

Character and Extent of Land Stripped for Coal in Kentucky

by

Robert W. Merz



Kentucky Agricultural Experiment Station
University of Kentucky
Lexington

In cooperation with the Central States Forest Experiment Station,
Forest Service, U. S. Department of Agriculture



Natural stand of sweet gum, sycamore, and red cedar on land stripped for coal in western Kentucky. (Dempster Coal Co., vicinity of Luzerne, Muhlenberg county.)

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COAL MINING by the open-pit method in Kentucky began prior to World War I. The increased demand for coal during World War II greatly expanded the industry, and in the postwar period open-pit mines have increased still further in number and in size.

In 1947 and early 1948 a preliminary survey was made of the lands stripped for coal in Kentucky to determine their extent, physical characteristics, types of vegetation, and reclamation possibilities. This survey, which was a part of a similar survey made throughout the central states, showed that more than 7,200 acres of land had been stripped for coal in Kentucky. Operations since 1942 account for more than 70 percent of this area (Table 1).

The initial cut in a stripping operation on a slope usually removes a relatively large proportion of soil and weathered parent material. As succeeding cuts are made the overburden thickens and is composed of increasing proportions of massive stone and other unweathered material. At the time of reconnaissance much of the stripping in Kentucky was in the initial stage, often consisting of a single cut along the slope. On steep slopes, such as those of common occurrence in the mountainous region in eastern Kentucky, stripping is often restricted to this initial cut and is often made to facilitate underground operations. Elsewhere in the state, however, several successive cuts are usually feasible. The condition of strip-mined lands as described in this report may not, therefore, be typical of many spoils created by present and future operations that extend more than three successive cuts into the slopes.

¹ Forester, Buckeye Branch, Central States Forest Experiment Station, Athens, Ohio. The author acknowledges the aid of A. G. Chapman and G. A. Limstrom of the Division of Forest Management Research in the preparation of this publication, and the cooperation extended by the Kentucky Agricultural Experiment Station, the Division of Forestry of the Kentucky Department of Conservation, the Kentucky Reclamation Association, the West Kentucky Coal Company, and the coal-mine operators who permitted access to their operations and, in many cases, supplied maps of the stripped areas.

Table 1.—Area of strip-mined land in Kentucky, by county and age of spoil banks, 1947

County	1-5 years	6-10 years	11-15 years	16-20 years	21-25 years	26-30 years	Total
	(Acres)						
Boyd	707	0	0	0	0	0	707
Christian	0	0	79	0	0	0	79
Hancock	99	0	0	0	0	0	99
Hopkins	2,261	740	116	161	298	197	3,773
Laurel	65	148	0	0	0	0	213
Letcher	199	0	0	0	0	0	199
McLean	0	0	0	0	16	0	16
Muhlenberg	565	0	45	135	0	0	745
Ohio	329	0	0	0	0	0	329
Perry	217	0	0	0	0	0	217
Pike	171	0	0	0	0	0	171
Webster	90	295	0	0	0	0	385
Whitley	334	0	0	0	0	0	334
Total	5,037	1,183	240	296	314	197	7,287
Percent	70	16	3	4	4	3	100

SURVEY METHODS

An extensive type of survey was used to determine the extent and character of the spoil banks. A map of each mined area was made by using aerial photographs, coal company maps, and United States Geological Survey topographic quadrangles as a basis.

Each stripped area was examined and a record made of the following conditions: (1) location, age of spoil banks, mining method used, coal seam removed, and ownership of the land; (2) physical composition of the spoil, including character of the rocks, stability, and the ratio of soil-sized materials to stone; (3) determination of the acidity of the spoils by sampling the range of conditions found; and (4) character and relative stocking of the vegetation by species.

In addition, a representative cross-section of the strata removed in the mining operation was examined for the coal seams mined in each county. A record was made of the stratigraphy as it was found in the last cut of a typical operation.

Samples of forms used in the survey are given in the Appendix.

CLASSIFICATION OF STRIP-MINED LANDS IN KENTUCKY

There are several bases for classifying (Limstrom, 1948)² spoil banks, such as age, texture, acidity, percent vegetated, and the manner

² See "Literature Cited," page 24.

in which spoils are piled. A classification based on acidity is especially pertinent from the reclamation viewpoint because this factor often limits the successful establishment of vegetation. Spoils are here classified into five groups based on the proportion of the spoil surface in the various acidity³ classes.

1. *Toxic*. Banks having more than 75 percent of the surface area with a pH less than 4.0.
2. *Marginal*. Banks having 50 to 75 percent of the surface area with a pH less than 4.0.
3. *Acid*. Banks having more than 50 percent of the surface area with a pH ranging from 4.0 to 6.9.
4. *Calcareous*. Banks having more than 50 percent of the surface area with a pH of 7.0 or more.
5. *Mixed*. Banks in this class have patches with widely varying acidity but less than 50 percent of the area of the mixed banks is toxic, less than 51 percent acid, and less than 51 percent calcareous.

According to the foregoing classification the area of spoil banks so far developed in Kentucky falls into three classes: slightly less than 16 percent is in the marginal group, 84 percent is in the acid group, and a fraction of one percent in the calcareous group. More than 99 percent of the area of spoils in the state is silty shales and loams. Sandy and clayey spoils account for less than one percent of the total area stripped (Table 2).

Table 2.—Area of strip-mined land by acidity and texture classes, 1947

Acidity class	Sands		Loams and silty shales		Clay		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
<i>Toxic</i> . More than 75% of area with pH less than 4.0 ..	0	0.0	0	0.0	0	0.0	0	0.0
<i>Marginal</i> . 50-75% toxic. Less than 51% with pH 4.0-6.9, and less than 51% with pH 7.0+	0	.0	1,154	15.9	0	.0	1,154	15.9
<i>Acid</i> . More than 50% with pH of 4.0-6.9	22	.3	6,052	83.3	23	.3	6,097	83.9
<i>Calcareous</i> . More than 50% with pH of 7.0 or higher ...	0	.0	16	.2	0	.0	16	.2
<i>Mixed</i> . Approximately the same proportion of toxic, acid, and calcareous areas ..	0	.0	0	.0	0	.0	0	.0
Total	22	0.3	7,222	99.4	23	0.3	7,267	100.0

³ Acidity is usually expressed by the term "pH" and is readily determined by several field and laboratory methods. A pH of 7.0 is neutral, more than 7.0 is alkaline or basic, and less than 7.0 is acid.

A large part of the stripped area of Kentucky is restocking naturally to trees. Approximately 20 percent of the area of spoils more than 5 years old was, at the time of the survey, adequately reforested through natural seeding (see frontispiece). A considerably larger percentage was partially stocked, and many areas need only supplemental plantings to make the stocking satisfactory. The following species were found growing naturally on the spoil banks of Kentucky:

- | | |
|----------------------------|-----------------------------|
| 1. Sweet gum | 9. White oak |
| 2. Sycamore | 10. Chestnut oak |
| 3. Cottonwood | 11. Red cedar |
| 4. Yellow poplar | 12. River birch |
| 5. Elm (native species) | 13. Cherry (native species) |
| 6. Maple (hard and soft) | 14. Sassafras |
| 7. Willow (native species) | 15. Persimmon |
| 8. Ash (native species) | 16. Black locust |

Although some of these species are of little or no commercial value, they are important in providing cover, reducing erosion, and improving the site for more valuable species. They also serve as indicators of the plantability of stripped areas.

