U.S. DEPARTMENT OF INTERIOR

GEOLOGICAL SURVEY

Descriptions and correlations of coal bed facies: Lower Freeport(?) coal bed, west-central Pa.

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Open-File Report 85-393

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Introduction

In July 1984, the United States Geological Survey (USGS) entered into a cooperative research effort with the Pennsylvania Electric Company (PENELEC) and the New York State Electric and Gas Corporation (NYSEG) to continue research that the USGS began in previous years in cooperation with the Environmental Protection Agency. The primary objective of this project is to determine and interpret the compositional and geologic parameters that can be related to quality variations of the Lower Freeport(?) coal bed, west-central Pennsylvania (fig. 1). This project complements a larger study being conducted by the Environmental Protection Agency, PENELEC, and NYSEG. The larger study is developing and validating new engineering models to optimize the planning and execution of SO_2 compliance strategies which involve mining, blending, and preparation of coal for electric power generation. Other aspects of the study include: washability analysis of samples obtained from coring, stopped-belt run-of-mine sampling, and channeling; chemical and petrographic characterization of selected samples; and the quantification of X-ray radiographic descriptions for use as a coal bed quality evaluation tool.

Descriptions of sample locations

A total of 37 field descriptions for 11 separate sample sets were made during 1982, 1983, and 1984 (table 1). Initially, channel samples for washability characterization were obtained from each active mining section in the Lucerne #9 mine. In 1983, PENELEC and NYSEG cored through two projected mining areas and then during the advance of mining, obtained a set of channel and stopped-belt run-of-mine (ROM) samples for washability testing. For each location in the mine, channel samples were obtained around both the 30'x30' mined block and the core hole. In 1984, six additional core holes were drilled in projected mining sections following which a minimum of five channel samples and one stopped-belt ROM sample, which represented total section production, were obtained in a manner similar to that of the 1983 sampling. Core from eight drill holes (fig. 2) in the Lower Freeport(?) coal bed was recovered and packaged immediately following extraction from the core barrel. At each mined block, descriptions of the channel sampled facies were made. These descriptions are presented in this report.

Channel sampled faces were described megascopically using criteria similar to that used in describing the Upper Freeport coal bed (Cecil and others, 1981). Descriptive criteria included fracture or breakage type, average bright and dull band widths, minerals along cleats and layers, and fusain layers. Coal bed facies were also delineated by using these criteria. Section sampling layouts and descriptions are presented in figures 4-11; symbols used in figures 4-11 are explained in figure 3. Three other descriptions of channel samples that were obtained in 1982 are shown in figures 12-14.

X-ray radiography

X-ray radiographs were prepared for core numbers 2584 and 2585 (fig. 15) using point-source radiation. Features in these radiographs correlate well with in-mine descriptions made adjacent to the core hole. The primary level of description involves identification of coal bed facies. Facies are mappable units within the bed; although they may change laterally in thickness, they commonly have less areal variation in quality than the whole bed thickness

(Cecil and others, 1981). Each coal bed is composed of one and commonly more facies. Facies are, compositionally, sub-units of the coal bed that are megascopically identifiable and mappable (or have lateral continuity that can be delineated). Areally, facies do not have a consistent composition, however, their compositional and thickness variability is usually less than that of the complete bed. Facies are more readily apparent in the radiographs than they are underground primarily because of conditions under which the descriptions are made. Water on the mined face, dust, and limited lighting all affect the quality of the in-mine description.

Correlation of coal bed facies

The degree of banding is the most obvious difference among facies. Other differences include the amount of fusain and minerals such as pyrite and calcite. A correlation of compiled descriptions is shown in a fence diagram in figure 16. Several observations can be made from this figure: (1) two major interruptions in peat accumulation resulted in the deposition of clay-rich partings probably as a result of flooding; (2) the source of the flood waters was from the south-southeast based on the thickening and decrease of organic content of the clay-rich layers; (3) thick clay-shale layers pinch out and correlate with durain layers (compare figs. 7b-d and 4b-f); and (4) a bright upper facies of the bed (woody paleo-peat) can be found in the northern part of the mine and above the main parting in the southern part of the mine.

There are some similarities between the indicated depositional histories of the Lower(?) and Upper Freeport coal beds as shown in the fence diagram of the Upper Freeport bed (Cecil and others, 1981). Both peat bodies probably began as topogeneous accumulations of peat (filling in low-lying areas). During early stages of peat formation, most areas of the peat swamp were at or below adjacent stream levels. Flooding caused extensive inundation and detrital influx across both swamps, resulting in deposition of a clay-rich parting or mineral-rich durain layer. In the Lower Freeport(?) paleo-swamp, a second major detrital influx was probably restricted to the marginal areas of the swamp because the interior part had changed to a more domed accumulation which was also more acidic, similar to modern ombrogenous (domed) peats. The greater preservation of wood fragments in this acidic, slightly domed environment resulted in a brighter banded coal than in lower facies.

Summary

The initial sampling phase of the cooperative research agreement between the U. S. Geological Survey and PENELEC and NYSEG resulted in a set of megascopic descriptions from which preliminary correlations of coal bed facies could be made and related to depositional factors. These descriptions coupled with related physical, petrographic, and chemical data should make it possible to interpret the geologic factors that relate to the variability of both coal bed quality and cleanability of the Lower Freeport(?) coal bed.

Acknowledgments

The following were especially cooperative to the completion of this phase of the study and to whom we extend our appreciation:

Personnel of Pennslyvania Electric Company, in particular, Francis Martino, Ray McGraw, Susan Latimer, and James Tice;

Personnel of Rochester and Pittsburgh Coal Company, in particular, William Bragonier, Joe Wilcox, Dennis Shay, and Steve Harvan;

Employees of the Lucerne #9 Mine, Helvetia Coal Company, in particular, Mike Gatski, Sam Zack, Mark Lablant, Frank Petro, and Bruce Springer.

Reference cited

Cecil, C.B., Stanton, R.W., and Dulong, F.T., 1981, Geology of contaminants in coal: Phase I report of investigations: U. S. Geological Survey Open-file Report 81-953A, 92 p.

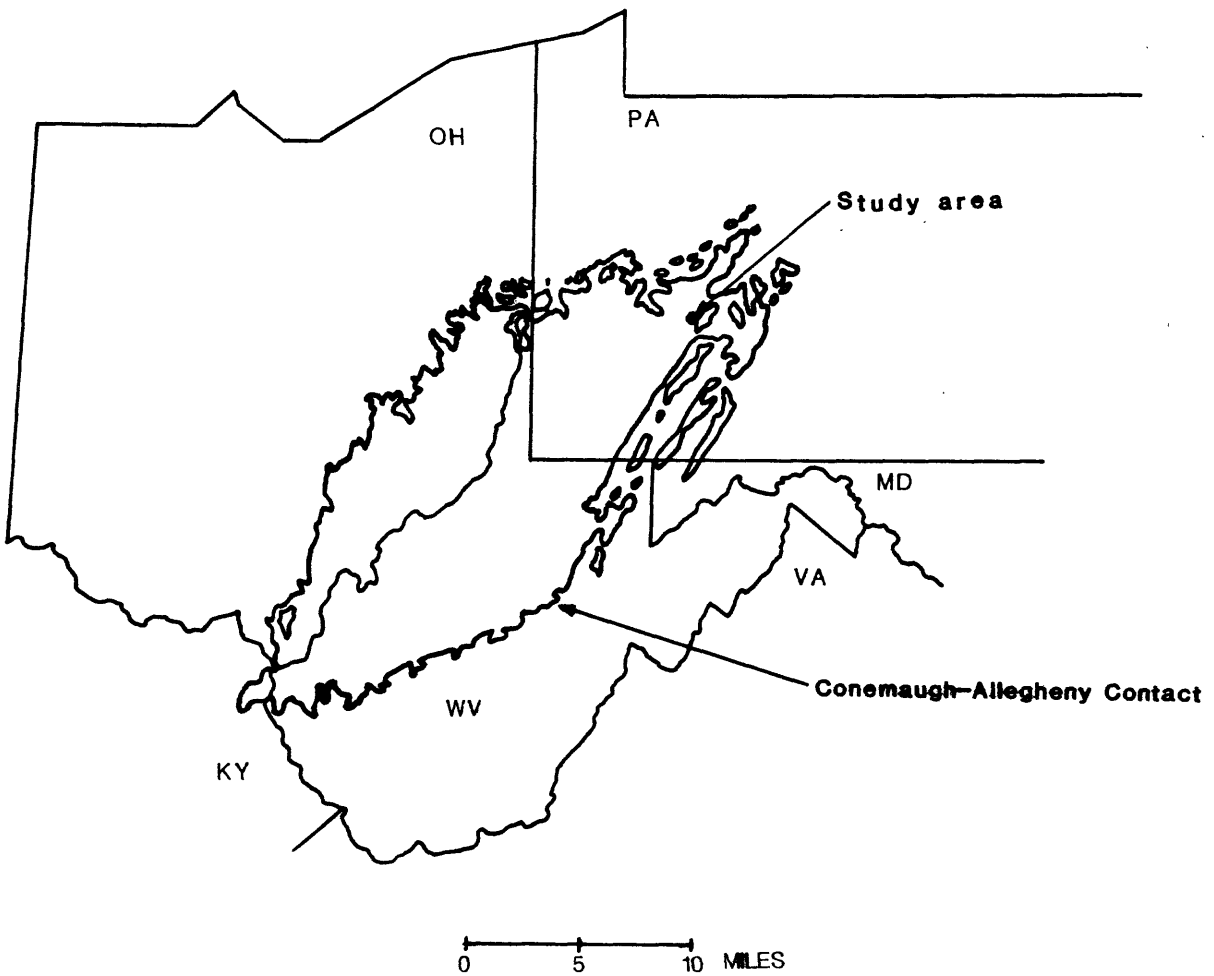


Figure 1. Index map of the study area and Conemaugh–Allegheny contact.

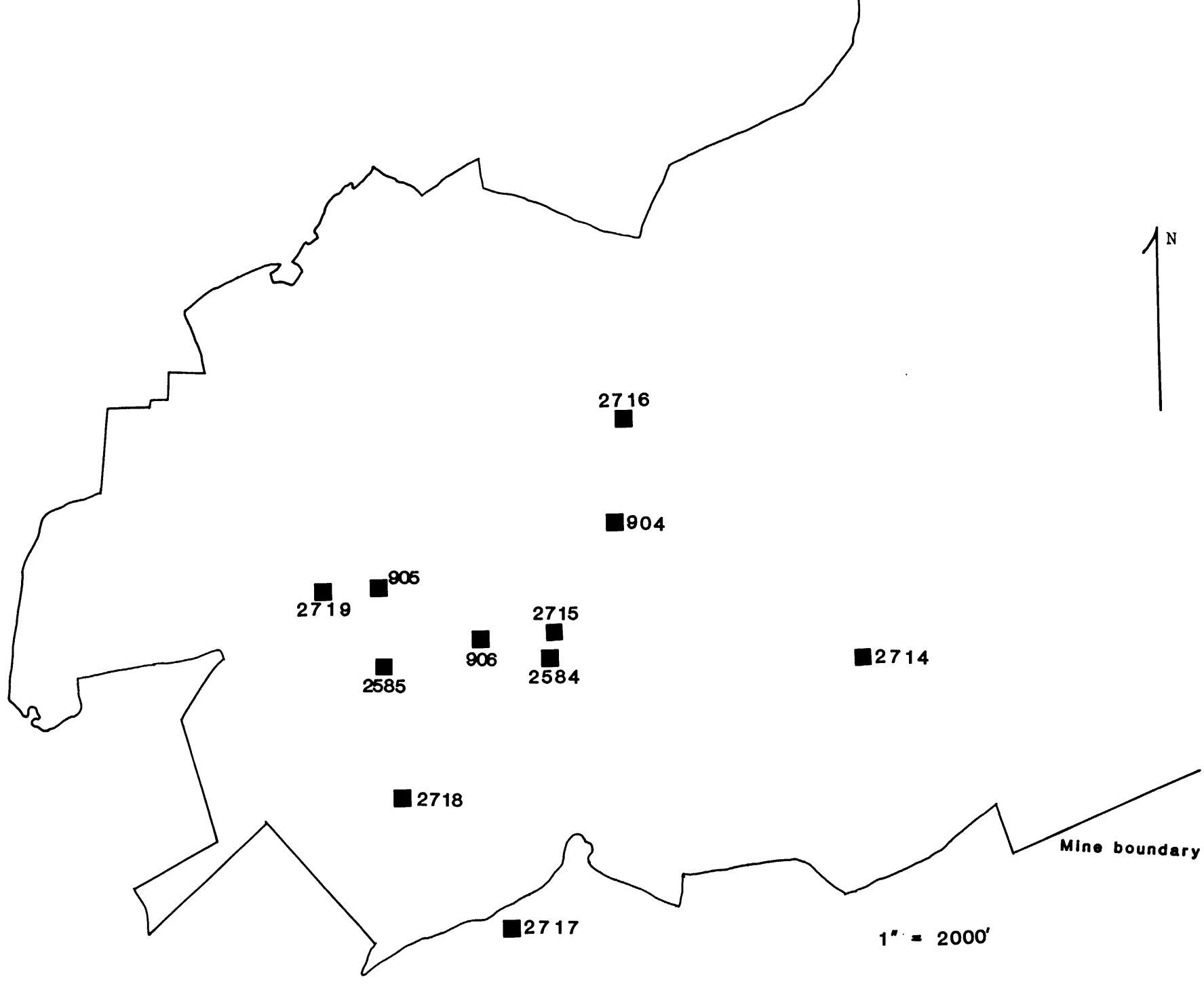


Figure 2. Sample locations in the Lucerne #9 mine, west-central Pennsylvania.

LEGEND

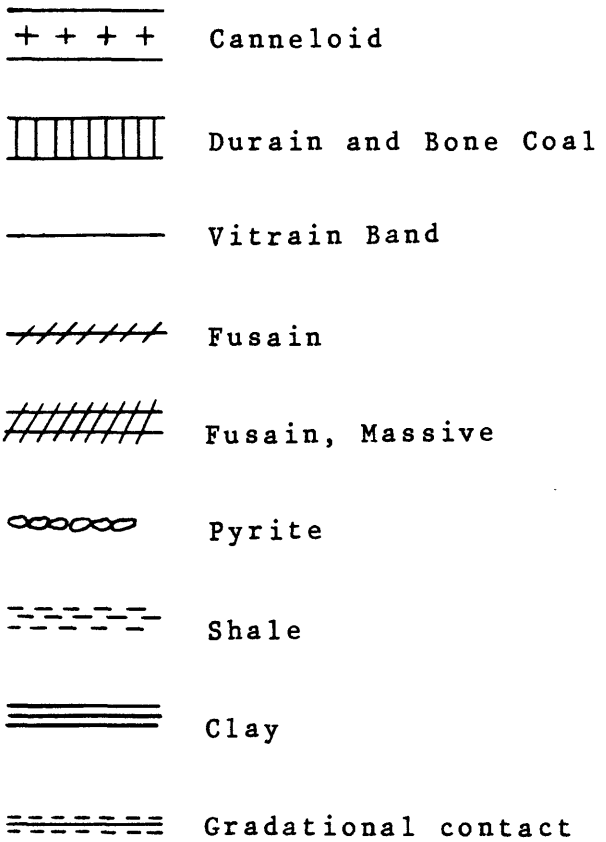


Figure 3. Legend for channel descriptions.

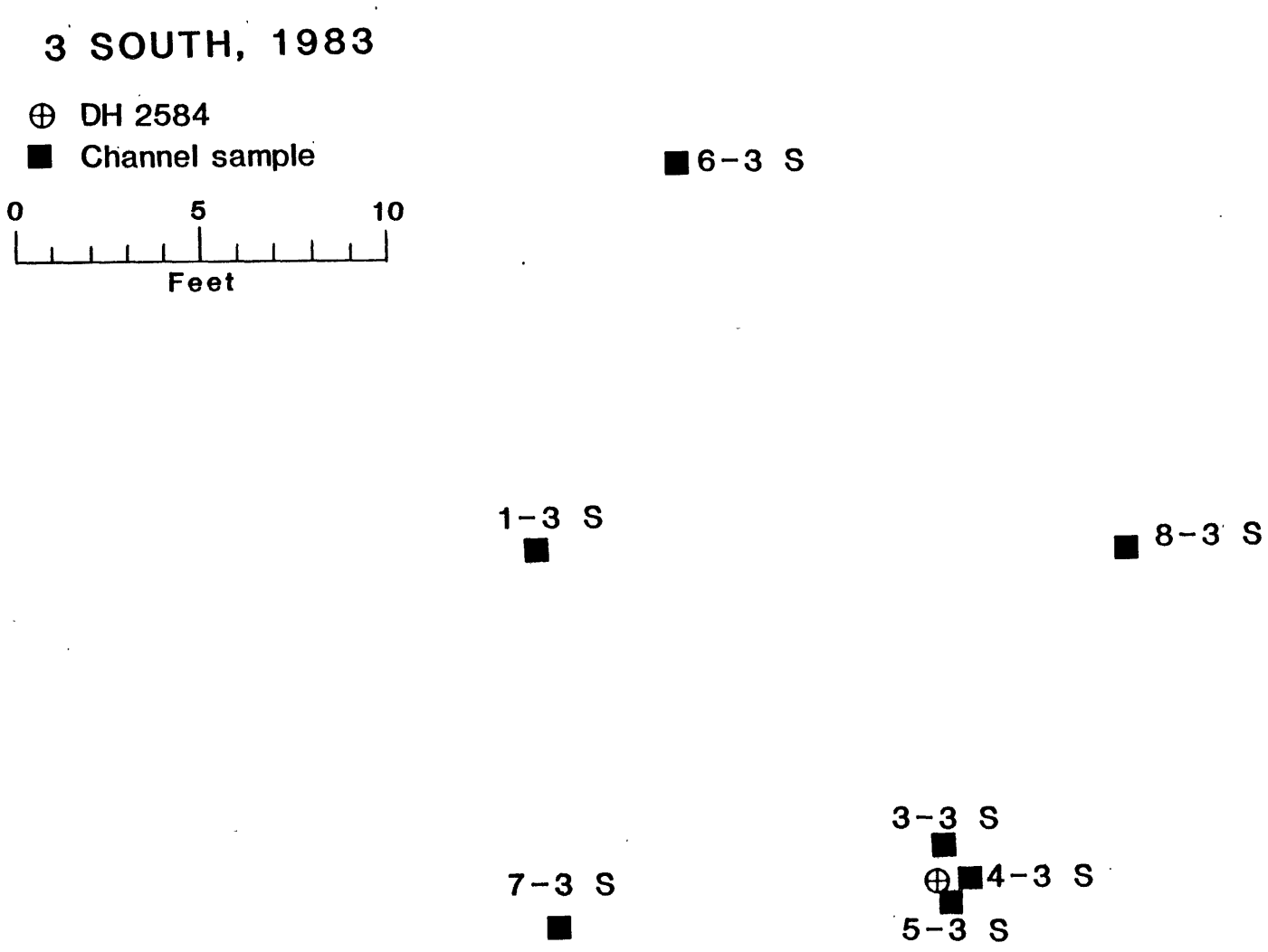


Figure 4a. Location of channel descriptions in 3 South and core #2584, 1983 sampling.

1-3 South 1983

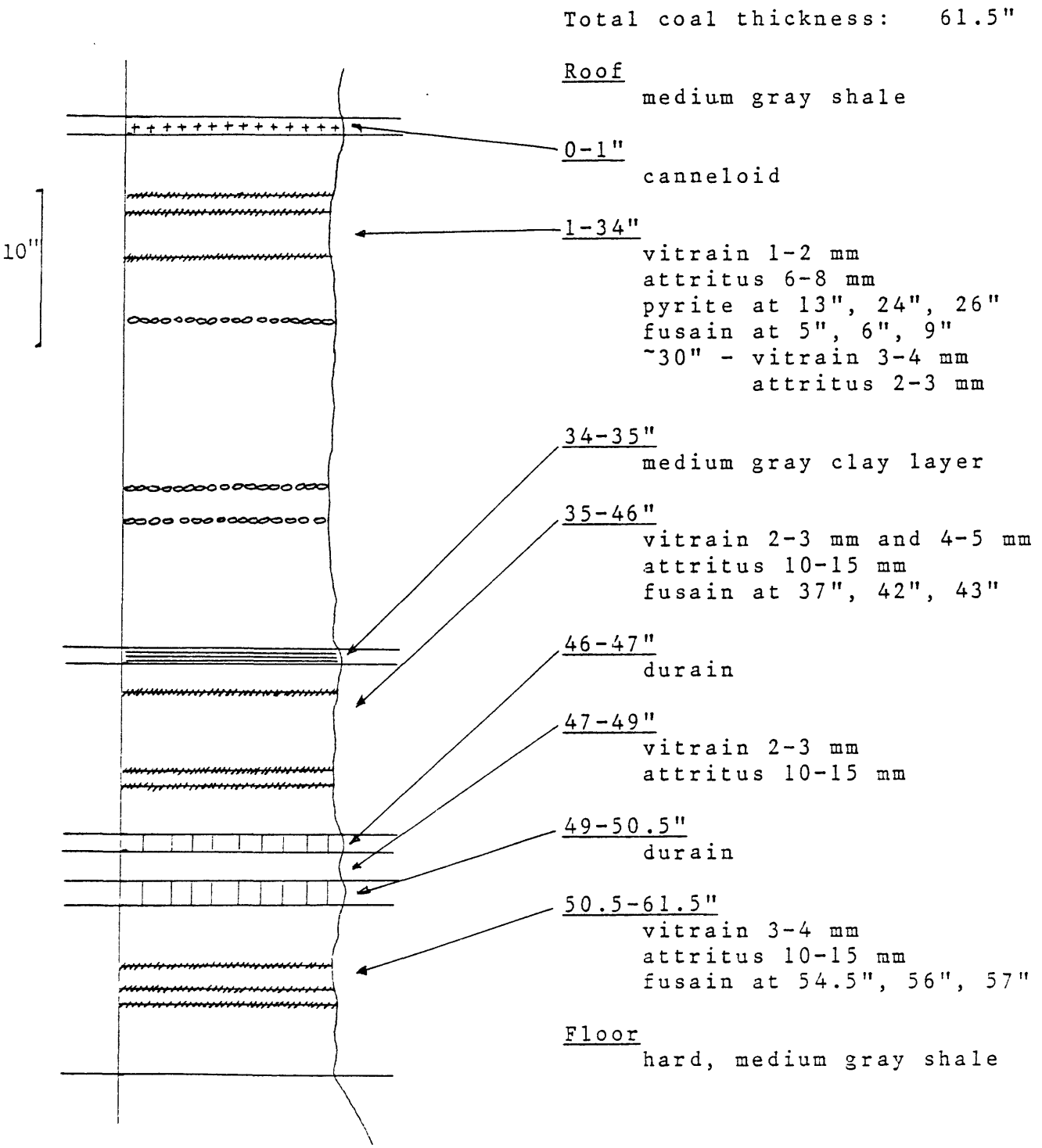
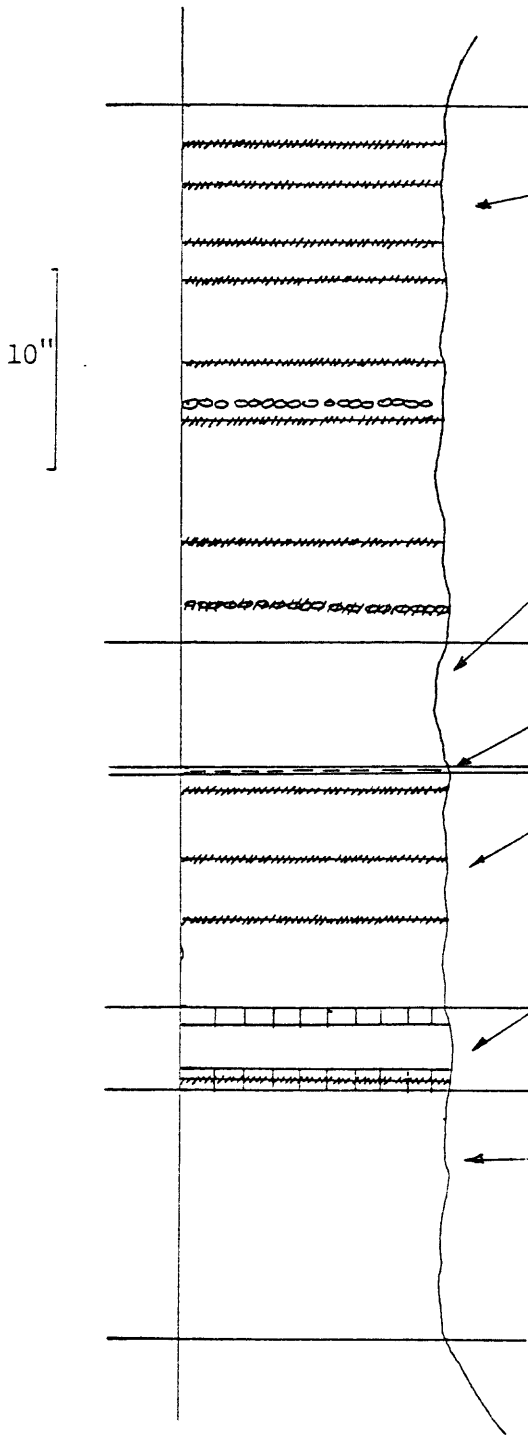


Figure 4b. In-mine description of channel #1 (3 South, 1983) collected near core #2584.



