

Figure 2.5.1-1. Map of Physiographic Provinces

2.5.1-163 Revision 1

CENOZOIC MESOZOIC PALEOZOIC PRECAMBRIAN PERIOR DE LA CALLANTA DEL CAL EPOCH PERIOD EPOCH MAASTRICHTIAN EDIACARAN ZANCI FAN CAMPANIAN CRYOGENIAN CRETACEOUS MESSINIAN TONIAN TORTONIAN STENIAN CENOMANIAN SERRAVALLIAN MESOPRO-TEROZOIC LANGHIAN **ECTASIAN** ALBIAN MIDDLE MOSCOVIAN EARLY BASHKIRIAN BURDIGALIAN CALYMMIAN SERPUKHOVIAN APTIAN AQUITANIAN BARREMIAN STATHERIAN TOURNAISIAN OLIGOCENE CHATTIAN VALANGINIAN FAMENNIAN OROSIRIAN PALEOPRO-TEROZOIC TITHONIAN FRASNIAN RUPELIAN RHYACIAN KIMMERIDGIAN GIVETIAN EIFELIAN JURASSIC OXFORDIAN EMSIAN SIDERIAN PRIABONIAN PRACIAN LOCHKOVIAN BARTONIAN NEOARCHEA LUTETIAN KATIAN MESO-ARCHEAN SINEMURIAN SANDBIAN YPRESIAN ပ PALEO-ARCHEAN TRIASSI NORIAN THANETIAN CAMBRIAN CARNIAN SELANDIAN AGE 3 AGE 2 DANIAN ANISIAN

GSA GEOLOGIC TIME SCALE v.4.0



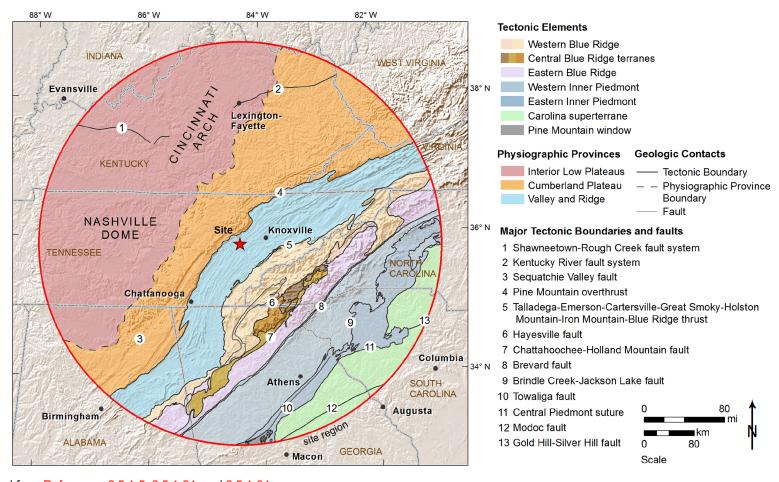
"The Plestocen is divided in to loar age, but only two are shown here. What is shown as Calabanan is actually three ages—Calabrain from 18 to 0.78 Ma. Mode from 0.78 to 0.13 Ma, and tale from 0.13 to 0.01 Ma. Walker, J. D. Geschan, J. W. Rowman, S. A. on Babcoot, L. E. complexe, 2012. Geological Society of America, do: 10.1301/CSTOWARCA COURT The Geological Society of America and Court The Court The Geological Society of America and Court The Court The Court The Court The Court The Main International Geological Court Court The Court The management of Court The Court The Main International Geological Court Court The Court The Main International Geological Court The Court The Main International Geological Court The Court The Court The Main International Geological Court The Court The Court The Main International Geological Court The Court The Court The Main International Geological Court The Court The Court The Main International Geological Court The Court The Court The Main International Geological Court The Court The Court The Main International Court The Court T

Gradstein, FM, Ogg, J.G., Schmitz, M.D., et al., 2012, The Geologic Time Scale 2012: Boston, USA, Elsevier, DOI: 10.1016/8978-0-444-59425-9.00004-4

Source: Reference 2.5.1-33

Figure 2.5.1-2. Geologic Time Scale

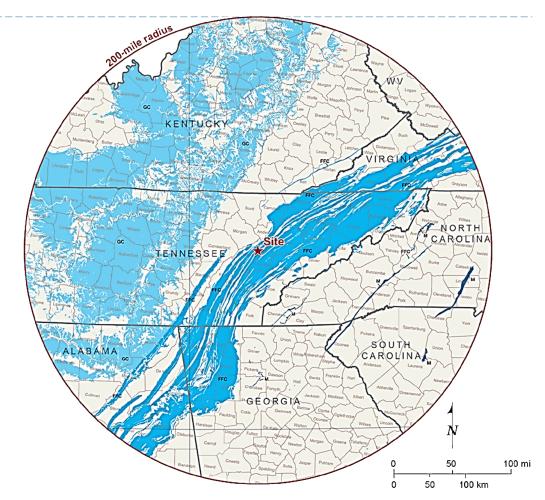
2.5.1-164 Revision 1



Note: Modified from References 2.5.1-5, 2.5.1-24, and 2.5.1-34

Figure 2.5.1-3. Map of Lithotectonic Tectonic Terranes, Provinces and Major Tectonic Boundaries

2.5.1-165 Revision 1



Source: Modified from Reference 2.5.1-26

Description of Map Units

Gently folded and flat-lying carbonates rocks: indurated limestone and dolomite that has not been strongly deformed. Predominantly found in interior plateaus and lowlands. Dissolution may produce solution, collapse, and cover-collapse sinkholes. Where carbonates are thick and extensive, cave systems may be long and complex. Where thin and interbedded with non-carbonates, caves are small and short. Geometry of cave passage patterns often shows stratigraphic and bedding-plane control often resulting in branchwork caves. (Reference 2.5.1-35)

Folded, faulted carbonate rocks: limestone and dolomite in areas flanking and in orogenic zones. May be intensely folded and faulted, commonly well jointed, commonly with cleavage. These rocks are located in the Valley and Ridge Province on this map and most are Paleozoic in age. Dissolution may produce solution, collapse, and cover-collapse sinkholes. Caves range from small and simple to long and complex systems. Geometry of cave passage patterns tend to show at least some structural control producing network caves. (Reference 2.5.1-35)

Marbles and metalimestones: highly deformed carbonate rocks, usually found in long, thin, linear belts or pods. Mapped areas are often exaggerated as these rocks are usually mapped with associated, non-soluble metamorphic rocks. Dissolution may result in solution, collapse, and cover-collapse sinkholes and small, short caves.

Figure 2.5.1-4. Regional Distribution of Carbonate Rocks

2.5.1-166 Revision 1

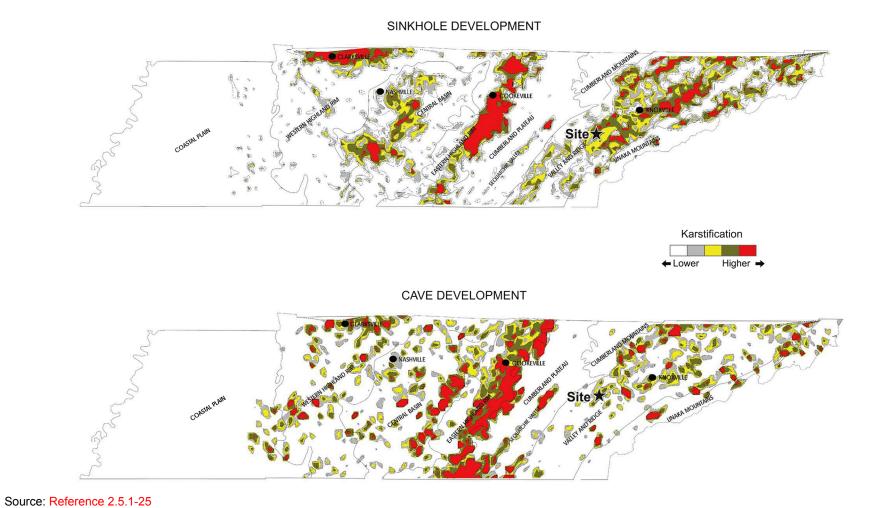
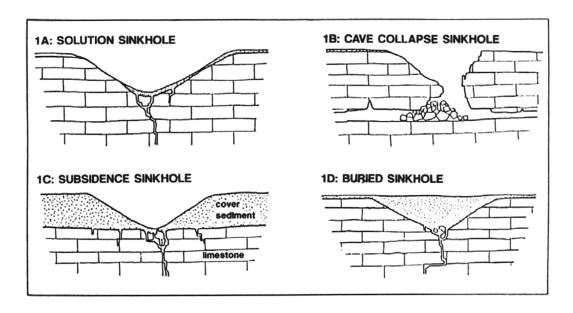
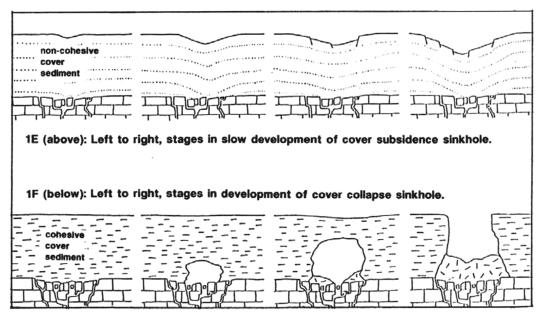