More than 10 percent of the area examined had a good cover of native weeds, grasses, and legumes, which help to stabilize the bank surfaces. Many of the plants, especially the legumes, improve the fertility of these areas through nitrogen fixation. A limited acreage of strip-mined land is suitable for grazing, but no extensive forage use was observed in the state. Herbaceous species most commonly observed on spoil banks were as follows:

- | | | |
|---------------------|--------------------|---------------|
| 1. Native grasses | 8. Smartweed | 15. Pigweed |
| 2. Ragweed | 9. Thistle | 16. Primrose |
| 3. Broomsedge | 10. Spanish-needle | 17. Mullen |
| 4. Sweetclover | 11. Wild lettuce | 18. Cocklebur |
| 5. Lespedeza | 12. Cattail | 19. Aster |
| 6. Goldenrod | 13. Trumpetvine | 20. Dock |
| 7. Common pokeberry | 14. Partridge-pea | |

Some shrub species occur on most areas having herbaceous or tree cover, but only a small acreage is fully occupied by them. Sumac, blackberry, dewberry, and green briar are the most common.

At the time of the survey about 80 percent of the mined area was barren or inadequately stocked with herb, shrub, or tree cover. This is not, however, indicative of the potentialities of the spoils, since most of the stripping has occurred in the last 5 years and insufficient time has elapsed to permit full stocking by natural seeding. Excluding the area stripped in the last 5 years, 46 percent of the mined area was well-stocked with some type of vegetation (Figs. 1 and 2).

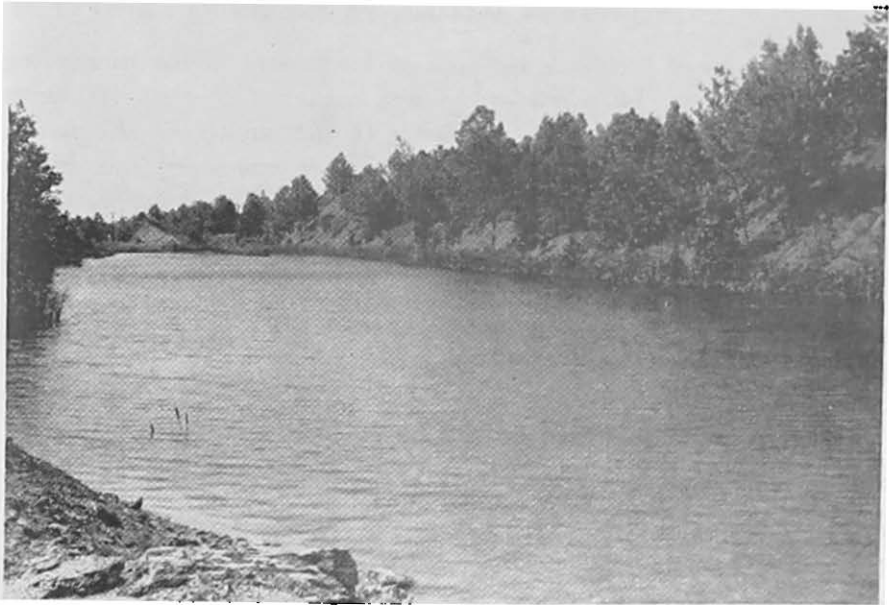


Fig. 1.— Water impounded in final cut of strip mine together with natural stand of mixed hardwoods offers good opportunity for recreational development. (No. 9 coal seam near Homestead Mine, St. Charles, Hopkins county.)



Fig. 2.— Vegetation on area stripped for coal during last 10 years. Dark cover visible in center of the photo is volunteer lespedeza. Tree reproduction can be noted throughout the area. (No. 14 coal, Sentry Mining Co., near Madisonville)

FOREST PLANTING PROGRESS

Planting forest trees on strip-mined lands was in the pioneering stage in Kentucky when the survey was made. Less than 100 acres had been planted, and only a quarter of this area was adequately stocked. Planting on stripped lands has been voluntary, but during the past year it has been stimulated by the formation of the Kentucky Reclamation Association, an organization of coal-mine operators in the western part of the state. This association has a man in the field who makes planting surveys, orders planting stock, and supervises the planting crews. Each member pays the cost of the planting done on his land. As in other states, such programs are limited by the amount of planting stock that can be obtained at a reasonable cost. The state nursery facilities are being expanded to permit larger planting programs.

High-quality planting stock is especially desirable for spoil-bank planting. Only under very favorable conditions can success be attained with stock of poor quality. Spoil banks, especially when newly formed and without vegetation, are difficult planting sites because of the wide range in acidity, low percentage of soil-sized material, high surface temperatures, rapid evaporation, and the movement of surface material by water and wind (Chapman, 1947). The combination of all these factors makes survival difficult.

