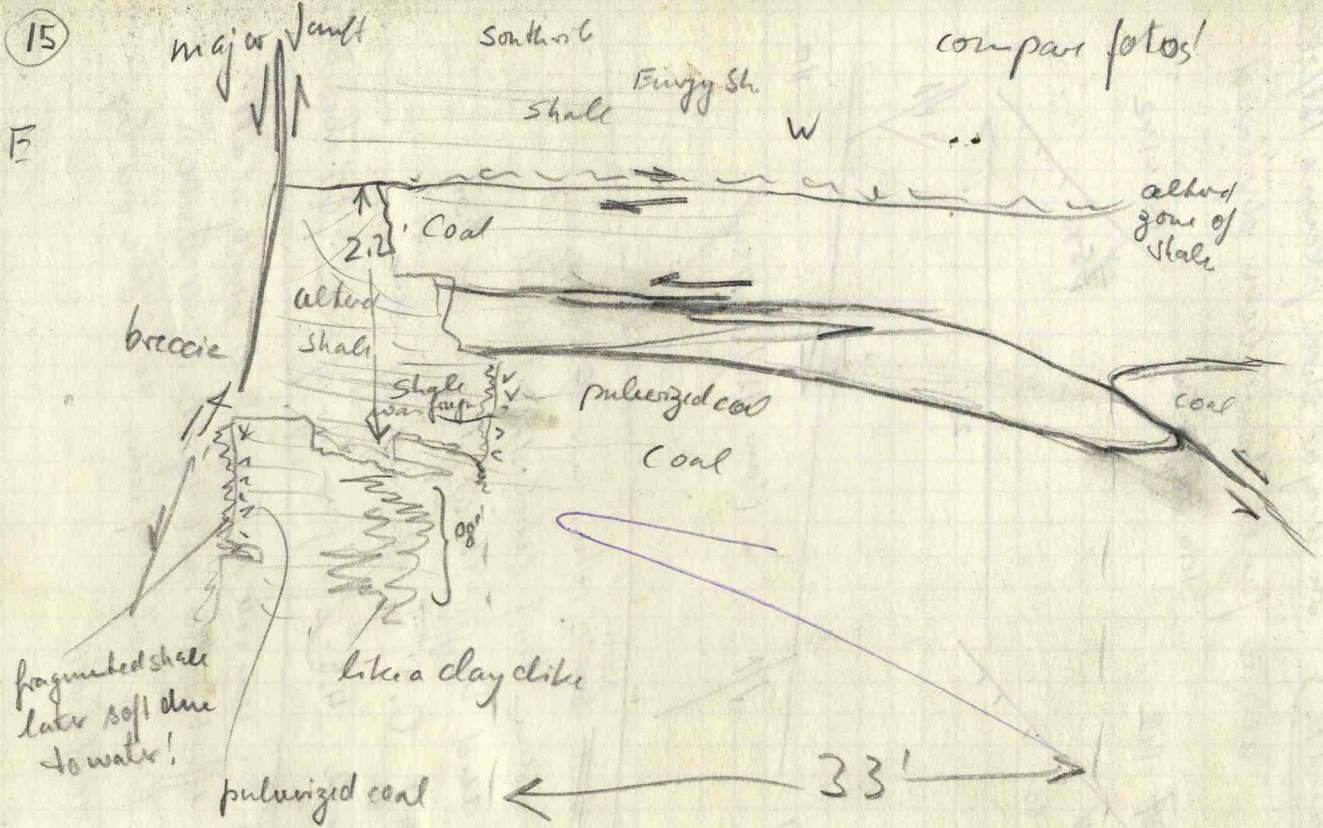
(13) ~~North~~ ~~South~~ North return air escapeway seam has heaved out well and major shear planes are now

#1 0.9' from top of seam

#2 4.6-5.0' from top of seam; 0.7' above BB

(14) Big wide roll in Energy Shale hardly at all effecting the coal top, but will trouble in Energy Shale roof rock. total area one cy roof fall.

15

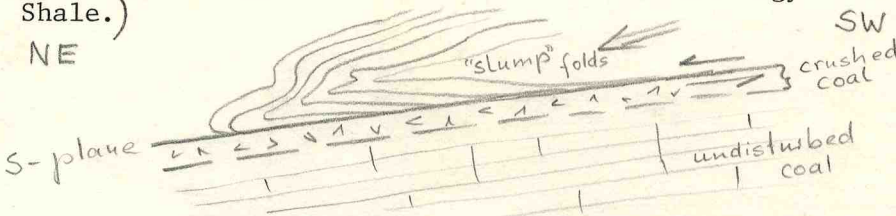


at opposite rib (N-116) measured displacement
t = 4.8'

Zeigler Coal Co. U. G. Mine No. 4, Williamson County/ Ill.
Mapping in Cottage Grove Fault System
August 15, 1977 H.-F. Krausse (notes) and J. W. Nelson

Location: 1st Main East in return air course (escape way) north and south of belt and track entries (intake) at steep hill; station number as indicated on mine map.

General Geol. Setting: Coal seam thickness is not determined, because shearing ± parallel to bedding may have reduced or increased coal thickness. At hill the coal bed dips towards the NE (ss 50/10NE) in places as much as 88°/16°NE strike and inclination. Shear planes or shear zones ± parallel to the bedding are found within the coal as well as interface between coal and roof rock. These shear planes are younger than coalification and lithification, since coal has been found crushed to small and big (mm to cm diameter) coal fragments or pulverized, forming a breccia. Locally also small "slump" folds (soft sediment def.) with scraped off, yet almost unbroken coal stringers are found particularly in lowermost layers of roof rock (which is Energy Shale.)

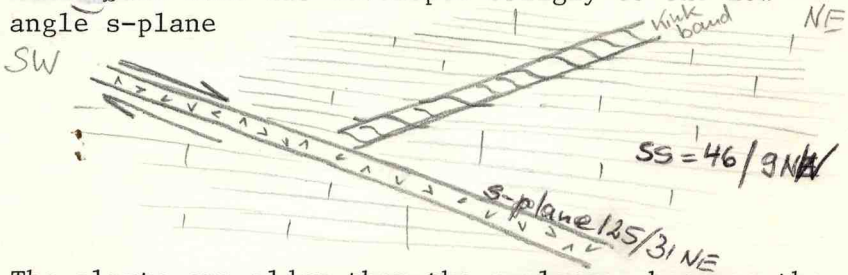


In some places the bedding parallel shear planes cut through and displace older high angle normal faults.

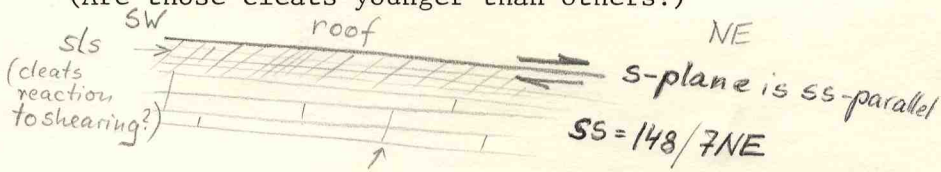
bedding parallel = ss-parallel
shear plane = s-plane
bedding plane = SS (or) ss
cleats normal to bedding = scr
-"- obliquely to -"- = scls

Zeigler # 4

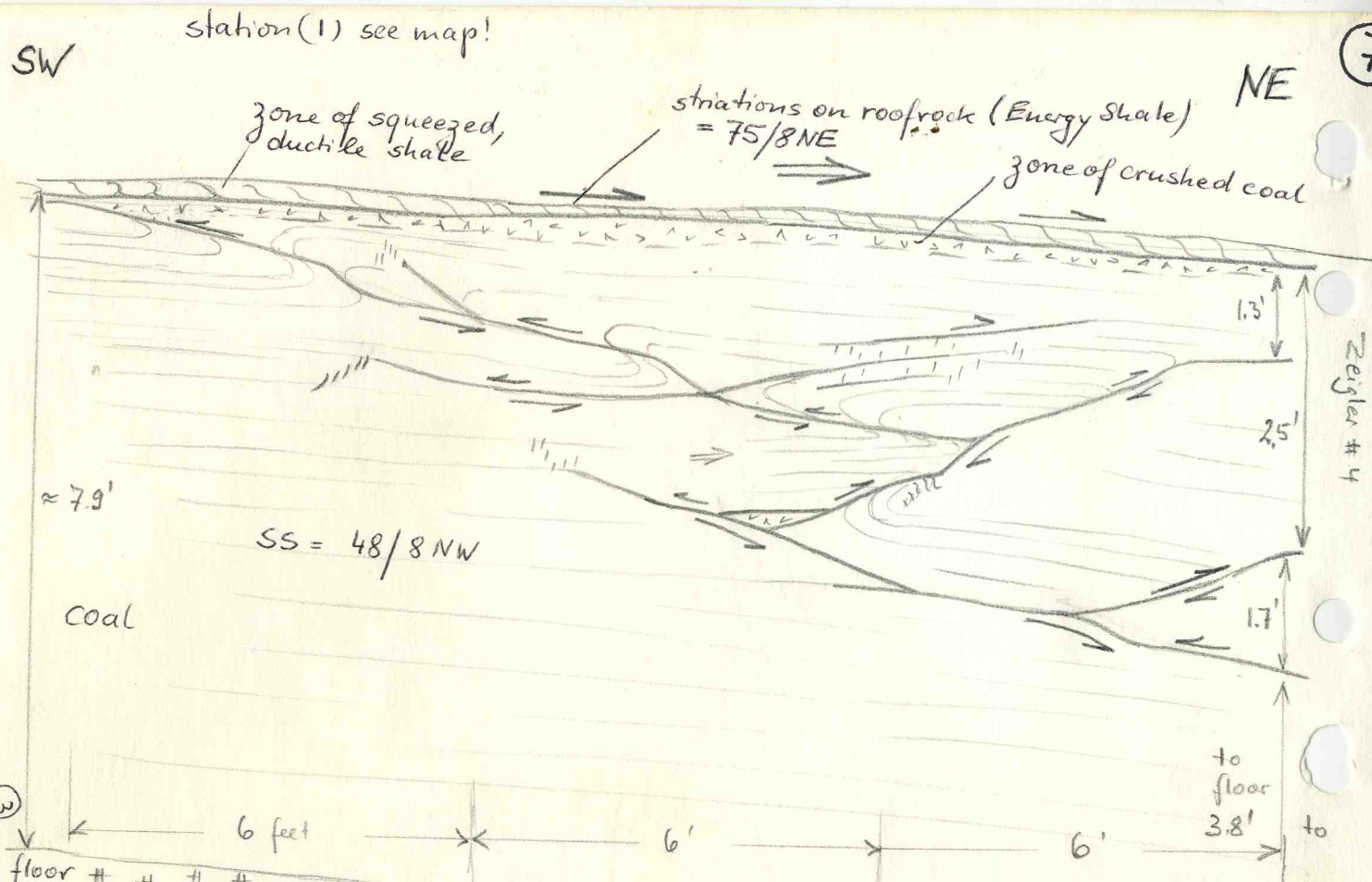
(1) South return air course: Major shear plane forms interface between top of coal and roof rock. From this bedding parallel shears plane (s-plane) branches off another low angle s-plane downwards through coal (s-plane: 125/31NE with striations of movement 70/22 NE; 63/18 NE. As stress relief a kink band zone has developed obligly to the low angle s-plane



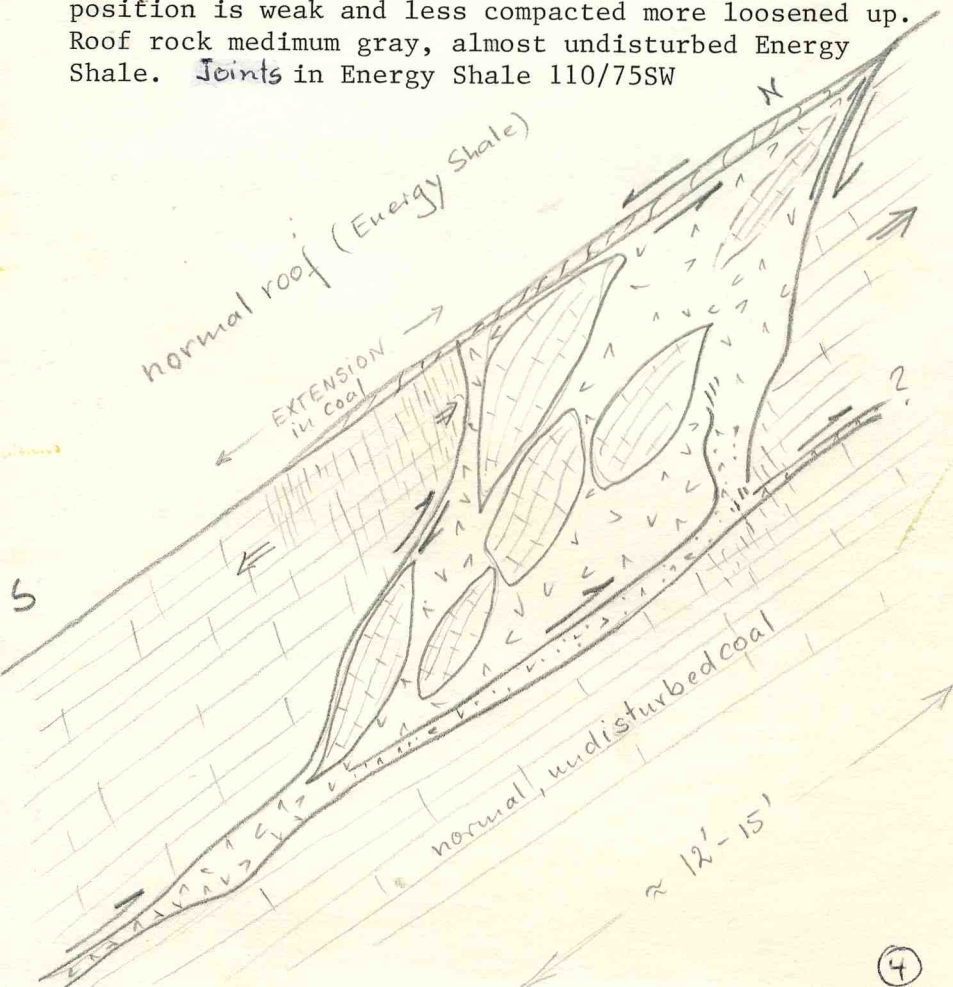
The cleats are older than the s-planes, because they have been disrupted and larger breccia fragments, which are tilted or rotated, also show cleats being rotated along with the fragment. - Somewhat strange appears to be the ("soft sediment") drag folds in the coal in direct connection with and at the s-planes as visible at clean cleat surfaces. - At places s-planes (striations on s-planes) override and deform cleats; at other places, mainly along a zone close to the major s-planes, cleats are very much more frequent and very densely spaced, they occur oriented in relation to and influenced by the shear movement (Are those cleats younger than others?)



face cleats:	butt cleats	other cleats:
45/82NW	135/85SW	170/85NE
42/88SE	142/82SW	166/83NE
50/87NW	138/79SW	Kaolin mineralizatio
46/83NW	(not well developed)	
no mineralization	Kaolin mineralization	

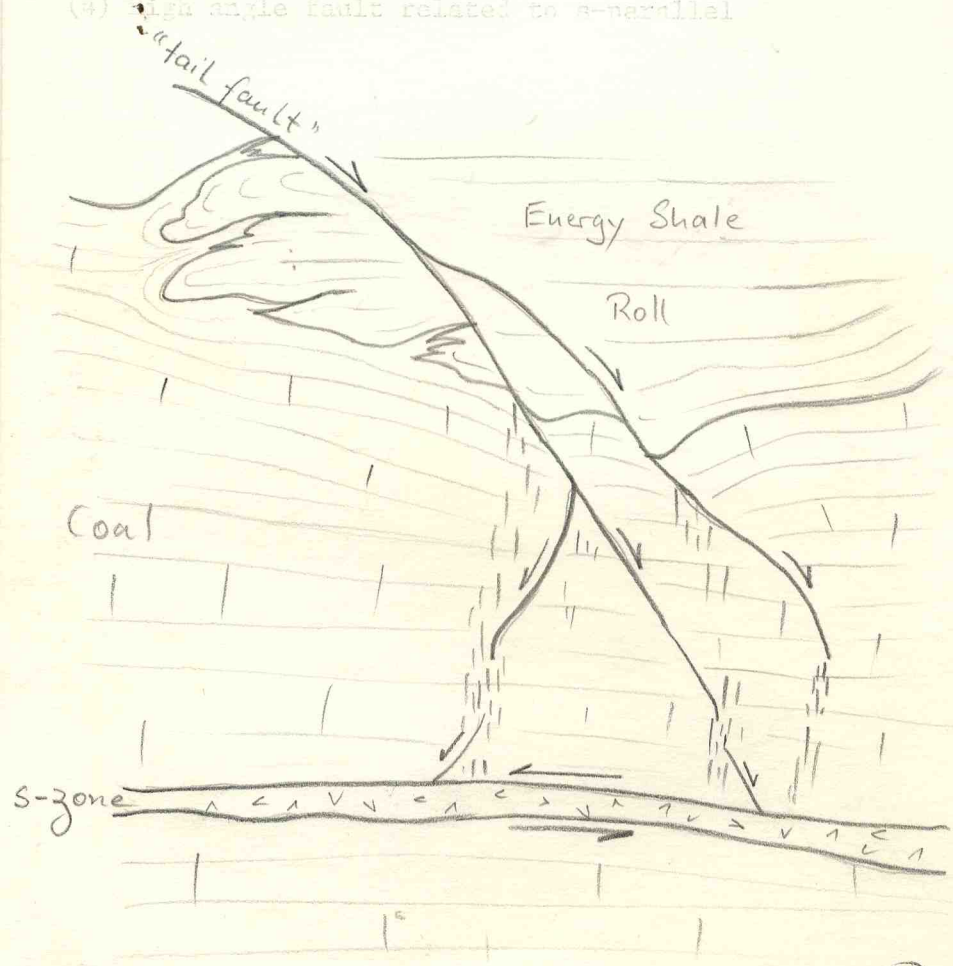

station (1) see map!
SW
NE
zone of squeezed, ductile shale
striations on roofrock (Energy Shale) = 75/8 NE
zone of crushed coal
1.3'
2.5'
1.7'
Zeigler #4
≈ 7.9'
SS = 48/8 NW
coal
6 feet
6'
6'
to floor 3.8'
to
floor

(2) Change of position of major ss-parallel s-plane (ss-parallel = parallel to bedding) from interior of coal bed to top of coal.
The upper bench of the coal have been sheared downslope from SW towards NE, at this point s-plane "shifts" along two low angle reverse faults to top of coal and only roof rock has been sheared off. In disturbed zone of low angle s-planes tilted blocks of coal "swim" in finely crushed or even pulverized coal breccia. Zone along major shear plane and below it contains very hard compacted well bedded coal, while upper position is weak and less compacted more loosened up. Roof rock medimum gray, almost undisturbed Energy Shale. Joints in Energy Shale 110/75SW



(3) Shear zone, ss-parallel, is still within coal, about 3.6' from top of coal and 0.3' thick, filled with pulverized and crushed coal.

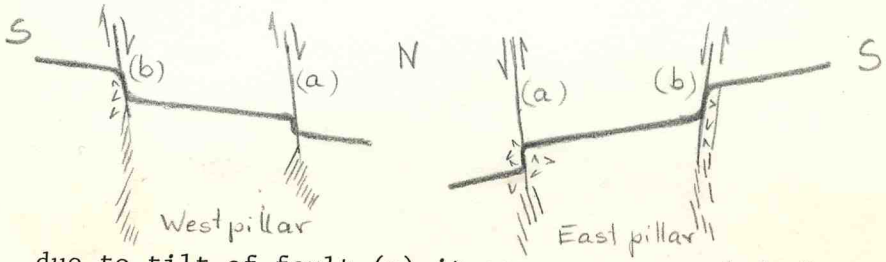
(3a) Location just south of (3) but beyond reach of map: Rolls trending 105°, (in form of double-toe rolls) Roll, compactional tail fault and goat beard fractures are older than the s-parallel s-plane, which indicated previously mentioned features.



(4) High angle fault related to ss-parallel s-zone, probably extension fault due to differential movement downslope and collapse of beds. J. W. Nelson has more details.