(1" cannel coal not sampled at top.)

Total coal thickness: 62"

Roof
medium gray shale

0-27"
vitrain 2-3 mm
attritus 10-12 mm
small columnar fracture
pyrite at 15", 25"
fusain at 2", 4", 7", 9", 13", 16", 22", 25"

27-33.25"
vitrain 3-5 mm
attritus 1-2 mm
small blocky fracture
bright

33.25-33.325"
shale

33.325-45.25"
vitrain 2-3 mm
attritus 3-4 mm
fusain at 34.5", 38", 41"

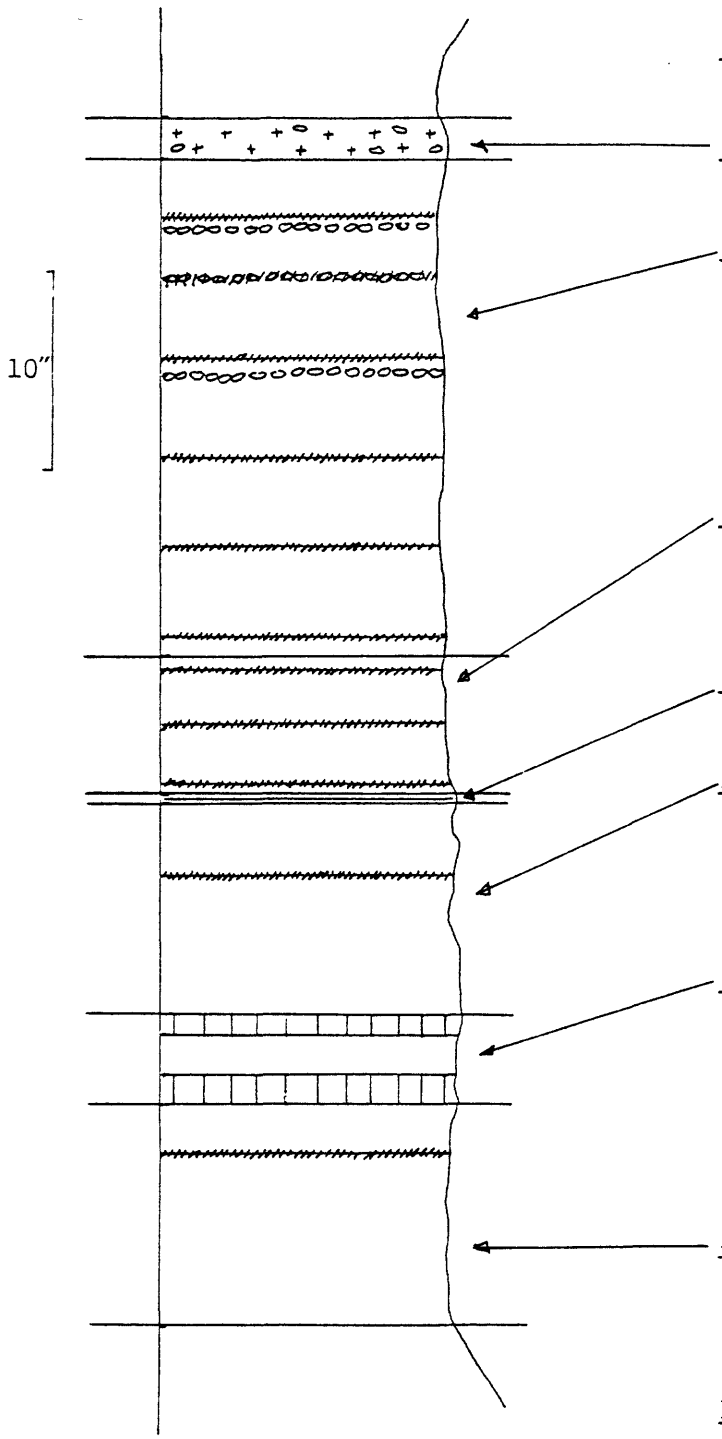
45.25-49.5"
vitrain 3-4 mm
attritus 1-2 mm
fusain at 49"
durain at 45.25" (2.5 cm), 48.5" (2.5 cm)
banded coal 46.25-47.75"

49.5-62"
vitrain 2-3 mm
attritus 10-15 mm

Floor
hard, medium gray shale

Figure 4c. In-mine description of channels #3,4,5 (3 South, 1983) collected at core #2584.

6-3 South 1983



Total coal thickness: 60.75"

Roof
medium gray shale

0-2"
cannel coal with pyrite

2-27"
vitrain 2-3 mm
attritus 15-20 mm
columnar fracture
pyrite at 5.5", 8", 13"
fusain at 5", 8", 12", 17",
21.5", 26"

27-34"
vitrain 3-4 mm
attritus 1-2 mm
fusain at 27.5", 30.5", 33.5"

34-34.25"
clay

34.25-45"
vitrain 2-3 mm
attritus 10-12 mm
hard blocky fracture
fusain at 38"

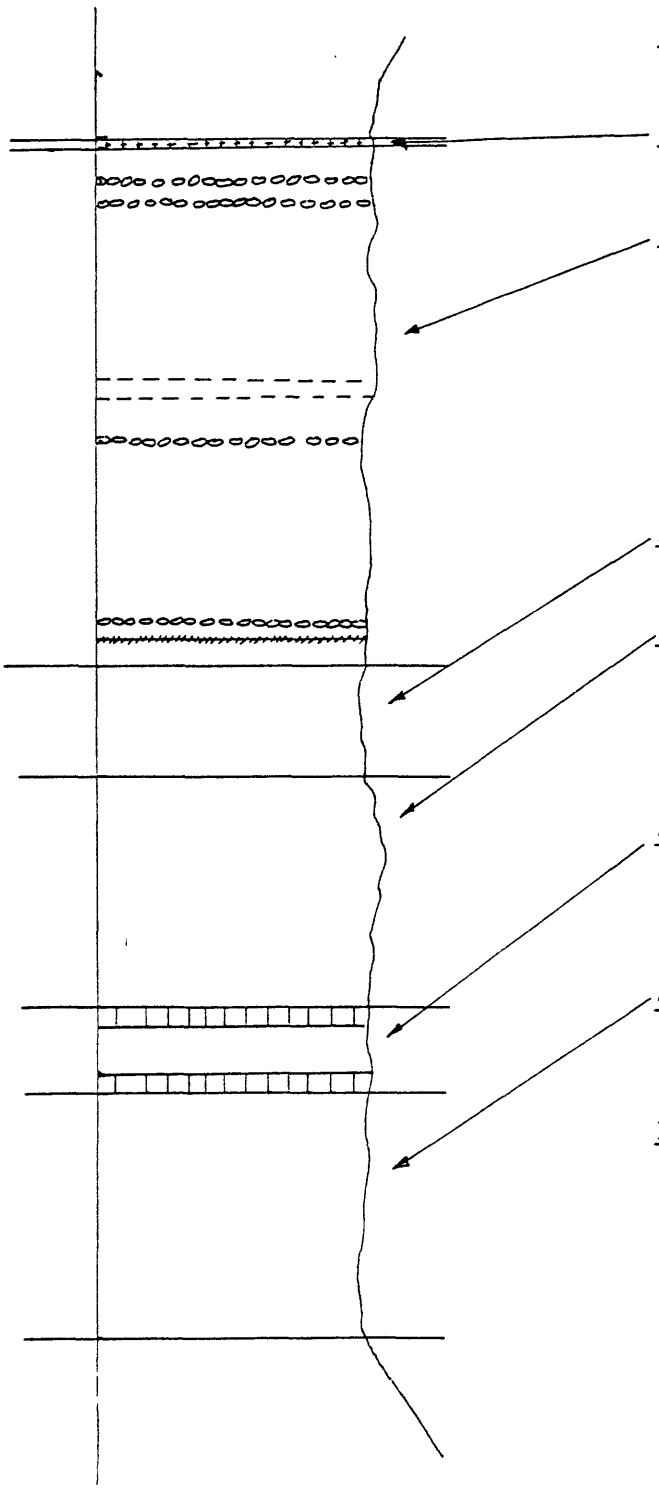
45-49.5"
45-46" - durain
46-48" - banded coal
vitrain 3-4 mm
attritus 1-2 mm
48-49.5" - durain
vitrain spars 2-3 mm

49.5-60.75"
vitrain 3-4 mm
attritus 1-2 mm
fusain at 52"

Floor
hard, medium gray shale

Figure 4d. In-mine description of channel #6 (3 South, 1983) collected near core #2584.

7-3 South 1983



Total coal thickness: 60.25"

Roof
medium gray shale

0-0.5"
canneloid

0.5-26.5"
vitrain 3-4 mm
attritus 10-15 mm
hard, columnar fracture
pyrite at 2", 3", 15", 24"
fusain at 25"
shale lenses at 12", 13"
dull

26.5-32"
no description

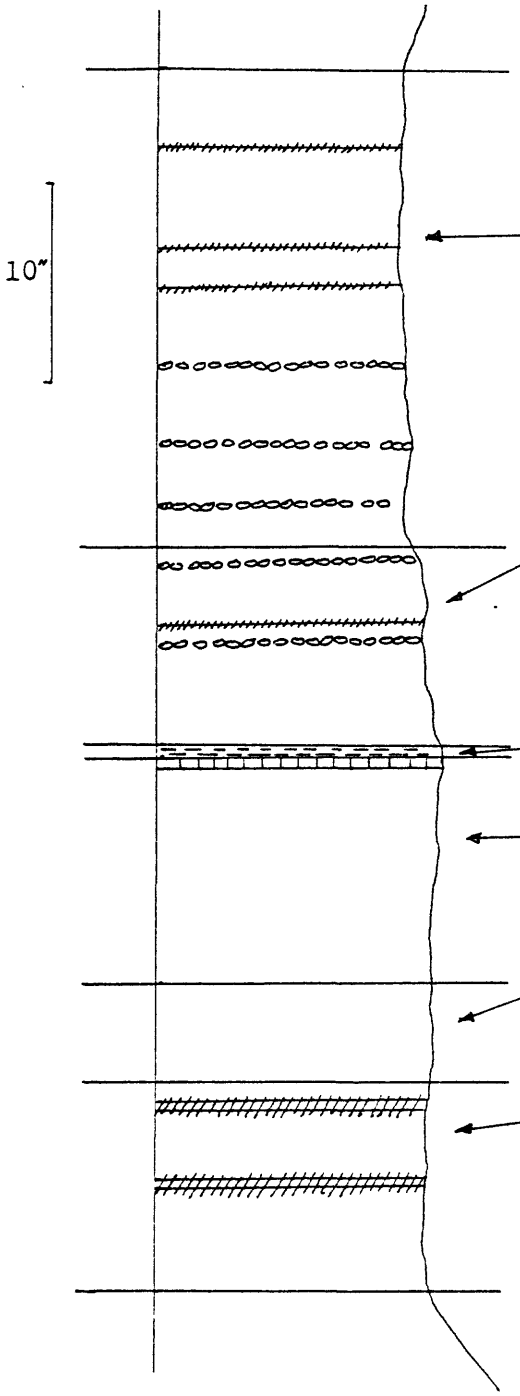
32-43.75"
vitrain 2-3 mm
attritus 3-4 mm
large blocky fracture
bright

43.75-48"
vitrain 2-3 mm
attritus 1-2 mm
durain at 43.75-44.75" and 47-48"

48-60.25"
vitrain 2-3 mm
attritus 10-12 mm

Floor
hard, medium gray shale

Figure 4e. In-mine description of channel #7 (3 South, 1983) collected near core #2584.



(1/2" canneloid coal not sampled at top.)

Total coal thickness: 61.5"

Roof
medium gray shale

0-24"
vitrain 1-2 mm
attritus 8-10 mm
pyrite at 15", 19", 22"
fusain at 4", 9", 11"
banded

24-34"
vitrain 3-4 mm
attritus 1-2 mm
hard large blocky fracture
pyrite at 25", 29"
fusain at 28"
bright

34-34.5"
shale

34.5-46"
durain at 34.5-35"

46-51"
vitrain 3-4 mm
attritus 1-2 mm
durain 1.3 cm

51-61.5"
fusain at 52" (1.3 cm thick) and 56" (1.3 cm thick)

Floor
hard, medium gray shale

Figure 4f. In-mine description of channel #8 (3 South, 1983) collected near core #2584.

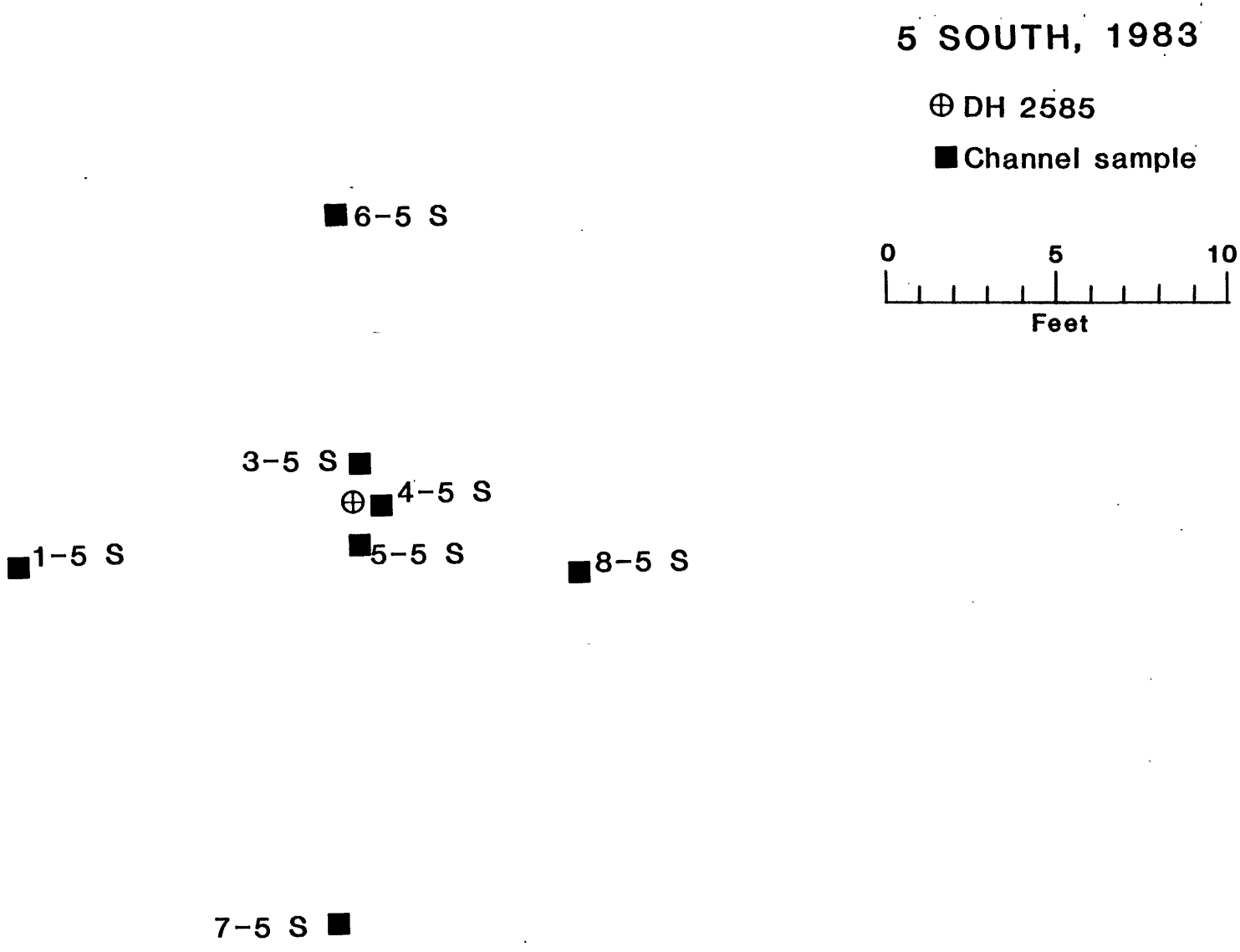
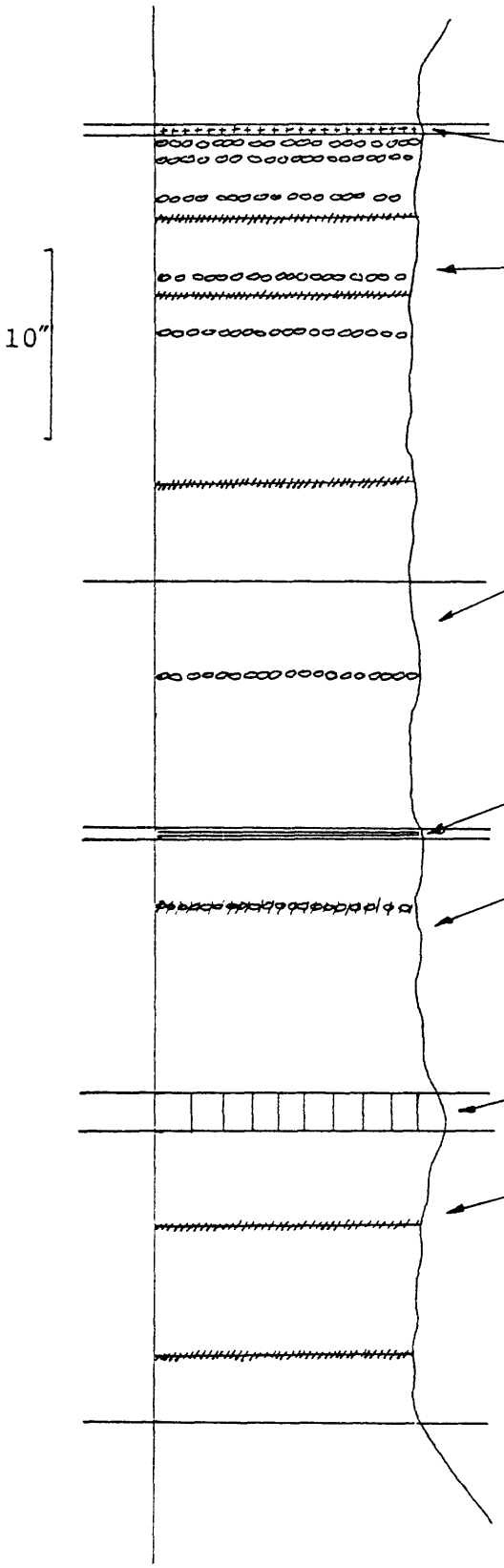


Figure 5a. Location of channel descriptions in 5 South and core #2585, 1983 sampling.



Total coal thickness: 68.25"

Roof
dark gray shale

0-0.5"
canneloid

0.5-24"
vitrain 1-2 mm
attritus 1-2 cm
small blocky fracture
pyrite at 1", 2", 4", 8", 11"
fusain at 5", 9", 19"
dull banded

24-37"
vitrain 2-3 mm
attritus 3-4 mm
columnar fracture
pyrite at 29"
bright banded

37-37.5"
dull clay layer

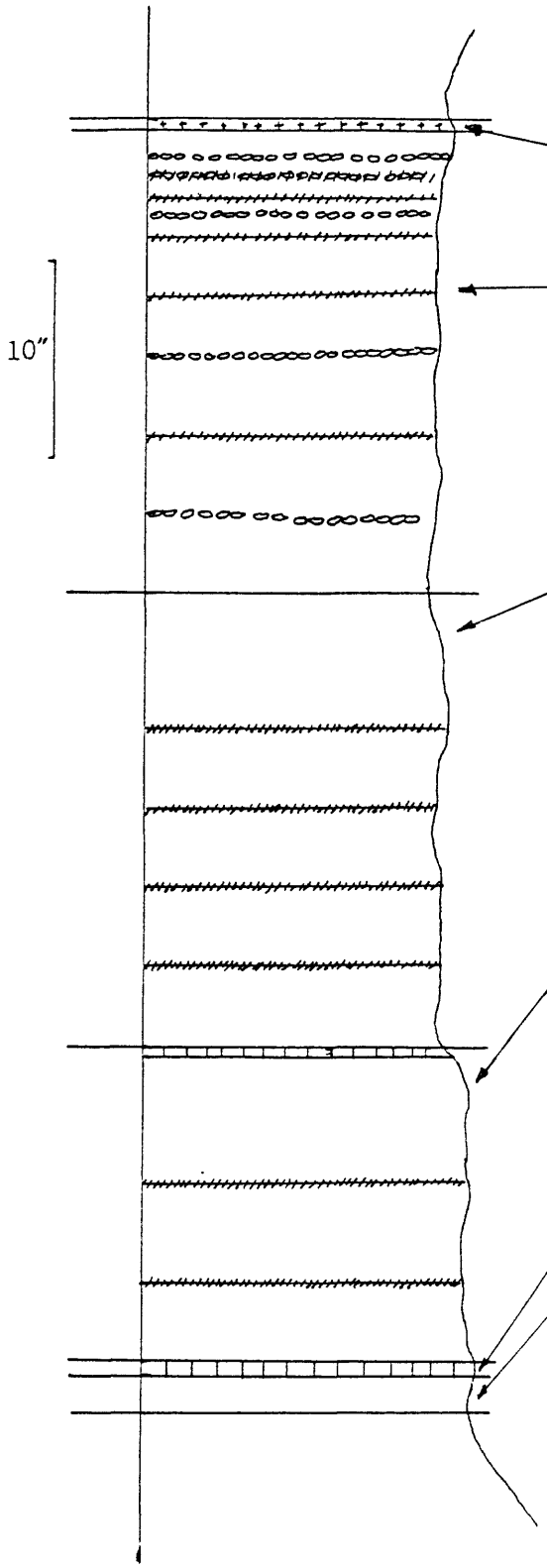
37.5-51"
vitrain 1-2 mm
attritus 0.5-1 cm
pyrite at 41"
fusain at 41"
bright banded

51-53"
durain layer

53-68.25"
vitrain 1-2 mm
attritus 1-2 cm
fusain at 58", 65"
dull banded

Floor
medium gray shale

Figure 5b. In-mine description of channel #1 (5 South, 1983) collected near core #2585.