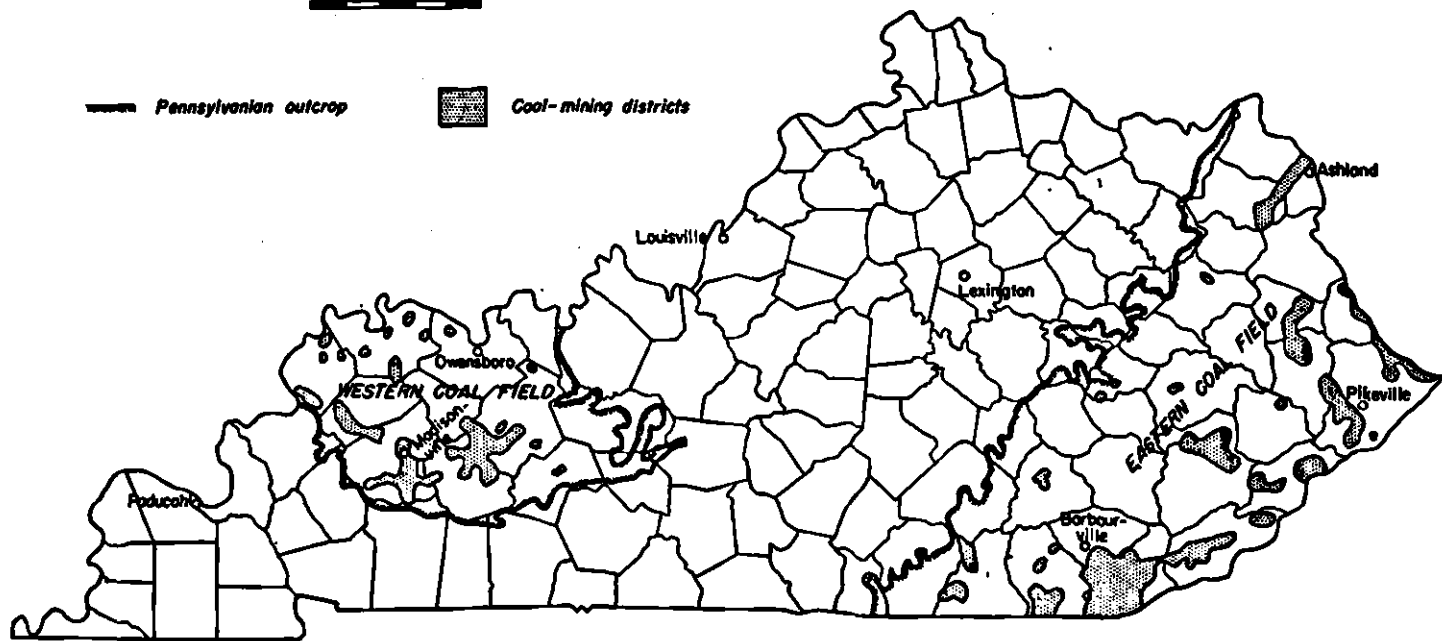
THE COAL FIELDS OF KENTUCKY

The commercial coal fields of Kentucky are usually referred to as the Eastern and Western Fields. They are separated by the Bluegrass, Knobs, and Pennyroyal regions in the central part of the state. Fig. 3 shows the general boundaries of both fields and the important coal districts in each. A report on these fields follows, with special reference to the strip-mining activity in each as observed during the survey.

Eastern Coal Field

The Eastern Coal Field constitutes all or parts of 37 counties and is part of the much larger Appalachian Coal Field. According to McFarlan (1943) it "occupies the eastern flank of the Cincinnati arch and the section from the Pine Mountain thrust fault eastward. . . . The region is maturely dissected, with thus a minimum of flat upland or bottom land." Elevations range from 1,000 to 4,150 feet and the relief is generally from 500 to more than 2,000 feet. The region is

SCALE - STATUTE MILES



LAND STRIPPED FOR COAL IN KENTUCKY

Fig. 3.— Kentucky coal fields, showing mining districts and the outcrops of the Pennsylvanian (coal-bearing) formation. (From "Geology of Kentucky" by Arthur C. McFarlen.)

drained by the Big Sandy, Licking, Kentucky, and Cumberland rivers, none of which is navigable except parts of the Big Sandy. Valleys provide routes for railroads and highways which serve the coal field, and these major drainages form a natural basis for subdividing the field into coal-mining areas (Fig. 4). Within each area are located one or more coal-mining districts.

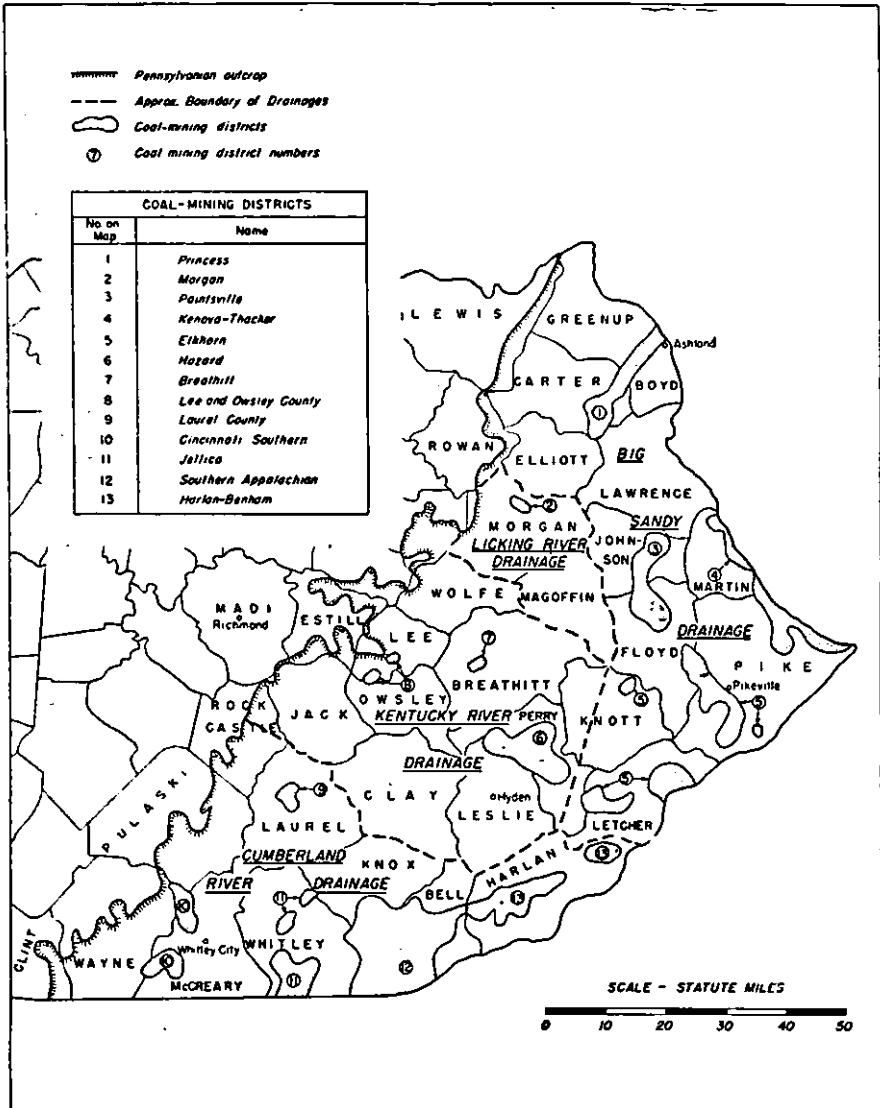


Fig. 4.— The Eastern Coal Field of Kentucky

Big Sandy drainage

At the time of this survey, the largest acreage of stripped lands in the Eastern Coal Field was in this area. Activity was centered in Boyd county near the city of Ashland, where a total mined area of 707 acres was mapped. The terrain of this vicinity is hilly, and most of the stripping follows the contours for the No. 7 and No. 8 coal seams. The overburden displaced in mining the coal is mainly sandstone and silty shales. This material weathers into a stony, sandy loam with an acid reaction, the pH varying from 4.0 to 6.5.

Except for some of the No. 8 coal strippings, all the spoils are suitable for planting to the native pines and many hardwoods. Early planting of some areas stripped for the No. 8 coal is questionable because they are composed of a relatively large amount of toxic material. No attempt should be made to reclaim them with vegetation covers until the toxic conditions are considerably modified by leaching and weathering.

Licking river drainage

No strip-mining activity was observed in this area. However, at the time of survey, a small operation was planned in Morgan county northeast of West Liberty. No extensive operations are expected to develop in this field in the near future.

Kentucky river drainage

Only one strip mine of any consequence was found in this area, but it is likely that several will develop soon because of the relatively high development of underground mining in this locality and the large amount of outcrop coal not obtainable by deep methods. As in all parts of eastern Kentucky, topography is the important limiting factor in operating strip mines.

