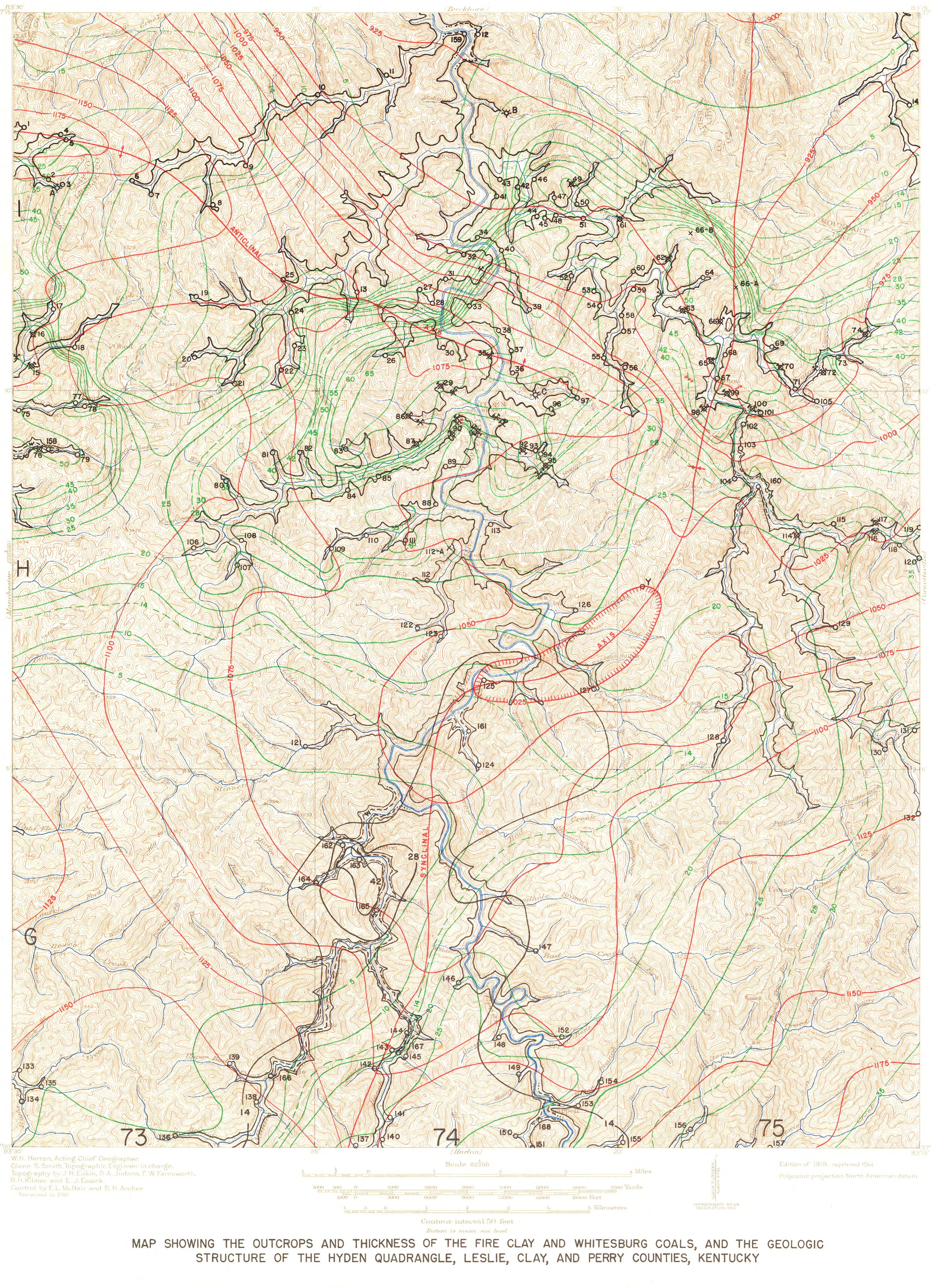
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PREPARED WITH THE COOPERATION OF THE
UNIVERSITY OF KENTUCKY AND THE KENTUCKY GEOLOGICAL SURVEY

COAL INVESTIGATIONS
MAP C 5




## MAP SHOWING THE OUTCROPS AND THICKNESS OF THE FIRE CLAY AND WHITESBURG COALS, AND THE GEOLOGIC STRUCTURE OF THE HYDEN QUADRANGLE, LESLIE, CLAY, AND PERRY COUNTIES, KENTUCKY

## EXPLANATION

1100 — Structure contours on top of flint clay in Fire Clay coal. Contour interval 25 ft; datum mean sea level. Control obtained by transit traverses and aneroid traverses corrected to stationary barometer.

15 — Lines of equal thickness on Fire Clay coal at 5 in. intervals.

28 — Lines of equal thickness corresponding to boundaries between catagories of coal thickness shown in table of coal reserves.

42 — Lines of equal thickness in inches on Whitesburg coal.

27 — Outcrop of Fire Clay coal showing location and number of coal section.

Outcrop of Whitesburg coal showing location and number of coal section (outcrop shown discontinuously).

Operating mine.

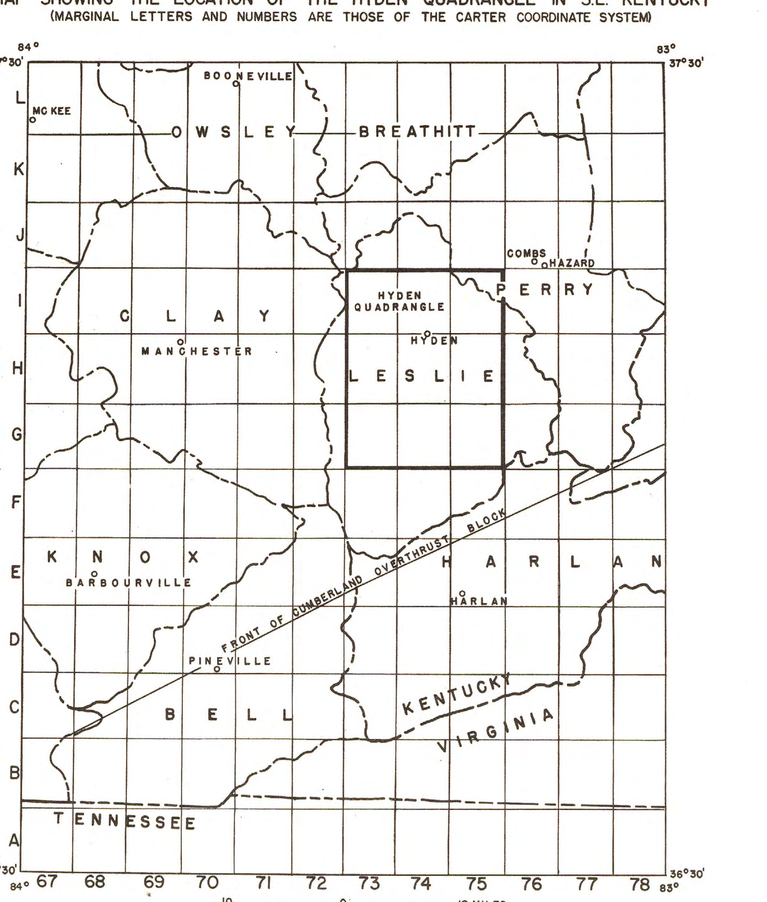
Well with show of gas.