Total coal thickness: 65.75"

Roof
dark gray shale

0-0.5"
canneloid

0.5-24"
vitrain 1 mm
attritus 2-3 cm
pyrite at 2", 3", 5", 12", 20"
fusain at 3", 4", 6", 9", 16"
dull banded

24-47"
vitrain 3-4 mm
attritus 2-3 mm
fusain at 31", 35" (with clay), 39", 43"
bright banded

47-63"
vitrain 3-4 mm
attritus 5-6 mm
hard blocky fracture
fusain at 54", 59"
durain 47-47.5"
dull

63-63.75"
durain

63.75-65.75"
coal - no description

Floor
medium gray shale

Figure 5c. In-mine description of channels#3,4,5 (5 South, 1983) collected at core #2585.

6-5 South 1983

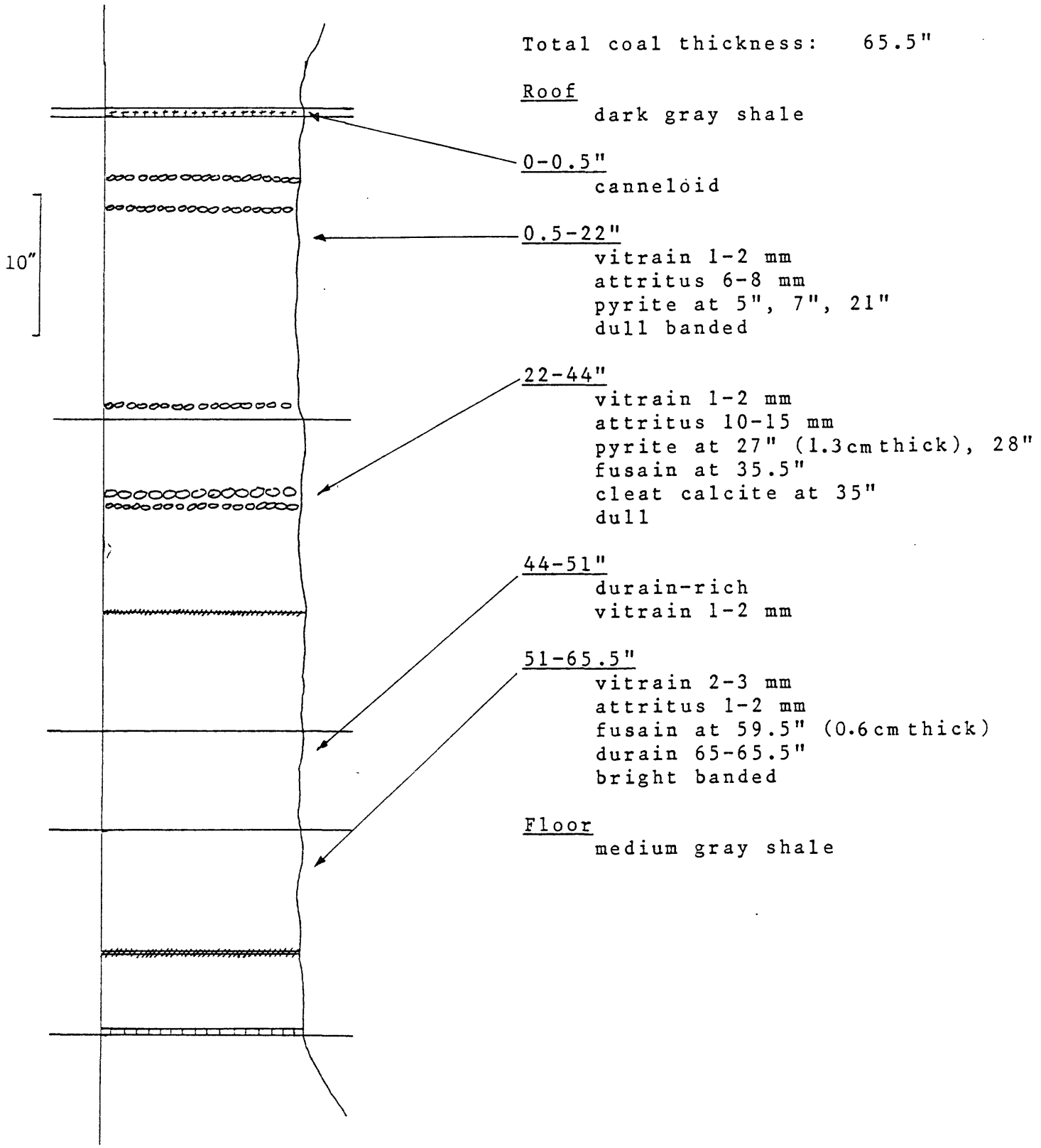


Figure 5d. In-mine description of channel #6 (5 South, 1983) collected near core #2585.

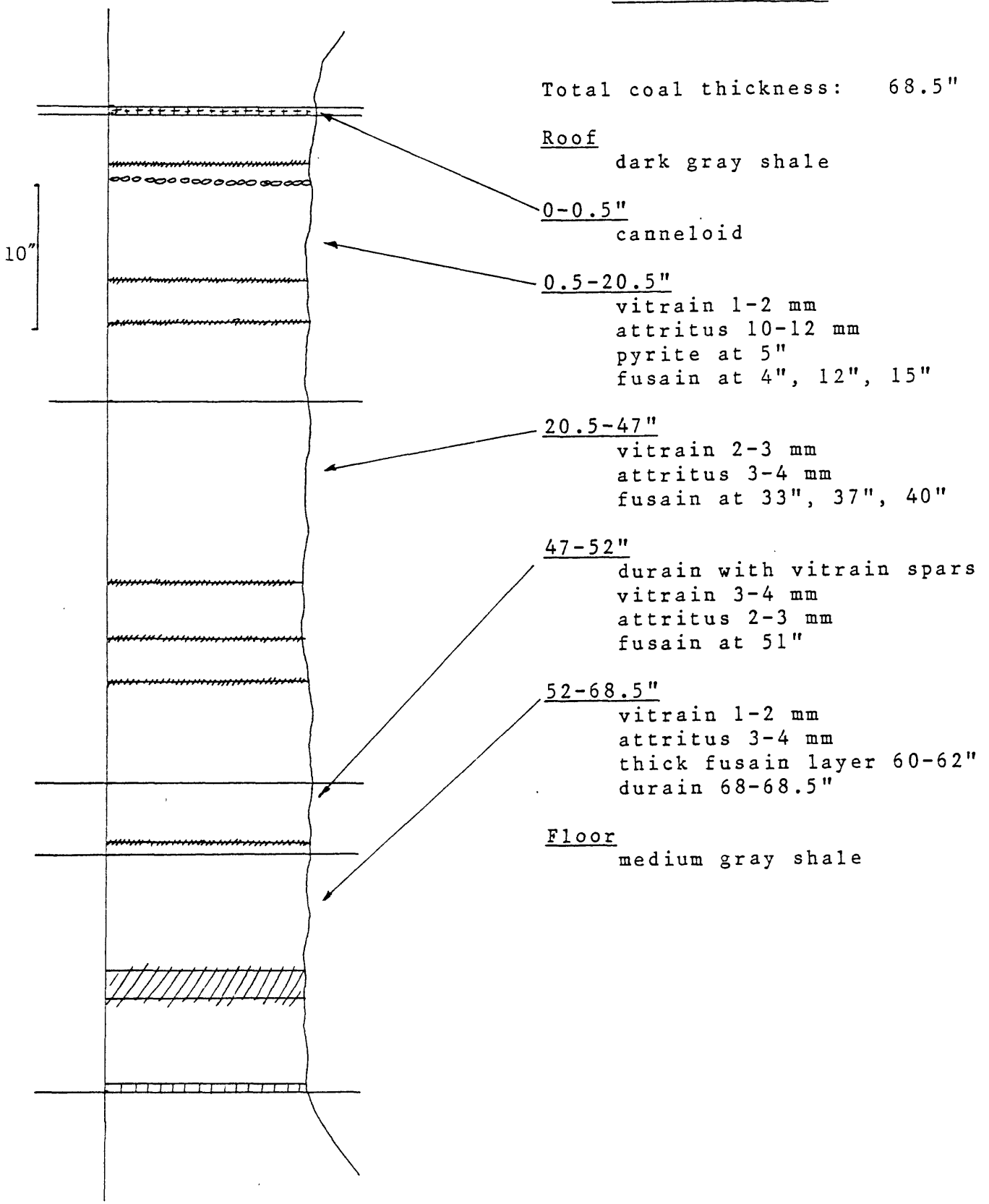


Figure 5e. In-mine description of channel #7 (5 South, 1983) collected near core #2585.

8-5 South 1983

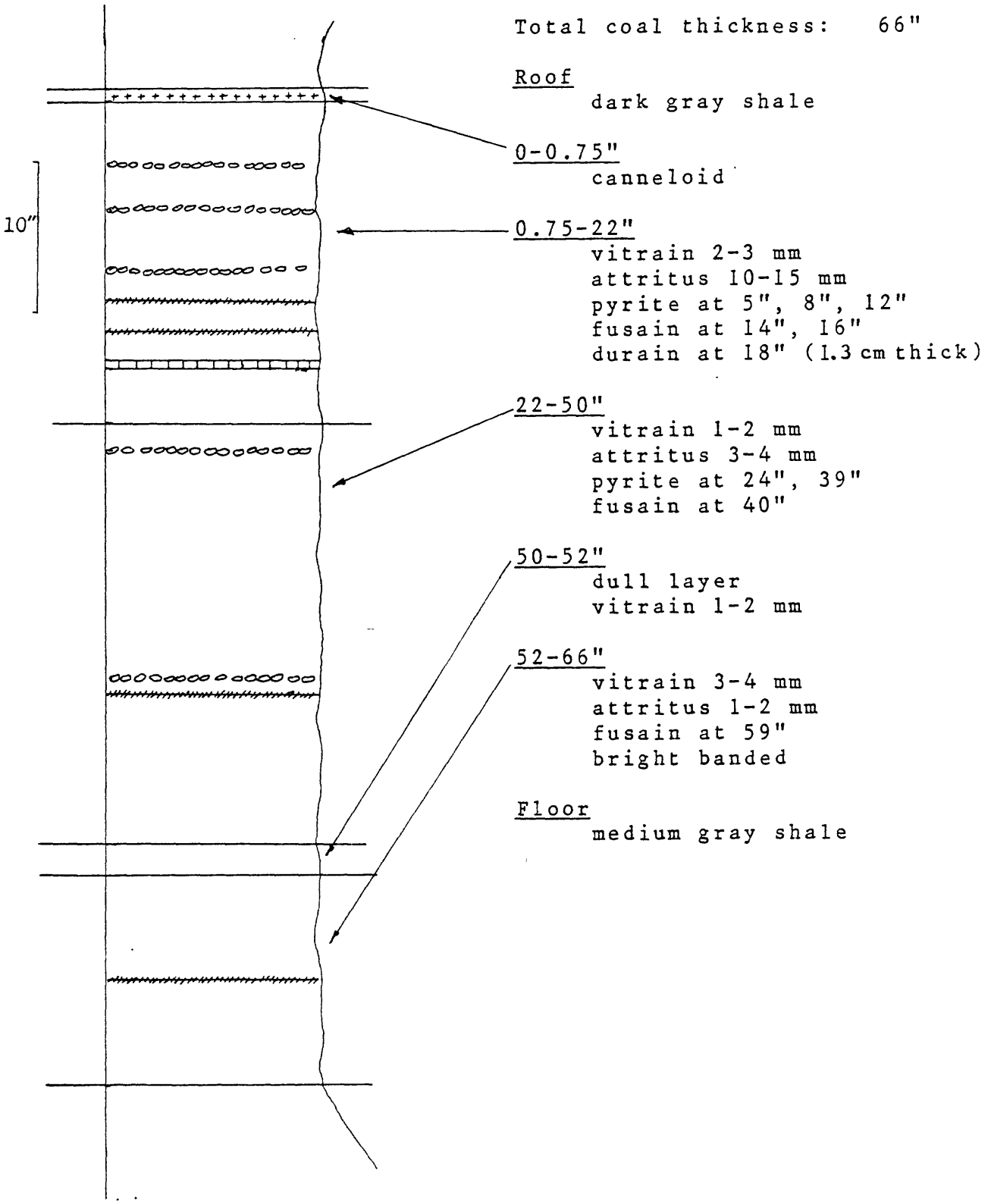


Figure 5f. In-mine description of channel #8 (5 South, 1983) collected near core #2585.

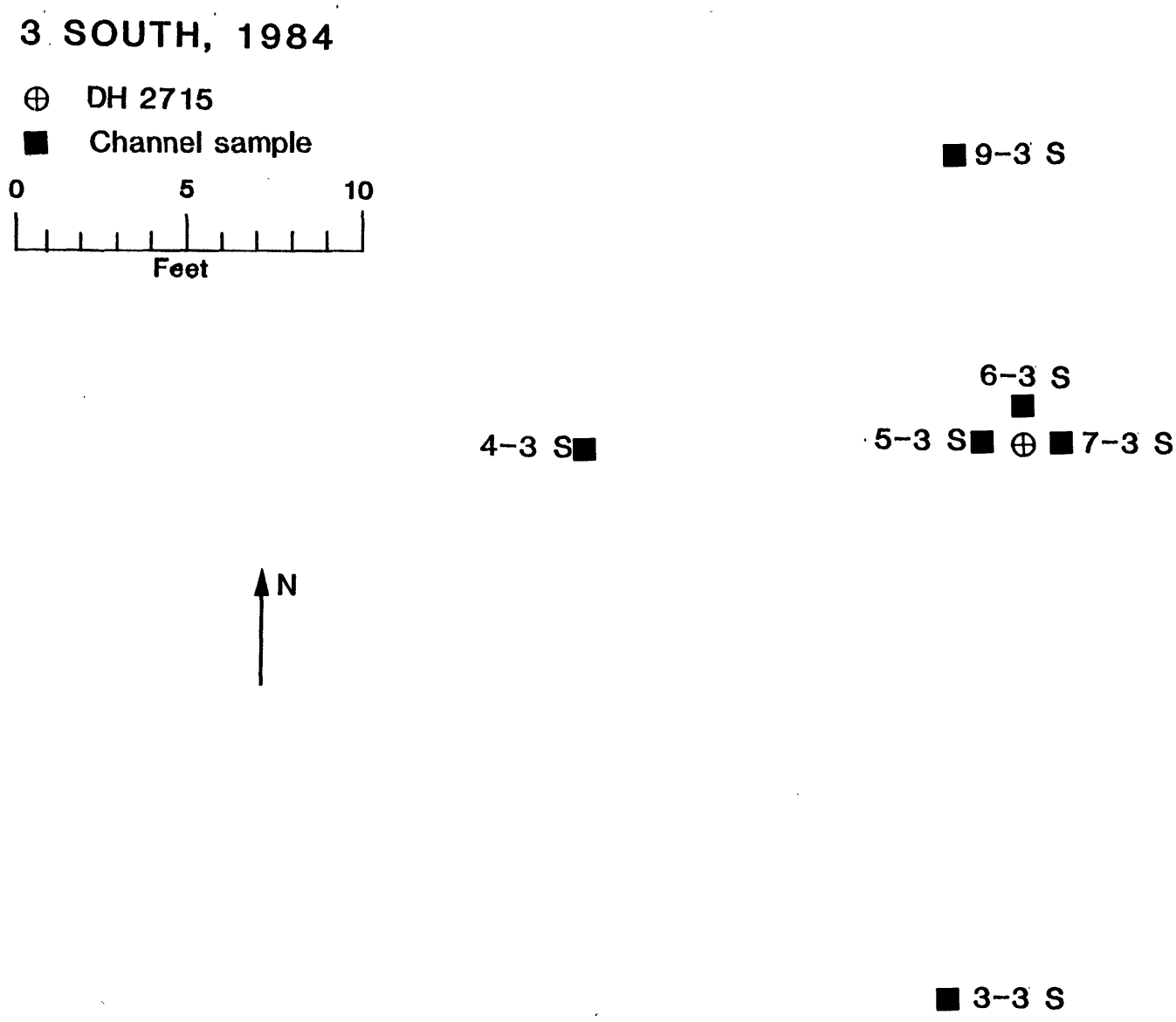


Figure 6a. Location of channel descriptions in 3 South and core #2715, 1984 sampling.

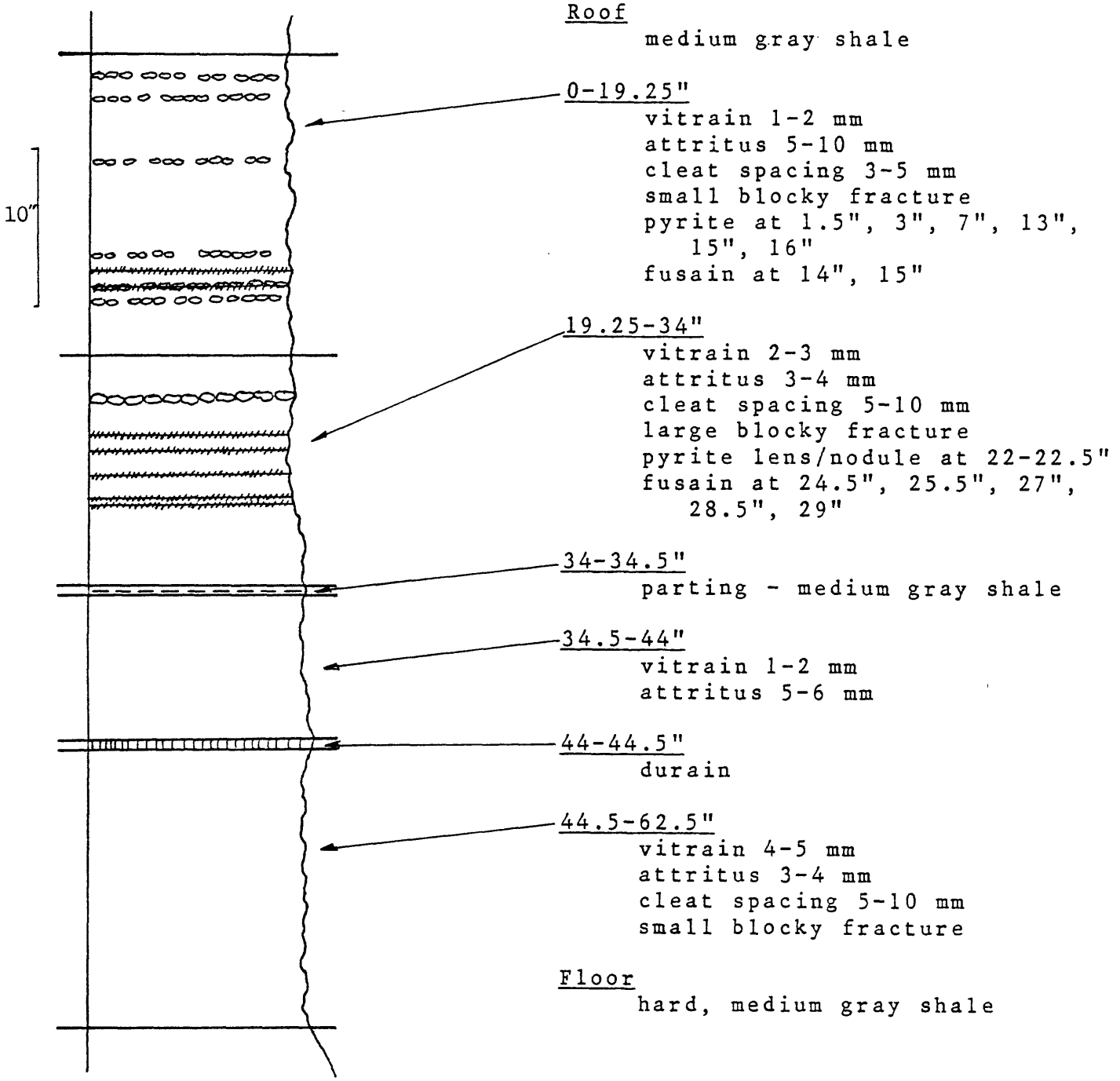
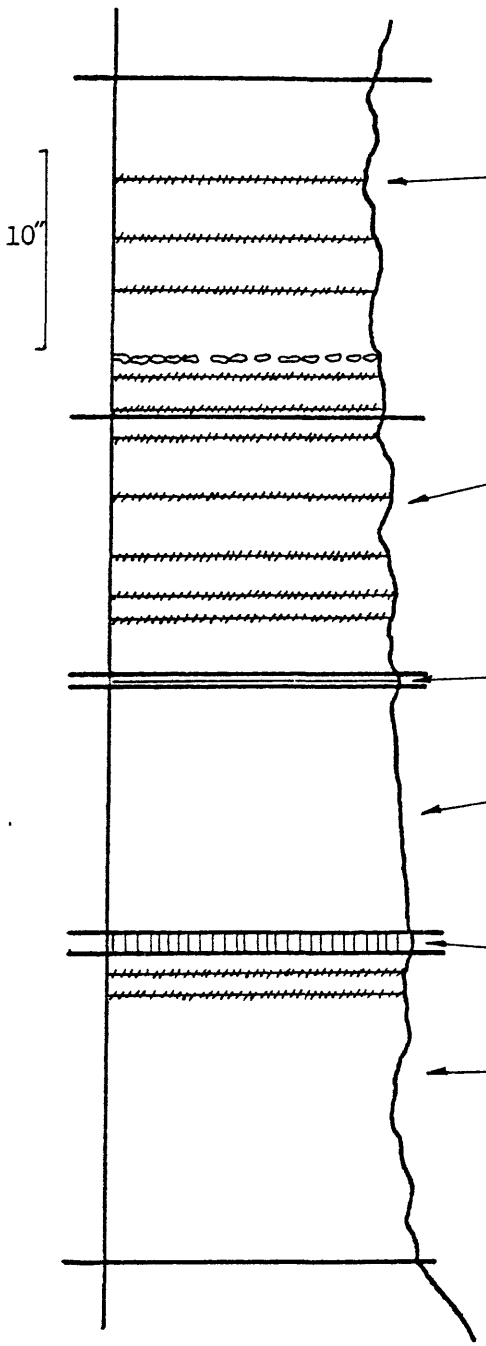


Figure 6b. In-mine description of channel #1 (3 South, 1984) collected near core #2715.

