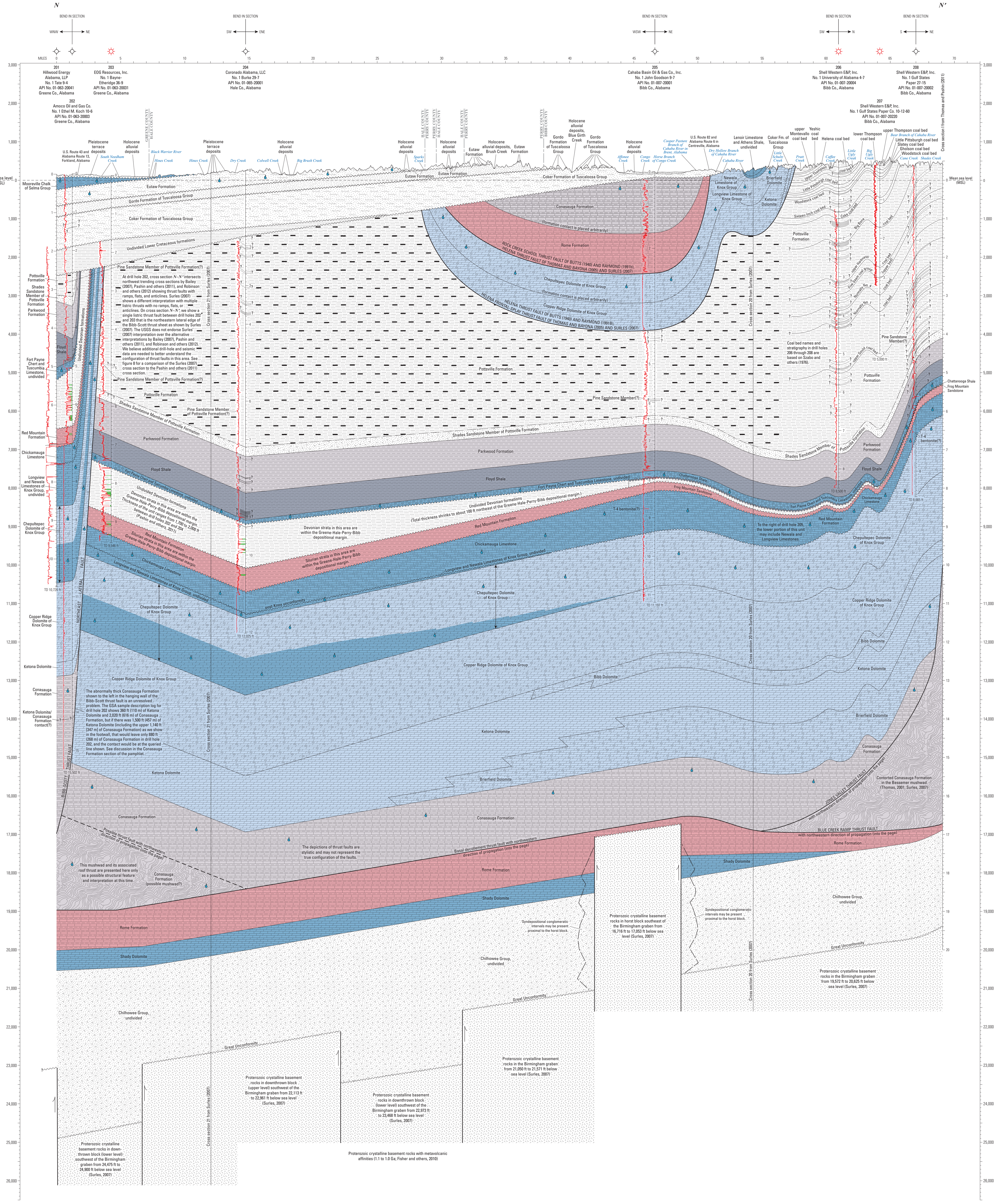


EXPLANATION

SEDIMENTARY ROCKS
[Dominant Lithology]

- Sandy gravel and conglomeratic sandstone
- Sandstone
- Shaley sandstone
- Interbedded sandstone and shale
- Interbedded sandstone, siltstone, and shale
- Interbedded shale and sandstone
- Dark gray to black sandy shale
- Contorted shale in mushwad
- Interbedded shale and carbonates
- Red interbedded shale and carbonates
- Red interbedded shale and sandstone
- Chalk
- Argillaceous limestone
- Cherty limestone
- Dolomitic limestone
- Dolomite
- Cherty dolomite

IGNEOUS AND METAMORPHIC ROCKS

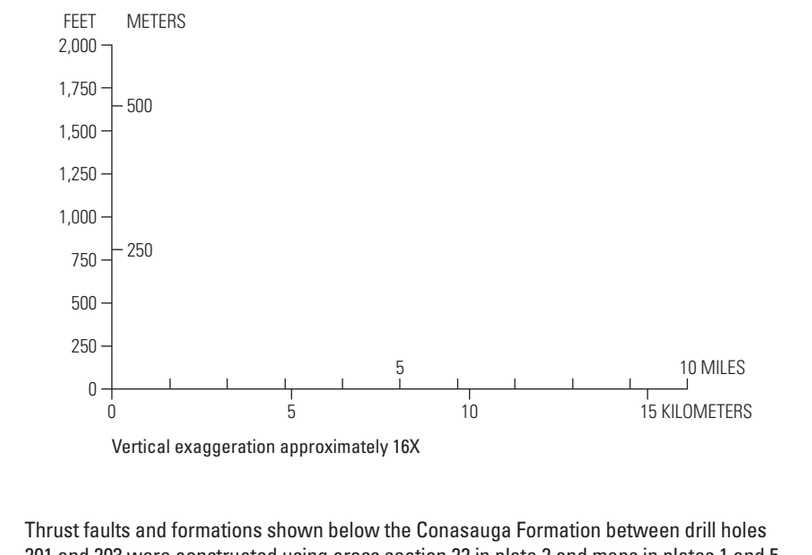
- Granite and (or) gneiss

LITHOLOGIC MODIFIERS
[Used in conjunction with dominant lithology]