A. Lucy A. Nield; Petroleum Exploration Company.
B. Begley Coal and Land Company.
C. Black Star Coal Co. No. 1; Sun Oil Company.

××× Scour channel.

× Location of samples in mines.

### MAP SHOWING THE LOCATION OF THE HYDEN QUADRANGLE IN S.E. KENTUCKY
(MARGINAL LETTERS AND NUMBERS ARE THOSE OF THE CARTER COORDINATE SYSTEM)




Analyses of the Fireclay (No. 4) and Whitesburg coals in the Hyden quadrangle, Leslie, Clay, and Perry Counties, Kentucky
Samples collected by the U.S. Geological Survey, 1949; analyses by the U.S. Bureau of Mines

| Location on map | Bureau of Mines laboratory sample number | Coal bed | Rank 1/ | Condition of sample 2/ | Form of analysis 3/ | Proximate analysis (percent): Moisture | Volatile matter | Fixed carbon | Ash | Ultimate analysis (percent): Sulfur | Hydrogen | Carbon | Nitrogen | Oxygen | Air drying loss | Heating value, B.t.u. | Free swelling index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | D-21259 | Fire Clay | Hvab | 1 | A | 2.8 | 39.7 | 53.6 | 3.9 | 0.7 | 5.7 | 77.9 | 1.8 | 10.0 | 0.5 | 14,000 | 5 1/2 |
| | | | | | C | | 42.5 | 57.5 | | 0.7 | 5.8 | 83.5 | 2.0 | 8.0 | | 15,000 | |
| 16 | D-21261 | Fire Clay | Hvab | 1 | A | 3.4 | 36.5 | 53.0 | 7.1 | 1.8 | 5.4 | 74.5 | 1.6 | 9.6 | 0.8 | 13,320 | 5 1/2 |
| | | | | | C | | 40.8 | 59.2 | | 2.0 | 5.6 | 83.2 | 1.8 | 7.4 | | 14,890 | |
| 29 | D-10415 | Fire Clay | Hvab | 1 | A | 3.4 | 38.0 | 54.8 | 3.8 | 0.8 | 5.6 | 77.8 | 1.7 | 10.3 | 1.5 | 13,900 | 6 1/2 |
| | | | | | C | | 41.0 | 59.0 | | 0.9 | 5.6 | 83.8 | 1.8 | 7.9 | | 14,980 | |
| 35 | D-10416 | Fire Clay | Hvbb | 1 | A | 5.6 | 34.7 | 55.2 | 4.5 | 0.6 | 5.4 | 74.8 | 1.6 | 13.1 | 3.1 | 13,260 | 4 1/2 |
| | | | | | C | | 38.6 | 61.4 | | 0.7 | 5.4 | 83.1 | 1.8 | 9.0 | | 14,740 | |
| 62 | D-21265 | Fire Clay | Hvab | 1 | A | 3.4 | 38.2 | 54.0 | 4.4 | 0.8 | 5.6 | 76.9 | 1.7 | 10.6 | 0.8 | 13,760 | 5 1/2 |
| | | | | | C | | 41.5 | 58.5 | | 0.9 | 5.7 | 83.4 | 1.9 | 8.1 | | 14,930 | |
| 66 | D- 9789 | Fire Clay | Hvab | 1 | A | 3.8 | 37.2 | 53.8 | 5.2 | 0.7 | 5.6 | 76.3 | 1.7 | 10.5 | 1.5 | 13,580 | 5 1/2 |
| | | | | | C | | 40.9 | 59.1 | | 0.8 | 5.7 | 83.8 | 1.9 | 7.8 | | 14,920 | |
| 66A | D-21264 | Fire Clay | Hvab | 1 | A | 3.5 | 37.5 | 55.3 | 3.7 | 0.7 | 5.5 | 78.0 | 1.7 | 10.4 | 0.8 | 13,840 | 5 |
| | | | | | C | | 40.3 | 59.7 | | 0.8 | 5.5 | 84.1 | 1.8 | 7.8 | | 14,910 | |
| 66B | D-21263 | Fire Clay | Hvab | 1 | A | 3.4 | 39.3 | 54.1 | 3.2 | 0.7 | 5.6 | 77.9 | 1.8 | 10.8 | 0.9 | 13,950 | 6 |
| | | | | | C | | 42.0 | 58.0 | | 0.8 | 5.6 | 83.4 | 1.9 | 8.3 | | 14,930 | |
| 69 | D-21251 | Fire Clay | | 3 | A | 4.8 | 36.6 | 54.6 | 4.0 | 0.6 | 5.5 | 76.0 | 1.7 | 12.2 | 1.6 | 13,540 | 3 |
| | | | | | C | | 40.0 | 60.0 | | 0.7 | 5.4 | 83.3 | 1.8 | 8.8 | | 14,830 | |
| 72 | D-21249 | Fire Clay | Hvab | 1 | A | 3.2 | 39.3 | 51.7 | 5.8 | 1.2 | 5.6 | 75.6 | 1.7 | 10.1 | 0.6 | 13,600 | 5 |
| | | | | | C | | 43.2 | 56.8 | | 1.3 | 5.7 | 83.1 | 1.9 | 8.0 | | 14,940 | |
| 74 | D-21248 | Fire Clay | Hvab | 1 | A | 3.3 | 36.9 | 53.4 | 6.4 | 0.7 | 5.4 | 74.8 | 1.7 | 11.0 | 0.9 | 13,450 | 5 |