(5) Coal seam is rather inclined ss 100/11NE; cleats are all somewhat tilted: slr 85/60S
Joints in Energy Shale :80/49S

(6) Two minor faults, high angle: 85/86NW with vertical displacement t= 0.6' and 0.3'

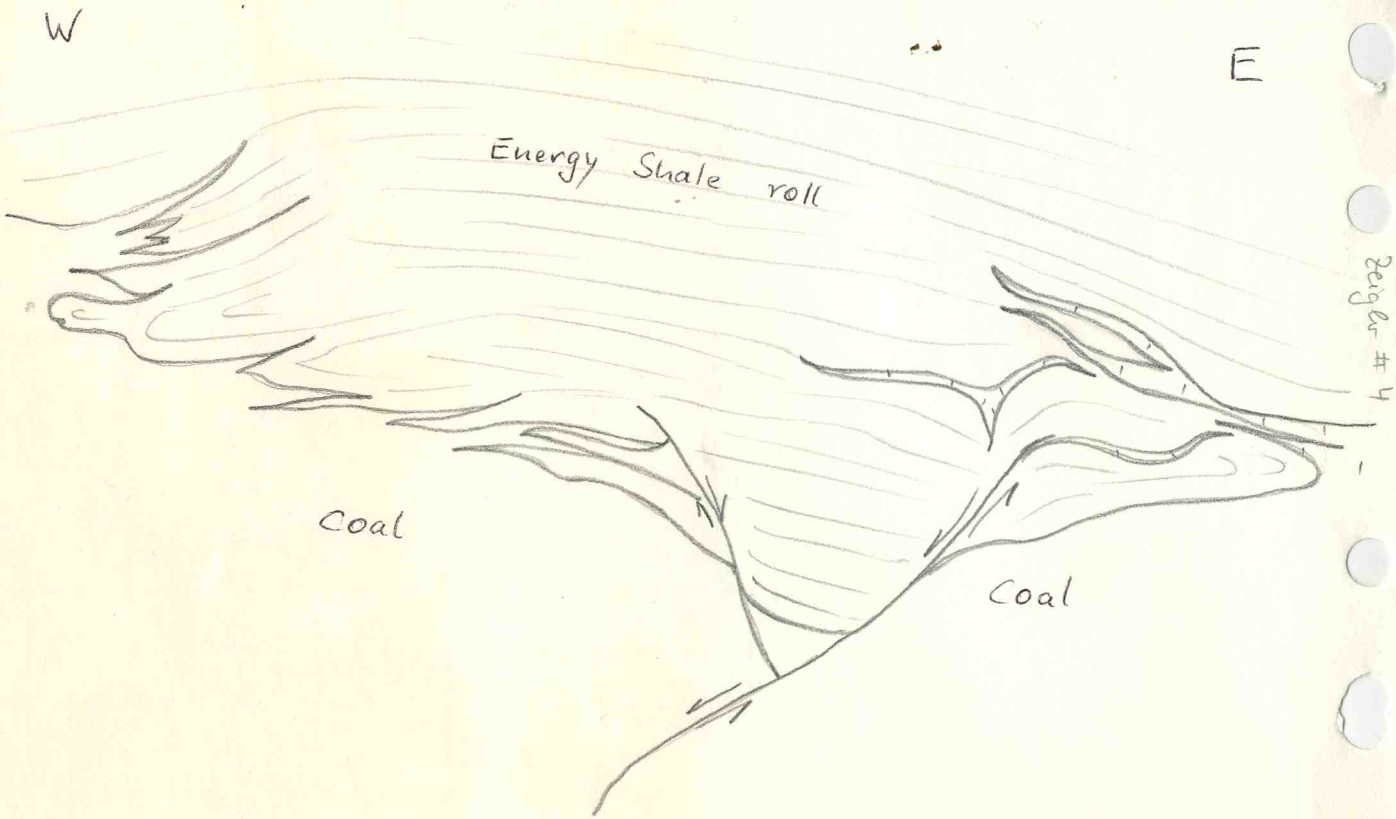


due to tilt of fault (a) it occurs as normal fault on west pillar and as reverse fault at east pillar. The tilt probably is caused by down-slope slippage along ss-parallel shearing of beds.

All coal is indensively sheared mainly along minor s-planes with horizontal striations. s-pl 30/54SE striations on this plane plunge 9° SE. Numerous small s-planes of that kind branch into major s-plane of ss-parallel shearing "bending" it at the junctions.

(6) Major ss-parallel s-plane is 4.8' beneath the base of the Energy Shale roof.

station (7) see map!



Zeigler #4

(7)

Bergler # 4

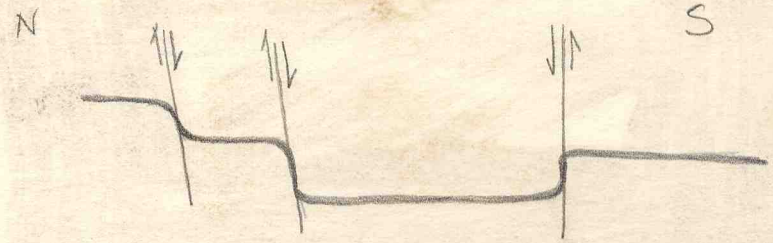
(7) Large roll of gray Energy Shale in top of coal, 5' down into coal at north side. Roll is a double-toe roll (soft sediment folded and deformed shale at both toes, no real tail of roll developed.) Main body of roll is wedge shaped with nearly horizontal bedding in it. Usual compaction faults (normal throw) at eastern third form small graben at bottom of roll and on top coal. East-west trending minor high angle normal faults (see map) seem to be younger than the roll because they truncate the roll and the compactional toe - fault. Both are truncated by ss-parallel s-plane, which is thicker here and contains as well folded coal laminations as pulverized and brecciated coal.

(7a) See J. W. Nelson with details

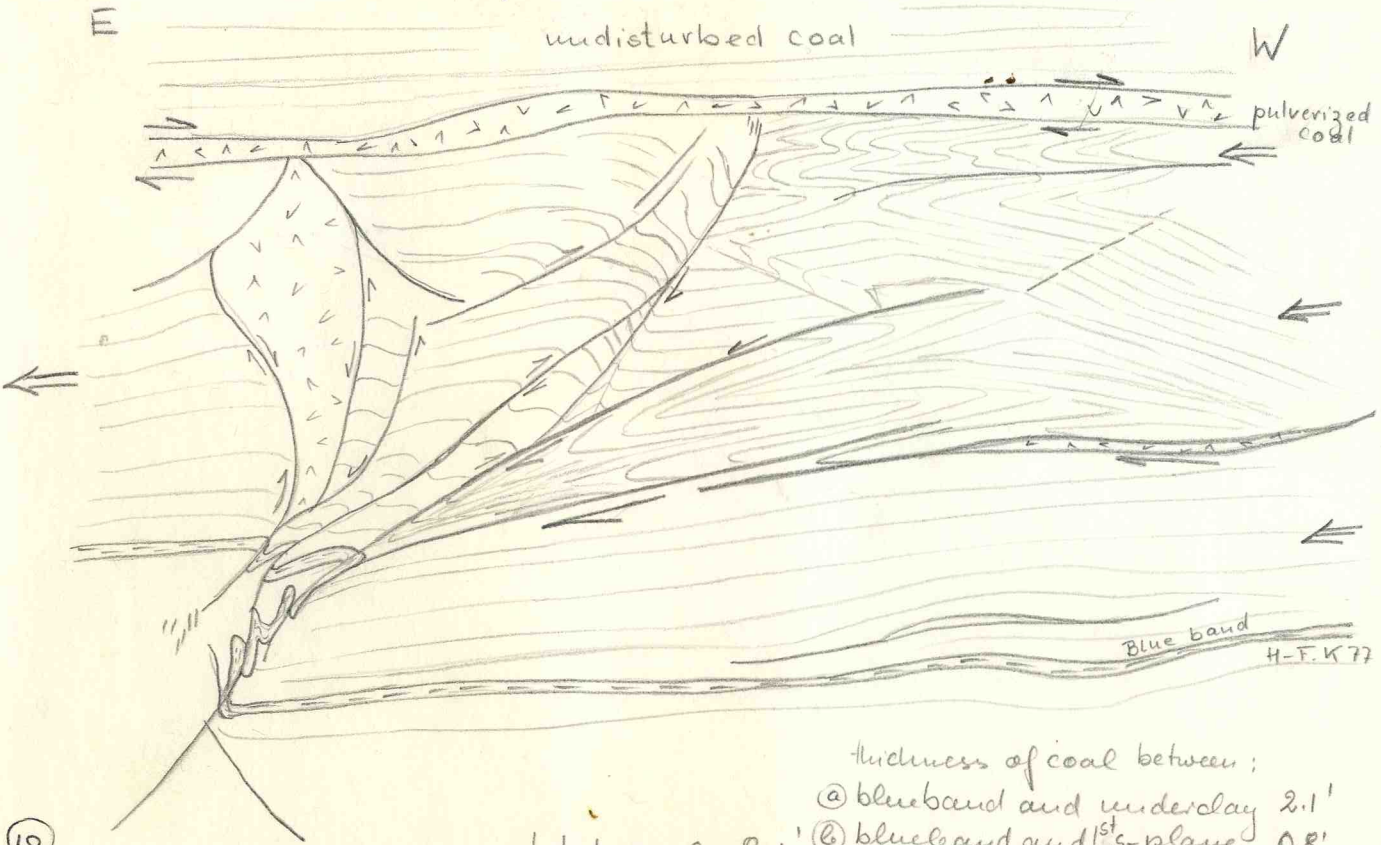
August 16, 1977 (ctd. from August 15, 1977)

(8) At this point major ss-parallel s-plane is still existing and indeed well developed as shear zone. Coal has been separated into thin 0.5-1cm laminae and folded very disharmonically. (see sketch next page) Total thickness of coal 8.1'

(9) High angle minor fault "double -spaced" with a filling (gauge?) of altered, very soft shale. Offset is visible by coal streaks on Energy Shale roof rock. Faults 78/73 SE; 81/81SE



Station (8a) see map



thickness of coal between:

ⓐ blue band and underclay 2.1'

ⓑ blue band and 1st s-plane 0.8'

ⓒ blue band and 2nd (major) s-plane 3.4'

total coal 8.1'

(8)

(5)

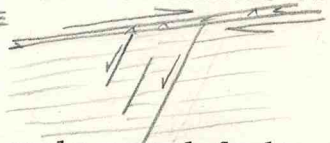
Zeigler #4

H-F.K. 08-15-77

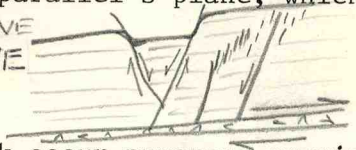
Zeigler # 4

(10) Striations on bedding planes (ss-planes) in Energy Shale roof rock, Li: 45/14NW. Stria are mainly on interface between coal and rock (on rock surface). Joints in roof rock (partly developed to shear planes with stria)
78/70-90 dipping in both directions

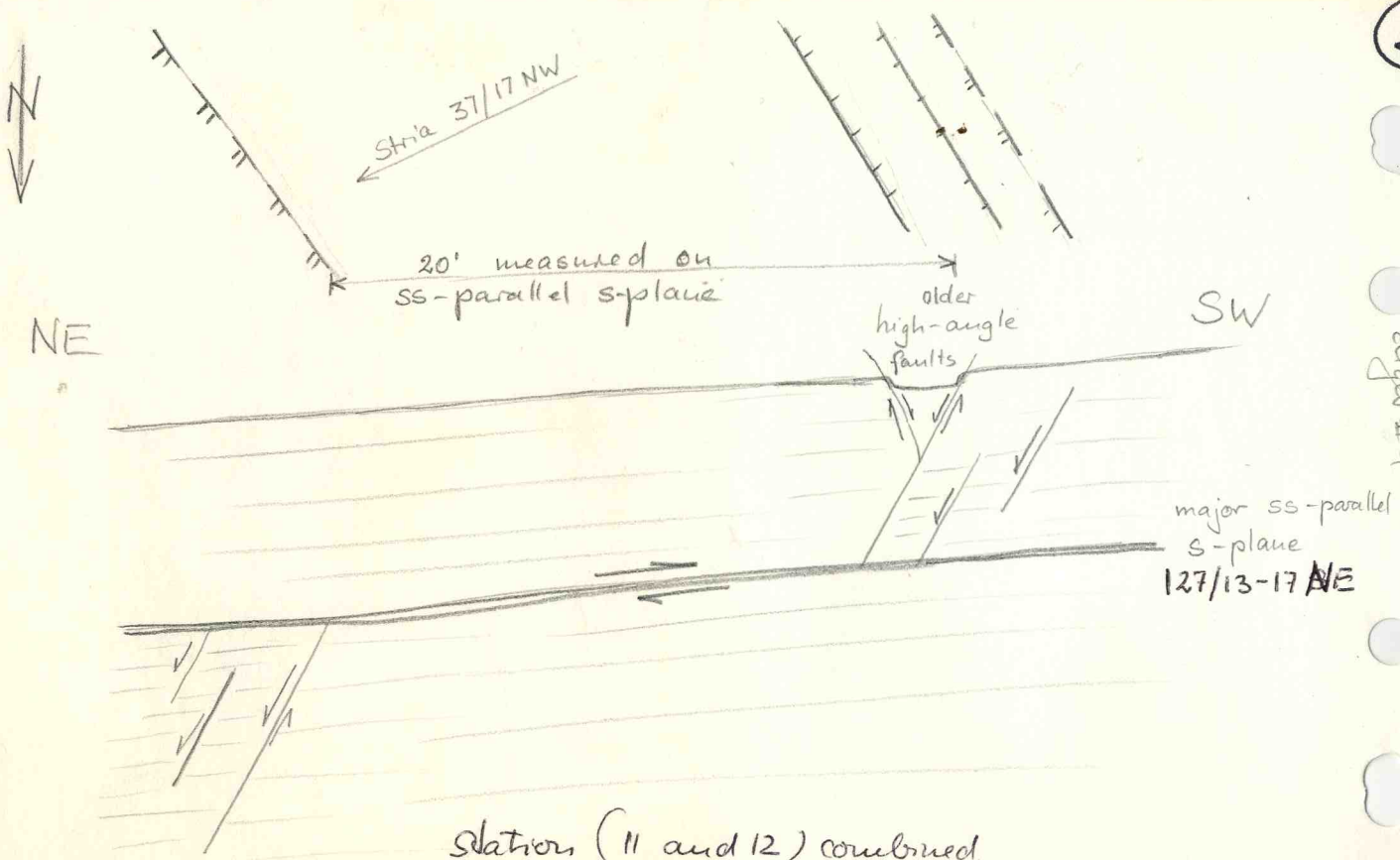
(11) Minor high angle normal faults in lower bends of coal 135/70-80NE; displacement of few mm only. These faults are older than and truncated by a major ss-parallel s-plane, which bears striations of movement Li 38-42/10-12 NE
Comp. sketch (11-12)



(12) Set of minor high angle normal faults in upper bend of coal and in roof rock 135-140/45 NE and 75-80SW, of a few mine only (max 0.1' to west) at coal/roof interface. Faults trend along roof in a set of "enechelon" fractures. These faults are older than trinacted by a major ss-parallel s-plane, which bears striations of movement (Li 128/17SE) to 37/17NE
comp. sketch (11-12)
(very local!)



In Energy Shale roof rock occur numerous prominent joints and s-fractures with very little displacement. These fractures trend 80-85/75-85 SE and intersect the 135° striking faults. Age relationship cannot be found. E-W jointly is very intensive and spacing is very dense, much more than usually in Energy Shale roof rock; (somewhat comparable to the striations in Orient #4 U. G. Mine old E-W Mains in far South Main towards old portal).



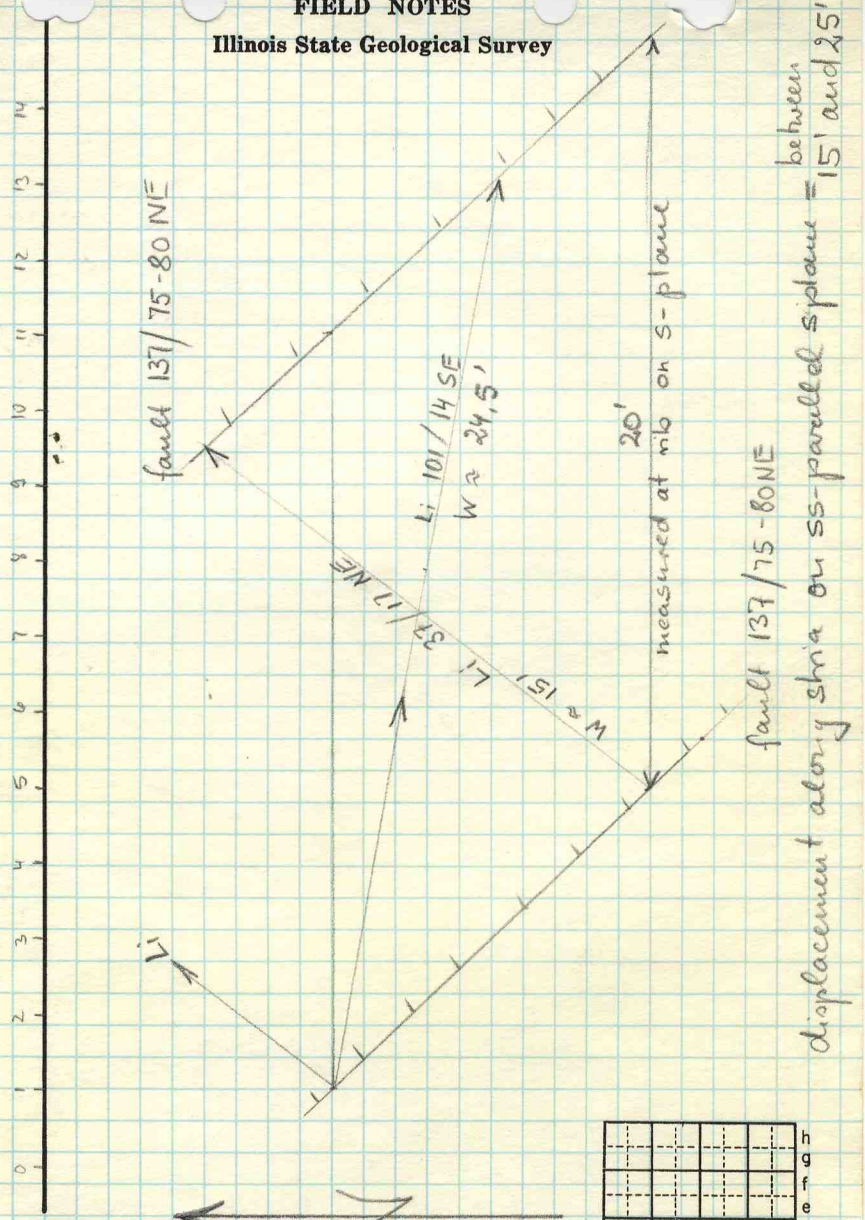
Station (11 and 12) combined.

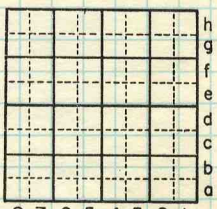
Sketch, no scale! high angle faults displaced by ss-parallel s-plane sh

Bergh #4

FIELD NOTES

Illinois State Geological Survey





By H-F.K. 08-15-77 Date

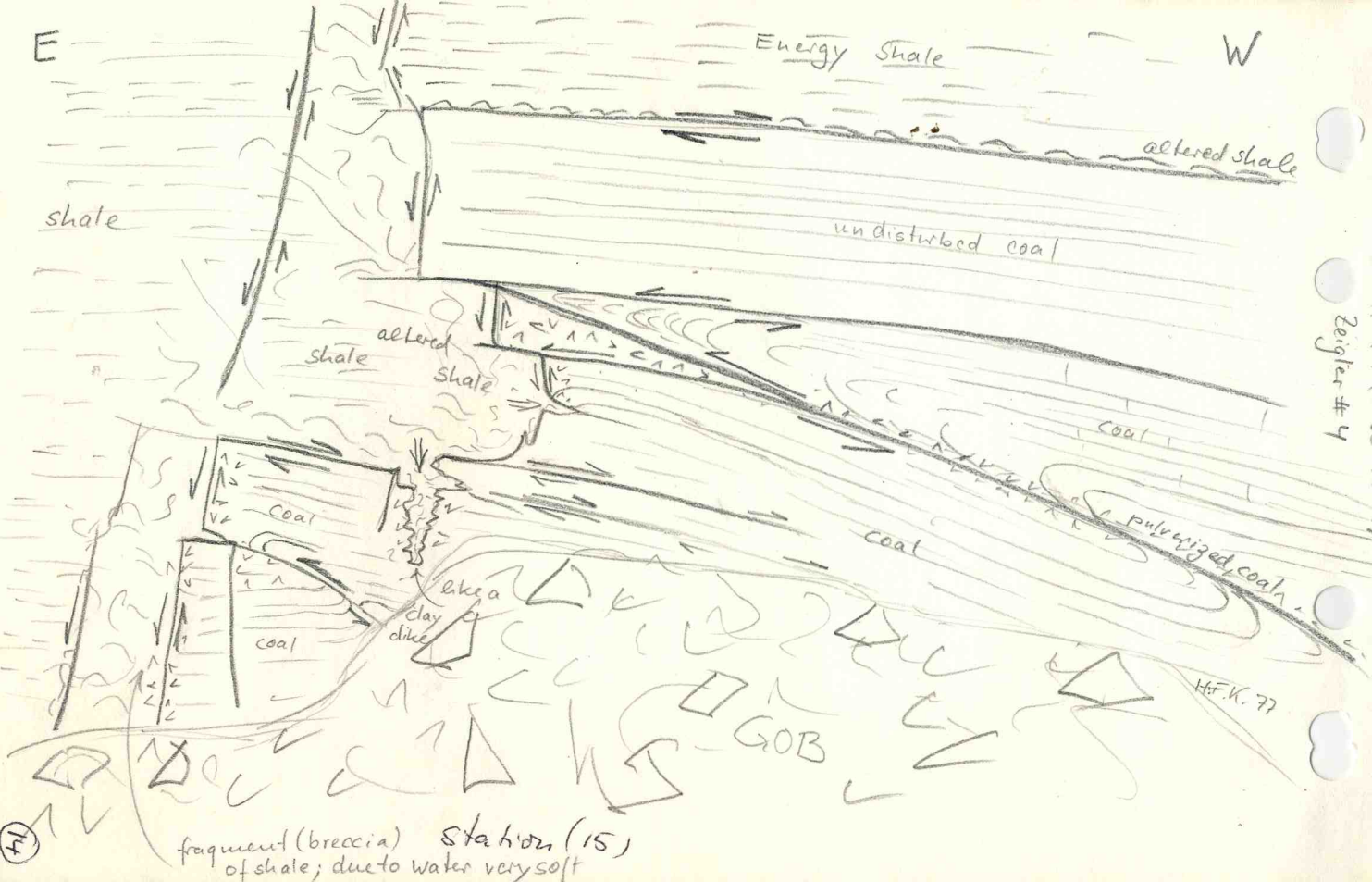
Quadrangle Zeigler # 4

County Sec. T R

(13) North return air course and escape way:
Coal seam and roof is pretty much leveled out and bedding ± horizontal. Two major s-planes in coal, upper s-plane is 0.9' from top of seam
lower s-plane is 4.9-5.0' from top of seam and 0.7' above blue band. NW of this station is a large roll in coal and Energy Shale trending SW-NE

(14) Very large and wide roll in Energy Shale roof. Roll is effecting the coal hardly at all, but well developed in medimum gray shale of roof. Width of roll is increasing towards the NW. Trend is SE-NW. Total area is one by roof fall.