- Coal bearing
- Fossiliferous

OTHER SYMBOLS

- Contact
- Member contact
- Coal bed—Queried where presence is unknown
- Unnamed thin coal bed or coaly shale bed—Queried where presence is unknown
- Extent of syndepositional conglomeratic intervals that may be proximal to the horst block
- Unconformity
- Normal fault—Arrow shows relative movement
- Thrust or bedding plane fault—Dashed where presence is uncertain. Arrow shows relative movement
- Gamma-ray log curve—Units and scales vary
- Radioactive black shales (Pashin and others, 2011)—Occur in undivided Devonian formations and Red Mountain Formation only
- dry well
- gas well
- API American Petroleum Institute
- Co. Company
- Fm. Formation
- ft feet
- Ga giga-annum (billion years before present)
- GSA Geological Survey of Alabama
- m meters
- No. number
- TD total depth (measured)
- USGS U.S. Geological Survey
- ? uncertain, questionable



Vertical exaggeration approximately 16X

Thrust faults and formations shown below the Conasauga Formation between drill holes 201 and 203 were constructed using cross section 22 in plate 2 and maps in plates 1 and 5 of Surles (2007). To the right of drill hole 203, faults and formations below the Conasauga Formation were constructed using cross sections 19, 20, and 21 in plate 2 and maps in plates 1 and 5 of Surles (2007), as well as Butts (1940), Batchelder (1984), Sternbach (1984), Hooks (1985), Raymond (1991b), Osborne and others (1998), Johnson and Tull (2002), Osborne and Irvin (2002), and cross section I in figure 7 of Thomas and Pashin (2011).

It is possible that the decollement thrust faults with northwestern direction of propagation (into the page) shown on cross section *N–N′* are more complex than shown here and involve both the Rome and Conasauga Formations in the development of low amplitude "mushwads" or involve more coherent duplex structures as shown in cross section 22 of Surles (2007).

The geometry of the Rock Creek School and Helena thrust faults shown on cross section *N–N′* (from Butts [1940] and Raymond [1991b]) is idealized and likely does not reflect any internal complexities that may be present (see plate 1 of Surles, 2007).

The thicknesses of the Rome and Conasauga Formations, and the Brierfield, Ketona, Bibb, Copper Ridge, and Chepultepec Dolomites below drill holes 205 through 208, were interpreted from Butts (1940), Batchelder (1984), James L. Coleman (Coleman Geological Services, unpublished data, 1983), Sternbach (1984), and Hooks (1985). It is possible that these formations are thicker, thinner, or not present below drill holes 205 through 208.

The thicknesses of the Red Mountain Formation, undivided Devonian formations, Fort Payne Chert and Tuscumbia Limestone (undivided), and Floyd Shale below drill holes 206 through 208 were assumed to be the same as the thicknesses shown in drill hole 205. It is possible that these formations are thicker, thinner, or not present below drill holes 206 through 208.

Cross section *N–N′* is not balanced.