| | | | | | C | | 40.9 | 59.1 | | 0.8 | 5.6 | 82.9 | 1.8 | 8.9 | | 14,900 | |
| 75 | D-20618 | Fire Clay | Hvab | 1 | A | 3.3 | 38.0 | 53.3 | 5.4 | 0.7 | 5.5 | 76.2 | 1.8 | 10.4 | 0.9 | 13,610 | 5 |
| | | | | | C | | 41.7 | 58.3 | | 0.7 | 5.6 | 83.5 | 2.0 | 8.2 | | 14,910 | |
| 76 | D- 8850 | Fire Clay | Hvab | 1 | A | 3.0 | 38.4 | 54.0 | 4.6 | 0.8 | 5.6 | 77.2 | 1.7 | 10.1 | 1.3 | 13,860 | 5 |
| | | | | | C | | 41.6 | 58.4 | | 0.9 | 5.7 | 83.6 | 1.9 | 7.9 | | 15,010 | |
| 79 | D-20619 | Fire Clay | | 2 | A | 3.3 | 38.9 | 53.2 | 4.6 | 1.1 | 5.6 | 76.4 | 1.8 | 10.5 | 0.9 | 13,770 | 5 |
| | | | | | C | | 42.2 | 57.8 | | 1.2 | 5.7 | 83.0 | 1.9 | 8.2 | | 14,950 | |
| 82 | D-20615 | Fire Clay | Hvab | 1 | A | 2.9 | 37.8 | 51.8 | 7.5 | 0.7 | 5.5 | 74.5 | 1.8 | 10.0 | 0.6 | 13,320 | 5 |
| | | | | | C | | 42.1 | 57.9 | | 0.8 | 5.7 | 83.1 | 2.0 | 8.4 | | 14,860 | |
| 84 | D-20614 | Fire Clay | Hvab | 1 | A | 3.4 | 35.6 | 54.0 | 7.0 | 1.0 | 5.4 | 73.9 | 1.8 | 10.9 | 0.6 | 13,240 | 4 |
| | | | | | C | | 39.7 | 60.3 | | 1.1 | 5.6 | 82.5 | 2.0 | 8.8 | | 14,760 | |
| 86 | D- 9791 | Fire Clay | Hvab | 1 | A | 3.3 | 37.9 | 54.4 | 4.4 | 0.8 | 5.6 | 77.2 | 1.7 | 10.3 | 1.3 | 13,770 | 6 |
| | | | | | C | | 41.1 | 58.9 | | 0.8 | 5.6 | 83.7 | 1.8 | 8.1 | | 14,930 | |
| 87 | D- 6985 | Fire Clay | Hvab | 1 | A | 3.5 | 38.3 | 53.9 | 4.3 | 0.8 | 5.5 | 76.8 | 1.7 | 10.9 | 1.4 | 13,730 | 5 1/2 |
| | | | | | C | | 41.5 | 58.5 | | 0.9 | 5.6 | 83.3 | 1.9 | 8.3 | | 14,900 | |
| 89 | D-10419 | Fire Clay | Hvab | 1 | A | 4.6 | 36.4 | 54.0 | 5.0 | 0.7 | 5.5 | 74.4 | 1.7 | 12.7 | 2.0 | 13,270 | 2 |
| | | | | | C | | 40.3 | 59.7 | | 0.7 | 5.6 | 82.4 | 1.9 | 9.4 | | 14,690 | |
| 91 | D- 8848 | Fire Clay | Hvab | 1 | A | 4.2 | 37.3 | 53.7 | 4.8 | 1.3 | 5.6 | 75.7 | 1.7 | 10.9 | 2.1 | 13,600 | 5 |
| | | | | | C | | 41.0 | 59.0 | | 1.4 | 5.7 | 83.2 | 1.8 | 7.9 | | 14,950 | |
| 92 | D- 6982 | Fire Clay | Hvab | 1 | A | 3.2 | 38.2 | 53.3 | 5.3 | 0.9 | 5.5 | 76.3 | 1.7 | 10.3 | 1.2 | 13,630 | 5 |
| | | | | | C | | 41.7 | 58.3 | | 0.9 | 5.6 | 83.3 | 1.9 | 8.3 | | 14,890 | |
| 98 | D- 9788 | Fire Clay | Hvab | 1 | A | 3.9 | 36.3 | 54.5 | 5.3 | 0.7 | 5.6 | 75.8 | 1.6 | 11.0 | 1.4 | 13,530 | 5 1/2 |
| | | | | | C | | 40.0 | 60.0 | | 0.8 | 5.8 | 83.4 | 1.8 | 8.4 | | 14,900 | |
| 102 | D-20623 | Fire Clay | | 2 | A | 8.8 | 33.0 | 53.5 | 4.7 | 0.6 | 5.4 | 69.2 | 1.7 | 18.4 | 2.9 | 12,050 | N.C.4/ |
| | | | | | C | | 38.1 | 61.9 | | 0.7 | 5.1 | 80.0 | 1.9 | 12.3 | | 13,930 | |
| 104 | D-21250 | Fire Clay | | 2 | A | 7.8 | 35.6 | 50.9 | 5.7 | 0.7 | 5.8 | 71.2 | 1.7 | 14.9 | 5.8 | 12,770 | 5 |
| | | | | | C | | 41.1 | 58.9 | | 0.8 | 5.6 | 82.3 | 1.9 | 9.4 | | 14,750 | |
| 105 | D-21246 | Fire Clay | | 2 | A | 3.4 | 36.8 | 51.6 | 8.2 | 1.3 | 5.4 | 72.3 | 1.7 | 11.1 | 0.8 | 13,090 | 4 1/2 |
| | | | | | C | | 41.6 | 58.4 | | 1.5 | 5.6 | 81.7 | 1.9 | 9.3 | | 14,800 | |
| 108 | D-20613 | Fire Clay | Hvab | 1 | A | 3.9 | 39.1 | 52.3 | 4.7 | 1.3 | 5.6 | 75.6 | 1.9 | 10.9 | 1.2 | 13,620 | 6 |
| | | | | | C | | 42.8 | 57.2 | | 1.4 | 5.6 | 82.7 | 2.0 | 8.3 | | 14,900 | |
| 109 | D-20620 | Fire Clay | | 2 | A | 3.3 | 36.9 | 54.5 | 5.3 | 0.8 | 5.5 | 75.8 | 1.8 | 10.8 | 0.0 | 13,480 | 2 1/2 |