(15) High angle normal fault, which throws roof rock (Energy Shale) side by side to coal, has been sheared and in parts been truncated by several very low angle and subhorizontal ss-parallel shear planes. Amount of movements on subhorizontal s-planes vary from plane to plane. Total displacement on high angle fault at north t= 4.8' (see sketch and photos).


E
Energy Shale
W
altered shale
undisturbed coal
shale
altered shale
shale
coal
coal
coal
pulverized coal
like a clay dike
coal
GOB
H.F.K. 77
Zeigler #4
fragment (breccia) of shale; due to water very soft
Station (15)

MOORE'S MODERN METHODS
FORM 180 W

ZEIGLER COAL CO. MINE NO. 4 WILLIAMSON COUNTY
9/7/77
Notes by John Nelson on visit with John Popp.

Continue study of faulted area on 1st East Mains. Roger Snow, surveyor, from Zeigler. Stop numbers continue from previous visit; using same field map.

17.) I attempt mapping on the belt entry and John Popp maps the travelway. Conditions are very poor on both entries, with heavy rock dust and, in many places, Mando-seal obscuring roof and ribs. The numerous falls are heavily cribbed and most of the crosscuts are filled with fallen material and "gob". Very little can be seen on either entry.

Here in the crosscut is seen prominent east-west fracturing in the roof. These fractures end abruptly on a bedding plane about 0.1' above the top of the coal. The shale below this bedding plane is soft, gooey, and structureless. Contact of this to coal is very sharp and even.

I believe there has been horizontal shearing along this bedding plane and that the east-west fractures have been offset so that the fractures in the roof no longer line up with those in the coal.

18.) Projected position of fault offset by horizontal shearing, as seen in south returns. Cannot see a thing here due to rock dust, Mando-seal and cribbing.

19.) Projected position of main fault (32' reverse). Again very little to be seen.

On the north rib the coal seam turns gently downward to the west near the fault. Then it appears to plunge almost vertically against the fault plane. West of the fault is a brow of Brereton Limestone overlying Anna and Energy Shale. This is all that can be seen.

20.) Roof is lower surface of Brereton Limestone. Two distinct directions of fracturing; 065° and 160°.

Most of the 160° fractures show no visible displacement and have thin fillings of white calcite. The 065° fractures range from calcite-filled cracks with no displacement to vertical faults with several inches displacement. Locally the limestone is shattered and blocks of it have fallen out between fracture planes.

In some places fractures intersect with no offset but elsewhere the 065° fractures displace the 160° fractures laterally, with strike-slip movement. The movement amounts to a few inches at the most and may be either right- or left-lateral. No 065° fractures are noticeably displaced by 160° faults.

Westward the structural situation becomes very complex, with larger faults, but cribbing and Mandoseal make study impossible.

So here we see repeated the pattern observed at Stop 16 (previous visit), where the 160° fractures parallel with the main fault are offset by apparent strike-slip movement on faults running at right angles.

21.) For some reason not known to me the 065° fracturing all along the belt entry appears much more noticeable in the crosscuts than in the entry itself. This is the opposite of what might be expected; fractures usually show much more clearly where they run parallel with entries. Possibly the cracks really are better developed in the crosscuts for geologic reasons.

The 160° fractures are not apparent here, though they might be hidden by rock dust.

22.) Now mapping return-air entries south of travelway. Note that most of this area is inaccessible. The Returns have not been maintained and so are choked with falls. However, the accessible areas generally provide good views of roof and ribs.

In this area the upper 1-2' of the coal shows intensive horizontal shearing. The sheared zone varies considerably in thickness and in extent of deformation. The top surface of the coal undulates and there are numerous small "rolls" and coal "riders" in the roof, along with lenses of shale in the coal. Some of these shale lenses are stretched out along the shear planes. The interaction of "rolls" and shearing creates strange patterns in the upper part of the coal.

No definite patterns of vertical fracturing exist. Some slips and fractures are seen in the roof but these appear to be randomly oriented, probably compactional slips related to roll activity. The coal contains scattered vertical and high-angle faults or slips. Some of these show vertical slickensides, but others show horizontal striations and thus appear to be strike-slip faults.

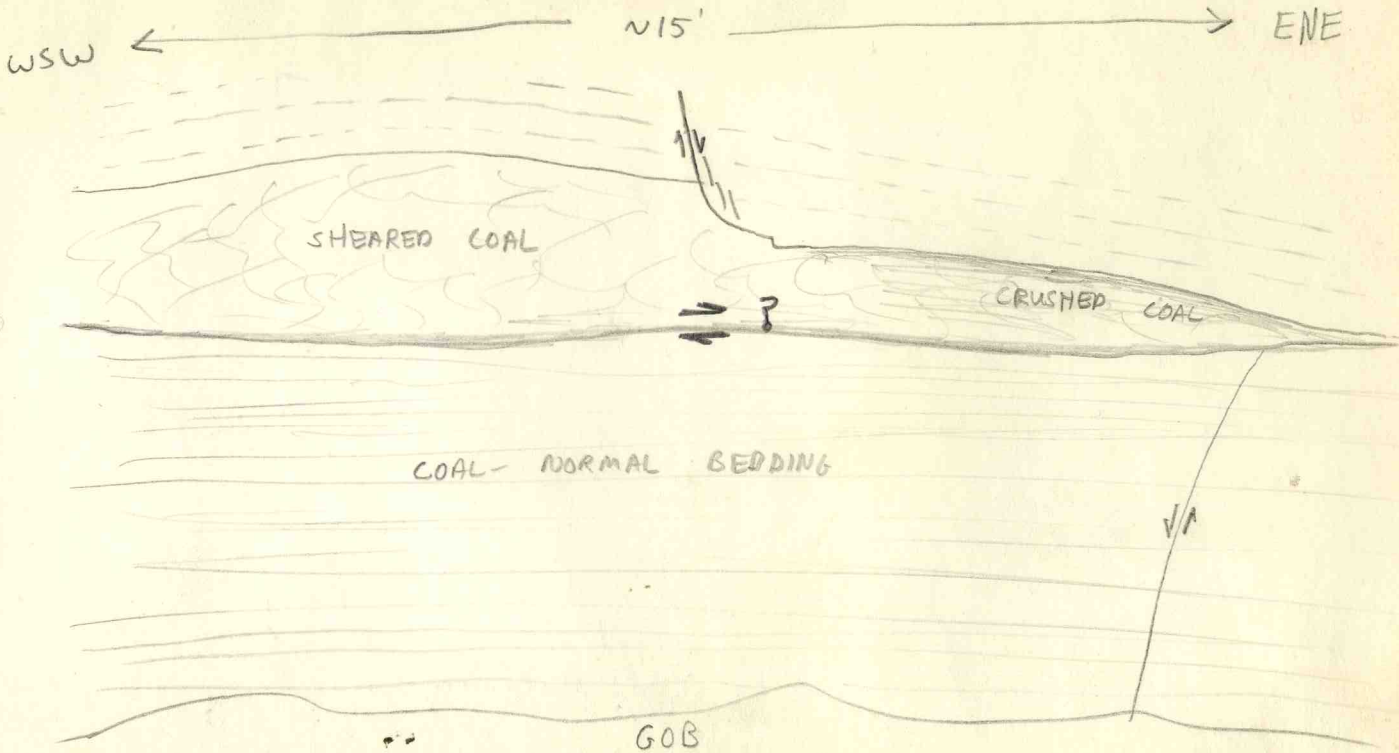
23.) Numerous fractures and small faults trending 155-160° in roof and coal. Displacements (normal) up to several inches. The faults do not cross the roof/coal contact, which apparently is a shear plane with horizontal offset. It is not possible to link specific fractures across this plane.

The shear plane is marked by a zone up to several inches thick of crushed and highly deformed coal and locally crushed roof shale. Other shear planes, resembling fusain partings, are seen in places in the top 1-2' of the coal seam.

24.) Vertical fault apparently both offsetting and offset by horizontal shear plane at top of coal. See sketch (over).

The fault trends 160° and is traceable across the roof of the entry. Where it contacts the coal it abruptly shallows out and appears to merge with the shear plane. Another horizontal plane of movement lies several inches down in the coal, and the coal between these two planes is crushed and very

Stop 24 - View of N Rib



FORM 180 W
MOORE'S MODERN METHODS

friable. There appear to be multiple shear planes within this wedge.

Eastward is a "bulldozer effect" with the wedge of coal looking like a mound of earth pushed in front of a bulldozer. It would appear that the top block moved downhill (ENE) and coal underneath locally piled up.

The lower part of the vertical fault was not found in the coal seam.

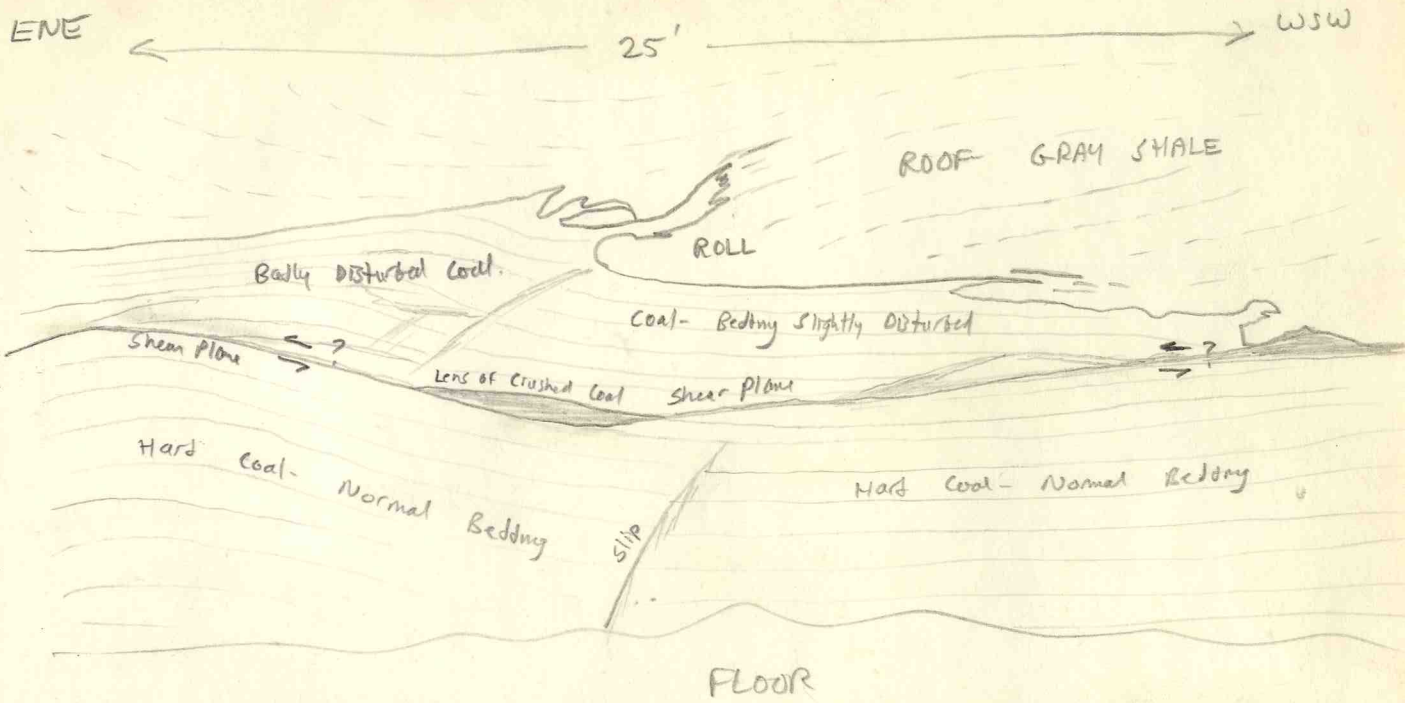
Again, this seems to be a case of more or less simultaneous vertical and horizontal movement.

25.) Roll cut by horizontal shear planes (see sketch, over). The main shear plane is folded with the coal into the trough of the roll, and locally it cuts across bedding planes at a shallow angle. The coal below is hard and appears normal. The coal above the shear is friable, appears disturbed, and contains numerous small low-angle and horizontal shears.

It appears that shear planes normally try to follow bedding planes, which are normal zones of weakness, but when they reach some irregularity in the bedding such as a roll, they may jump across bedding planes. Another less likely possibility is that the shearing took place before the coal was fully compacted, and thus the shear plane folded with the coal. I personally much favor the first explanation.

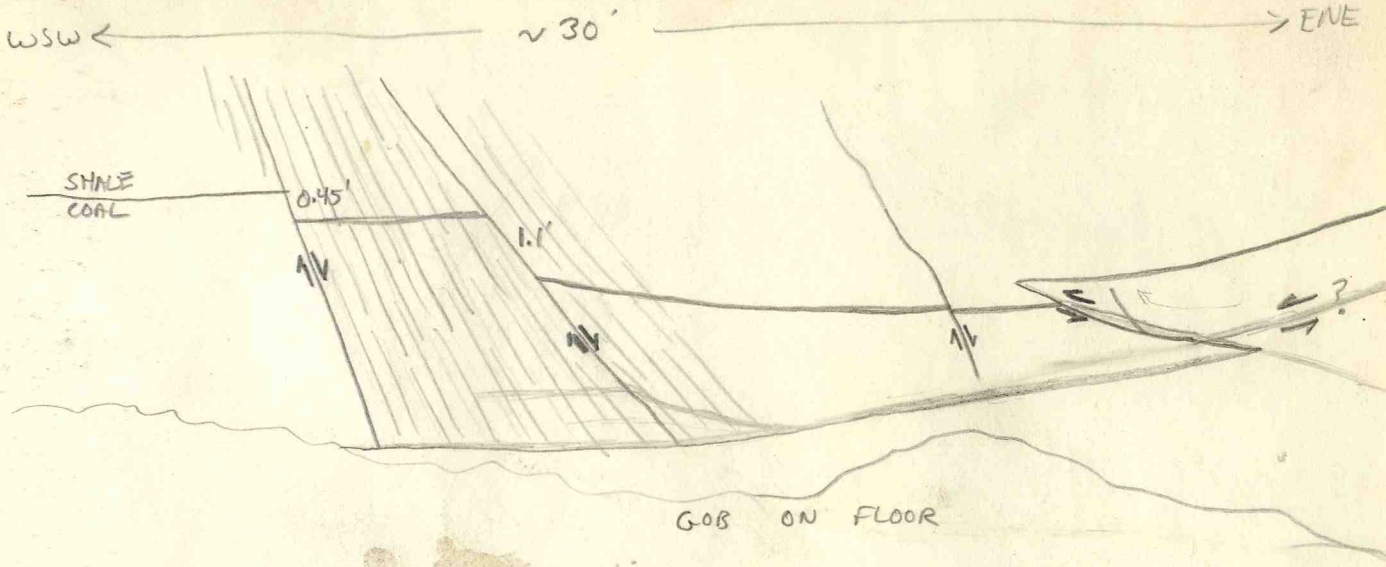
26.) Series of small normal and low-angle reverse faults affected by horizontal shearing. See sketches (over).

On the west are east-dipping medium-to-high-angle normal faults of which the largest have 0.45' and 1.1' displacement on the north rib. With these are a great number of parallel fractures without visible displacement. All of these affect the roof



FORM 180 W
MOORE'S MODERN METHODS

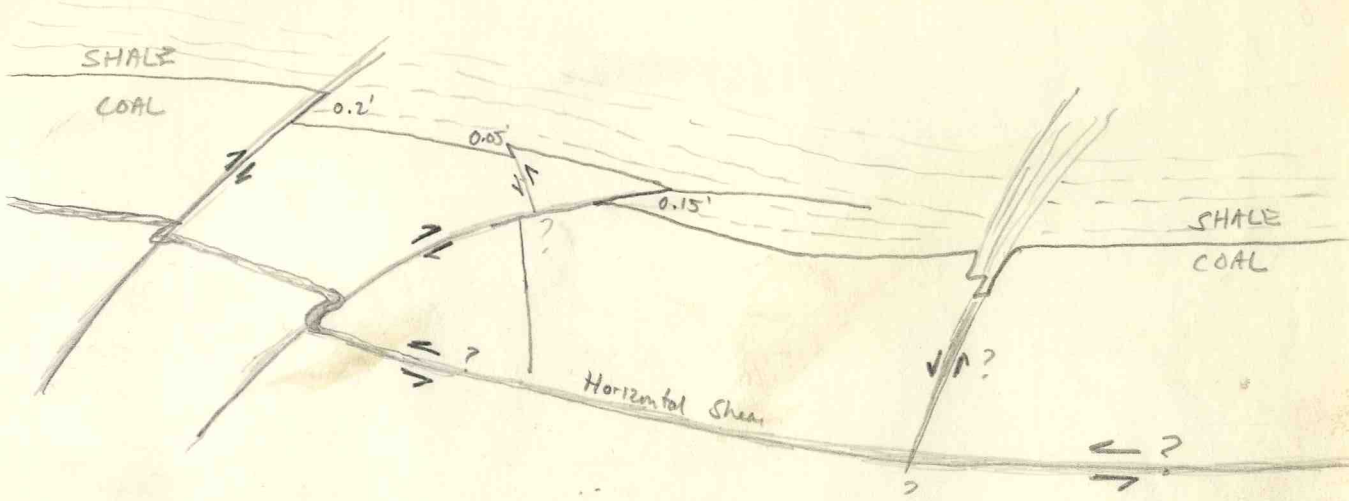
Stop 26
Overall View N. R16



MOORE'S MODERN METHODS
FORM 180 W

Stop 26. East Rib

ENE ← 12' → WSW



FORM 180 W
MOORE'S MODERN METHODS

and the upper part of the coal, being terminated on a shear plane 3-4' down in the coal. The fractures dip at progressively shallower angles eastward.

The coal below the horizontal shear plane appears normal and not fractured. Some 20 feet east (down dip) a series of high-angle fractures is found in the coal below the shear plane, but many of these dip westward and they cannot be correlated with fractures seen in the roof. Indications are that horizontal offset may exceed 20 feet.

The small reverse faults have shallow-dipping planes and are upthrown to the east. There is one such fault on the north rib dividing into two on the south rib. The coal is not cleanly displaced all along these, but is tightly folded. The horizontal shear is also clearly displaced or folded along these faults. This displacement is about the same (0.3') as the offset at the top of the coal.

Thus three separate stages of movement are clearly indicated:

(1) Normal faulting
(2) Horizontal shearing
(3) Reverse faulting

27.) In next entry, structural pattern of Stop 26 is repeated. One normal fault trends 160/55° E and has 2.0' displacement on the north rib. The reverse fault is a sharp "S"-shaped flexure on the north rib, and a clean break with 0.5' displacement on the south rib. The reverse fault offsets the horizontal shear, which in turn displaces the normal fault.

9/8/77 Continue mapping same area. Miners were on strike due to pickets at the gate. The pickets were mine construction workers from Inland Steel # 2.

Zeigler miners are known for going on strike on the slightest pretense. According to Roger Snow, a strike was narrowly averted over having the county

sheriff come to the mine to pick up stray dogs that hang around the tipple.

28.) Series of small faults trending 155° with less than 0.1' displacement. These are vertical or steeply dipping and are seen to affect the roof and the exposed upper 5 feet or so of the coal. Below this the coal is buried by debris and so cannot see horizontal shearing that might be present. Some of the small faults appear to die out within the exposed part of the coal seam.

The roof fall west of here probably was triggered by fault surfaces along the east side of the intersection. The fall is flat-topped on a shale bedding plane some 4 feet above the top of the coal. This surface displays 080° jointing, as is common in this area.