The stripping observed was on the No. 9 coal seam, which until now has not been an important source of coal. The operation consisted of a cut approximately 50 feet wide that followed a contour for more than 15 miles. The spoils were mostly leveled for use as haul roads and as roadbeds for track over which to haul underground-mined coal in the same area (Fig. 5). The spoil was very acid; 20 percent of the area had a pH of less than 4.0. The weathered spoils form soils of a sandy to a silt loam texture. No reclamation can be undertaken in this area until all mining has been completed, because the future use of the spoil banks by underground mining operations cannot be predicted.

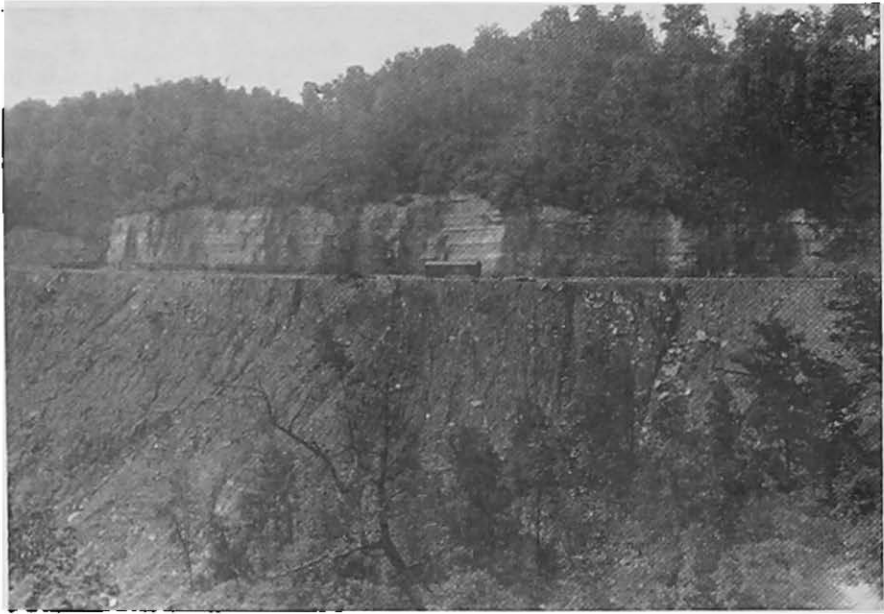


Fig. 5.— Open-cut coal mine in southeastern Kentucky. Much of the overburden is dispersed down the sides of the steep slope below the cut. When the slope becomes stabilized, much of the area may restock itself by seeding from the adjoining woods. No further stripping is likely here, but the seam will be further mined by underground methods. (Fourseam Coal Co., Perry county.)

Cumberland river drainage

Open-cut coal mining in this drainage was found only in Whitley and Laurel counties. Most of the strippings in Whitley county were less than 5 years old, and those in Laurel county were up to 10 years old. In both counties the strippings are small and scattered; only one large operation was found in the district, and that was located on the Kentucky-Tennessee line near Jellico.

The coal in Whitley county is referred to locally as River Coal, River Gem, and Swamp Angel. The overburden is seldom more than 12 feet deep and consists of soil and subsoil to a depth of 2 to 4 feet, under which is a bed of shale varying from 4 to 10 feet in thickness. This shale is multicolored; tans and greys predominate and grade to black directly above the coal. The shale is often pyritic, fissile, and silty in composition. The resulting spoils are acid, and in some instances as much as 30 percent of the area is toxic. The acidity is mostly due to oxidation of the pyrites found associated with the shale and wasted coal.

Forest plantings on the spoils in Whitley county should be confined to species adapted to poor sites and tolerant of high acidity. Savings in planting costs can be made by avoiding the toxic areas. The small acreage of stripping in Whitley county, 334 acres at time of survey, is relatively unimportant when compared to the area of nonproductive, undisturbed land.

The area stripped in Laurel county was about 225 acres. Although the spoils in this county are all acid, the area of toxic spoils is smaller than in Whitley county. Most of the stripping was for one coal seam and was largely confined to stream bottoms. Only two active operations were observed, but it is possible that strip-mining activity will increase under good economic conditions. The strippings in the vicinity of East Bernstad consisted of small scattered operations, and no single area covered more than 6 acres. The spoils consist mainly of silty clay shales with little or no massive, hard rock. Planting should be postponed until after the banks have weathered 1 or 2 years. Growing conditions are generally favorable; the pH ranges from 4.0 to 7.0, and toxic areas occupy less than 10 percent of the total.

Reclamation problems in the Eastern Coal Field

Open-pit mining in eastern Kentucky is still on a relatively small scale. For decades, small openings have been made along outcrops but only during the last five years has any appreciable acreage been worked in any one place. The larger operations usually serve as a starting point for underground mining.

Except in the northern and southwestern parts of the field, the mining operations have been more destructive than elsewhere in the state because of the sliding of spoil material down the steep slopes. Vegetational cover immediately below the cut is usually threatened; in some cases streams that drain the area are also affected (Fig. 6).

Most of the stripped land in the wooded, mountainous section of the coal field has a good chance to restock by seeding from adjoining timber stands. However, the highly unstable condition of the material on some steep slopes can easily retard natural regeneration. On such spoils, planting black locust at a close spacing (6- by 6-feet) will hasten stabilization. In addition to its effectiveness in controlling erosion, black locust develops a good ground cover and serves as a nurse crop for trees of greater economic importance.

As long as there is a good market for outcrop coal, strip mining is likely to increase in this field. Several operations have started since

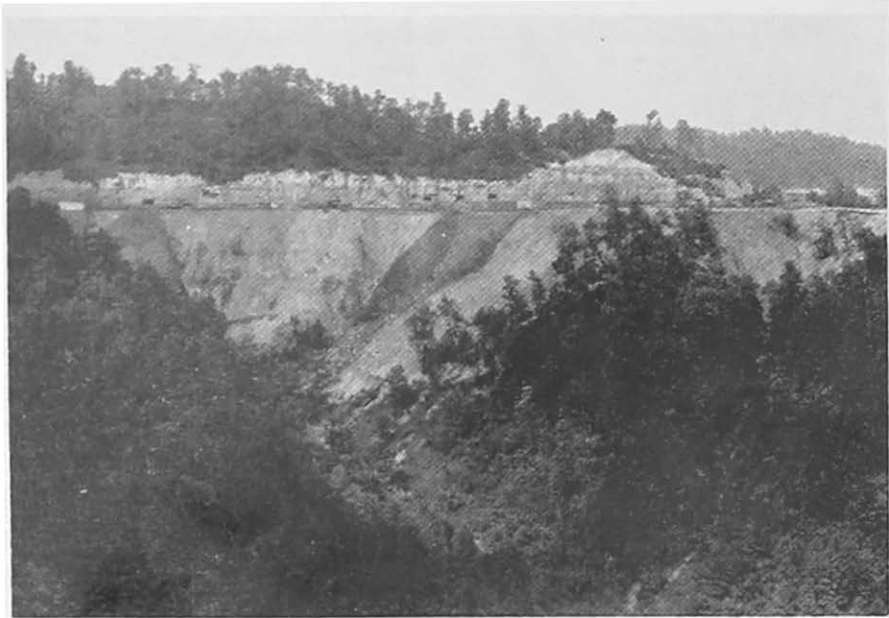


Fig. 6.—Sliding spoil material on steep slopes frequently destroys more forest cover than was destroyed on the area actually stripped. The cut serves as a base for the operation of drift mines into the hillside. (Fourseam Coal Co., Perry county.)

the field survey was completed. Because several coal seams outcrop on the hillsides throughout this field, a potentially large tonnage of coal is recoverable by open-pit mining.