2-3 South 1984



Total coal thickness: 59.5"

Roof
medium gray shale

0-17"
vitrain 1-2 mm
attritus 5-10 mm
cleat spacing 5-8 mm
large blocky fracture
pyrite at 14"
fusain at 5", 8", 10.5", 15", 16.5"

17-30"
vitrain 2-3 mm
attritus 3-4 mm
cleat spacing 8 mm
blocky fracture
fusain at 18", 21", 24", 26", 27"

30-30.375"
clay parting

30.375-43"
vitrain 3-5 mm
attritus 5-10 mm
cleat spacing 5-8 mm
large blocky columnar fracture

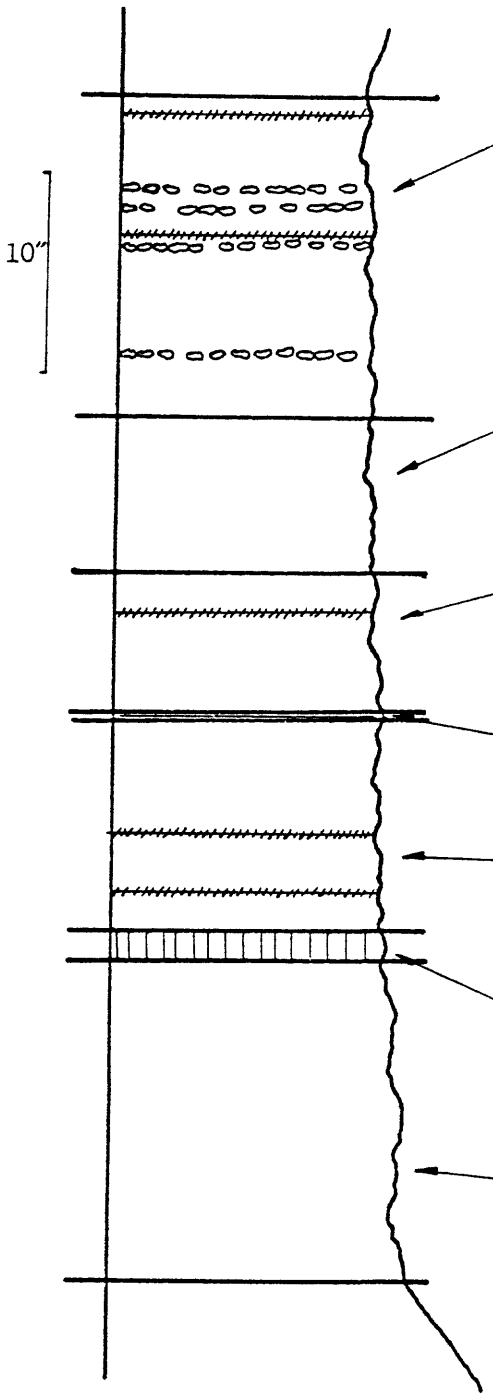
43-44"
steel gray durain

44-59.5"
vitrain 3-5 mm
attritus 2-3 mm
cleat spacing 8-10 mm
hard blocky fracture
fusain at 45", 46"

Floor
hard, medium gray shale

Figure 6c. In-mine description of channel #2 (3 South, 1984) collected near core #2715.

3-3 South 1984



Total coal thickness: 59.875"

Roof
medium gray shale

0-16"
vitrain 2-3 mm
attritus 15-20 mm
cleat spacing 5-10 mm
large blocky fracture
pyrite at 4.5", 5.5", 7.5", 13"
fusain at 1", 7"
very dull

16-24"
vitrain 2-3 mm
attritus 3-4 mm
cleat spacing 8 mm
small blocky fracture

24-31"
vitrain 3-4 mm
attritus 5-10 mm
cleat spacing 8 mm
large blocky fracture
fusain at 26"

31-31.25"
clay lens

31.25-42"
vitrain 1-2 mm
attritus 5-10 mm
cleat spacing 8 mm
large blocky fracture
fusain at 37", 40"

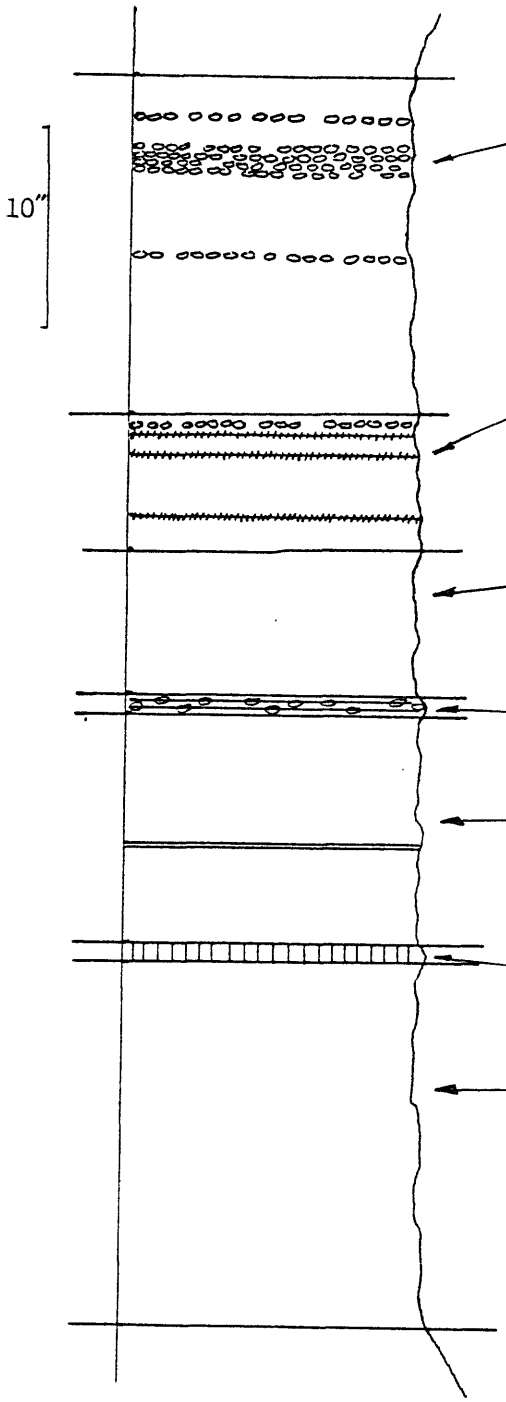
42-43.5"
steel gray durain

43.5-59.875"
vitrain 3-5 mm
attritus 5-6 mm
cleat spacing 5-10 mm
hard blocky fracture

Floor
hard, medium gray shale

Figure 6d. In-mine description of channel #3 (3 South, 1984) collected near core #2715.

4-3 South 1984



Total coal thickness: 63"

Roof
medium gray shale

0-17"
vitrain 2-3 mm
attritus 3-10 mm
small blocky fracture
pyrite at 2", 3.5", 3.75", 4", 4.25"
9"

17-23.75"
vitrain 2-4 mm
attritus 4-9 mm
small blocky fracture
pyrite at 17.5"
fusain at 18", 19", 22"

23.75-31"
vitrain 1-3 mm
attritus 2-6 mm
small blocky fracture

31-32"
clay vein with pyrite

32-43.5"
vitrain 0.5-3 mm
attritus 2-6 mm
clay vein at 38.5" (0.6 cm thick)

43.5-44.5"
steel gray durain

44.5-63"
vitrain 2-5 mm
attritus 2-5 mm
small blocky fracture

Floor
hard, medium gray shale

Figure 6e. In-mine description of channel #4 (3 South, 1984) collected near core #2715.

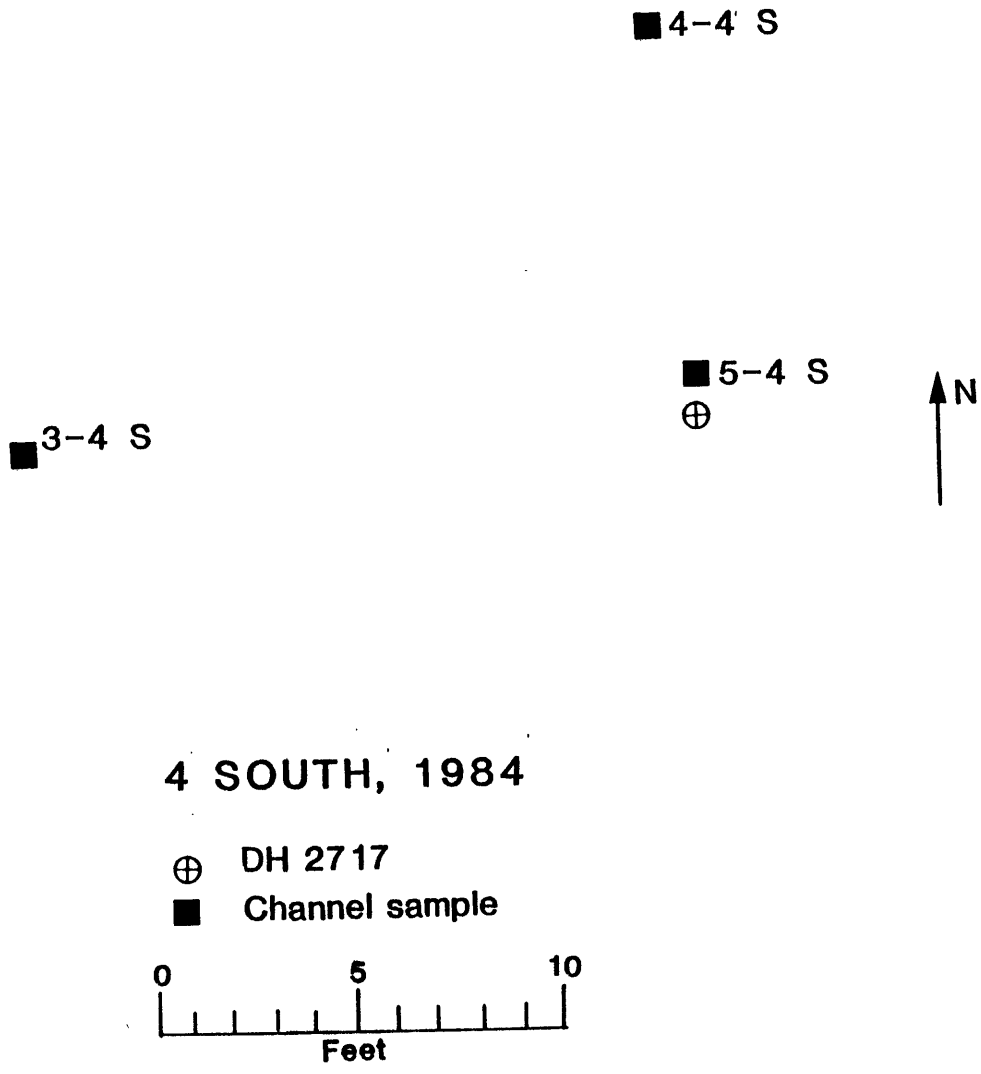


Figure 7a. Location of channel descriptions in 4 South and core #2717, 1984 sampling.

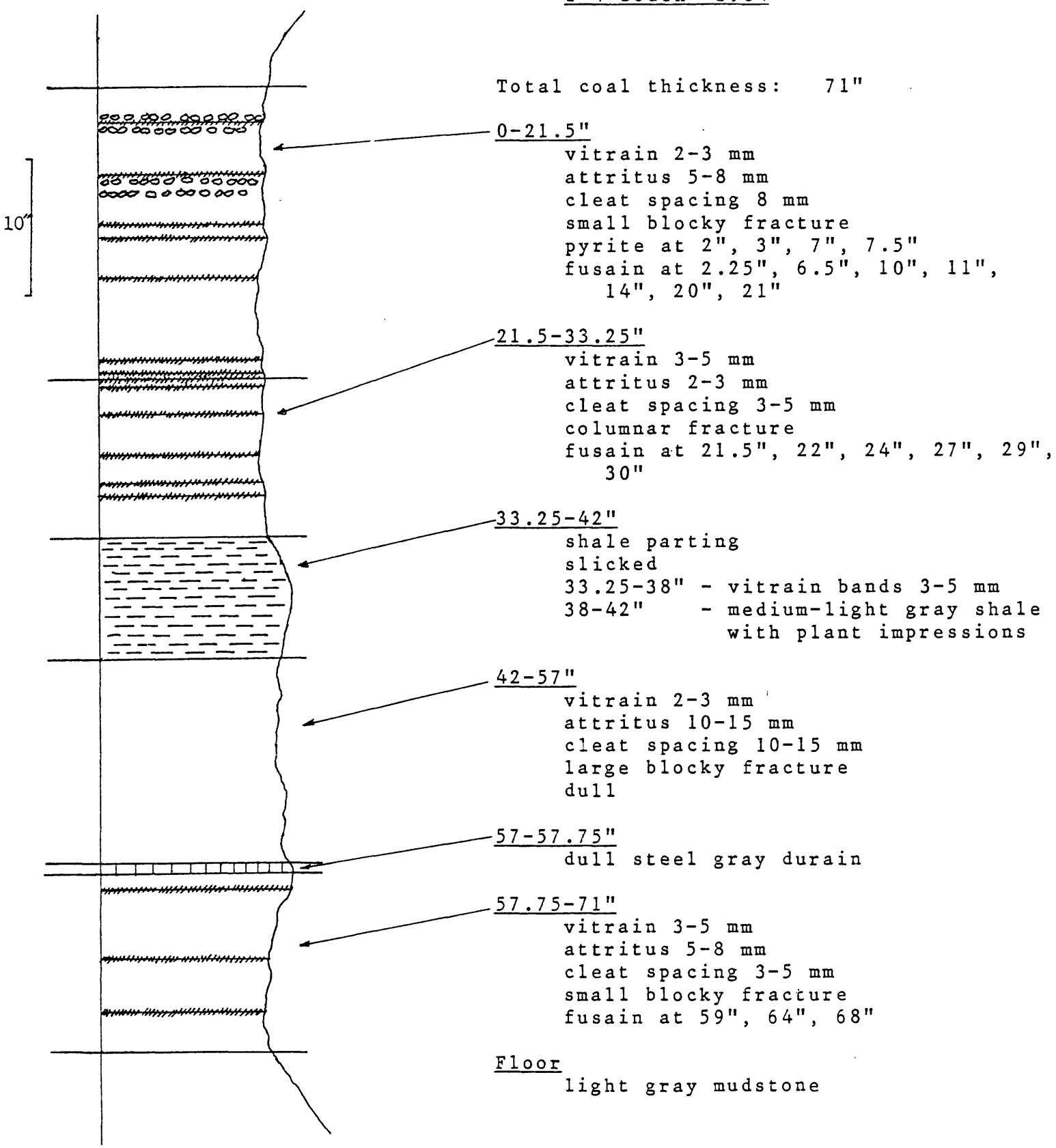


Figure 7b. In-mine description of channel #1 (4 South, 1984) collected near core #2717.

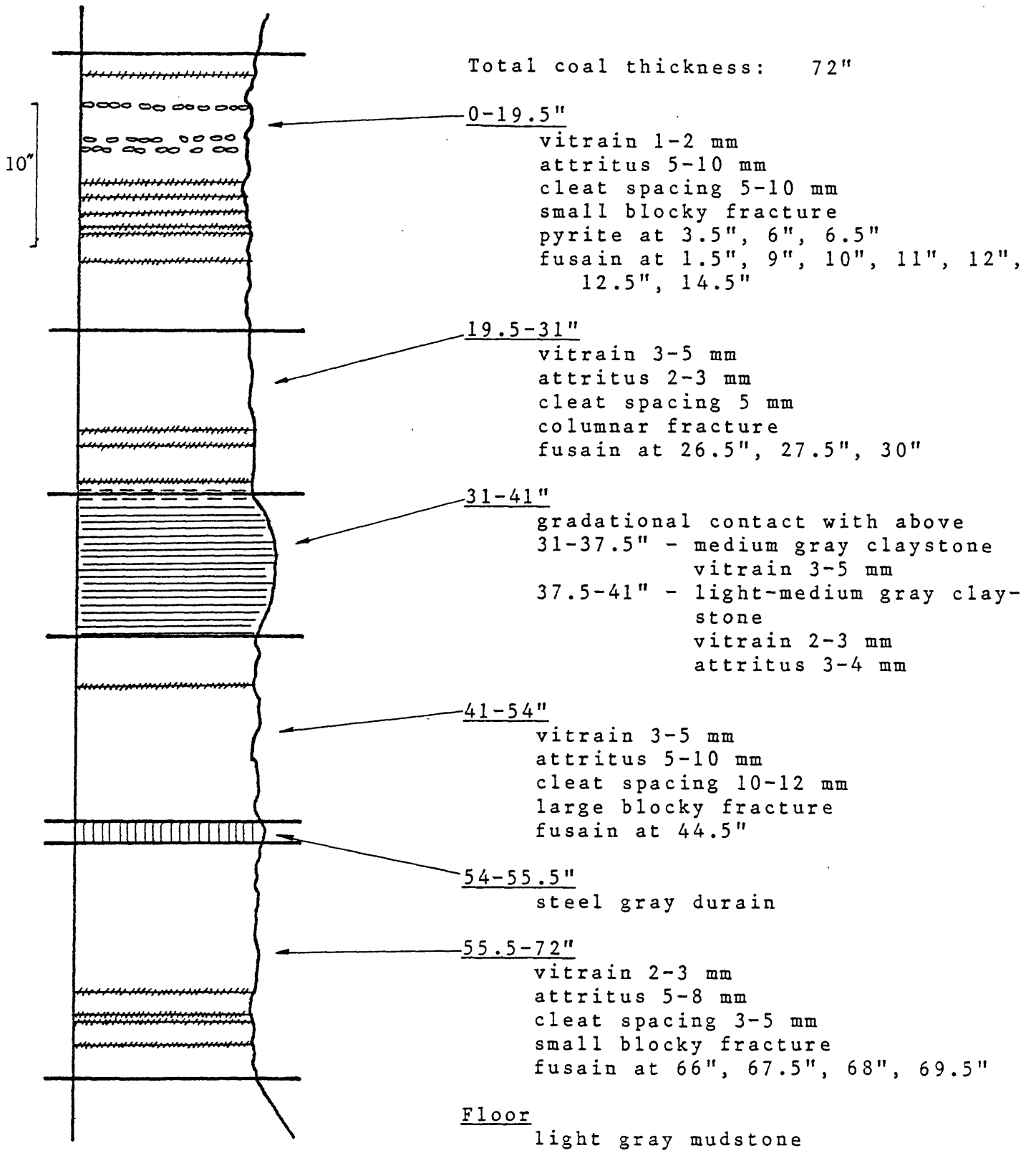
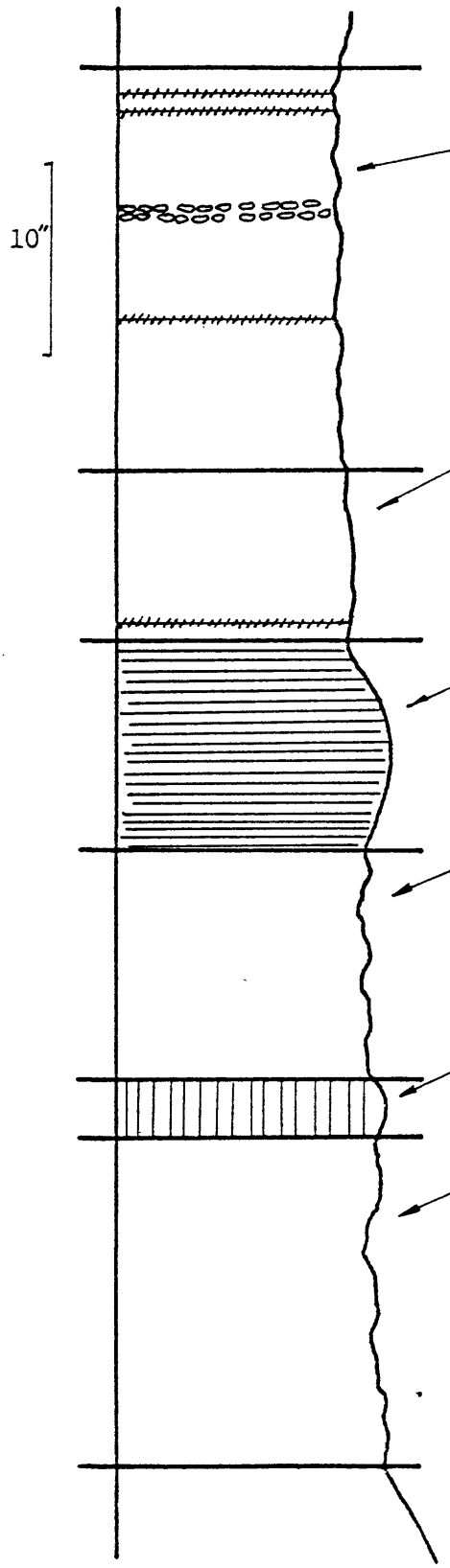


Figure 7c. In-mine description of channel #2 (4 South, 1984) collected near core #2717.

3-4 South 1984



Total coal thickness: 73.125"

0-21"
vitrain 1-2 mm
attritus 5-10 mm
cleat spacing 5 mm
small blocky fracture
pyrite at 7.5"; 7.75"
fusain at 1.25", 2.125", 13"

21-30"
vitrain 5-8 mm
attritus 1-2 mm
cleat spacing 5-10 mm
columnar fracture
fusain at 29"

30-41"
clay binder
30-37" - dark gray shale with vitrain 2-3 mm
37-41" - medium gray claystone

41-53"
vitrain 2-4 mm
attritus 5-10 mm
cleat spacing 8-10 mm
large blocky fracture

53-56"
steel gray durain clayrock
vitrain bands

56-73.125"
vitrain 1-3 mm
attritus 3-5 mm
cleat spacing 5-8 mm
large blocky fracture

Floor
light gray mudstone

Figure 7d. In-mine description of channel #3 (4 South, 1984) collected near core #2717.

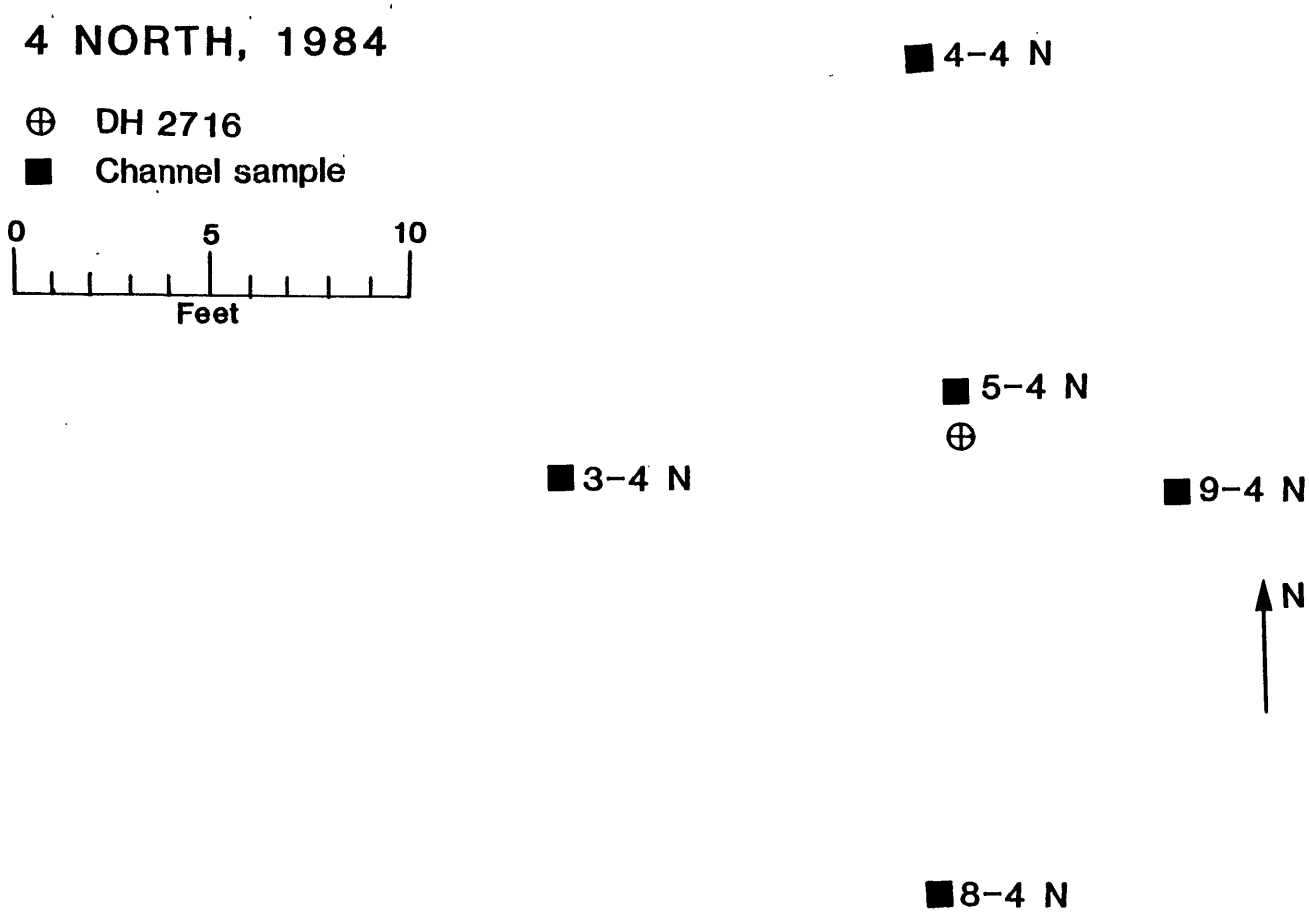


Figure 8a. Location of channel descriptions in 4 North and core #2716, 1984 sampling.