Figure 2.5.1-5. Map of Sinkhole and Cave Development for the State of Tennessee

2.5.1-167 Revision 1

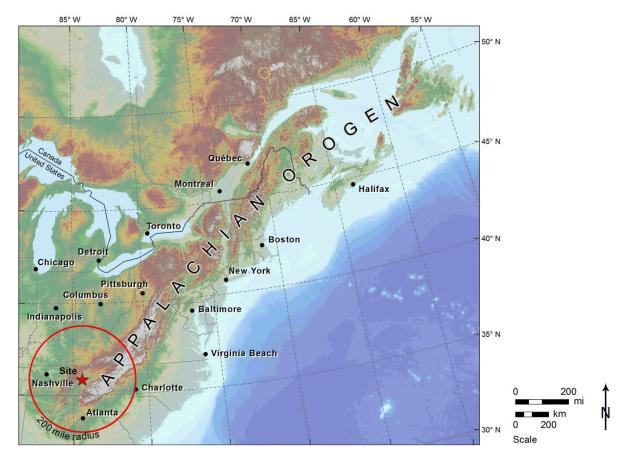




Note: Reference 2.5.1-27

Figure 2.5.1-6. Sinkhole Types

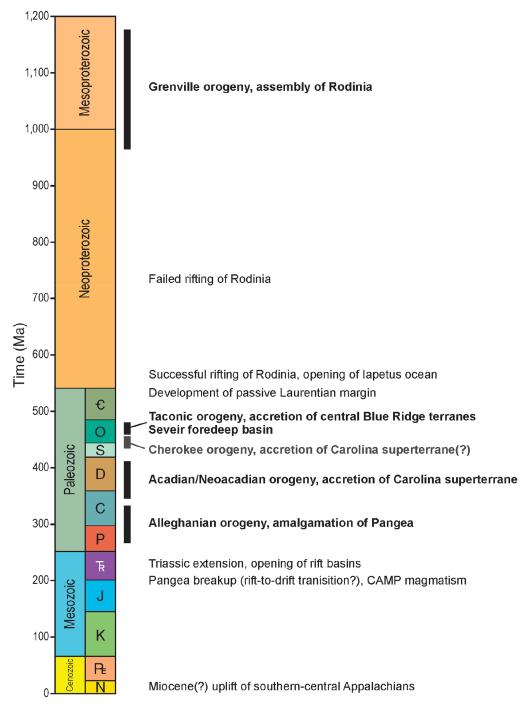
2.5.1-168 Revision 1



Note: Elevation and bathymetric data from Reference 2.5.1-190, Sheet A-1.

Figure 2.5.1-7. Shaded Relief Map of Eastern North America Demonstrating the Extent of the Appalachian Orogenic Belt

2.5.1-169 Revision 1

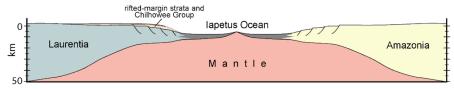


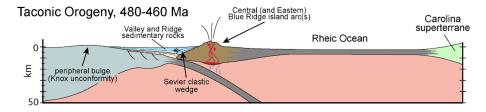
Note: Geologic time scale (Reference 2.5.1-33) with tectonic events that have affected the Appalachian orogenic belt (References 2.5.1-34 and 2.5.1-65).

Figure 2.5.1-8. Geologic Time Scale with Orogenic Events

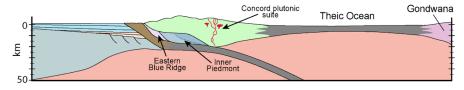
2.5.1-170 Revision 1

Rodinia Breakup to Iapetan Passive Margin late Neoproterozoic-early Cambrian

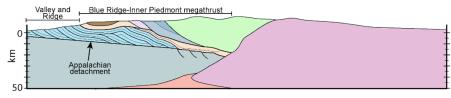




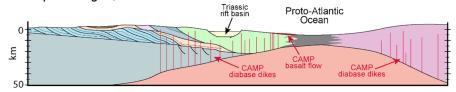
Acadian-Neoacadian Orogeny, 415-355 Ma



Alleghanian Orogeny (Formation of Pangea), 340-280(?) Ma







Notes:

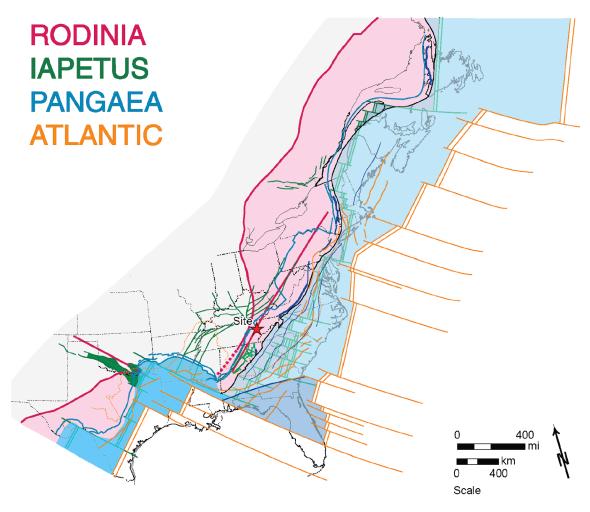
Sequential development of the Appalachian orogen from the breakup of Rodinia to the breakup of Pangea, from Reference 2.5.1-73.

Deep crustal structure from Reference 2.5.1-277.

See Figure 2.5.1-3 for map of lithotectonic terranes.

Figure 2.5.1-9. Sequential Development of Appalachians Profiles

2.5.1-171 Revision 1



Map of eastern North America, illustrating tectonic inheritance through the amalgamation and breakup of two supercontinents.

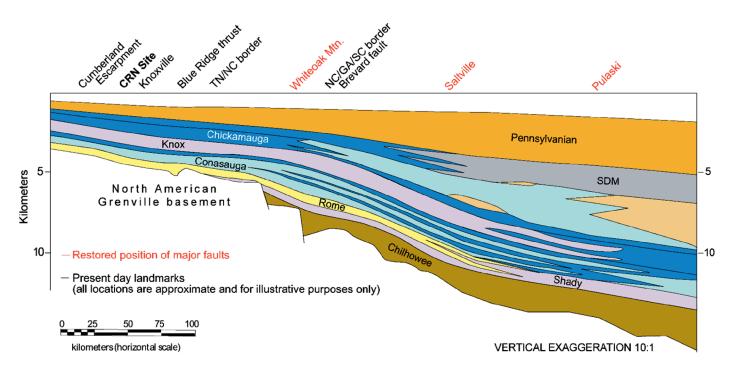
Features formed during the Grenville orogeny (formation of Rodinia) shown in red; those formed during the Appalachian orogenies (formation of Pangea) shown in blue.

Rifted margins that formed from supercontinent breakup are shown in green (lapetus ocean) and orange (Atlantic

Modified from Thomas, 2006 Reference 2.5.1-38.

Figure 2.5.1-10. North American Rifted Margin

2.5.1-172 Revision 1

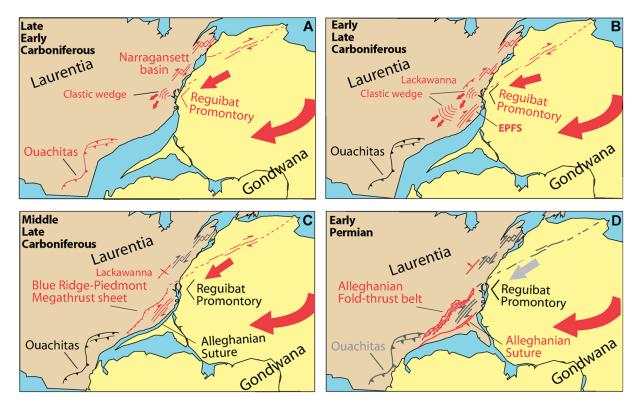


Facies diagram of passive margin to stable shelf strata of the western Blue Ridge and Valley and Ridge (from Reference 2.5.1-13). Units have been palinspastically restored along major Valley and Ridge thrust faults.

