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GEOLOGIC MAP OF THE OAK RIDGE RESERVATION, TENNESSEE

William M. McMaster, Geologist
U.S. Geological Survey

HEALTH PHYSICS DIVISION

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By

William M. McMaster*

Abstract

The Oak Ridge area is underlain by nine Paleozoic sedimentary formations or groups ranging in age from Early Cambrian to Early Mississippian. These units consist mostly of dolomite, limestone, and shale. The Conasauga Group, the Knox Group, and the Chickamauga Limestone can be further subdivided, but on the map accompanying this report only the major contacts are shown.

The Oak Ridge reservation is crossed by two major thrust faults: (1) the Copper Creek fault in the southeastern part of the area and (2) the Whiteoak Mountain fault in the northwestern part. The strata and the fault zones dip primarily to the southeast. The Whiteoak Mountain fault in the Oak Ridge area exhibits several subsidiary features, including branch faults, a syncline northwest of the fault, and two slices of dolomite of the Knox Group.

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Introduction

Location and Size of Area

The Oak Ridge reservation is in the Tennessee Section of the Valley and Ridge province and occupies parts of Anderson and Roane Counties. It is bounded on the northeast, southeast, and southwest by the Clinch River. The area is approximately 14 miles long, has an average width of 6 miles, and comprises an area of about 86 square miles.

Purpose and Scope of Investigation

The mapping project was undertaken by the U. S. Geological Survey in cooperation with the Radioactive Waste Disposal Section, Health Physics Division, Oak Ridge National Laboratory; and the Division of Reactor Development of the U. S. Atomic Energy Commission.

The purpose of the investigation was to prepare a geologic map of the Oak Ridge area on a recent topographic base map, showing locations of outcrop of major contacts and faults with as much accuracy as possible within the available time.

The geology was mapped on five Tennessee Valley Authority 7 1/2 minute quadrangles, each of which covers a part of the Oak Ridge reservation. These maps are: the Windrock quadrangle (129 SE), the Clinton quadrangle (137 SW), the Lovell quadrangle (138 NW), the Bethel Valley quadrangle (130 NE), and the Elverton quadrangle (130 NW). The geology was later transferred to a topographic map of the Oak Ridge area having a scale of 1:31,680, prepared for the Oak Ridge Operations Office of the Atomic Energy Commission by the Tennessee Valley Authority.

Field work was begun in December 1957 under the immediate supervision of R. M. Richardson. Most of the accompanying map is the result of field observations at rather widely spaced points. Contacts have not, for the most part, been walked out. Only major faults and contacts are indicated on the map. Three of the broad stratigraphic units shown - the Conasauga Group, the Knox Group, and the Chickamauga Limestone - can be further subdivided.

The locations of faults and contacts are shown by solid lines where they have been observed in the field, and by dashed lines where they have been inferred on the basis of topography, or where they are covered.

Previous Investigations

Generalized geologic maps which include the Oak Ridge area are available (Keith, 1896; Rodgers, 1953); although these maps indicate the formations present and their approximate occurrence, they are inadequate to meet the needs for detailed information in the area.

Detailed geologic studies have been made in small areas within the reservation, such as that of the vicinity of the Oak Ridge National Laboratory site, completed in 1950 by Stockdale, De Buchananne, and Klepser (1951) and that of a part of Melton Valley by Barnett in 1954.

Topography and Drainage

The topography of the Oak Ridge reservation is typical of the Valley and Ridge province, being characterized by subparallel northeast trending ridges and valleys. It reflects the geologic structure of the

area, which consists of generally southeast-dipping strata; the different lithologies of the formations result in different rates of weathering and erosion. The ridge-producing formations of the Oak Ridge area are the Rome Formation, the Knox Group, the Rockwood Formation, and the Fort Payne Chert. Most of the valleys are underlain by the Conasauga Group and the Chickamauga Limestone.

Altitudes within the area range from 741 feet in the southwestern part of the area to 1,356 feet at Melton Hill, which is also in the southwestern part of the area, the maximum relief being 615 feet. The region is thought to have undergone two cycles of erosion and to be presently in a third. The surface resulting from the last complete cycle is represented by the tops of the present ridges, which have a more or less uniform altitude in the Oak Ridge area.

The drainage of the area is mostly of the trellis type, although there are variations from this in some places. The master stream of the area is the Clinch River, an incised, meandering, superimposed stream. The largest tributary to the Clinch River in the reservation is the East Fork of Poplar Creek, which flows southwestward through East Fork Valley to join Poplar Creek in the western part of the reservation. Poplar Creek enters the southwestern extremity of the Oak Ridge area and flows about 2 miles within the area before entering the Clinch River.