Western Coal Field

There are about 12 counties in the Western Kentucky Coal Field, only 5 of which are important coal producers. The region is hilly, but does not have as much relief as the eastern field. All strip mines are accessible by road and rail, and large scale operations have developed. Geologically, the area is a maturely dissected plateau with rolling hills; valleys are generally of moderate width. The Green and Trade-water rivers and their tributaries have, however, carved out wide valleys through the shale deposits in the area. The field is thus subdivided by location of coal formations rather than by degree of accessibility, as is the case in the Eastern Field (Fig. 7).

Caseyville formation

Little commercial coal has been produced from this formation of the Pennsylvania system (McFarlan, 1943), none by stripping.

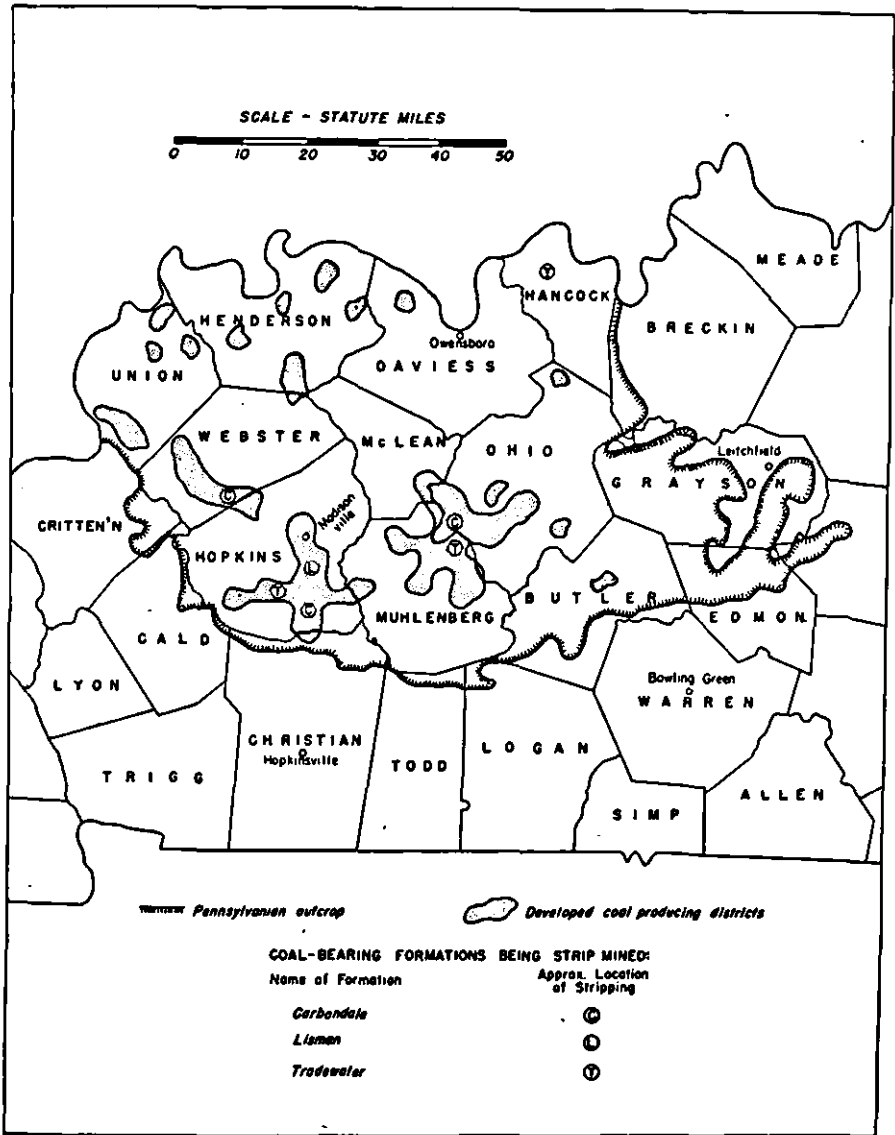


Fig. 7.— The Western Coal Field of Kentucky

Tradewater formation

One strip mine was observed in the Lewisport seam of this formation. This has been referred to in some reports as the No. 7 seam but is now generally believed to lie below the No. 7 stratigraphically

(McFarlan, 1943). At the time of the survey one active operation had stripped approximately 100 acres in the vicinity of Lewisport.

As in all hilly country, the overburden varies considerably in thickness, the average depth being about 30 feet. The spoil banks, composed mainly of soil, subsoil, sandstone, and shale, are toxic to calcareous; 85 percent of the spoils area is in the pH range of 4.0 to 5.5.

The spoils derived from strata over the Lewisport seam weather rather rapidly into a silt loam. They are at first loose and should settle at least 1 year before planting.

The most important coal seam mined by the open-cut method in the Tradewater formation is the No. 6. This seam also has been referred to as the Mannington or Empire seam. A recent opening in Hopkins county revealed a mixed sandy and clayey overburden consisting of 1 foot of sandy loam soil, 2 to 4 feet of mottled, sandy-clay subsoil, and 6 to 10 feet of sandy shale that in places grades to sandstone. Below this is a bed of hard, massive, steel-grey, silty shale that is sometimes absent in the shallower cuts (Fig. 8). Another opening several miles distant showed essentially the same overburden except that there was no sandstone.

The 833 acres of No. 6 coal spoil banks in the Western Coal Field represent more than 10 percent of the spoils area of the state and in general offer relatively uniform reclamation conditions. About 45 percent of the surface material is in soil-sized particles (2 mm or less). This is adequate for plant establishment. The soft sandstone and silty shales weather into soils of a sandy or silty loam texture. In general, the No. 6 coal spoils are 10 percent toxic, 50 percent with a pH range of 4.0 to 5.5, 25 percent with a range of 5.6 to 6.9, and 15 percent with pH 7.0 or higher.

Some of the No. 6 spoils are more than 5 years old and support a wide variety of vegetation. Sweet gum, sycamore, and red cedar, as well as a few planted shortleaf and pitch pines, are growing well on these banks. It appears unlikely that further exploiting of this seam will reveal a larger proportion of toxic strata. All native tree species of moderate acid tolerance and adapted to lighter soils can be planted on these areas.

Carbondale formation

This is the important coal-producing formation in western Kentucky. Several seams are mined both by stripping and underground methods. The No. 9 and No. 11 seams supply the bulk of the coal.