| | | | | | C | | 40.3 | 59.7 | | 0.8 | 5.6 | 82.8 | 2.0 | 8.8 | | 14,740 | |
| 111 | D-20622 | Fire Clay | | 2 | A | 4.4 | 36.1 | 54.2 | 5.3 | 0.6 | 5.5 | 75.1 | 1.8 | 11.7 | 1.7 | 13,340 | 3 |
| | | | | | C | | 40.0 | 60.0 | | 0.7 | 5.6 | 83.2 | 2.0 | 8.5 | | 14,780 | |
| 112A | D-20621 | Fire Clay | | 2 | A | 4.2 | 38.8 | 51.7 | 5.3 | 1.1 | 5.6 | 74.9 | 1.8 | 11.3 | 1.5 | 13,470 | 4 1/2 |
| | | | | | C | | 42.9 | 57.1 | | 1.3 | 5.7 | 82.8 | 2.0 | 8.2 | | 14,890 | |
| 113 | D-20624 | Fire Clay | | 2 | A | 5.7 | 35.5 | 53.3 | 5.5 | 0.7 | 5.5 | 71.9 | 1.8 | 14.6 | 1.4 | 12,710 | 1 |
| | | | | | C | | 40.0 | 60.0 | | 0.8 | 5.4 | 81.1 | 2.0 | 10.7 | | 14,320 | |
| 114 | D-20633 | Fire Clay | Hvab | 1 | A | 2.6 | 38.4 | 50.6 | 8.4 | 0.9 | 5.4 | 73.9 | 1.8 | 9.6 | 0.6 | 13,270 | 5 |
| | | | | | C | | 43.1 | 56.9 | | 1.0 | 5.7 | 83.1 | 2.0 | 8.2 | | 14,920 | |
| 116 | D-21243 | Fire Clay | Hvab | 1 | A | 8.7 | 31.7 | 51.7 | 7.9 | 0.8 | 5.1 | 66.2 | 1.5 | 18.5 | 2.8 | 11,510 | 1 |
| | | | | | C | | 38.0 | 62.0 | | 0.9 | 5.0 | 79.4 | 1.8 | 12.9 | | 13,800 | |
| 119 | D-20635 | Fire Clay | Hvab | 1 | A | 5.1 | 36.8 | 54.4 | 3.7 | 0.7 | 5.7 | 76.4 | 1.8 | 11.7 | 2.3 | 13,600 | 5 |
| | | | | | C | | 40.3 | 59.7 | | 0.7 | 5.6 | 83.7 | 2.0 | 8.0 | | 14,910 | |
| 120 | D-21242 | Fire Clay | Hvab | 1 | A | 2.7 | 38.7 | 54.1 | 4.5 | 0.7 | 5.6 | 77.3 | 1.8 | 10.1 | 0.5 | 13,870 | 5 |
| | | | | | C | | 41.7 | 58.3 | | 0.8 | 5.7 | 83.3 | 1.9 | 8.3 | | 14,950 | |
| 123 | D-10418 | Fire Clay | | 3 | A | 3.4 | 36.5 | 47.8 | 12.3 | 1.6 | 5.2 | 69.3 | 1.5 | 10.1 | 1.8 | 12,460 | |
| | | | | | C | | 43.3 | 56.7 | | 1.9 | 5.7 | 82.2 | 1.7 | 8.5 | | 14,790 | |
| 131 | D-21252 | Fire Clay | Hvab | 1 | A | 3.4 | 37.9 | 55.2 | 3.5 | 0.9 | 5.7 | 76.8 | 1.9 | 11.2 | 0.5 | 13,780 | 4 1/2 |
| | | | | | C | | 40.8 | 59.2 | | 0.9 | 5.7 | 82.5 | 2.1 | 8.8 | | 14,800 | |
| 132 | D-21253 | Fire Clay | Hvbb | 1 | A | 11.4 | 32.9 | 51.5 | 4.2 | 0.6 | 5.6 | 66.4 | 1.6 | 21.6 | 5.8 | 11,600 | N.C.4/ |
| | | | | | C | | 39.0 | 61.0 | | 0.7 | 5.1 | 78.6 | 1.9 | 13.7 | | 13,740 | |
| 140 | D- 9793 | Fire Clay | | 3 | A | 4.2 | 35.6 | 50.2 | 10.0 | 1.3 | 5.4 | 71.0 | 1.6 | 10.7 | 2.3 | 12,730 | |
| | | | | | C | | 41.5 | 58.5 | | 1.5 | 5.7 | 82.8 | 1.9 | 8.1 | | 14,840 | |
| 143 | D- 9792 | Fire Clay | Hvab | 1 | A | 3.5 | 33.3 | 48.0 | 15.2 | 2.1 | 5.0 | 66.8 | 1.4 | 9.5 | 1.7 | 12,040 | 6 |
| | | | | | C | | 40.9 | 59.1 | | 2.6 | 5.7 | 82.2 | 1.8 | 7.7 | | 14,810 | |
| 163 | D- 6981 | Whitesburg | Hvab | 1 | A | 3.7 | 37.4 | 52.0 | 6.9 | 1.8 | 5.4 | 74.4 | 1.5 | 10.0 | 1.8 | 13,330 | 4 1/2 |
| | | | | | C | | 41.8 | 58.2 | | 2.0 | 5.6 | 83.2 | 1.7 | 7.5 | | 14,900 | |
| 164 | D-28599 | Whitesburg | | 3 | A | 2.9 | 40.5 | 49.4 | 7.2 | 1.9 | 5.5 | 73.9 | 1.6 | 9.9 | 1.1 | 13,350 | 4 |
| | | | | | C | | 45.0 | 55.0 | | 2.1 | 5.8 | 82.2 | 1.8 | 8.1 | | 14,840 | |
| 165 | D- 9790 | Whitesburg | Hvab | 1 | A | 2.6 | 38.5 | 52.9 | 6.0 | 1.3 | 5.5 | 76.6 | 1.6 | 9.0 | 1.1 | 13,820 | 6 1/2 |
| | | | | | C | | 42.2 | 57.8 | | 1.4 | 5.7 | 83.8 | 1.7 | 7.4 | | 15,130 | |

