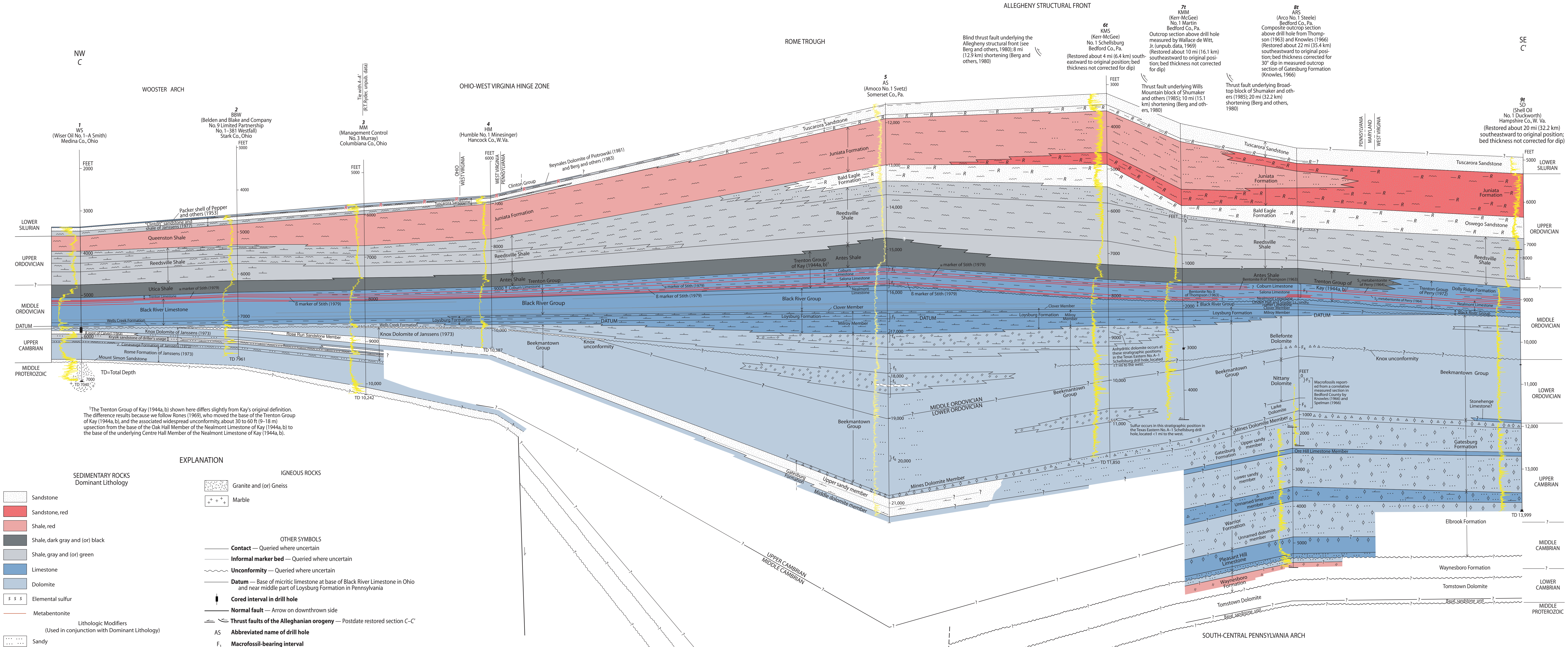
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

BULLETIN 1839–K
PLATE 1


NW
C
SE
C′
WOOSTER ARCH
OHIO-WEST VIRGINIA HINGE ZONE
ROME TROUGH
ALLEGHENY STRUCTURAL FRONT
SOUTH-CENTRAL PENNSYLVANIA ARCH
1 WS (Wiser Oil No. 1–A Smith) Medina Co., Ohio
2 BBW (Belden and Blake and Company No. 9 Limited Partnership No. 1–381 Westfall) Stark Co., Ohio
3 MM (Management Control No. 3 Murray) Columbiana Co., Ohio
4 HM (Humble No. 1 Minesinger) Hancock Co., W. Va.
5 AS (Amoco No. 1 Svetz) Somerset Co., Pa.
6t KMS (Kerr-McGee) No. 1 Schellsburg Bedford Co., Pa. (Restored about 4 mi (6.4 km) southeastward to original position; bed thickness not corrected for dip)
7t KMM (Kerr-McGee) No. 1 Martin Bedford Co., Pa. Outcrop section above drill hole measured by Wallace de Witt, Jr. (unpub. data, 1969) (Restored about 10 mi (16.1 km) southeastward to original position; bed thickness not corrected for dip)
8t ARS (Arco No. 1 Steele) Bedford Co., Pa. Composite outcrop section above drill hole from Thompson (1963) and Knowles (1966) (Restored about 22 mi (35.4 km) southeastward to original position; bed thickness corrected for 30° dip in measured outcrop section of Gatesburg Formation (Knowles, 1966)
9t SD (Shell Oil No. 1 Duckworth) Hampshire Co., W. Va. (Restored about 20 mi (32.2 km) southeastward to original position; bed thickness not corrected for dip)
Blind thrust fault underlying the Allegheny structural front (see Berg and others, 1980); 8 mi (12.9 km) shortening (Berg and others, 1980)
Thrust fault underlying Wills Mountain block of Shumaker and others (1985); 10 mi (15.1 km) shortening (Berg and others, 1980)
Thrust fault underlying Broadtop block of Shumaker and others (1985); 20 mi (32.2 km) shortening (Berg and others, 1980)
LOWER SILURIAN
UPPER ORDOVICIAN
MIDDLE ORDOVICIAN
LOWER ORDOVICIAN
UPPER CAMBRIAN
MIDDLE CAMBRIAN
LOWER CAMBRIAN
MIDDLE PROTEROZOIC
DATUM
Tuscarora Sandstone
Juniata Formation
Bald Eagle Formation
Oswego Sandstone
Queenston Shale
Reedsville Shale
Utica Shale
Antes Shale
Trenton Group of Kay (1944a,b)
Black River Limestone
Black River Group
Wells Creek Formation
Knox Dolomite of Janssens (1973)
B zone of Calvert (1964)
Krysik sandstone of driller's usage
Conasauga Formation of Janssens (1973)
Rome Formation of Janssens (1973)
Mount Simon Sandstone
Rose Run Sandstone Member
Packer shell of Pepper and others (1953)
Reynales Dolomite of Piotrowski (1981) and Berg and others (1983)
Clinton Group
Loysburg Formation
Clover Member
Milroy Member
Coburn Limestone
Salona Limestone
Nealmont Limestone
Beekmantown Group
Bellefonte Dolomite
Nittany Dolomite
Stonehenge Limestone
Larke Dolomite
Mines Dolomite Member
Upper sandy member
Gatesburg Formation
One Hill Limestone Member
Lower sandy member
Unnamed limestone member
Warrior Formation
Unnamed dolomite member
Pleasant Hill Limestone
Waynesboro Formation
Tomstown Dolomite
Elbrook Formation
Middle dolomite member
Knox unconformity
B marker of Stith (1979)
a marker of Stith (1979)
Anhydritic dolomite occurs at these stratigraphic positions in the Texas Eastern No. A-1 Schellsburg drill hole, located <1 mi to the west.
Sulfur occurs in this stratigraphic position in the Texas Eastern No. A-1 Schellsburg drill hole, located <1 mi to the west.
Macrofossils report ed from a correlative measured section in Bedford County by Knowles (1966) and Spelman (1966)
FEET
TD 7040
TD 7961
TD 10,242
TD 10,387
TD 21,460
TD 11,850
TD 13,999
TD=Total Depth
OHIO
WEST VIRGINIA
PENNSYLVANIA
MARYLAND
UPPER CAMBRIAN
MIDDLE CAMBRIAN
LOWER CAMBRIAN
MIDDLE PROTEROZOIC

[1]The Trenton Group of Kay (1944a, b) shown here differs slightly from Kay's original definition. The difference results because we follow Rones (1969), who moved the base of the Trenton Group of Kay (1944a, b), and the associated widespread unconformity, about 30 to 60 ft (9–18 m) upsection from the base of the Oak Hall Member of the Nealmont Limestone of Kay (1944a, b) to the base of the underlying Centre Hall Member of the Nealmont Limestone of Kay (1944a, b).

EXPLANATION

SEDIMENTARY ROCKS
Dominant Lithology

- ⬚ Sandstone
- 🟥 Sandstone, red
- ▨ Shale, red
- ▇ Shale, dark gray and (or) black
- ▨ Shale, gray and (or) green
- 🟦 Limestone
- ▨ Dolomite
- S S S Elemental sulfur
- — Metabentonite

Lithologic Modifiers
(Used in conjunction with Dominant Lithology)

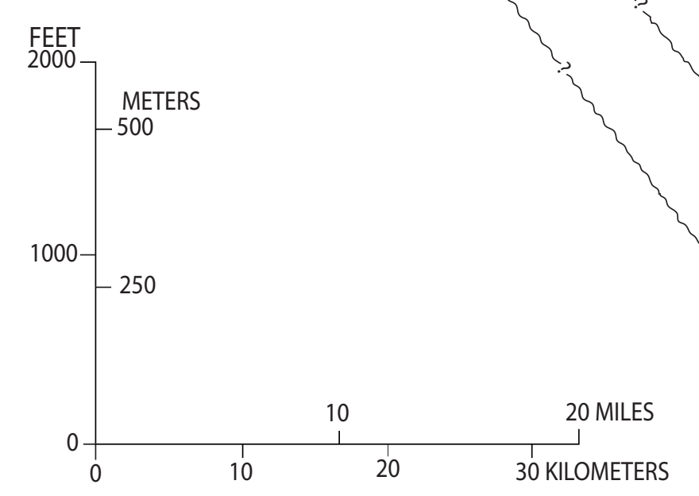
- Sandy
- Silty
- Argillaceous, gray and (or) green
- Argillaceous, red (red *R* shown where dominant lithology of gray and (or) green shale contains minor red shale beds)
- Calcareous
- Dolomitic
- Anhydritic
- Cherty
- Oolitic

IGNEOUS ROCKS

- Granite and (or) Gneiss
- Marble

OTHER SYMBOLS

- **Contact** — Queried where uncertain
- **Informal marker bed** — Queried where uncertain
- **Unconformity** — Queried where uncertain
- **Datum** — Base of micritic limestone at base of Black River Limestone in Ohio and near middle part of Loysburg Formation in Pennsylvania
- **Cored interval in drill hole**
- **Normal fault** — Arrow on downthrown side
- **Thrust faults of the Alleghanian orogeny** — Postdate restored section *C–C′*
- AS **Abbreviated name of drill hole**
- F_1 **Macrofossil-bearing interval**
  - F_1—Wallace de Witt, Jr. (unpub. data, 1969)
  - F_2—Reported by Knowles (1966)
  - F_3—Reported by Thompson (1963)
  - F_4—Reported by Knowles (1966)
  - F_5 and F_6—Reported by Spelman (1966)
- f_1 **Microfossil-bearing interval** — See table 2 for description of identifiable conodonts
- 0 GR 200 Gamma-ray curve.—Log scale generally from 0 to 200 API units



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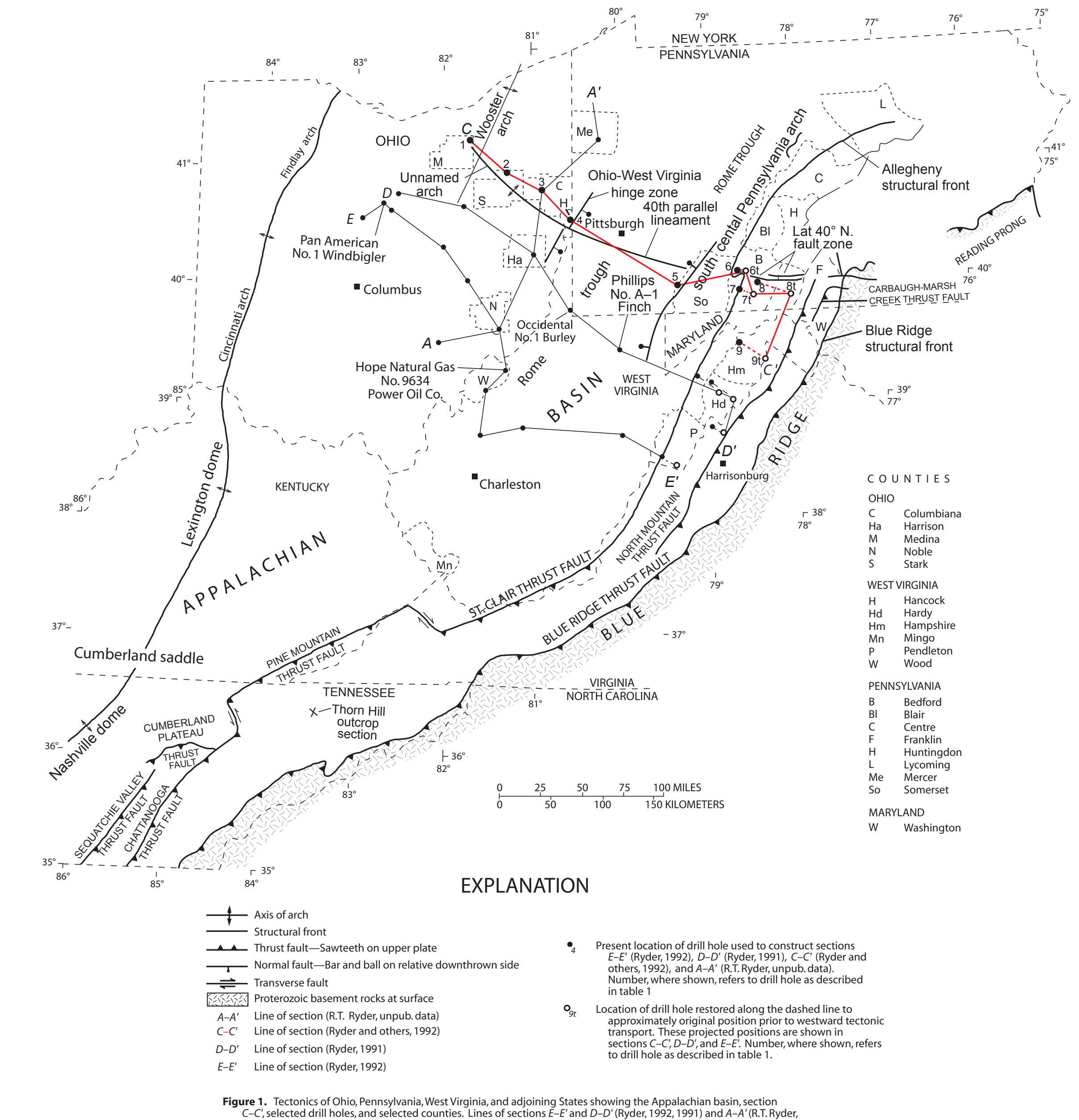
NEW YORK
PENNSYLVANIA
OHIO
WEST VIRGINIA
KENTUCKY
TENNESSEE
MARYLAND
VIRGINIA
NORTH CAROLINA
Findlay arch
Cincinnati arch
Lexington dome
Nashville dome
Cumberland saddle
Unnamed arch
Ohio-West Virginia hinge zone
40th parallel lineament
ROME TROUGH
South-central Pennsylvania arch
Allegheny structural front
Blue Ridge structural front
READING PRONG
CARBAUGH-MARSH CREEK THRUST FAULT
Lat 40° N. fault zone
Pan American No. 1 Windbigler
Columbus
Pittsburgh
Phillips No. A–1 Finch
Occidental No. 1 Burley
Hope Natural Gas No. 9634 Power Oil Co.
Charleston
Harrisonburg
APPALACHIAN
BASIN
BLUE
RIDGE
ST. CLAIR THRUST FAULT
PULASKI THRUST FAULT
BLUE RIDGE THRUST FAULT
PINE MOUNTAIN THRUST FAULT
CUMBERLAND PLATEAU THRUST FAULT
SEQUATCHIE VALLEY THRUST FAULT
CHATTANOOGA THRUST FAULT
Thorn Hill outcrop section
0 25 50 75 100 MILES
0 50 100 150 KILOMETERS
COUNTIES
OHIO
C Columbiana
Ha Harrison
M Medina
N Noble
S Stark
WEST VIRGINIA
H Hancock
Hd Hardy
Hm Hampshire
Mn Mingo
P Pendleton
W Wood
PENNSYLVANIA
B Bedford
Bl Blair
C Centre
F Franklin
H Huntingdon
L Lycoming
Me Mercer
So Somerset
MARYLAND
W Washington
EXPLANATION
Axis of arch
Structural front
Thrust fault—Sawteeth on upper plate
Normal fault—Bar and ball on relative downthrown side
Transverse fault
Proterozoic basement rocks at surface
A–A′ Line of section (R.T. Ryder, unpub. data)
C–C′ Line of section (Ryder and others, 1992)
D–D′ Line of section (Ryder, 1991)
E–E′ Line of section (Ryder, 1992)
4 Present location of drill hole used to construct sections E–E′ (Ryder, 1992), D–D′ (Ryder, 1991), C–C′ (Ryder and others, 1992), and A–A′ (R.T. Ryder, unpub. data). Number, where shown, refers to drill hole as described in table 1
9t Location of drill hole restored along the dashed line to approximately original position prior to westward tectonic transport. These projected positions are shown in sections C–C′, D–D′, and E–E′. Number, where shown, refers to drill hole as described in table 1.

Figure 1. Tectonics of Ohio, Pennsylvania, West Virginia, and adjoining States showing the Appalachian basin, section *C–C′*, selected drill holes, and selected counties. Lines of sections *E–E′* and *D–D′* (Ryder, 1992, 1991) and *A–A′* (R.T. Ryder, unpub. data) are also identified on the map. Base from Wallace and de Witt (1975). Major tectonic and geologic features are from Cooper (1945), Calver and Hobbs (1963), Swingle and others (1966), Rodgers (1970), Wallace and de Witt (1975), Root and Hoskins (1977), Berg and others (1980), Shumaker and others (1985), and Coogan and Maki (1988a). Recent studies (for example, Wickstrom, 1990) indicate that the structure of the Cincinnati and Findlay arches is more complex than shown in this figure and by Wallace and de Witt (1975). Numbered drill holes in section *C–C′* are identified in table 1.

Table 1. Drill holes used in section *C-C′*

[Locations shown on figure 1]

Identification no.	Name used in text (abbreviation)	Location	Permit no.	Lithologic log[1]	Cored intervals (ft) and formation	Total depth (ft)	Age of oldest rocks penetrated (formation)
1	Wiser Oil No. 1–A Smith (WS).	Hinckley Township, Medina County, Ohio.	1143	GSLC, J	5,700–5,714; Black River Limestone. 5,742–5,746; Wells Creek Formation. 5,759–5,890; Wells Creek Formation, Knox Dolomite of Janssens (1973). 7,028–7,040; basement rocks of Middle Proterozoic age.	7,040	Middle Proterozoic.
2	Belden and Blake and Company No. 9 Limited Partnership No. 1–381 Westfall (BBW).	Marlboro Township, Stark County, Ohio.	1080	GSLC, J		7,961	Late Cambrian (Rome Formation of Janssens, 1973).
3	Management Control No. 3 Murray (MM).	Hanover Township, Columbiana County, Ohio.	648	GSLC, J		10,242	Middle Proterozoic(?).
4	Humble No. 1 Minesinger (HM).	Clay District, Hancock County, W. Va.	80	GSLC		10,387	Late Ordovician (part of Beekmantown Group).
5	Amoco No. 1 Svetz (AS)	Middle Creek Township, Somerset County, Pa.	45	GSLC		21,460	Late Cambrian (Gatesburg Formation).
6	Kerr-McGee No. 1 Schellsburg (KMS).	Napier Township, Bedford County, Pa.	34	GSLC		11,850	Late Cambrian (Gatesburg Formation).
7	Kerr-McGee No. 1 Martin (KMM).	Harrison Township, Bedford County, Pa.	13	GSLC, W	3,000–3,027; Beekmantown Group. 5,002–5,025; Beekmantown Group. 6,671–6,676; Juniata Formation.	6,676	Early and Middle Ordovician (Beekmantown Group) thrust over Early Middle and Late Ordovician (Beekmantown Group, Reedsville Shale, Bald Eagle Formation, and Juniata Formation).
8	Arco No. 1 Steele (ARS)	Snake Spring Township, Bedford County, Pa.	009–20060	GSLC		15,500	Early(?) and Middle Cambrian (Waynesboro Formation) thrust over Middle and Late Cambrian and Early and early Middle Ordovician (Warrior Formation, Gatesburg Formation, and Beekmantown Group).
9	Shell Oil No. 1 Duckworth (SD).	Springfield District, Hampshire County, W. Va.	12	GSLC, W	10,522–10,528; Beekmantown Group. 13,958–13,999; Elbrook Formation	13,999	Middle and Late Cambrian (Elbrook Formation).

[1]Lithologic logs from Geological Sample Log Company (GSLC) Pittsburgh, Pa., Janssens (1973) (J), and Wagner (1966) (W).

Table 2. Conodonts from the Amoco No. 1 Svetz drill hole, Somerset County, Pa.

[100- to 200-g cuttings taken at 100-ft intervals between 15,000 and 21,000 ft were processed for conodonts; only the productive samples are listed. Well collar at 2,480-ft elevation; total depth 21,460 ft. Conodont color alteration index (CAI) is a measure of organic maturation (Epstein and others, 1977)]

Sample interval (ft)	USGS collection no.	Conodonts	Age	CAI
		Coburn Limestone		
15,400–15,500.....	10750–CO	1 P (dichognathiform) element of *Phragmodus* sp. indet. or *Plectodina* sp. indet.	Middle Ordovician, no older than early Chazyan [no older than *Phragmodus tangshanensis* Zone (= *P*. pre-*flexuosus* Zone of Sweet and Bergström (1986)]	5
		Trenton Group		
15,700–15,800.....	10751–CO	1 P (dichognathiform) element of *Phragmodus* sp. indet. or *Plectodina* sp. indet. 1 M element, unassigned.	do.	5
		Trenton and Black River Groups		
15,800–15,900.....	10752–CO	1 P (dichognathiform) element of *Phragmodus* sp. indet. or *Plectodina* sp. indet.	do.	5
		Loysburg Formation		
16,500–16,600.....	10753–CO	1 M element, unassigned. 1 indeterminate fragment.	do.	5
16,600–16,700.....	10754–CO	1 robust hyaline ramiform fragment.	do.	5
16,900–17,000.....	10755–CO	do.	do.	5
		Beekmantown Group		
17,000–17,100.....	10756–CO	1 Pb element of *Curtognathus* sp. indet.	do.	5
17,100–17,200.....	10757–CO	1 Pb element of *Curtognathus* sp. indet. 1 robust hyaline ramiform fragment.	do.	5
17,700–17,800.....	10758–CO	1 indeterminate fragment.	do.	5
17,800–17,900.....	10759–CO	1 M element of *Phragmodus* sp. indet. 1 fragment of *Multioistodus*? sp. 7 indeterminate fragments.	Middle Ordovician, interval of *P. tangshanensis* Zone–*Cahabagnathus friendsvillensis* Zone.	5
18,000–18,100.....	10759–CO	1 indeterminate fragment.	do.	5
18,100–18,200.....	10760–CO	1 P (dichognathiform) element of *Phragmodus* sp. indet.	do.	5
18,200–18,300.....	10760–CO	2 indeterminate fragments.	do.	5
18,400–18,500.....	10760–CO	1 indeterminate hyaline fragment.	do.	5
19,900–20,000.....	10760–CO	1 poorly preserved panderodontacean? element. 1 hyaline coniform fragment.	Middle(?) Ordovician, probably downhole contamination.	5

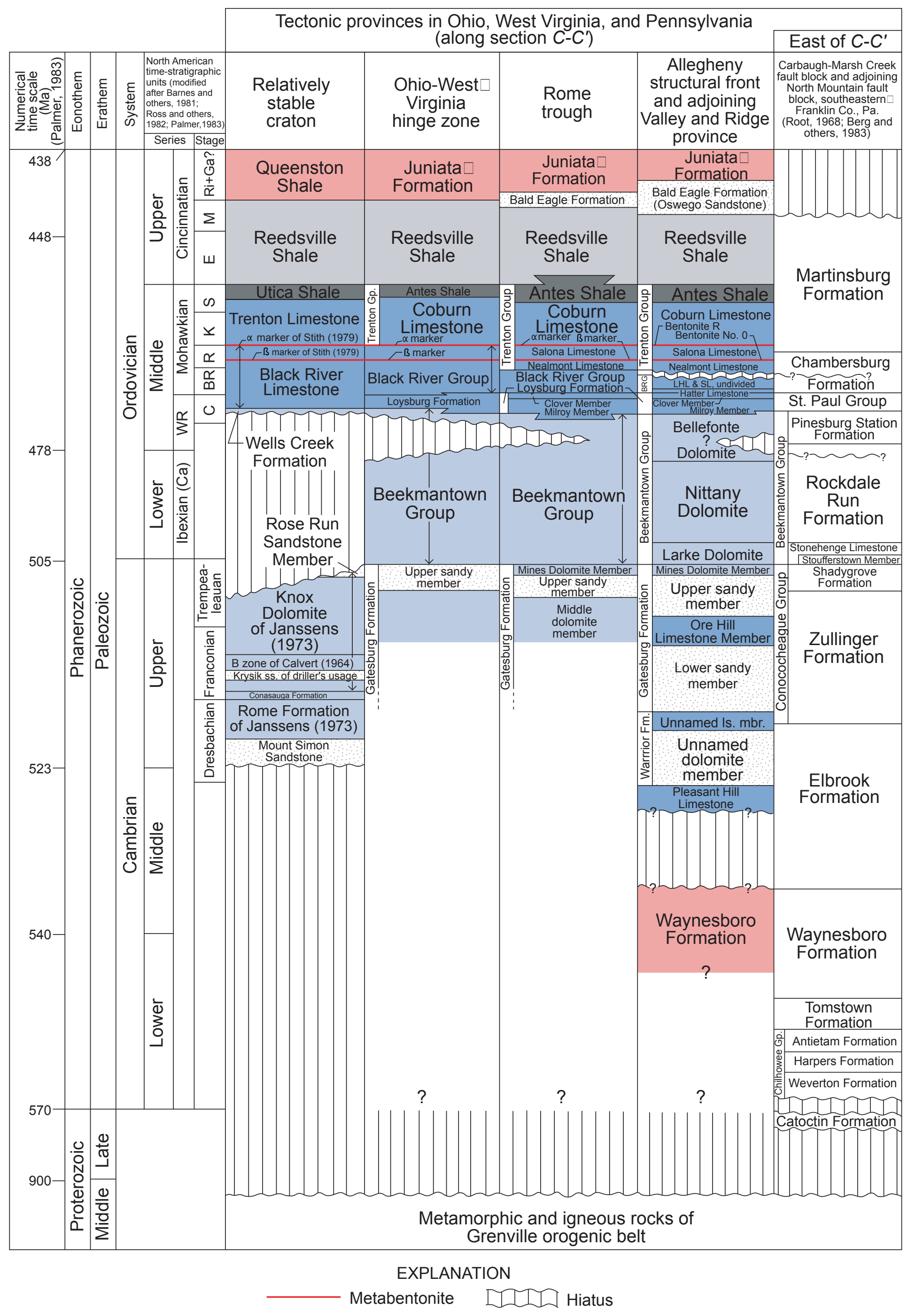

Figure 2.—Correlation chart of Middle Proterozoic, Cambrian, and Ordovician rocks along section *C-C′* and in the adjoining Franklin County, Pa. Absolute age (in Ma) is taken from the geologic time scale compiled by Palmer (1983). The time scale is nonlinear. North American chronostratigraphic units are modified after Barnes and others (1981), Ross and others (1982), and Palmer (1983). Series and Stage names: BR, Blackriveran; Ca, Canadian; C, Chazyan; E, Edenian; Ga, Gamachian; K, Kirkfieldian; M, Maysvillian; R, Rocklandian; Ri, Richmondian; S, Shermanian; WR, Whiterockian. Group name: BRG, Black River Group. Formation names: LF, Loysburg Formation; LHL, Linden Hall Limestone; SL, Snyder Limestone.

RESTORED STRATIGRAPHIC SECTION *C-C′* FROM MEDINA COUNTY, OHIO, THROUGH SOUTHWESTERN AND SOUTH-CENTRAL PENNSYLVANIA TO HAMPSHIRE COUNTY, WEST VIRGINIA, SHOWING THE CAMBRIAN AND ORDOVICIAN SEQUENCE

By
Robert T. Ryder, Anita G. Harris, and John E. Repetski
1992

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2002