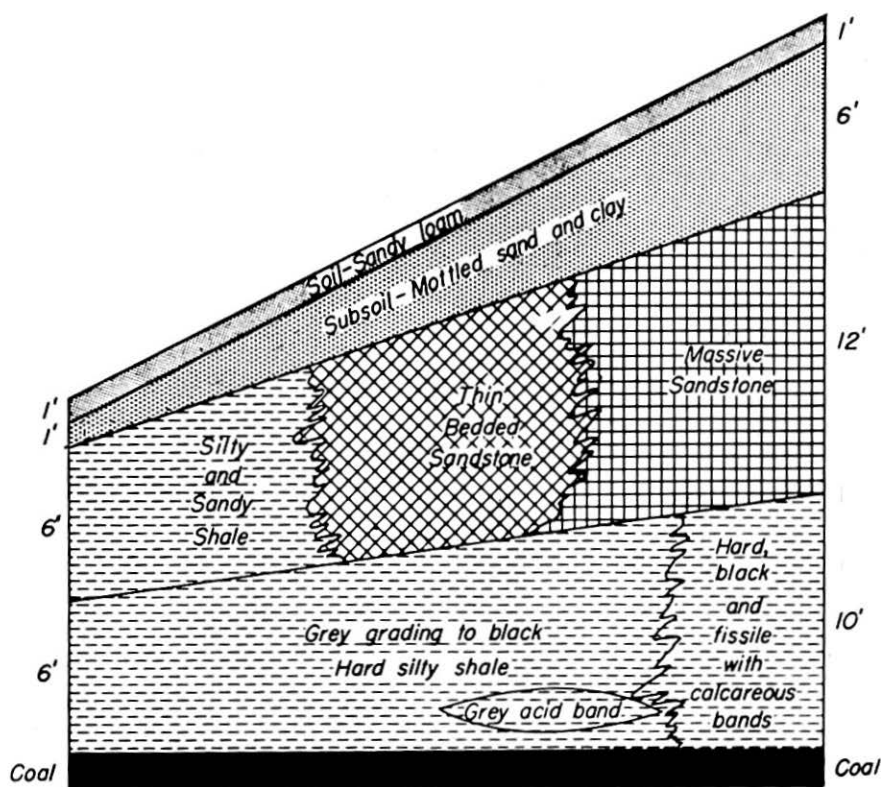


Fig. 8.— Variations in stratigraphy over the No. 6 coal seam in the Western Coal Field of Kentucky.

The No. 9 coal seam has been mined by stripping in Hopkins, McLean, Muhlenberg, Ohio, and Webster counties. A typical 30-foot overburden observed on the No. 9 coal consisted of less than 1 foot of soil, 1 to 6 feet of mottled, nodular clay subsoil, 6 to 12 feet of either silty or sandy shale replaced in some localities by thin- and thick-bedded sandstone, below which is 6 to 10 feet of hard, silty shale that grades from dark grey to black directly over the coal (Fig. 9). In one area in Webster County there was a band of grey, acid shale about 2 feet above the coal. At one mine in Hopkins county this lower bed of shale was black throughout, fissile in spots, and calcareous in certain bands.

The spoil banks of the No. 9 coal present a variety of conditions that affect plant growth. The proportion of soil-sized material in the spoils varied from 30 percent to 75 percent, with most samples

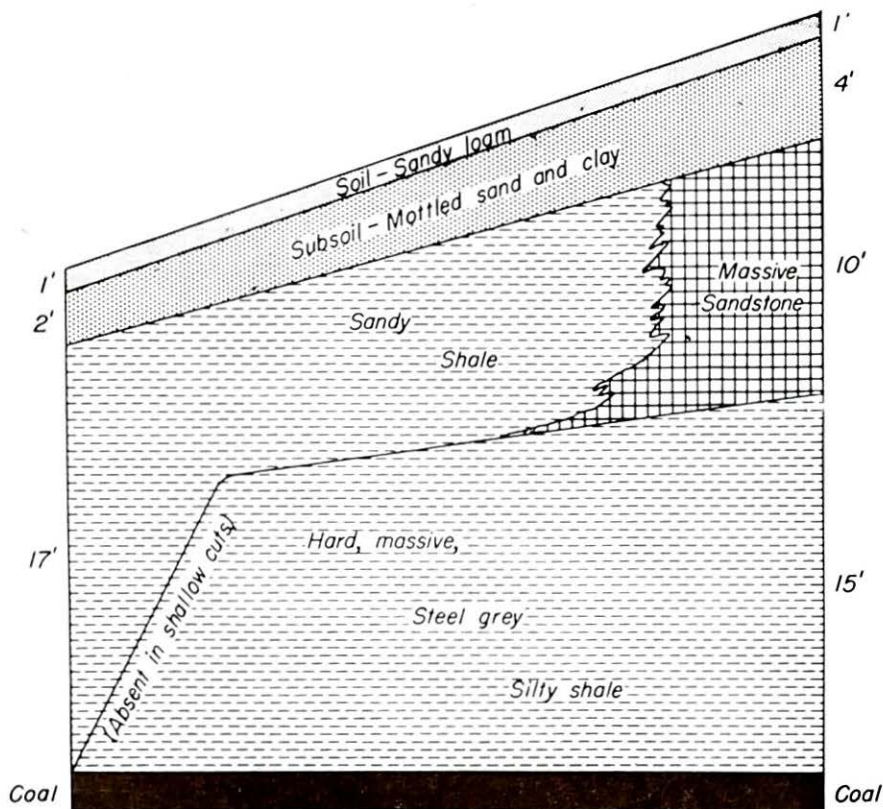


Fig. 9.— Variations in stratigraphy over the No. 9 coal seam in the Western Coal Field of Kentucky.

having about 45 percent. This is adequate for most tree species. On most areas 75 percent or more of the spoil surface was in the 4.0 to 5.5 pH range. The texture is generally a sandy or silty loam. At the time of the survey the area of No. 9 spoils in the state totalled 2,038 acres, which accounted for nearly 30 percent of the total stripped acreage in the state.

Acidity is about the only limiting factor in reclaiming the No. 9 spoils by forestation. Generally, the toxic spots can be avoided and a 75 percent tree cover still attained. These spoils are best suited to conifers and the less exacting hardwoods, such as cottonwood, and sycamore.

The No. 11 and No. 12 coal seams are only a few feet apart and are usually mined together in open-cut mining operations (Fig. 10). The No. 12 is often of low quality and, since it occurs above the No.



Fig. 10.— Typical high-wall for the No. 11 and No. 12 coal as observed in the Western Coal Field in Hopkins county. The two coal seams are separated by a bed of limestone and clay. The height of wall is about 40 feet. (Homestead Mining Co., near St. Charles, Hopkins county.)

No. 11 stratigraphically, is sometimes discarded and left on the spoil banks. This is an important factor in affecting the plantability of the banks resulting from the mining of these coals. Even where the No. 12 is utilized, some low-quality and otherwise nonrecoverable coal appears on the spoils.

The combined acreage of the No. 11 and No. 12 spoils comprises about 20 percent of the stripped land in the state. Under certain conditions, where the No. 12 coal is fully utilized, the banks make good sites for forest trees; but other strippings of these seams have limitations due to toxic materials present on the spoil surface.