Climate

According to U. S. Weather Bureau records obtained at the Oak Ridge area station at X-10 from 1944 to 1961, the average annual rainfall is 51.87 inches, the mean annual temperature is 58.3°F, the average maximum

temperature is 69.2°F, and the average minimum temperature is 47.3°F. The coldest months are December, January, and February, and the hottest months are June, July, and August.

Rainfall is relatively well distributed throughout the year but varies seasonally, generally being greatest in December, January, February, and March and least in September and October. A secondary maximum occurs in July due to thundershowers. Snow forms only a small part of total precipitation and heavy snowfalls are infrequent.

Acknowledgments

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Stratigraphy

The Oak Ridge reservation is underlain by nine geologic formations or groups ranging in age from Early Cambrian to Early Mississippian. The formations are of sedimentary origin, both chemical (limestone and dolomite) and clastic (sandstone and shale) and from oldest to youngest include the Rome Formation, the Conasauga Group, the Knox Group, the Chickamauga Limestone, the Sequatchie Formation, the Rockwood Formation, the Chattanooga Shale, the Maury Formation, and the Fort Payne Chert. Of these, the most important from the standpoint of occurrence in the

Oak Ridge area are the Rome Formation, the Conasauga Group, the Knox Group, and the Chickamauga Limestone. The others occupy relatively small parts of the area.

Three disconformities are present in the column: one separating Lower and Middle Ordovician rocks, one within the Middle Ordovician rocks, and one separating Lower Silurian and Devonian and Mississippian rocks. The total stratigraphic thickness of the sediments in the area is approximately 9000 feet.

Cambrian and Ordovician Systems

Rome Formation.-- The Rome Formation underlies Haw Ridge (grid sections G-1 to G-4 and F-5 to F-19), Pine Ridge (grid sections D-1 to D-19), and the southeastern side of the valley northwest of Pine Ridge.

The Rome Formation is composed of interbedded sandstone, siltstone, shale, and, locally, dolomite. Siltstone and shale form the bulk of the formation in the Oak Ridge area. Sandstone beds in the Rome, which range in thickness from 3 to 14 inches, are more abundant in the upper half of the formation than in the lower.

The sandstone is composed of light-gray to light-brown fine- to medium-grained quartz sand, cemented with silica or iron oxide. In places the sand is so well cemented as to be quartzitic. Weathered surfaces of the sandstone generally are dark brown or red brown.

Siltstone in the Rome is generally light to dark brown and green brown, thin bedded, and has irregular bedding surfaces along which small flakes of mica are concentrated.

A striking characteristic of the Rome is its banded coloration, caused primarily by the shale beds, which are green, maroon, red, violet, purple, yellow, tan, and brown. Very small flakes of mica are common along the bedding surfaces.

A belt of shale occurs northwest of Pine Ridge which heretofore has not been assigned a definite stratigraphic position, as it is faulted above and below, has no obvious lithologic similarity to other formations in the area, and lacks identifiable fossils. The shale is dominantly maroon, red, and tan, fairly silt-free clay, interbedded with smaller amounts of brown, purple, and green, more silty clay. The maroon and red shale beds may be a potential source of brick clay, being very similar to the shale of the Pennington Formation of Mississippian age which is used in several places in southwestern East Tennessee for brick and pottery. The surface underlain by the shale is characteristically strewn with 2- to 6-inch-diameter cobbles of dense blue-white to blue chalcedony which is probably derived from weathering of calcareous beds interbedded with the shale. Many of these cobbles exhibit cryptozoan-like structures on the exterior. Wad (a hydrous manganese oxide mineral) occurs locally as nodules in the shale, and a few fine- to medium-grained, maroon and brown thin-bedded sandstone beds are present.

The shale is thought to be an older part of the Rome not exposed in the belts southeast of Pine Ridge, perhaps corresponding to the Apison Shale member of the Rome, which crops out in southwestern East Tennessee. For the purpose of differentiation from the Rome underlying Haw Ridge the shale unit is designated by the symbol Ers on the accompanying map.

The typical sandstones and siltstones of the Rome are characterized by abundant primary features, such as ripple marks, rill marks, swash marks, mud cracks, and, locally, raindrop imprints.

