IMPLEMENTATION OF SLOPE STABILITY RESEARCH: GEOLOGIC PROFILES ALONG I-70 AND I-77

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Acknowledgments. The field work, which consisted of identification of the various geologic formations and members, was done by G. O. Johnson, formerly of ODOT, and R. L. Williams, formerly of OSU. Records of recent boreholes were provided by M. Stouffer of ODOT. The contact person at ODOT was E. C. Geiger, who participated in and contributed much to the earlier research projects. The drafting was done by W. J. Hartleib.

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16. Abstract

Abstract. The objective is to produce geologic profiles along interstate routes I-70, Mi. 163 to 203, and I-77, Mi. 6 to 38. These sections traverse regions where the red shales of the Pennsylvanian and Permian ages occur near the surface in many localities. Slope failures in the red shales constitute a serious maintenance problem. The geologic profiles were constructed to provide engineers with advance information as to where the red shales are likely to be encountered, so that potential problems can be anticipated and included in the planning process.

The geology was studied as a part of earlier research projects. The various geologic formations and members were identified by inspection of materials exposed in cut slopes and natural slopes. Borehole records were used to locate the formations between the exposures. This information was presented in the form of geologic profiles. Information from records of boreholes made by ODOT along these routes after 1987 was incorporated into the profiles.

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1. INTRODUCTION

Failures of cut slopes in shale and embankment slopes built of shale have occurred on many of Ohio's highways. This is particularly serious in southeastern Ohio where red shales of Pennsylvanian and Permian ages are encountered. Slope failures in red shales constitute a serious maintenance problem.

Causes of slope failures along I-70 and I-77 were studied in three research projects. The failure mechanisms and recommendations for choice of design parameters were presented in Wu (1977, 1981, and 1987) and Wu et al (1987, 1991). Two remedial measures for slope failures were evaluated and found to be successful during the period of the observation (Wu, 1995). These results provide ODOT engineers with basic information for design of slopes in the red shales. General descriptions of the red shales are given in Condit (1912) and Fisher et al (1968).

It is realized that knowing the geology of the bedrock and localities where the red shales occur near the surface will be helpful to ODOT engineers planning various construction and maintenance activities. Geologic profiles would provide engineers with advance information as to where the red shales are likely to be encountered, so that potential problems can be anticipated and included in the planning process.

2. OBJECTIVE

The objective is to produce geologic profiles along interstate routes I-70, Mi. 160 to 204, and I-77, Mi. 6 to 38. These sections traverse regions where the red shales occur near the surface in many localities.

3. DESCRIPTION OF RESEARCH

The geology along I-70, Mi. 163 to 203, and I-77, Mi. 6 to 38 were identified as a part of the earlier research described above. The geologic section along the corridor was controlled stratigraphically by Ohio Geological Survey's registered measured sections with defined stratigraphic units. These units are major limestone and coal units with regional continuity. The intervening "shale" units were defined by their positions in relation to the limestone and coal beds. Additional control was developed from waterwells registered at the Ohio Dept. of Natural Resources, Div. Of Water, and borehole records of ODOT. Observations of significant

stratigraphic outcrops exposed in cut slopes and natural slopes defined the specific stratigraphic units.

We produced the profiles with the data collected in three research projects: Stability and Performance of Earthworks in Residual Clay Soils of Southeastern Ohio, Stability of Slopes in Shale and Colluvium, and Long-term Strength of Embankments: Shale and Colluvium, to produce the geologic profiles. In addition, we obtained from ODOT records of boreholes made along these routes after 1987. This information was incorporated into the profiles.

4. RESULTS

The three formations that contain red shales are the Washington, Monongahela, and Conemaugh. The region where these formations occur close to the surface are shown in Fig. 1. A simplified stratigraphic column showing the prominent members of these formations is given in Table1. The detailed stratigraphic column by Johnson (1982) is reproduced in Appendix A.

Table 1 also shows the notations used to identify the various members in the geologic profiles. The notations are assigned according to the following system. The First few letters denote the name of the member (eg. LM= Lower Marietta, C = Creston, Wa = Washington, etc.) The last capital letter, which may be followed by a lower case letter, denote the material type : C = coal, L = limestone, S = shale, Ss = sandstone (CS = Creston Shale, LMSs = Lower Marietta Sandstone). Where a member contains more than one facies, only the first is represented in the notation for brevity (MSs = Mannington Sandstone and Shale). In this report, the term "shale" includes clay-shale, siltstone and mudstone.

The geologic profiles are shown in Appendices B and C. In the profiles, thick formations are assumed to be continuous, whereas thin layers, primarily sandstone and limestone, that are known to be of limited extent, are shown as discontinuous. Unconsolidated materials (colluvium and alluvium) and unidentified materials are shown as blank spaces.

The user should note that the profiles are simplifications, based on extrapolation between observation points, that are located far apart. Therefore, continuity of formations as shown

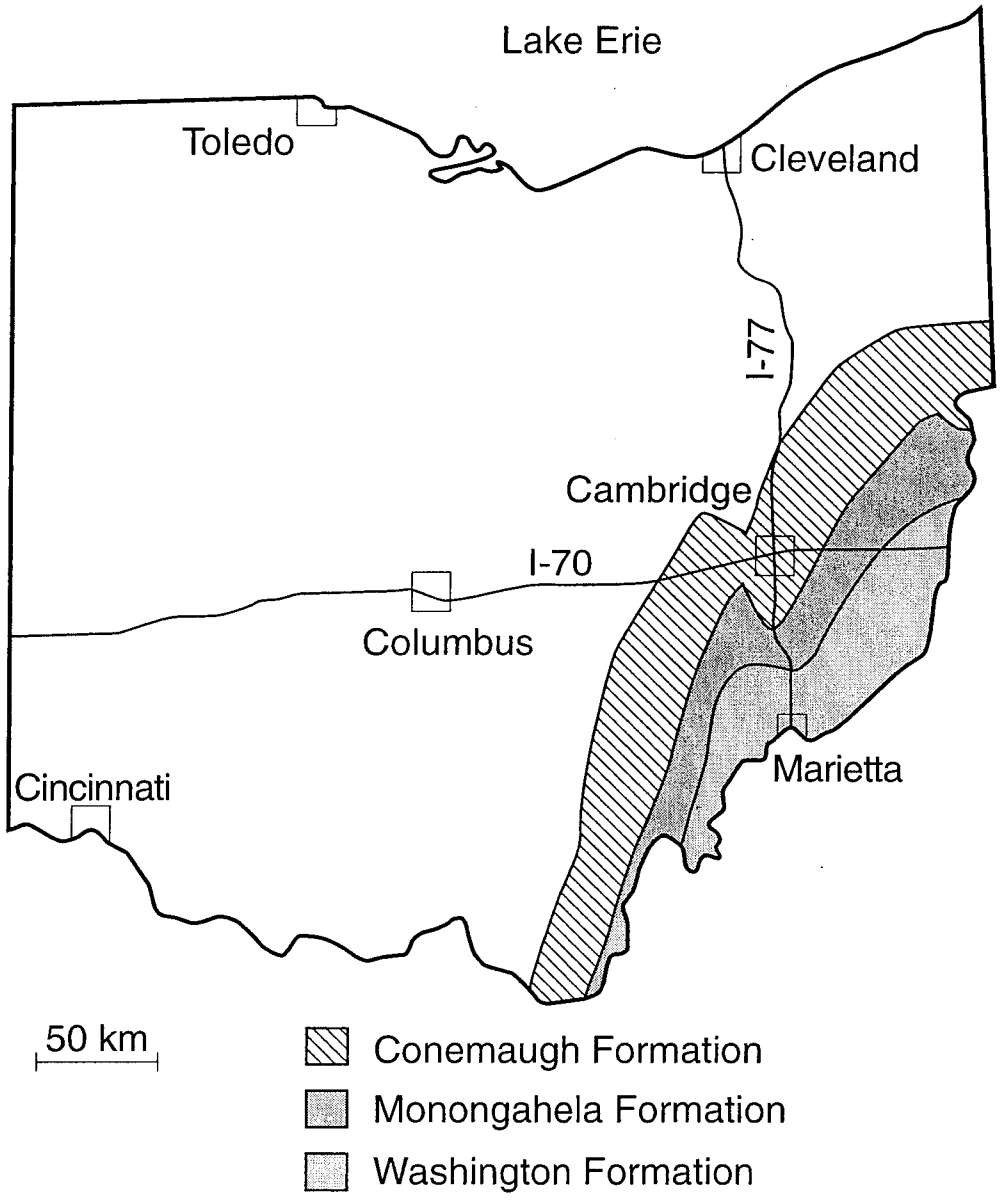

Fig. 1. Outcrop of Washington, Monongahela and Conemaugh Formations

Table 1. Simplified Stratigraphic Column

(a) Members of Washington Formation.

Jollytown Coal	
Upper Washington Limestone and Shale	
Upper Marietta Sandstone	
Washington "A" Coal	
Creston Shale	CS
Lower Marietta Sandstone	LMSs
Washington Coal No.12	WaC
Washington Sandstone and Shale	WaSs
Mannington Sandstone and Shale	MSs
Waynesburg "A" Coal	WAC

(b) Members of Monongahela Formation

Waynesburg Coal No.11	WC
Gilboy Sandstone	GSs
Waynesburg Limestone	WL
Uniontown Sandstone and Shale	USs
Uniontown Coal	UC
Arnoldsburg Limestone and Shale	ArL
Benwood Limestone and Shale	BL
Sewickley Sandstone and Shale	SSs
Meigs Creek Coal No. 9	MCC
Fishport Limestone	FL
Pomeroy Sandstone and Shale	PmSs
Redstone "Pomeroy" Coal	RC
Pittsburgh Sandstone and Shale	PSs

Table 1 (continued)

(c) Members of Conemaugh Formation	
Pittsburgh Coal No. 8	PC8
Bellaire Sandstone and Shale	BeSs
Lower Little Pittsburgh Coal	LLPC
Summerfield Limestone	SuL
Connellsville Shale	CoS
Connellsville Sandstone and Shale	CoSs
Clarksburg Limestone and Shale,	CL
Morgantown Sandstone and Shale	MoSs
Elk Lick Limestone	ELL
Birmingham Shale	BiS
Duquesne Shale	DS
Gaysport Limestone	GL
Ames Limestone	AL
Round Knob Shale	RKS
Harlem Coal	HC
Saltsburg Sandstone and Shale	SSs
Ewing Limestone	EL
Cowrun Sandstone and Shale	CrSs
Anderson Coal	AC
Cambridge Limestone	CaL
Wilgus Coal	WiC
Buffalo Sandstone and Shale	BuSs
Brush Creek Shale	BCS
Mason Coal	MC
Upper Mahoning Sandstone and Shale	UMaSs
Lower Mahoning Sandstone and Shale	LMaSs
Upper Freeport Coal No.7	UFC

cannot be assured. In addition, the user should be aware of the variability of natural materials. The material characteristics may vary considerably even between two points that are not very far apart.

5. CONCLUSIONS AND RECOMMENDATIONS

The profiles make the geologic information readily available to engineers in a user-friendly format. The information would alert engineers to probable presence of red shales and allow them to take the potential problems into account in planning and design.

6. IMPLEMENTATION

The implementation of the results will consist of the use of the geologic profiles by ODOT engineers when planning various construction and maintenance activities. The geologic profiles would provide engineers with advance information as to where the red shales are likely to be encountered, so that potential problems can be anticipated and included in the planning process.

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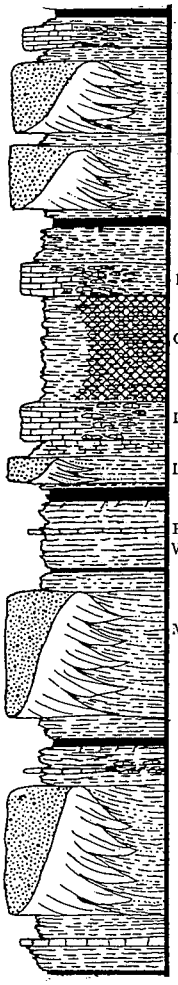
APPENDIX A. STRATIGRAPHIC COLUMNS
(from Johnson, 1982)

WASHINGTON



Jollytown "A" Coal

Upper Washington Limestone and Shale;fresh water, white to blue, fossiliferous.

Hundred Sandstone and Shale: medium to coarse grained with pebbles, light brown, massive to ripple marked, lime cemented, micaceous.

Upper Marietta Sandstone and Shale;medium grained, light brown to gray, massive to laminated, micaceous (black).

Washington "A" Coal

Middle Washington Limestone and Shale; fresh water, light-brownish gray with orange hue, massive, fossiliferous.

Creston-Reds Shale and Mudstone;dusky red to dark red or dark olive with limestone nodules.

Lower Washington Limestone and Shale;fresh water, medium to olive gray, contains clay and silt, conglomeratic.

Lower Marietta Sandstone and Shale;med-fine gr, cross bedded

Washington Coal No. 12

Bristol Limestone;fresh water, yellowish gray, clayey, conglom.

Washington Sandstone and Shale;fine gr., lt. gray, micaceous.

Little Washington Coal

Mannington Sandstone and Shale;fine grained, gray to greenish gray, massive to laminated, micaceous, fossiliferous.

Waynesburg "A" Coal No. 11a

Mount Morris Limestone and Shale;fresh water, clayey, gray.

Waynesburg Sandstone and Shale; fine to coarse grained with pebbles, gray, massive cross bedded to thin bedded, micaceous.

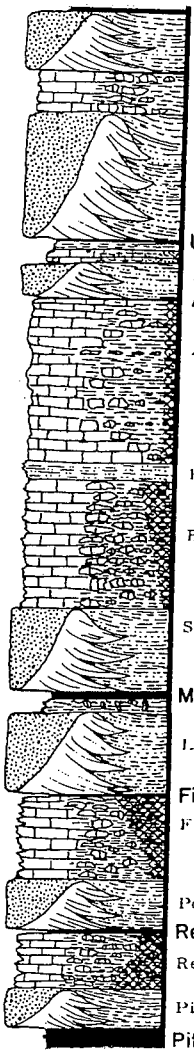
Wegee Limestone and Shale;fresh water, silty, conglomeratic.

Elm Grove Limestone;marine, dark bluish gray, laminated

Cassville Shale;medium blue gray, fossiliferous.

Waynesburg Coal No. 11

MONONGAHELA



Waynesburg Coal No. 11

Gilboy Sandstone and Shale; shaley sandstone, gray to olive gray, thin bedded.

Little Waynesburg Coal

Waynesburg Limestone and Shale; fresh water, olive gray silty to clayey, conglomeratic.

Uniontown Sandstone and Shale; fine to medium grained, light gray to tan, massive to shaley, micaceous, fossiliferous may contain Annabelle Shale.

Uniontown Coal No. 10

Uniontown Limestone and Shale; fresh water, med gn gy, brecc.

Arnoldsburg Sandstone and Shale; fine grained, gn gy, mica.

Arnoldsburg Coal

Arnoldsburg Limestone and Shale; fresh water, light brownish gray, silty to clayey, conglomeratic.

Fulton Shale; green to bluish green, graded to siltstone.

Benwood Limestone and Shale; fresh water, light to olive gray, argillaceous, upper portion is sedimentary breccia, lower basal layers are conglomeratic.

Sewickley Sandstone and Shale; fine grained to siltstone, laminated, greenish gray, glauconitic, lenses of medium to coarse grained sandstone in lower unit.