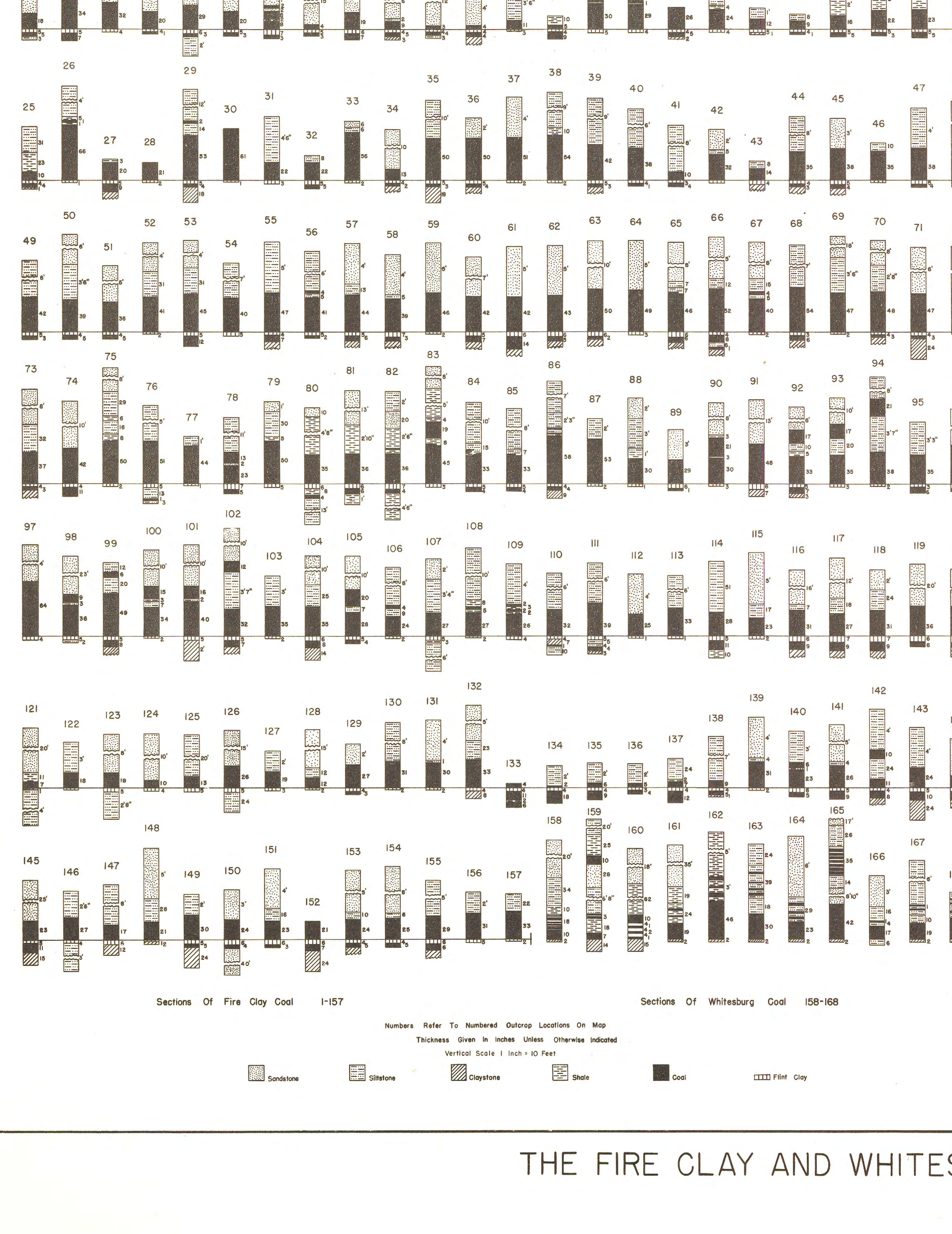
1/ Hvab, High volatile A bituminous; Hvbb, High volatile B bituminous
2/ 1, fresh; 2, semi-fresh; 3, weathered
3/ A, as received; C, moisture and ash free
4/ non-coking