Blue — limestone facies; Lavender — dolomite facies; Light blue — shale facies; Beige and medium brown — coarse clastics and turbidites; Gray — siltstone facies; Light yellow — sandstone, shale, and dolomite intertidal facies.

Figure 2.5.1-11. Facies Diagram of Stable Shelf Strata

2.5.1-173 Revision 1



Collision model for the Alleghanian orogeny (From Reference 2.5.1-74).

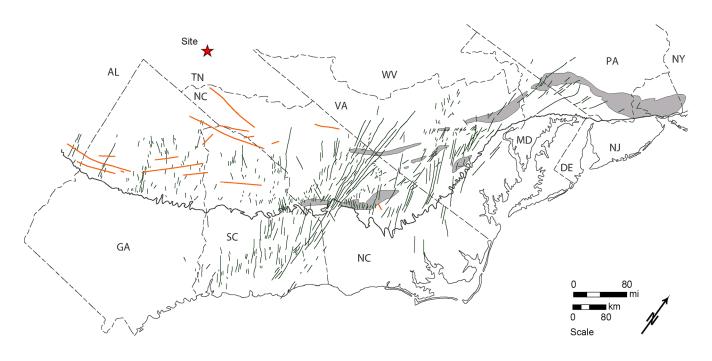
Red lines and symbols indicate the feature is active in the time interval shown.

- A) Initial contact between Gondwana and Laurentia produced step-over basins in New England and deposition in the Appalachian basin.
- B) Continued collision resulted in greater clastic input in the foreland, with the development of dextral strike-slip faults in the interior of the orogen.
- C) Clockwise rotation of Gondwana begins to dominate the collision, resulting in a more head-on collision in the southern Appalachians.
- D) Head-on collision in the southern Appalachians results in thrusting of the Blue Ridge-Piedmont megathrust sheet and foreland fold-thrust belt development.

EPFS — Eastern Piedmont Fault System.

Figure 2.5.1-12. Alleghanian Zipper Tectonics

2.5.1-174 Revision 1



Distribution of Mesozoic features in the southern and central Appalachians.

Central Atlantic Magmatic Province (CAMP) diabase dikes shown as thin green lines, with silicified faults shown as heavy orange lines.

Dark shaded areas represent exposed Triassic rift basins.

From Reference 2.5.1-87.

Figure 2.5.1-13. Mesozoic Features Map

2.5.1-175 Revision 1

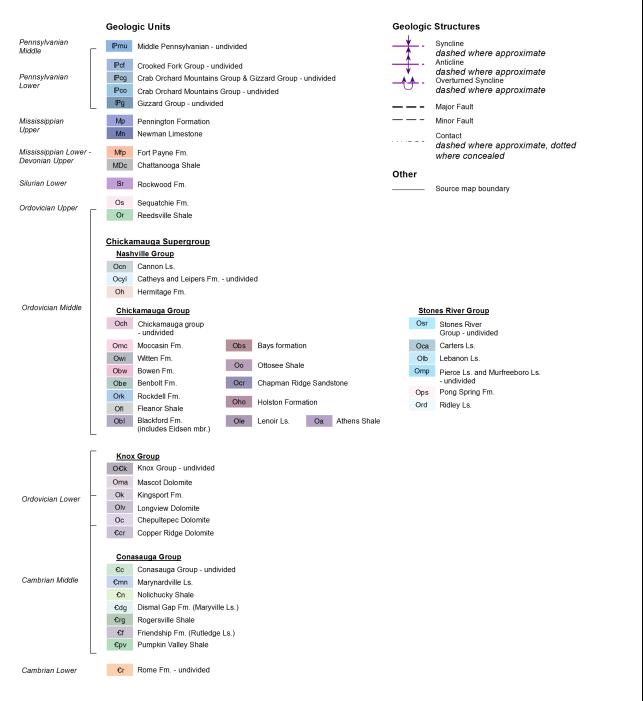
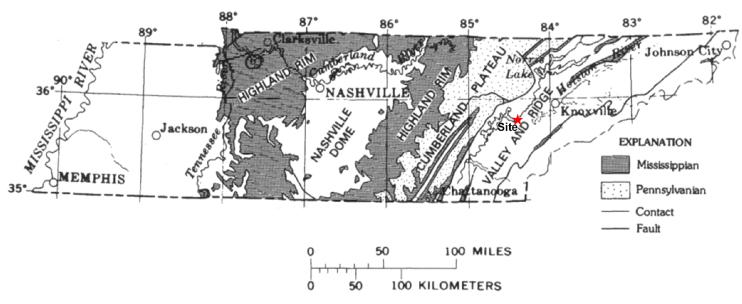


Figure 2.5.1-14. Site Vicinity Stratigraphic Columns

2.5.1-176 Revision 1



Note: After Reference 2.5.1-112

Figure 2.5.1-15. The Cumberland Plateau and Interior Low Plateaus in Tennessee

2.5.1-177 Revision 1

| SERIES | WESTERN HIGHLAND RIM | CUMBERLAND PLATEAU AND EASTERN HIGHLAND RIM | PINE MOUNTAIN BLOCK (Englund, 1964, 1968) | | NEWMAN RIDGE (Mixon and Harris, 1971) | | LT EAST OF CLINCH MOUNTAIN anders, 1952, unpub. data; Hasson,1973) | CHILHOWEE MOUNTAIN (Newman and Nelson, 1965) |
|-----------------------|-----------------------------|------------------------------------------------------|-------------------------------------------------|-----------------------|------------------------------------------|-------------|-----------------------------------------------------------------------------|-------------------------------------------------------|
| MERAMECIAN CHESTERIAN | | Gizzard Group (lower part) | Pennington Foramtion | | Pennington Formation | | Pennington Formation | |
| | | Pennington Formation | | | | | Cove Creek Formation | |
| | | Bangor Limestone | | | | tone | Fido Sandstone | |
| | | Hartselle Sandstone | | | | | Fisher Creek Limestone | |
| | Ste. Genevieve Limestone | Monteagle Limestone | Newman i | Limestone | Newman Limestone | n Limestone | Gilliam Creek Limestone | |
| | St. Louis Limestone | St. Louis Limestone | | | | Newman | Clifton Creak Limestone | |
| | | | | | | | Snowflake Formation Laurel Branch Limestone | |
| | Warsaw Limestone | Warsaw Limestone | | | | | Pressmens Home Formation | Greasy Cove Formation |
| H | | | | | | | Maccrady Formation | |
| OSAGEAN | Fort Payne Formation | Fort Payne Formation | Fort Payne Chert | Grainger Formation | Grainger Formation | | Grainger Formation | Grainger Formation |
| KINDERHOOKIAN | Maury Shale | Maury Shale | Maurý | Shale | Chattenooga Shale (upper part) | | Chattanooga Shale (upper part) | Chattanooga Shale (upper part) |

Notes: From Reference 2.5.1-112

Figure 2.5.1-16. Mississippian Stratigraphic Units in Tennessee

2.5.1-178 Revision 1

| SERIES | Wilson and others (1956) | | Englund (1964, 1968) Wanless (1946, pl. 32) | | |
|-----------|-------------------------------|-----------------|------------------------------------------------|--|--|
| ALLEGHENY | Cross Mountain Formation | | Bryson Formation | | |
| AL | -Grassy Spring coal bed - | | - Red Spring coal bed ? - | | |
| | — Rock Spring coal bed — | | | | |
| | Vowell Mountain Formation | Breathitt Group | | | |
| | Pewee coal bed | | Hignite Formation | | |
| | Readoak Mountain Formation | | Sharp coal bed ——— Catron Formation | | |
| | Windrock coal bed | | Poplar Lick coal bed | | |
| KANAWHA | Graves Gap Formation | | | | |
| | Jordan coal bed | | Mingo Formation | | |
| | Indian Sluff Formation | | | | |
| | Jellico coel bed | | Harlan coal bed | | |
| | Slatestone Formation | | Hence Formation | | |

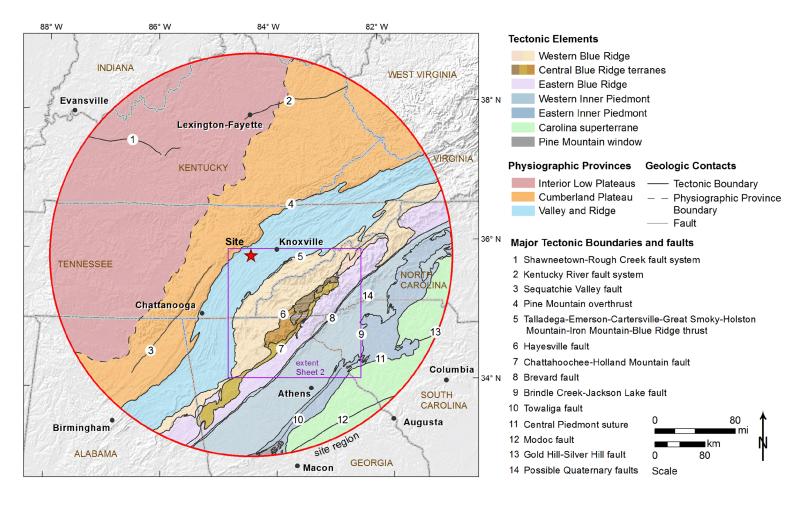
| | | | , | ······································ | | |
|-----------|------------------------------|---------------------------------------------------|----------------------------------------|----------------------------------------|--|--|
| SERIES | w | Slighty modified from ilson and others (1956)¹ | Englund(1964, 1968) ¹ | | | |
| | Crooked Fork Group | Poplar Creek coal bed Wartburg Sandstone | roup | Hance Formation | | |
| | | Glenmary Shale | Breathitt Group | | | |
| | | Coalfield Sandstone | | | | |
| | | Burnt Mill Shale | | | | |
| | | Crossville Sandstone | | | | |
| | | Dorton Shale | | | | |
| RIVER | Crab Orchard Mountains Group | Rockcastle Conglomerate | | Lee Formation | | |
| NEW RIVER | | Vandever Formation | Lee Formation | | | |
| | | Newton Sändstone | | | | |
| | | Whitwell Shale | | | | |
| | | Sewanee Conglomerate | | | | |
| | Gizzard Group | Signal Point Shale, | Pennington Formation (upper member) | | | |
| -?- | | Warren Point Sandstone | Tongues of Lee Formation | | | |
| CHESTER | Ğ | Raccoon Mountain Formation | | Pennington Formation (lower member) | | |

*Queried double lines show opinions concerning the Mississippian -- Pennsylvanian boundary.

Note: Reference 2.5.1-112

Figure 2.5.1-17. Pennsylvanian System in Tennessee

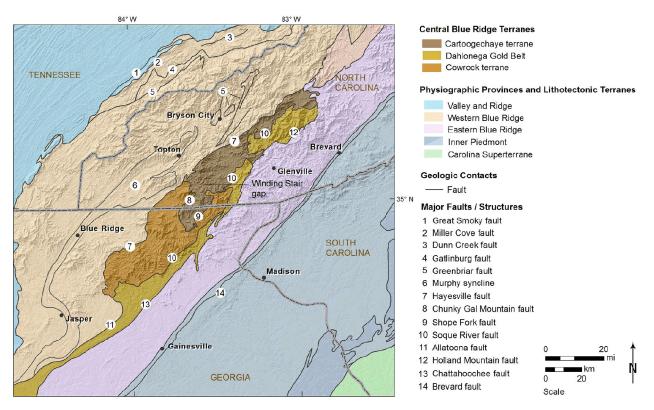
2.5.1-179 Revision 1



Lithotectonic terranes, provinces, and major tectonic boundaries (after References 2.5.1-24, 2.5.1-34, and 2.5.1-137)

Figure 2.5.1-18. (Sheet 1 of 2) Lithotectonic Terrane Map

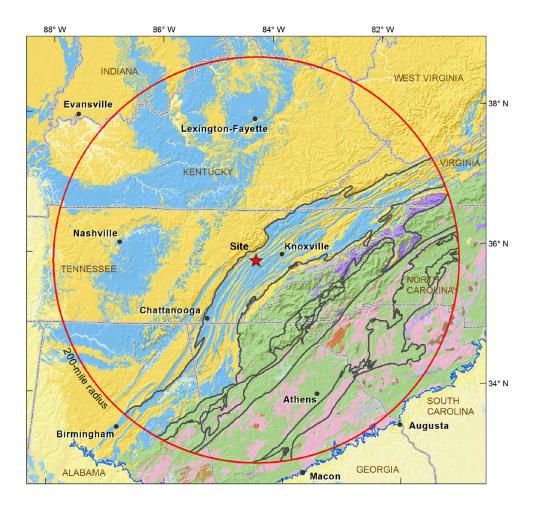
2.5.1-180 Revision 1

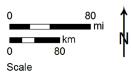


Note: Simplified tectonic map of the Central Blue Ridge terranes.

Figure 2.5.1-18. (Sheet 2 of 2) Lithotectonic Terrane Map—Blue Ridge Zoom

2.5.1-181 Revision 1



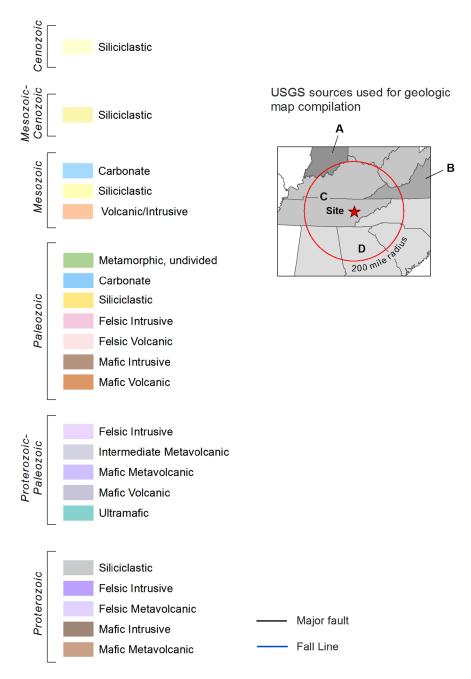


USGS sources for geologic map: A - OFR-04-1355, Reference 2.5.1-116; B - OFR-05-1325, Reference 2.5.1-115; C - OFR-05-1323, Reference 2.5.1-114; D - OFR-05-1324, Reference 2.5.1-117. Major faults from References 2.5.1-24 and 2.5.1-34. Fall Line from Reference 2.5.1-20.

Figure 2.5.1-19. (Sheet 1 of 2) Site Region Geologic Map

2.5.1-182 Revision 1

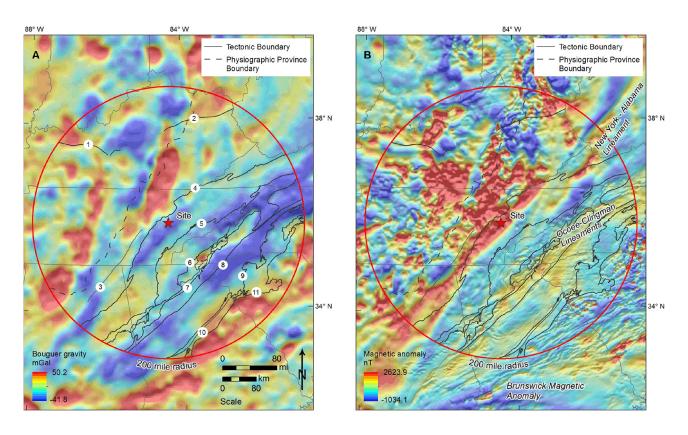
Aggregated Geologic Units



Note: USGS sources for geologic map: A - OFR-04-1355, Reference 2.5.1-116; B - OFR-05-1325, Reference 2.5.1-115; C - OFR-05-1323, Reference 2.5.1-114; D - OFR-05-1324, Reference 2.5.1-117. Major faults from References 2.5.1-24 and 2.5.1-34. Fall Line from Reference 2.5.1-20.

Figure 2.5.1-19. (Sheet 2 of 2) Site Region Geologic Map

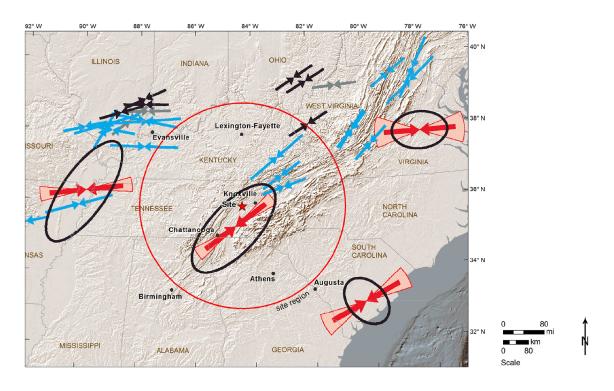
2.5.1-183 Revision 1



Gravity anomaly (A) and aeromagnetic residual data (B) from CEUS SSC (Reference 2.5.1-190). See Figure 2.5.1-18, Sheet 1 for numbered fault references.