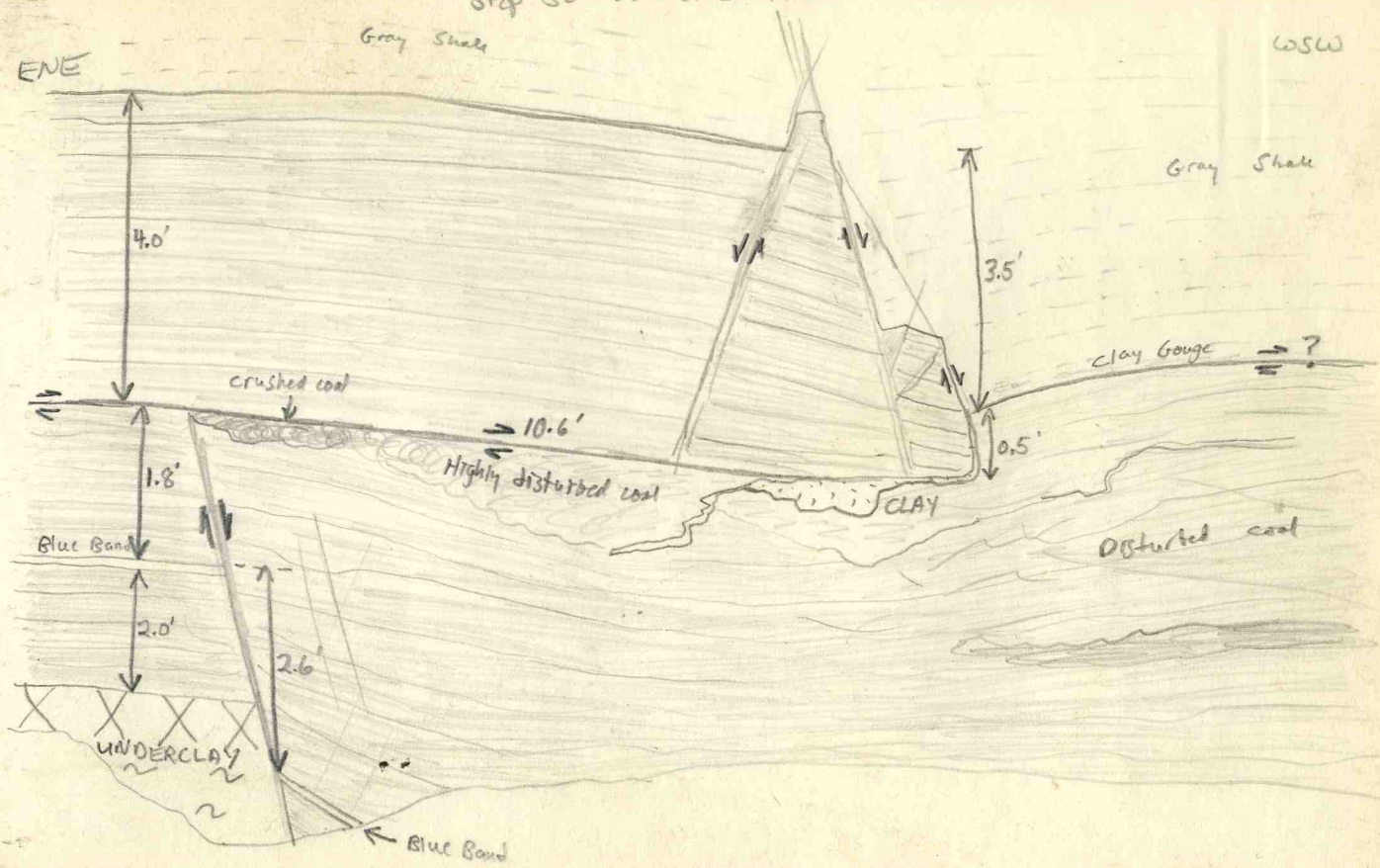
Note that we are near the intersection of two fairly large faults that meet at right angles. The actual junction point is not accessible. See also John Popp's notes.

29.) Continuation of 155° faults from previous stop. Here is a better view of the lower part of the coal and a shear zone can be seen about 4 feet below the top of the coal. The shear zone is up to half a foot thick with severely crushed coal, and the vertical fractures do not cross it. Some "decapitated" faults are present below the shear zone, but these cannot be matched with faults in the roof.

30.) Large, complex structure, showing results of both horizontal and vertical movement. See sketch (over).

A normal fault trending 150/75°W with 3.5' throw on the south rib is displaced 10.6' along a horizontal shear plane. We dug out the lower half of the fault on both sides of the entry and found Blue Band and floor displaced by several feet. The

FORM 180 W
MOORE'S INDUSTRIAL METHODS



block above the shear plane moved westward relative to the block below. We could not find slickensides to indicate the actual direction and distance of offset (the 10.6' figure is measured along the rib).

There has been vertical movement after horizontal shearing as well. This is shown by a sharp 0.5' vertical offset of the horizontal shear along the main fault.

The coal below the shear plane and west of the vertical fault is much disturbed and mineralized so that it is hard to tell if other planes of movement exist. Note thick clay pockets along shear planes.

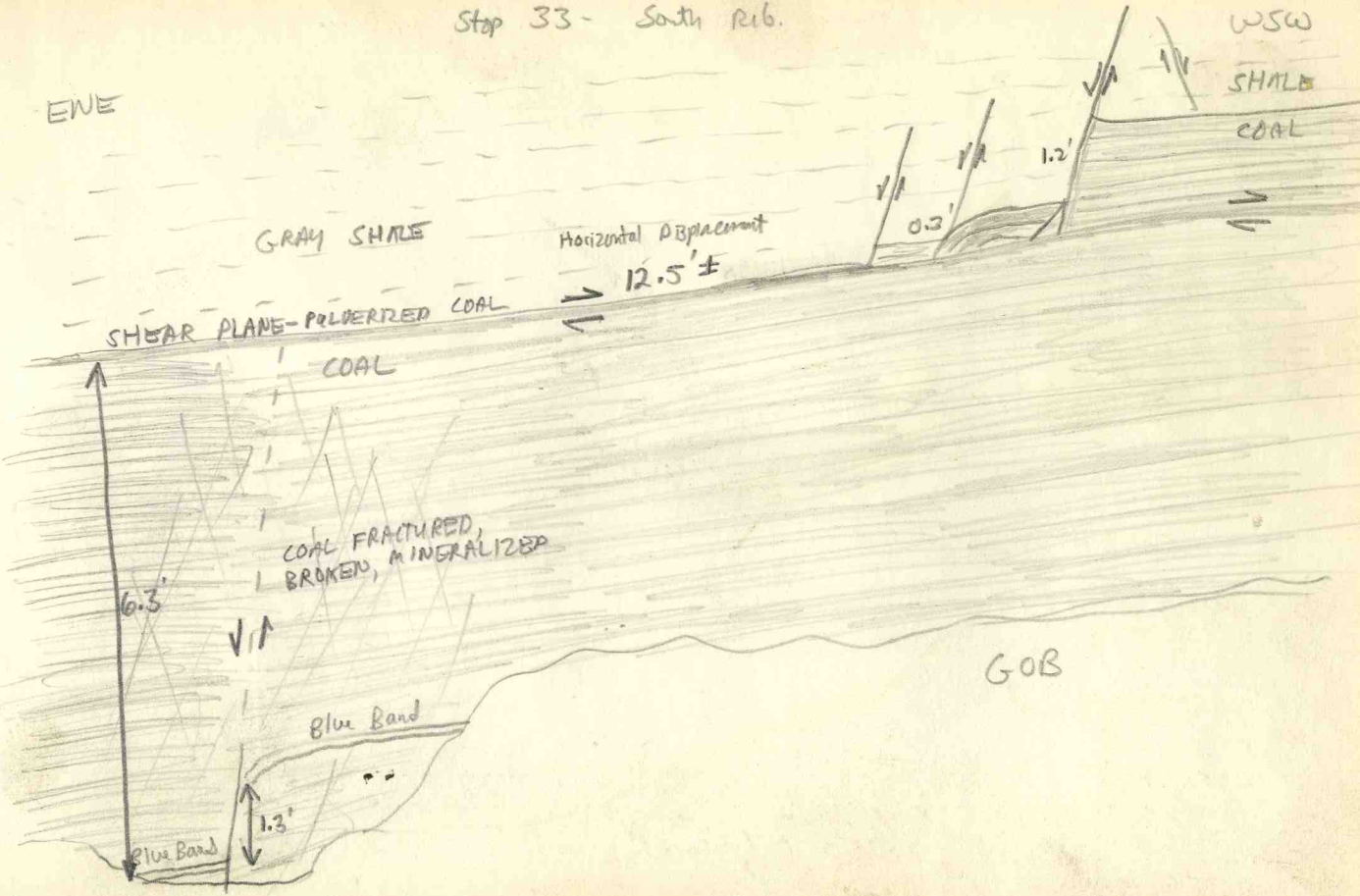
31.) Small roll with compactional slips at tail. These slips trend 110/40°N and tend to curve, branch, and steepen downward. They are intersected by a series of high-angle faults trending about 145 and showing almost no displacement. It is not possible to actually demonstrate that these offset the compactional slip, though most likely they do.

Bedding-plane shear is probably present in the lower half of the seam, which is mostly buried in "gob".

32.) Prominent shear planes and crushed zones in the upper 1-2' of the coal. Local crushed zones are present up to several inches thick. Some cross bedding planes at shallow angles.

33.) Small normal fault trending about 160/60°E with 1.2' displacement on the south rib is displaced 12.5' along a horizontal shear plane which is at the top of the coal east of the fault. Here, as at Stop 30, the upper block moved westward. True direction and distance of offset not determined (no slickensides visible).

Lower half of fault displaces Blue Band 1.3'



FORM 180 W
MOORE'S MODERN METHODS

and a small amount of drag is shown.

This is an excellent, simple example of a normal fault offset by simple horizontal movement.

It should be pointed out that horizontal shearing is present in the coal practically everywhere west of the main 32-foot reverse fault. This shearing continues west off the edge of the field map area. However, only in a few places is it possible to demonstrate actual displacement along horizontal shears.

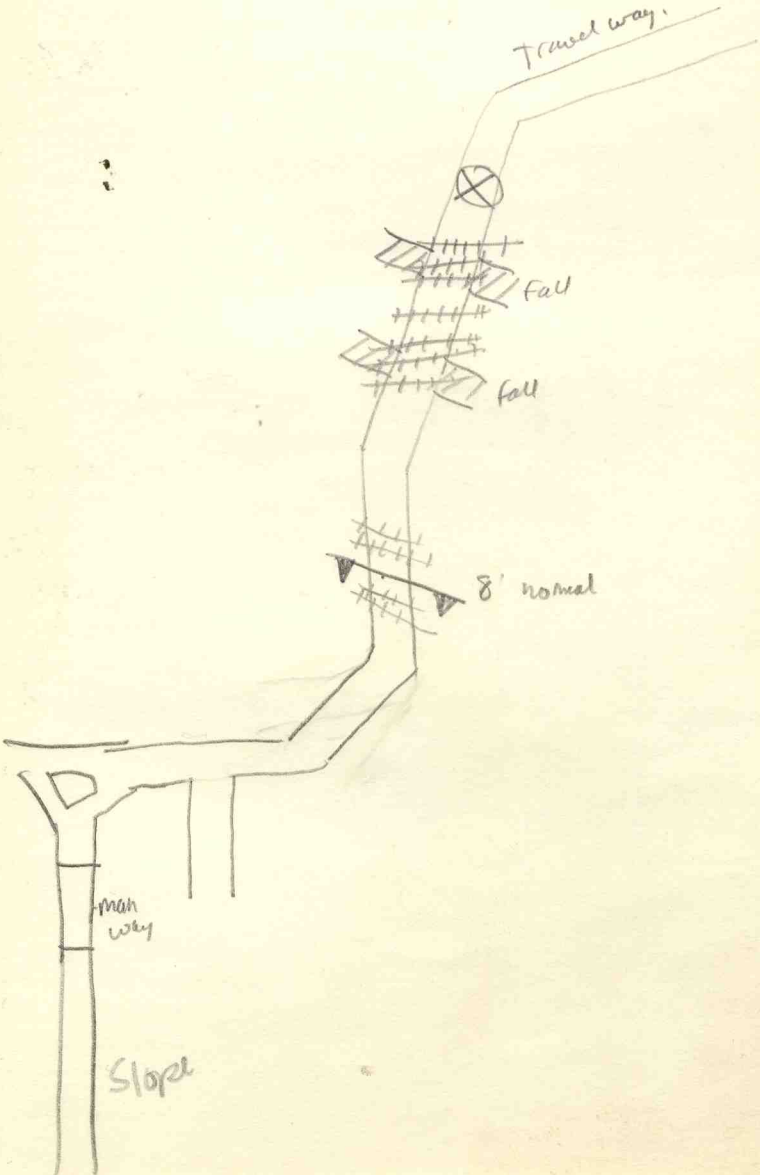
The same shearing is present east of the main fault and appears to die out near the point where the coal levels out at the east end of the field map area.

In every case we have studied except possibly Stop 24, this visit, the upper block moved westward or uphill relative to the lower block. This would indicate the shearing is not a downhill slide or slump.

The relative direction of movement is the same as the direction of movement on the big 32' reverse fault and is of the same order of magnitude (10-20' in the horizontal plane) so we might expect the two movements are directly related-maybe simultaneous. Unfortunately there is no place to see what happens to the horizontal shears at the big fault.

This concludes, at least for the present, our study of this part of Zeigler No. 4. We had a little time to look for other structures on our way walking out of the mine. As the travelway was heavily rock-dusted not a great deal could be seen.

34.) Located off map (see sketch map). Large fault crosses travelway trending 094/70°S and has some 8 feet displacement. Roof and coal are heavily sheared with parallel fractures. This fracturing continues some 300 feet north of the fault. Condition for study are very poor.


Travel way
Fall
Fall
8' normal
main way
Slope

Ziegler Coal Company -- No. 4 Mine
September 7, 1977
J. Popp, J. Nelson, Roger Snow, rodman--notes by Popp

The purpose of this visit was to continue mapping the Cottage Grove Fault System in the 1st Main East fault area. *See mine map 10-3-9*

Booknote 1

Z-type fault in rib along travelway. Z-type fault is a vertical fault with a horizontal component off-setting the vertical component. The upper half of the vertical fault has 3.5' normal displacement and is truncated by a shale parting or injection coming into the coal seam along the bedding plane shear. This bedding plane (horizontal) shear is traceable about 30' east from the fault.

I could not find the lower half of the vertical fault component, where the floor should have been raised. Coal cleat is very well formed in the ribs and trends:

face cleat: 220°-230°
butt cleat: 150°-160°

The coal is dipping strongly to the northeast and the coal-shale bedding plane contact is very smooth, probably polished. Shale bedding plane strike/dip is: 128°/12-38°.

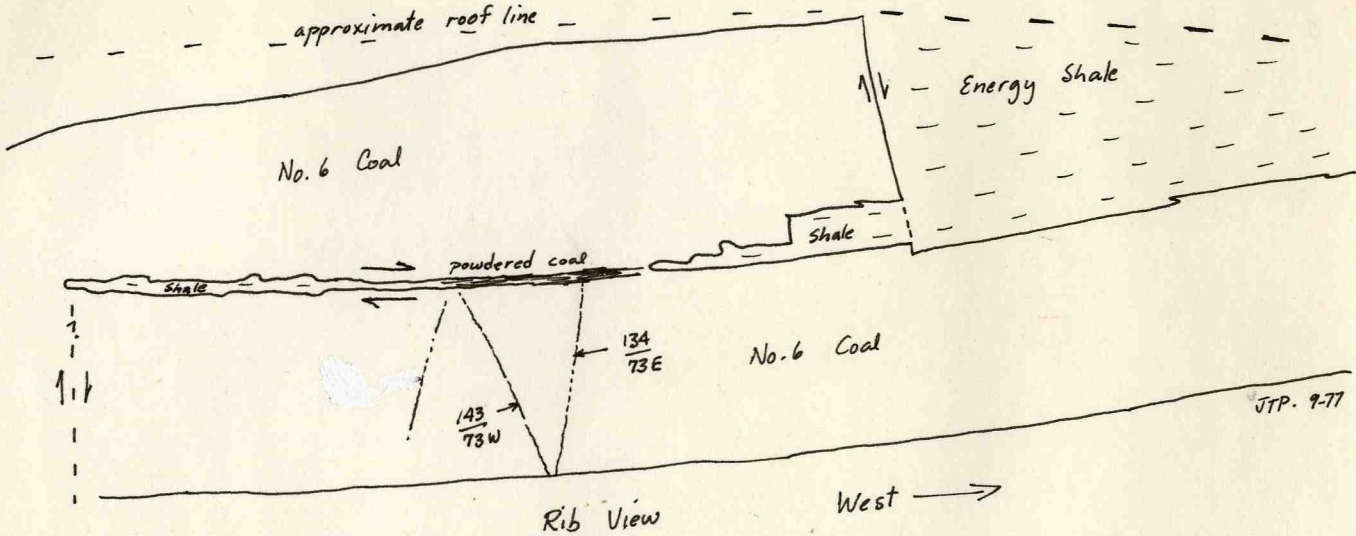
There is some good jointing in the coal in the lower bench, and the joints do not seem to appear in the upper bench. The upper bench is not traceable as a separate unit to the east where the single seam thickness reappears.

(See sketch on next page.)

Booknote 2

This area is of interest because the upper 1'± of coal is generally sheared or crushed. The shale in immedia te contact with coal is usually soft (gouged) and clay-like, and bedding planes in the lower foot or two are polished so that the rock splits and falls. Other massive roof falls are common in the area but may not be directly related to the polishing.

Ziegler No. 4 Mine
Booknote 1



In general it appears that the coal and shale have slid on one another, giving the polished, gouged, and crushed appearance. The coal still has a pronounced NE dip, and small offsets in vertical joints, or slips, support the presence of horizontal movement.

Small (discontinuous?) shears are present in the shale, and although the shale is well bedded, the combination of vertical shears and horizontal shears seem to cause it to fall.

Booknote 3

South rib in the returns; see J. Nelson's notes for a description of the north rib.

This is the location of a very small fault; displacement is about 0.5' on the north rib and less on the south rib. As sketched below, there appears to be a wedge of crushed coal thickening to the west with shale gouge between it and the competent gray shale above.

A slip, coming down from the shale roof into the coal, is apparently offset to the east by a bedding plane slip; the fault then continues in the crushed coal zone where it apparently dissipates into several shear components.

Coal cleat and goatbeards just below the crushed coal is heavily pyritized.

(See the sketch on the next page.)

Booknote 4

The north rib here has a good section of wavy-banded coal. The upper 1.0-1.4' of coal is soft, somewhat crushed and displays irregular bedding.

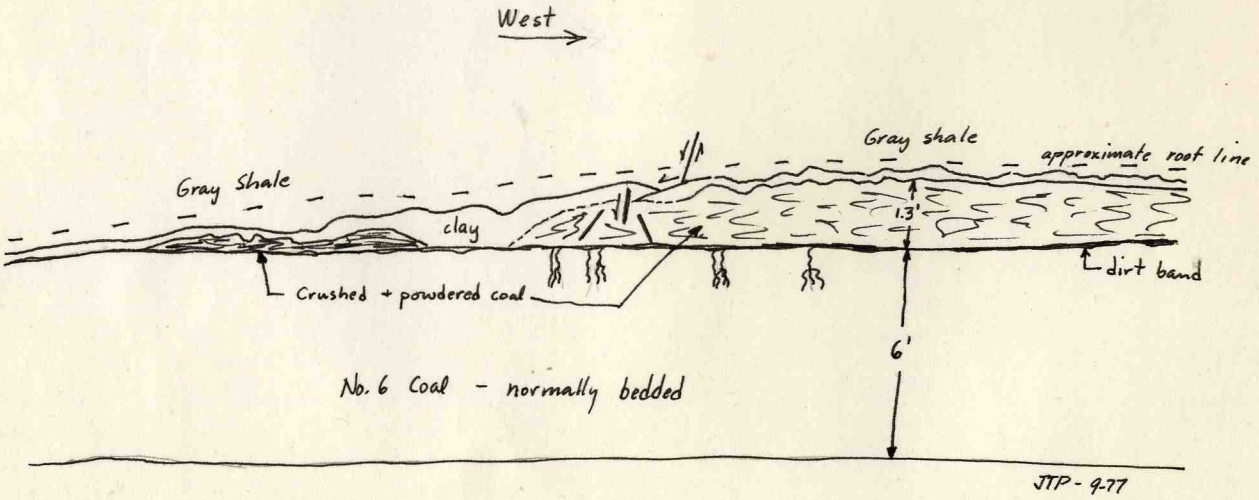
The gray shale roof is polished along the bedding planes.

Booknote 5

This entry seems to show very well a two benched seam. The top bench is the curshed, contorted coal that thins and thickens and often has a very undulatory contact with the shale roof.

Ziegler No. 4 Mine

Booknote 3



The lower bench is normal bedded coal, hard, well-cleated, and separated from the upper bed by a polished surface that often has a dirt band and/or mineralization (pyrite and melanterite).

Booknote 6

At this stop the mine is beginning to get into roll country, as evidenced by features in this entry. The upper bench of crushed coal is dissected by injections of gray shale and clay gouge. Their roll-like appearance is betrayed by the fact that the shale stays in the upper bench and by the presence of many shear planes most of which are in the upper bence.

A yellow dirt band, or sulfur band, pretty much delineates the bottom of the crushed coal zone, but within the crushed coal zone is a zone, from 0-3 inches thick, of what looks like fusain. However, the composition of the band is granular and does not dirty the fingers as would be expected with fusain. The band must represent gouged coal.

It would appear that at this location the order of events would include: deposition of the lower coal bench, deposition of the upper bench, shearing of the upper bench, deposition of the shale, shearing and injection of the shale at the same time or immediately after coal shearing.

The fusain-like band is fairly contiunous in length, continuing on west into the crosscut. It's lower contact is polished and appears to have striations.

The roof is gray shale, the bedding planes of which are polished and undulatory. The rock is brittle and is falling in small slabs. It is not well jointed but appears to be broken up.

(See sketch on next page.)

Booknote 7

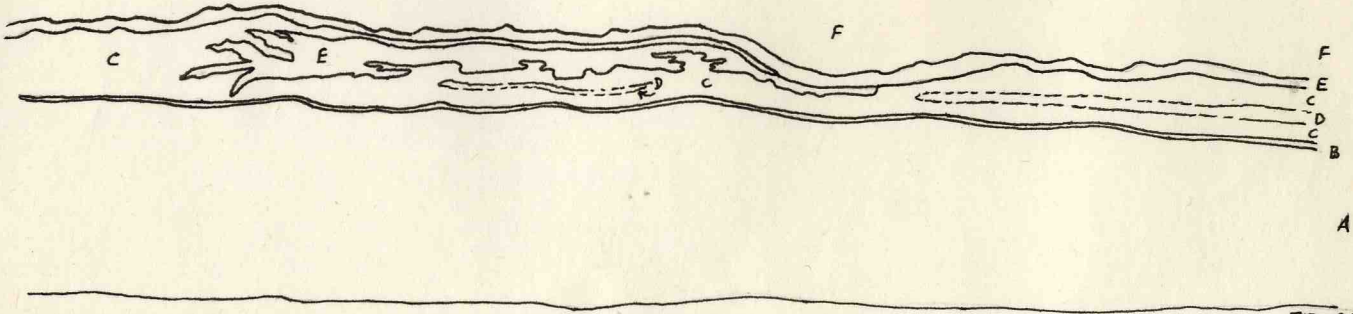
Normal fault with 1.9' displacement. It does not seriously affect roof conditions at this location but continues east to a roof fall where it appears as a slip.

The fault displaces the entire seam including the shear zone. The age of this fault is younger than the

Ziegler No. 4 Mine , Booknote 6

Rib View, facing southwest

A - Herrin (No.6) Coal, normally bedded
B - Dirt band, undulatory contact
C - Herrin (No.6) Coal, crushed and folded
D - Coal, crushed and powdered
E - Shale and clay, gouged
F - Energy Shale



Ziegler Coal Company -- No. 4 Mine
September 8, 1977
J. Popp, J. Nelson, R. Snow -- notes by Popp

The mine went on a wildcat strike today, probably because of sympathy for a construct ion union strike at Inland Steel Mine No. 2.

Booknote 8

Small normal fault. It appears to have two components in the west rib with displacement of 0.25' and 0.7', but only one component is present in the east rib.

This fault probably ties in with the fall one cross-cut east and to the fault two cross-cuts east.

Booknote 9

Series of small displacement normal faults and shears. The faults have displacement of less than 0.5', strike 160°, dip 53 ENE, and appear to cut the upper 2/3 of the coal.

The shears are joint-like (perhaps that is what they are). They are very prominent, strike at 165°, dip 55°W. They do not cut the entire seam although they have very prominent planes. They seem to peter out downward.

Other joints are trending parallel with the faults.

These joints and faults may in part stop at a horizontal shear zone present about 4' below the roof. The shear zone is not real obvious, but is present in places as a jumble of crushed and powdered coal.

Booknote 10

Normal fault with horizontal shear (fault). Strike 150°, dip 75°W. This fault was preceeded as noted in Booknote 9 by a series of very small displacement normal faults. It was noted that some indication was seen at Booknote 9 in that a possible shear zone occurred about 4' below the roof. This would agree with what we see here for vertical displacement.

Another indication of the upcoming Z-shaped fault is the slight "hill" or rise in elevation of the entry looking east toward Booknote 9. The rise is indicative of the abnormal coal thickness, and consequent thinning

back to regular height.
(See sketch on next page.)

Booknote 11

Intersection of entries with major roof falls. Two small displacement normal faults cross the intersection as indicated. Energy shale has fallen in large, well-bedded slabs, and about 10' of roof is exposed.

I can't tell on the north fault whether there has been shear but the south fault does appear to have horizontal shear as indicated by a shale band across the fault plane at the shale/coal contact.

Displacement on the north rib: .6 - 1.0'
Displacement on the south rib: 1.0 - 1.5'

Booknote 12

Spectacular fall, 10-12' wide, and 30-35' high. The fall is knife edge along a series of faults and joints coming from the east. The fault curves across the west entry as indicated, and has about 1' displacement. The area is wet.

Booknote 13

Large displacement normal fault. Vertical displacement is 4.1', horizontal displacement is ?, and the strike/dip is 147°/73SW.

This fault appears to be very similar to and probably the same as the Z-type fault described at Booknote 10. We could not measure the horizontal movement. The roof fall is high, from 8-12' exposed, with a wide zone of shear-faulting and jointing as seen at Booknote 12.

Very prominent joints trend east-west. The joints extend into the coal as a prominent (face?) cleat or shear joint.

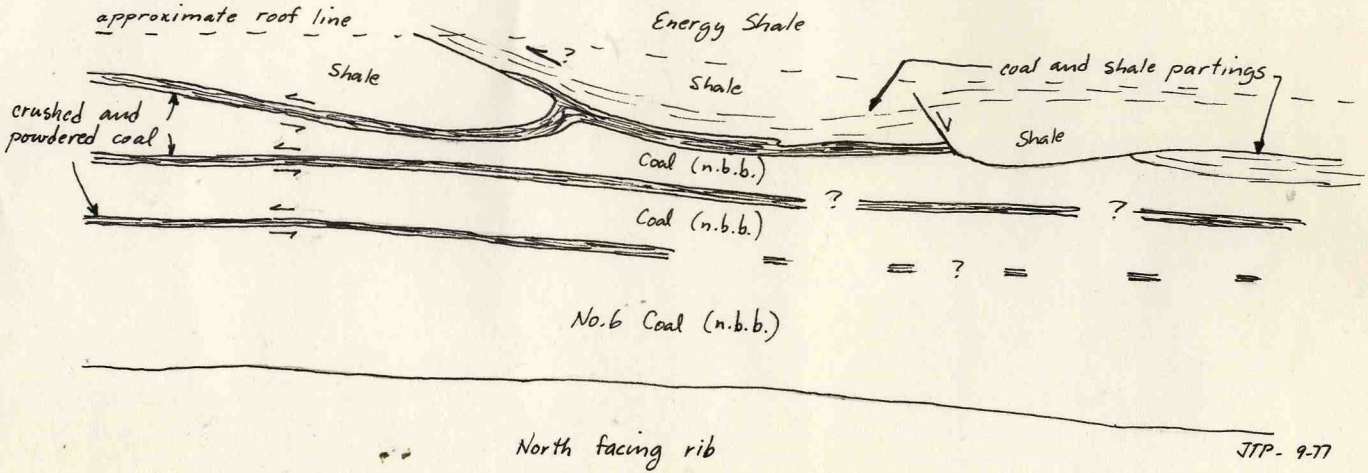
Booknote 14

Energy Shale Roll, with a normal fault.

Normal fault has fault plane displacement of 3.7' and vertical displacement of 1.8'; occurs just west in the rib near a gray shale roll. The roll has several

Ziegler No. 4 Mine

Booknote 15



JTP- 9-77

small asymmetrical riders at the toe, and shows various soft-sediment deformational features.

Normal fault is relatively low angle, dipping at 53°NE, and strikes 150°. It appears to transect most of the coal, and the coal is well jointed around the fault area.

Fault shows brittle deformation and gouge while roll shows soft-sediment deformation.

Booknote 15

Roll country. Several gray shale rolls are present. They do not seriously disturb the coal so that only the upper two feet or so of the coal is affected. However, the upper 2-2.5' of coal is crushed and powdered indicating shearing. Structurally the coal is dipping east or northeast pretty steeply. The gray shale/coal contact is irregular, with coal stringers riding up into the coal or rashy dirty coal forming a top coal. Assuming that the rolls are soft-sediment features, and that they formed before the shearing occurred, it is curious that the bedding, rider coals, fish tails and associated features in the roll area were not destroyed or pulverized similar to the shear coal.

The shear zone coal has many of the features seen yesterday. However, some cleat is well exposed, or bedding is intact, The crushed coal bands (looking like fusain) are present.

On the next page is a sketch of the north rib at this location; it is highly schematic and generalized. Probably there are at least three shear horizons along which horizontal movement has taken place. Coal inbetween shear is mostly crushed while shale and coal on either sides is not.

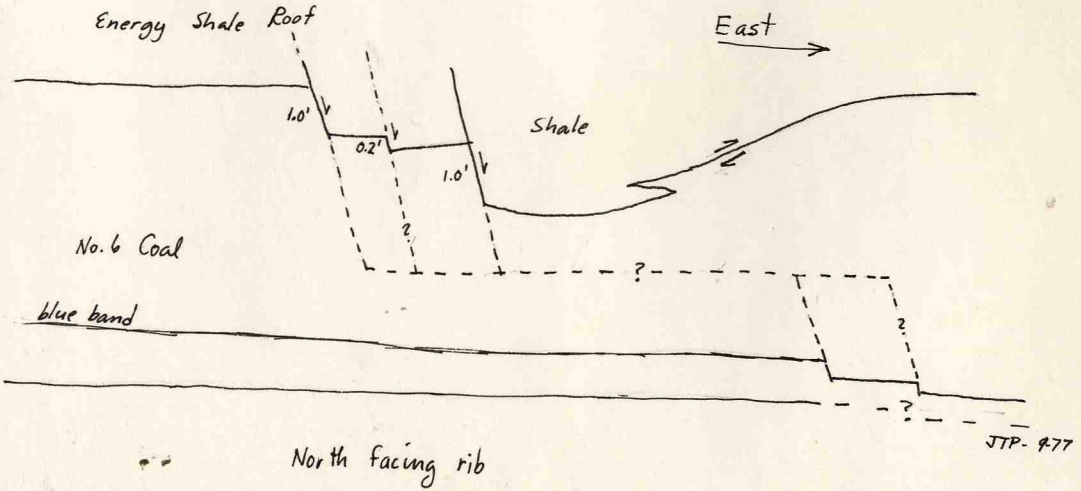
Booknote 16

Set of normal faults with a reverse fault or small fold and slump feature along the travelway.

The fault is a Z-type fault with apparent displacement as indicated. Again the upper part of the coal is soft as if crushed. The rib is poorly exposed because of rock dust. (See sketch on next page.)

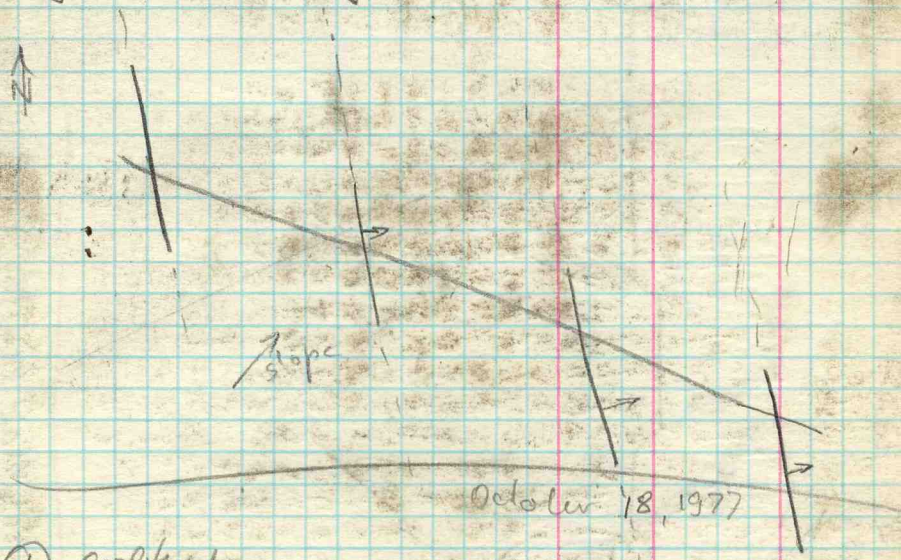
Ziegler No. 4 Mine

Booknote 16



Zeigler #4 October 16, 1977

together with W. J Nelson and J Poff

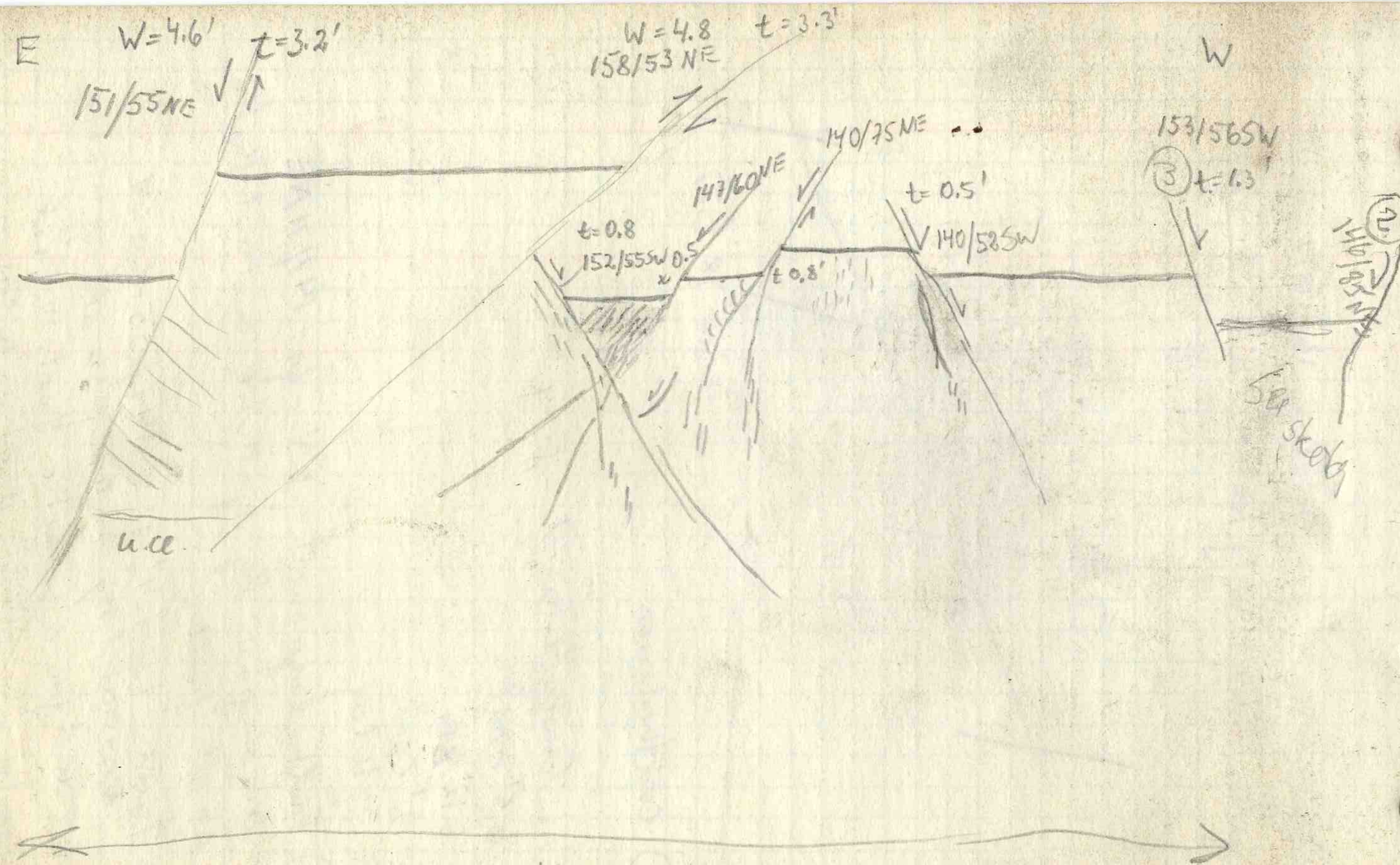


(1) Coal thickness

Energy Sh (medium gray sh)
6.5' coal
0.12' BB
2' coal
Underclay

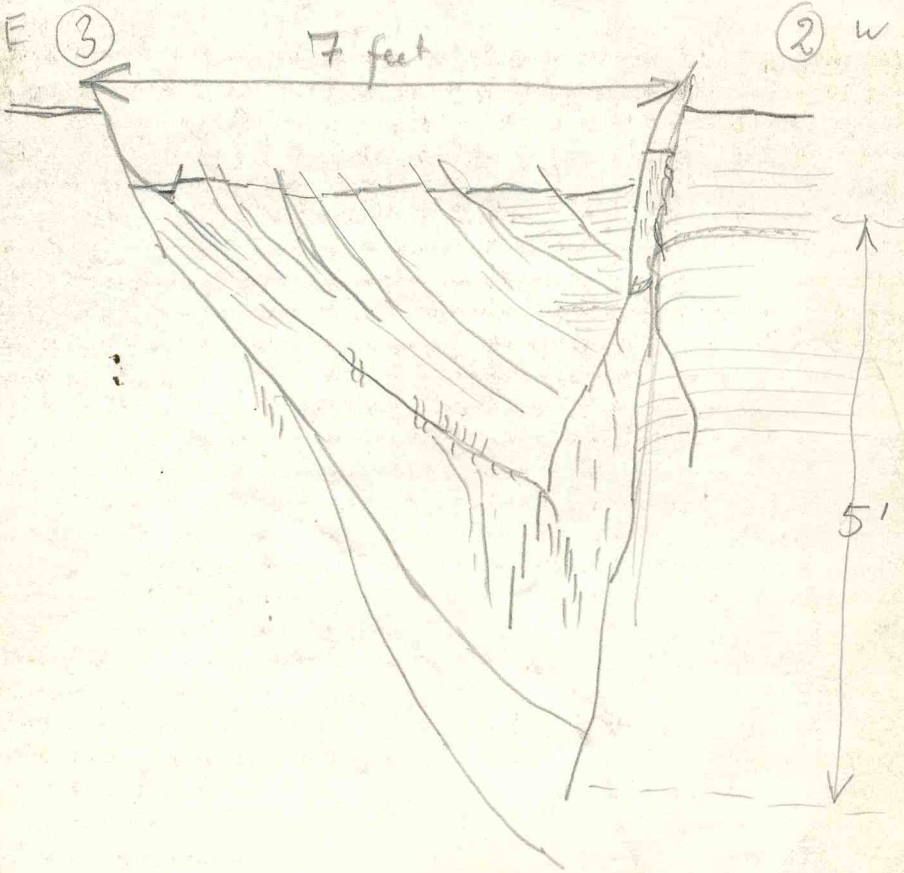
(2) Fault large one $t = 0.9'$ f_s: 147/71 NE accompanied by synthetic and antithetic smaller faults.

(3) Fault $t = 1.4'$, f_s: 147/55-60 SW associated by many small synthetic and few antithetic faults in coal with displacement of only cm



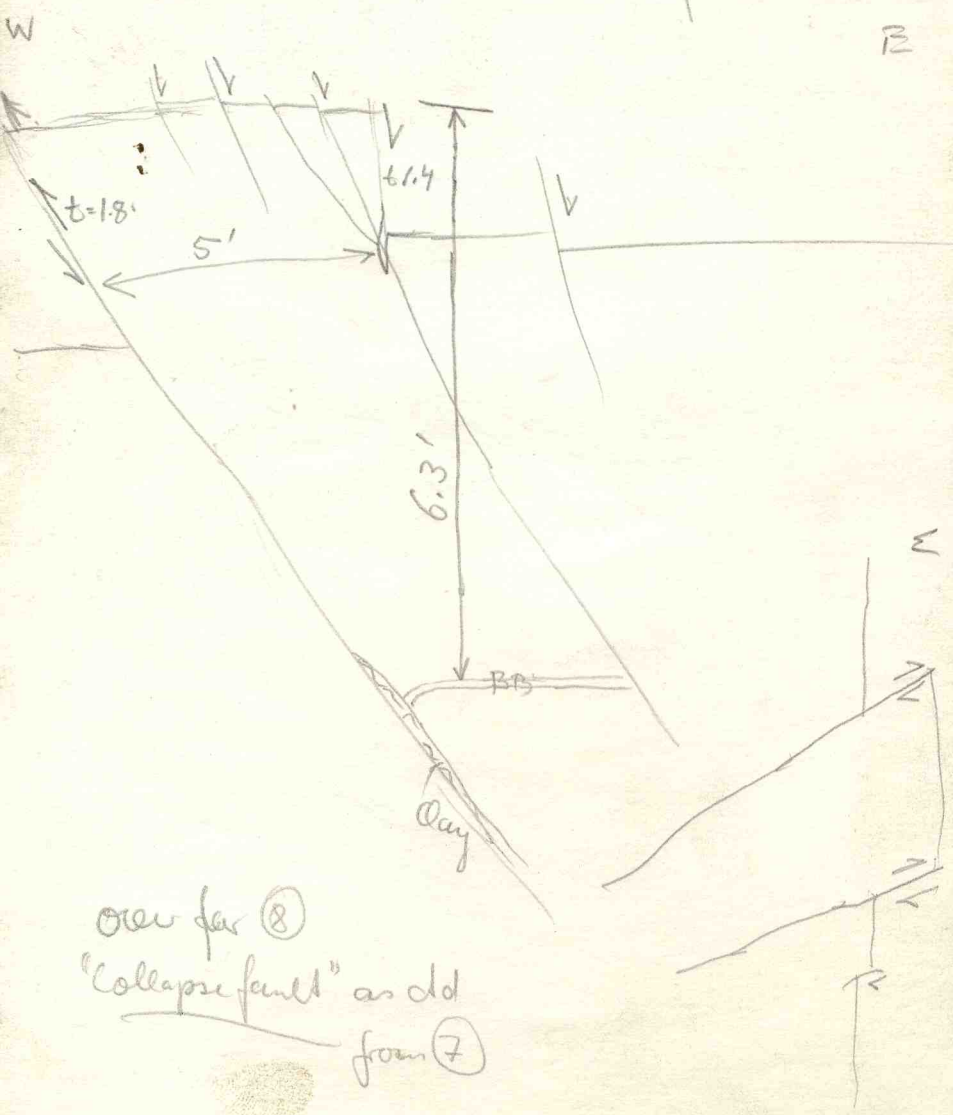
View of south side

12 m ≈ pillar length


E
3
7 feet
2
W
5'