Estimated original reserves in the Fire Clay (No 4) and Whitesburg coal beds, Hyden quadrangle, Leslie, Clay, and Perry Counties, Kentucky
All under less than 1,000 feet overburden
(in thousands of short tons)

| Carter Grid Section | % Sulfur | Measured reserves: In beds 14 to 28 inches thick | In beds 28 to 42 inches thick | In beds more than 42 inches thick | Total | Indicated reserves: In beds 14 to 28 inches thick | In beds 28 to 42 inches thick | In beds more than 42 inches thick | Total | Inferred reserves: In beds 14 to 28 inches thick | In beds 28 to 42 inches thick | In beds more than 42 inches thick | Total | Total reserves in all categories: In beds 14 to 28 inches thick | In beds 28 to 42 inches thick | In beds more than 42 inches thick | Carter Grid section total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FIRE CLAY (NO 4) COAL | | | | | | | | | | | | | | | | | |
| 73 G | | | | | | 651 | | | 651 | | | | | 651 | | | 651 |
| 73 H | .7-1.4 | 8,678 | 12,160 | 8,072 | 28,910 | 10,477 | 1,190 | 43 | 11,710 | | | | | 19,155 | 13,350 | 8,115 | 40,620 |
| 73 I | .7-2.0 | 13,407 | 4,442 | 4,633 | 22,482 | 9,115 | | | 9,115 | 2,177 | | | 2,177 | 24,699 | 4,442 | 4,633 | 33,774 |
| 74 G | 1.3-2.6 | 17,703 | | | 17,703 | 8,689 | | | 8,689 | | | | | 26,392 | | | 26,392 |
| 74 H | .6-1.3 | 10,806 | 18,146 | 13,963 | 42,915 | 4,914 | 2,417 | 1,201 | 8,532 | | | | | 15,720 | 20,563 | 15,164 | 51,447 |
| 74 I | .6- .7 | 2,826 | 7,751 | 24,378 | 34,955 | 298 | | 1,384 | 1,682 | | | | | 3,124 | 7,751 | 25,762 | 36,637 |
| 75 G | .6- .7 | 3,008 | 6,418 | | 9,426 | 14,782 | 12,001 | | 26,783 | 9,457 | 19,508 | | 28,965 | 27,247 | 37,927 | | 65,174 |
| 75 H | .6-1.5 | 17,125 | 17,315 | 4,087 | 38,527 | 10,144 | 12,239 | 1,553 | 23,936 | | | | | 27,269 | 29,554 | 5,640 | 62,463 |
| 75 I | .6-1.3 | 1,485 | 10,512 | 17,976 | 29,973 | 4,579 | 2,762 | 187 | 7,528 | | | | | 6,064 | 13,274 | 18,163 | 37,501 |
| Total | | 75,038 | 76,744 | 73,109 | 224,891 | 63,649 | 30,609 | 4,368 | 98,626 | 11,634 | 19,508 | | 31,142 | 150,321 | 126,861 | 77,477 | 354,659 |
| Total estimated original reserves, Fire Clay (No 4) coal | | | | | | | | | | | | | | | | | 354,659 |
| Depletion through mining and losses in mining to October 1, 1949, assuming past losses equal production 1/ | | | | | | | | | | | | | | | | | 11,984 |
| Estimated reserves remaining in ground, October 1, 1949 | | | | | | | | | | | | | | | | | 342,675 |
| Recoverable reserves as of October 1, 1949, assuming 50% recovery | | | | | | | | | | | | | | | | | 171,337 |
| WHITESBURG COAL | | | | | | | | | | | | | | | | | |
| 73 G | | 1,934 | | | 1,934 | 995 | | | 995 | | | | | 2,929 | | | 2,929 |
| 74 G | 1.3-2.0 | 10,577 | 3,301 | 1,155 | 15,033 | 14,404 | | | 14,404 | 1,610 | | | 1,610 | 26,591 | 3,301 | 1,155 | 31,047 |
| 74 H | | 1,572 | | | 1,572 | 2,997 | | | 2,997 | 913 | | | 913 | 5,482 | | | 5,482 |
| 75 G | | | | | | 68 | | | 68 | | | | | 68 | | | 68 |
| Total | | 14,083 | 3,301 | 1,155 | 18,539 | 18,464 | | | 18,464 | 2,523 | | | 2,523 | 35,070 | 3,301 | 1,155 | 39,526 |
| Total estimated original reserves, Whitesburg coal | | | | | | | | | | | | | | | | | 39,526 |
| Depletion through mining and losses in mining to October 1, 1949, assuming past losses equal production 2/ | | | | | | | | | | | | | | | | | 10 |
| Estimated reserves remaining in ground, October 1, 1949 | | | | | | | | | | | | | | | | | 39,516 |
| Recoverable reserves as of October 1, 1949, assuming 50% recovery | | | | | | | | | | | | | | | | | 19,758 |

1/ Total production, 1933 to October 1, 1949, from Annual reports of Kentucky Department of Mines and Minerals, and ramp loading figures at railroad terminals at Combs and Manchester, Kentucky, equals 5,992,000 tons.
2/ Estimated production to October 1, 1949, equals 5,000 tons.

### GRAPHIC SECTIONS OF THE FIRE CLAY AND WHITESBURG COALS




### MEANING AND USE OF THIS MAP

From this map the location of outcrops of the Fire Clay and Whitesburg coals as known or interpreted by the geologist can be read. The map can also be used to determine the thickness and dip or "pitch" of the coal beds at different places and the depth of overburden beneath which they lie.

On the map the altitude of the surface of the ground is shown by the brown lines (topographic contours). These lines connect points on the ground at the same altitude above sea level and show the shapes of the hills and valleys. The altitude of a particular point can be read from the map with an accuracy at least equal to the contour interval (50 feet for this map).

The altitude of the flint clay parting in the Fire Clay coal is shown in feet above sea level by red lines (structure contours). These lines connect points on the top of the flint clay parting that have the same altitude. For example, the red line in the lower right corner of the map numbered 1175 connects points on the flint clay parting that are 1175 feet above sea level. Points on the flint clay southeast of this line are at a higher elevation than 1175, and points between the 1150 line and the 1175 line are between 1150 and 1175 feet above sea level. The flint clay and the Fire Clay coal at any point on the map slope toward the nearby line with the lower altitude. The closer the lines are spaced the steeper the slope of the clay and the coal, and the farther apart the lines the more gentle the slope. Mine-water problems may be expected in the low spots or basins shown on the flint clay.

From the information given by the topographic contours and the structure contours on the map it is possible to determine the overburden above the flint clay at any point where it is below the ground surface. To do this, subtract the altitude of the flint clay from the altitude of the ground. The point Y on the map in the west central part of the section 75H is on a structure contour line showing the flint clay at 1025 feet above sea level. The brown topographic contour at Y shows the land surface to be 1500 feet above sea level. The altitude of the structure contour, 1025 feet, subtracted from the altitude of the ground, 1500 feet, equals 475 feet, which is the approximate depth to the flint clay. Other similar calculations can be made.

Because the structure contour lines represent the geologists' picture of the folding of the rocks they have been drawn uninterruptedly across the valleys even where the valley has been eroded below the altitude shown by the structure contour. At such places the altitude of the coal is shown as higher than the altitude of the ground; this shows that the coal has been removed by erosion.

The thickness of the Fire Clay coal is shown on the map by green lines, and the thickness of the Whitesburg coal is shown by black lines. At every point along one of these lines the coal has the thickness in inches indicated by the number on the line. For example, at every point along the green line numbered 5 in the upper right corner of the map the Fire Clay coal is 5 inches thick. The next green line south of the 5-inch thickness line is the line of coal 10 inches thick. In the area between these two lines the Fire Clay coal is between 5 and 10 inches thick. The green line nearest the upper right corner of the map is labeled "0." North of this line the Fire Clay coal is absent in the Hyden quadrangle. The thickness lines are closely spaced when the change in thickness of the coal is rapid and are far apart when the change is slow. The accuracy of location of the thickness lines depends on the number of places the coal has been measured. These control points are shown on the map as black, numbered localities. Near these points the thickness lines may be considered accurate to within an inch of thickness. In the southwest portion of the quadrangle, where there are few points of known thickness, the error may be as great as 5 inches. Interpolation for points between the thickness lines is often satisfactory, but may lead to errors as great as the interval between lines, or 5 inches.