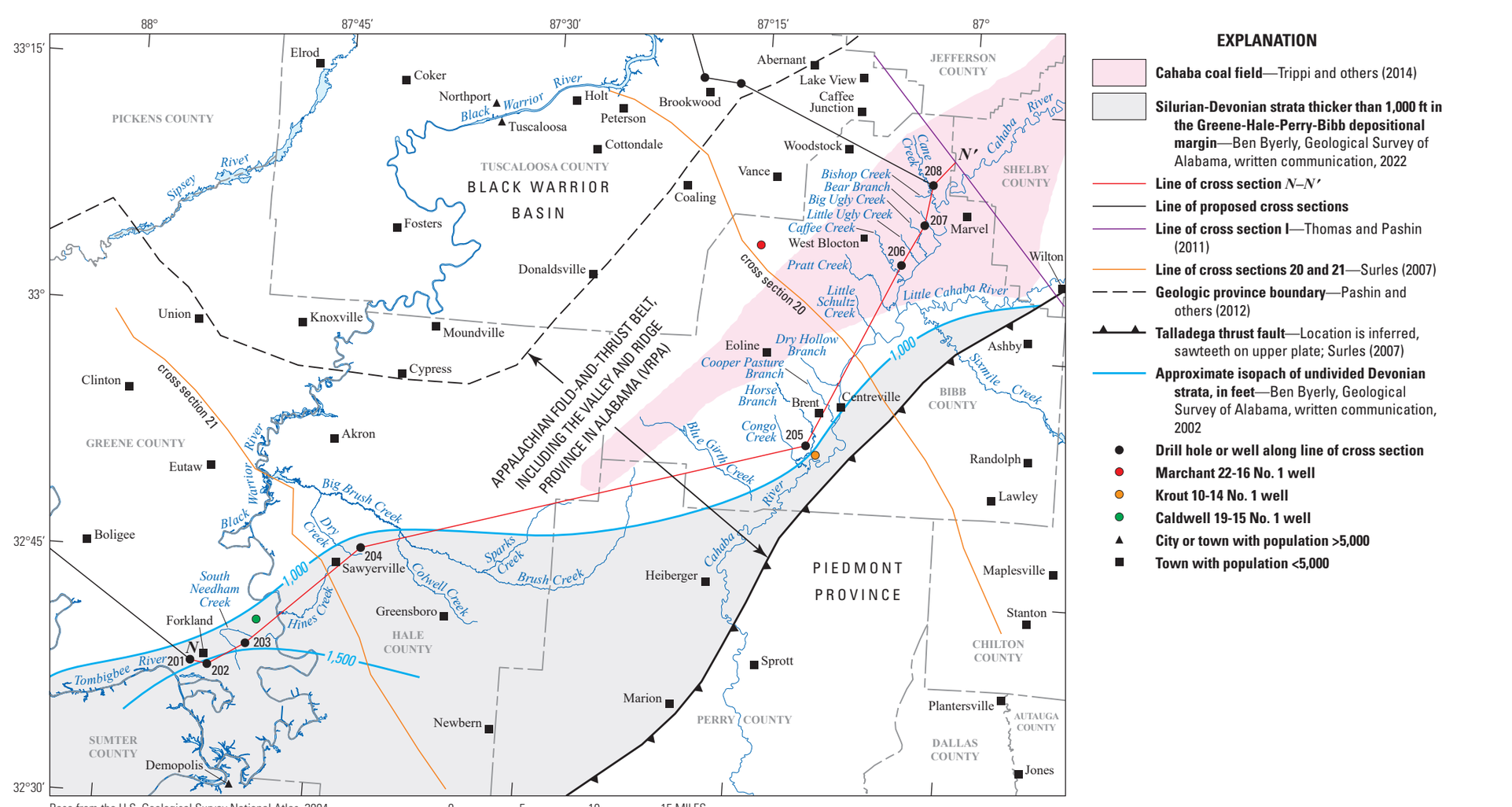


Figure 1. Map showing the location of cross section *N–N′* with drill holes, cross sections 20 and 21 from Surles (2007), cross section I from Thomas and Pashin (2011), the Marchant 22-16 No. 1 well (Geological Survey of Alabama, 2024), the Krout 10-14 No. 1 well (Geological Survey of Alabama, 2024), and the Caldwell 19-15 No. 1 well (Geological Survey of Alabama, 2024). Also shown are rivers, counties, cities, towns, geologic provinces, the Talladega thrust fault (Surles, 2007), the Cahaba coal field, the approximate area of the Greene-Hale-Perry-Bibb depositional margin in the study area, and isopachs of the undivided Devonian strata in the Greene-Hale-Perry-Bibb depositional margin (Ben Byerly, Geological Survey of Alabama, written communication, 2022). Drill hole/well locations are from Alabama Geological Survey (2024). Geologic province boundaries are from Pashin and others (2012). County boundaries, rivers, and town locations are from the U.S. Geological Survey National Map (https://www.usgs.gov/programs/national-geospatial-program/national- map).

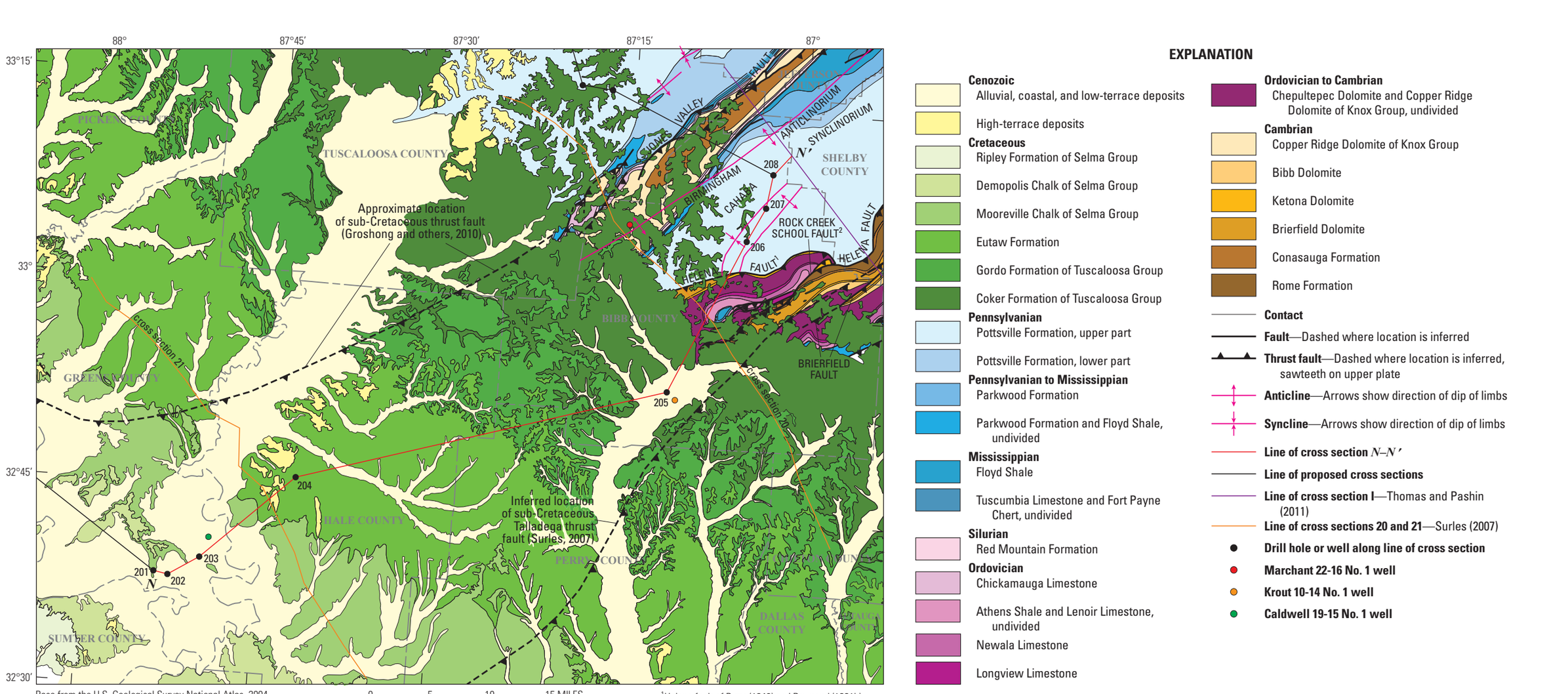


Figure 2. Geologic map showing cross section *N–N′* with drill holes 201–208, cross sections 20 and 21 from Surles (2007), cross section I from Thomas and Pashin (2011), Marchant 22-16 No. 1 well, Krout 10-14 No. 1 well, Caldwell 19-15 No. 1 well, surface formations, and structural features in the study area. Surface formations, faults, Birmingham anticlinorium, and unnamed anticline and syncline northwest of Jones Valley Fault are from Geological Survey of Alabama (2006). Sub-Cretaceous thrust faults are from Groshong and others (2010, west) and Surles (2007, east). The unnamed anticline and unnamed syncline near wells 206–208 are from Szabo and others (1976). "Sub-Cretaceous" refers to faults in Paleozoic rocks. County boundaries are shown with dashed lines.

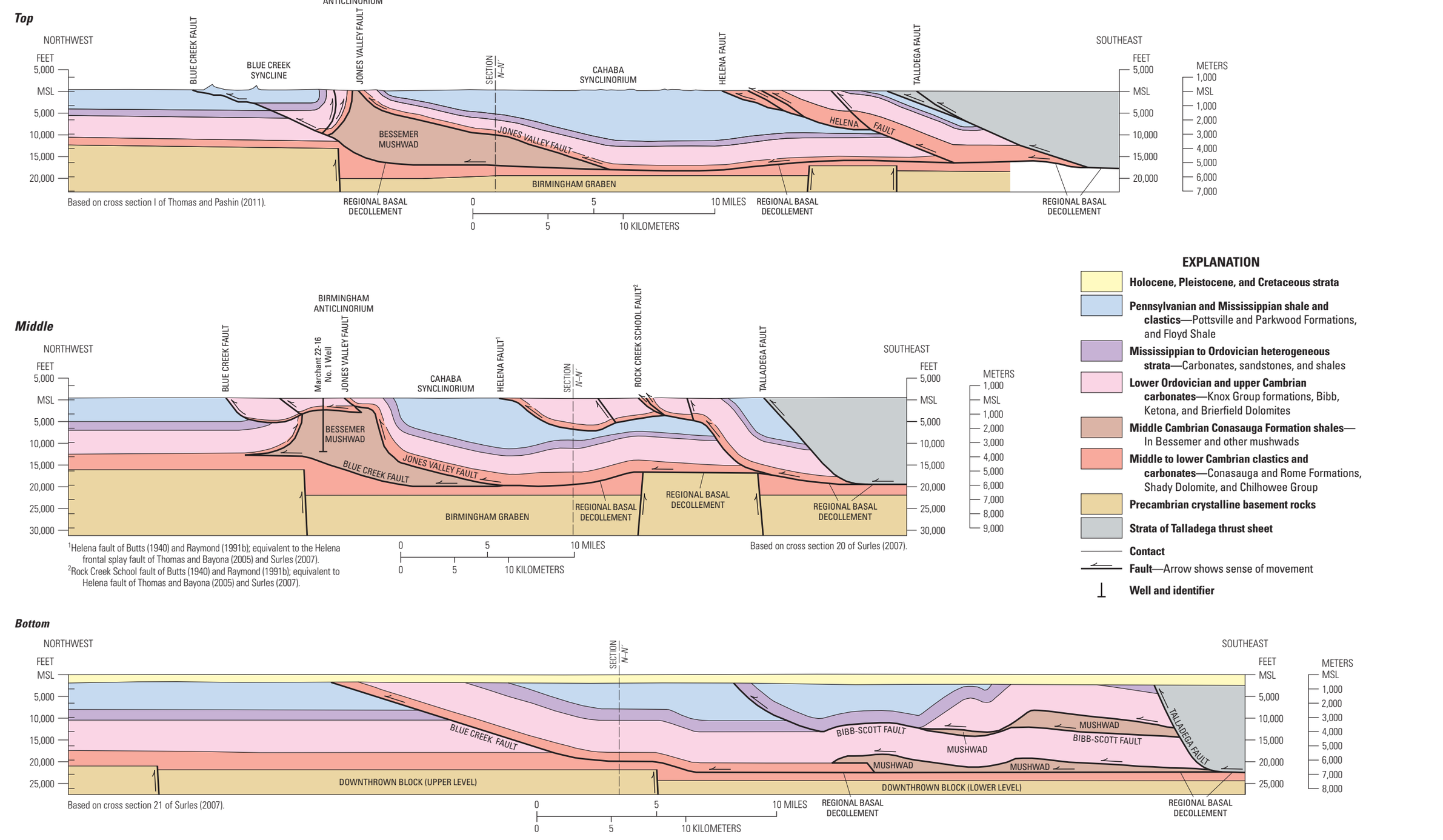
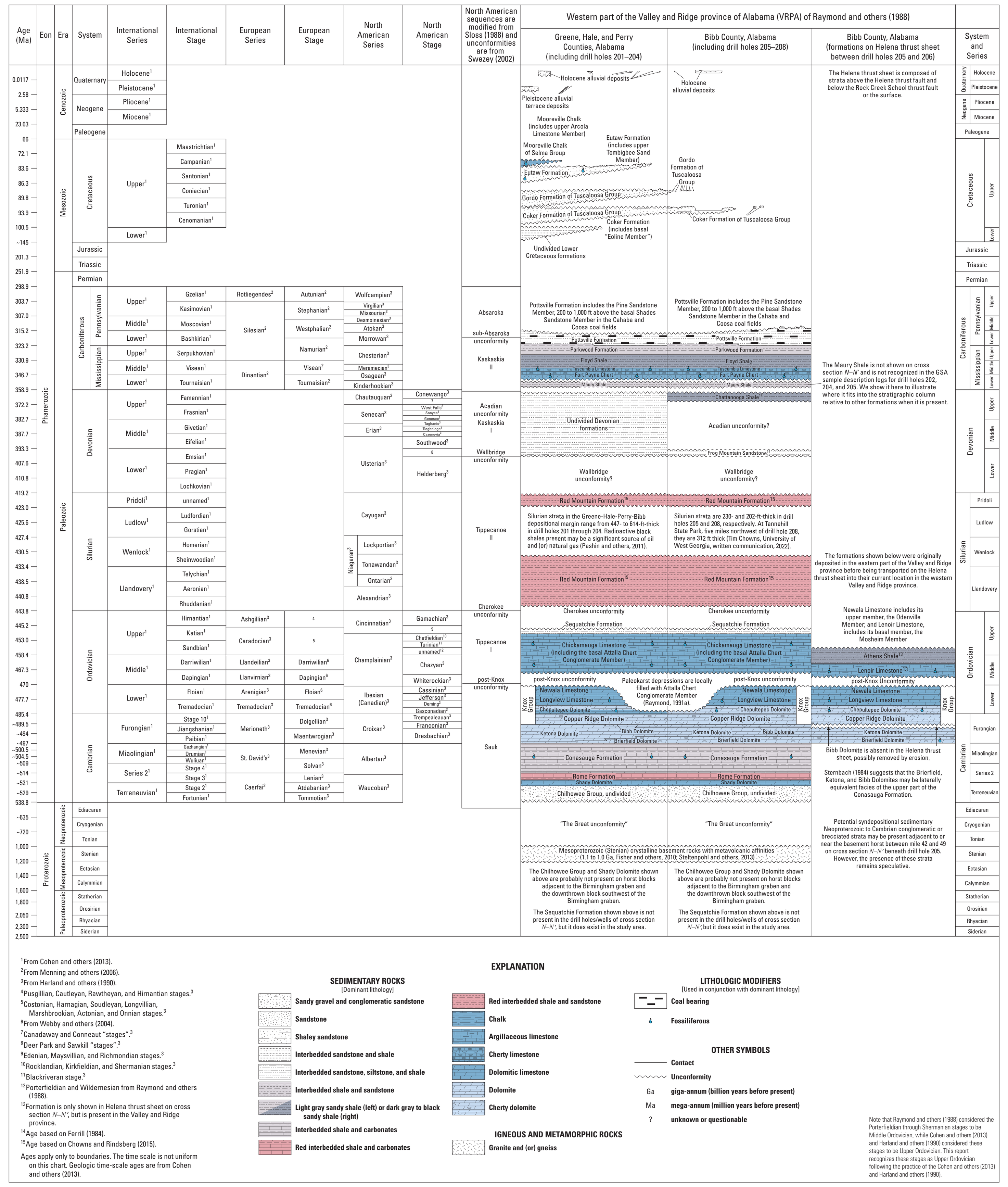


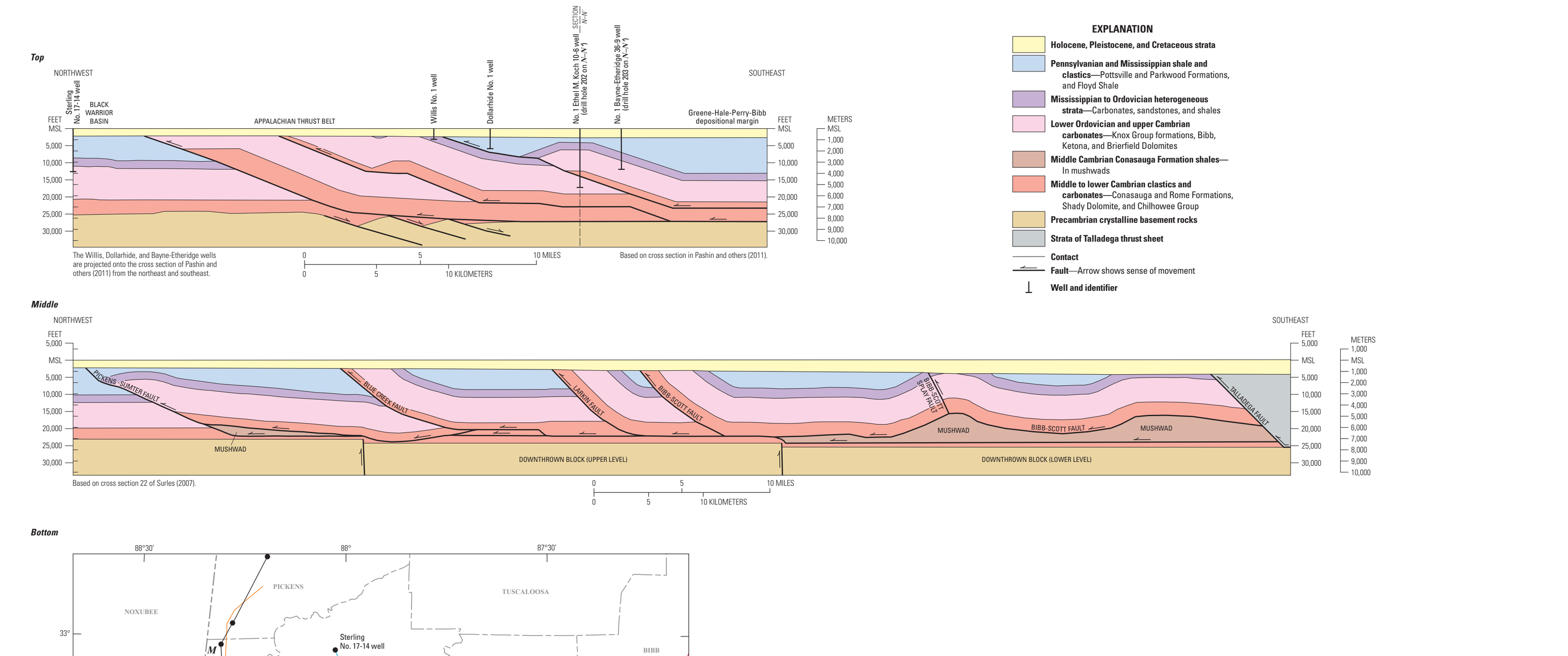
Figure 7. Cross sections through the Birmingham graben and the downthrown block southwest of the Birmingham graben in Alabama. *Top*, cross section I based on Thomas and Pashin (2011); *Middle*, cross section 20 based on Surles (2007); and *Bottom*, cross section 21 based on Surles (2007). Locations of these three cross sections are shown in figures 1, 2, and 6. Cross section I passes through the Bessemer mushwad in southwestern Jefferson and Shelby Counties, Alabama, and northeastern Tuscaloosa and Bibb Counties, Alabama. Cross section 20 passes through the Bessemer mushwad in eastern Tuscaloosa and central Bibb County, Alabama. The Marchant 22-16 No. 1 well in western Bibb County, penetrated 10,580 ft (3,225 m) of shaly Conasauga Formation at the apex of the Bessemer mushwad near cross section 20. The Bessemer mushwad pinches out somewhere between cross sections 20 and 21. ft, feet; m, meters; MSL, mean sea level; mushwad, Malleable, Unctuous SHale, Weak layer Accretion in a Ductile duplex (Thomas, 2001).



[1]From Cohen and others (2013).
[2]From Menning and others (2006).
[3]From Harland and others (1990).
[4]Pusgillian, Cautleyan, Rawtheyan, and Hirnantian stages.[3]
[5]Costonian, Harnagian, Soudleyan, Longvillian, Marshbrookian, Actonian, and Onnian stages.[3]
[6]From Webby and others (2004).
[7]Canadaway and Conneaut "stages".[3]
[8]Deer Park and Sawkill "stages".[3]
[9]Edenian, Maysvillian, and Richmondian stages.[3]
[10]Rocklandian, Kirkfieldian, and Shermanian stages.[3]
[11]Blackriveran stage.[3]
[12]Porterfieldian and Wildernesian from Raymond and others (1988).
[13]Formation is only shown in Helena thrust sheet on cross section *N–N′*, but is present in the Valley and Ridge province.
[14]Age based on Ferrill (1984).
[15]Age based on Chowns and Rindsberg (2015).
Ages apply only to boundaries. The time scale is not uniform on this chart. Geologic time-scale ages are from Cohen and others (2013).

Note that Raymond and others (1988) considered the Porterfieldian through Shermanian stages to be Middle Ordovician, while Cohen and others (2013) and Harland and others (1990) considered these stages to be Upper Ordovician. This report recognizes these stages as Upper Ordovician following the practice of the Cohen and others (2013) and Harland and others (1990).

Figure 3. Correlation chart of Proterozoic, Paleozoic, Cretaceous, and Quaternary rocks along cross section *N–N′* in Alabama. Sources of all series and stages are given in the footnotes. "Sub-Absaroka" means the unconformity is below the Absaroka sequence from Sloss (1988). ft, feet; ~, approximately.



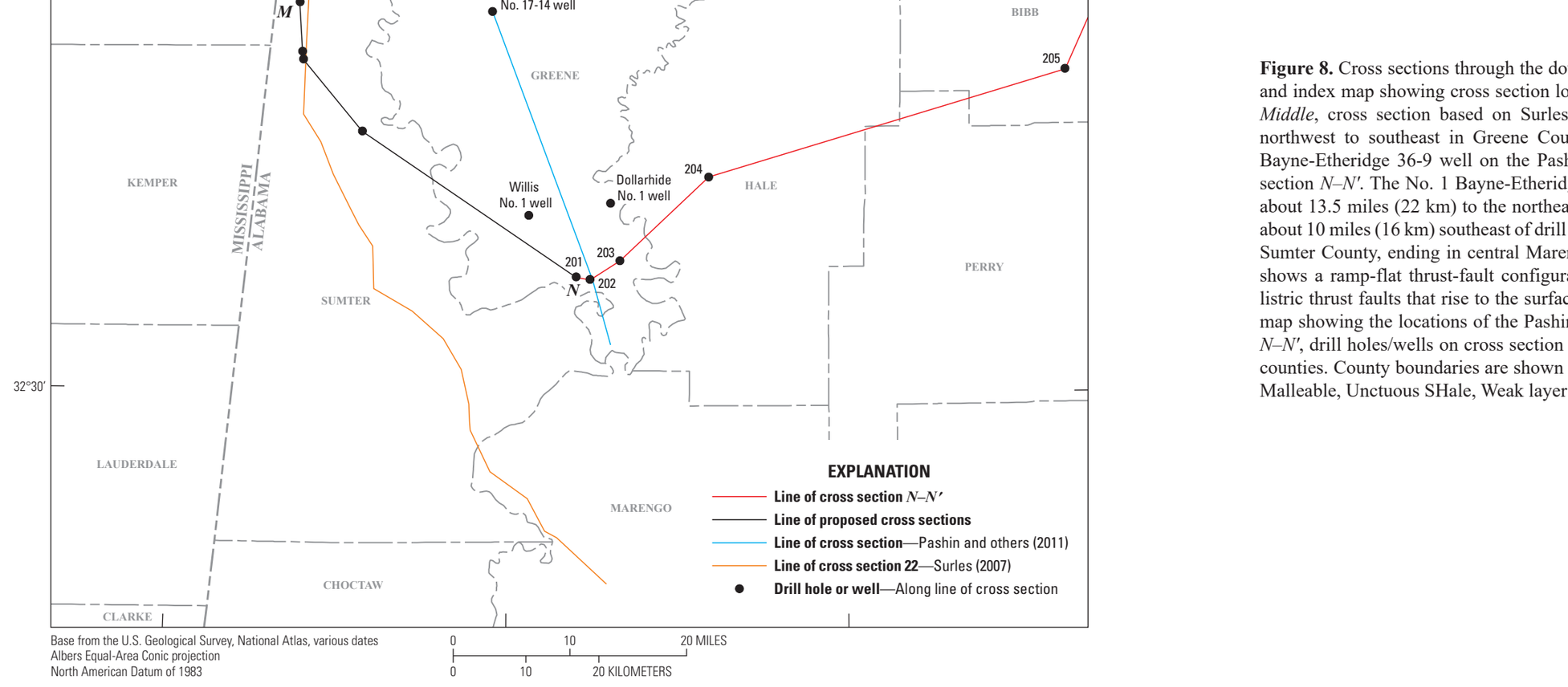
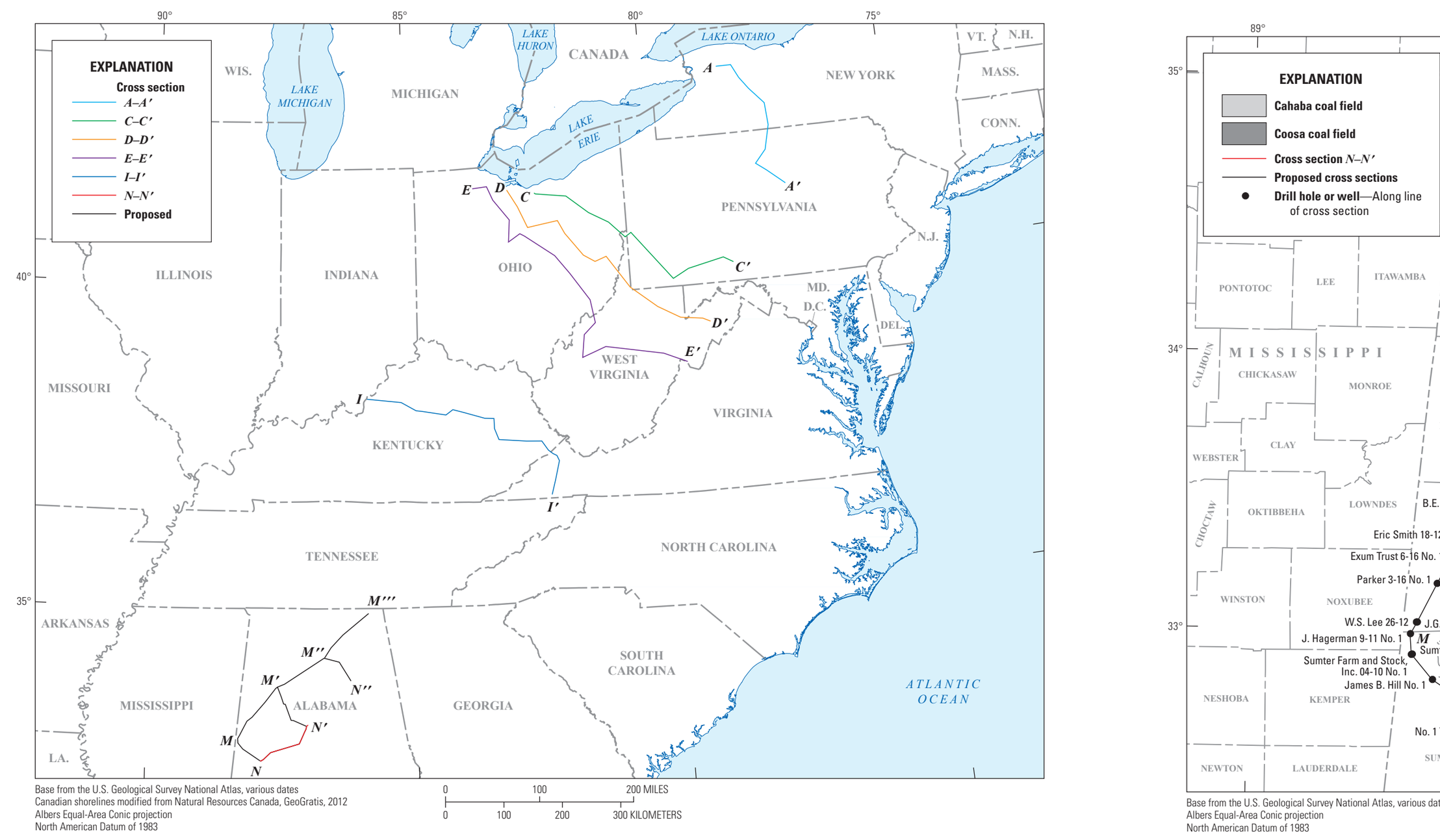
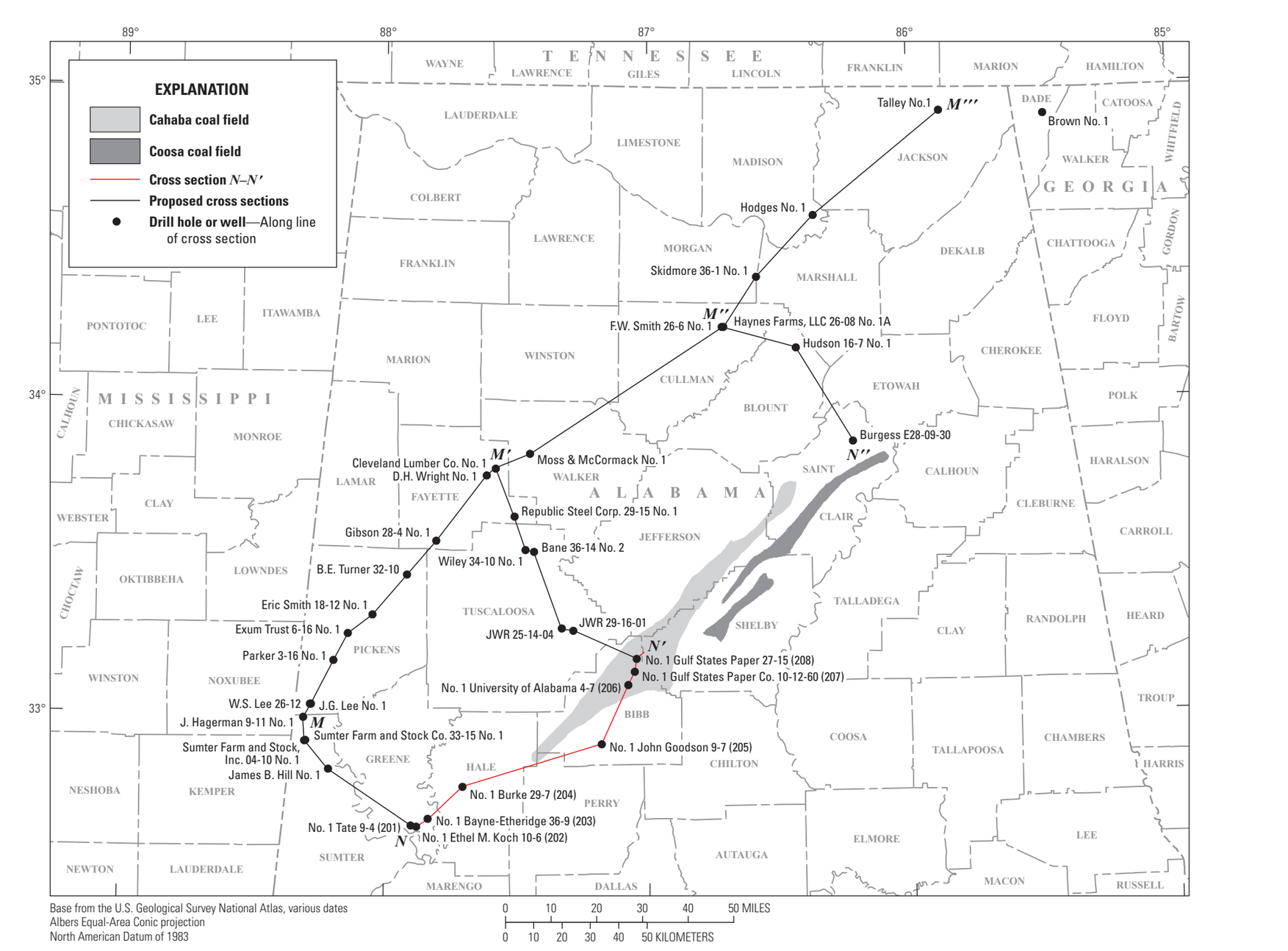


Figure 8. Cross sections through the downthrown block southwest of the Birmingham graben in Alabama, and index map showing cross section locations. *Top*, cross section based on Pashin and others (2011); and *Middle*, cross section based on Surles (2007). The Pashin and others (2011) cross section runs from northwest to southeast in Greene County, Alabama. The No. 1 Ethel M. Koch 10-6 well and No. 1 Bayne-Etheridge 36-9 well on the Pashin and others cross section are drill holes 202 and 203 on cross section *N–N′*. The No. 1 Bayne-Etheridge 36-9 well was projected onto this cross section from a location about 13.5 miles (22 km) to the northeast in Hale County, Alabama. The Surles (2007) cross section 22 is about 10 miles (16 km) southeast of drill holes 201 and 202, and runs from southern Pickens County, through Sumter County, ending in central Marengo County, Alabama. The Pashin and others (2011) cross section shows a ramp-flat thrust-fault configuration, whereas the Surles (2007) cross section 22 shows multiple listric thrust faults that rise to the surface but do not demonstrate a ramp-flat configuration. *Bottom*, index map showing the locations of the Pashin and others (2011) and Surles (2007) cross sections, cross section *N–N′*, drill holes/wells on cross section *N–N′*, proposed cross sections, and boundaries of nearby Alabama counties. County boundaries are shown with dashed lines. km, kilometer; MSL, mean sea level; mushwad, Malleable, Unctuous SHale, Weak layer Accretion in a Ductile duplex (Thomas, 2001).



Index map 1. Map showing the locations of U.S. Geological Survey cross sections in the Appalachian basin. Cross sections that were previously published include *E–E′* (Ryder and others, 2008), *D–D′* (Ryder and others, 2009), *C–C′* (Ryder and others, 2012), *I–I′* (Ryder and others, 2015), and *A–A′* (Trippi and others, 2019). The locations of cross section *N–N′* (this report) and several proposed cross sections in Alabama are also shown.



Index map 2. Map showing the location of cross section *N–N′* and several proposed cross sections in Alabama with drill holes/wells, surrounding counties, and the locations of the Cahaba and Coosa coal fields. Names of drill holes are given next to each location. Drill hole numbers 201 to 208 from cross section *N–N′* are enclosed in parentheses following the well name.

Cross Section *N–N′* through the Valley and Ridge Province of the Southern Appalachian Basin, from Greene County, West-Central Alabama, to Bibb County, Central Alabama

By

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