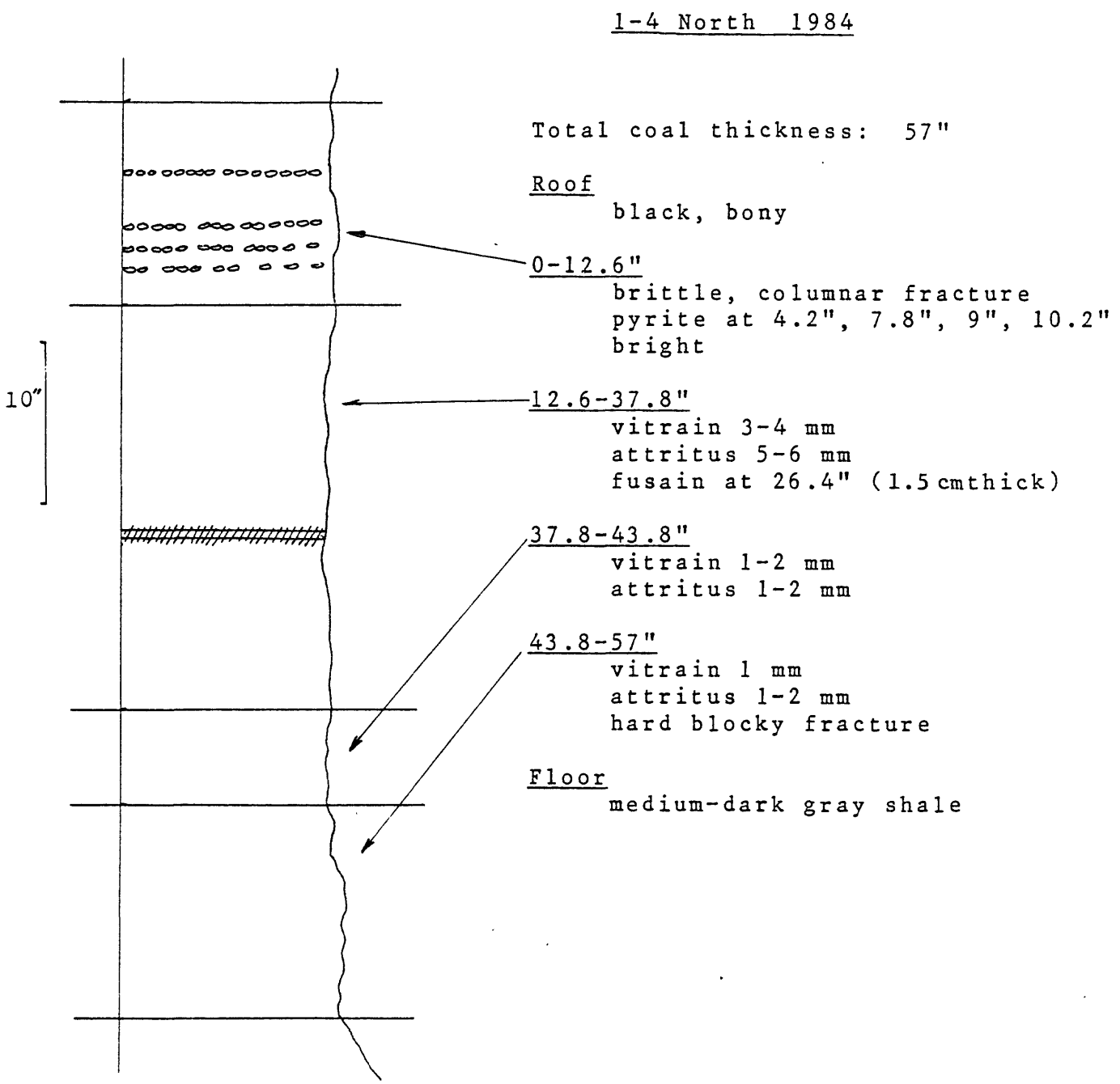
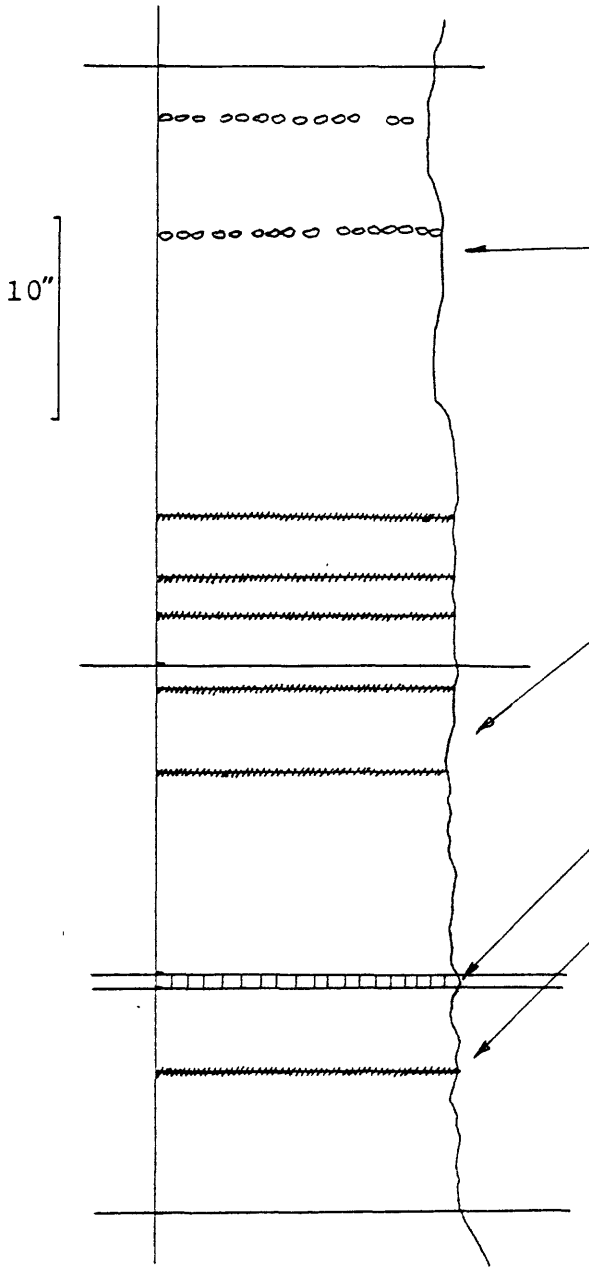


Figure 8b. In-mine description of channel #1 (4 North, 1984) collected near core #2716.

2-4 North 1984



Total coal thickness: 57.6"

Roof
black, bony

0-30"
vitrain 1-2 mm
attritus 1-2 mm
brittle, columnar fracture
pyrite at 2.4", 8.4"
fusain at 22.8", 25.8", 27.6"
bright

30-45.6"
vitrain 1-2 mm
attritus 3-10 mm
fusain at 31.2", 35.4"

45.6-46.2"
dull bony layer

46.2-57.6"
vitrain 1-4 mm
attritus 1-6 mm
hard blocky fracture
fusain at 50.4"

Floor
medium-dark gray shale

Figure 8c. In-mine description of channel #2 (4 North, 1984) collected near core #2716.

3-4 North 1984

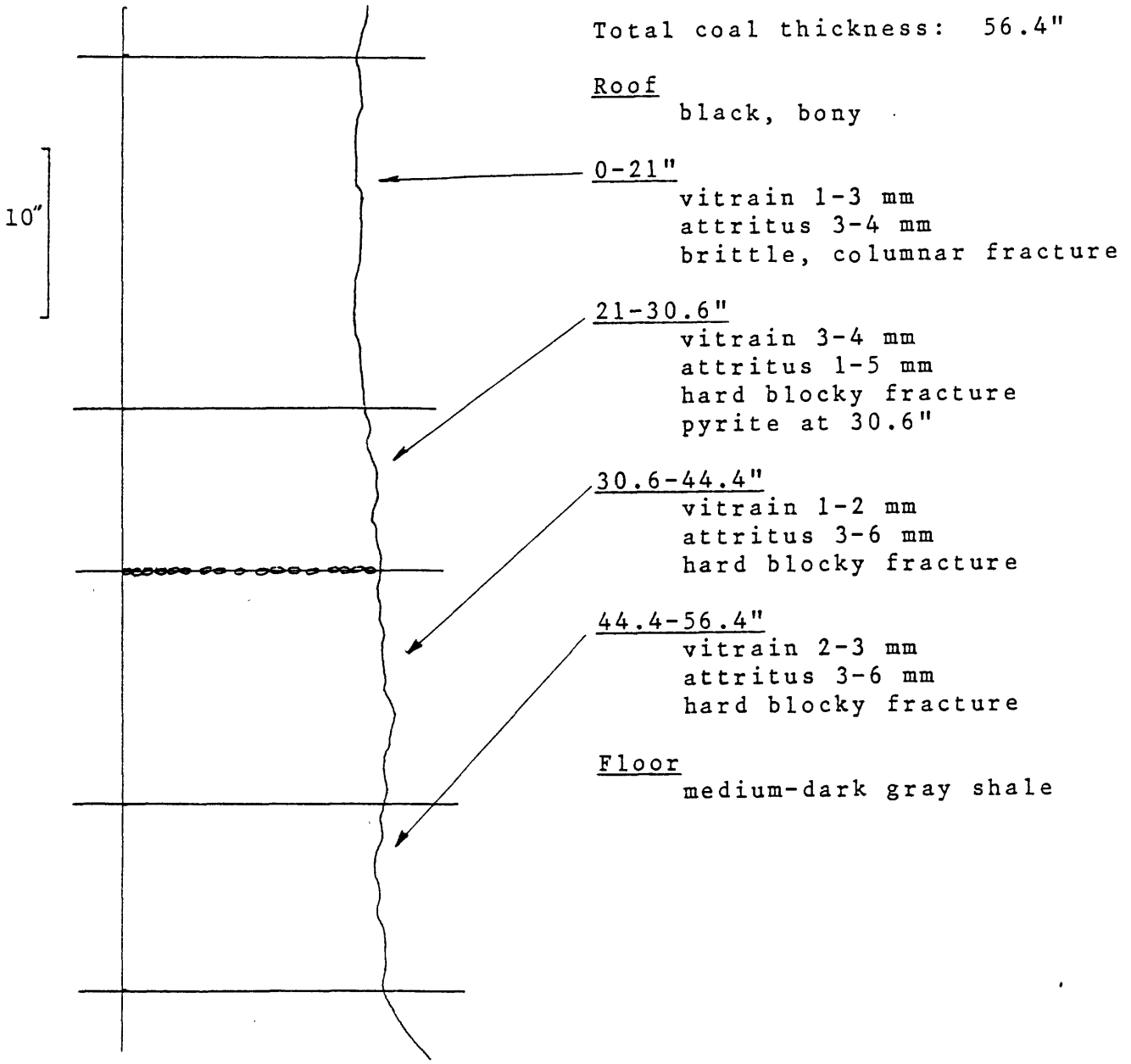


Figure 8d. In-mine description of channel #3 (4 North, 1984) collected near core #2716.

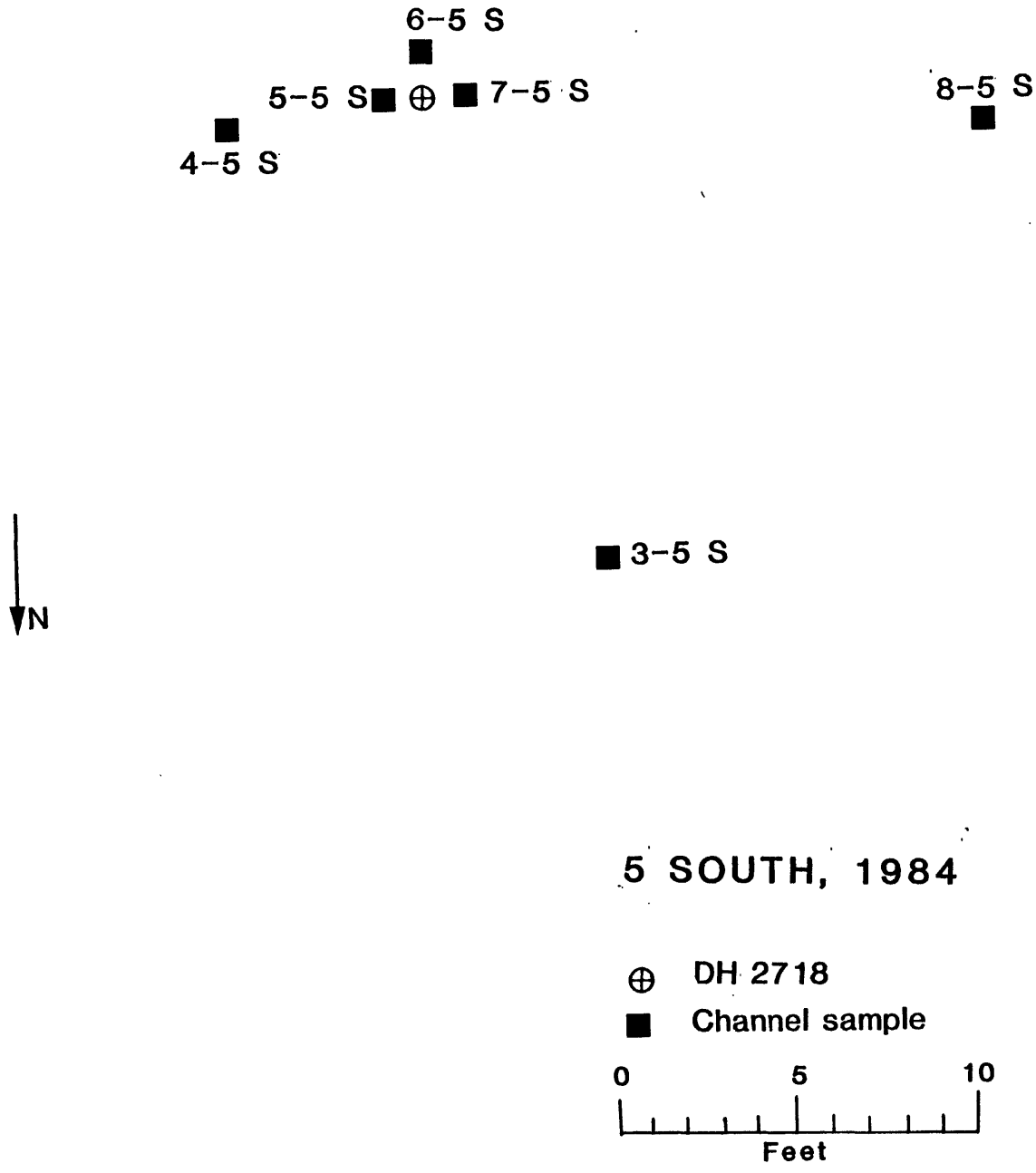
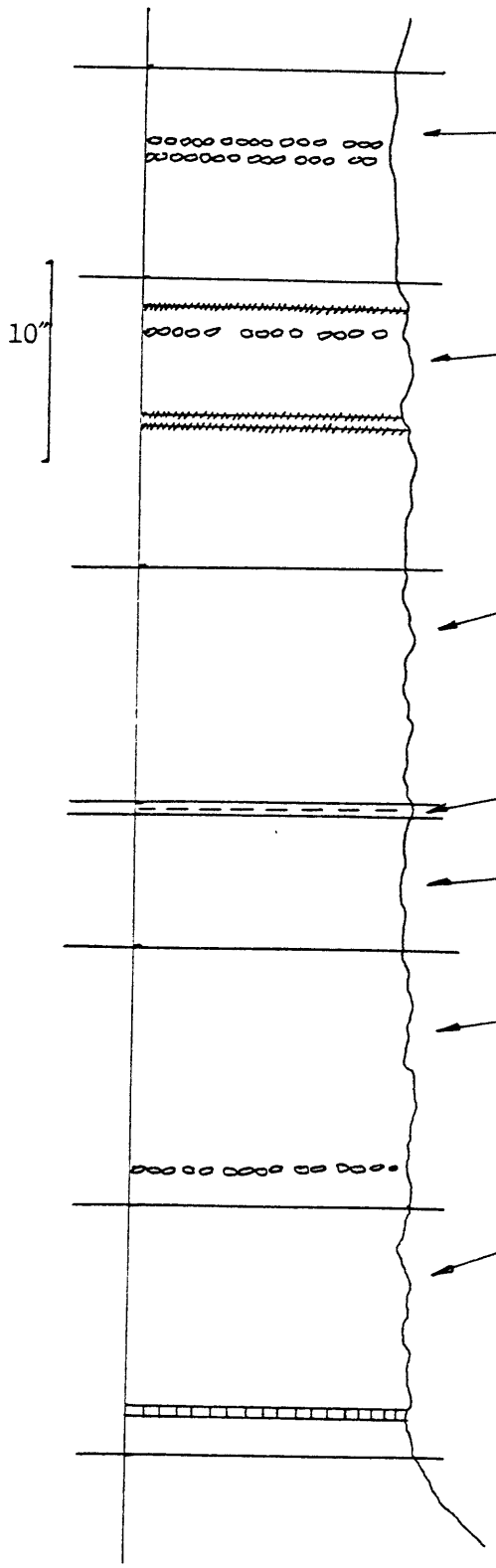


Figure 9a. Location of channel descriptions in 5 South and core #2718, 1984 sampling.



Total coal thickness: 70.2"

Roof
very dark bony shale

0-10.8"
vitrain 1-2 mm
attritus 5-10 mm
brittle, columnar fracture
pyrite at 3.6", 4.2"

10.8-25.2"
vitrain 1-3 mm
attritus 3-8 mm
hard blocky fracture
pyrite at 13.2"
fusain at 12", 17.4", 18"

25.2-37.2"
vitrain 1-3 mm (most abundant)
attritus 1-4 mm
hard blocky fracture
bright

37.2-37.8"
dark shaley layer

37.8-44.4"
vitrain 1-3 mm
attritus 1-3 mm

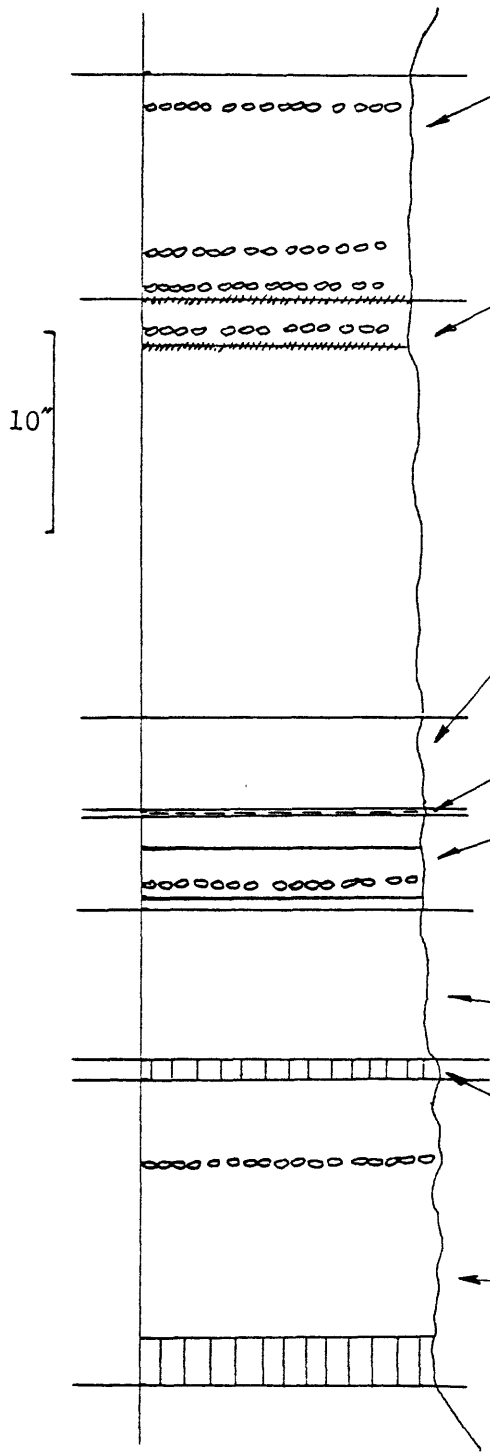
44.4-57.6"
vitrain 1-2 mm
attritus 3-8 mm
hard blocky fracture
pyrite at 55.8"

57.6-70.2"
vitrain 1-2 mm
attritus 3-4 mm
hard blocky fracture
67.8-70.2" very dull durain with vitrain spars

Floor
medium gray silty shale

Figure 9b. In-mine description of channel #1 (5 South, 1984) collected near core #2718.

Total coal thickness: 66"



Roof
dark bony shale

0-11.4"
vitrain 1-2 mm
attritus 3-5 mm
pyrite at 1.8", 9", 10.8"
fusain at 11.4"

11.4-32.4"
vitrain 1-2 mm
attritus 3-5 mm
pyrite at 11.76"
fusain at 13.8"
cleat calcite at 30"

32.4-37.2"
vitrain 1-2 mm
attritus 2-3 mm
increase in attritus bands toward bottom of interval
cleat calcite at 36.6"

37.2-37.26"
dark shale parting

37.26-42"
vitrain 1-2 mm
large vitrain bands at 39" 41.4"
attritus 3-10 mm
increases in attritus towards bottom of interval
pyrite at 40.8"

42-49.8"
vitrain 3-4 mm
attritus 3-6 mm
cleat calcite at 45"

49.8-50.64"
dull hard durain

50.64-66"
vitrain 1-3 mm
attritus 3-8 mm
hard blocky fracture
pyrite at 54.6"
cleat calcite 62.4" to bottom
durain 63.6" to bottom

Floor
medium gray shale

Figure 9c. In-mine description of channel #2 (5 South, 1984) collected near core #2718.