Collapse - ~~Fault~~ at Cottage Grove ~~Fault System~~ dipping along shale from a reverse fault! at 6

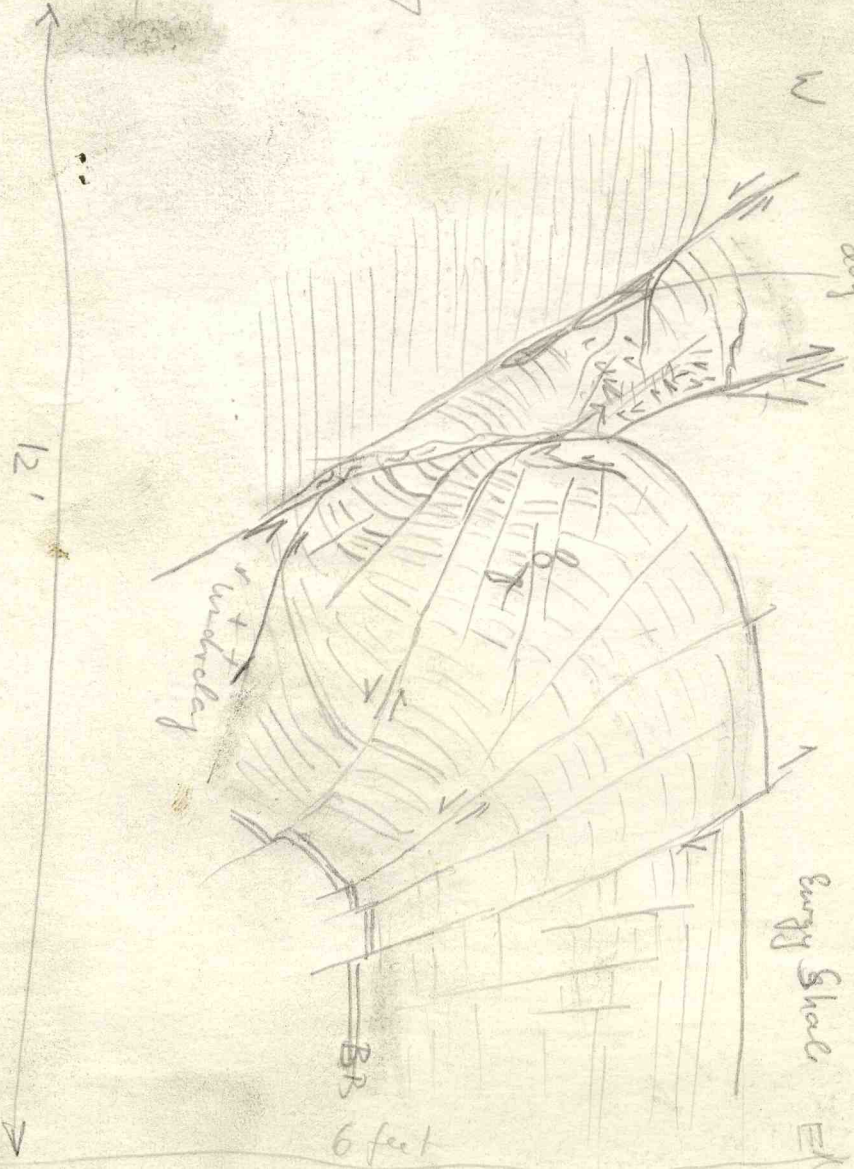
(7) Reverse and Normal fault

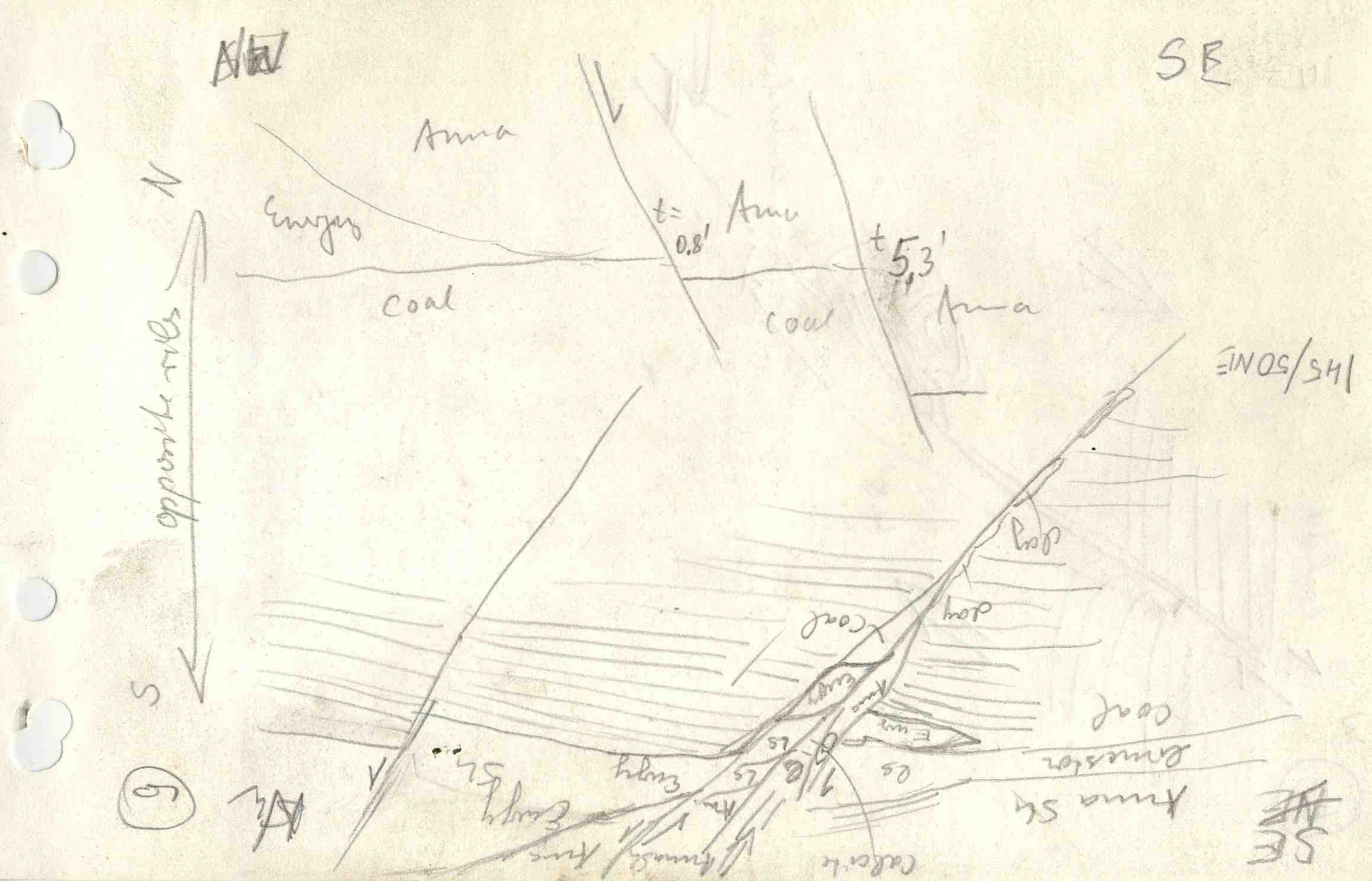


over for (8)

"Collapse fault" as dd from (7)

(8) "Collapse fault" in Cottage Grove fault system. "reverse fault + normal fault" as of station (7) huge wave and wave




SE
NW
Anna
Energy
Coal
t= 0.8'
Anna
Coal
t 5.3'
Anna
145/50NE
opposite rolls
N
S
clay
clay
Coal
Coal
limestone
Anna Sh
Energy
Sh
Ls
Ew
calcite
9

MOORE'S MODERN METHODS

ZEIGLER COAL CO. MINE NO. 4 WILLIAMSON COUNTY

Notes by John Nelson on visit with John Popp and H.-F. Krausse, and Roger Snow (company) 10/18/77.

A series of faults has recently been encountered in the 5th South Panel. The company map shows three faults, all trending roughly 150°, with up to 4 feet displacement. These project toward the 4th South Panel where no faults are shown, but according to George Little there was a zone of bad top directly in line with the faults. No faults or bad top were found farther northwest in the East Mains.

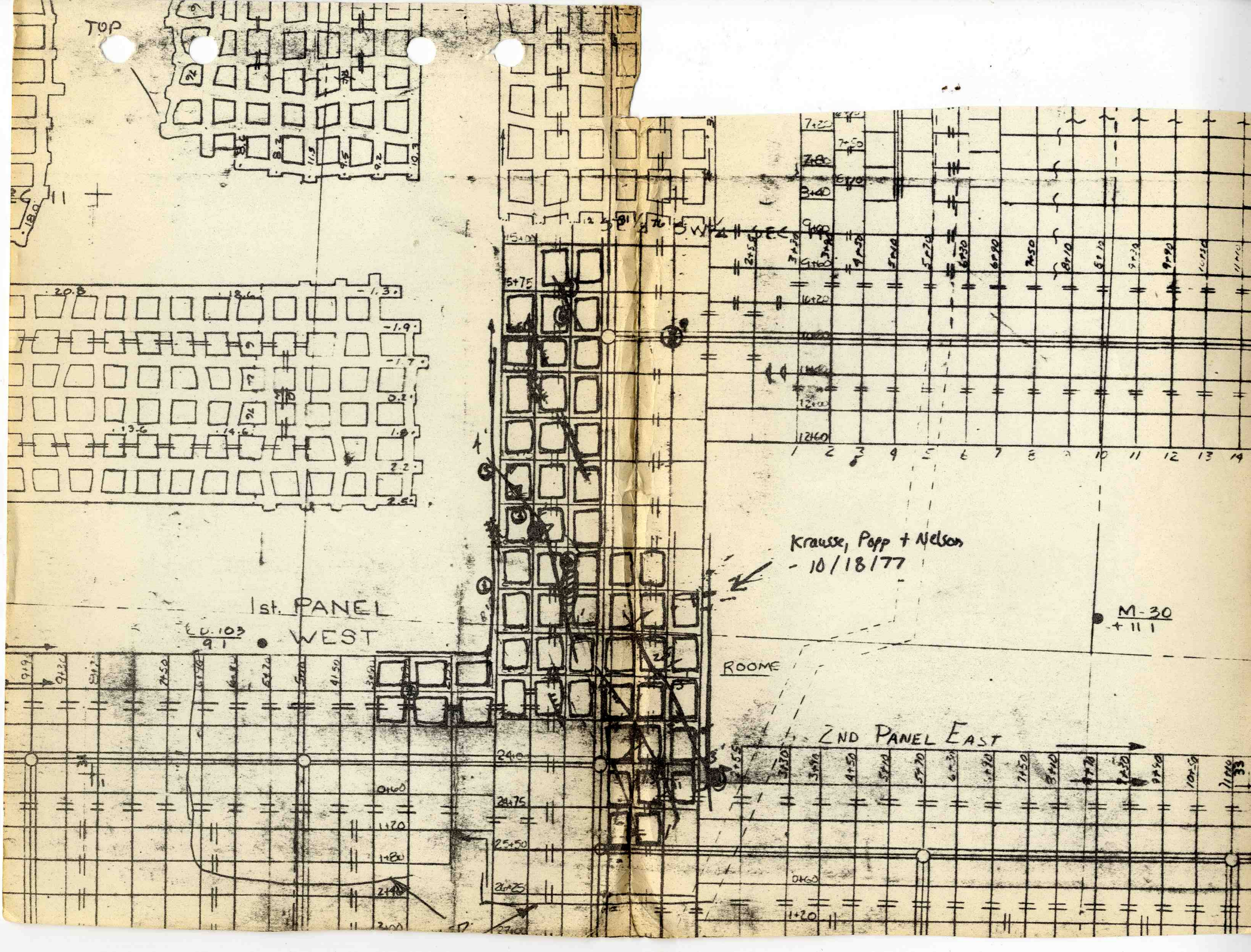
We spend the entire day in the 5th South examining the newly discovered faults. The company furnished us with a 1"-200' scale map; too large a scale for detail mapping. Thus only major features are shown on the attached map.

On arriving at the 5th South we found a structurally complicated area. In addition to the reported tectonic faults, there were large "rolls", compactional faults, and very rapid transitions from Energy Shale to black shale/limestone roof. This is the first area in Zeigler # 4 where we have seen black shale directly on the coal.

1.) Anna/Energy contact. Contact trends about 150°; roughly parallel with tectonic faults. Energy Shale forms a wedge abruptly thickening to the ENE. The contact to the Anna Shale is sharp. About 10 feet east of the contact and roughly parallel with it is an eastward-pointing "rider"of coal turning sharply upward into the gray shale. This "rider" has the appearance of having been flipped upward.

Farther south in the same feature, a second sharply upturned coal "rider" lies along the Anna/Energy contact and forms in effect a "double roll".

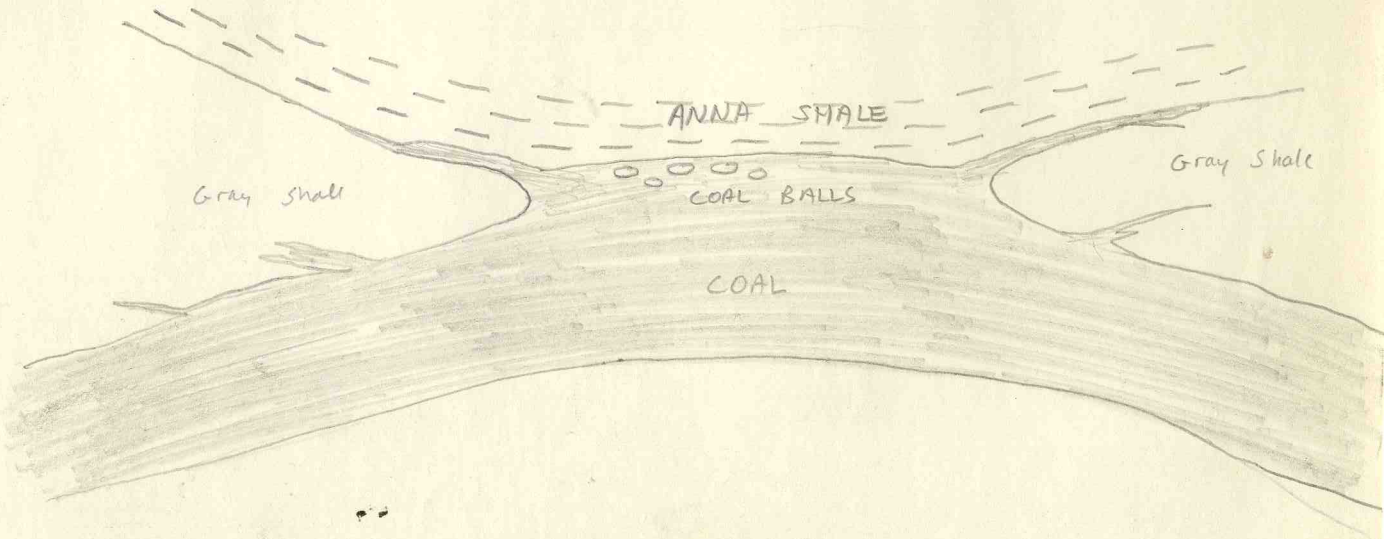
2.) A low ridge in the coal trending roughly 150° with Anna Shale roof above the crest and Energy Shale roof along both flanks. The Energy Shale occupies


TOP
Krause, Popp + Nelson
- 10/18/77
1st PANEL
WEST
M-30
+111
ROOME
2ND PANEL EAST

Stop 2 - Looking NNW
General Impression of situation

WSW

ENE



large "rolls" with coal "riders" pointing away from the ridge. Coal balls occur in the top coal along the ridge crest, under Anna Shale. See sketch (over).

This fits a pattern we have seen in other mines, including Old Ben # 24, Orient # 4, and Orient # 3. It is best developed in the northwest part of Orient # 3. Gray shale roof is found in troughs or depression in the coal seam, and black shale roof above high places.

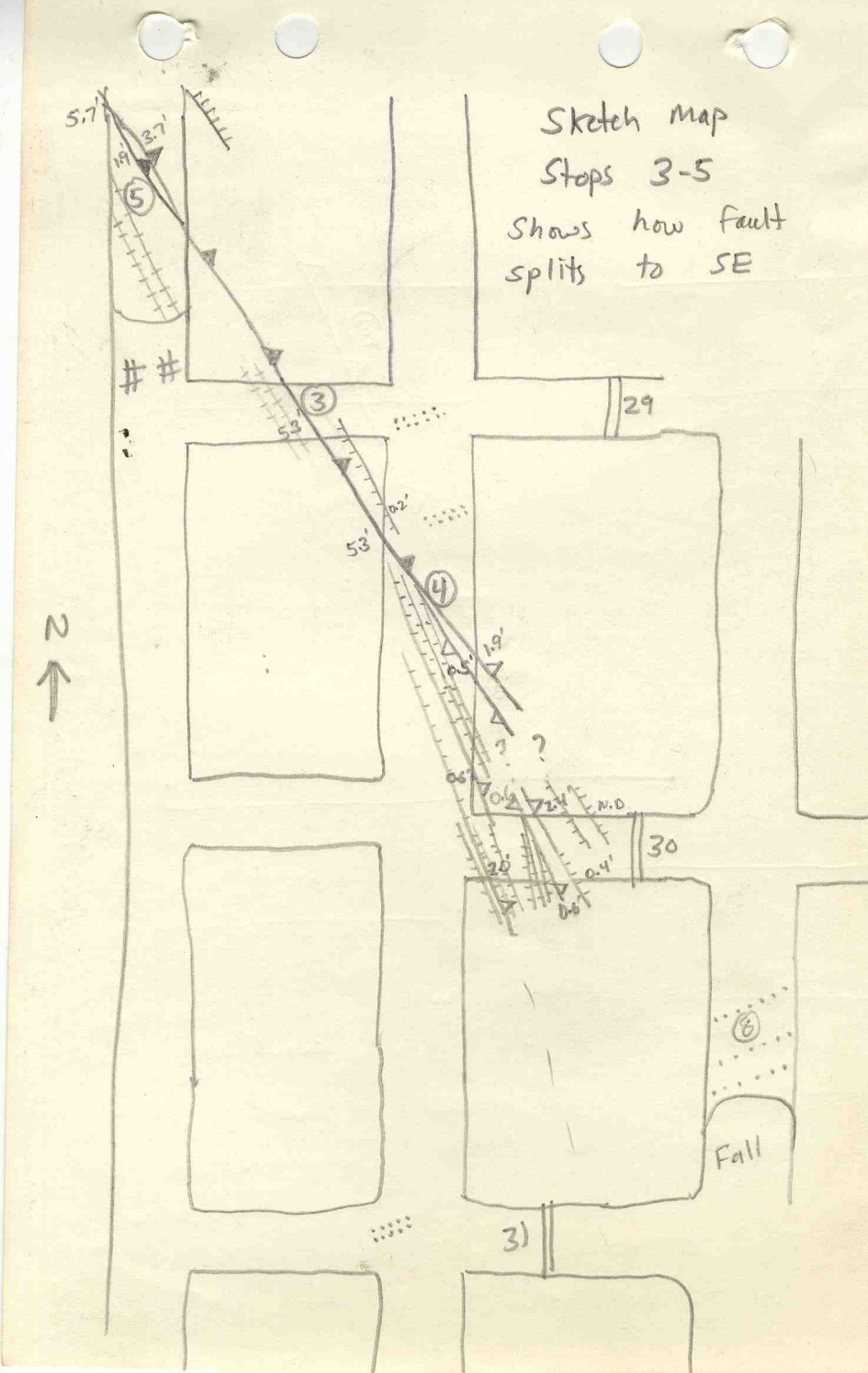
3.) Fault plotted on company map trends 152/65° NE with about 5.3' displacement. It is a normal fault with the downthrown block to the northeast. Like most of the smaller faults we have seen in this mine this one shows no drag in the coal and very little drag in the roof shale. Along the fault plane is a zone of crushed coal and shale up to 0.5' wide with numerous calcite (?) filled fractures.

The main fault is accompanied by numerous smaller normal faults which run parallel and dip both NE and SW. These have no more than a couple inches displacement.

Strike and dip measurements directly on the main fault plane: 158/64° NE on the south rib and 140/63° NE on the north rib. The coal is 9.0' thick with a Blue Band about 0.05' thick 2.3' above the base. The roof at the fault is about 2.0' of gray Energy Shale overlain by Anna Shale. The gray shale thins eastward.

4.) Fault splits and fans out to the southeast. All faults are normal. See sketch map (over).

There are actually many more faults and fractures than even the sketch map can show. Individual faults change displacement very rapidly and some appear to "scissor", being down to the northeast on one rib and down to the southwest on the opposite rib. This, however, may be a misleading appearance. Most faults trace across the roof as zones of very closely-spaced parallel or "en echelon" fractures. It is impossible to show that any individual fracture pivots in throw.


Sketch Map
Stops 3-5
Shows how fault splits to SE
5.7'
3.7'
1.9'
5
3
5.3'
10.2'
5.3'
4
1.9'
10.5'
N
29
30
31
Fall
N.D.
2.4'
2.0'
0.4'
0.6'

The faults fan out not only along strike but along dip. The dips range from vertical to about 35 . The largest faults are down to the northeast.

We note that pyrite bands in the coal are offset along the faults, showing that faulting occured after pyrite emplacement.

The roof is dark gray Energy Shale at least 5 feet thick; the Anna is not exposed.

5.) Main fault here has about 5.7' displacement, down to northeast. A few fractures with almost no displacement run parallel. In the roof fall (see sketch map) Energy Shale is sharply overlain by Anna. The shale contact appears conformable with small lumps on the lower surface of the black shale protruding into the gray shale. Also there are small wispy inclusions of black shale in the upper part of the gray.

The "rolls" and Anna/Energy contacts continue to run parallel with the tectonic faults in this area.

6.) Small fault not plotted by company trends 150/67° SW and has about 1.1' displacement on the north rib. It is a normal fault down to the southwest. It shows not as a single clean break, but as a heavily mineralized zone of intensely crushed rock and coal with abundant "goat beards" and calcite veinlets.

7.) The same fault traced to here apparently changes from a normal fault to a reverse fault across the crosscut. On the south rib is a normal fault down 0.45' to the southwest. On the north rib is a reverse fault down 0.35' to the northeast. This apparently changes to a normal fault downward as the Blue Band is offset by 0.2' of normal movement along the same fault plane.

There is almost no doubt that this fault has actually "scissored". The fault plane can be clearly traced across the roof of the crosscut. The plane maintains the same dip (roughly) on both sides of the crosscut and evidently pivots somewhere in the middle

of the crosscut. This is the first case I have seen of a definite "scissors fault".

Despite the reverse movement on the north rib, the small features all seem to indicate extension rather than compression. All the little fractures associated with the main fault seem to be extension fractures; many contain calcite filling. No folding or drag is evident.

It would seem that the fault is basically a normal fault, caused by extension. But at this one place the blocks rotated and the direction of movement reversed. Only a small amount of rotation could produce the effect of a reverse fault, as seen.

8.) Continuation of fault zone of Stops 3-5. A large roof fall has occured, restricting our view of the faults. We see a large number of normal faults dipping both NE and SW. The largest has about 3 feet throw to the NE and appears to split and die out to the SE.

The Anna/Energy Shale contact appears somewhat gradational. The lower foot or so of the Anna grades from black to dark gray, and the upper foot or so of the Energy grades from medium to medium-dark gray. There is still a definite contact line, but the color change is much less distinct than normal. The contact line is irregular and pitted, with wisps of darker shale in the light shale below.

General Conclusions

We found the tectonic faulting to be much as we expected for the smaller subsidiary branches of the Cottage Grove Fault. There is a series of high-angle normal faults trending about 150° and forming fanning or "en echelon" patterns. Individual faults rapidly branch both in strike and dip before dying out. The feature is apparently due to extension forces. The small reverse fault noted at Stop 7 apparently is a local feature caused by rotation of a coal block.

The fault system is known to die out to the northwest, in the 4th Panel South. There are no indications whether the faults will become any larger to the southeast. It is fairly certain that the zone will continue to the southeast and it probably joins the main Cottage Grove Fault.

The rolls and shale transitions are prominent features of this area and they adversely affect roof stability. The gray shale wedges are very abrupt, even more so than usual. There is a definite tendancy for Anna Shale roof to occur above rises in the coal and for gray shale and rolls to be found in coal seam depressions. This very likely may reflect the original topography at the time of shale deposition.

The rolls and shale boundaries consistently run about 150°, parallel with the faulting. This is difficult to explain, as presumably the rolls and shale were formed before the faults. More detailed mapping will be needed to work out the relationship.

10/19/77 Continue mapping with Popp, Krausse and Roger Snow (company).

Mapping East Mains around mouth of 2nd Panel South, and mapping in 2nd Panel South. This is an area of numerous small faults, all trending about 150°. Conditions for mapping are excellent, with very little rock dust on the ribs and few roof falls or "gob" piles to block our access to areas of interest. The position of panels will afford us nearly continuous exposures of faults for 1600-1800 feet. This is the greatest distance we have been able to follow Cottage Grove faults in a mine. The faults are large enough to be interesting but not quite large enough to disrupt the mining plan, except locally.

The area was mapped on a scale of 1"-100'. A copy of the map is included. We were only able to cover a portion of the area and hope to return later to finish mapping the region.

1.) See sketch map and drawing (over). See also John Popp's Note 4 for more details and sketches.

A complexly faulted area, with normal faults up to 2.5' and reverse faults up to 1.6'. All faults are roughly parallel, trending about 150°. Normal faults predominate. The faults branch and change rapidly in displacement.

The largest fault is a normal fault ("A" on sketch map) with 2.5' displacement on the south rib. This is shown on Zeigler company maps. The trend, measured directly on the fault plane at the northwest corner of the crosscut, is 162/52°NE.

The second largest normal fault (marked "B" on sketch map) has 1.1' displacement on north rib and 1.4 on south rib. This fault undergoes some complicated branching and it is difficult to match features across the entry.

There are a great number of smaller normal faults and fractures. The easternmost of these lies about 50 feet east of Fault "A". From here to the east end of the mappping area, about 500 feet, there is not the slightest indication of tectonic movement. No fractures, "goat beards", or joints are seen in coal or roof. The only features of interest are several rather shallow, discontinuous "rolls" with associated minor compactional slips.

A few small normal faults occur directly west of Fault "B". From here to west end of the included map there are no major faults, but there are several distinct high-angle to vertical fractures in the coal, trending about 150°. Some of these connect to joints in the roof shale trending the same direction. The roof shale is otherwise not jointed. These fractures show no displacement, but I believe they are fault related. About 800 feet west of Stop 1 is another zone of faults up to about 3' throw and trending 150°. These were not studied by us today and are not shown on the map included with these notes. See notes of May 1977 visit with Fred Krausse.

There appears to be only one reverse fault (Fault

2.4' Normal Fault Over 1'

0.3 Normal Fault Under 1'

2.4' Dip Down Thrown Side — Reverse Fault Over 1'

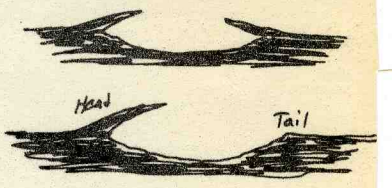
Reverse Fault Under 1'

Roll - Symmetrical

Tail / Head — Roll - Asymmetrical

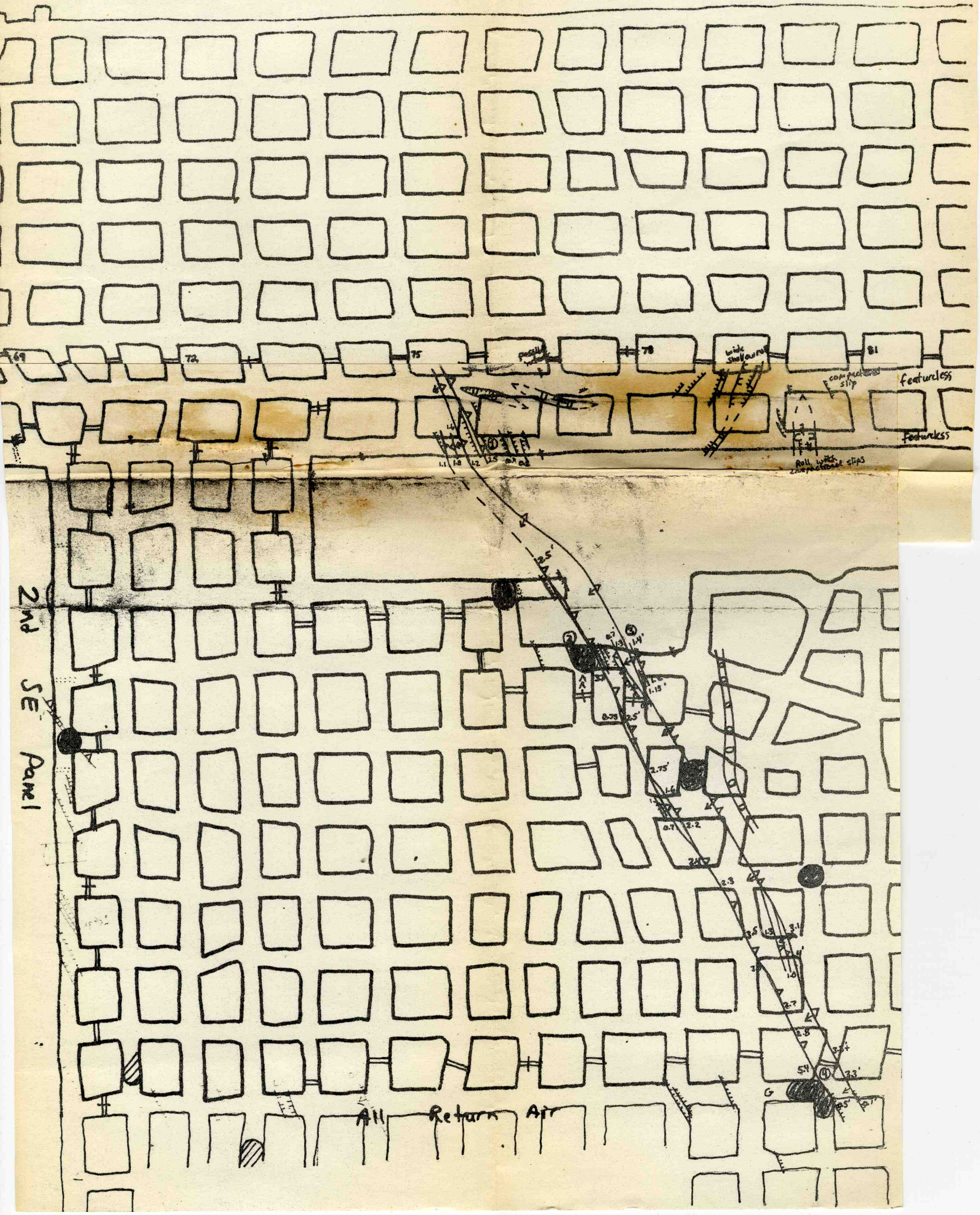
Fall - Blocking

Fall - Not Blocking

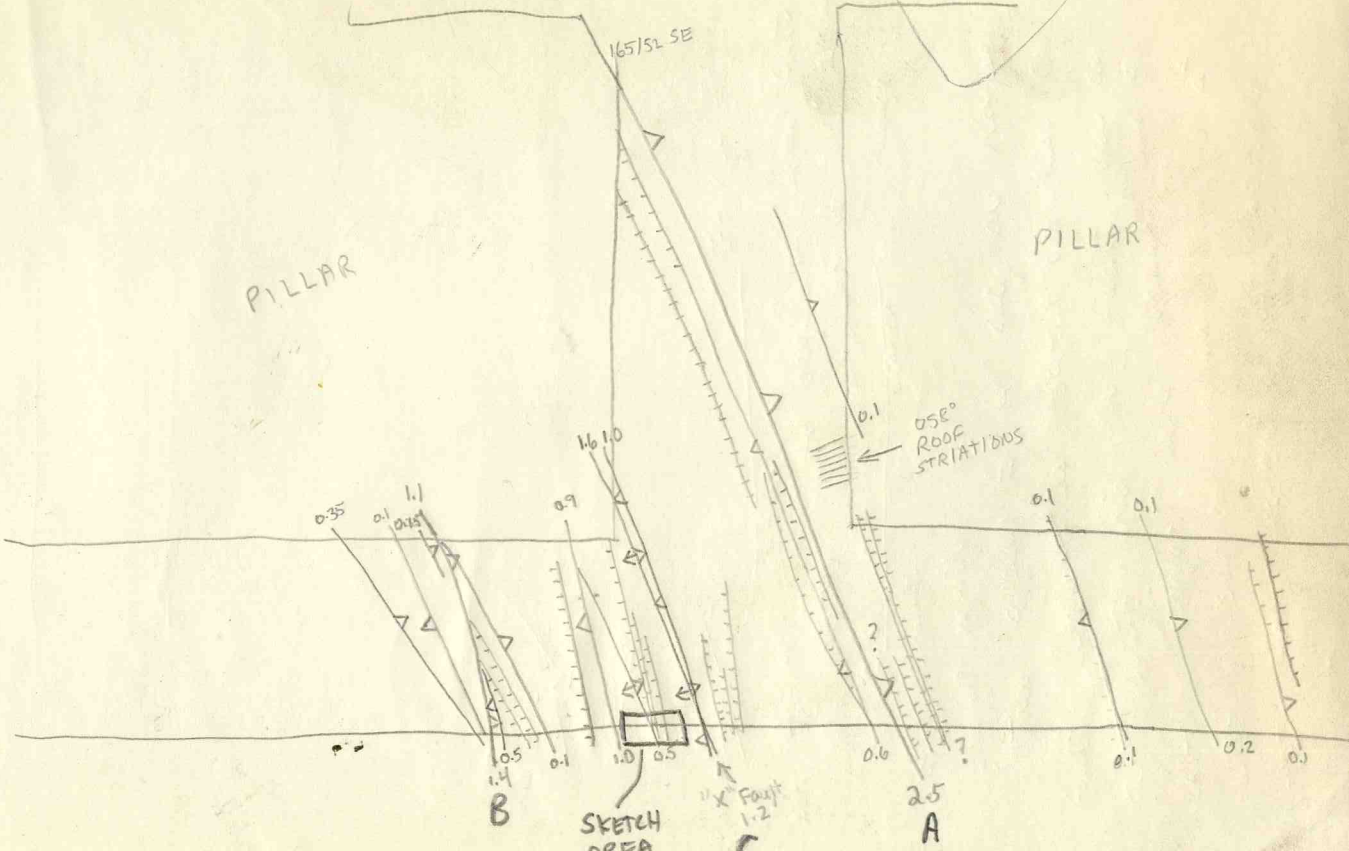


10/19/77

FIELD MAP BY JOHN NELSON



STOP 1 - SKETCH MAP



"C" on sketch map). In the north rib only one reverse fault, of 1.6' displacement is seen. It extends down at least to the Blue Band and has well-developed drag in the coal on both sides of the fault plane. The coal is heavily fractured along the fault plane.

On the south rib there are several reverse faults, but they all appear to be branches of the same fault. Part of this system is shown in the sketch (over). The main fault is the easternmost of the set; it is fairly high-angle and has 1.2' of throw. West of this are several smaller reverse faults (shown in sketch). Of these the largest is 0.5' down to the west. It is fairly high-angle at the top of the coal but turns shallow downward and appears to join the 1.2' fault near the base of the coal. Other, still smaller reverse faults also appear to branch off from the main fault.

The reverse faulting apparently occured after the normal faulting as we see numerous examples of small normal faults interrupted by reverse faults, but no cases of a reverse fault offset by normal faulting. It is of course possible that all the faults developed at the same time, with the normal faults forming antithetic to the reverse faults.

2.) Fault pattern changed in northernmost complete entry of 2nd SE Panel. The westernmost large fault is a normal fault with 3.7' displacement down to the northeast. This forms the east side of a major roof fall and eveidently is the main cause of the fall. The fault probably traces to a 2.5' normal fault in the stub entry to the north and then to Fault "B" at Stop 1.

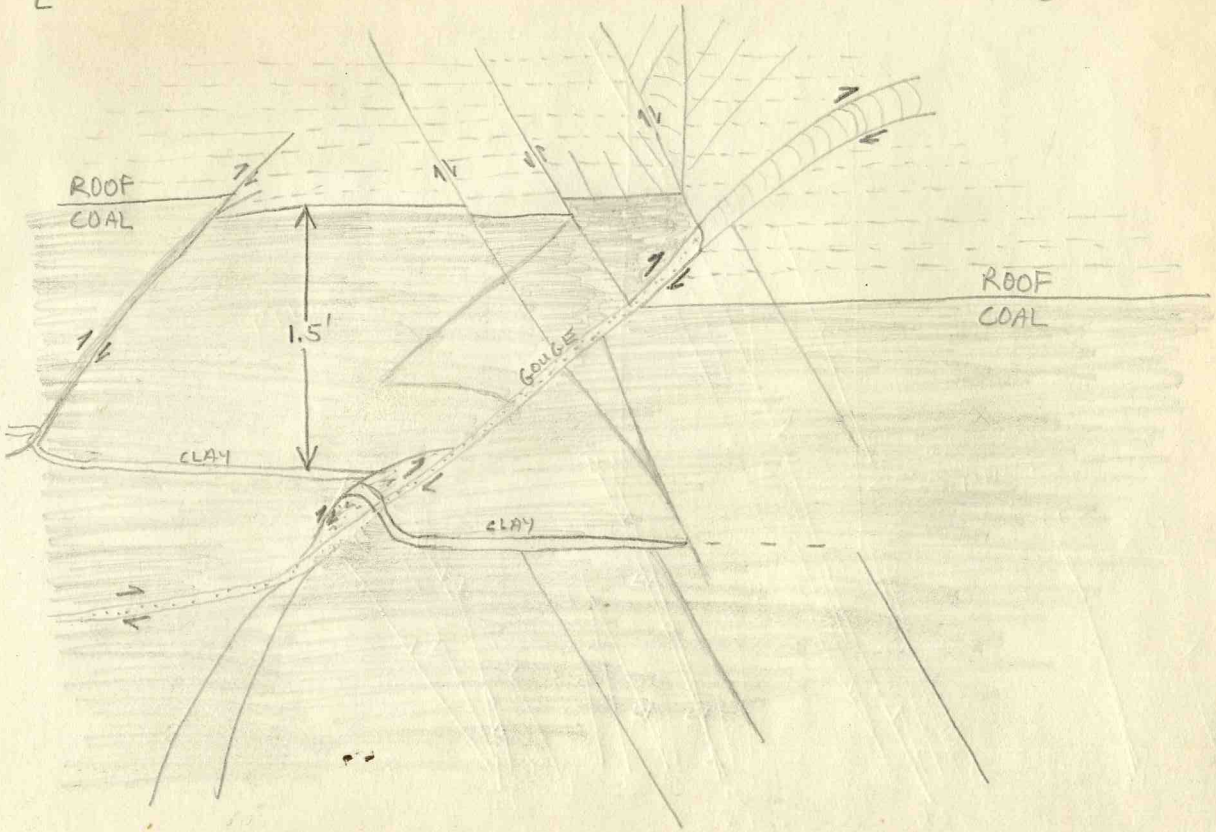
3.) Just east of Stop 2. Excellent exposure of multiple faults on north rib. See John Popp's Note 5 for sketch.

The two main faults are a reverse fault of 1.8' displacement and a normal fault of 1.4' displacement.

E

STOP 1 - SKETCH OF PORTION OF SOUTH RIB

W



The normal fault lies about 5 feet east of the reverse fault and the block between is upthrown forming sort of a horst. These faults probably connect with Faults A and C at Stop 1. There are no significant faults east of the 1.4' normal fault.

So overall we have Fault A decreasing in displacement to the south east and Fault B is increasing. Fault C, the reverse fault, is maintaining about the same displacement. The entire fault zone is becoming narrower and Faults A and C are merging. This creates some very peculiar structures in the next three entries to the south, where the normal and reverse faults are practically on top of one another. See Krausse Note 8.

4.) See also Krausse Note 9 for more details of this same location.

This is an extremely complicated area with not only very unusual tectonic features but also very rapid lithologic changes in the roof strata. It is a transitional Anna/Energy Shale area with large "rolls" and very abrupt wedges of gray shale.

There are two main tectonic faults, a westerly normal fault traceable to Fault "B", and an easterly reverse fault which is Fault "C". These change dramatically in displacement across the entry. The normal fault has 5.4' displacement on the north rib and about 0.5' on the south rib, as the reverse fault goes from 3.3' on the north rib to a barely recognizable 0.1' displacement on the south rib, less than 20 feet away.

The 5.4' displacement seen on the normal fault on the north rib is by far the largest displayed along this fault. In the next entry north it has only 2.8' of throw. The reverse fault is more constant in the entries to the north, with 3-4' of throw in most places, gradually decreasing to the northwest.

Though the normal fault has small displacement on

the south rib it has a wide gouge zone indicative of a major fault. There is squeezed clay or shale all along the fault plane and near the top both Anna and Energy Shale are recognizable. But these have been dragged or dropped below the level of the top of the coal on the hanging wall. See sketch by H.-F. K.

I get the impression that when first formed the faults had more or less equal displacement on both sides of the entry. The normal fault may have had 3-5' of displacement and shale was dragged down along the fault plane. Then the block between the two faults rotated on a NE-SW axis and increased the fault displacement on the north rib while causing reverse movement on the south rib and practically restoring the top of the coal to its original, unfaulted position. But shale dragged down along the fault on the first movement remained trapped along the fault and thus we see it today below the level of the coal on either side.

Another way to explain the shale below the level of the coal is to assume that the top of the coal seam split apart during faulting, creating an open fissure into which the shale fell. We have received this impression from the appearance of other faults at this mine and at Orient # 4. However, this does not account for the drastic change in displacement of both the normal and the reverse fault.

As noted above, the lithologic sequence in this area is very complex. Between the two faults Anna Shale lies directly on the coal. A wedge of gray shale appears to the southwest with the contact line almost exactly along the normal fault. This shale thickens from zero along the fault to roughly 10 feet across the intersection in the roof fall. The Anna/Energy contact dips northeastward at almost a 30° angle in the roof fall. This is the steepest I have ever seen this contact. The contact is very sharp and unconformable (Energy Shale bedding is horizontal

and Anna Shale bedding is parallel with the contact, dipping 30°NE).

Where the Anna Shale lies directly on the coal the lower half is hard and fissile, with numerous concretions. The shale contains very abundant vertical fractures filled with calcite-these obviously are related to faulting. The fissile shale grades upward to a softer, mottled shale containing irregular nodules of limestone. This shale also is highly fractured. The Anna Shale appears to be overlain by limestone but this is not accessible to study.