Figure 2.5.1-20. Aeromagnetic and Gravity Maps

2.5.1-184 Revision 1



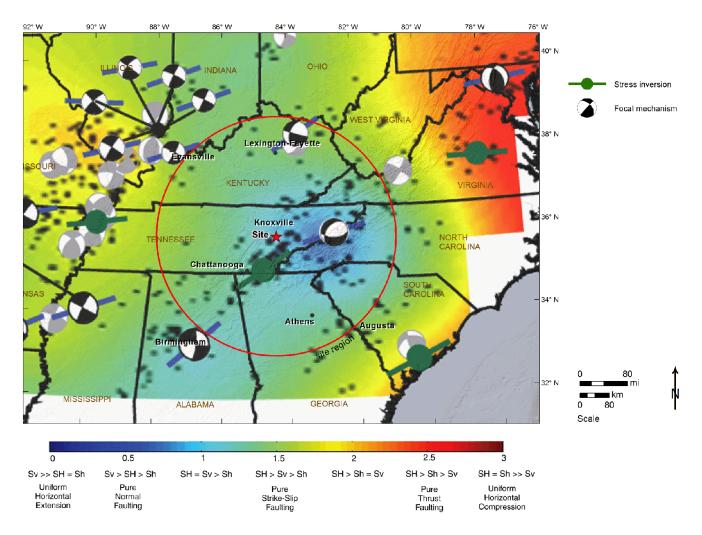
Map of current stresses in the central and eastern U.S. (after Reference 2.5.1-185).

Black and gray arrows – orientation from borehole observations;

Blue arrows – borehole observations used in calculating the regional average within 250 km (155 mi) of the seismic zones (solid ellipses); Red arrows and angular sectors – orientation from focal mechanism inversion.

Figure 2.5.1-21. (Sheet 1 of 2) Current Compressive Stress—Eastern United States

2.5.1-185 Revision 1

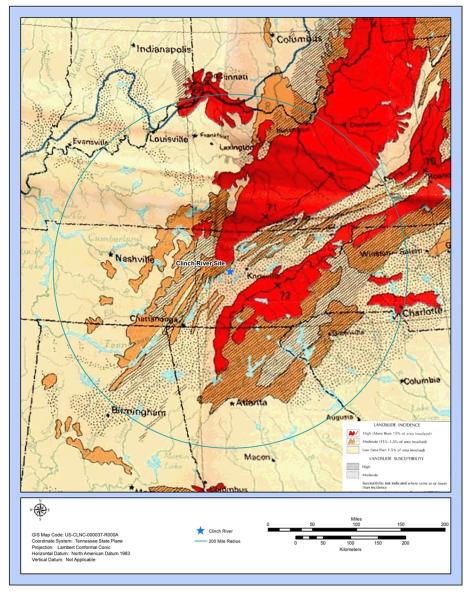


Gray focal mechanisms from Reference 2.5.1-183; black focal mechanisms from Reference 2.5.1-306. SH – maximum horizontal stress; Sh – minimum horizontal stress; Sv – vertical stress.

Source: Reference 2.5.1-306

Figure 2.5.1-21. (Sheet 2 of 2) Regional Stress Map from Hurd and Zoback

2.5.1-186 Revision 1



Note: Modified from Reference 2.5.1-202

Figure 2.5.1-22. Landslide Hazard Map for the Clinch River Nuclear Site Region

2.5.1-187 Revision 1

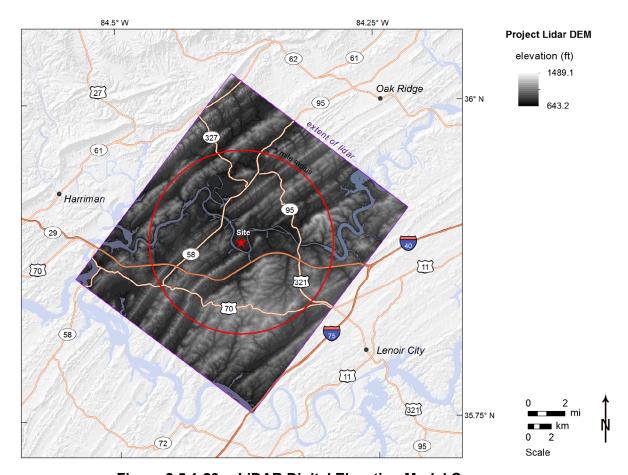
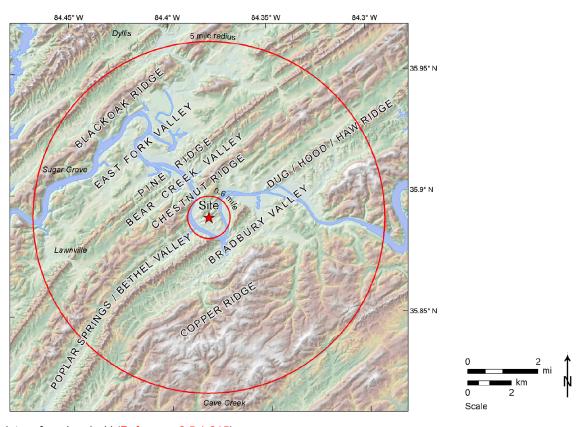


Figure 2.5.1-23. LiDAR Digital Elevation Model Coverage

2.5.1-188 Revision 1



Note: Local geographic nomenclature from Lemiszki (Reference 2.5.1-215)

Figure 2.5.1-24. Local Physiography with Local Nomenclature for Valleys and Ridges

2.5.1-189 Revision 1

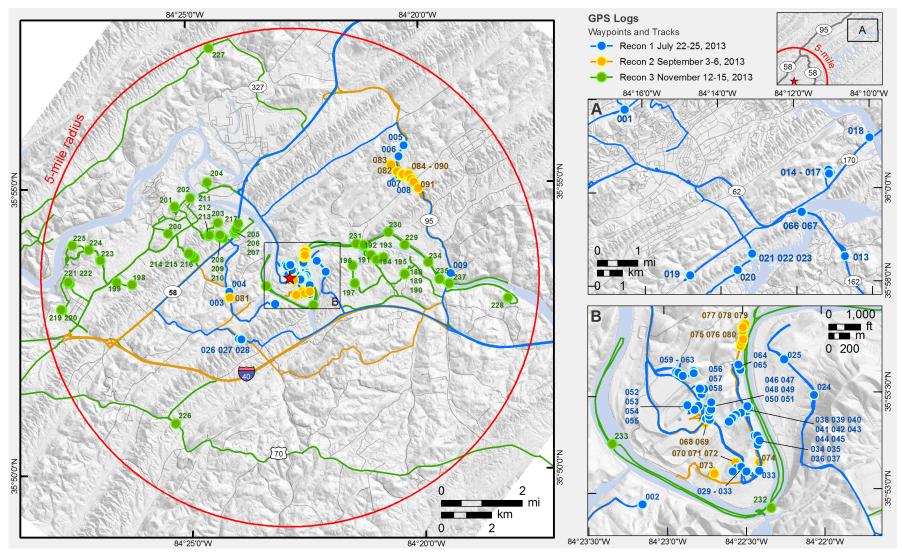


Figure 2.5.1-25. Geologic Field Reconnaissance Waypoint Locations

2.5.1-190 Revision 1

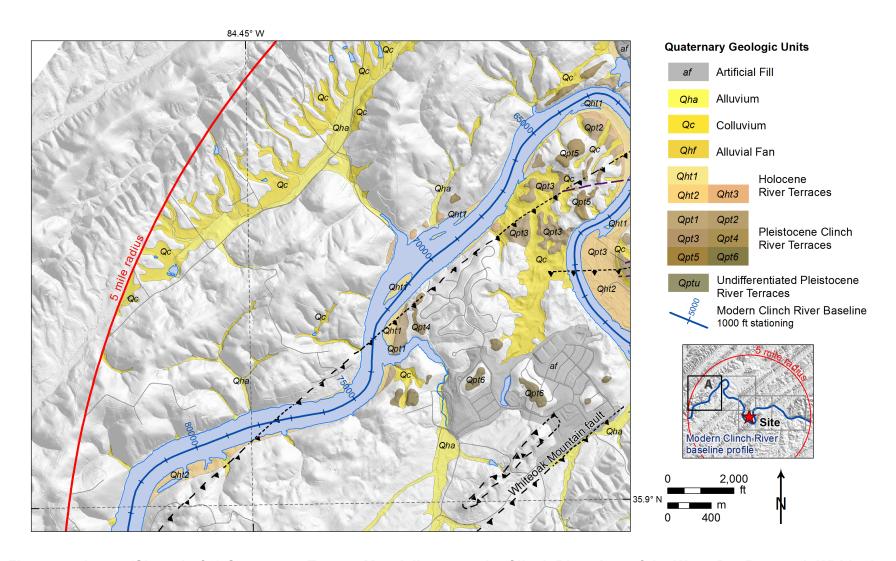


Figure 2.5.1-26. (Sheet 1 of 6) Quaternary Terrace Map Adjacent to the Clinch River Arm of the Watts Bar Reservoir Within the Clinch River Nuclear Site Area, Location A

2.5.1-191 Revision 1

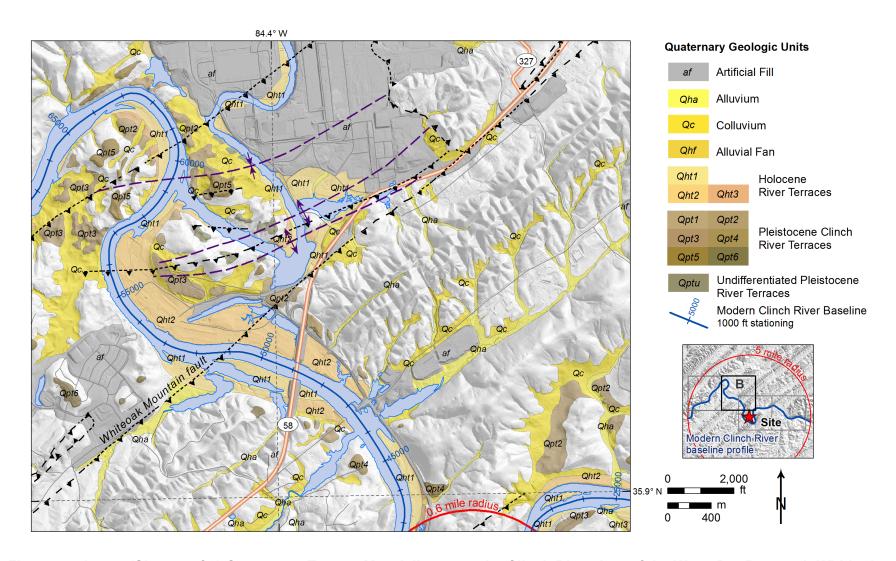


Figure 2.5.1-26. (Sheet 2 of 6) Quaternary Terrace Map Adjacent to the Clinch River Arm of the Watts Bar Reservoir Within the Clinch River Nuclear Site Area, Location B

2.5.1-192 Revision 1

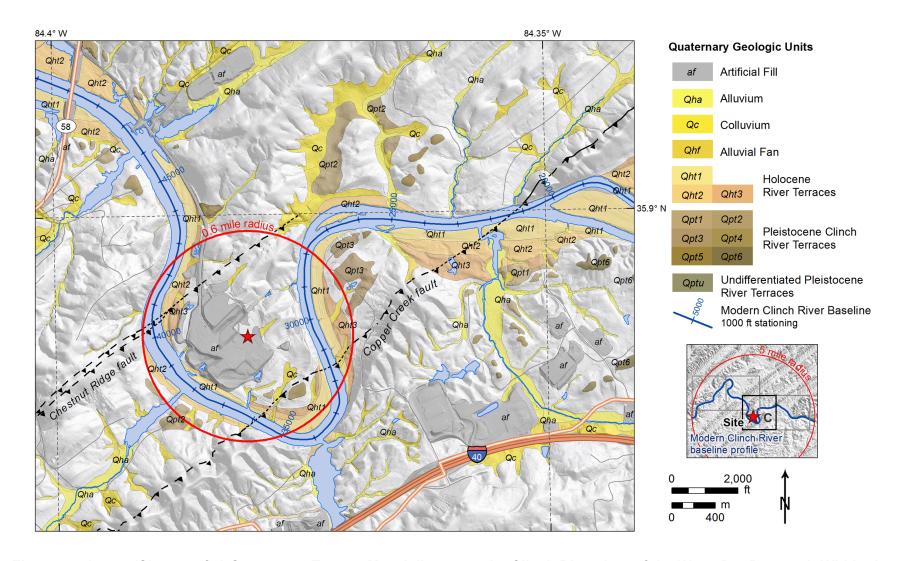


Figure 2.5.1-26. (Sheet 3 of 6) Quaternary Terrace Map Adjacent to the Clinch River Arm of the Watts Bar Reservoir Within the Clinch River Nuclear Site Area, Location C

2.5.1-193 Revision 1

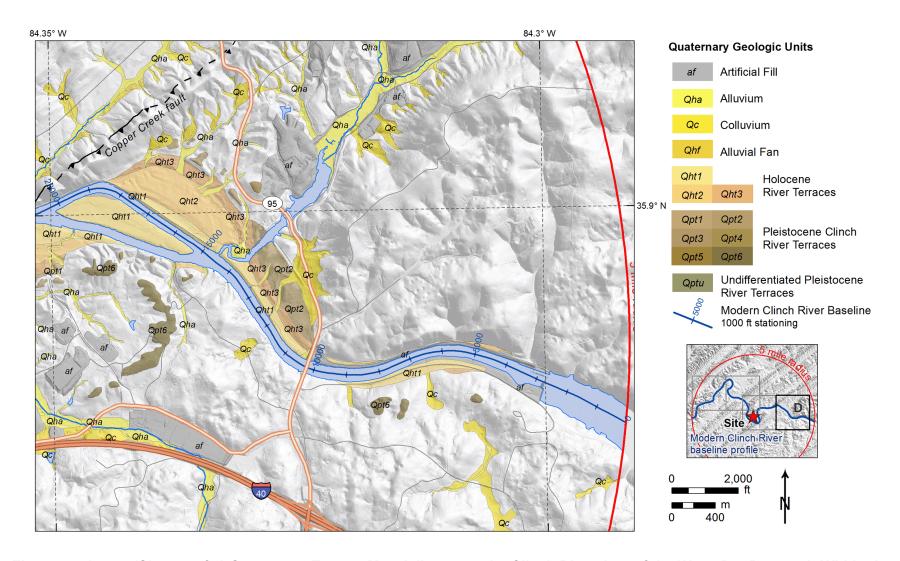
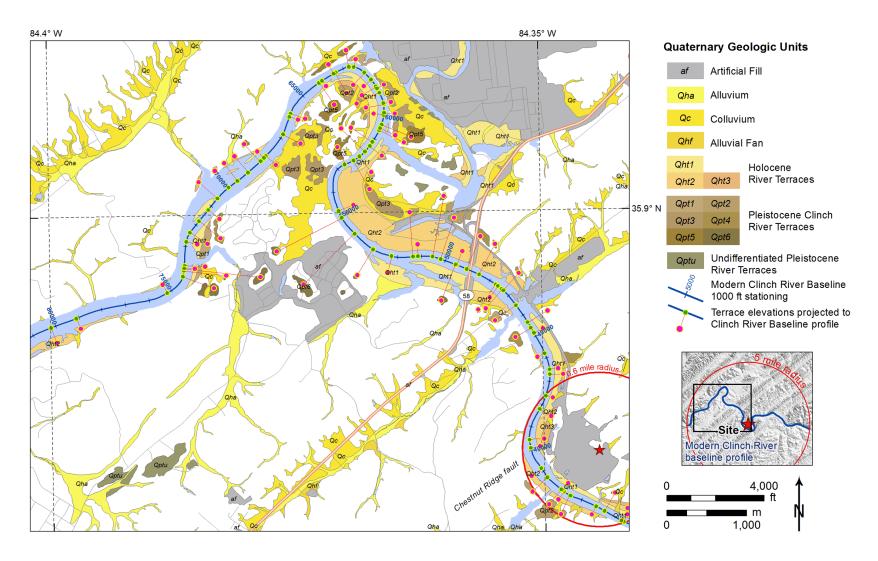


Figure 2.5.1-26. (Sheet 4 of 6) Quaternary Terrace Map Adjacent to the Clinch River Arm of the Watts Bar Reservoir Within the Clinch River Nuclear Site Area, Location D

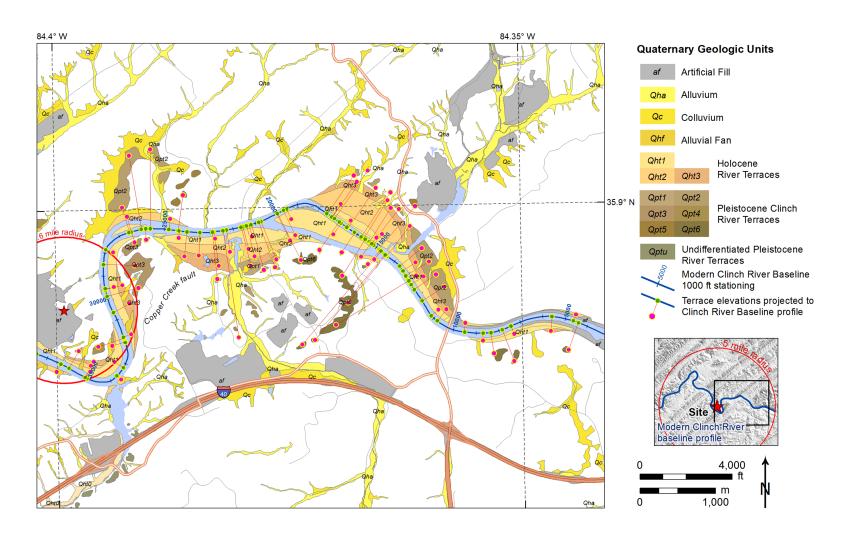
2.5.1-194 Revision 1



See Figure 2.5.3-4 for Longitudinal Profiles of Quaternary Terraces along the Clinch River. Quaternary mapping by Lettis Consultants International, Inc.

Figure 2.5.1-26. (Sheet 5 of 6) Quaternary Terrace Projections to the Clinch River for creation of Longitudinal Profile

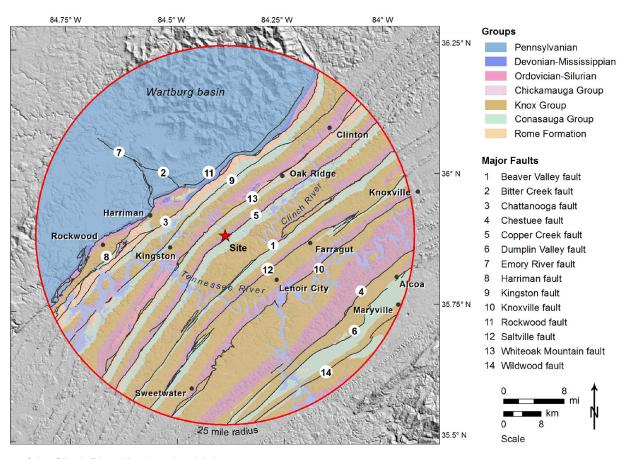
2.5.1-195 Revision 1



See Figure 2.5.3-4 for Longitudinal Profiles of Quaternary Terraces along the Clinch River. Quaternary mapping by Lettis Consultants International, Inc.

Figure 2.5.1-26. (Sheet 6 of 6) Quaternary Terrace Projections to the Clinch River for creation of Longitudinal Profile

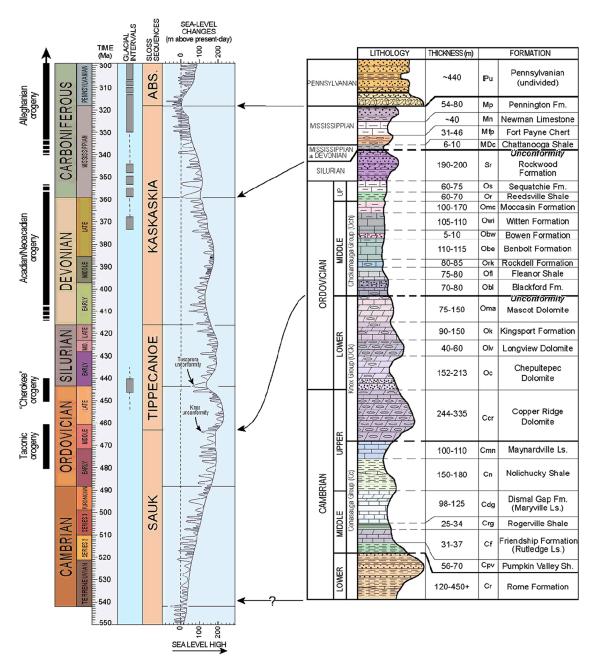
2.5.1-196 Revision 1



Note: Simplified geologic map of the Clinch River Nuclear site vicinity.

Figure 2.5.1-27. Simplified Site Vicinity Geologic Map

2.5.1-197 Revision 1



Generalized stratigraphic column of the geology of the CRN site vicinity (right) with Paleozoic sea level curves, Reference 2.5.1-49 cratonic sequences, glacial intervals, and tectonic events (left; modified from Reference 2.5.1-206) that correspond to the time interval represented by the stratigraphic section (modified from Reference 2.5.1-9). ABS-Absaroka