The following composite cross-section of the overburden removed in mining these seams at three locations indicates the composition of the resulting spoil banks. The topsoil varies in thickness from 8 inches to 1 foot and is usually a grey-brown silt loam. The subsoil ranges from a reddish-brown sandy loam to silt loam in texture, varying in thickness from 1 to 4 feet. Beneath the subsoil is either a tan to multi-colored, thin-bedded sandy shale or a bed of creamy-tan, massive sandstone 3 to 12 feet thick. The sandy strata are underlain by a bed of silty shale varying in color from dark grey to black and interspersed

with thin lenses of reddish limestone. The No. 12 coal is usually found below the silty shale bed, but occasionally a thin bed of sandstone occurs between it and the coal. The No. 12 coal varies in thickness from 3 to 6 feet. Below it is a grey underclay about 1 foot thick. This is usually extremely acid. Below the underclay and directly over the No. 11 coal is a bed of limestone from 1 to 4 feet thick (Fig. 11).

All of these strata except the limestone are rather strongly acid. When deposited heterogeneously in the spoil banks, they present conditions that make difficult the spoils classification by texture and acidity. Throughout the mass limestone, sandstone, sandy soils and

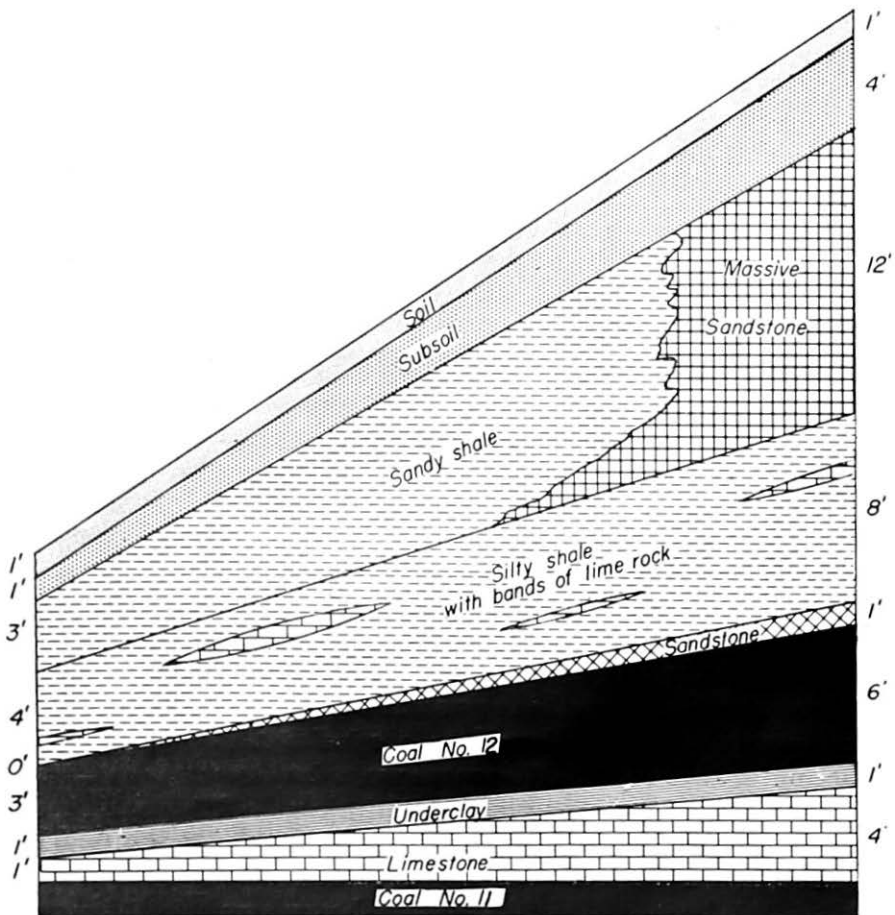


Fig. 11.— Variations in stratigraphy over the No. 11 and No. 12 coal seams in the Western Coal Field of Kentucky.

shales, silty shales, clays, and often wasted coal are found. At least 15 percent of the surface area of these spoils is toxic, about 60 percent has pH ranging from 4.0 to 5.5, about 20 percent from 5.6 to 6.9, and the remaining 5 percent 7.0 and higher. One stripping was observed, however, on which 50 percent of the surface was toxic; another was 25 percent calcareous. On the average, 40 percent of the spoils surface was made up of soil-sized particles. These spoils are adapted to forest plantings, but toxic conditions will limit plantation success in certain areas.

Lisman formation

The Lisman formation is usually considered unimportant in western Kentucky because the coal seams are too thin to work commercially. In places, however, No. 13 and No. 14 coal seams range from 4 to 7 feet in thickness. Both of these seams are sometimes called the Baker seam.

The No. 14 coal, as the Baker seam is designated in this paper, was observed only in Hopkins county. As far as can be determined it is not extensive and has never been mined by the open-pit method in any other location. This stripping is the largest single stripped area in the state. A cross-section of the strata removed in the mining operation (Fig. 12) showed a chocolate to grey-brown, silt-loam topsoil 1 foot thick, and 1 to 2 feet of sandy, reddish-tan subsoil. Below the subsoil is a 2-foot bed of sandy, nodular shale, light in color but containing black streaks. This is underlain by 6 to 8 feet of olive-tan silty shale, and 3 to 4 feet of a dark-colored limestone. A 1-foot parting of silty carbonaceous shale occurs in the lower portion of this limestone bed. Below the limestone is a bed of grey to black silty shale, 8 to 10 feet thick, which is underlain by 2 to 6 feet of massive steel-grey sandstone. Between this sandstone and the No. 14 coal is a layer of dark-grey, silty shale of varying thickness. Some of the shales in the above strata are very acid and cause the toxic conditions that occur on about 25 percent of the area. About 65 percent of the stripped area has a pH between 4.0 and 5.5, and 10 percent between 5.6 and 6.9. Except for the toxic areas these spoils offer good reclamation possibilities. In general 40 percent of the spoils surface was made up of soil-sized particles, and the volume of rock is seldom sufficient to prevent successful planting.