Meigs Creek Coal No. 9

Lower Sewickley Sandstone and Shale; fine grained, light tan gray, clay bonded, thin bedded to massive.

Fishpot Coal

Fishpot Limestone and Shale; fresh water, light brownish to olive gray, laminated fine grained limestone, breccia, fossiliferous.

Pomeroy Sandstone and Shale; coarse grained, light bluish gy.

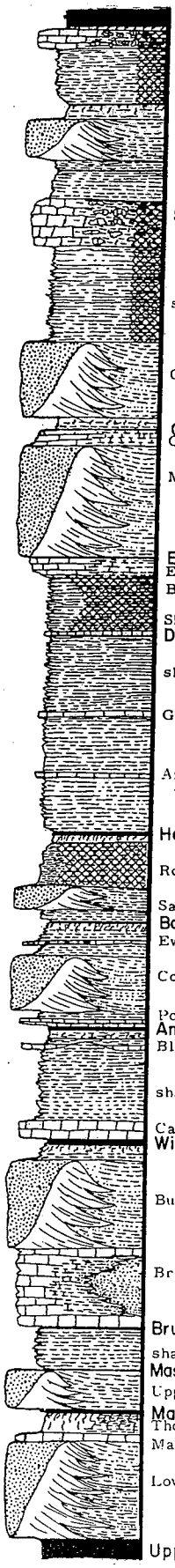
Redstone "Pomeroy" Coal

Redstone Limestone and Shale; fresh water, medium gray to light olive, brecciated and shrinkage cracks, sideritic.

Pittsburg Sandstone and Shale; coarse to fine gr, light gray.

Pittsburgh Coal No. 8

CONEMAUGH



Pittsburgh Coal No.8

Pittsburgh Limestone and Shale;fresh water, black to bluish tan, dolomitic, amorphous, brecciated,

shale

Upper Little Pittsburgh Coal

Bellaire Sandstone and Shale;coarse grained to fine grained,

Lower Little Pittsburgh Coal

Summerfield Limestone and Shale;fresh water, light to medium tan gray, amorphous, conglomeratic, interbedded clay

shale

Connellsville Sandstone and Shale;coarse grained, yellowish gray, crossbedded to laminated.

Clarksburg Coal

Clarksburg Limestone and marly Shale;fresh water, bluish gy.

Morgantown Sandstone and Shale;coarse to fine grained, bluish gray, massive, arkosic.

Elk Lick Coal

Elk Lick Limestone and marly Shale;fresh water, nodular.

Birmingham Shale, marine, gray to red shale, fossiliferous, hematite nodules, facies to Morgantown Sandstone

Skelly Limestone;marine, blue to greenish gray, fossiliferous

Duquesne Coal

shale

Gaysport Limestone;marine, nodular, light to dark gn gray, impure with sand and silt.

Ames Limestone; marine, crinoidal, light brownish gray, crystalline

Harlem Coal

Round Knob Shale, red,clay stone, calcareous, fresh water limestone nodules and beds.

Saltzburg Sandstone and Shale;fine grained, thin bedded, gray

Barton Coal

Ewing Limestone, fresh water, light gray, ferruginous.

Cowrun Sandstone and Shale;coarse grained,massive, light yellowish gray.

Portersville Limestone;marine, black, fossiliferous, pyritic.

Anderson Coal

Bloomfield Limestone, fresh water, light gray, nodular

shale

Cambridge Limestone, marine, light yellowish gray, flinty, fossiliferous.

Wilgus Coal

Buffalo Sandstone and Shale;coarse grained light yellowish gray, massive to thin bedded.

Brush Creek Limestone and Shale; marine, medium bluish gray, cherty, hard, fossiliferous.

Brush Creek Coal

shale

Mason Coal

Upper Mahoning Sandstone and Shale;fine grained to shaley,

Mahoning Coal

Thornton Clay, mottled green and red claystone

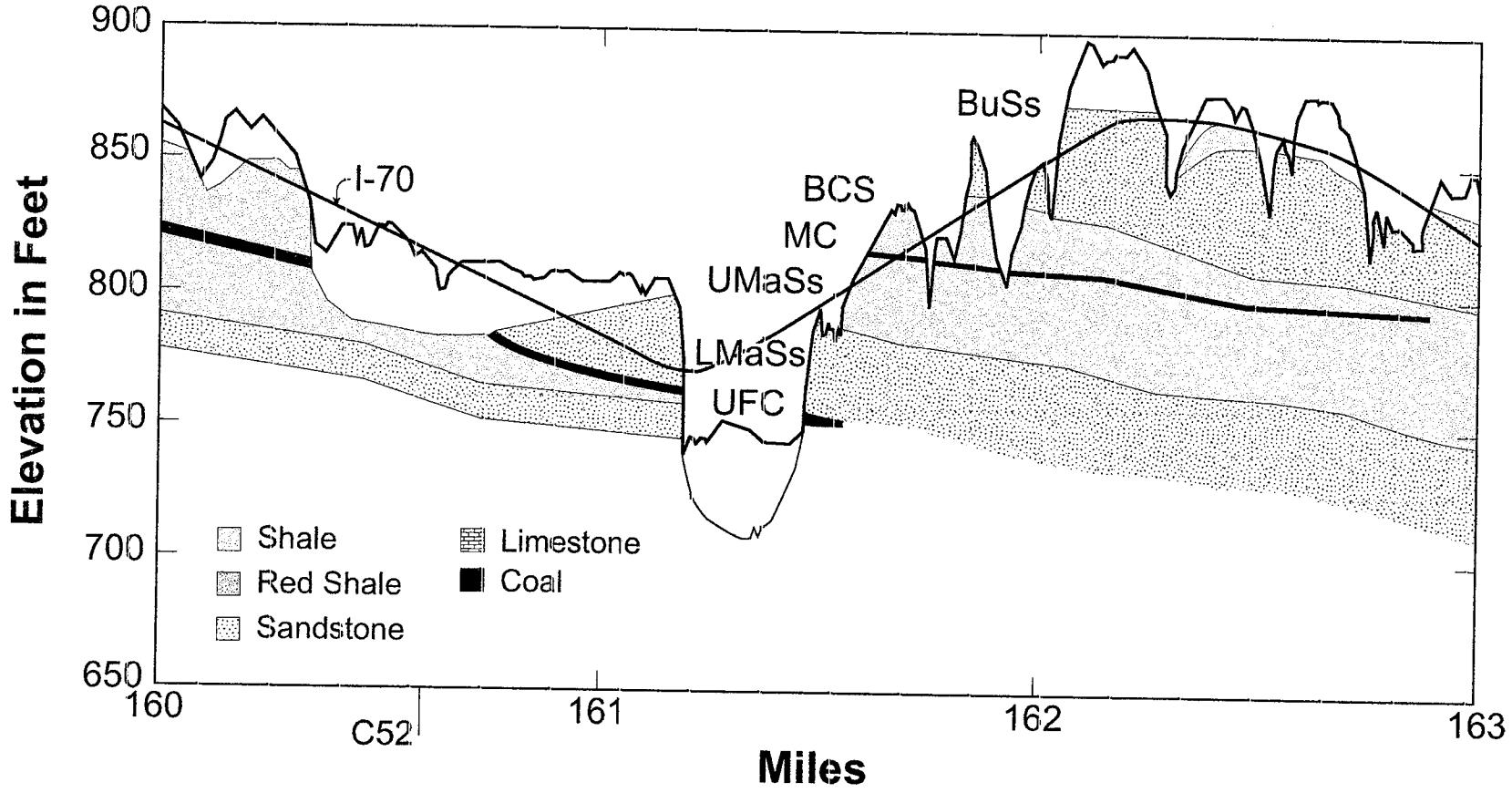
Mahoning Limestone;fresh water, bluish gray, ferruginous

Lower Mahoning Sandstone and Shale;coarse grained with pebbles, massive to cross bedded, light gray.

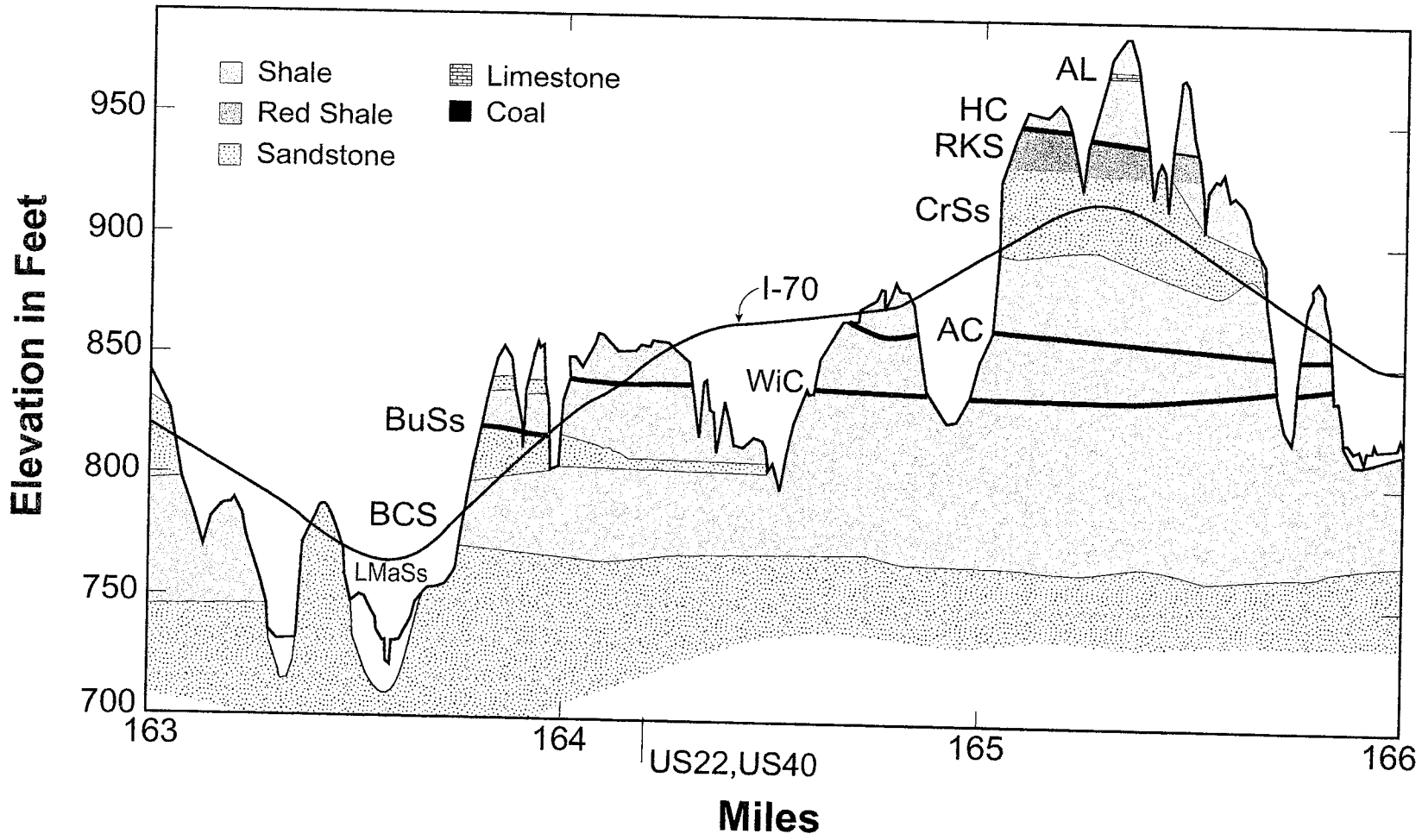
Upper Freeport Coal No.7

APPENDIX B GEOLOGIC PROFILES, I-70

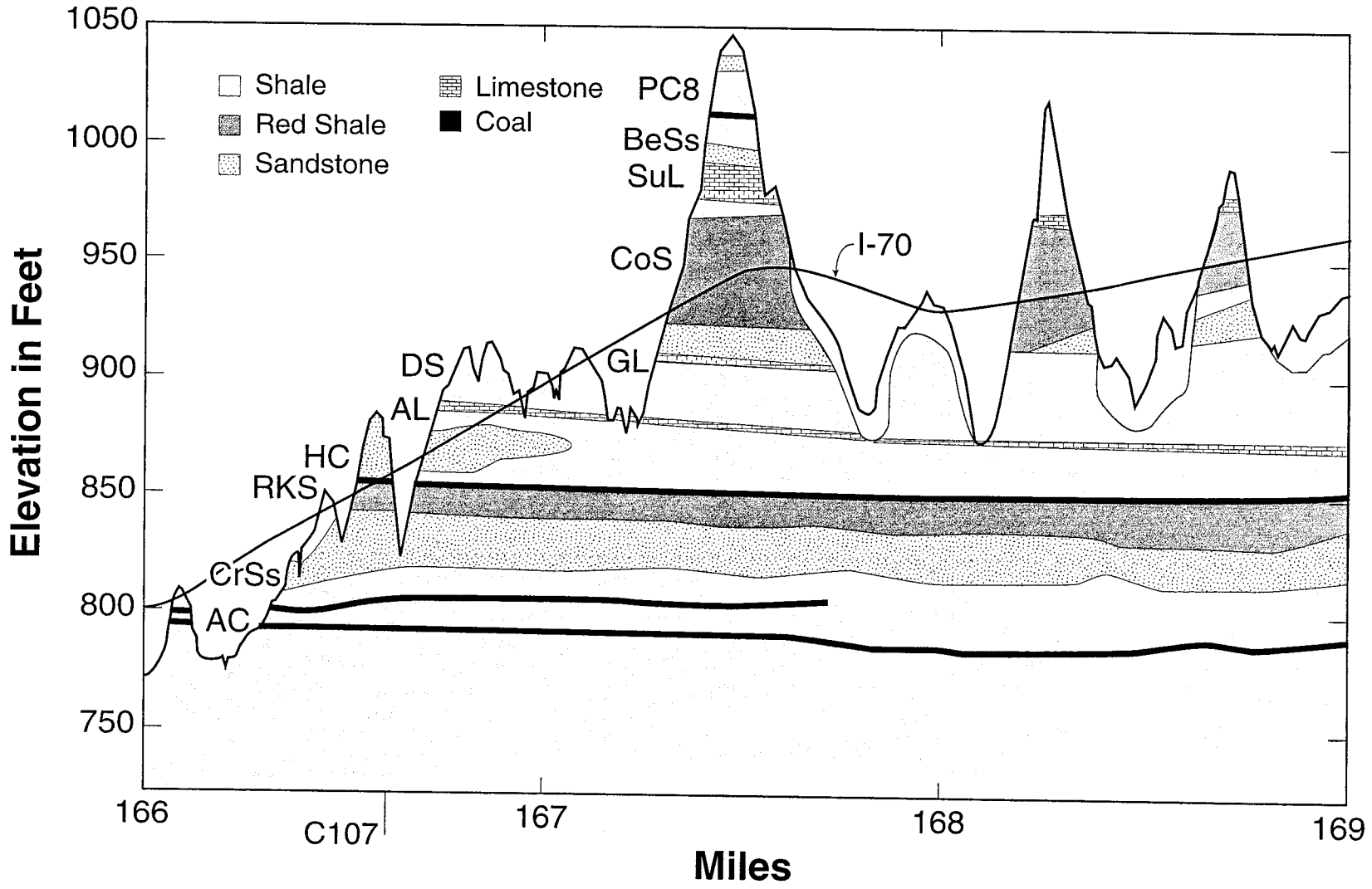
BuSs = Buffalo Sandstone and Shale; BCS = Brush Creek Shale; MC = Mason Coal; CL = Brush Creek Limestone; UMaSs = Upper Mahoning Sandstone and Shale; LMaSs = Lower Mahoning Sandstone and Shale; UFC = Upper Freeport Coal No.7



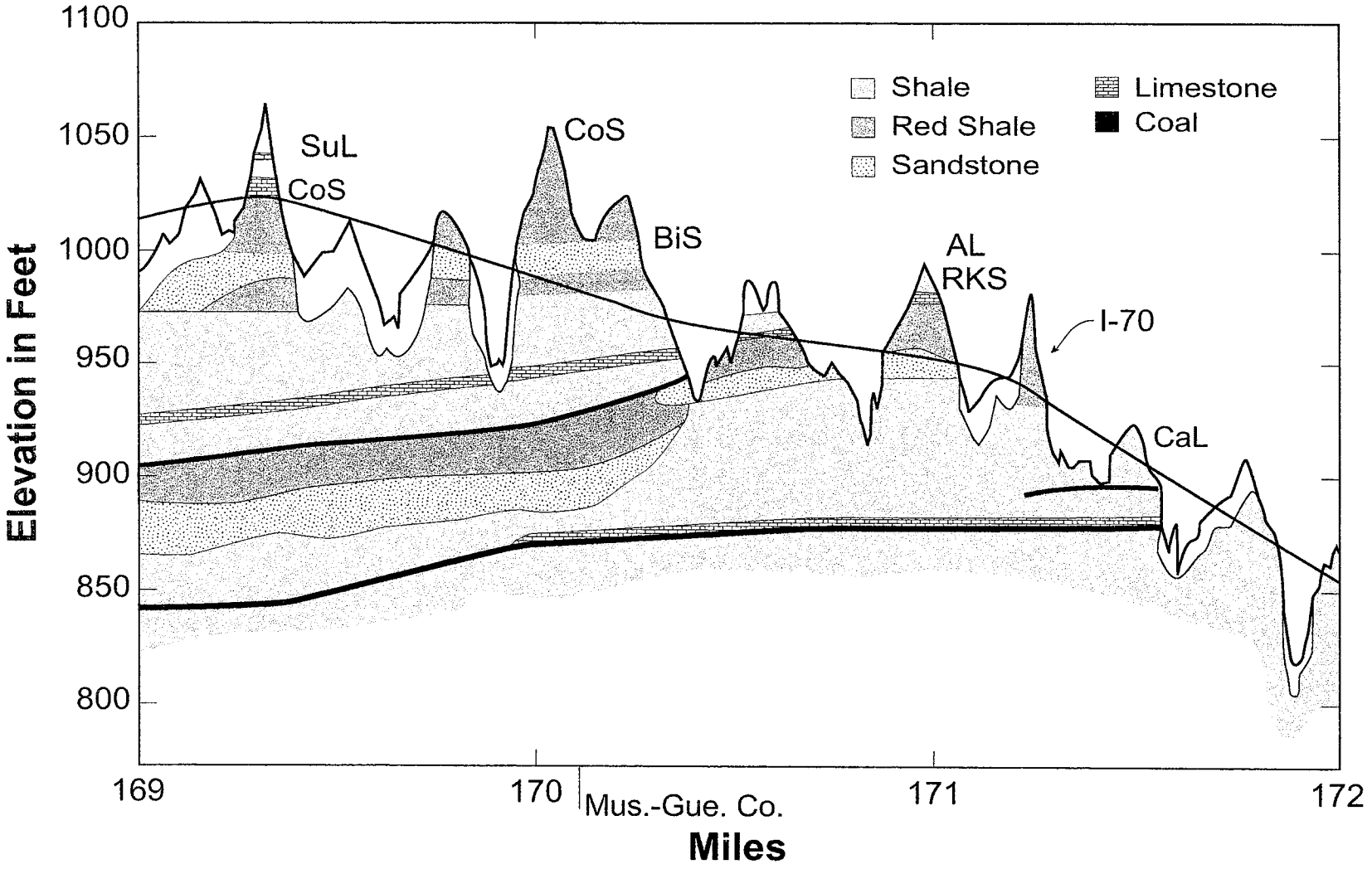
AL = Ames Limestone; HC = Harlem Coal; RKS = Round Knob Shale; CrSs = Cowrun Sandstone and Shale; AC = Anderson Coal; WiC = Wilgus Coal; BuSs = Buffalo Sandstone and Shale; BCS = Brush Creek Shale; BCL = Brush Creek Limestone; LMaSs = Lower Mahoning Sandstone and Shale



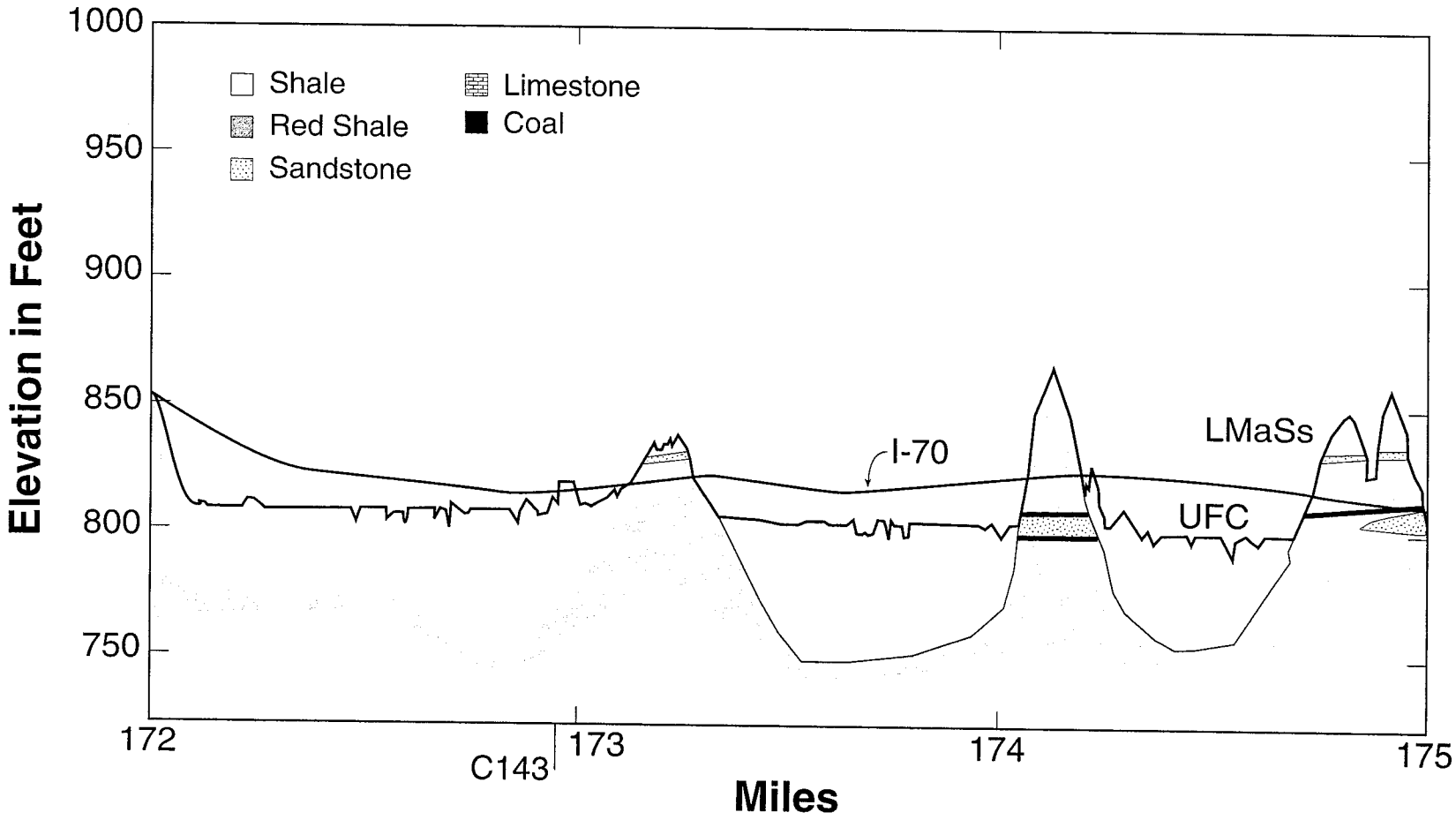
PC8 = Pittsburgh Coal No. 8; BeSs = Bellaire Sandstone; SuL = Summerfield Limestone; CoS = Connellsville Shale; DS = Duquesne Shale; GL = Gaysport Limestone; AL = Ames Limestone; HC = Harlem Coal; RKS = Round Knob Shale; CrSs = Cowrun Sandstone and Shale; AC = Anderson Coal



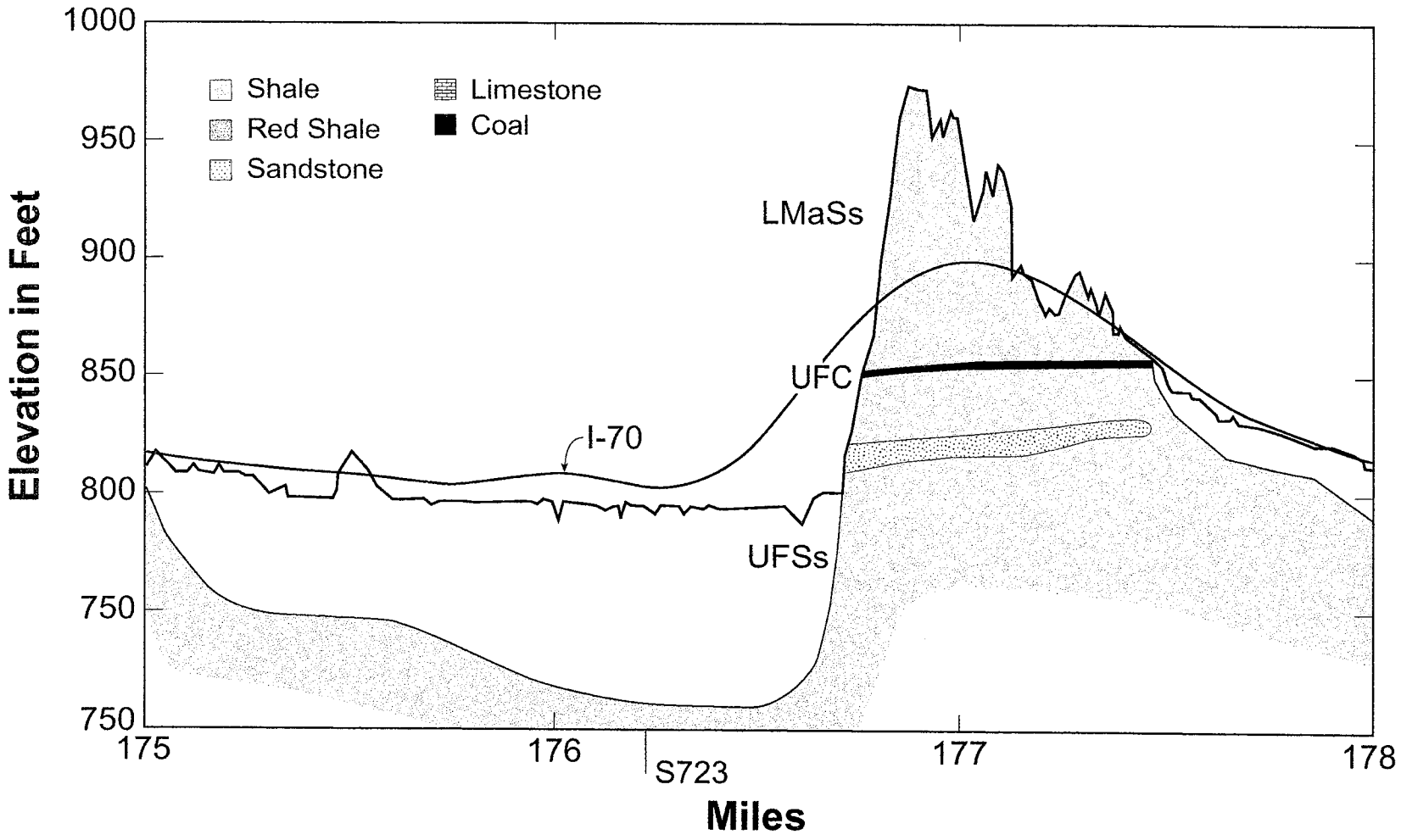
SuL = Summerfield Limestone; CoS = Connellsville Shale; BiS = Birmingham Shale; AL = Ames Limestone; HC = Harlem Coal; RKS = Round Knob Shale; CaL = Cambridge Limestone



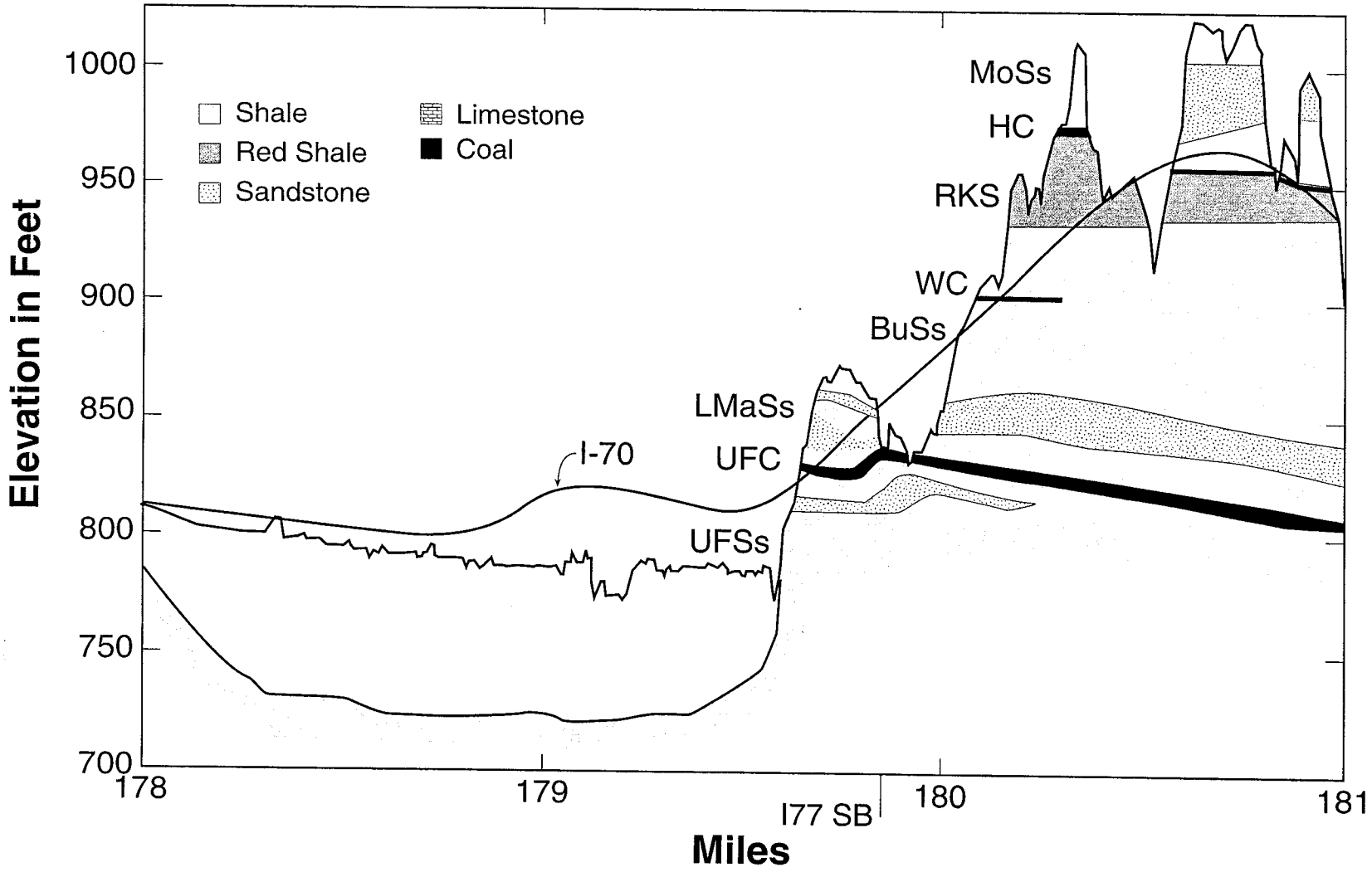
LMaSs = Lower Mahoning Sandstone and Shale; UFC = Upper Freeport Coal No.7



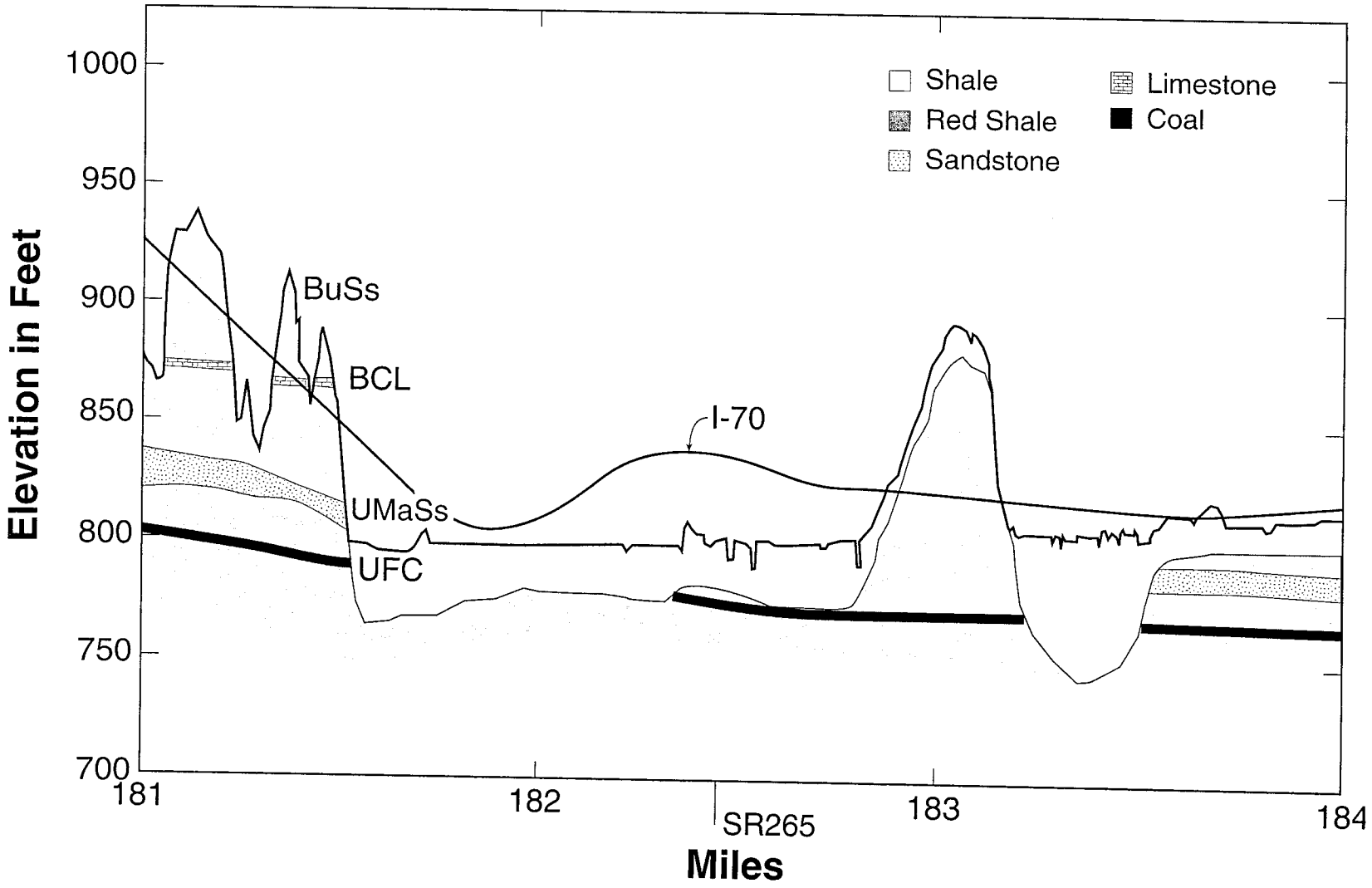
LMaSs = Lower Mahoning Sandstone and Shale; UFC = Upper Freeport Coal No.7; UFSs = Upper Freeport Sandstone and Shale



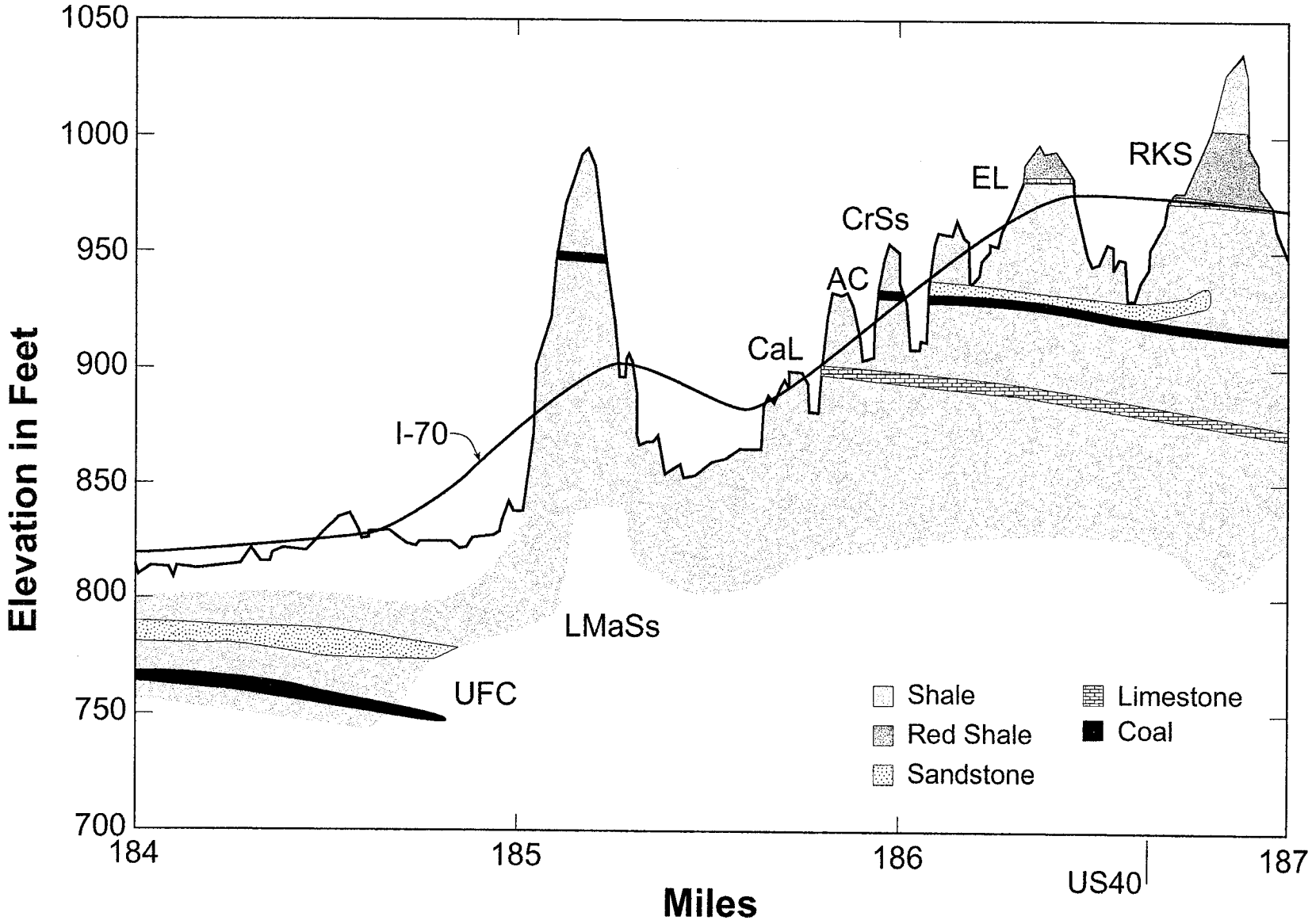
MoSs = Morgantown Sandstone and Shale; HC = Harlem Coal; RKS = Round Knob Shale; WiC = Wilgus Coal; BuSs = Buffalo; Sandstone and Shale; LMaSs = Lower Mahoning Sandstone and Shale; UFC = Upper Freeport Coal No.7; UFSs = Upper Freeport Sandstone and Shale



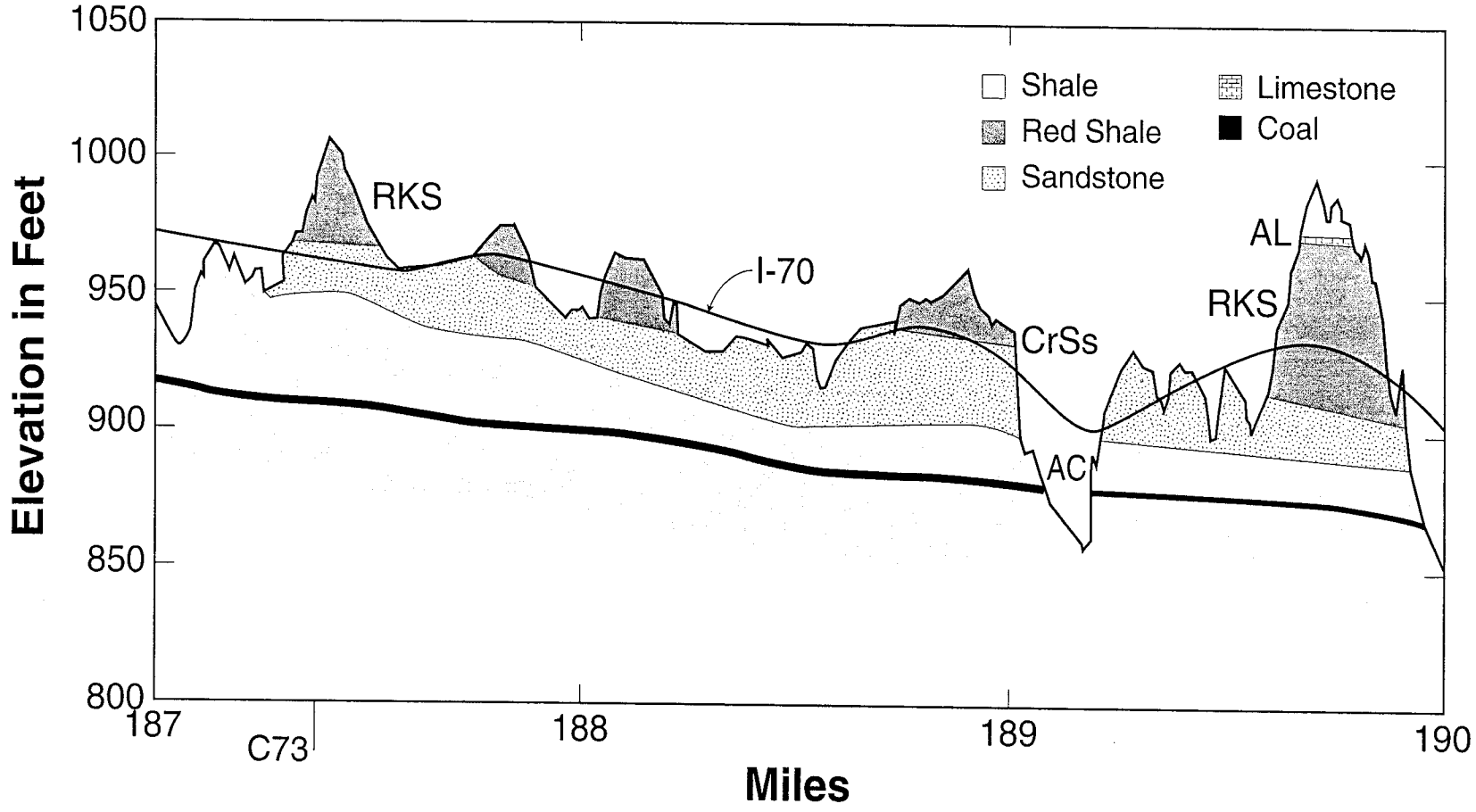
BuSs = Buffalo Sandstone and Shale; BCL = Brush Creek Limestone; UMaSs = Upper Mahoning Sandstone and Shale; UFC = Upper Freeport Coal No.7



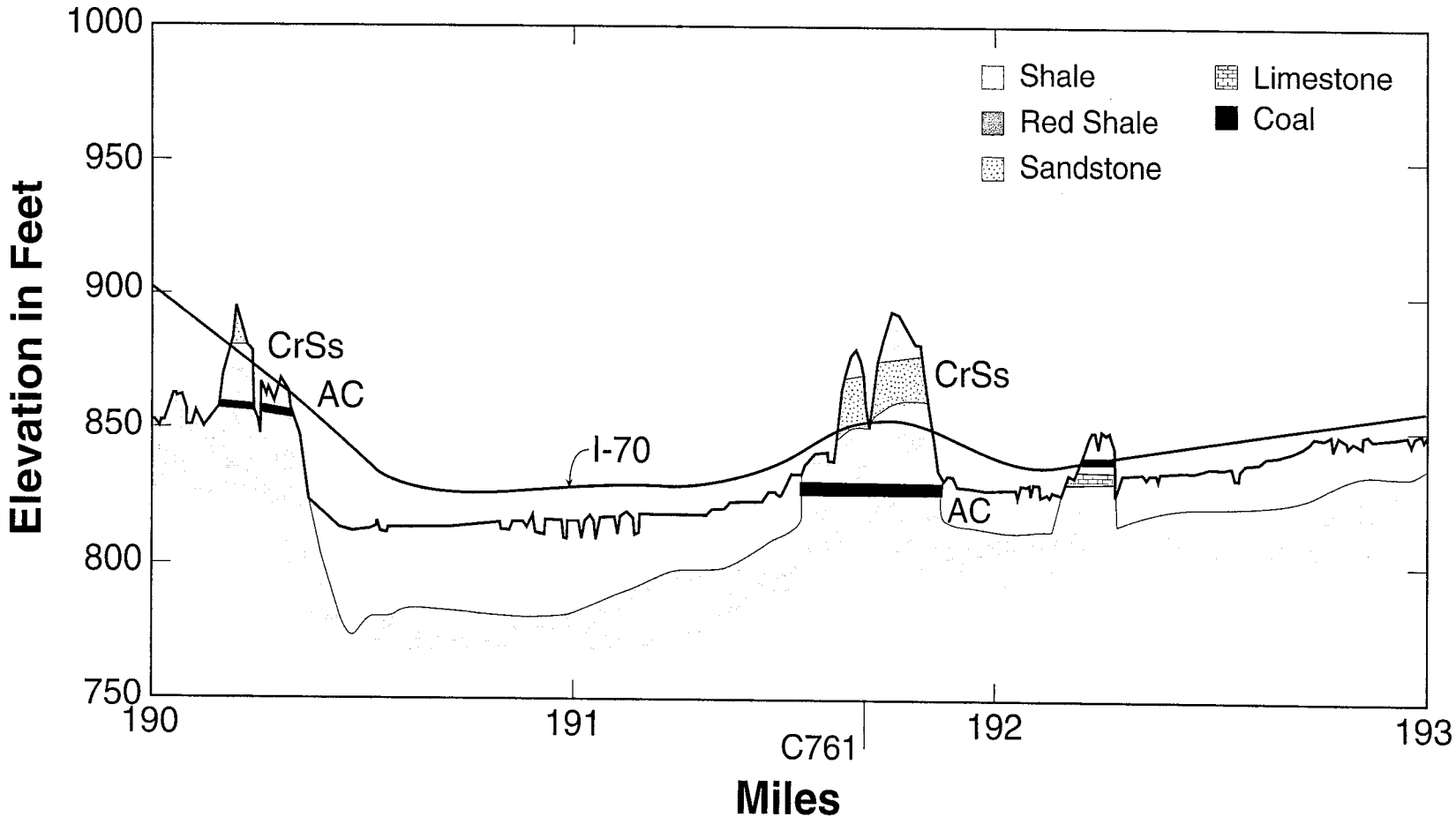
RKS = Round Knob Shale; EL = Ewing Limestone; CrSs = Cowrun Sandstone and Shale; AC = Anderson Coal; CaL = Cambridge Limestone; LMaSs = Lower Mahoning Sandstone and Shale; UFC = Upper Freeport Coal No.7



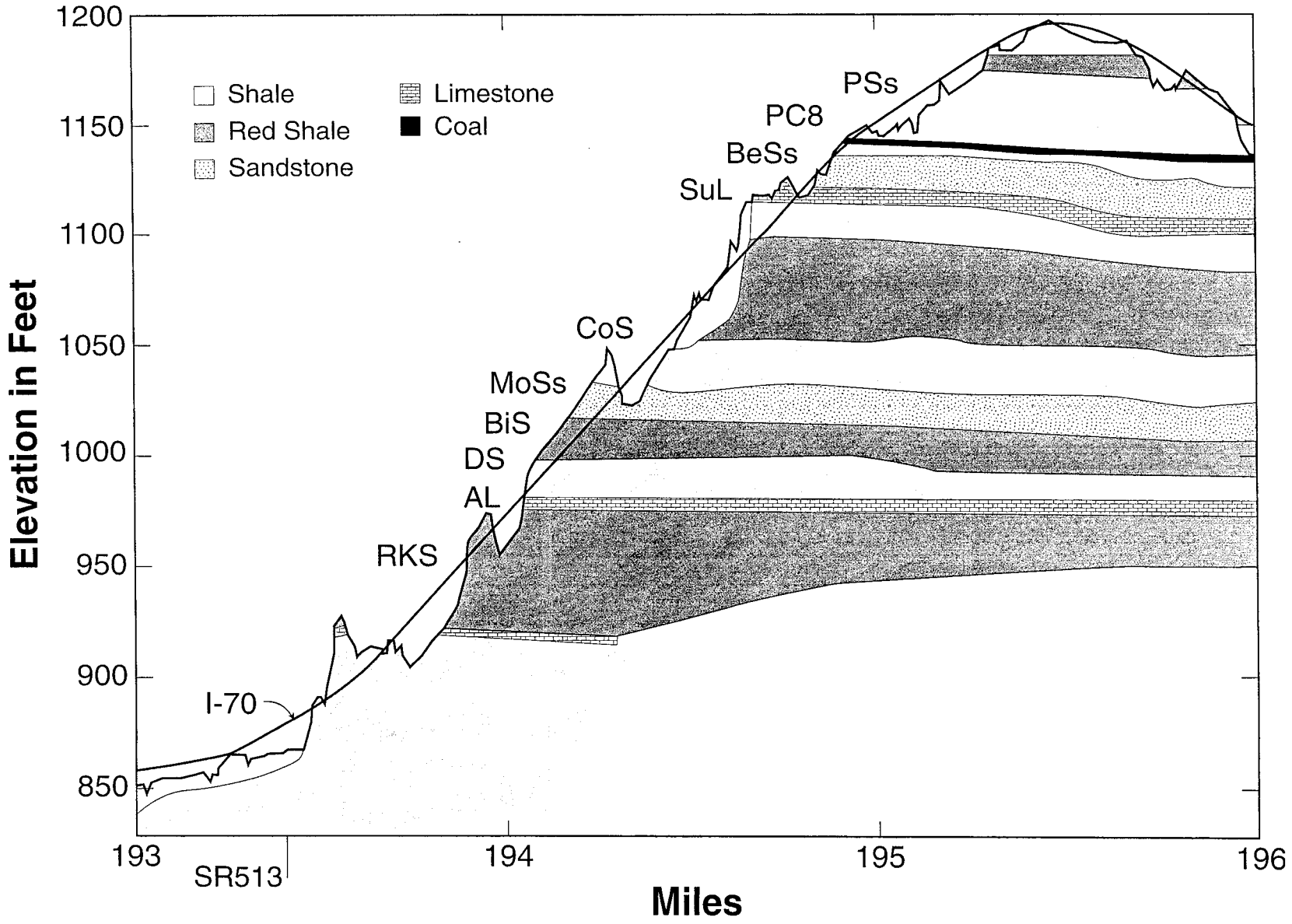
AL = Ames Limestone; RKS = Round Knob Shale; CrSs = Cowrun Sandstone and Shale; AC = Anderson Coal



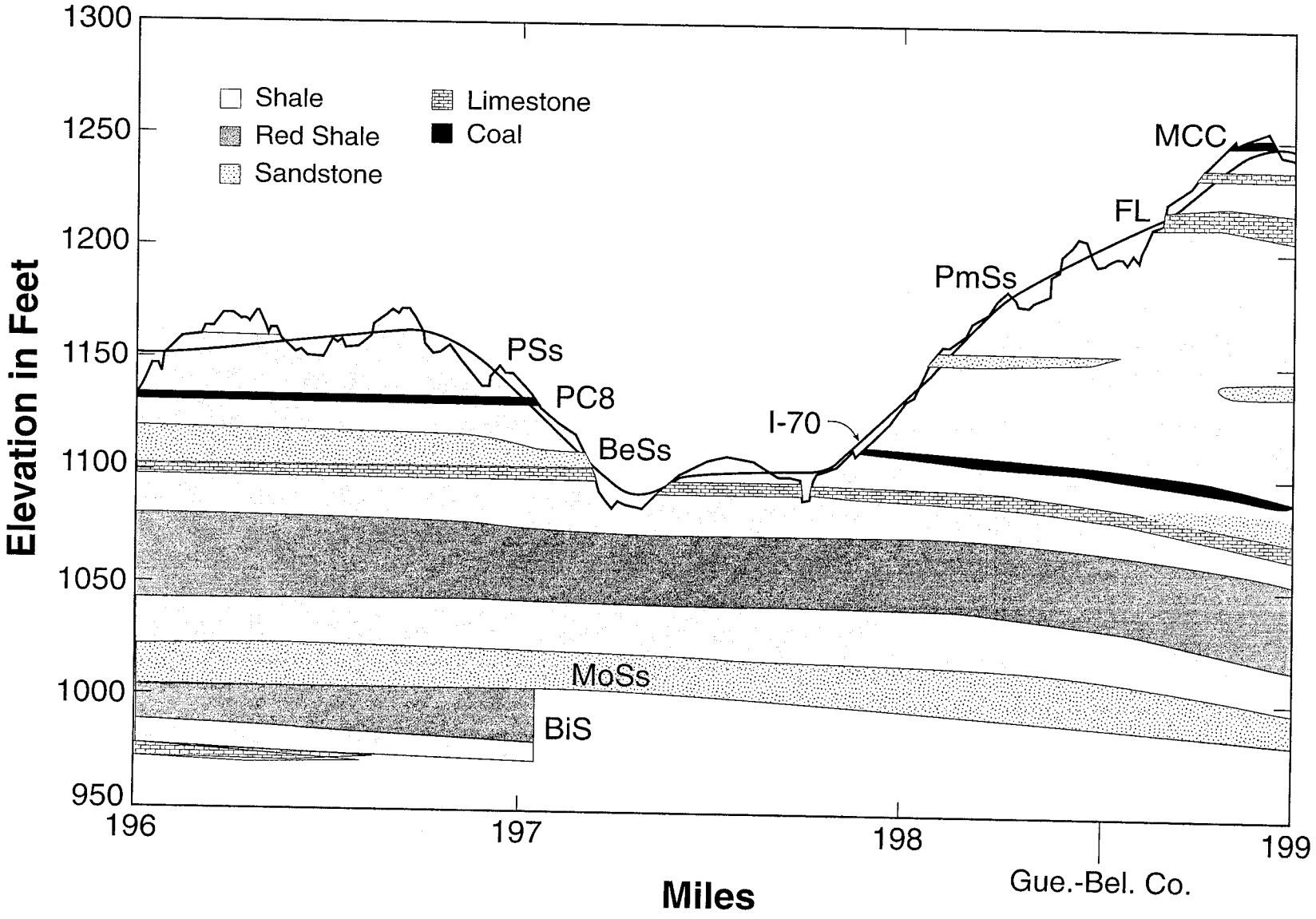
CrSs = Cowrun Sandstone and Shale; AC = Anderson Coal



PSs = Pittsburgh Sandstone and Shale; PC8 = Pittsburgh Coal No. 8; BeSs = Bellaire Sandstone; SuL = Summerfield Limestone; CoS = Connellsville Shale; MoSs = Morgantown Sandstone and Shale; BiS = Birmingham Shale; DS = Duquesne Shale; AL = Ames Limestone; HC = Harlem Coal; RKS = Round Knob Shale



MCC = Meigs Creek Coal No. 9 ; FL = Fishport Limestone; PmSs = Pomeroy Sandstone and Shale; PSs = Pittsburgh Sandstone and Shale; PC8 = Pittsburgh Coal No. 8; BeSs = Bellaire Sandstone; MoSs = Morgantown Sandstone and Shale; BiS = Birmingham Shale



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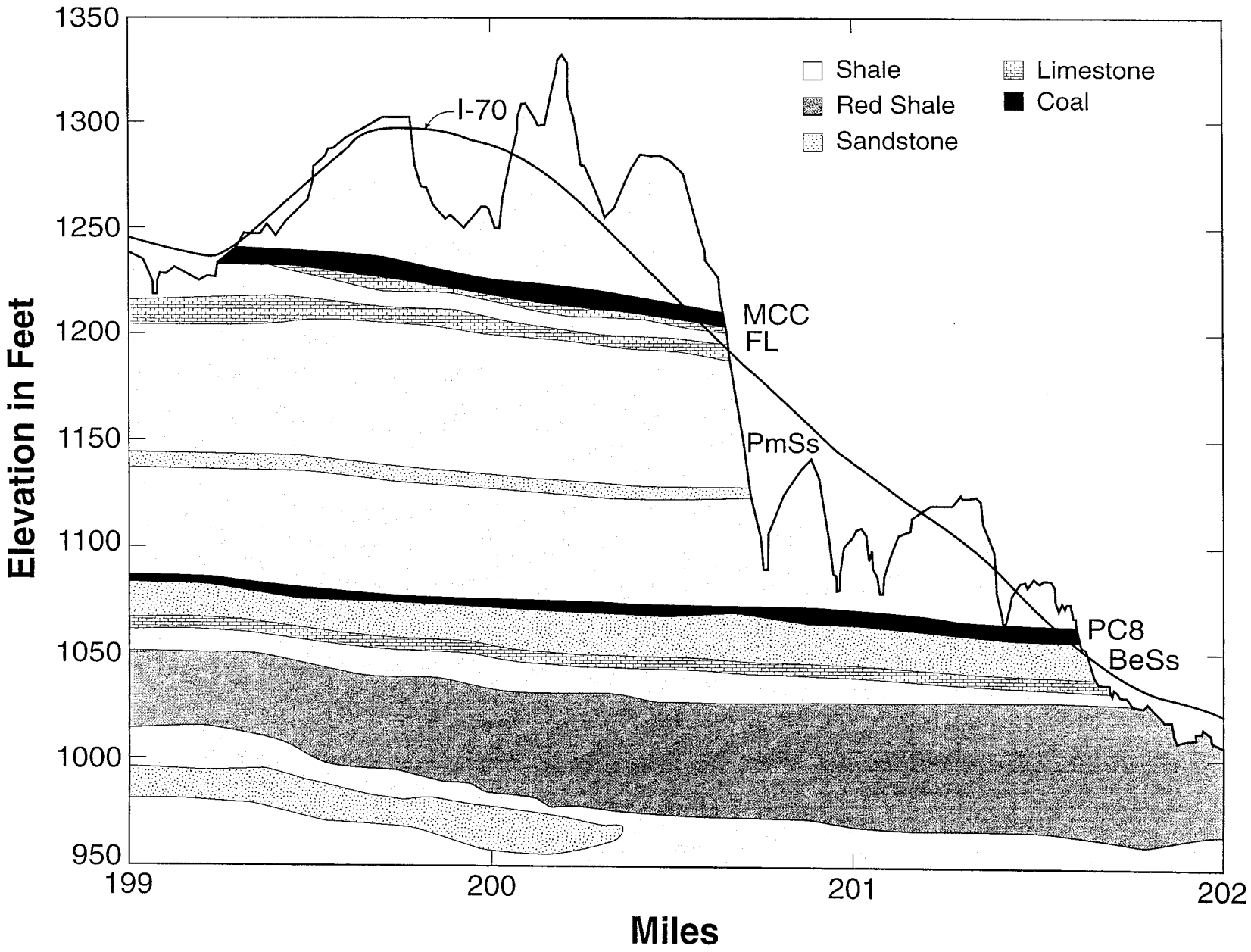
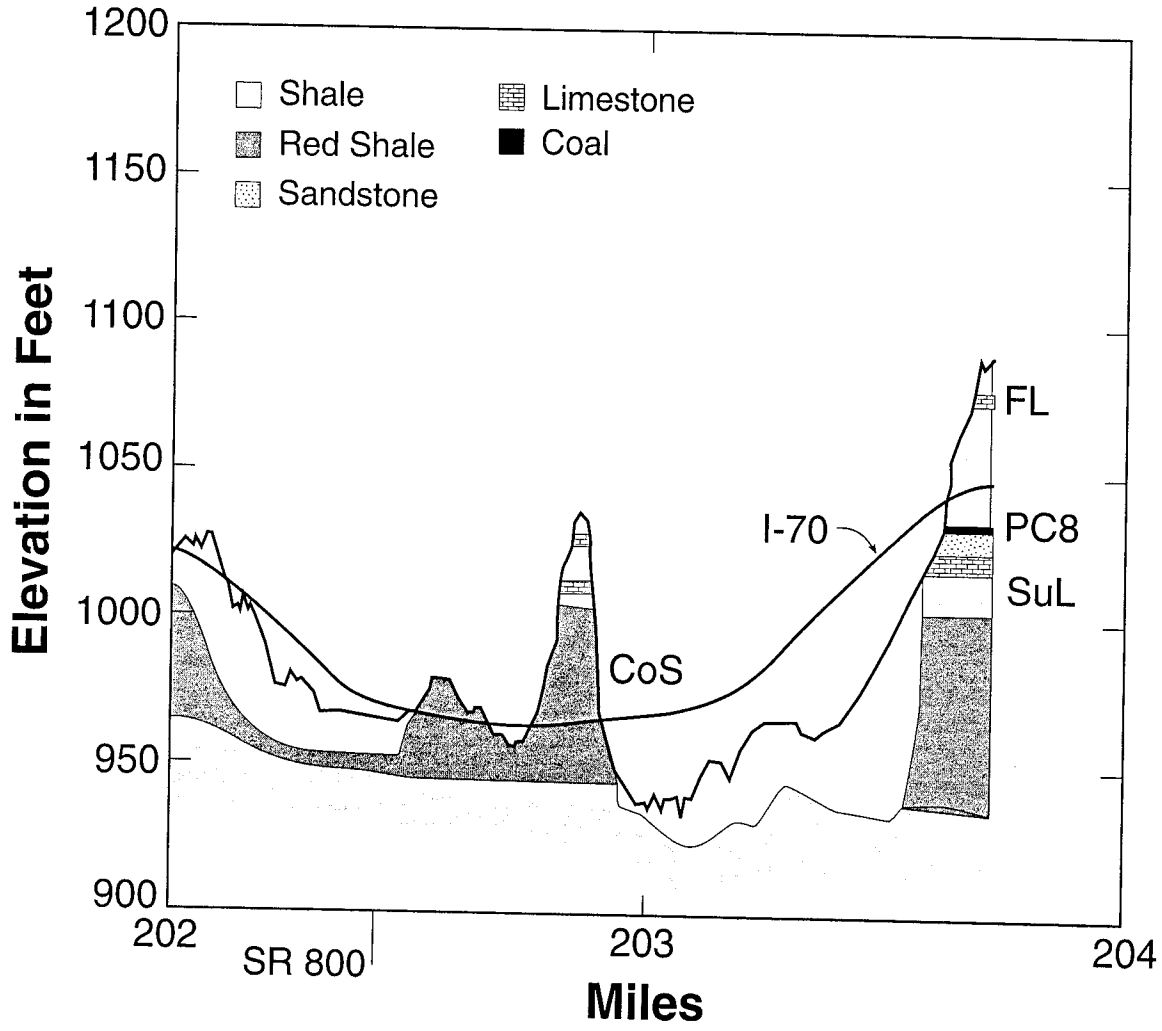
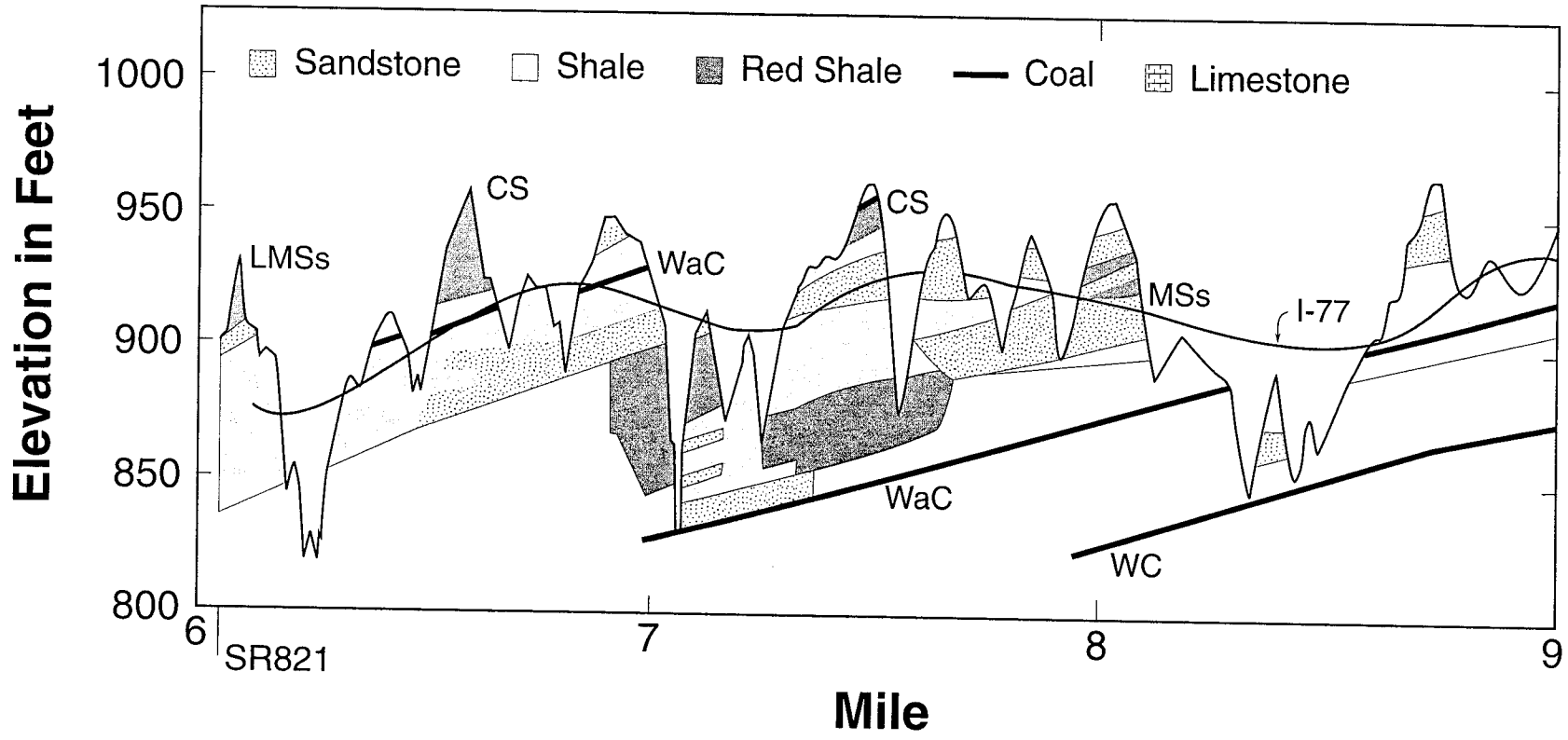


FL = Fishport Limestone; PC8 = Pittsburgh Coal No. 8; SuL = Summerfield Limestone; CoS = Connellsville Shale

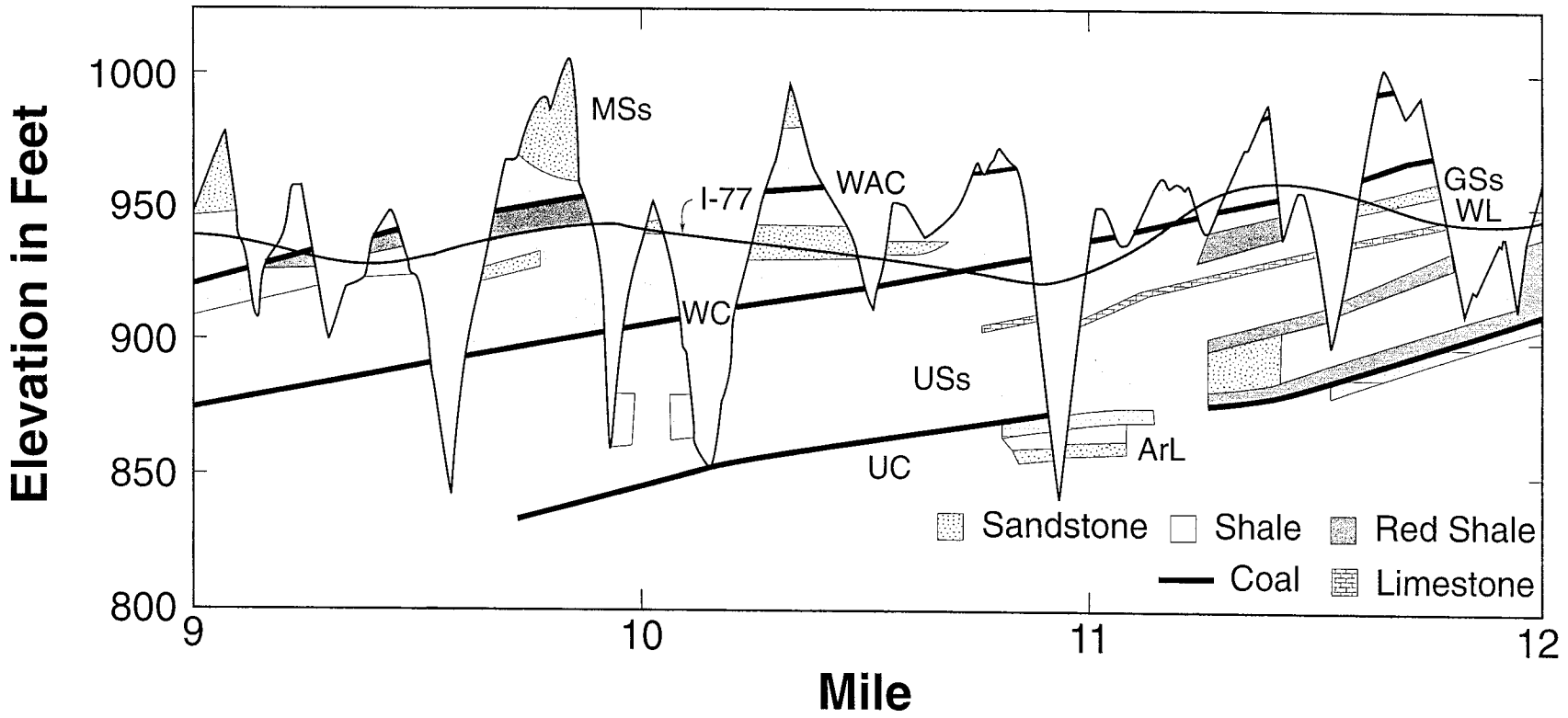


APPENDIX C GEOLOGIC PROFILES, I-77

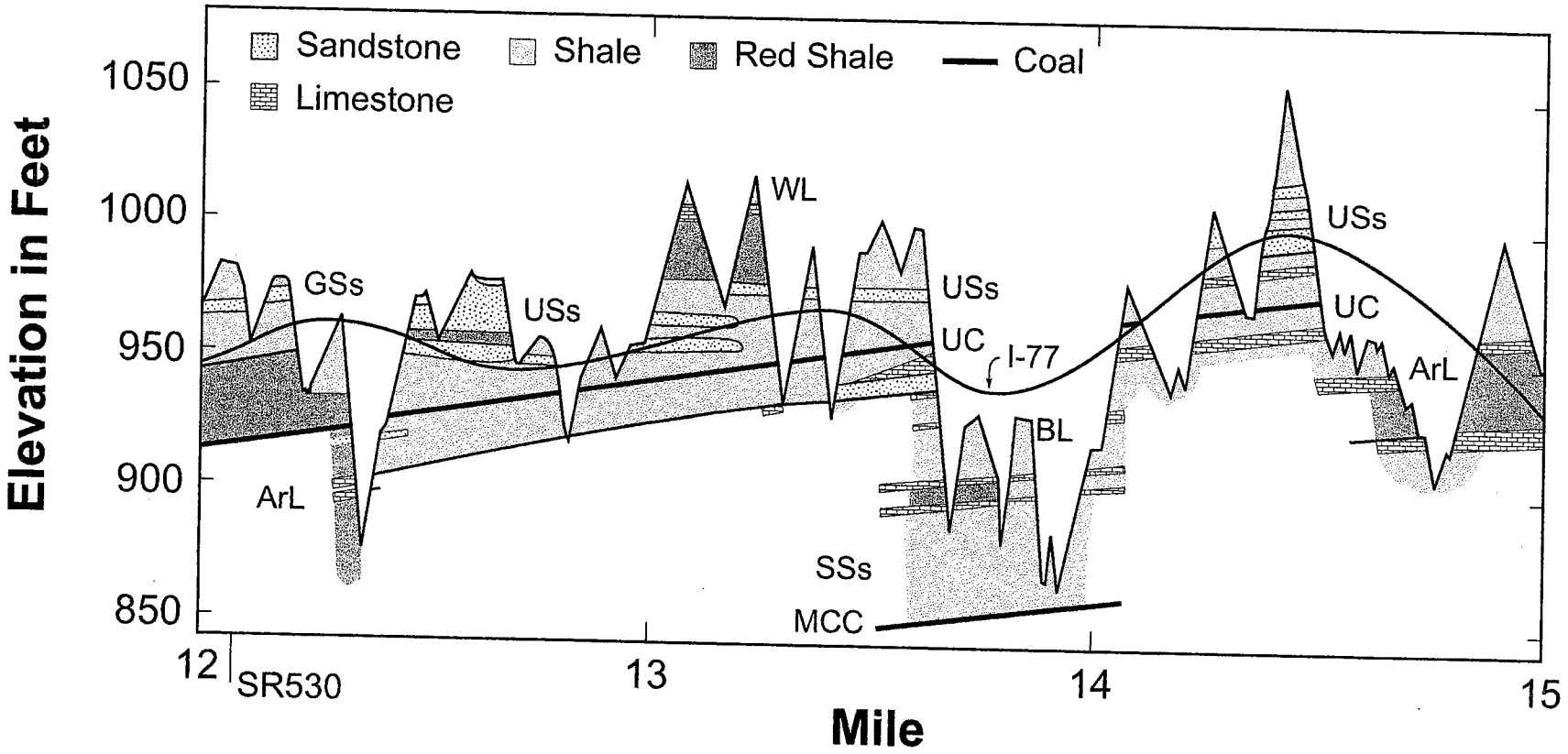
CS = Creston Shale; LMSs = Lower Marietta Sandstone; WaC = Washington Coal; MSs = Mannington Sandstone and Shale; WAC = Waynesburg "A" Coal; WC = Waynesburg Coal No.11

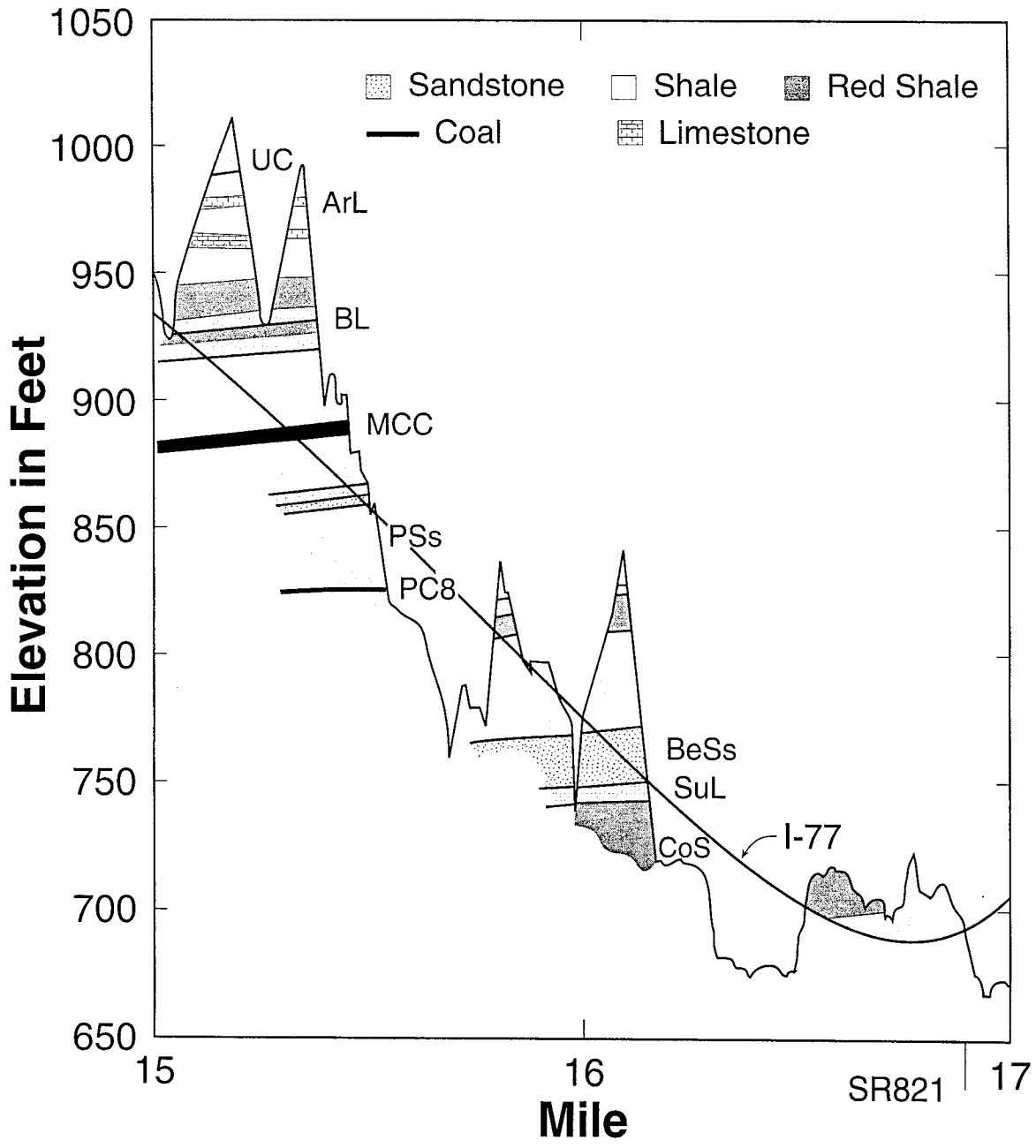


MSs = Mannington Shale and Sandstone; WAC = Waynesburg "A" Coal; WC = Waynesburg Coal No.11; GSs = Gilboy Sandstone; WL = Waynesburg Limestone; UC = Uniontown Coal; ArL = Arnoldsburg Sandstone



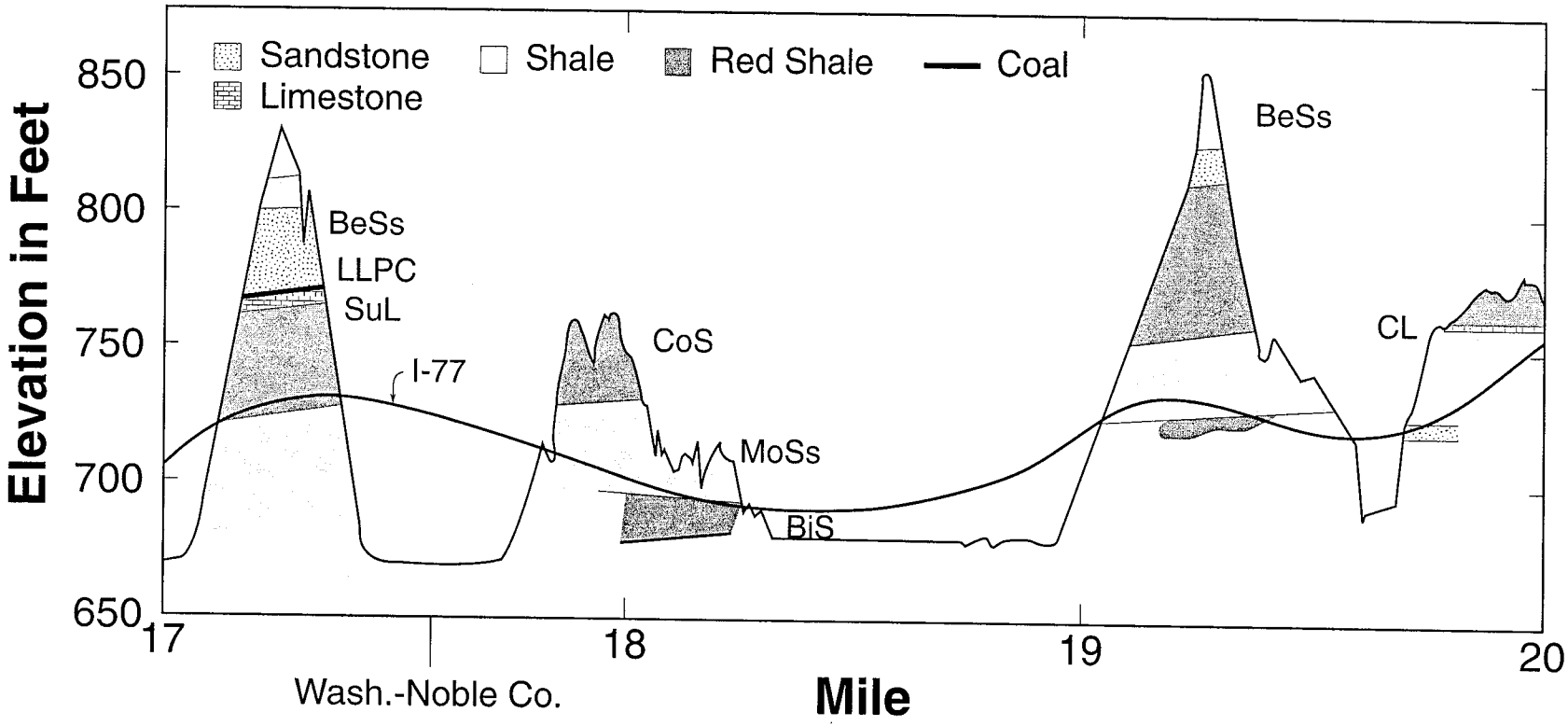
GSs = Gilboy Sandstone; WL = Waynesburg Limestone; USs = Uniontown Sandstone and Shale; UC = Uniontown Coal; ArL = Arnoldsburg Sandstone; BL= Benwood Limestone and Shale; SS = Sewickley Sandstone and Shale, MCC = Meigs Creek Coal No. 9



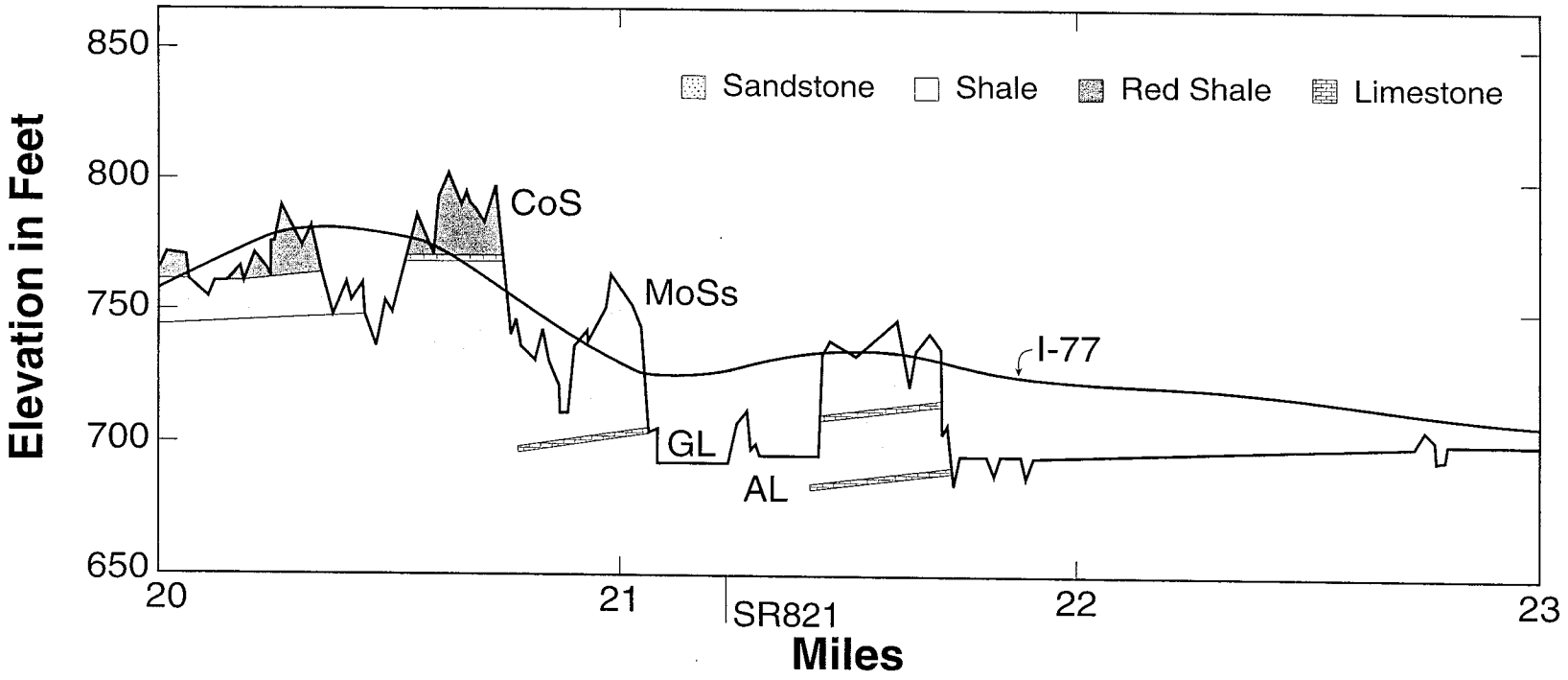


UC = Uniontown Coal
ArL = Arnoldsburg Sandstone
BL= Benwood Limestone and Shale
MCC = Meigs Creek Coal No. 9
PSs = Pittsburgh Sandstone and Shale
PC8 = Pittsburgh Coal No. 8
BeSs = Bellaire Sandstone
SuL = Summerfield Limestone
CoS = Connellsville Shale

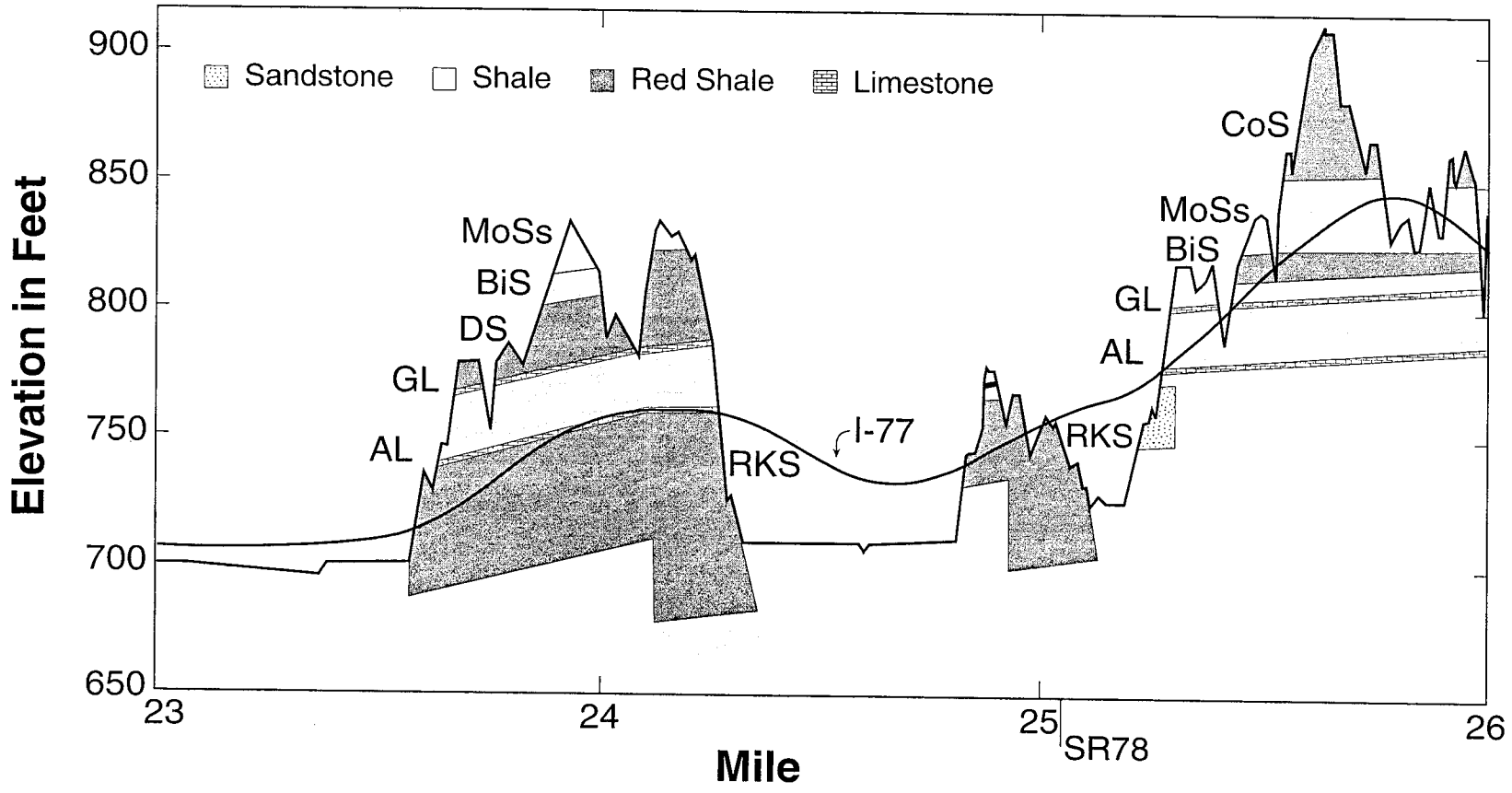
BeSs = Bellaire Sandstone; LLPC = Lower Little Pittsburgh Coal; SuL = Summerfield Limestone; CoS = Connellsville Shale
MoSs = Morgantown Sandstone and Shale; BiS = Birmingham Shale



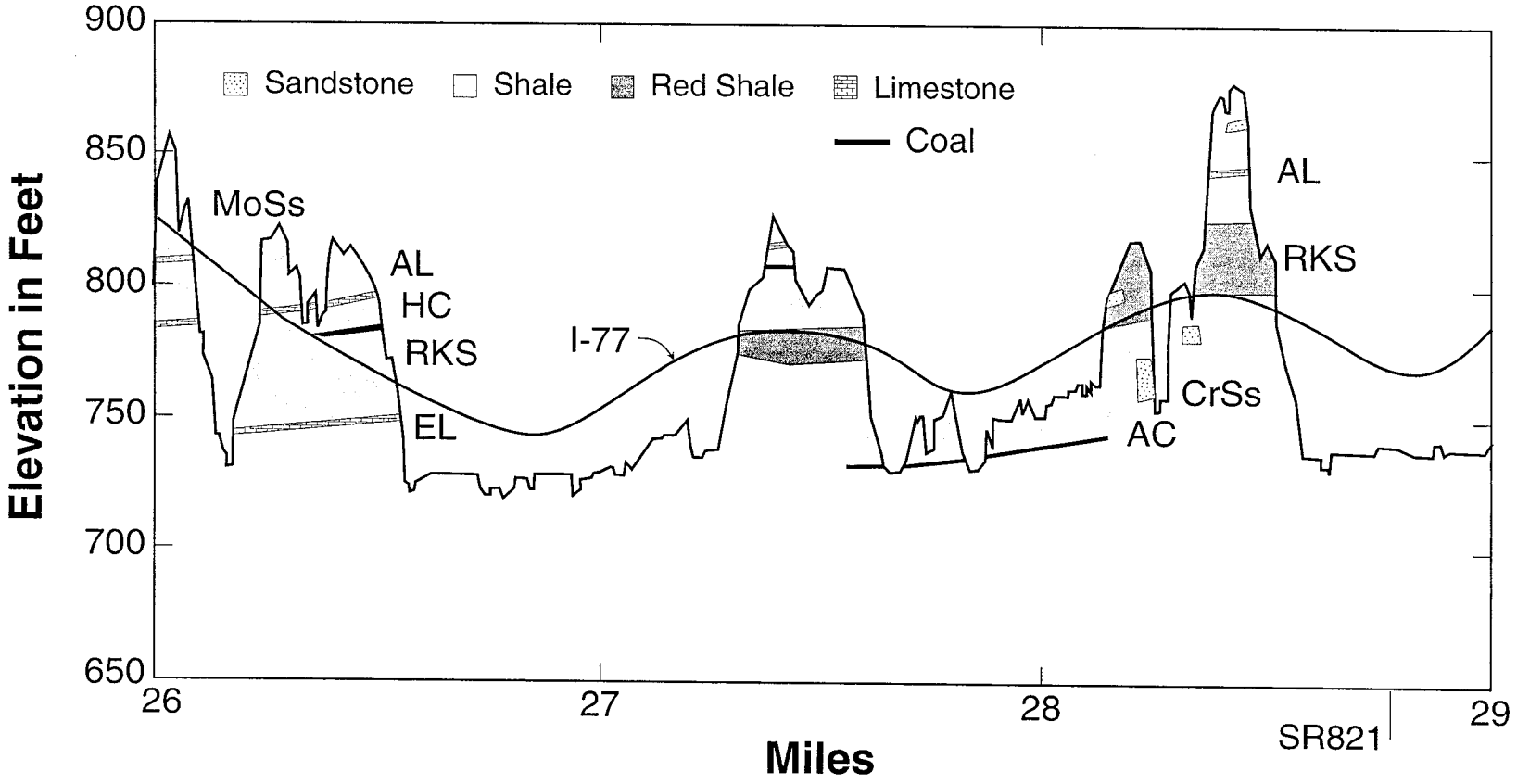
CoS = Connellsville Shale; MoSs = Morgantown Sandstone and Shale; GL = Gaysport Limestone; AL = Ames Limestone



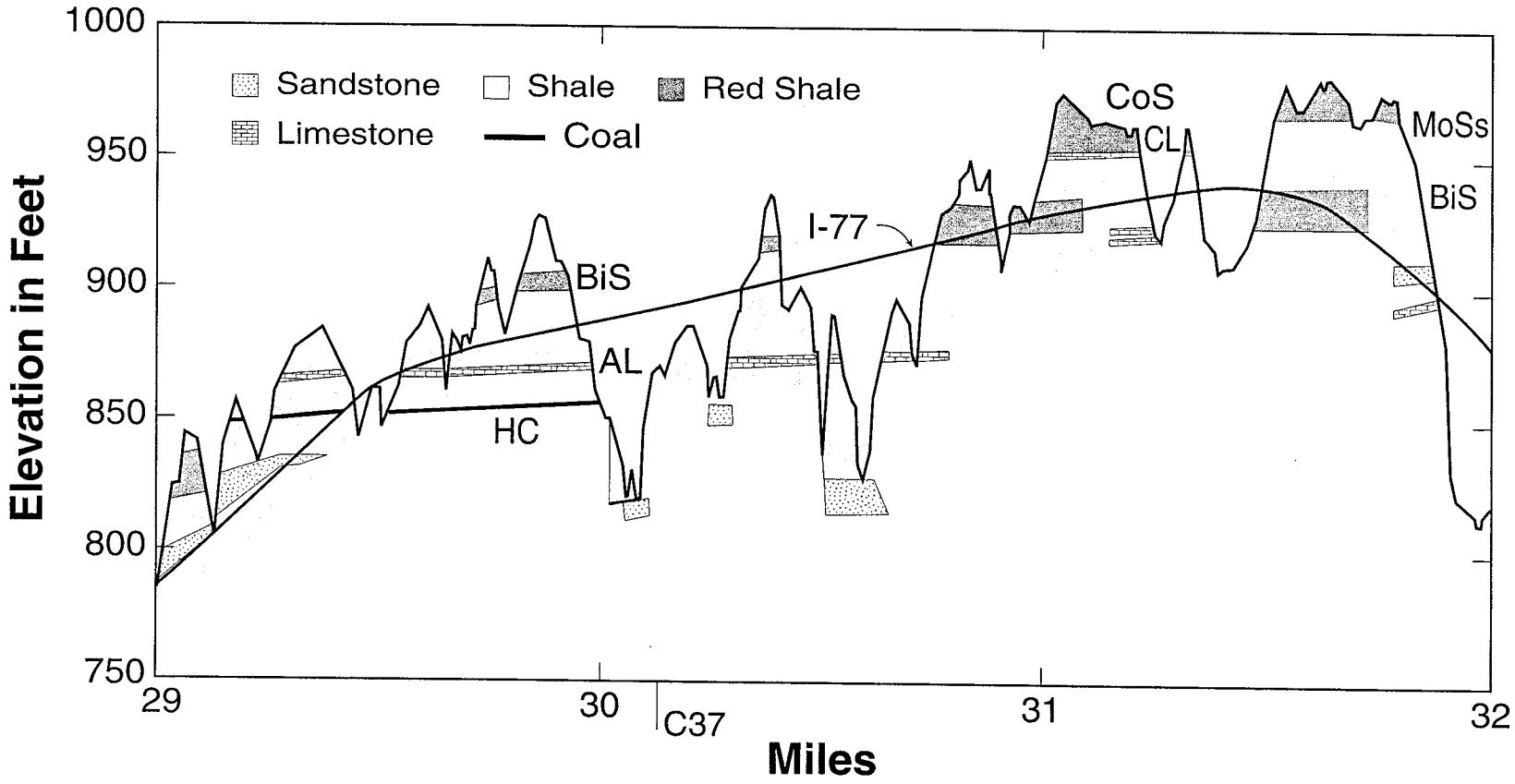
CoS = Connellsville Shale; MoSs = Morgantown Sandstone and Shale; BiS = Birmingham Shale; DS = Duquesne Shale; GL = Gaysport Limestone; AL = Ames Limestone; RKS = Round Knob Shale



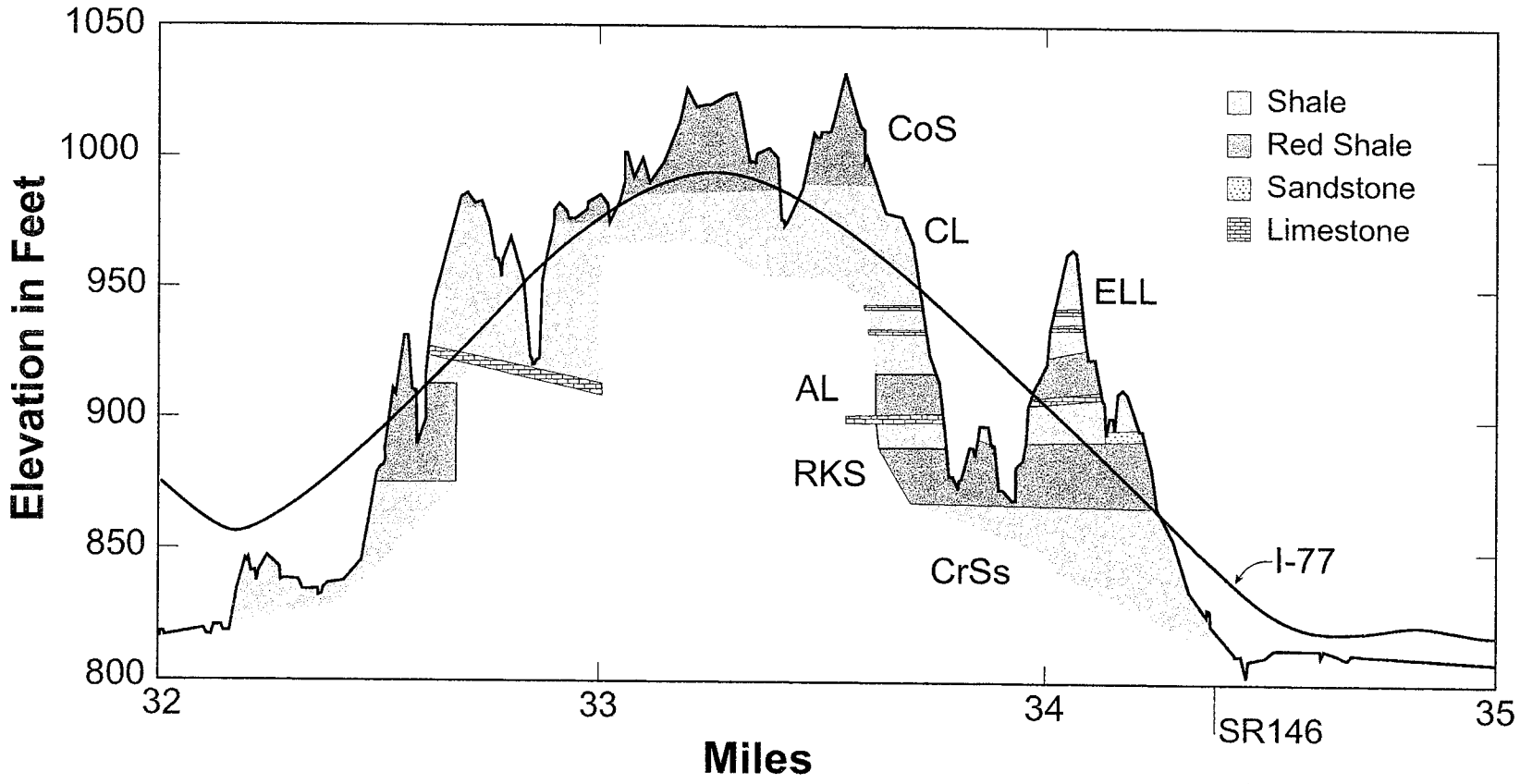
MoSs = Morgantown Sandstone and Shale; AL = Ames Limestone; HC = Harlem Coal; RKS = Round Knob Shale; SSs = Saltsburg Sandstone and Shale; EL = Ewing Limestone; CrSs = Cowrun Sandstone and Shale; AC = Anderson Coal



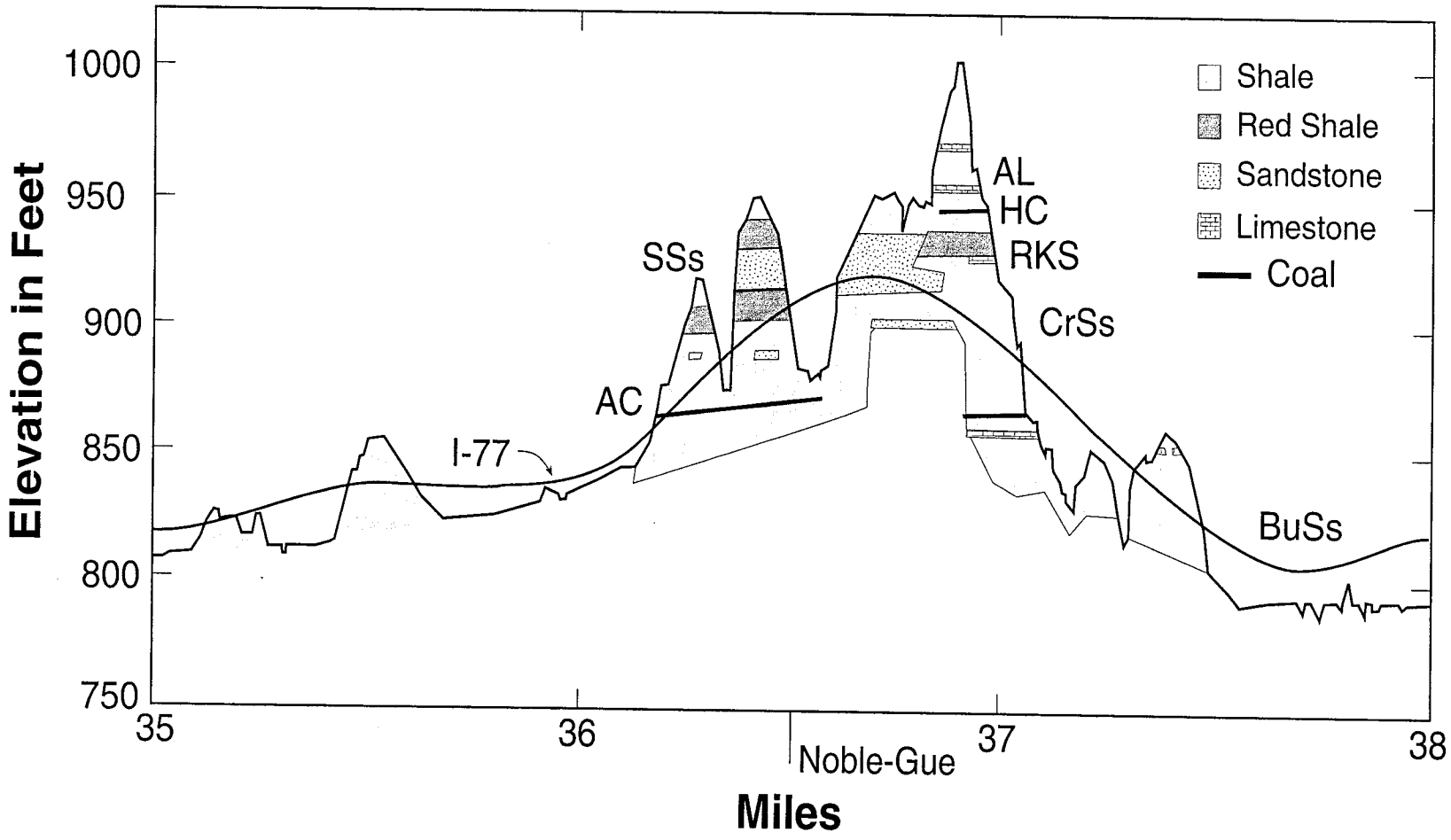
CoS = Connellsville Shale; CL = Clarksburg Limestone and Shale; MoSs = Morgantown Sandstone and Shale; BiS = Birmingham Shale; AL = Ames Limestone; HC = Harlem Coal



CoS = Connellsville Shale; CL = Clarksburg Limestone and Shale; ELL = Elk Lick Limestone; AL = Ames Limestone; HC = Harlem Coal; RKS = Round Knob Shale; CrSs = Cowrun Sandstone and Shale



AL = Ames Limestone; HC = Harlem Coal; RKS = Round Knob Shale; SSs = Saltsburg Sandstone and shale; AC = Anderson Coal; BuSs = Buffalo Sandstone and Shale



RKS = Round Knob Shale; CrSs = Cowrun Sandstone and Shale; AC = Anderson Coal; CaL = Cambridge Limestone; WiC = Wilgus Coal; BuSs = Buffalo Sandstone and Shale