Figure 2.5.1-28. Stratigraphic Column with Sea Level Curve

2.5.1-198 Revision 1

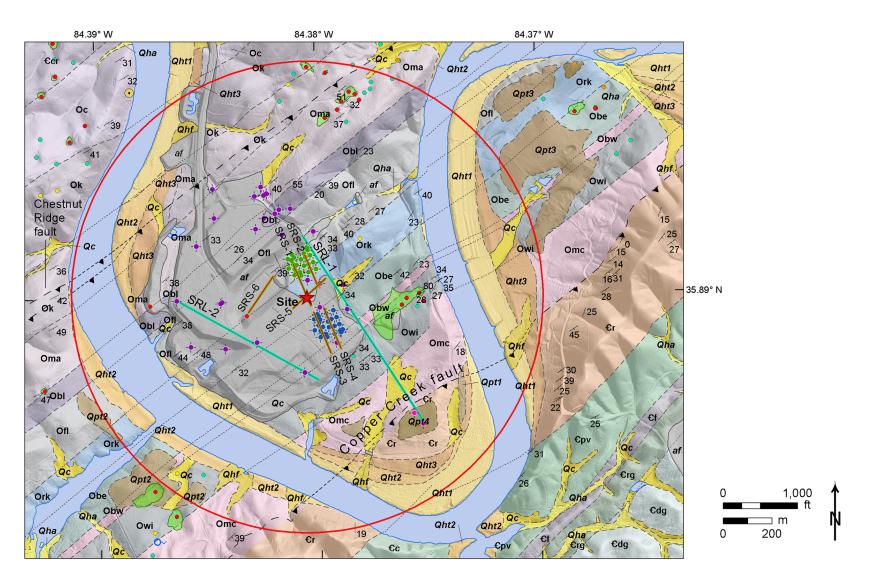


Figure 2.5.1-29. (Sheet 1 of 2) Site Location Geologic Map Showing Borings

2.5.1-199 Revision 1

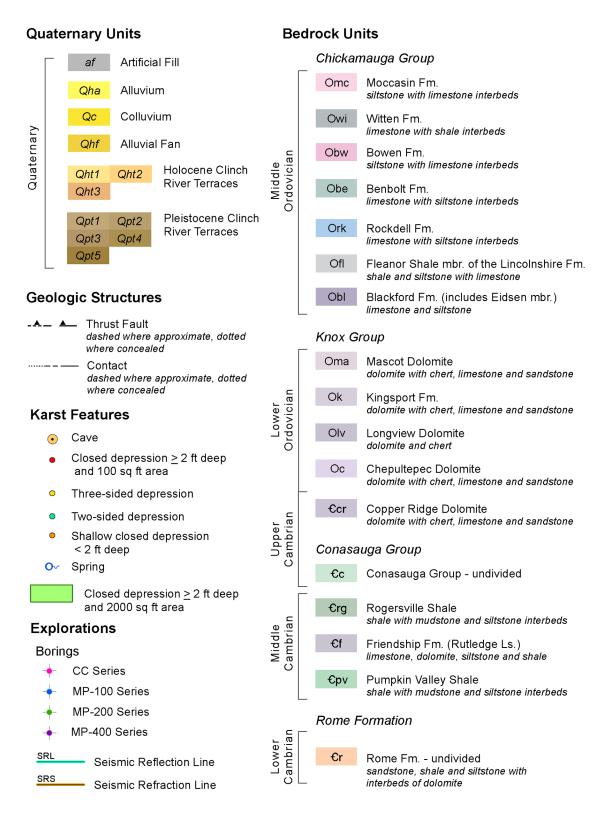


Figure 2.5.1-29. (Sheet 2 of 2) Site Location Geologic Map Showing Borings

2.5.1-200 Revision 1

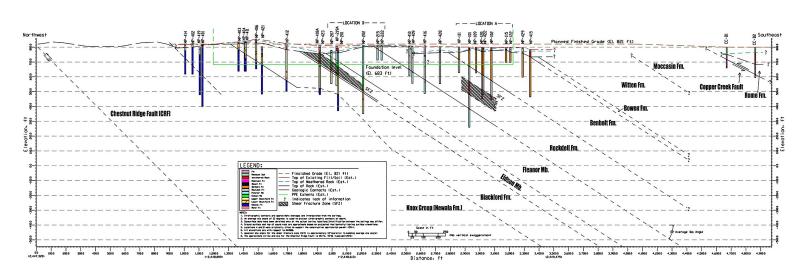


Figure 2.5.1-30. Geologic Cross-Section K-K' of the Clinch River Nuclear Site

2.5.1-201 Revision 1

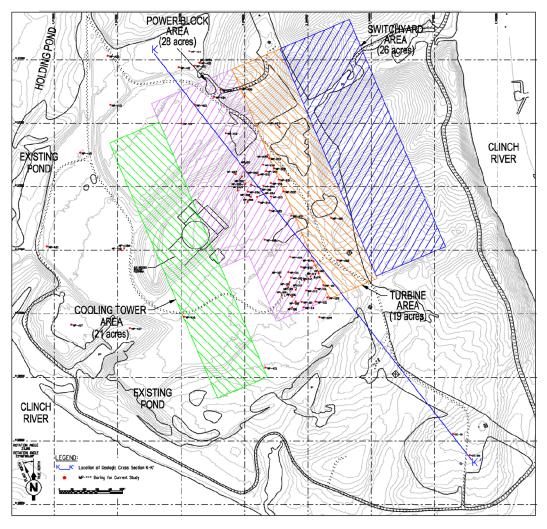
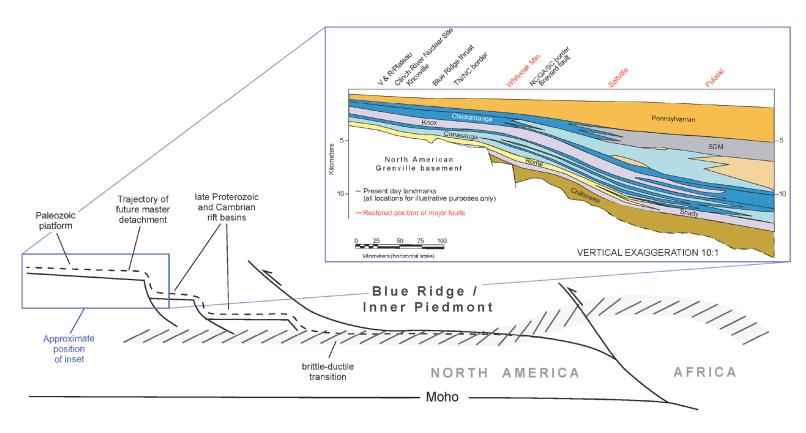


Figure 2.5.1-31. Subsurface Investigation Borehole and Geologic Cross-Section K–K′ Locations

2.5.1-202 Revision 1

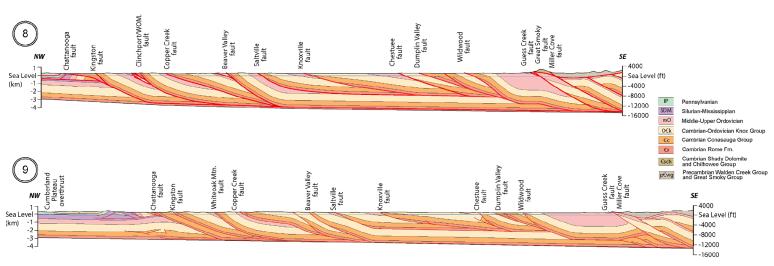


Diagrammatic illustration of the propagation of the master Appalachian detachment (modified from Reference 2.5.1-159). Inset shows palinspastically restored facies diagram of Neoproterozoic to late Paleozoic passive margin strata that was deposited along the lapetan margin (modified from Reference 2.5.1-13).

Blue box indicates the approximate location of area depicted in inset.

Figure 2.5.1-32. Schematic Appalachian Detachment

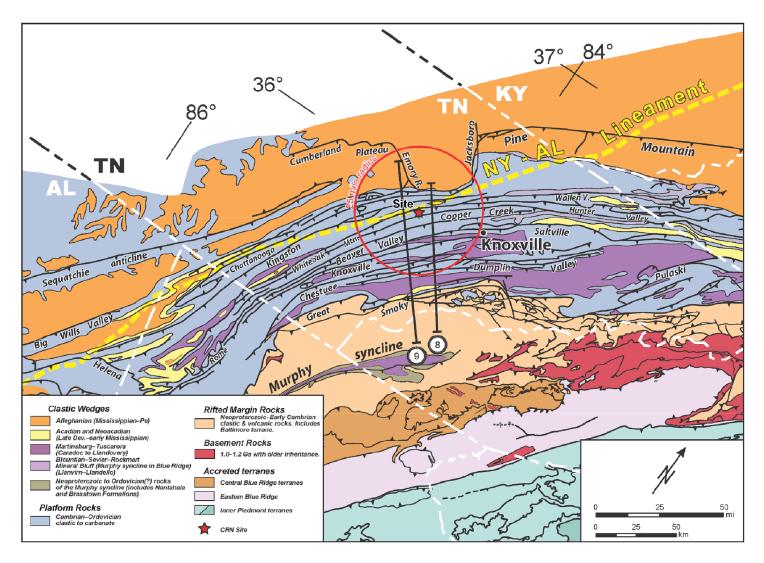
2.5.1-203 Revision 1



Note: Balanced cross-sections through the Valley and Ridge province from Reference 2.5.1-230 that intersect the Clinch River Nuclear site vicinity.

Figure 2.5.1-33. (Sheet 1 of 2) Tectonic Map Cross-Sections—Valley and Ridge

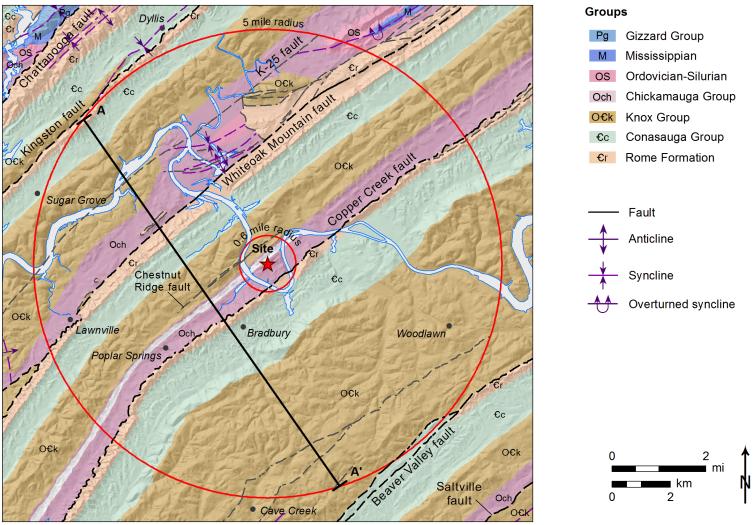
2.5.1-204 Revision 1



Location of cross-sections shown in (A). Tectonic map modified from Reference 2.5.1-102.

Figure 2.5.1-33. (Sheet 2 of 2) Tectonic Map Cross-Sections—Locations

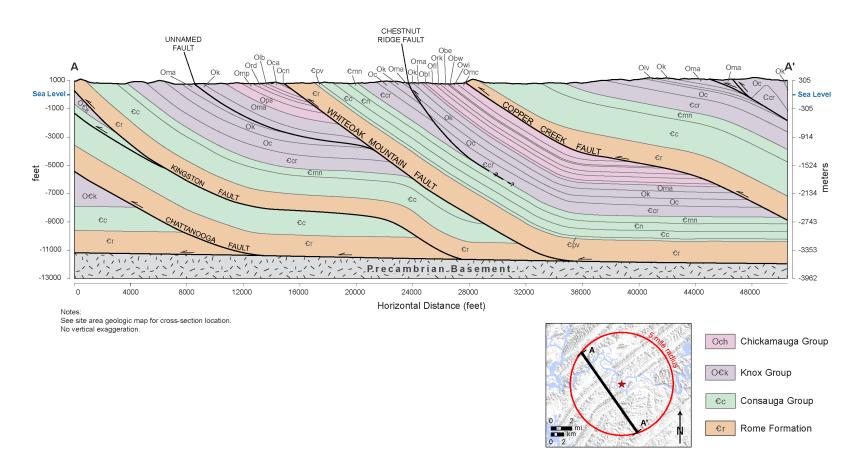
2.5.1-205 Revision 1



Notes: Simplified geologic map of the Clinch River Nuclear site area developed by Lettis Consultants International, Inc. See Site Area Geologic Cross Section A-A' (Figure 2.5.1-35). See Plate 2 in Part 8 for more detailed geologic map of the site area.

Figure 2.5.1-34. Site Area Geologic Map

2.5.1-206 Revision 1



See site area geologic map for cross-section location (Plate 2).
Cross section developed by Lettis Consultants International, Inc. No vertical exaggeration.

Geologic cross-section through the site area projected to Precambrian basement.

Figure 2.5.1-35. Site Area Geologic Cross-Section A-A'

2.5.1-207 Revision 1