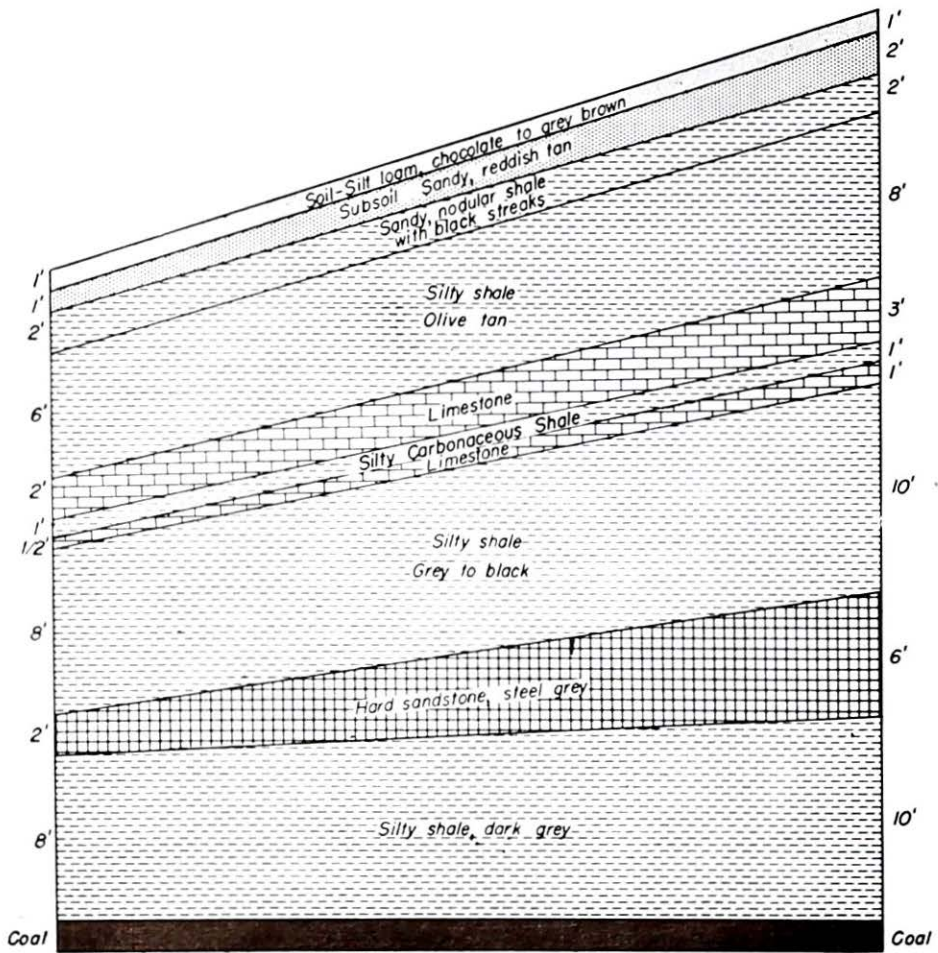


Fig. 12.— Variations in stratigraphy over the No. 14 coal seam in Hopkins county Kentucky.

Reclamation problems in the Western Coal Field

Open-pit mining in the Western Coal Field began during World War I. No appreciable acreage was involved, however, until about 1940 when some of the present active operations began. The number and size of the operations have rapidly increased, and at present open-pit-mined coal constitutes a large proportion of the total tonnage produced in the field.

Natural tree reproduction of several species is common on many of the strip-mined areas. Sweet gum and sycamore are especially successful, and in some cases a good stocking of cottonwood occurs. Although yellow poplar was noted, it was not commonly found in pure, fully stocked stands. Erosion is no more serious on the strippings in this field than on spoil banks in other parts of the Central States region. On the large stripped areas tree planting will be desirable to obtain fully stocked stands of desirable species. Because most of the spoil surfaces are acid the seeding of grasses and legumes for pasture development offers little promise. Certainly a wide range of grasses and legumes is not likely to prove successful.

SUMMARY

A survey of coal spoil lands in Kentucky in 1947 and early 1948 showed that a total of 7,267 acres had been mined for coal by the open-pit method. Approximately 75 percent of the stripped area was in the Western Coal Field, and 52 percent was in Hopkins county. Strip-mined areas were found in 15 counties. Fifteen coal seams had been mined by open-pit methods, but 28 percent of the mined area in the state resulted from the mining of the No. 9 coal seam of the Western Field.

Approximately 80 percent of the stripped area was without vegetation. However, 46 percent of the area that had been stripped longer than 5 years was fully revegetated. Twenty percent of the area stripped prior to 1942 had adequately stocked stands of forest trees. About 15 percent of the stripped lands were so toxic that only one-half of their area is plantable.

Any reclamation program should take into account natural stocking which has already occurred and the possibility of natural seeding which may occur on areas adjacent to forest cover.

Most of the stripped areas were not being effectively used at the time of the survey. Trees can be planted on at least 85 percent of these lands, and a small portion can be seeded to certain types of forage crops.

LITERATURE CITED**CHAPMAN, A. G.**

1947. Rehabilitation of areas stripped for coal. Cent. States Forest Expt. Sta., Tech. Paper 108. 13 p. (multilith).

LIMSTROM, G. A.

1948. Extent, character, and forestation possibilities of land stripped for coal in the central states. Cent. States Forest Expt. Sta., Tech. Paper 109. 79 p. (multilith).

McFARLAN, ARTHUR C.

1943. *Geology of Kentucky*. 531 p. illus. Univ. of Ky. Press, Lexington, Kentucky.

APPENDIX

Forms Used in Survey

Spoils Form No. 2
Rev. June 1947

(Reconnaissance)
(Plantation)

Character of Spoils Material

I. GENERAL State County
 Twp. Rg. Sec. Forty Plot
 Relief Range (Av.) Aspect Date
 Crew Age of Spoils
 Nearest High Wall: Coal Vein
 Slope: (None 0-5%) (Slight 5%-30%) (Medium 30%-60%) (Steep 60%+)
 Type of Relief:% Lev.,% Pt. Lev., LS.....%, SR.....%, RR.....%
 Stripped by:
 Stripping Equipment:

II. CHARACTER OF SURFACE SPOILS MATERIALS

Material	Spoils Texture by Size Class in %				
	Over 12"	4"-12"	1"-4"	½"-1"	½-Soil
Native: Limestone (Massive) ()
(Thin Bedded) ()
Sandstone (Massive) ()
(Thin Bedded) ()
Shale (Thick Bedded) ()
(Thin Bedded) ()	Soil...
(Concentrations) ()
Glacial:
Other:
TOTAL

Soil Class	Nutrients	Color	Soil Reaction
Consistency of Soil Portion			
Very Loose	P.....	(HCL): Effervescence
Loose		No effervescence
Friable	N.....	Under pH 4.0
Compact		pH 4.0-5.5
Very Compact	K.....	pH 5.6-6.9
		pH 7.0 or over

Erosion - Gully: Slight..... Moderate..... Severe.....
 Sheet: Slight..... Moderate..... Severe.....
 Humus layer forming to a depth of inches. Depth of litter
 % Plantable by: Mattock Bar

REMARKS:

III. VEGETATION BY SPECIES (Barren %)

		Trees	
Herbaceous (%)	Shrubs (%)	Natural (%)	Planted (%)

IV. DISEASES AND INSECT INFESTATION

	<u>Diseases</u>	<u>Insects</u>
Kind and Trees Affected
Extent of Damage
Degree of Damage
% of Total Trees Affected

V. MISCELLANEOUS DATA

Photographic Record: Photo Nos.

Soil Samples: Fld. No.	Remarks	Fld. No.	Remarks
.....
.....

Wildlife and Recreation Notes:

Agricultural Use of the Banks:

REMARKS:

SPOILS FORM NO. 1 (June 1946)

Stratigraphic Record No.

Overburden and Mine Survey

State

County

Twsp Rg Sec 40

Crew

Date

Coal Vein Removed

General Spoils Group

Type of Stripping

Spoil banks sample plots to which applicable

.....

Stratigraphic record of overburden before stripping:

<u>Description of Strata (Top to Bottom)</u>	<u>Thickness (Ft.)</u>	<u>pH</u>	<u>Soil Tests</u>		
			<u>P</u>	<u>N</u>	<u>K</u>
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Photographic Record: Photo No.

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Remarks: