COMPILATION OF COAL RESOURCES DATA ON FEDERAL LANDS IN VIRGINIA

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INTRODUCTION

Compilation of coal resources data on federal lands in Virginia encompassed all or part of twenty-four 7.5' quadrangles located in parts of eleven counties: Botetourt, Roanoke, Montgomery, Pulaski, Wythe, Bland, Smyth, Dickenson, Wise, Scott and Lee. In gathering data for this report, material was researched and evaluated from several sources. A literature search was carried out of published and unpublished reports. Assistance was also received from geologists familiar with the geology of the Valley and Ridge and Appalachia Plateaus physiographic provinces. Additional field work was performed by staff members of the Virginia Division of Mineral Resources.

The project area is located in the Valley and Ridge and Appalachia Plateaus physiographic provinces. The rocks range in age from Early Cambrian to Middle Pennsylvanian. Carboniferous rocks range from Early Mississippian to Middle Pennsylvanian in age. Mississippian and Pennsylvanian systems consist of sedimentary rocks of coal, sandstone, siltstone, shale, claystone and limestone. Within the Valley and Ridge province, coal bearing Mississippian rocks are found in highly deformed fault slices that strike northeast across the west-central section of the state. Coal-bearing Pennsylvanian age

rocks of the Appalachian Plateaus are relatively flat except for upturned beds along Pine Mountain to the northwest, Stone and Powell Mountains to the southeast and Hunter Valley Fault on the southeastern edge.

Valley Coal Fields

The Valley coal fields are a part of a more or less continuous outcrop of Mississippian age rocks along the western edge of the Valley and Ridge physiographic province in western Virginia. The coal fields have been known for at least 100 years and obtained their name from their proximity to the "Valley of Virginia."

The Price Formation of Early Mississippian age, named by Campbell (1894,1925) from exposures on Price Mountain, Montgomery County, Virginia, is the major coal-bearing formation within the Valley coal fields. Rocks of the Price Formation intertongue downward into Devonian sandstones and grade upward into the predominantly red shales of the Mississippian age Maccrady Formation. The coal rank ranges from high volatile bituminous to semi-anthracite and is structurally complex. Most previous mining operations were confined to small drift or slope mines which are now caved.

The Price Formation consists of light-gray, very fine to medium grained sandstone and light-gray to olive gray shale and siltstone. Thin bands of grayish-red beds are present in the upper part of the formation, but generally the top of the formation is where the rocks cease to be predominantly gray. Campbell (1925) records the thickness of the Price Formation, at its type locality on Price Mountain in Montgomery County, to be 1,700 to

1,800 feet. The most important coal beds occur near the middle of the formation. To the southwest in western Bland and eastern Smyth counties, the formation's thickness decreases to 600 feet and the coal beds lie within a few feet of the overlying Maccrady shale. Further to the southwest, the Price Formation was measured to be 300 feet thick at Cumberland Gap and Little Stone Gap, Virginia (Butts, 1940). No coal is reported southwest of approximately Saltville.

Campbell (1925) and Butts (1940) report the coal to be found in many horizons. At the type locality, the most important coal beds lie approximately 1,000 feet above the base of the formation and 700 feet below the red Maccrady shale. Within the formation, the coal zone averages in thickness between 15 to 70 feet. The thickest coal beds are found in Montgomery, Pulaski, Wythe and Bland counties.

The base of the Price Formation is marked by the Cloyd member composed of one to three thick to massive beds of conglomerate or conglomeratic sandstone. The Cloyd is 20 to 25 feet thick at its type locality near the crest of Cloyd and Brush mountains, southwest of New River in Pulaski County (Butts, 1940). Along the crest of Little Walker Mountain, Pulaski County, the maximum combined thickness is 95 feet. To the southwest, the Cloyd thins to 20 feet as the upper lenses tongue out. Further to the west, the Cloyd is represented by sandstone

and siltstone and is developed only locally as a conglomerate (Bartlett, 1974).

Descriptions of the Valley coal fields for this report were subdivided into four groups. Progressing from north to south, these groups are as follows: 1) Coals of Botetourt and Roanoke counties; 2) Coals of Montgomery and Pulaski counties; 3) Coals of Wythe County; and 4) Coals of Bland and Smyth counties.

The Botetourt and Roanoke counties coal area is the northeast extension of the coals in Montgomery County occupying portions of Oriskany, Daleville and Catawba quadrangles. In the past, the Botetourt and Roanoke counties coal attracted attention due to its close proximity to the James River and the possibility of transporting the coal to Richmond, Virginia. The coal-bearing Price Formation follows North Mountain to the northeast until it terminates northwest of Fincastle, Virginia. Outcrops within this belt dip to the southeast and are covered along the southeastern slope of North Mountain by limestone overthrust (Fig. 1).

Due to the folding and faulting of the strata containing the coal, the Mississippian coals are fractured and in places ground to a fine powder. Locally, the coal may be removed by faulting and in other locations may have been overthickened by faulting into beds many times its normal thickness. Generally, the coal is fractured, impure and usually in thin, irregular beds.

West of Fincastle, the best known coal prospect in this field was opened along Stone Coal Run (loc. MRC-71). Campbell (1925) suggests two coal seams were mined, referring to two coal dumps found at this site. If the Stone Coal Run prospect was characteristic of the coal beds to the southwest, its lower coal would have been small and fairly solid and the upper coal thicker but with impurities such as bone within the bed. Along Stone Coal Creek, located in Daleville and Catawba quadrangles, the coal ranged in thickness from .10 foot to 2 feet. Northwest from Stone Coal Creek, large abandoned pits were found but no visible coal could be measured. In a small stream southeast of the pits, a .20 foot coal bed was measured.

The Montgomery and Pulaski counties coal can be divided into two areas: 1) the area lying along the base and south slope of Little Walker and Brush Mountains, and 2) the coal-bearing rocks of Price Mountain.

The principal coal outcrop in the Little Walker and Brush Mountain area dips to the southeast. The Price Formation has excellent exposures on Little Walker, Cloyds and Brush Mountains, but is gradually covered by a limestone overthrust northeast of Blacksburg, Virginia. In many locations, the basal conglomerate of the Cloyd member form the crest of the mountains with the coal beds found on the south slope. Lying at the base of ridges, the coal fields proper have a wooded, rugged topographic.

Coal beds of minable thickness occur near the middle of the Price Formation. Most are thin and irregular but one coal, the Merrimac bed, is of minable thickness. Below the Merrimac, at a depth ranging from 20 to 70 feet, is a thinner, but persistent, second bed referred to as the Langhorne bed.

Recent coal exploration within Montgomery and Pulaski counties has taken the form of surface mining and core drilling. A small surface mine was attempted in White Gate Quadrangle, Pulaski County (loc. WHG 891). Located west of State Route 643, the mine was opened along the south slope of Little Walker Mountain. Although the mine is now abandoned, both the Merrimac and Langhorne coal beds were exposed during the surface mining operation. Measuring 3.3 feet, the Langhorne bed was found approximately 15 feet below the overlying 15 feet thick Merrimac bed. In 1982, the Department of Energy, in cooperation with the Virginia Division of Mineral Resources, drilled three test holes into the Price Formation in Montgomery County. Two core holes were drilled in Blacksburg Quadrangle, Prices Fork No. 1, northeast of Prices Fork, Virginia and VMR No. 3, north of Merrimac, Virginia. The third core hole was drilled in Radford North Quadrangle near the south slope of Brush Mountain, VMR No. 2 (Stanley and Schultz, 1983).

The Parrott mine (loc. MRC 35), was the principal mining operation in the Little Walker and Brush Mountains

coal field. In the Merrimac coal bed, the mine was located west of New River with lateral entries driven westward a distance of more than 4,000 feet.

Another mining operation of importance was the Empire mine (loc. MRC 43). Located west of the Parrott mine, the Empire mine was opened in the Langhorne coal bed. At this site, the Langhorne coal bed thickened to a minable thickness of 5 feet before decreasing in thickness to the west. The Empire mine also contained a rock tunnel driven approximately fifteen feet into the overlying 15 feet thick Merrimac bed.

Price Mountain in Montgomery County is the type locality of the Price Formation. Located between Christiansburg and Blacksburg, Virginia, Price Mountain is a domal structure appearing as a window in the Staunton-Pulaski overthrust block. Once overthrusted by limestone from the southeast, the window or fenster occurred as the limestone was eroded from the folder rock leaving the underlying carboniferous rocks exposed.

Trending in a east-west direction, the Price Mountain dome is bounded by the Pulaski Fault. Contained in an elliptical carboniferous structure 7.5 miles in length and 2.25 miles in width, the boundary of the Merrimac coal outcrop is only about 4 miles in length and 1.5 miles in width (Campbell, 1925). Named from the Merrimac mine on Price Mountain (loc. MRC 28), the Merrimac coal bed is the

thickest and most laterally continuous coal bed in this area. Located at the base of the upper Price Formation member, the Merrimac coal has been heavily prospected throughout the area. Numerous thinner beds occur stratigraphically above and below the Merrimac bed but appear to be discontinuous.

The largest mining operation on Price Mountain was the Merrimac mine. Stated earlier, the Merrimac coal bed not only received its name from this mine but the Merrimac mine also furnished fuel for the Confederate frigate Merrimac, or Virginia, during the War Between the States. The mines in the Price Mountain area are abandoned and have caved with only dumps of waste coal and small depressions remaining to indicate their location. Coal measures may extend beneath the Pulaski Fault to the north and south of Price Mountain, but core drilling or seismic profiles would be necessary to determine its location, thickness and quality of the coal.

Wythe County contains two important coal areas. The larger area extends across the county to the north in an east-west direction along the south side of Little Walker and Brushy Mountain. The smaller coal area lies in an isolated syncline near Max Meadows, Virginia. Present exposures of the coal are poor but caved prospect pits indicate the coal is near the middle of the Price Formation. Campbell (1925) identified two coals of minable thickness

correlating with the Merrimac and Langhorne coals and another bed of probable minable thickness in parts of Wythe County.

Coal in the north belt of Wythe County is a narrow belt extending east-west along the southeast side of Little Walker and Brushy Mountains. Generally, the dip of the coal-bearing rocks is to the south. The north boundary follows the mountain ridge crest and the southern boundary extends under the limestone overthrust. The extent of exposed coal beds is controlled by the limestone overthrust which in an easterly direction overlies the coal completely. Along Interstate 77 in Bland Quadrangle, a one foot coal was found in a small tributary of St. Lukes Fork (loc. Bld 751). Located on the south slope of Little Walker Mountain, the fractured coal is near the Tract Mountain Fault. The coal is overthrusted by the fault within a mile to the northeast.

Southwest of Interstate 77, scattered coal prospect pits can be seen in tributary streams. North of Shupe, Virginia, a poorly exposed three foot coal lies in a stream bed. The coal is interbedded and impure on both the top and bottom one foot of section (loc. CRO 315). A mined out area can be seen north of Favonia, Virginia, along Stony Fork (loc. CRO 2520). Three small prospect pits lie a few hundred feet to the west.

West of Stony Fork, Little Walker Mountain turns due north at Reed Creek. Rocks forming this ridge are cut off by a cross-fault affecting the ridge for about three-fourths of a mile. The fault trends northeast-southwest and correlates with the fault cutting Walker Mountain near the Bland County line. Coals found in stream tributaries between the fault and Stony Fork to the east were folded, fractured and averaged two feet in thickness. At loc. CRO 271, an abandoned coal pit slopes into Grippy Branch. A little digging exposed the coal to be approximately two feet in thickness. Prospect pits and a two foot coal were also found along Dry Branch to the west (loc. CRO 176). Coals have also been prospected near the cross-fault contact along Whetstone Hollow. Small fragments of coal were found near a pit dug approximately 20 feet into a hill slope. The collapsed pit is 15 feet wide but is filled to within 5 feet of surface with debris.

From Whetstone Hollow, coal prospect pits can be traced to the southwest. Large abandoned pits were found in Monkey Run and Brown Hollow but the pits were collapsed with no visible coal. In the next hollow to the west, Campbell (1925) reopened a prospect pit where he measured a coal bed over 3 feet thick (loc. MRC 70). At the extreme western edge of Wythe County, the Price Formation is cut off by erosion. Lying in a long, narrow syncline, the formation rises towards the west and rests near the top of

hills. There are numerous abandoned prospect pits but most are now caved with only small depressions and waste dumps visible. Little information was found to describe the coal or its thickness.

The Max Meadows coal area, located north of Max Meadows, Virginia, consists of a syncline separated from other coal fields in this region (Fig. 1). Its northern extent is Brushy Ridge. The south border is bounded by the Pulaski Fault. Campbell (1925) hypothesizes the south limb of the syncline as having been overturned. A large part of this area is covered by overthrusted limestone. Recent field work cannot totally disprove his statement, but it can offer an alternate suggestion. Due to the consistency in their dips, we suggest the coal-bearing rocks are doubled by faulting and not by being overturned.

Within the Max Meadows area there were several prospect pits opened but none extensively developed. In 1923, a mine was opened by Pulaski Smokeless Coal Company (loc. MRC 59). Driven down dip for approximately 400 feet, the mine probably was opened in the Merrimac coal bed. The coal bed is between five and six feet thick with only one other coal bed reported to be observed. At this mine, a tunnel twelve feet in length was driven downward into a very crushed second coal. This second coal is reported to have been overthickened by folding or faulting to an approximate thickness of sixteen feet (Campbell, 1925).

The most extensive prospecting was performed along Miller Creek on the west end of the syncline in Wythe County. Unfortunately, almost all the prospects are now caved except for a few isolated pits found near location MRC 62. Located on the south slope of Brushy Ridge, the pits were observed to be unsafe to enter. The coal has been reported to be badly crushed and varying in thickness within short distances. At least one thick coal, which may correlate with the Merrimac coal bed, was mined at this site.

The coals of Bland and Smyth counties consist of a narrow belt extending approximately thirty miles along the south slope of Brushy Mountain. Because of its resistance to erosion, the basal conglomerate of the Cloyd member forms the main ridge of Brushy Mountain or its secondary crests. The coal beds are thin and irregular, and correlations are questionable because of the Saltville and associated faults, minor folding and poor exposures. The Mississippian coals are completely overridden by the Saltville fault block in eastern Bland County and northern Smyth County.

Mined primarily for local uses, the coal beds were not prospected in an organized manner. Drifts were dug into hillsides, abandoned and allowed to cave. Old prospect pits are now filled with water or rocks. Campbell (1925) measured a weathered coal from a prospect

pit at location C-4. The two foot coal was driven into the hillside for more than 100 feet. A very crushed coal nearly three feet thick was measured by Campbell (1925) at a prospect a mile east of Bland, Virginia (loc. C-5).

North of Bland, Virginia, coal was found in a stream near the Saltville Fault (loc. Bld 148). Along Interstate 77 northwest of Bland, Virginia, a seven foot, sheared coal with a small siltstone parting was measured (loc. BBD 363). Campbell (1925) measured a coal over four feet thick at location C-9. Recent field work located a possible coal pit at this site but the pit was collapsed and filled with debris.

The coal beds lie uniformly along Brushy Mountain until reaching Laurel Creek, Big Bend Quadrangle, Bland County. Here the coal beds bend sharply to the north and again turn to the southwest within a few thousand feet. Coal outcrops along State Route 615 in several locations. The coal is fractured and ranges from approximately six feet thick (loc. BBD 531) to nearly four feet thick (loc. BBD 291). One recent operation was found at location BBD 511 in Bland County, Big Bend Quadrangle. The new prospect was found along the south slope of Brushy Mountain, southwest of Laurel Creek. Coal was measured to be approximately three feet thick, but highly fractured. Four abandoned pits were also found several hundred feet

to the northeast of this site. These pits were caved with no coal available for measurement.

Southwest of Garden Mountain Quadrangle, the coal continues to lie adjacent to the Saltville Fault. Although the coal is highly folded and faulted, prospect pits can be found. At location GDM-632, a small prospect pit dug eight feet into a hill was found. The authors were able to uncover a fractured two foot coal but were unable to dig the coal out further. To illustrate the condition of the coal, the authors located a 14 foot, highly folded and faulted coal along the northeast slope of a small hill (loc. GDM-654). Along the west slope of the same hill, the coal was measured to be only four feet thick (loc. GDM-657). Campbell (1925) states these prospects to be on the southeast limb of the syncline that has been preserved but badly squeezed. Further to the southwest, the overturned limb is covered by the Saltville-Bland Fault.

The coal-bearing rocks southwest of Ceres, Virginia, lie in two distinct synclines. The southeast belt is a continuation of the main belt from the northeast. The northwest belt is an independent syncline beginning near Ceres, Virginia, and is continuous to the southwest along the northwest edge of Brushy Mountain. Both belts continue until they are cut off by the Saltville Fault in Smyth County, Nebo Quadrangle. Little is known about the coal beds in Smyth County, but the coal is reported to thin and its quality deterioriates towards the west.

Recent field work located a 3 foot, extremely folded coal near Lick Creek (loc. Neb 222). A 3 foot coal was found in a prospect pit on the south slope of Carter Mountain (loc. Neb 242). Along State Route 621, southeast of Laurel Branch, the authors found a faulted area where a small amount of coal was associated with a 3 foot limestone (loc. Neb 243). In Jones Hollow, a possible coal prospect pit was observed along the road leading across Little Mountain. No coal was observed at this site although Campbell (1925) reported an old prospect near here. Campbell (1925) indicated the coal consisted of several beds but none of the beds was greater than 10 inches in thickness (loc. C-24).

Southwest Virginia Coal Fields

Southwest Virginia coal fields, situated in the Appalachian Plateau physiographic provinces, are of Pennsylvanian age. In southwest Virginia, the coal fields are essentially horizontal except for upturned beds located along Pine Mountain to the northwest, Stone and Powell Mountains to the southeast and Hunter Valley Fault near the southeastern edge.

Structural features are mainly faulted zones associated with the Cumberland thrust sheet. Paralleling Appalachian folding, the thrust sheet trends northeast-southwest. The Cumberland thrust sheet is limited to the northwest by the Pine Mountain Fault, to the northeast by the Russell Fork Fault and to the southeast by the Hunter Valley Fault. Pine Mountain and Hunter Valley faults are low-angle thrust faults whereas the Russell Fork Fault is essentially a high-angle, strike-slip fault. A reported right lateral movement of approximately four miles, the Russell Fork Fault causes significant offset to economically important coal beds (Miller, 1974).

The Pennsylvanian strata, the main coal-bearing strata in Virginia, consist of sandstone, siltstone, shale and coal. This report will be concerned primarily with three commercially important coal-producing formations. In ascending order, these formations are the Lee Formation,

Norton Formation and the Wise Formation. The Gladeville Sandstone separates the Norton Formation from the overlying Wise Formation.

The Lee Formation, named for Lee County, Virginia, includes the coal-bearing strata lying above the Bluestone Formation. The formation is composed of three quartz arenite members separated by intervals of shale, siltstone and two to six named coal beds. Usually characterized by cross-bedding, the resistant quartz arenites are prominent ridge makers developing a rugged terrain with steep cliffs. Normally covered at the surface, the less resistant units separating the arenites are difficult to observe. The generally finer-grained upper quartz arenite has been mapped as the Bee Rock in Big Stone Gap, Virginia, and as the McClure Sandstone of the Norton Formation in Buchanan County. In Wise and Lee counties, the basal arenite member is a thick-bedded, grayish white sandstone with conglomerate layers at its base. The conglomerate usually shows a sharp basal contact and contains rounded, milky quartz pebbles (Giles, 1925, and Miller, 1974).

The Norton Formation, named for Norton, Virginia, in Wise County, includes all strata lying between the Lee Formation's upper quartz arenite member and the base of the overlying Gladeville Sandstone. Composed mostly of medium to dark gray shale, siltstone and fine to medium grained sandstone, the formation also contains nine named

coal beds. The Norton Formation is exposed in portions of Buchanan, Dickenson, Russell and eastern Wise County. It also is exposed in narrow strips on the north and south sides of Wise County and outlying patches on Powell Mountain in Wise, Lee and Scott counties (Eby, 1923, and Butts, 1940).

The Gladeville Sandstone, named for Gladeville, now Wise, Virginia, is a sometimes resistant unit lying between the Norton Formation and overlying Wise Formation. Not mapped separately in this report, the Gladeville Sandstone lies throughout the area just below the lower boundary of the Wise Formation. Described as a massive, cross-bedded, medium coarse-grained, quartzose sandstone, the Gladeville Sandstone in western Wise County is locally a conglomeratic sandstone in the lower 50 feet of section (Eby, 1923 and Butts, 1940). At Wise, Virginia, the sandstone is hard, white and resistant, forming the bench on which the town is built. To the north, the sandstone becomes less quartzose as it grades into a fine-grained, feldspathic, micaceous sandstone which is nonresistant and less persistent. Here, the Gladeville Sandstone rarely forms strong cliffs and is friable in weathered exposures. Throughout Lee County, the basal portion of the Gladeville Sandstone is a conglomerate (Giles, 1925).

The Wise Formation, named from Wise County, Virginia, lies above the Gladeville Sandstone and is capped by the Harlan Sandstone. The formation extends from Lee County,

in the south, across Wise, Dickenson and the northern part of Buchanan County. Lithologically similar to the Norton Formation, the Wise Formation consists of sandstone, siltstone, shale, minor limestone and eighteen named coal beds. The sandstones, which constitute approximately one-third of the formation, are light gray, fine- to medium-grained, thin- to massive-bedded, micaceous, feldspathic, and contain about 50-60 percent quartz (Eby, 1923 and Englund, 1979).

Parts of ten 7.5' quadrangles in four Virginia counties in the southwest Virginia coal fields were studied during this project. For convenience of describing the study area, the quadrangles were divided into two separate regions. Beginning northeast to the Buchanan County line, the first region consisted of Elkhorn City, Haysi, Clintwood, Jenkins East, Jenkins West and Flat Gap 7.5' quadrangles in Dickenson and Wise counties. The second region consists of Keokee, East Stone Gap, Fort Blackmore, Wise and Dungannon 7.5' quadrangles in Lee, Wise and Scott counties.

The first study area focused primarily on the region between the Pound River and the Kentucky state line to the north and southwest. Structurally, the area is bounded to the northeast by the Russell Fork Fault and to the north by the Pine Mountain Fault. Due to steeply dipping incompetent shale and coal beds, the south slope of Pine Mountain is geologically and physiographically a potential site for

landslides. On the north slope of Pine Mountain, an observer can notice major rock falls on the slopes. In some locations, the rock falls have almost completely covered the area.

The southwest Virginia study area begins in the Elkhorn City Quadrangle, southwest of the Russell Fork Fault. Along State Route 611 in the southwest section of the quadrangle, the Raven coal bed of the Norton Formation was measured in a roadcut at two locations (loc. GQ-951-13g). The Raven bed measured 42 inches along the top roadcut and only 12 inches of clayey coal at the lower roadcut. Within the surrounding area, the Raven bed averaged 36 inches in thickness (Alvord and Miller, 1972). Recent field work along State Route 611 found a 0.15 foot thick coal bed that was polished, soft and weak in the vicinity of the Raven bed (loc. Elc-781g). Northeast of State Route 611, in the vicinity of the Splash Dam bed, a 0.40 thick coal bed was measured. Located along a small access road cutting into a hillside, the coal is brittle, cleated and underlain by 5.20 feet of medium dark gray shale with interlaminated coal (loc. Elc-791g).

In the Haysi Quadrangle, recent mining activity was located within the Splash Dam coal bed of the Norton Formation. The mines are along Blacklog Branch north of Pound River (loc. Hay-131F through Hay-133F). In this area, the Splash Dam bed averages between 4 and 5 feet in thickness.

Near the approximate location of the Russell Fork Fault, State Route 611 cuts across three coal beds as the road climbs in elevation from the Russell Fork River below. At the bottom of the incline, the road cuts the Upper Banner bed. The 1.30 foot coal is cleated, brittle and contains a 0.20 foot carbonaceous shale parting (loc. Hay-211g). A 0.50 foot Splash Dam bed was next cut by the road in a highly structurally contorted zone. The Splash Dam bed located here is folded containing a 0.30 foot parting of claystone and coal that is soft, weak and slickensided (loc. Hay-213g). This section is overlain by approximately 3 feet of Hagy coal seam. The Hagy bed contains three dark gray claystone partings that are soft, weak and slickensided (loc. Hay-212g).

The Hagy coal bed was also measured near the mouth of Skeet Rock Branch where it flows into the Pound River (loc. Hay-152g). Cleated and brittle, the coal here is 2.0 feet thick. On State Route 615, a 1.0 foot thick Upper Banner coal bed was measured. The highly weathered coal was located near the mouth of Lower Twin Branch where it flows into the Pound River (loc. Hay-171g). Upstream from this site, two prospect pits were found.

Isolated beds of coal were observed in the Clintwood Quadrangle. Abandoned coal pits were located along the mouth of Moore Branch north of Pound River. The pits were opened in a 1.20 foot thick Hagy coal bed of the

Norton Formation (loc. CLI-534g). Strip mines can be found along Upper Twin Branch at locations CLI-352g and CLI-353g. At these mine sites, the 2.5 to 3.0 foot thick Upper Banner coal bed of the Norton Formation has been stripped and also underground mined. At the present time, all mining at these sites has been discontinued. An abandoned strip mine was also found near Star Branch, south of State Route 619 (loc. CLI-292g). Being stripped probably in the Norton coal bed of the Norton Formation, local information reports the coal to be approximately 3 feet in thickness.

Additional isolated coals were observed southwest into Jenkins East Quadrangle. Northwest of Norland, Virginia, the Dorchester coal bed of the Wise Formation was measured (loc. JNE-671g). The bottom 1.0 foot coal contained interlaminated shale and was separated from the top 0.60 foot crushed coal by a 1.0 foot thick light gray, rooted seatearth. Along State Route 630 near Almira, Virginia, a coal was found that probably is the Upper Banner coal bed of the Norton Formation. Located behind Lone Pine Chapel, the bottom crushed coal measured 1.40 feet thick and was separated from the overlying 0.30 foot cleated coal by 1.00 foot of carbonaceous shale (loc. JNE-741g).

North of Pound, Virginia, in Wise County, a faulted zone containing fault breccia was located along relocated

U. S. Route 23 (loc. JNE-742g). The 0.60 foot Kennedy coal bed of the Norton Formation measured here is soft, weak, folded and crushed. A coal that probably correlates with the Kennedy coal bed was also measured along the relocated section of U. S. Route 23 at locations JNE-743g and JNE-744g. The coal here measured 1.10 feet and 2.50 feet respectively. Thin beds of coal were also found in the underlying Lee Formation along relocated U. S. Route 23.

Southwest into Jenkins West Quadrangle, coal can be seen along the abandoned Chesapeake and Ohio Railroad. The railroad bisects the Norton and Wise formations, crossing approximately six coal beds. A 1.10 foot thick coal, probably the Kennedy coal, was measured along an unstable slope at location JNW-998g. Along the abandoned railroad at location JNW-993g, two coals can be observed. At this point, a cleated, 0.60 foot thick Lower Banner coal bed was separated from the overlying 1.0 foot thick Upper Banner coal bed by 30 feet of coarse-grained, cross-bedded sandstone and 5 feet of shale. A fractured, 0.80 foot Splash Dam coal bed containing three claystone partings was located at JNW-994g. Two coal beds from the overlying Wise Formation were also measured along this abandoned section of railroad, a cleated, 0.80 foot Dorchester coal bed at location JNW-996g and the overlying 0.50 foot Lyons coal bed at location JNW-997g.

Within the Jenkins West Quadrangle, coals from the Lee Formation can also be observed. A Lee Formation coal was found at the south opening of the Pine Mountain railroad tunnel at location JNW-962g. The coal found here was cleated and measured 1.70 feet in thickness. Another Lee Formation coal of notable thickness was found along State Route 23 near the Kentucky state line. The bottom 0.80 foot thick, crushed coal was separated from the overlying 0.30 foot thick crushed coal by 0.30 feet of claystone.

The last quadrangle within this study area is the Flat Gap Quadrangle. Field work in this quadrangle found poor rock exposures and only a minor amount of coal from the Norton Formation. Although continuous southwest to the Kentucky state line, most coals are thin, probably due to faulting.

The second area in the southwest Virginia coal field is composed of Keokee, Wise, East Stone Gap, Fort Blackmore, and Dungannon quadrangles. All of these quadrangles have the Lee Formation steeply dipping off of the Powell Valley anticline. Resistant sandstones of the Lee mapped by Miller (1971) and seen in the field work of this report form sharp crested steep sided ridges. The stratigraphic interval between these sandstones is almost always covered. On the Keokee and Wise quadrangles the moderately exposed Norton Formation and the generally

well exposed Wise Formation extend to the north. On the East Stone Gap, Fort Blackmore, and Dungannon quadrangles the Lee Formation is terminated to the south by an area of steeply dipping and overturned rocks associated with the Hunter Valley fault.

In the Keokee Quadrangle, the Lee Formation, except for resistant ridge forming sandstones, is almost completely covered. A transect across the Lee outcrop belt south from Sigma indicates only sandstone exposed in natural outcrops and streams. What are inferred to be several small prospect pits were seen just to the north of Olinger Lookout Tower, but no coal was exposed. Overlying the steeply dipping Lee Formation is the moderately to low dipping Norton Formation. Several coals were mapped by Miller in the Norton but none are very widespread or thick. Further to the north, the Wise Formation is fairly well exposed and intensely mined, but these rocks do not outcrop on National Forest property.

The geology of the Wise Quadrangle is similar to the Keokee Quadrangle with poorly exposed, steeply dipping Lee and Norton Formation rocks on the northern limb of the Powell Valley anticline. Eby (1923) located isolated exposures of coal in the Lee and Norton formations, but no attempt has been made to draw outcrop lines or correlate the coals. Two coal exposures were found on the southern part of the quadrangle and are included on the map.

On the East Stone Gap, Fort Blackmore and Dungannon quadrangles, the Lee Formation is moderately to steeply dipping to the south and southeast. The sandstones and conglomerates form sharp crested, steep sided ridges, and, as on the Keokee and Wise quadrangles, the stratigraphic interval between the sandstones is generally covered. To the south and southeast, the Lee Formation has been deformed by the Hunter Valley Fault into a zone of very steeply dipping to overturned rocks.

There has been some underground mining on Cove Creek on the East Stone Gap Quadrangle (ESG-571) but this mine has closed. Several coal outcrops were seen along road in the quadrangle, but most coal data is from Eby (1923) in the Stock Creek and Shupe Branch drainages. Most of the coal thickness data on the Fort Blackmore and Dungannon quadrangles is from Eby (1923). Because of the poor exposure of the coal interval and the widely scattered coal thickness data, these coals have not been correlated and croplines have not been drawn.

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STRATIGRAPHIC CORRELATION CHART

	POWELL VALLEY	PINE MOUNTAIN	VALLEY FIELD
PENNSYLVANIAN	WISE FORMATION	WISE FORMATION	Footwall Sequence of Saltville or Pulaski Thrusts
	GLADEVILLE SANDSTONE		
	NORTON FORMATION	NORTON FORMATION	
	LEE FORMATION	LEE FORMATION	
MISSISSIPPIAN	BLUESTONE FORMATION	BLUESTONE FORMATION	
	PRINCETON SANDSTONE		
	HINTON FORMATION	HINTON FORMATION	
	BLUEFIELD FORMATION	BLUEFIELD FORMATION	
	GREENBRIER LIMESTONE	GREENBRIER LIMESTONE	
	MACCRADY FORMATION	MACCRADY FORMATION	MACCRADY FORMATION
	PRICE FORMATION	PRICE FORMATION	PRICE FORMATION
DEVONIAN	CHATTANOOGA SHALE	CHATTANOOGA SHALE	CHEMUNG FORMATION
	WILDCAT VALLEY SANDSTONE		Hanging Wall Sequence of Saltville or Pulaski Thrusts
SILURIAN	HANCOCK LIMESTONE		
	ROSE HILL FORMATION		
ORDOVICIAN			BEEKMANTOWN FORMATION
CAMBRIAN			COPPER RIDGE FORMATION
			ELBROOK FORMATION / HONAKER FORMATION

Age	Name	Character	Approximate thickness in feet
PENNSYLVANIAN	Wise Formation	Siltstone, shale, sandstone and interbedded coal beds near top and bottom. Siltstones and shales are olive gray to dark gray, in part black and carbonaceous, sandy, micaceous and calcareous. Composing 1/3 of the formation, sandstones are light to dark gray, very fine- to medium-grained, poorly to moderally well-sorted, thin- to massive-bedded, in part cross-bedded, generally lenticular, silty, feldspathic, micaceous, scattered shale pebbles, moderately quartzose, 50-60% quartz, also containing two units of limestone with calcareous shale and siltstone. In Wise County the formation is 2,300 feet thick, thinning to the northeast with average thickness of 190 feet.	190-2,300
	Gladeville Sandstone	Sandstone, white, fine- to coarse-grained, massive bedded, in part cross-bedded, quartzose, resistant, in part conglomeratic, grades to fine-grained, feldspathic, micaceous sandstone that is nonresistant and absent in places.	0-50
	Norton Formation	Siltstone, shale, sandstone, coal and underclay. Siltstones and shales are light to dark gray, sandy, even to rippled laminated bedding, weathers platy to blocky, partly carbonaceous, micaceous, abundant ironstone concretions and bands, with plant fossils. Sandstones are light to dark gray, impure, very fine- to medium-grained, poor to moderately well-sorted, thin- to thick-bedded, in part cross-bedded near top of unit, rarely rippled marked, weakly cemented, moderately consolidated, argillaceous, feldspathic, micaceous, moderately quartzose near base, 50-60% quartz. Thickness increases towards the northeast and averages between 1,300 to 1,500 feet.	1,300-1,500
	Lee Formation	Sandstone, siltstone, shale and coal. Sandstones are white to light gray, very fine- to coarse-grained, well to poorly sorted, thin- to thick-bedded, in part cross-bedded, quartzose, in places micaceous and feldspathic, friable, porous, silty, weakly cemented, moderately consolidated, carbon-	

Age	Name	Character	Approximate thickness in feet
PENNSYLVANIAN	Lee Formation(cont.)	aceous with massive coarse conglomerate at base and two other massive conglomeratic sandstones above. Upper conglomeratic sandstone, the Bee Rock, is white to light gray, fine- to coarse-grained, fair sorted, subangular to subrounded, medium to thick bedded, in part cross-bedded, silica cemented, strongly consolidated, in part friable, porous, quartzose, partly conglomeratic, well rounded quartz pebbles, massive form prominent cliffs, greater than 90% quartz, mica is rare, separated by siltstones, shales and thin-bedded sandstones with several thin beds of sheared coal. Siltstones and shales are olive to dark gray, partly carbonaceous, micaceous, silty to sandy, even to ripple laminated. Formation thins to the west and northwest measuring 1,800 feet at Little Stone Gap, Virginia.	1,800
MISSISSIPPIAN	Bluestone Formation	Siltstone, sandstone, shale with minor beds of coal and argillaceous limestone. Formation thins to the southwest obtaining its maximum thickness of 830 feet in Tazewell County.	830
	Princeton Sandstone	Sandstone, polymictic conglomerate or coarse conglomeratic subgraywacke with lenticular beds of shales, siltstones and rarely limestones. Formation thins to the southwest with maximum thickness of 60 feet in Tazewell County.	60
	Hinton Formation	Shale, siltstone, minor sandstone, limestone and coal. Formation is 1,317 feet thick in Tazewell County. The Stony Gap Member consist of sandstones and shales, although largely sandstone.	1,317
	Bluefield Formation	Shale, siltstone, sandstone and limestone. Upper section of unit is carbonaceous with thin coal beds. Formation increases in thickness to the east measuring 300 feet at Cumberland Gap and 1,217 feet in Tazewell County.	300-1,217
	Greenbrier Limestone	Limestone, cryptocrystalline to medium crystalline, oolitic in upper and basal sections with chert near base. Few beds of dolomitic limestone in Lower Section. Formation measures 266 feet at Cumber-	

Age	Name	Character	Approximate thickness in feet
	Greenbrier Limestone (cont.)	land Gap and 3,000 feet in the Greendale syncline faulted belt.	266-3,000
	Maccrady Formation	Siltstone, shale, minor amounts of sandstone, very fine crystalline dolomitic limestone and thin coal beds. Siltstones and shales are red, grayish red with minor greenish gray mottling, interbedded with thin bedded, medium gray sandstones that are fine- to coarse-grained, feldspathic and/or micaceous, quartzose, in part cross-bedded and in part a coarse-grained conglomeratic, quartzose sandstone to a sandy quartz pebble conglomerate. Maximum thickness measured 1,000 feet which thins to the southwest and absent at Cumberland Gap.	1,000
MISSISSIPPIAN	Price Formation	Siltstone, shale, sandstone, coal and minor limestone. Siltstones and shales are light gray to greenish gray, locally grayish red, platy, well layered, feldspathic and/or micaceous, some clay ball conglomerates. Upper mottled maroon and green shales are underlain by interbedded dark gray to black shales and coals which are underlain by nonmarine quartzose sandstones, sandstones are light gray to brownish gray, very fine- to coarse-grained, quartzose, thick-bedded, in part cross-bedded, feldspathic and/or micaceous, in Valley fields the sandstone can contain well rounded quartz pebbles and glauconite beds. Basal section is dominantly marine interbedded sandstones and siltstones. Sandstones are medium gray, fine- to medium-grained, plately and in part cross-bedded. Thickness of formation increases to the northeast measuring 300 feet at Cumberland Gap and 1,700 to 1,800 feet at the type locality. The basal Cloyd Member is in part quartz pebble conglomerates, white to light gray, milky quartz pebbles and scattered rock fragments in a siliceous cement, well rounded pebbles, fair sorted, massive bedded, interbedded and laterally gradational into a quartzite with thick-bedded, well-rounded, well-sorted quartz grains and silica cemented. The Cloyd thins to the southwest with maximum thickness of 95 feet on crest of Little Walker Mountain in	

Age	Name	Character	Approximate thickness in feet
	Price Fm.(cont.)	Pulaski County.	300-1,800
	Chattanooga Shale	Shale and siltstone. Black, few beds of medium gray siltstone, even bedded, laminated, fissile, slightly carbonaceous, slickensided, chevron folds near major overthrust fault. Thickness increases from 100 feet northeastward from Cumberland Gap to 1,730 feet.	100-1,730
DEVONIAN	Chemung Formation	Interbedded sandstone, mudstone and minor thin bedded, quartz pebble conglomerates. Sandstones are tan, light gray to greenish gray, fine-grained, slightly calcareous, resistant, fossiliferous, maximum thickness of 710 feet.	710
	Wildcat Valley Sandstone	Fine- to coarse-grained, calcareous.	50
SILURIAN	Hancock Limestone/Dolomite	Cryptocrystalline to very fine crystalline with sandstone locally at base.	150-200
	Rose Hill Formation	Shale, siltstone and sandstone with several workable hematite iron ore beds.	407
ORDOVI-CIAN	Beekmantown Formation	Dolomite, limestone and minor sandstone. Sparsely fossiliferous with light to dark chert in north.	1,500
	Copper Ridge Formation	Sandy laminated dolomite, massive dolomite and sandstone. Maximum thickness in Valley Field measures 1,2000 feet.	1,200
CAMBRIAN	Elbrook Formation	Dolomite with sandstone lenses. Maximum thickness in Valley measures 1,500 feet.	1,500
	Honaker Formation	Dolomite, limestone and sandstone. Formation measures 800 feet in the Valley field.	800

APPENDIX A

NATIONAL COAL RESOURCES DATA SYSTEM (NCRDS)

U.S. Geological Survey

USTRAT Data Base

STRATIGRAPHIC SEQUENCE (STRAT) FORM MANUAL -
Guide for entering Stratigraphic data into NCRDS

This manual provides guidelines, suggestions, and procedures for completing the STRAT forms. Any interested in contributing data to NCRDS should first contact the NCRDS program manager in Reston. Questions on filling in forms should be directed to NCRDS personnel in Reston and Denver.

INTRODUCTION

The stratigraphic sequence (STRAT) form and associated point-location map allow data to be 1) stored permanently in the STRAT files of NCRDS, 2) retrieved by any field of entry using PACER (data base storage and retrieval system), and 3) interactively used for NCRDS programs, e.g. strip log plots, drill hole stratigraphic sections, statistics, contouring, resource calculation, and other GARNET (graphic analysis and resource calculation system) options.

The stratigraphic section point location should be marked by "X" on a mylar topographic map and identified with a unique data point I.D. number assigned by the geologist. This exact same number including spaces and hyphens, must be on the related STRAT form in the "DATA POINT ID" field. Each point location will be digitized from the topographic map to provide precise latitude and longitude coordinates that will be added to the PACER data file. Latitude and longitude values given to at least the nearest

second must be filled in on the STRAT form if providing a point location map is not feasible.

Completion of most of the heading area and those columns marked(*) on the form is mandatory before a form will be accepted.

NCRDS abbreviations must be used for all data entry. Not all words need to be abbreviated - only those that will be used frequently. The personnel filling in STRAT forms should check the NCRDS abbreviation list before entering data into the appropriate fields. If a term is not on the list, but will be used frequently and is longer than 4 characters (one computer unit of storage), contact NCRDS personnel. New abbreviations can then be distributed to all NCRDS users to maintain consistency of data for more rapid retrieval. For those with an account on the Multics computer system the current abbreviations list may be obtained by typing "listabb" on your terminal.

SPECIFIC GUIDELINES

NOTE: Information preceding each Data Element indicates the field length and the character type of each Data Element and the Data Element name spelling in NCRDS.

16(M) = 16 (field length) is maximum number of characters including spaces. The computer will truncate data at these limits. M (character type) indicates the type of characters that may be entered for that field: alpha = (A), numeric = (N), or mixed = (M).

pointid = The spelling of the Data Element used in PACER retrievals, e.g. Data Point Id = pointid.

I. HEADER INFORMATION

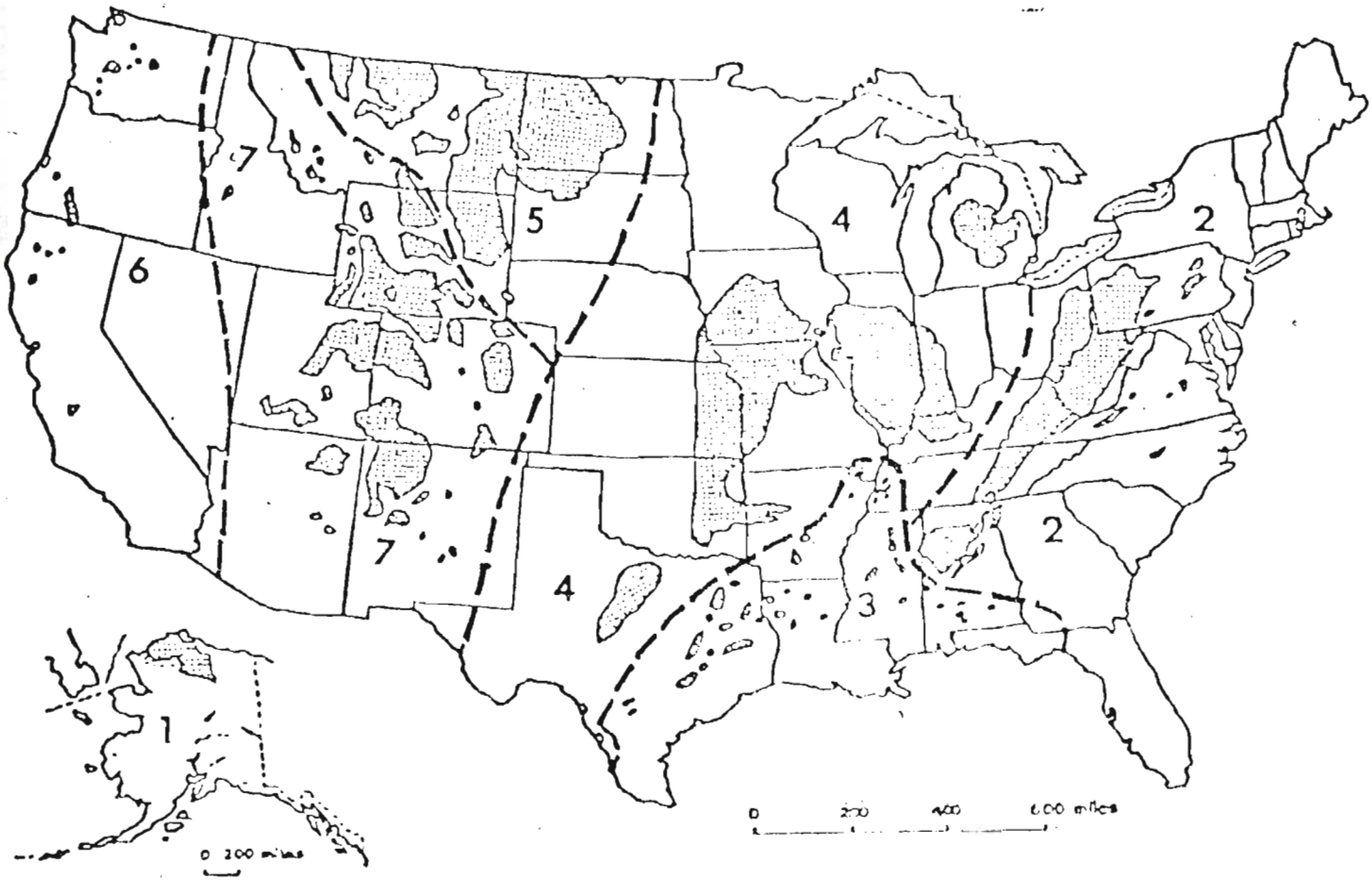
Field length and Character Type PACER field name	Data Element	Description/Guidelines
16(M) pointid	DATA POINT ID	The system is arbitrary for the geologist and is intended to provide a unique identifier between the stratigraphic sequence data and the point location on the map. The Pointid number must match those used on the point location map submitted to NCRDS for digitizing. Use unique identifiers for all data points within the same quadrangle. (See Measured Section write up if applicable.)
16(M) krcra	KRCRA	Known Recoverable Coal Resource Area as defined by Minerals Management Service. Enter appropriate name as shown on Figures 1-3.

NOTE: Discuss your numbering system with NCRDS personnel before filling in forms.

1) to avoid duplication with other contributors

2) to facilitate subsequent sorting of records -- i.e., SH001-SH010, can be sorted 1....10 but SH1-SH10 would be sorted to 1, 10, 2, 3, ...9.

(8M) clsa (16M) leaseno	CLSA/LEASE #	Coal Lease Study Area for MMS. CLSA = coal lease study area LEASE # = lease number
(16A) State (24A) County	STATE/COUNTY	Enter state name in full. Enter only one county name in full.
(20M) colectr	GEOLOGIST (Project Leader or submitter of data.	A four character alpha code for the submitting agency precedes the submitter name. Contact NCRDS for your code. Submitter's name format: Code - Last Name First initial Middle initial e.g., COGS-Stewart J E
(16A) & (24A) coalprv region	COAL PROVINCE/REGION	Enter appropriate names as shown in figures 4 and 5.
(6N) date	DATE	enter yr/mo/dy: enter 00 for unknown month or day, e.g., 67/04/00. The default will be January 1 of the year the data is entered into the system if left blank.
(1N) confid	CONFIDENTIAL	Circle the C if the data are company confidential.

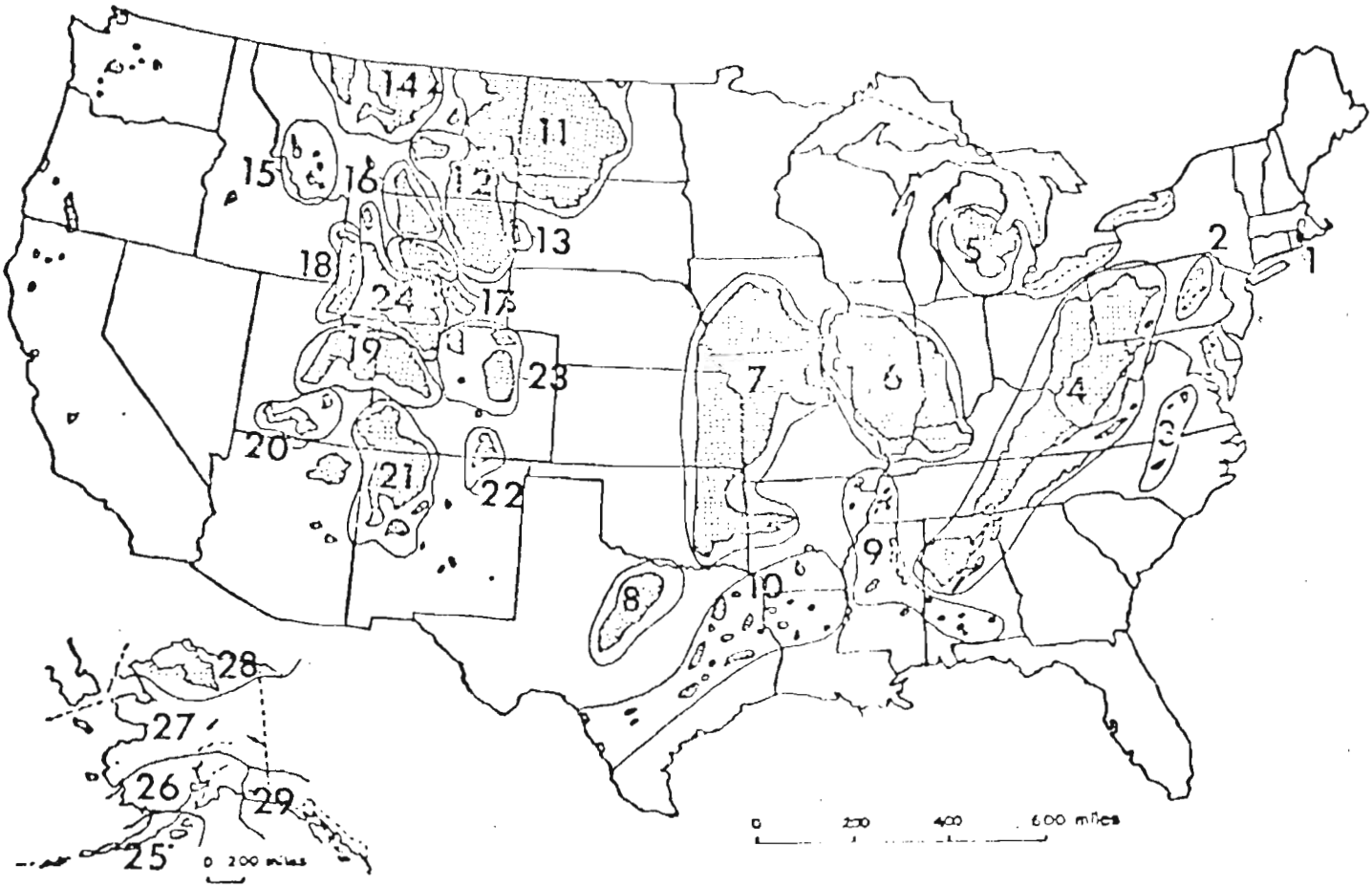


EXPLANATION

Provinces

1. Alaska
2. Eastern
3. Gulf
4. Interior
5. Northern Great Plains (Enter n great plains on form)
6. Pacific Coast
7. Rocky Mountain

Figure 4 . - Coal provinces of the conterminous United States.



EXPLANATION
Regions

1. Rhode Island meta-anthracite
2. Pennsylvania anthracite
3. Atlantic coast
4. Appalachian
5. Northern
6. Eastern
7. Western
8. Southwestern
9. Mississippi
10. Texas
11. Fort Union
12. Powder River
13. Black Hills
14. North Central
15. Tertiary lake beds
16. Bighorn Basin
17. Wind River
18. Hams Fork
19. Uinta
20. Southwestern Utah
21. San Juan River
22. Raton Mesa
23. Denver
24. Green River
25. Alaska Peninsula
26. Cook Inlet - Susitna
27. Central Alaska
28. Northern Alaska
29. Southeastern Alaska

Figure 5. - Coal regions of the conterminous United States.

(28M) quad	QUAD NAME & SERIES	Enter as shown on USGS topographic map sheet, e.g., homestead draw sw (7.5'). The possibilities for series are (7.5'), (15'), (30'), (1 deg), and (2 deg).
(16A) field	COAL FIELD	Enter name (may not always be known).
(12A)	ESTIMATED RANK of coal	Enter anth, bit, subbit, lignite, unknown, multiple, or no coal. Only the rank names listed above are acceptable. If "multiple" is used, enter rank from the above list in comment 2 column for each coal unit. Enter "no coal" if there is no coal in the section.
(7N) surfelv	SURFACE ELEVATION	"surface" equals ground elevation - NOT coal bed surface or Kelly Bushing. Only decimal feet values are acceptable.
(2N) elvprec	ELVPREC (ELEVATION PRECISION)	Use only if surface elevation needs to be qualified. Qualifiers are listed below:

ENTER CODE ONLY:

Code

01 etm ± 10' (etm = estimated from topographic map)

02 etm ± 20'

03 etm ± 50'

04 as reported by driller

05 adjusted from Kelly Bushing: enter Kelly Bushing elevation in Comment 1 field, e.g. KB 1387, or KB-GL 15 ft.

(Continued)

(Cont.)

06 adjusted from Kelly Bushing ± 5'

07 adjusted from Kelly Bushing ± 10'

08 transit measurement

09 hand level measurement

10 barometer measurement

totthk	TOTAL THICKNESS REPORTED	Enter total thickness of section, core, log, etc. being described, in decimal feet, feet and inches, or inches. This figure must match the sum of the numbers in the THICKNESS column. The computer will check the sum of the thicknesses against these values.
(9N) locstr locdip locangl	LOCAL STRIKE, DIP & ANGLE	Strike and dip directions will be stored and retrieved as the number of degrees between 1 and 360, clockwise from north: i.e., E = 90°, S = 180°, W = 270°, N = 360°, e.g., N 10° W., 3° SW should be entered as: 350,260,3.
	APP THK (APPARENT THICKNESS)	Circle only if "local strike/dip/angle" is entered and bed thicknesses have not been corrected to true thickness. If APP THK is circled, angle - angle + 100°. If circled, NCRDS will enter angle of dip plus 100 to flag.
(24M) source	SOURCE	Enter primary source of data, e.g., Peabody Coal Co., e.g. Amax-BLM, USGS of 78-960, or Matson & Blumer, 1976.

BE CONSISTENT! Check with NCRDS for dictionary. Drill hole numbers and reference page numbers should NOT be entered in source. They should be entered in (Comment1) field.

(3N) DESCRIPTION or LOG

User must circle one. In the space that follows enter code for specifics, e.g. roadcut, gamma log; enter code from following list: (dscplog will be stored as a three digit code -- all descriptions are preceded, by "1", all logs by "2" e.g. outcrop = 102, coal test = 216.)

I. Description

Code	
01	roadcut
02	outcrop
03	underground mine
04	surface mine
05	prospect pit
*06	measured section (multiple point locations) A-Z top to bottom
*16	measured section (multiple point locations) A-Z bottom to top
07	mine mouth
08	composite section

II. Log

Code			
201	core	19	soil test
02	drill hole	20	power line hole
03	rotary	21	pump hole
04	drillers log	22	ventilation shaft
05	electric	23	gamma & neutron
06	geophysical	24	gamma & density
07	gamma (natural)	25	rotary & core
08	density (gamma-gamma)		
09	neutron (activation)	30	multiple: If more than one type of log in vertical sequence, list string of abbrev. in Comment 1 field. See also explanation for Unit Qualifier "L"
10	resistivity		
11	spon. potential		
12	sonic		
13	laterolog		
14	seismic		
15	caliper		
16	coal test		
17	oil and gas	31	combination: for combination of types for the entire log enter string of abbrev. in Comment 1 field.
18	water well		

*See "Measured Section" description for details.

Supply NCRDS with point location map for digitizing if a point location map is not submitted.

latitud n/s
longtud e/w

LAT/LONG

Enter precise values, e.g. latitude and longitude, to at least nearest second. See NCRDS manager for details.

(2N)
llprec

LL/PREC (LATITUDE/ LONGITUDE PRECISION)

Use only if lat/long coordinates need to be qualified. Qualifiers are: ENTER CODE ONLY

Code	
01	± 100'
02	± 200'
03	± 500'
04	± 1/4 mile
05	± 1/2 mile
06	GT ± 1/2 mile

(2N)
pmerid

PRINCIPAL MERIDIAN — Enter principal meridian code according to the Federal Information Processing Standards (FIPS). See list of codes below and figure 6.