3-5 South 1984

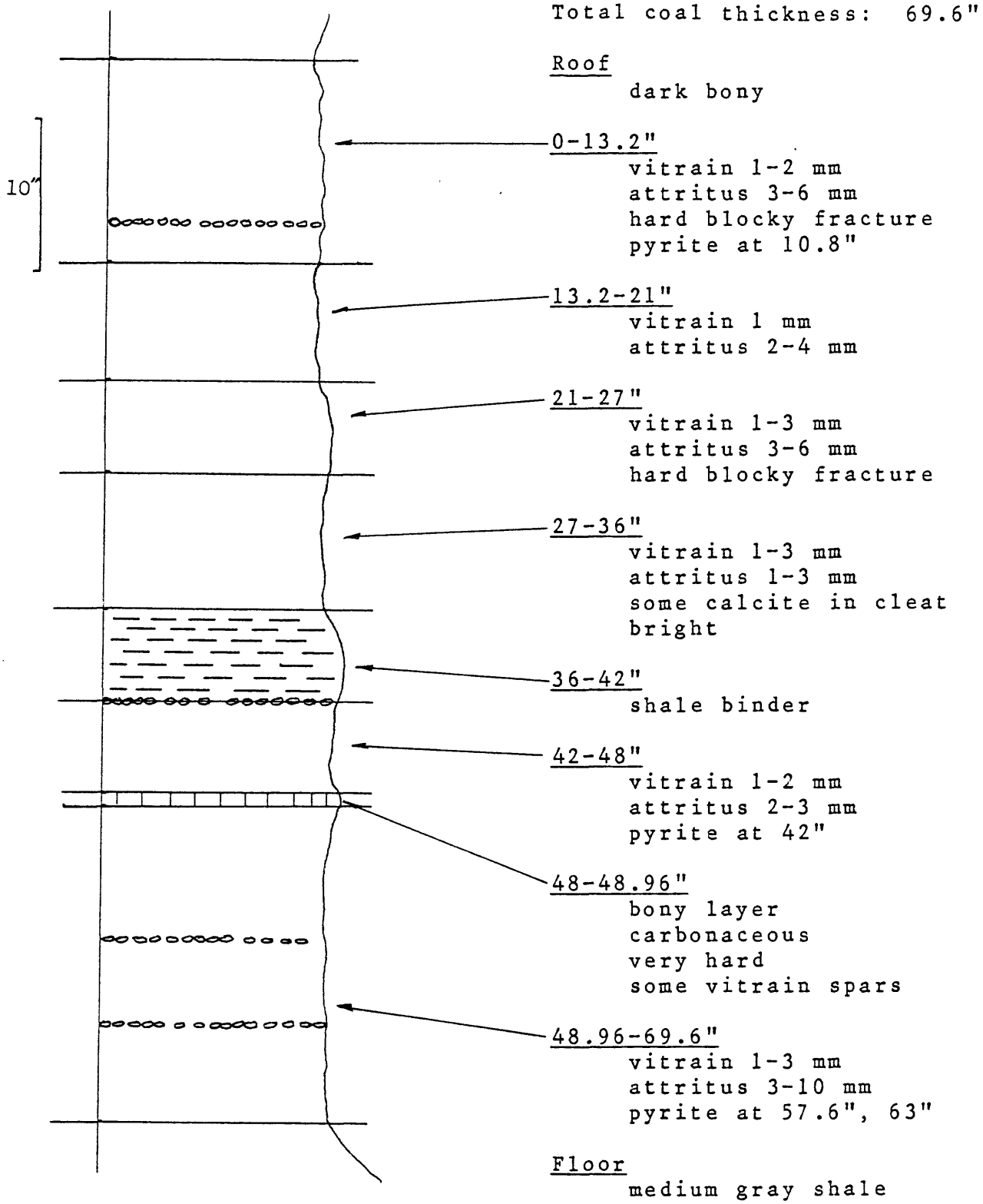


Figure 9d. In-mine description of channel #3 (5 South, 1984) collected near core #2718.

4-5 South 1984

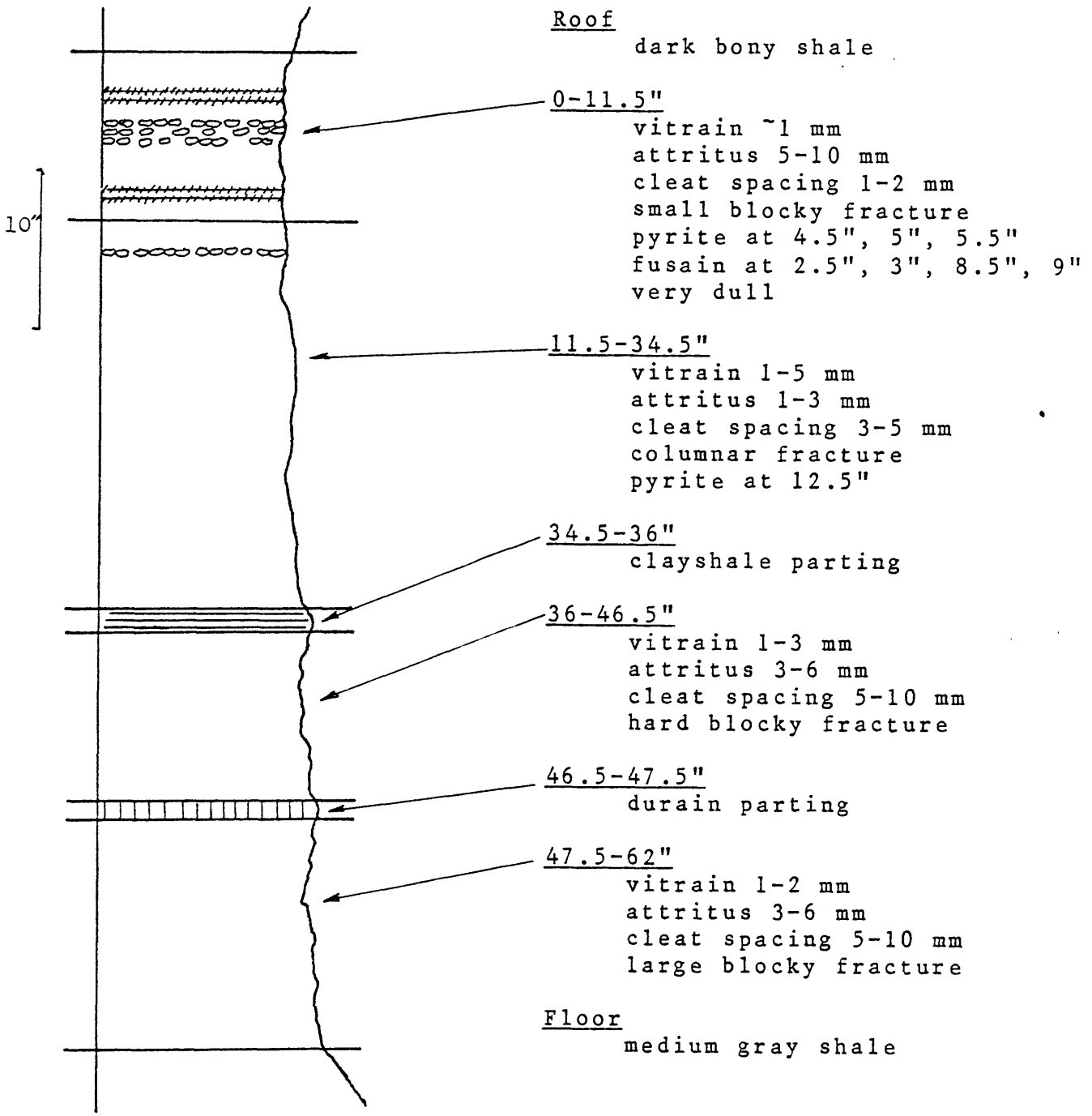


Figure 9e. In-mine description of channel #4 (5 South, 1984) collected near core #2718.

5,6,7-5 South 1984

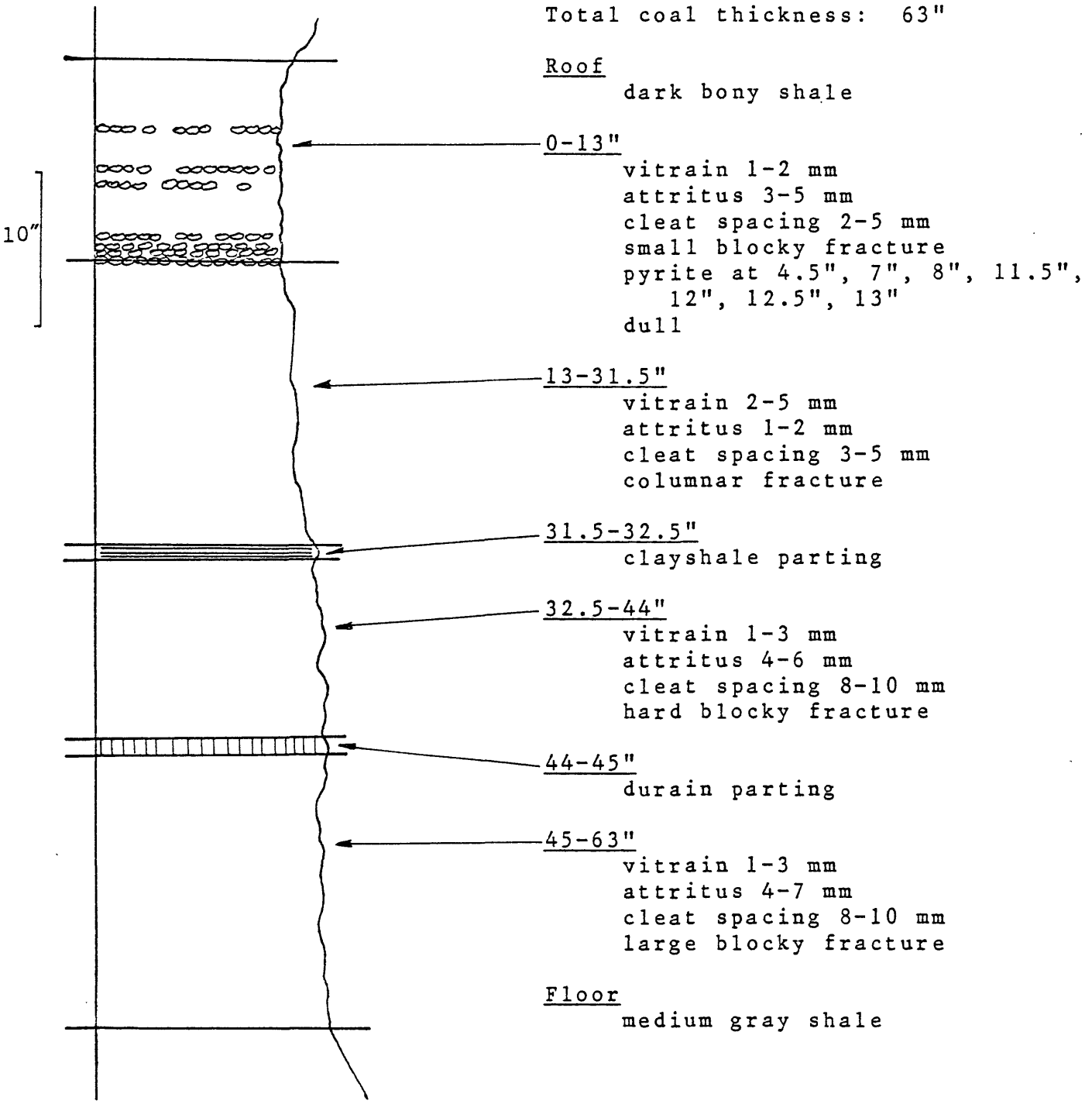
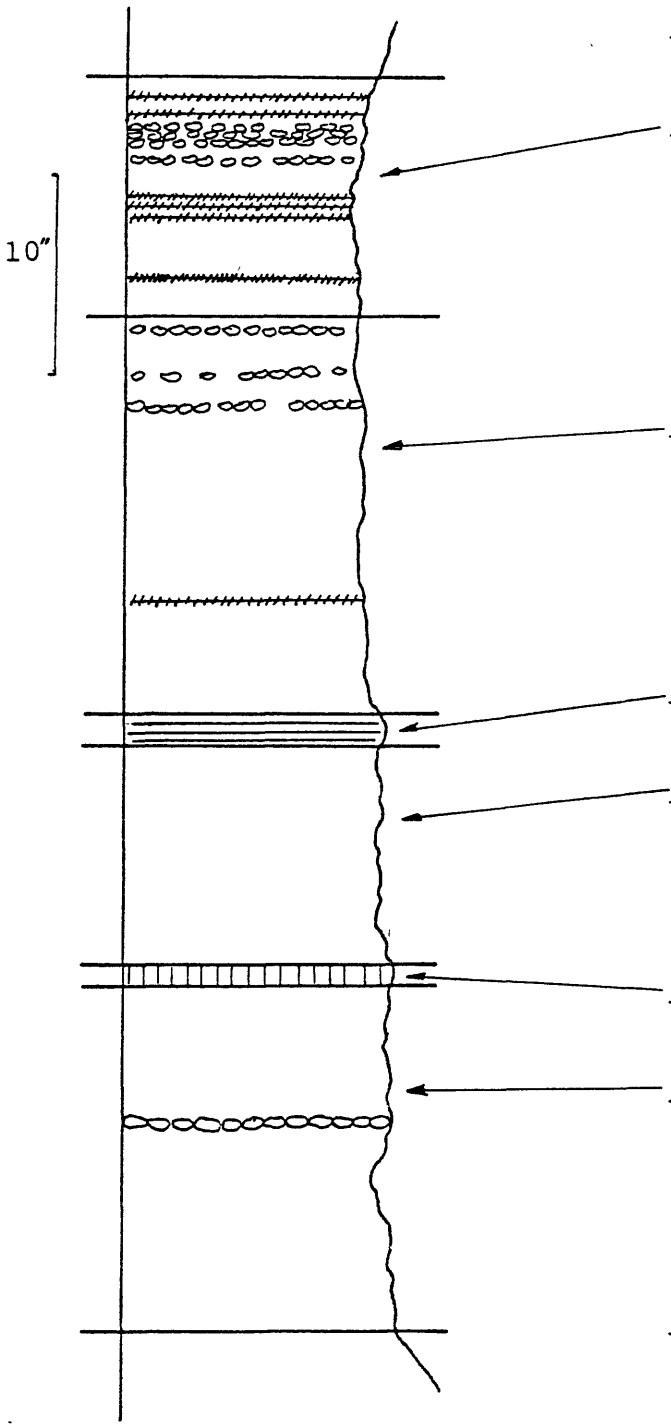


Figure 9f. In-mine description of channels #5,6,7 (5 South, 1984) collected at core #2718.

8-5 South 1984



Total coal thickness: 63"

Roof
dark bony shale

0-12"
vitrain 1-2 mm
attritus 4-6 mm
cleat spacing 3-5 mm
small blocky fracture
pyrite at 2.5", 3", 3.25", 4"
fusain at 1", 2", 6", 6.5", 7", 10"
dull

12-32"
vitrain 2-5 mm
attritus 1~3.5 mm
cleat spacing 1-3 mm
small blocky to columnar fracture
pyrite at 12.5", 15", 16.5"
fusain at 26.25"

32-33.5"
small clayshale parting

33.5-44.75"
vitrain 1-2 mm
attritus 5-8 mm
cleat spacing 8-15 mm
large blocky fracture

44.75-45.75"
durain parting

45.75-63"
vitrain 2-3 mm
attritus 5-8 mm
cleat spacing 8-15 mm
large blocky fracture
pyrite at 52.25-52.75"

Floor
medium gray shale

Figure 9g. In-mine description of channel #8 (5 South, 1984) collected near core #2718.

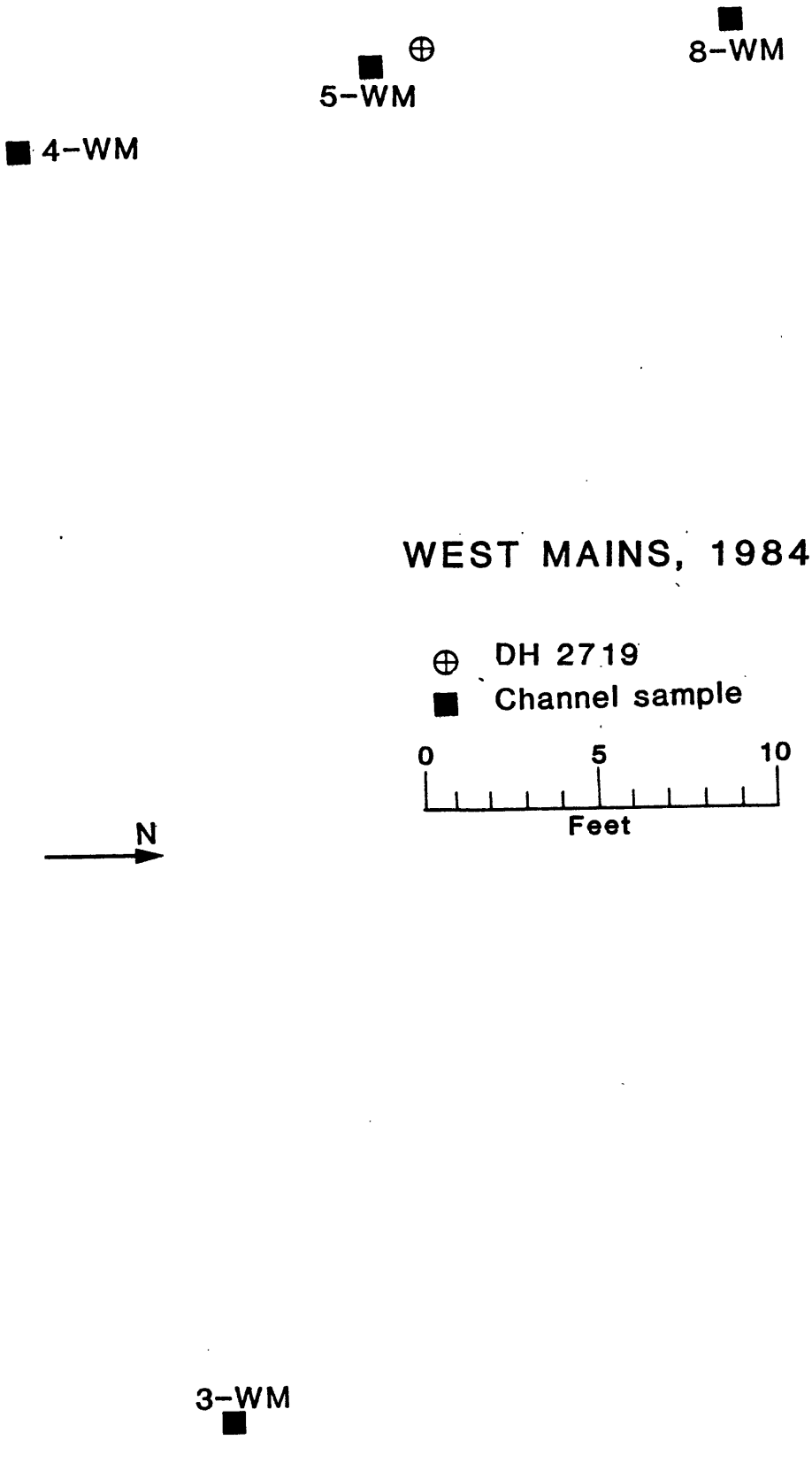
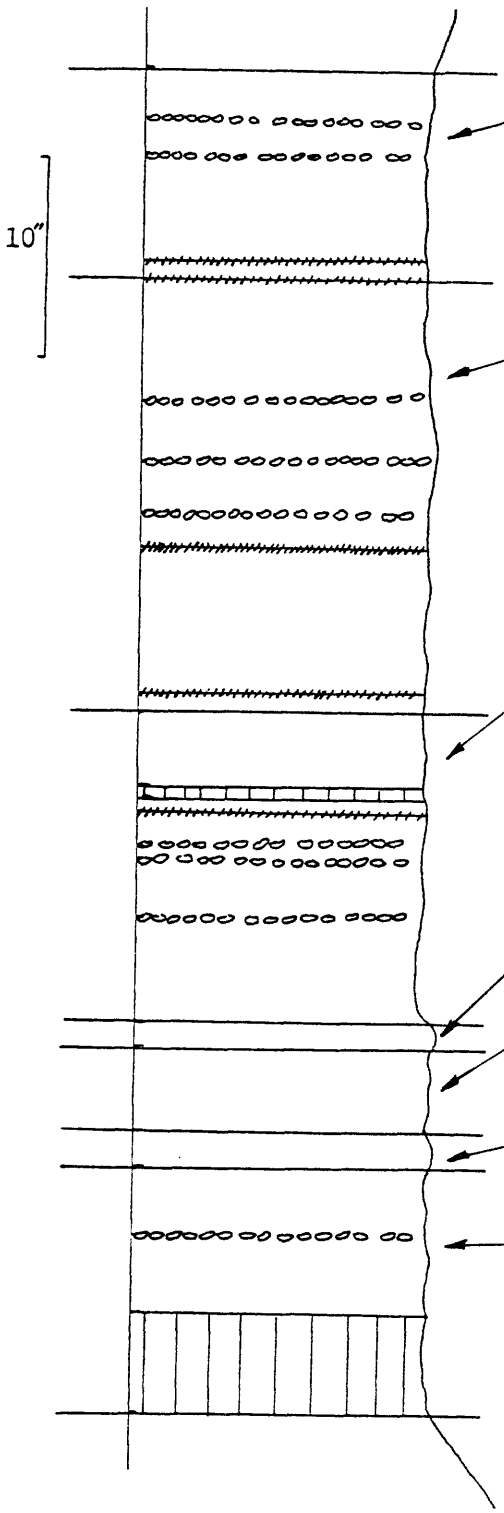


Figure 10a. Location of channel descriptions in West Mains and core #2719, 1984 sampling.



Total coal thickness: 67.8"

Roof
black bone

0-10.8"
vitrain 1-2 mm
attritus 1-2 mm (most abundant)
columnar fracture
pyrite at 2.4", 4.2"
fusain at 9.6"

10.8-32.4"
vitrain 1-2 mm (most abundant)
attritus 3-4 mm
brittle
pyrite at 16.8", 19.8", 22.2"
fusain at 10.8", 24", 31.8"
bright

32.4-48"
vitrain 1-2 mm
attritus 3-4 mm
attritus band from 36-36.6"
pyrite at 39", 39.6", 42.6"
fusain at 37.2"

48-49.2"
hard dull blocky durain
some vitrain bands

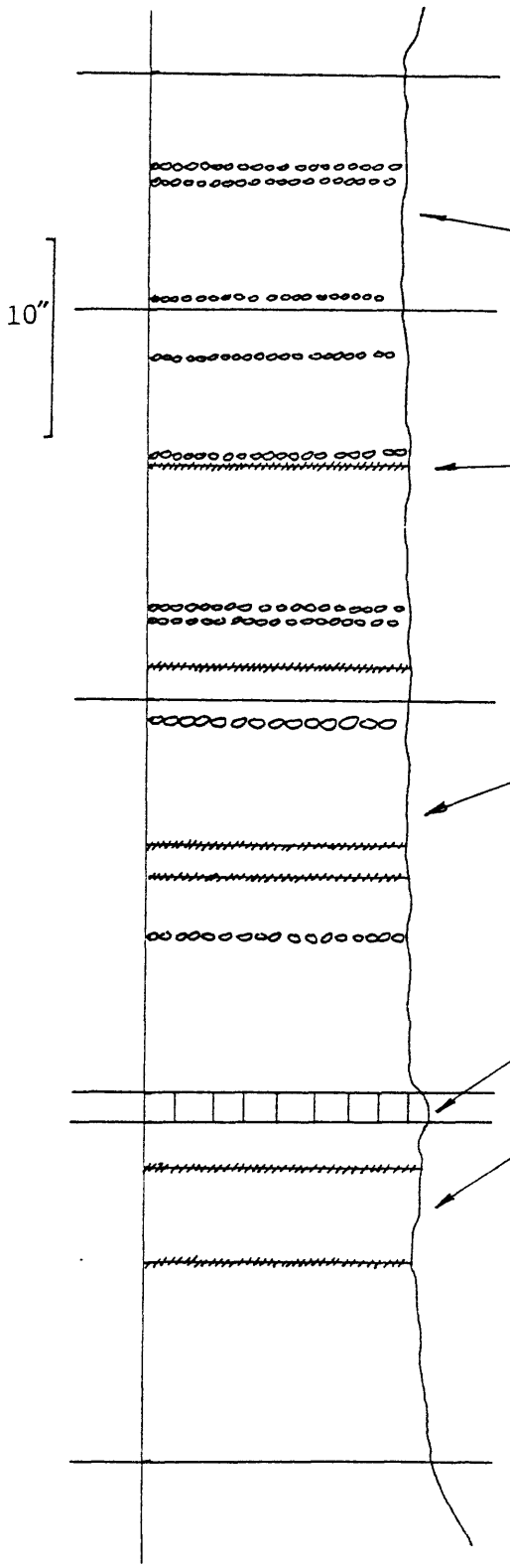
49.2-53.4"
vitrain 1-2 mm
attritus 3-6 mm
hard blocky fracture

53.4-55.2
very hard, blocky
some bands, 1 mm thick

55.2-67.8"
vitrain 1-3 mm
attritus 3-10 mm
hard blocky fracture
pyrite at 58.8"
hard layer at 57.6"
62.4" to bottom - very bony

Floor
medium gray shale

Figure 10b. In-mine description of channel #1 (West Mains, 1984) collected near core #2719.