The base of the Anna Shale contains an irregular zone of "bastard limestone" up to 0.5' thick. This varies greatly in appearance, from nearly black to tawny brown and fine to coarse-grained. It is impure, argillaceous, and contains abundant coarse shelly debris. It is highly fractured with fillings of white calcite. Streaks of coal are common. Some of the limestone resembles coal ball materials but no definite coal balls are present.

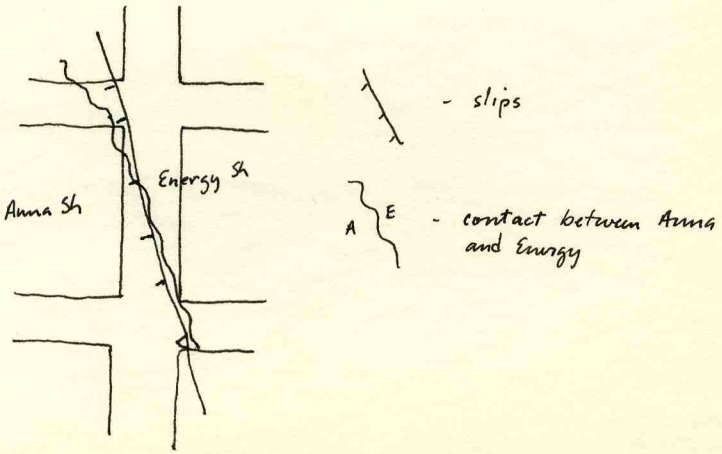
ZIEGLER COAL COMPANY - No. 4 Mine
Williamson County
October 18, 1977
Visit by J. Nelson, F. Krausse, J. Popp
Accompanied by Roger Snow, rodman
Notes by Popp

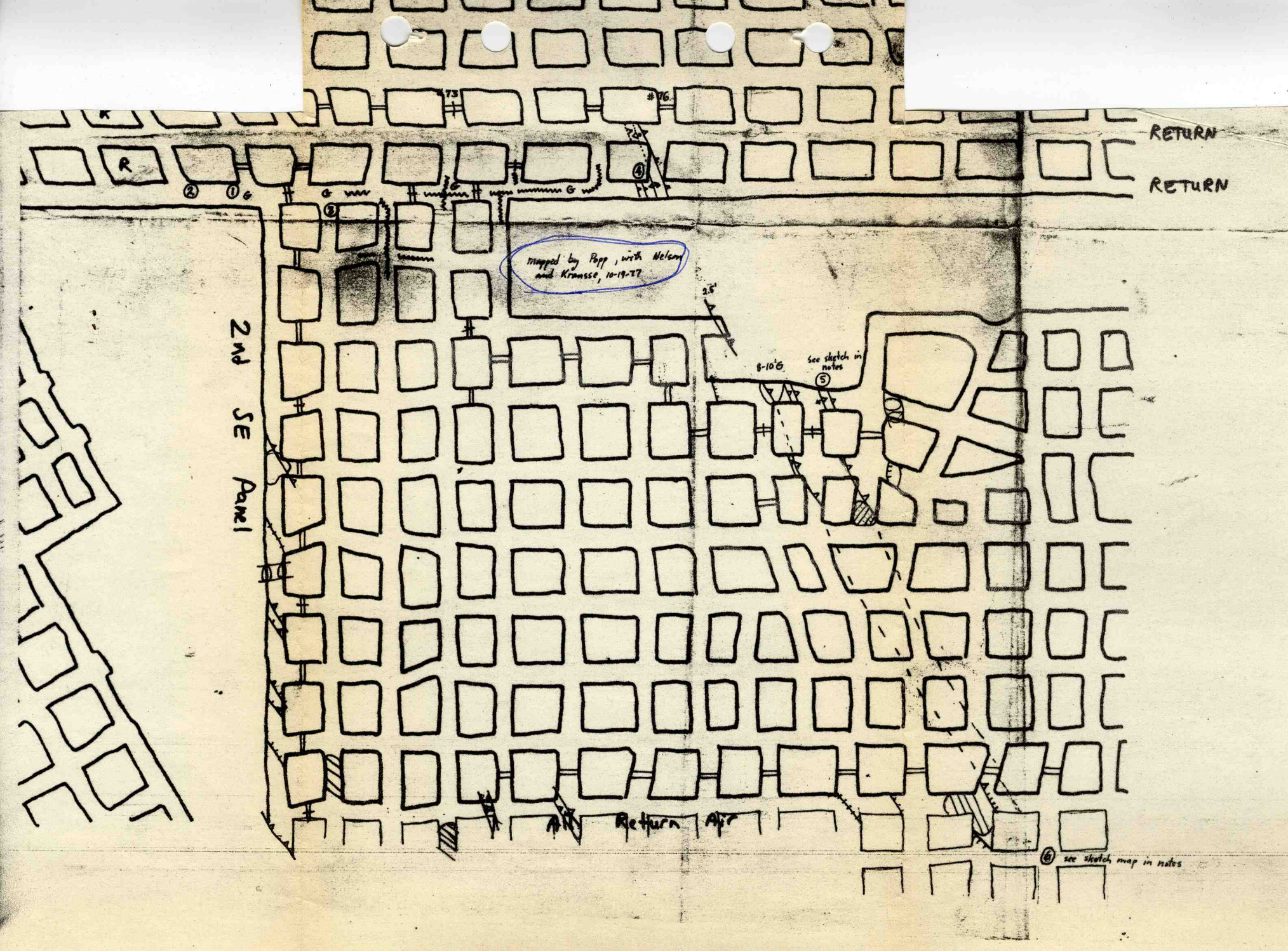
In this two day visit Krausse and Nelson are continuing a detailed study of the Cottage Grove Fault System. Our purpose on this visit is to map structures to the east and south of the slope bottom in a preliminary reconaissance visit.

Our first visit was to the 5th South Mains. Nelson had the only map so that stops referenced here are on his map. Mostly we made a "look-see" visit.

STOP 1

At this stop it appeared that the contact between the Anna Shale and Energy Shale did not coincide with a roll and set of slips. See sketch below.




#73
#76
RETURN
RETURN
R
mapped by Popp, with Nelson and Kramsse, 10-19-77
2nd SE Ave
8-10'6
see sketch in notes
Air Return Air
see sketch map in notes

STOP 2

See also discussion by Nelson

We can see the transition, at this stop and between here and the last stop, between black shale, dark gray—gray shale, and along with the transition which may be a consequence of the rolling nature of the floor. The question is, which came first - deposition of peat material on a rolling pre-peat topography, or deposition of shales after peat deposition with subsequent rolling.

This is a nice study area for transitional roof sequences.

These Stops are numbered according to the Stop numbers used by J. Nelson on the mini map. I made no notes at Stops 3 and 4.

STOP 5

Fall terminated to the north by a well-formed joint trending 60°.

Energy is 7.4' on the north, and 3.5-feet on the south. Anna is 7.0'+ thick, and is loaded with large concretions.

The fall is terminated to the east by the fault described at Stop 3. Crosscut just north dips strongly to the west, indicative perhaps of the fault.

Fault displacements are 1.7' on the NE rib, and 3.9' on the N, down thrown to the NE. Fault with 1.7' is increasing in throw to the SE while the 3.9' fault is decreasing. There are other numerous finger-width faults.

Krausse reports 3 generations of striation, with youngest dipping north, next older is dripping south, and oldest is plunging downdip on fault plane.

Structure orientations:
Fault plane: 152°/65°NE
Throw: 3.9'

Oldest striations: dipping 65°NE
Second oldest striations: dipping 30°S
Inclination angle of plunge of striations: 47°

Ziegler No. 4 October 19, 1977
2nd SE Panel, Returns

See mine map for locations of notes.

Booknote 1

Began mapping in gray shale lithology; small slip in coal, north rib, that offsets some shale or dirt bands in the coal but doesn't offset coal-roof contact. Although roof shale is jointed there is only a nominal affect on roof control.

Joints trend at 160°, slip is not on the south rib.

Booknote 2

Another small slip in coal with features very similar to BN1. Joints are present, and it is probable that the joints are related to the slips because the joints do not appear elsewhere with that frequency in Energy Shale.

Booknote 3

Nelson noted several very small slips trending a little different from what we saw at BN 1 & 2. None of these trends, however, has much continuity.

Note the floor heave which is up to 18".

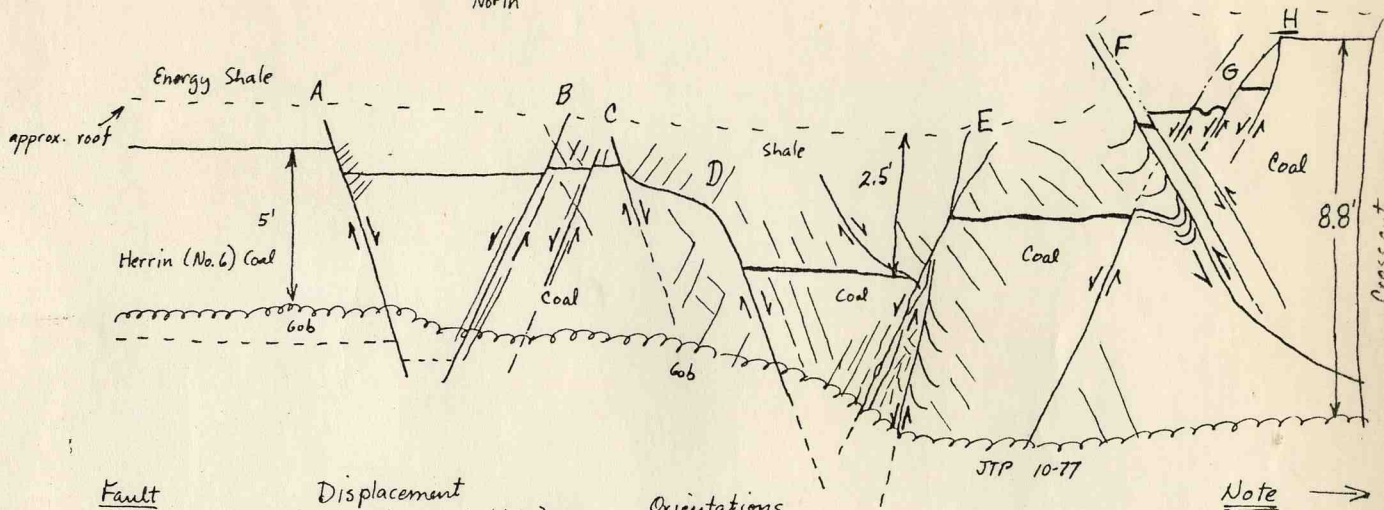
Booknote 4

Fault system - See sketches

Booknote 4 is continued after the drawings.

North Rib - Bookcase 4

North



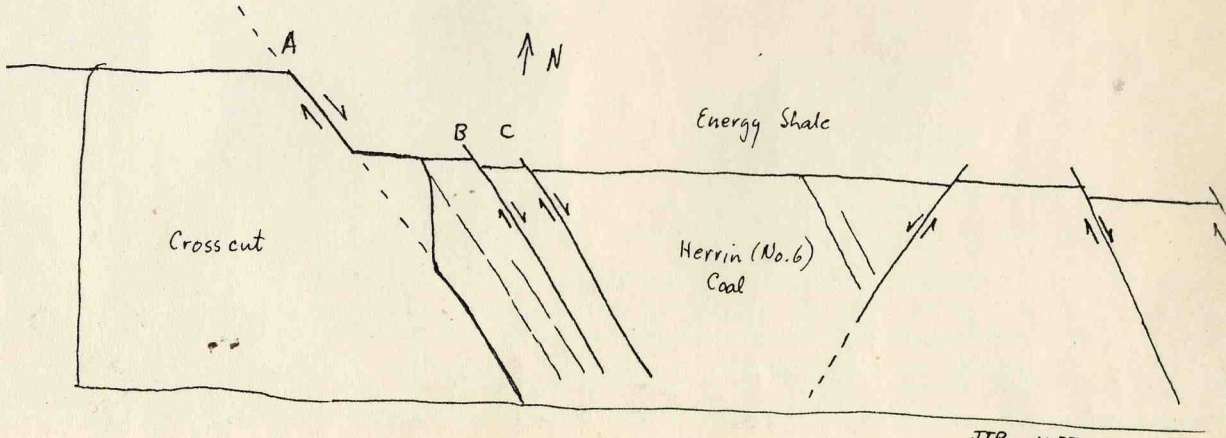
Fault	Displacement (measured ⊥ to bedding)	Orientations
A	0.4'	150°/75°NE
B	0.1'	150°/60° SW
C	0.2'	155°/71°NE
D	1.2'	
E	1.0'	145°/57°NE
F	1.5'	144°/66° SW
G	0.6'	158°/63 NE
H	0.4'	160°/ SW 150°/SW

Note →

See continuation on next page

Booknote 4 - Next crosscut east

Fault	Displacement	Orientation
A	2.4'	150°/61°NE
B	0.1'	150°/60°NE
C	0.1'	175°/65°NE (does not continue in roof)



JTP 10-77

The drawing pretty well tells the story of this stop. My view is on the north rib; J. Nelson described the south rib and F. Krausse discussed the next entry north.

Perhaps the most striking feature of these faults is their discontinuous nature across the entry and through the pillar. The faults change directions slightly They are continuous from the roof into the coal, although we did not dig out the floor rock because of rib rash.

The drawing shows most of the prominent faults, however, the coal, especially in the graben block, is very much broken, indicating many joints and slips that are perhaps "synthetic," or "antithetic" with the faults.

The normal faults are mostly high angle. The reverse fault is high angle toward the top of the seam but decreases its dip downward. I agree with Nelson that the reverse fault seems to cut or displace the normal faults, and therefore it would be younger.

To the east as shown in my sketch, several more small displacement faults are present, but they are dying out in number and their spacing is increasing. They do not have much affect on the roof quality.

Booknote 5

This is the same series of faults as sketched in BN 4. The difference is that the fault system is somewhat narrowing to the south.

I sketched the north rib in this entry while Krausse and Nelson sketched other ribs in the next crosscut south.

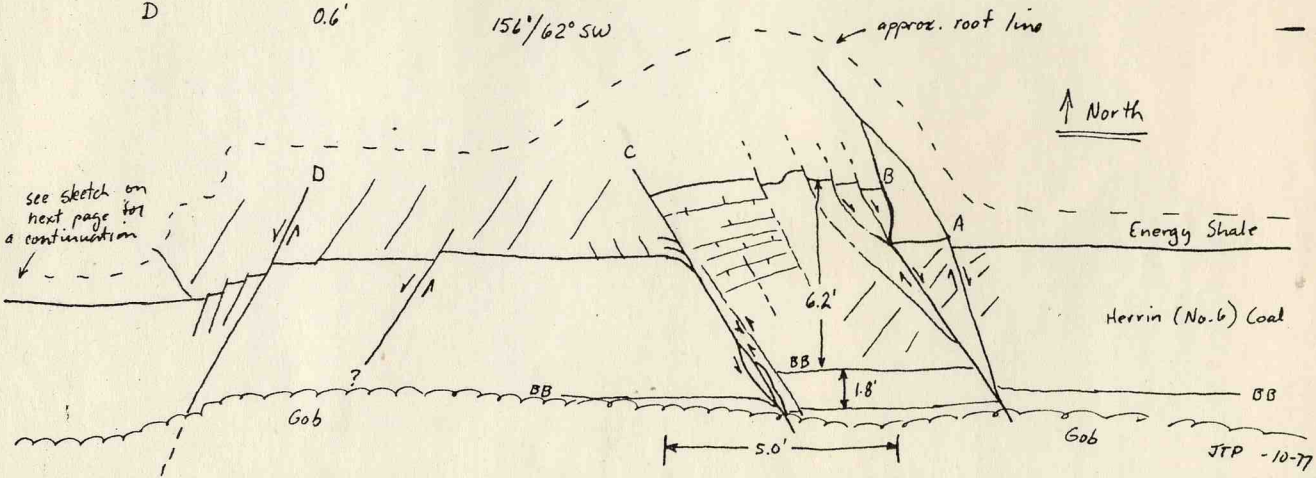
There is not much to say about the rib other than in the reverse fault floor gouge appears to be drug up along the fault plane hanging wall, and the blue band may be reverse dragged downward on the footwall. Drag is not apparent to me elsewhere along the fault, however, tilted coal bedding toward the top of the coal block at first looked like drag.

To the east, faults A and B appear to merge both upwards and downwards as sketched. Note also the difference in their orientations.

This sketch doesn't do justice to the detail present.

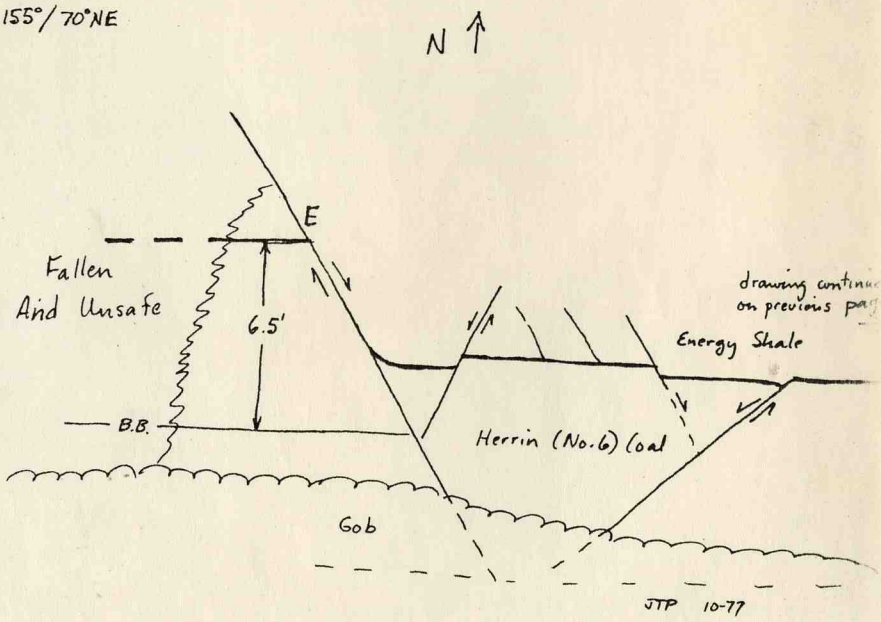
Booknote 5 North Rib, in the 2nd SE Panel Area

Fault	Displacement	Orientation
A	0.3'	170°/70° NE
B	1.4'	157°/50° NE
C	1.8'	160°/53° NE
D	0.6'	156°/62° SW



Continuation of BN 5 (to the west)

Fault	Displacement	Orientation
E	3.5'	155°/70°NE



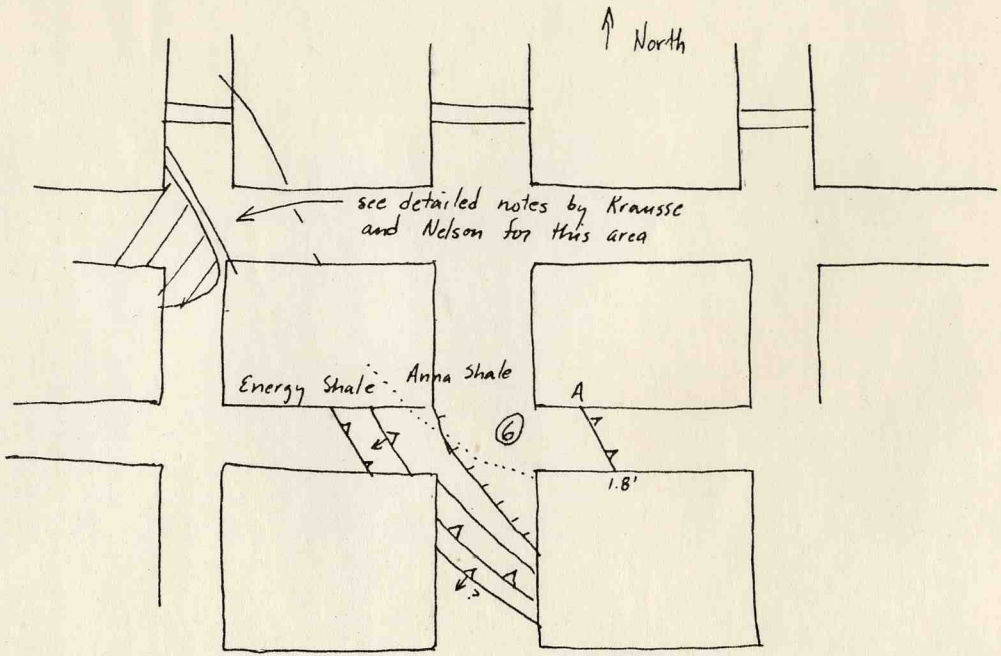
Booknote 6

After "ooh-ing" and "aah-ing" for awhile I tried to make a sketch map of the fault system as it continued so south. Krausse and Nelson sketched and described one crosscut north in more detail than I had time. My results here are incomplete.

The top conditions and exposures are generally bad, and rib rashing is hazardous. In the sketch map below I have incompletely begun to map the faults.

Fault A is a normal fault, 1.8' displacement, trending 150°/54°NE. Lithology above the coal includes an irregular coal ball zone, 0.1-0.3' resting on the coal, 0.4-0.6' of dark gray, fossiliferous limestone above the coalballs, and 1.6'+ black, fissile shale above the limestone.

Booknote 6


North
see detailed notes by Krausse and Nelson for this area
Energy Shale
Anna Shale
A
6
1.8'