Code	Principal Meridian and Base Line
01	1st Principal
02	2d Principal
03	3d Principal
04	4th Principal
05	5th Principal
06	6th Principal
07	Black Hills
08	Boise
09	Chickasaw
10	Choctaw
11	Cimarron
12	Copper River
13	Fairbanks
14	Gila and Salt River
15	Humboldt
16	Huntsville
17	Indian
18	Louisiana
19	Michigan
20	Montana Principal
21	Mount Diablo
22	Navajo
23	New Mexico
24	St. Helena
25	St. Stephens
26	Salt Lake
27	San Bernardino
28	Seward
29	Tallahassee
30	Uintah Special
31	Ute
32	Washington
33	Willamette
34	Wind River
35	Ohio
36	Great Miami River
37	Muskingum River
38	Ohio River
39	1st Scioto River
40	2nd Scioto River
41	3rd Scioto River
42	Ellicott's Line
43	Twelve Mile Square
44	Kateel River
45	Umiat
96	Principal meridian and base line unknown
99	Various principal meridians and base lines

quartr1-(2A) quartr2-(2A) quartr3-(2A) quartr4-(2A)	QUARTERS	Enter quarters in right justified position, e.g. | | |sw|ne| PLEASE NOTE SPACING FOR THESE ENTRIES.
section	SECTION	Enter section with decimal points, e.g. SECTION: |36. |
twnship tns range rew	TOWNSHIP, RANGE	Enter township and range with decimal points and N/S and E/W designator. Occasionally an odd sized unit is encountered with a fractional designation, for example, 16-1/2 which is entered into the system as 16.5. TOWNSHIP: |1.| |n| RANGE: |68.25w|
(1N) weaqual	WEATHERING QUALITY CODE	Enter one of the following numeric codes: Code 1 fresh 2 slightly weathered 3 weathered 4 highly weathered 5 bloom 6 clinkered 7 other: enter description in Comment 1 8 multiple: see also explanation for Unit Qualifier "W"
(40M) comment1	COMMENT 1	Include company drill hole number, mine name, page number and other qualifiers to items mentioned above if additional information is needed. Additional information on Source should be entered here. Limit punctuation to commas between thoughts. e.g. DH 50-1-128, p 147, 31 = 1 5 7 9.

ALL OF THE ABOVE INFORMATION WILL BE ASSOCIATED WITH EACH OF THE FOLLOWING UNIT SEQUENCES

II. UNIT INFORMATION

Field length and Character Type PACER field name	Data Element	Description/Guidelines
(4M) unit	UNIT	NCRDS will enter sequential numbers to identify each unit within the section or drill hole. Maximum number of units is 200. If more are required, contact NCRDS manager. NOTE: See writeup on Measured Section.
(4A) unitqal	UNIT QUALIFIER	To qualify or highlight specific information for the rock unit, enter from one to four letters from the list below: DO NOT ENTER COMMAS OR SPACES BETWEEN LETTERS

A analysis run on sample

B boundary (base or top of group, formation, etc.): enter detail in Comment2, e.g., B bs Pennsylvanian

C coal thickness for resource calculation if different than thickness measurement: enter resource thickness in inches in Comment2 column, e.g., C 238 in

D interbedded: See Primary Lithology and Lithology Modifier; enter all interbedded lithologies in Comment2 column, e.g. D ss sh

E elevation recorded: enter elevation value in feet or decimal feet in Comment2 and indicate base or top of unit, e.g., E bs 7387, E top 5342 (tce 4729 = top coal elevation is 4729 feet)

F floor rock

G gradational

(Continued)

(Unit qualifier codes continued)

I incomplete thickness

K coal burned: therefore may be no thickness measurement

L change in log type: indicate in Comment2 column, e.g. L top gamma

M estimated thickness, ±

N interlaminated: See Primary Lithology and Lithology Modifier; enter all interlaminated lithologies in Comment2 column, e.g. N ss slst sh

R roof rock

S sample has been collected

U uncertain - refers to name of bed

W weathering: indicate in Comment2 column with weathering code, e.g. w 2

X extrapolated thickness. Do not use this unit for coal resource calculation. May be mine map data with elevation but thickness not revealed. Bed may be X feet below observed marker bed, therefore, both elevation and thickness are derived. May be useful for control of isopach or structure contour.

thk	THICKNESS	One of three measurement values to be used for the entire log must be circled at the top of the column; (decimal feet, feet and inches, or inches). Units must be described in continuous sequence from ground surface downward i.e., from top to bottom. NOTE: "From" and "to" values will be calculated and stored. The PACER retrieval system will allow the user to display data in any desired unit of measurement.
(16M) formatn	FORMATION	Enter Formation name. See NCRDS dictionary. Note: if group, member, or zone are entered follow with gp, mbr, or zn.
*(20M) bed	NAME	Enter coal bed, marker bed, or other stratigraphic unit name if known. In order to retrieve data for a specific bed for such manipulation as isopaching or resource calculation, the same name must be entered for each unit of that bed including partings. Example below:

UNIT	UNIT	THICKNESS decimal ft ft In	FORMATION	NAME	PRIMARY LITHOLOGY	LITHOLOGY MODIFIER
4	4		16	20	8	12
1		10.			NR	
2		5.			slst	carb
3		16.		CANYON	coal	
4		7.		CANYON	sh	
5		10.		CANYON	coal	

If the bed is uncorrelated but the geologist expects that it will be correlated later, a unique temporary name should be entered. NCRDS has reserved the names temp 1, temp 2.....temp (n) for this purpose.

*(8a) lith

PRIMARY LITHOLOGY

use NCRDS abbreviation list. Enter appropriate abbreviation for lithology. Only one lithology is acceptable for computer entry and storage. If there are no data, enter NR (no record, not logged, no data, not available, core loss). For more than 1 LITH use "D" or "N", Unit Qualifier described above, if applicable. Where unit is stratigraphically missing see Lithology Modifier.

(12M) lithmod	LITHOLOGY MODIFIER	Use NCRDS abbreviation list for standard modifiers. No punctuation allowed. Where unit is stratigraphically missing insert 0 in Thickness, the name of the missing unit in Name, the lithology of the missing unit in Primary Lithology, and enter NP (not present) in Lithology Modifier, i.e. 0 cache coal NP
(8M) color	COLOR	GSA international standard color abbreviations preferable. Use dash (-) instead of slash (/), e.g., 10YR7-4. If GSA abbreviations are not available, use NCRDS abbreviation list; the only acceptable punctuation is a dash (-) or ampersand (&).
(8M) grnsize	GRAIN SIZE	Wentworth scale preferable.
(8M) grnshap	GRAIN SHAPE	use NCRDS abbreviation list.
(12M) mineral	MINERALOGY	use NCRDS abbreviation list.
(8A) bedding	BEDDING	use NCRDS abbreviation list.
(1A) contact	CONTACT	enter appropriate letter code in column for contact with unit above.

(continued)

S sharp
G gradational
U undulating
I irregular
N unconformable
L slump
O other (enter specifics in Comment2 column)

(1A)
fossils

FOSSILS enter appropriate letter code in column.

P plant
I invertebrate
V vertebrate
F freshwater
B brackish
M marine
O other (enter specifics in Comment2 column)

(3A)
fjc

FJC (FRACTURES/JOINTS/CLEATS) if applicable, enter one or more of three letter (F, J, and/or C) in the appropriate column to indicate presence of condition(s) and describe in Comment2 column. Use the following notation:

cf 73 86S for face strike N 73° E dip 86° S
cb 335 90 for butt strike N 25° W dip 90°
cb 345 42E for butt strike N 15° W dip 42° E
cf = cleat face strike and dip
cb = cleat butt strike and dip

Measurements are from 1° to 360° clockwise with E = 90°, S = 180° W = 270°, N = 360°

(40M)
coment2

COMMENT2 supplemental information to any of the elements for the described rock unit. Use NCRDS abbreviation list (see page 2). Forty characters are allowed including spaces; computer will truncate entry at 40 characters. Limit punctuation to commas between thoughts.

abnd ..... Abandoned
abv ..... Above
abdt ..... Abundant
aluv ..... Alluvial
alt ..... Altered (-ing)
amt ..... Amount
anal ..... Analysis (-itical)
ang ..... Angular
anhyd ..... Anhydrite
anth ..... Anthracite
appx ..... Approximately
arg ..... Argillaceous
ark ..... Arkose (-ic)
asph ..... Asphalt (-ic)
attr ..... Attritus (-al)
avail ..... Available
av ..... Average

bnd ..... Band (-s,-ed)
bs ..... Base (-al)
baux ..... Bauxite (-itic)
[illegible]m ..... Become (-s,-ing)
bd ..... Bed (-ded,-s)
bdg ..... Bedding
bnt ..... Bentonite
bioc ..... Bioclastic
bitrb ..... Bioturbated (-ion)
bitn ..... Bitumen
bit ..... Bituminous
blk..... Black
blky ..... Blocky
bn ..... Bone
bny ..... Boney
btm ..... Bottom
bldr ..... Boulder (-s) (256mm+)
brch ..... Brachiopod
brak ..... Brackish
brec ..... Breccia (-ted)
brt ..... Bright
brtl ..... Brittle
brkn ..... Broken
brn ..... Brown
brw ..... Burrows

calc ..... Calcareous
[illegible]t ..... Calcite
canl ..... Cannel (-oid)
carb ..... Carbonaceous

cv ..... Caved (-ing,-ings)
cmt ..... Cement (-ed)
cm ..... Centimeter (-s)
ch ..... Channel
chrt ..... Chert (-y)
clrn ..... Clarain
cly ..... Clay (-ey,<1/256mm)
clst ..... Claystone
cln ..... Clean
clt ..... Cleat (-s)
cb ..... Cleat Butt
strike and dip
cf ..... Cleat Face
strike and dip
cl ..... Clinker (-ed)
clus ..... Cluster
crs ..... Coarse (-ly)
coaly ..... Coaly
cbbl ..... Cobble (64-256mm)
cluv ..... Colluvial
col ..... Color (-ed)
com ..... Common
cpct ..... Compact
con ..... Concealed
conch ..... Conchoidal
cncr ..... Concretion (-ary)
cic ..... Cone-in-cone
cgl ..... Conglomerate
cndt ..... Conodont
cnsd ..... Consolidate (-d)
ctc ..... Contact
contm ..... Contaminated
cont ..... Continuous
ctrt ..... Contorted
cnvt ..... Convolute
coq ..... Coquina
crl ..... Coral
cr..... Cream
cren ..... Crenulated
crnd ..... Crinoid
x ..... Cross (as prefix)
xbd ..... Cross-bedded
xbdg ..... Cross-bedding
xlam ..... Cross-laminated
xl ..... Crystal (-s)
xln ..... Crystalline
ctfl ..... Cut and fill
ctg ..... Cutting (-s)
crnk ..... Crinkled

dk ..... Dark
deb ..... Debris
decr ..... Decrease (-ing)
dns ..... Dense (-er)
dtc ..... Depth to coal
dtr ..... Detritus (-al)
dia ..... Diameter
ddh ..... Diamond drill hole
drty ..... Dirty
dcnt ..... Discontinuous
dism ..... Disseminated
dstd ..... Distorted
dstb ..... Disturbed
dol ..... Dolomite (-ic)
dwn ..... Down (-ward)
dr ..... Drift
drlg ..... Drilling
dh ..... Drill hole
durn ..... Durain