2-West Mains 1984

Total coal thickness: 70.2"

Roof
bony, dark, carbonaceous

0-12"
vitrain 1-4 mm
attritus 1-4 mm
brittle, columnar fracture
pyrite at 4.8", 5.4", 11.4"

12-31.8"
vitrain 1-3 mm
attritus 1-6 mm
columnar fracture
pyrite at 14.4", 19.2", 27", 27.6"
fusain at 19.8", 30"
bright

31.8-51.6"
vitrain 1-2 mm
attritus 3-6 mm
pyrite at 32.4-32.88" (1.2 cm thick), 43.8"
fusain at 39", 40.8"

51.6-53.04"
dull hard durain

53.04-70.2"
vitrain 1-6 mm
attritus 1-6 mm
hard blocky fracture
fusain at 55.44", 60.24"
69" to bottom - dull and hard

Floor
medium gray shale

Figure 10c. In-mine description of channel #2 (West Mains, 1984) collected near core #2719.

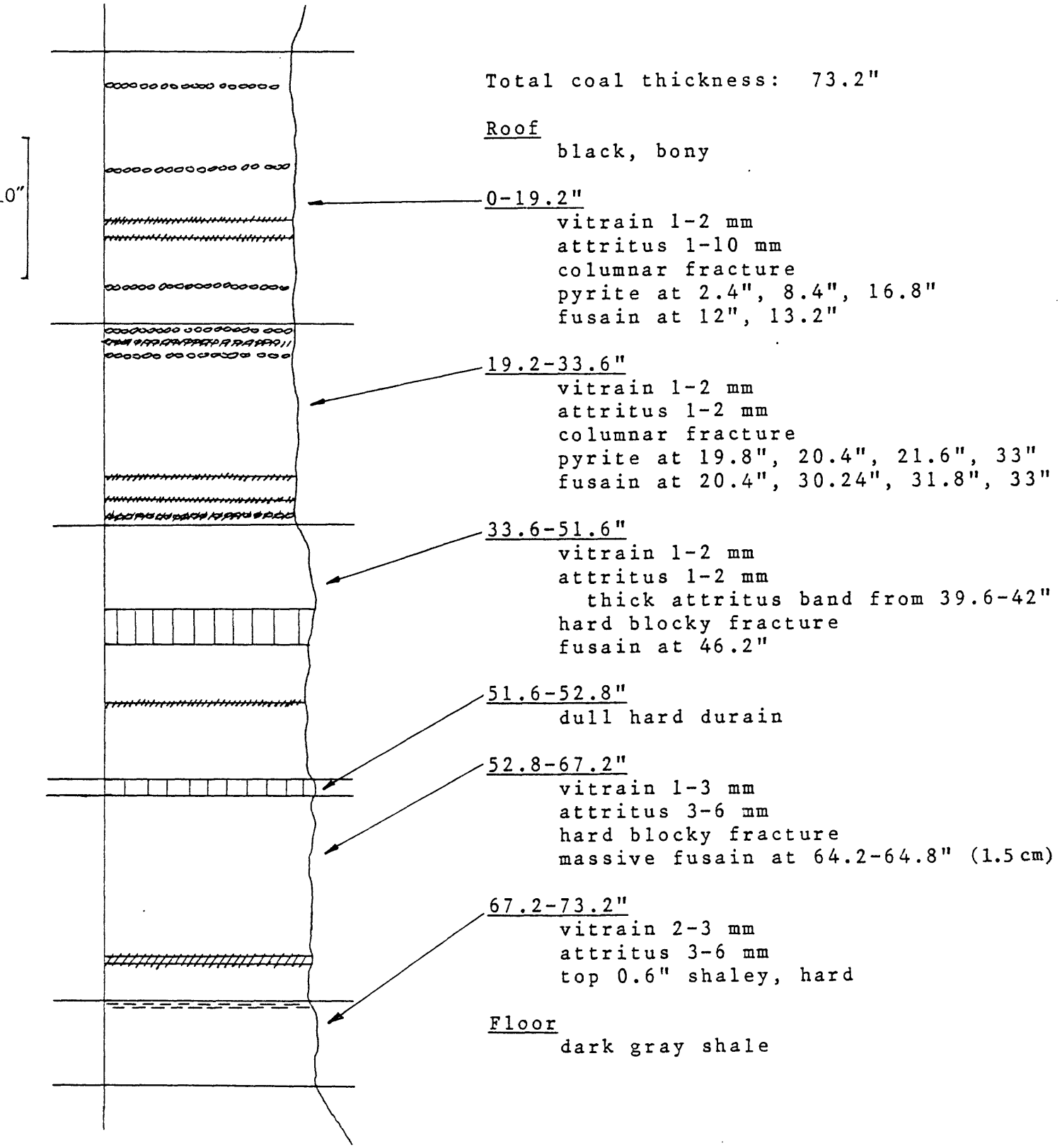


Figure 10d. In-mine description of channel #3 (West Mains, 1984) collected near core #2719.

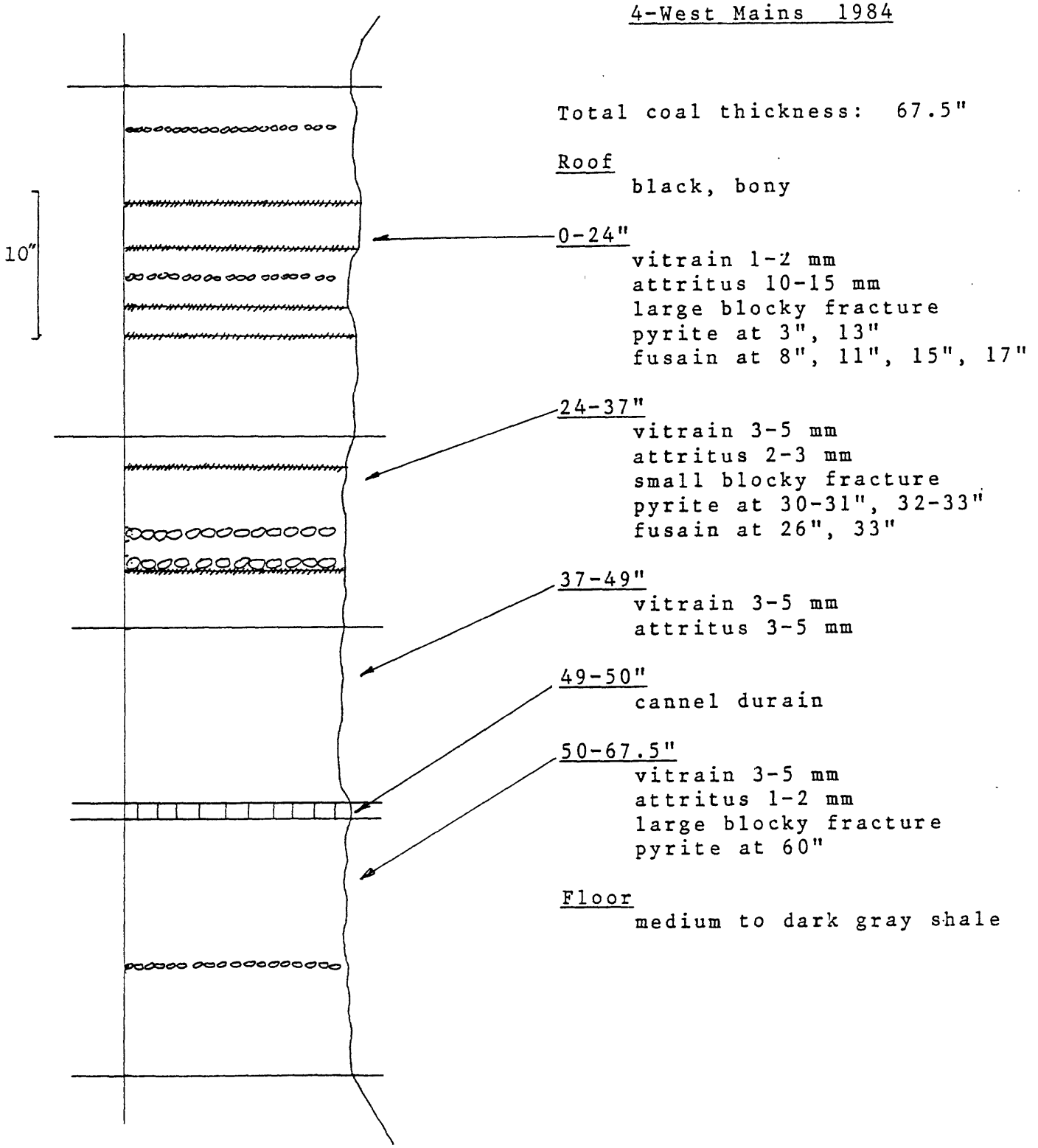
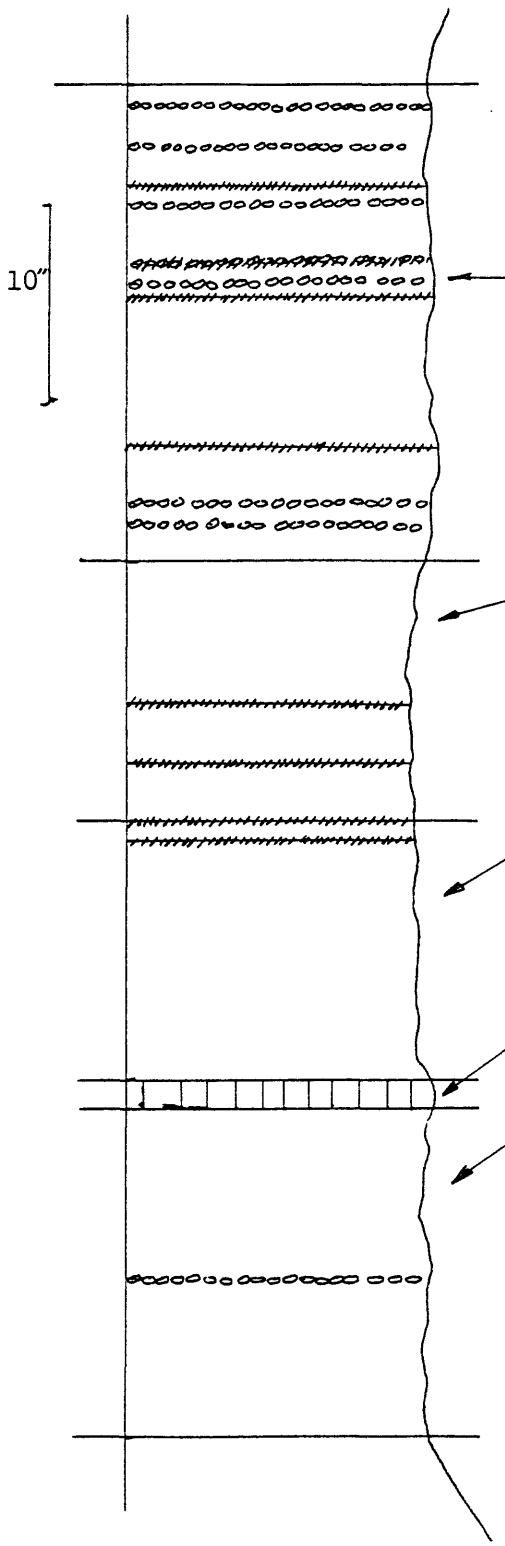


Figure 10e. In-mine description of channel #4 (West Mains, 1984) collected near core #2719.



5,6,7-West Mains 1984

Total coal thickness: 68"

Roof
black, bony

0-24"
vitrain 1-2 mm
attritus 5-10 mm
large blocky fracture
pyrite at 1", 3", 6", 9", 10", 21", 22"
fusain at 5", 9", 10.5", 18"

24-37"
vitrain 3-5 mm
attritus 2-3 mm
small blocky fracture
fusain at 31", 34"

37-50"
vitrain 3-5 mm
attritus 3-5 mm
fusain at 37", 38"

50-51.5"
cannel durain

51.5-68"
vitrain 3-5 mm
attritus 1-2 mm
large blocky fracture
pyrite at 60"

Floor
medium to dark gray shale

Figure 10f. In-mine description of channels #5,6,7 (West Mains, 1984) collected at core #2719.

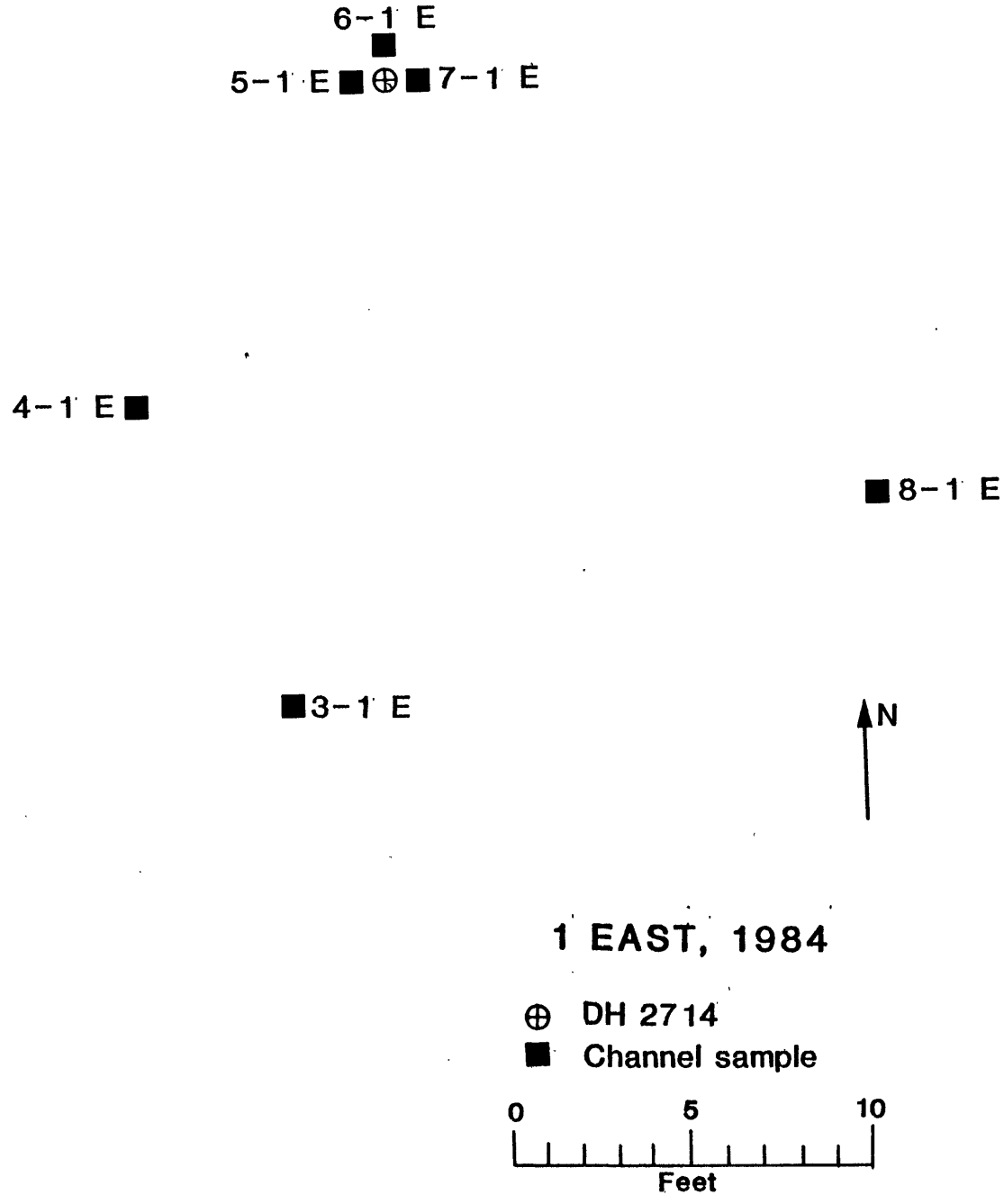
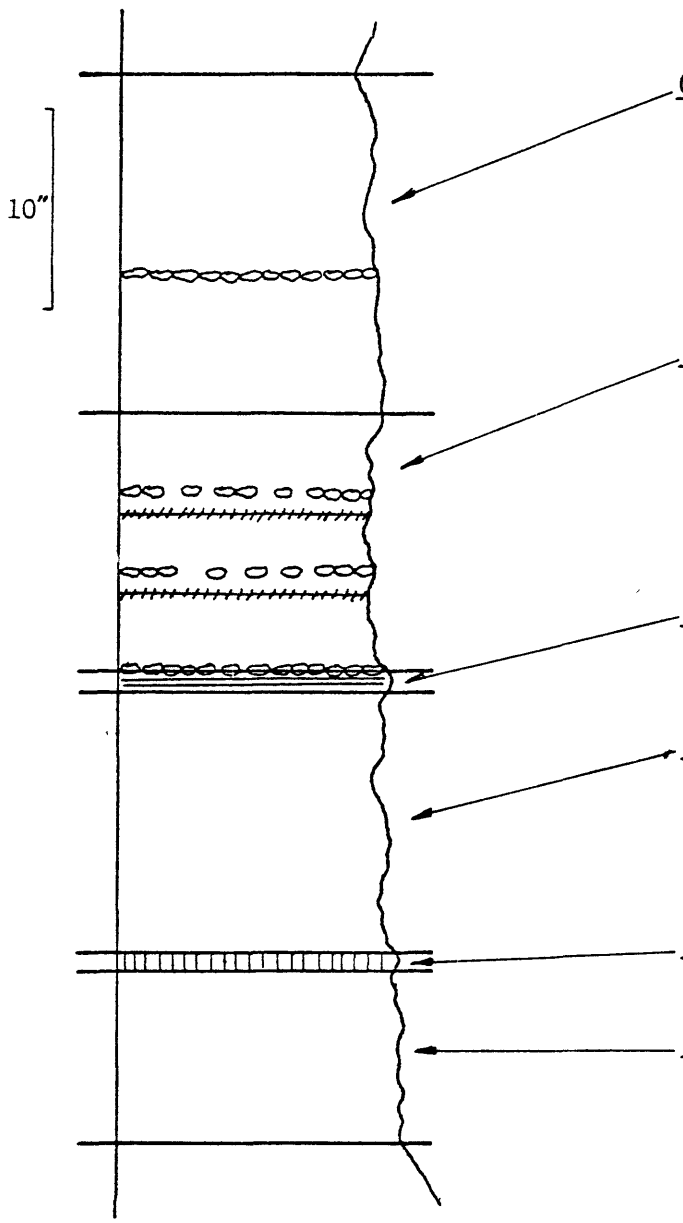


Figure 11a. Location of channel descriptions in 1 East and core #2714, 1984 sampling.

1-1 East 1984

Total coal thickness: 53.625"



Roof
2.5" canneloid
medium gray with vitrain spars
slicks

0-17"
vitrain 1-2 mm
attritus 10-15 mm
cleat spacing ~5 mm
large blocky fracture
pyrite lens at 10"
dull

17-30"
vitrain 2-3 mm
attritus 5-6 mm
cleat spacing ~5 mm
small blocky fracture
pyrite at 21", 25", 30"
fusain at 23", 26"

30-31"
medium gray clay parting
vitrain spars

31-44"
vitrain 3-4 mm
attritus 10-15 mm
cleat spacing 10 mm
large blocky fracture

44-45"
steel gray bone

45-53.625"
vitrain 1-2 mm
attritus 2-3 mm
cleat spacing 20 mm
large hard blocky fracture

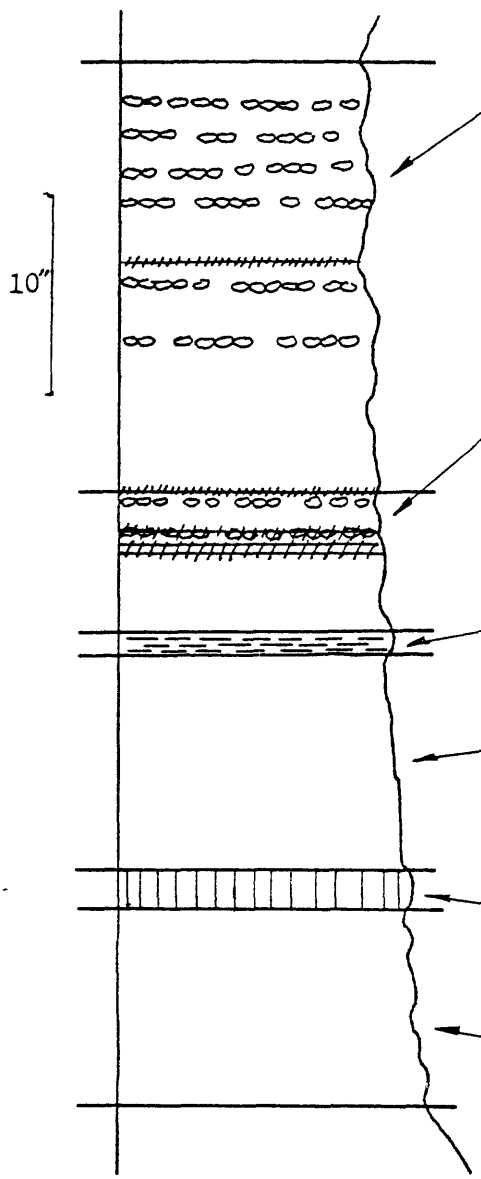
Floor
medium gray claystone

Figure 11b. In-mine description of channel #1 (1 East, 1984) collected near core #2714.