The thickness lines, like the structure contours, have been drawn uninterruptedly across the valleys.

## THE FIRE CLAY AND WHITESBURG COALS IN THE HYDEN QUADRANGLE, LESLIE, CLAY, AND PERRY COUNTIES, KENTUCKY

### INTRODUCTION

This preliminary report on the coal in the Hyden quadrangle, Kentucky, presents data on two of the principal commercial coals. The Fire Clay is the most valuable commercial coal in the quadrangle, and locally the Whitesburg bed is of minable thickness. Special emphasis has been placed on determining the thickness, extent, composition, and structure of these beds, and on obtaining an accurate estimate of the coal reserves.

The Hyden quadrangle, which covers an area of about 244 square miles in the southeastern part of Kentucky, occupies a large part of Leslie County, and small parts of Clay and Perry Counties. Hyden, the county seat of Leslie County, lies in the north central part of the quadrangle, and is 24 miles southwest of Hazard, Kentucky, and 31 miles north of Harlan, Kentucky.

The Hyden quadrangle lies in the Cumberland Plateau. This area is cut by many small streams occupying narrow, V-shaped valleys. Narrow flood plains that rarely exceed one-fourth mile in width are present along a few of the larger streams, and somewhat wider flood plains are present along the incised meandering course of the Middle Fork of the Kentucky River. The large number of streams, hill slopes of about 25°, and relief averaging 800 feet combine to form a rough terrain that is difficult of access.


We are indebted to W. R. Wood of the Louisville and Nashville Railroad for his suggestions and contributions, and to the local mine operators and engineers for their cooperation. P. T. Stafford served as geologic assistant in the field and Mary Beth McFarlan aided in the compilation of coal reserve data. A. F. Schneider and R. E. Shaffer served as assistants during the field season.

The cooperation of the University of Kentucky in furnishing office space and facilities for the preparation of this report is sincerely appreciated. We are indebted also to the staff of the Kentucky Geological Survey for many friendly courtesies that facilitated the field and office work.


### COAL GEOLOGY

About 1,000 feet of rocks of the Pottsville group of Pennsylvanian age is exposed in the Hyden quadrangle. The base of the Pottsville is below the lowest surface elevations and the top has not been recognized within the quadrangle. The rocks are mainly sandstone, but include lesser amounts of siltstone, shale, mudstone, and at least three persistent limestone beds. These limestone beds range in thickness from 1 inch to 36 inches, and at places grade laterally into fossiliferous limy shale. Nine coal beds are recognized in the quadrangle but only the Fire Clay and the Whitesburg beds are discussed in this report.

Fire Clay Coal. The Fire Clay coal, known locally as the No. 4 or Hyden coal, has been correlated with the Wallins Creek coal of Harlan County, the Bevins coal of Pike County, and the Dean coal of the Lower Cumberland Valley. 1/ These correlations are based on a flint clay parting, which is usually near the base of the coal. The Fire Clay coal is assigned to the Breathitt formation, which is approximately equivalent to the Lee, Hance, Mingo, Catron, Hignite, and Bryson formations of the Cumberland Gap field, and to the Norton, Gladeville, Wise, and Harlan formations in Virginia. 2/

The Fire Clay coal is banded with conspicuous bright bands of vitrain, and numerous thin bands of dull coal. Shaly partings other than the persistent flint clay appear at different horizons within the coal, and range in thickness from a knife edge to 28 inches. Marcasite is present in scattered flakes, in thin seams, and in discoidal nodules about 1 inch thick. Pyrite is found in a few places, and ironstone concretions are present in one outcrop. The coal appears blocky and unstained on the weathered exposures.

The variations in thickness of the Fire Clay coal are shown on the accompanying map by lines drawn through points of equal thickness of coal. The thickness figure given includes all the coal above the flint clay but excludes all partings. The thickest coal above the flint clay lies in three pockets in an east-west belt extending across the northern part of the quadrangle. The coal thins rapidly to the north; it has a 50-inch reduction within a mile in the north central part of the quadrangle. Thinning is more gradual to the southeast of the area of thickest coal.

At some places in the quadrangle the coal thins abruptly as much as 30 inches in a distance of 20 feet. These sudden thinnings of the coal, which are called "faults" or "pinchouts" by the miners, appear to be the result of stream scour during the deposition of the roof rock and not the result of structural movement. These scour channels occur at many places in the quadrangle but the data are not yet sufficient to prove their continuity, or to establish their pattern.

The Fire Clay coal derives its name from the parting of flint clay, which persists near the base of the coal. 3/ The distinctive lithology and singular occurrence in the stratigraphic sequence make the flint clay easy to trace and recognize. This clay is a tough, very finely crystalline vitreous rock averaging 4 inches in thickness. It is brittle and does not slake. The color ranges from light brown to black, depending on the amount of carbonaceous material that occurs as an impurity in addition to sand and silt. Although irregular areas of pure flint clay occur in the parting, the rock is a "flinty" claystone at most localities. Analyses and fusion tests on similar flint clays from the Allegheny formation in Maryland did not reveal any of commercial value. 4/ The presence of bedding in the clay, which may indicate erosion and redeposition, is of significance because commercial flint clays rarely display stratification. On the basis of thickness alone, the flint clay in the Hyden area is now of submarginal economic importance.

The coal beneath the flint clay parting averages 4 inches in thickness and reaches its greatest thickness of 22 inches in section 73G (see map ). Where the coal exceeds 10 inches in thickness beneath the flint clay, the coal overlying the clay does not approach a minable thickness. The coal beneath the flint clay is not being extracted in present mining procedure and is, therefore, excluded from the calculated reserve tonnage of the Fire Clay coal.

A bluish-gray clayey siltstone underlies the coal beneath the flint clay parting. It contains numerous plant remains, lacks bedding, and has a rather contorted appearance. Mica is plentiful in the very silty clays.

The rock overlying the Fire Clay coal is generally sandstone or siltstone. Transition from one rock type to another is rapid and cannot be predicted. The sandstone beds are generally medium bedded, but become thinner bedded with gradation to finer particle size.

Whitesburg Coal. The Whitesburg coal occurs 40 feet to 110 feet below the Fire Clay coal. Over a large part of the Hyden quadrangle the Whitesburg coal lies in a shaly zone between massive sandstone beds. The coal is characterized by many thin partings; sulfur, alum bloom, and iron stain further distinguish the bed. Generally, the Whitesburg coal consists of thin, interbedded coal and silty shale partings, which make it unfit for mining. Locally, near the mouth of Saltwell Branch of the Middle Fork, 42 inches of clean coal is mined from this bed.