[illegible]th ..... Earth (-y)
E ..... East
elog ..... Electric log
elv ..... Elevation
elip ..... Ellipsoidal
elon ..... Elongate
est ..... Estimate (-d)
evap ..... Evaporite (-ic)
elip ..... Ellipsoidal
elon ..... Elongate

fnt ..... Faint (-ly)
flt ..... Fault (-ed)
ft ..... Feet
feld ..... Feldspar (-thic)
fe ..... Iron-ferruginous
fest ..... Ironstone
fld ..... Field
fl ..... Fill (-ed)
f ..... Fine (-ly)
fcly ..... Fireclay
fis ..... Fissile
flky ..... Flaky
flsr ..... Flaser
[illegible]t ..... Flattened
fccy ..... Flintclay
flor ..... Fluorescence

fol ..... Foliated
fm ..... Formation
foss ..... Fossil(-iferous)
frac ..... Fracture (-ed)
frag ..... Fragment (-al,-ed)
freq ..... Frequent
frsh ..... Fresh
fri ..... Friable
fros ..... Frosted
fs ..... Fusain
fusl ..... Fusulinid

glog ..... Gamma log
gstr ..... Gastropod
gl ..... Glass (-ly)
glauc ..... Glauconite (-ic)
grdl ..... Gradational
grd ..... Grade (-ed,-s)
gr ..... Grain (-ed)
gran ..... Granule (2-4 mm)
grvl ..... Gravel (>2mm,-ly)
gy ..... Gray
gywke ..... Graywacke
grtr ..... Grazing trails
gn ..... Green
grty ..... Gritty
gyp ..... Gypsum

hky ..... Hacky
hd ..... Hard
hvy ..... Heavy
hem ..... Hematite (-ic)
hor ..... Horizontal
hum ..... Humus (-ic)
HC ..... Hydrocarbon

ign ..... Igneous
imbd ..... Imbedded
impr ..... Impression
in ..... Inch (-es)
inc ..... Inclined
incl ..... Included (-sive,-sion)
incr ..... Increase (-ing)
ind ..... Indurated
inbd ..... Interbedded
intlam ..... Interlaminated
intstl ..... Interstitial

intv ..... Interval
invt ..... Invertebrate
fe ..... Iron-ferruganous
fest ..... Ironstone
irreg ..... Irregular

jnt ..... Joints

kaol ..... Koalin (-itic)

lac ..... Lacustrine
lam ..... Laminated (-ae)
lrg ..... Large (-er)
lchd ..... Leached
len ..... Lentil (-cular)
lt ..... Light (-er)
lig ..... Lignite (-ic)
ls ..... Limestone
limy ..... Limey
lmn ..... Limonite (-ic)
lin ..... Lineation
loc ..... Location
loes ..... Loess
lng ..... Long
lwr ..... Lower
lstr ..... Lustre

magn ..... Magnetic
mar ..... Marine
mrlst ..... Marlstone
mass ..... Massive
mtx ..... Matrix
mat ..... Matter,material
mea ..... Measured
med ..... Medium
mgsp ..... Megaspores
mbr ..... Member
manth ..... Meta-anthracite
meta ..... Metamorphic
mica ..... Mica (-ceous)
mflt ..... Microfault
microfos ..... Microfossil (-iferous)

mid ..... Middle
mm ..... Millimeter (-s)
min ..... Mineral (-ized)
mnr ..... Minor
mis ..... Missing
mxd ..... Mixed
mod ..... Moderate
mot ..... Mottled
mdfl ..... Mudflow
mdst ..... Mudstone
musc ..... Muscovite (-itic)

nr ..... No data (see No record)
nr ..... No record,not logged, no data and not available
nod ..... Nodule (-ar,-s)
N ..... North
nr ..... Not available (see No record)
nr ..... Not logged (see No record)
np ..... Not present
ntbk ..... Notebook
num ..... Numerous

occ ..... Occasional
ool ..... Oolite (-ic)
orng ..... Orange
opq ..... Opaque
ovrbrdn ..... Overburden
ovly ..... Overlying
olv ..... Olive
ostr ..... Ostrocod

paln ..... Palynology
pt ..... Part (-ly)
ptg ..... Parting
pnl ..... Parting(s) Not Located in coal bed
prly ..... Pearly
pbl ..... Pebble (4-64 mm)
pbly ..... Pebbly
plcy ..... Pelecypod
perm ..... Permeability
ptrw ..... Petrified wood

pet ..... Petroleum (-ferous)
phos ..... Phosphate (ic)
pnk ..... Pink
piso ..... Pisolite (-ic)
pit ..... Pitted
plag ..... Plagioclase
plas ..... Plastic
pl ..... Plants
plty ..... Platy
pr ..... Poor (-ly)
por ..... Porous (-sity)
poss ..... Possible (-ility)
pred ..... Predominate (-ly)
pres ..... Preserved (-ation)
prim ..... Primary
prob ..... Probable (-ly)
proj ..... Project
prom ..... Prominent (-ly)
psdo ..... Pseudo
prpl..... purple
pyr ..... Pyrite (-ic,-ized)

qtz ..... Quartz
qtzte ..... Quartzite
qtzse ..... Quartzose
quat ..... Quaternary
(use abv form only
in misc and comments
fields

rng ..... Range (-ing)
reg ..... Regular
rmn ..... Remains (-nant)
repl ..... Replaced (-ing,-ment)
rsid ..... Residual (-uum)
rpl ..... Ripple
rplm ..... Ripple mark (-s)
rk ..... Rock
rf ..... Roof
rf rk ..... Roof Rock
r&p ..... Room & Pillar
root ..... Root (-s,-let)
rnd ..... Round (-ed)
rust ..... Rust (-ed,-y)

sach ..... Saccharoidal
s&p ..... Salt & Pepper

smpl ..... Sample
sd ..... Sand
sdrk ..... Sandrock
ss ..... Sandstone
sdy ..... Sandy
scat ..... Scattered
schst ..... Schist
strk ..... Seatrock
sec ..... Secondary
sect ..... Section
sed ..... Sediment (-s,-ary)
sel ..... Selenite
santh ..... Semianthracite
sept ..... Septarian
shft ..... Shaft
sh ..... Shale
shly ..... Shaly
shrp ..... Sharp
sid ..... Siderite (-ic)
sil ..... Silica (-eous)
slt ..... Silt
slst ..... Siltstone
slty ..... Silty
sks ..... Slickensided
sl ..... Slight (-ly)
slmp ..... Slump (-ed)
sml ..... Small
sm ..... Smooth
spst ..... Soapstone
sol ..... Solution
srtd ..... Sorted
So ..... South
sphl ..... Sphalerite
sph ..... Spherules
splnty ..... Splintery
stn ..... Stain (-ed,-ing)
strat ..... Strata (-ified)
str ..... Streak (-ed,-s)
stri ..... Striated
strg ..... Stringer
struc ..... Structure
styl ..... Stylolite
sbang ..... Subangular
subbit ..... Subbituminous
sbhz ..... Subhorizontal
S ..... Sulfur
surf ..... Surface

tab ..... Tabular
tex ..... Texture
thk ..... Thick (-ness)
thn ..... Thin
thru ..... Throughout
tt ..... Tight (-ly)
tng ..... Tongue
tnst ..... Tonstein
tce ..... Top of coal elevation
tgh ..... Tough
tr ..... Trace
trct ..... Tract
trans ..... Transitional
trnsl ..... Translucent
trnsp ..... Transparent
tub ..... Tubular
tuf ..... Tuffaceous
turq ..... Turquoise

unconf ..... Unconformity(-able)
unc ons ..... Unconsolidated
unc s mat ..... Unconsolidated Materia
uc ..... Underclay
ul ..... Underlying (lain)
undul ..... Undulates (-atory)
uni ..... Uniform
unkn ..... Unknown
uppr ..... Upper

var ..... Variable (varies)
vcol ..... Varicolored
vrgt ..... Variegated
vrvd ..... Varved
veg ..... Vegetation (-ed)
vn ..... Vein
vert ..... Vertebrate
vrtl ..... Vertical
v ..... Very
ves ..... Vesicular
vt ..... Vitrain
vit ..... Vitreous
volc ..... Volcanics

w ..... Water
wvy ..... Wavy
wxy ..... Waxy
wk ..... Weak

wthrd ..... Weathered
well ..... Well
W ..... West
wht ..... White
w- ..... With

x ..... Cross (as prefix)
xbd ..... Cross-bedded
xbdg ..... Cross-bedding
xlam ..... Cross-laminated
xl ..... Crystal (-s)
xln ..... Crystalline

ylw ..... Yellow

zn ..... Zone

& ..... And
- ..... hyphen (not minus sign
(.) ..... decimal pt(not period)
? ..... questionable