2-1 East 1984

(1" of cannel roof is included in channel sample)

Total coal thickness: 52.5"



Roof
canneloid

0-21.5"
vitrain 1-2 mm
attritus 5-10 mm
cleat spacing 10-15 mm
large blocky fracture
pyrite at 2", 3.5", 5.5", 7", 11", 14"
fusain at 10", 21.5"

21.5-28.5"
vitrain 3-4 mm
attritus 5-6 mm
cleat spacing 2-3 mm
large blocky fracture
pyrite at 22", 23.5"
fusain at 23.5" and at 24-24.5" (1.3cm with clay)

28.5-29.75"
medium gray shale
vitrain spars

29.75-40.5"
vitrain 3-5 mm
attritus 1-2 mm
cleat spacing 3-4 mm
columnar fracture

40.5-42.5"
steel gray durain
vitrain spars

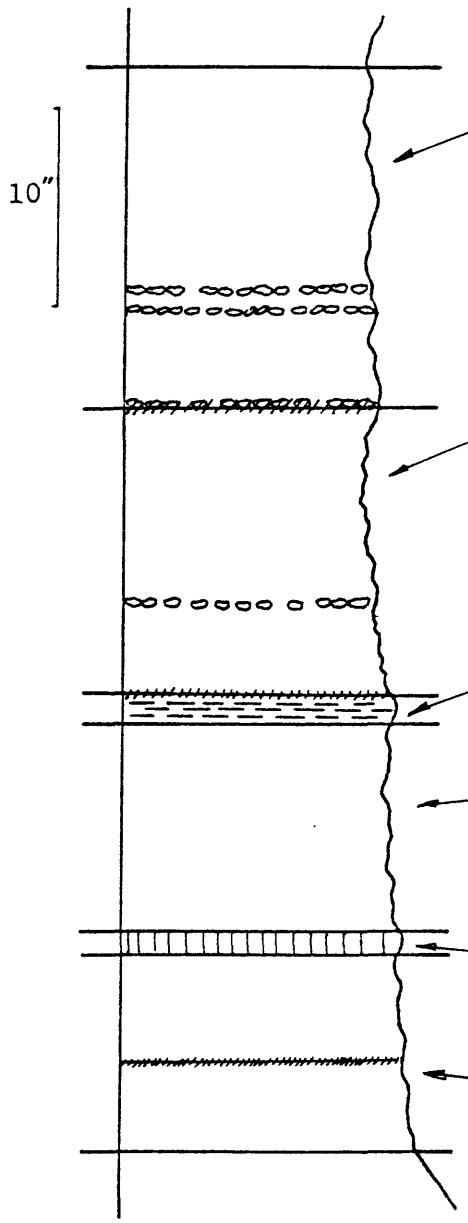
42.5-52.5"
vitrain 1-2 mm
attritus 5-10 mm
cleat spacing 5-10 mm
hard blocky fracture

Floor
medium gray claystone

Figure 11c. In-mine description of channel #2 (1 East, 1984) collected near core #2714.

3-1 East 1984

Total coal thickness: 54.5"



Roof

2" of canneloid with plant impressions
medium gray
slicks

0-17"

vitrain 1-2 mm
attritus 10-15 mm
cleat spacing 8-10 mm
large blocky fracture
pyrite at 11", 12", 17"
fusain at 17"
dull

17-31.5"

vitrain 2-3 mm
attritus 3-4 mm
cleat spacing 5 mm
small blocky fracture
pyrite at 27"
dull

31.5-33"

shale - medium gray
vitrain spars
fusain at top

33-43.5"

vitrain 1-2 mm
attritus 5-10 mm
cleat spacing 10-15 mm
large blocky fracture

43.5-44.5"

durain, non banded coal
steel gray

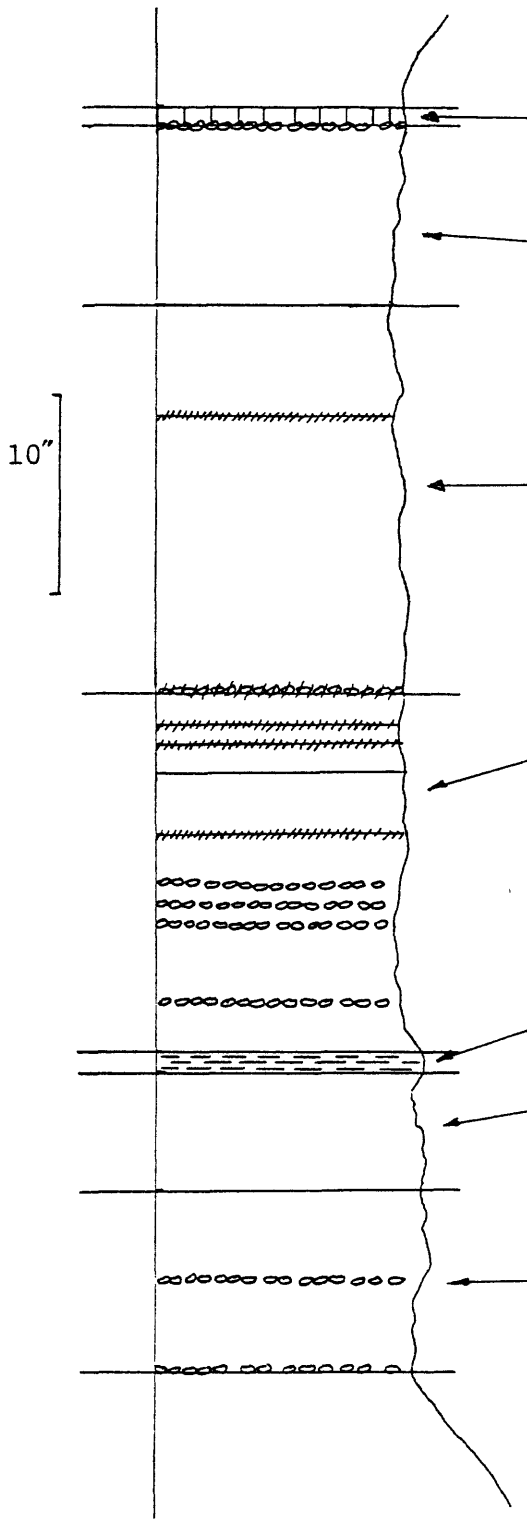
44.5-54.5"

vitrain 2-3 mm
attritus 5-10 mm
cleat spacing 2-3 mm
hard blocky fracture
fusain at 50"

Floor

medium gray claystone
slicks

Figure 11d. In-mine description of channel #3 (1 East, 1984) collected near core #2714.



Total coal thickness: 63.5"

Roof
black, bony

0-1"
medium gray bone cannel
conchoidal fracture

1-10"
vitrain 2-3 mm
attritus 5-10 mm
cleat spacing 5-8 mm
medium blocky fracture
pyrite at 1"

10-29.5"
vitrain 3-5 mm
attritus 5-8 mm
pyrite at 29.5"
fusain at 15.5", 29.5"
cleat calcite at 20"

29.5-47.5"
vitrain 1-2 mm
attritus 5-10 mm
layered pyrite at 39", 40", 41", 45"
fusain at 31", 32", 36.5"
vitrain bands at 31", 32", 33.5",
(5 mm thick)

47.5-48.5"
medium gray shale

48.5-54.5"
vitrain 3-4 mm
attritus 5-10 mm
cleat spacing 1-2 cm
hard, small blocky fracture

54.5-63.5"
vitrain 5-6 mm
attritus 5-10 mm
cleat spacing 5-8 mm
hard blocky fracture
pyrite at 59", 63.5"

Floor
medium-dark gray shale

Figure 12. In-mine description of sample taken in 4 North, 1982 sampling.

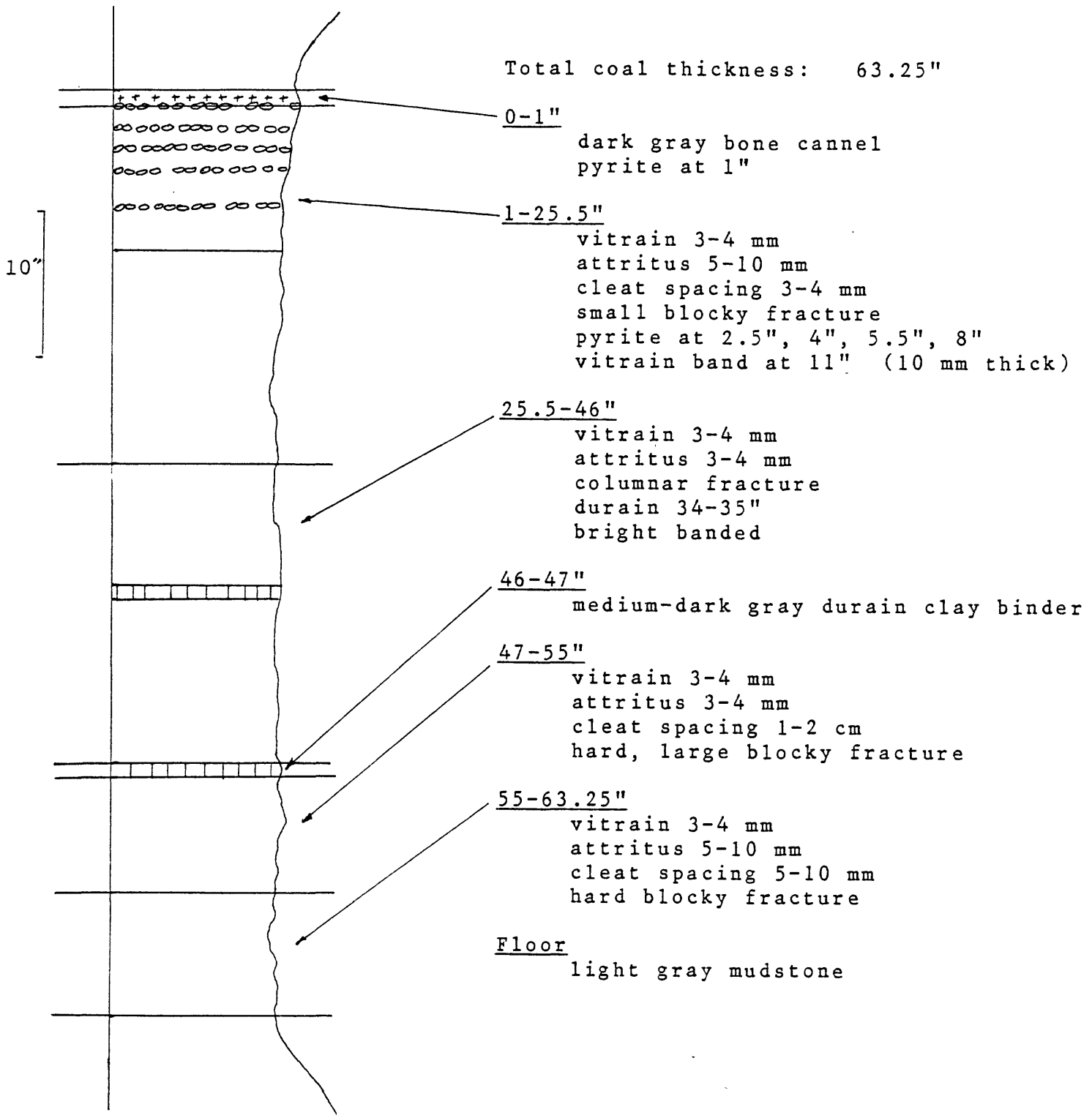
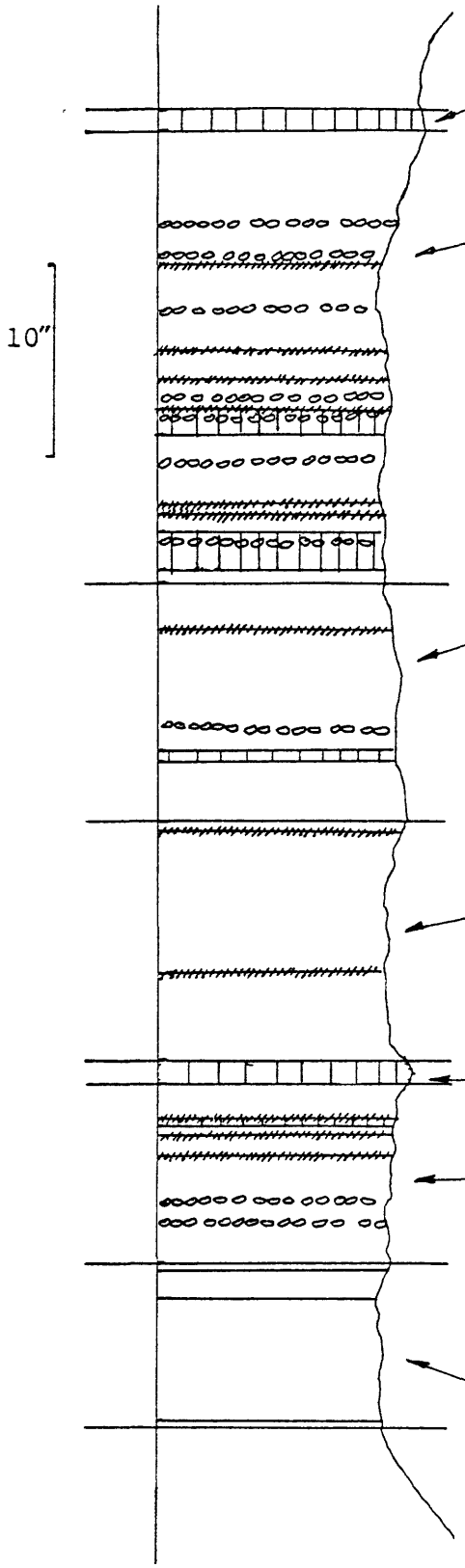


Figure 13. In-mine description of sample taken in 4 South, 1982 sampling.

Total coal thickness: 68.75"



Roof
black, bony

0-1"
dark gray bone cannel
cleat spacing 1-2 cm
medium blocky fracture

1-24.5"
vitrain 3-4 mm
attritus 6-8 mm
cleat spacing 3-4?
soft, small blocky fracture
pyrite at 6", 7.5", 10.5", 15", 16", 18.5", 22.5"
fusain at 8", 12.5", 14", 15.5", 20.5", 21"
dull durain with vitrain spars at 15.5-17", 22-24"
banded

24.5-37"
vitrain 3-10 mm
attritus 2-3 mm
cleat spacing 6-8 mm
columnar fracture
pyrite nodule at 32"
fusain at 27"
durain at 33.5-34"
vitrain bands at 28.5", 32"

37-49.5"
vitrain 2-3 mm
attritus 6-10 mm
cleat spacing 5-10 mm
small blocky fracture
fusain at 37.5", 45"

49.5-50.75"
medium-dark gray durain clay binder

50.75-60"
vitrain 3-5 mm
attritus 5-8 mm
cleat spacing 5-10 mm
small blocky fracture
layered pyrite at 57", 58"
fusain at 52.5", 53.5", 54.5"
durain at 52.5", 53"

60-68.75"
vitrain 1-2 mm
attritus 5-10 mm
cleat spacing 3-4 mm
small blocky fracture
vitrain at 60.5", 62", 68.5"

Floor
medium gray shale

Figure 14. In-mine description of sample taken in West Mains, 1982 sampling.

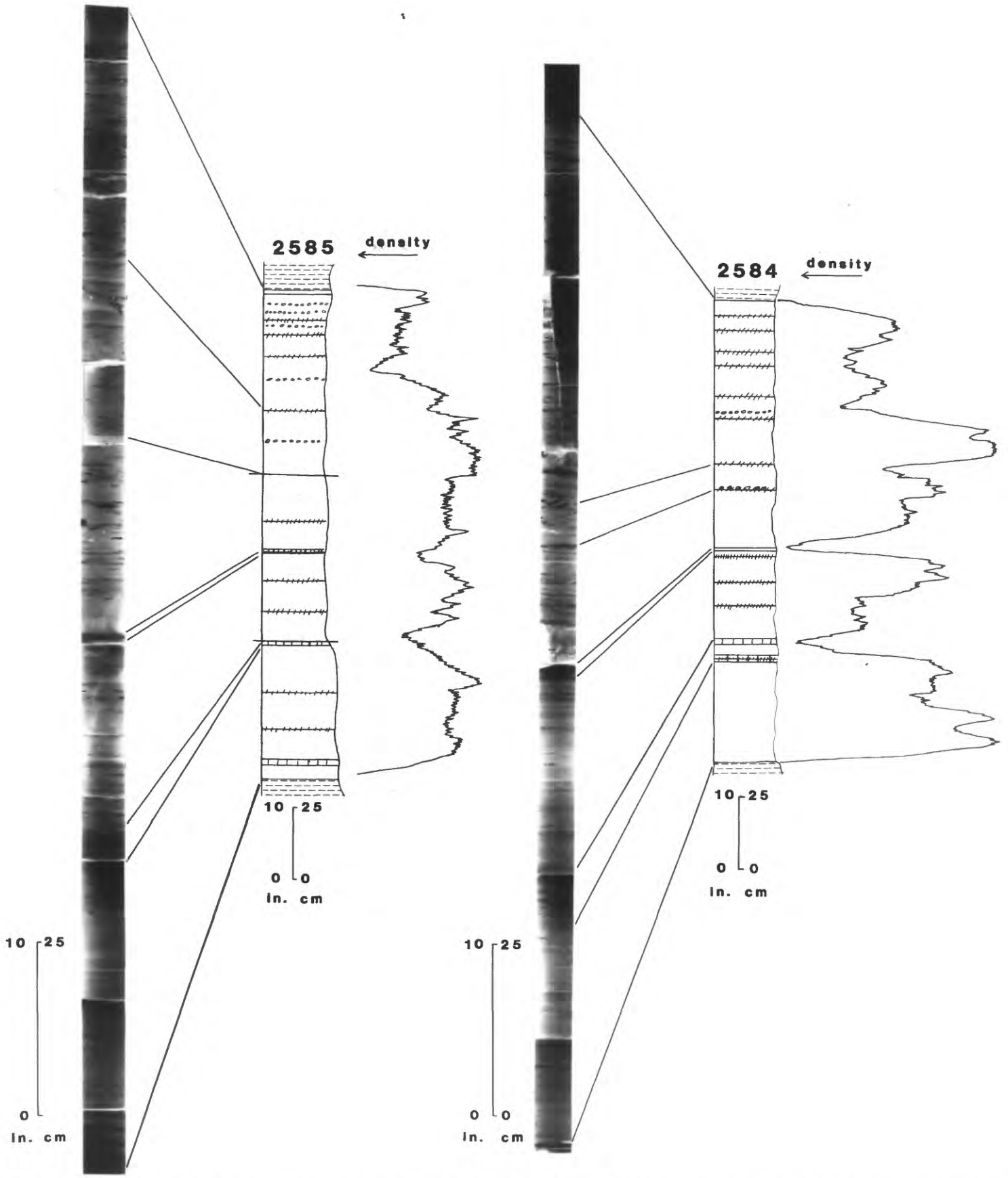


Figure 15 - Comparison of high-resolution density logs, megascopic logs, and x-ray radiographs of drill hole numbers 2584 and 2585 (locations are described in figures 4c and 5c).

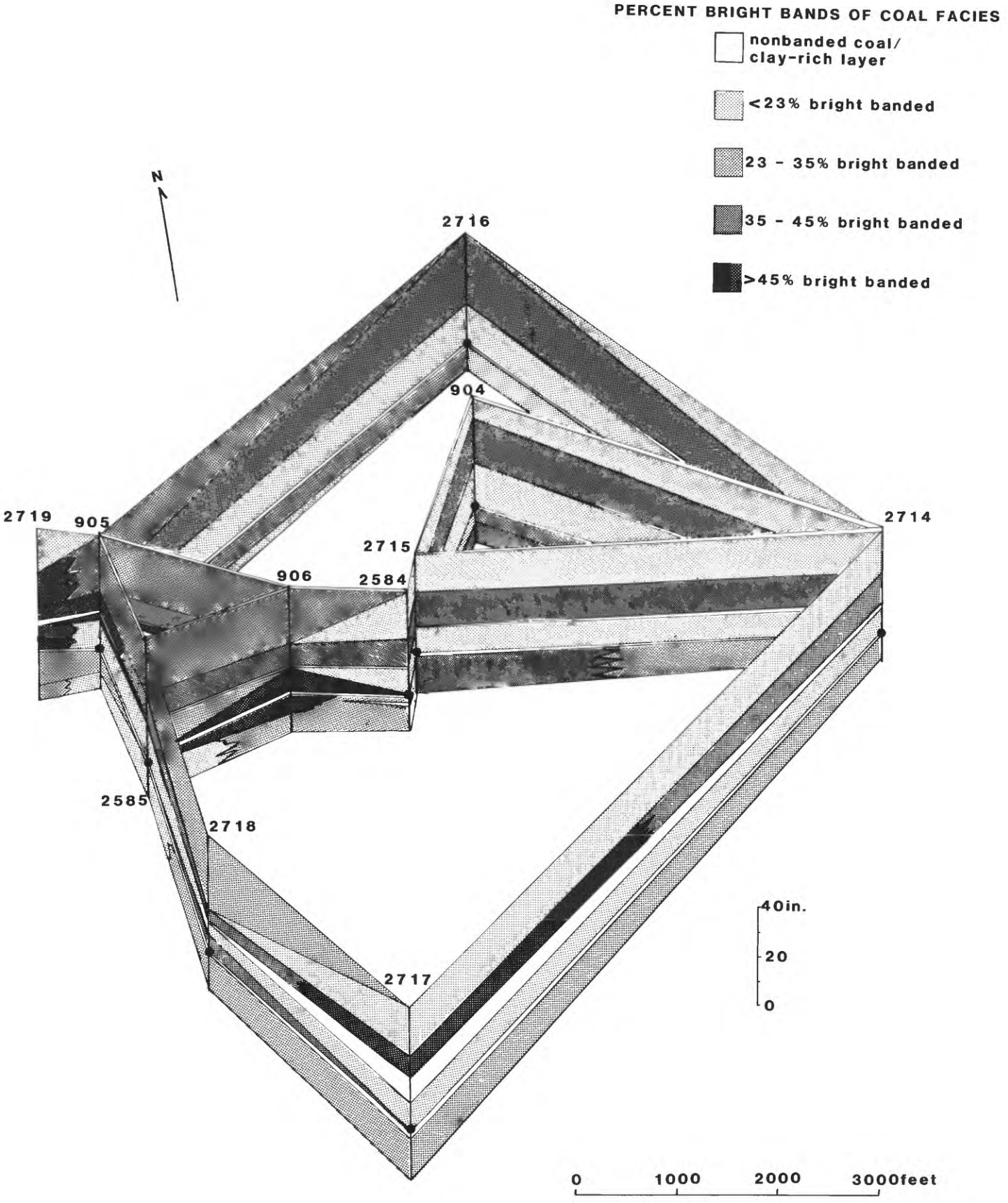


Figure 16 - Correlation of descriptions of underground mine sampling locations, Lucerne #9 Mine, west-central Pennsylvania

Table I Summary of 1982-84 descriptions at 11 locations in the Lucerne #9 Mine.

Year	Section Location	Number of Channel Samples	Number of Channel Descriptions	Core Number	Description Numbers	Figures	X-radiography
1983	3 South	7	5	2584	1,3-4-5,6,7,8	4b-f	yes
1983	5 South	7	5	2585	1,3-4-5,6,7,8	5b-f	yes
1984	3 South	8	4	2715	1,2,3,4	6b-e	planned
1984	4 South	5	3	2717	1,2,3	7b-d	planned
1984	4 North	7	3	2716	1,2,3	8b-d	planned
1984	5 South	8	6	2718	1,2,3,4,5-6-7,8	9b-g	planned
1984	West Mains	6	5	2719	1,2,3,4,5-6-7	10b-f	planned
1984	1 East	8	3	2714	1,2,3	11b-d	planned
1982	4 North (904-C)		1			12	
1982	4 South (906-C)		1			13	
1982	West Mains (905-C)		1			14	
	Lucerne #9 Total		37				