The roof rock of the Whitesburg coal is made up of thin, interbedded coal, siltstone, and shale stringers, the upper limit of which is usually about 4 feet above the main body of coal, but may locally be as much as 18 feet above it. The presence of these stringers above the 42-inch coal on Saltwell Branch refutes the idea that union of the thin coal stringers produces the pocket of minable coal at this place.

High B. t. u. value, low ash content, and accessibility make mining of this coal possible in a rather small local area. The coal is 40 feet above the valley floor in the area of minable thickness.

### STRUCTURE

The structure contours shown on the map, which are drawn on top of the flint clay parting in the Fire Clay coal, reveal a gentle northeast dip of about 15 feet per mile, which is locally disturbed by gentle flexures having random trends. The subdued structure suggests that depositional phenomena may have been the principal factors controlling the form of the structural features. The structural trends do not appear to be related to the Cumberland overthrust block to the southeast of the quadrangle. (See index map.)

### COAL ANALYSES

Analyses of coal samples that were taken by the standard method prescribed by the U. S. Bureau of Mines show the Fire Clay and Whitesburg coals to be of high volatile A bituminous rank. Both beds have a uniform composition over most of the area, but slight changes in percentage occur sporadically. Ash averages 5 per cent and sulfur about 0.97 per cent. Some indication of the coking quality of the samples may be noted from the free swelling index, which usually increases with the coking quality. (See table of analyses.)

### COAL UTILIZATION

Coal is being mined at about 50 places in the Hyden quadrangle. Room and pillar mining is employed in all operations, and advance work comprises 95 per cent of the present effort. Explosives used vary widely from black powder through the Permissibles to Cardox. Undercutting is practiced in most of the operations, but only 10 mines have mechanical loading equipment.

The roof conditions above both the Fire Clay and Whitesburg beds vary from place to place because of rapid transitions from siltstone to sandstone. Siltstone serves as a fair roof, but occasionally roof coal or shale stringers in the siltstone may necessitate drawing as much as 18 inches of rock. Unlike the soft plastic siltstone that forms the floor of the Whitesburg coal, the Fire Clay coal has an excellent floor of hard, smooth flint clay.

Water supply for coal washing is needed. Dirty coal has already caused several operators in this area to curtail production. Only three streams in the quadrangle — the Middle Fork, Greasy Creek, and Cutshin Creek — have a continuous flow. Stream-gaging data on the Middle Fork near Tallega, Lee County, which is about 45 miles below Hyden, show the mean discharge to be 614 cubic feet per second for the 1944-45 water year. The minimum discharge for this period was 4.8 cubic feet per second. 5/

Transportation difficulties impede development of the coal resources of the Hyden quadrangle. The absence of rail service in the quadrangle necessitates trucking to railroad shipping points at Combs and Manchester, Kentucky, which are respectively 15 and 30 miles away from the mining centers. State highway 80, an all-weather road, adequately serves the present traffic but heavy loads may create expensive maintenance problems. Trucking costs are at present large enough to place coal operators in the Hyden quadrangle in a poorer competitive position than those in more favorably located areas.

### COAL RESERVES

In calculating reserves of the Fire Clay and Whitesburg coals, lines were drawn on the map through all points where the coal beds are 14 inches, 28 inches, and 42 inches thick. These lines establish boundaries within which the coals are 14 to 28 inches, 28 to 42 inches, and more than 42 inches thick, conforming to categories of thickness recommended by the National Bituminous Coal Advisory Council for reporting coal reserves.

In addition to the three thickness categories, three additional categories based on the reliability of the information available for making reserve estimates were established as follows: Measured coal is defined as coal lying within 1/2 mile of the mapped outcrop. Indicated coal is coal extending 1 mile beyond the area thus assumed for Measured coal. The remaining coal in the quadrangle, all lying 1½ miles or more from the outcrop, is conservatively classed as Inferred, though geologic evidence is conclusive that the Fire Clay coal has wide distribution in the quadrangle.

The tonnage of coal in such category was determined by making planimeter measurements of the areas delineated on the map and multiplying the values obtained by the average thickness of the coal in the areas. The coal was assumed to weigh 1,800 tons per acre foot.

In order to present the reserve data in usable units, the Hyden quadrangle was divided into nine 5-minute rectangles according to the grid system introduced in Kentucky by the Carter Oil Company, and now widely known as the Carter grid. The nine small rectangles into which the Hyden quadrangle was divided are shown on the accompanying index map. The results of the calculations for each of the several categories of reserves in the nine rectangles are shown on the accompanying table. The lowest and highest sulfur content in samples from each rectangle is also shown in the table.

The total estimated original reserves in the Fire Clay coal bed above the flint clay parting are 354,659,000 short tons. Deducting the total production from the bed of 5,992,000 tons to October 1, 1949, and an equal amount of coal that can be assumed to have been lost in mining, or left in pillars, the remaining reserves in the Fire Clay bed on October 1, 1949, totaled 342,675,000 tons, of which at least half may be said to be ultimately recoverable. The total past production may be considered to have come from areas where the Fire Clay bed is more than 42 inches thick. An additional proved reserve of 2,155,000 tons of coal in a bench 14 to 22 inches thick lies below the flint clay parting.

The total estimated original reserves in the Whitesburg coal bed are 39,526,000 tons. Production from this bed to October 1, 1949, is believed to have been about 5,000 tons. Deducting this production and an equal amount for past losses, the remaining reserves in the Whitesburg bed on October 1, 1949, totaled 39,516,000 tons, of which half may be said to be ultimately recoverable.

### CONCLUSIONS

The Fire Clay coal is the only bed mined extensively in the Hyden quadrangle. Large-scale production began in 1943, and most of the total recorded production of 5,992,000 tons has been mined since that date. The Fire Clay coal, which is of high volatile A bituminous rank, has a high heat value, a relatively low ash content, and a moderate sulfur content. It is, therefore, useful for a wide variety of purposes. The full development of the bed is hampered at present by inadequate transportation facilities and water supply.

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by
J. E. Johnston and W. A. Heck


1950

COAL INVESTIGATIONS
MAP C 5


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