The lower contact of the Rome is not exposed in the Oak Ridge area, as it is everywhere in fault relationship with younger rocks which lie underneath it. The upper contact with shale of the Conasauga Group is gradational and was chosen arbitrarily, based primarily on topography and the coloration of the shales, the shales of the Conasauga being less brightly colored than those of the Rome Formation.

The Rome Formation underlies ridges which are typically narrow, steep sided, and broken by many closely spaced wind and water gaps which give the ridges a "comby" appearance.

The residual soil of the Rome is generally less than 15 feet thick, and is composed of sandy, silty, light-colored clay containing scattered siltstone and sandstone fragments.

No fossils were found in the Rome of the Oak Ridge area, but those found elsewhere in the formation show that its age is youngest Early Cambrian. The total thickness of the formation is not present in the Oak Ridge area, but probably 800 to 1000 feet of the upper part of the Rome is represented. The thickness of the older part of the Rome has not been determined.

Conasauga Group.-- The Conasauga Group underlies the valley northwest of Copper Ridge (grid sections D-1 to D-19), Bear Creek Valley (grid sections E-1 to E-19), the valley northwest of Black Oak Ridge (grid sections A-1 to A-19), and a small area southwest of McKinney Ridge (grid sections C-A and C-S).

The Conasauga is primarily calcareous shale interlayered with limestone and siltstone. The group has been divided into four units in Melton Valley (Barnett, 1954), but is undifferentiated on the accompanying geologic map.

The shale of the Conasauga ranges from pure clay shale to silty shale and is brown, tan, buff, olive green, green, and dull purple. Dark-gray, dense to crystalline, nodular, thin-bedded, silty limestone is interbedded with the shale and siltstone in the lower two-thirds of the group. Siltstone, which is brown, red brown, buff, and tan, is present throughout the lower four-fifths of the group and is abundant in the layers underlying a line of knob-like hills on the northwestern sides of the valleys underlain by the Conasauga.

Alternating beds of shale and light-gray, dense to crystalline, regularly bedded limestone are present about 500 feet below the top of the group. These beds are overlain by about 300 feet of massive, light- to medium-gray, dense to coarsely crystalline or oolitic limestone. The upper limestone beds of the Conasauga are used in many places in East Tennessee as a source of quarry stone for road aggregate; most of this limestone is fairly pure, and the oolitic beds are composed of nearly pure calcium carbonate.

The contact between the limestone of the Conasauga Group and the dolomite of the Knox Group is gradational from dolomitic limestone to dolomite containing stringers of limestone.

The Conasauga Group underlies valleys between ridges formed by the Rome Formation and the Knox Group. The surfaces of these valleys are characteristically irregular with many gullies and small hills. The

most prominent topographic feature is the line of knobs on the northwestern sides of the valleys.

Residuum derived from shale in the Conasauga is generally thin. Weathering has penetrated to a depth of about 20 feet in the layers where shale predominates, but the weathered part retains the appearance of the original rock, except that most of the limestone has been removed. The residuum derived from the massive limestone is characteristically orange red and contains little or no chert.

The thickness of the Conasauga Group is difficult to measure due to a number of minor folds and faults, but is estimated to be 1500 feet or more. The age of the Conasauga is Middle and Late Cambrian.

Knox Group.-- The Knox Group is one of the most widely distributed lithologic units in East Tennessee, and in the Oak Ridge reservation it occupies more surface area than any other unit. The Knox underlies Copper Ridge (grid sections H-1 to H-19), Chestnut Ridge (grid sections E and F, 1-19), Blackoak Ridge (grid sections A and B, 1-19), McKinney Ridge (grid sections C-5 and 6), and two areas along the Whiteoak Mountain fault.

The Knox is composed primarily of massive, siliceous dolomite. The group can be divided into five formations on the basis of lithologic variation, but on the accompanying map the group is undivided.

The general variation in lithology is from massive, dark gray, crystalline, very cherty dolomite at the base to generally less massively bedded, lighter-gray, dense to finely crystalline, less cherty dolomite at the top. Thin beds of light-gray, dense limestone are present in the upper part, and thin beds of relatively pure sandstone

occur about 1000 feet above the base of the group. Outcrops of the dolomite are not abundant due to the rapid weathering and deep soil cover; however, on the northwestern sides of ridges underlain by the group, erosion has removed the soil cover to an extent that outcrops are fairly common.

The amount and type of chert left by weathering varies from formation to formation within the group; and, because outcrops of the dolomite are not abundant, residual chert is used as a basis for differentiating the group. Due to the varying amounts of chert retained in the residuum, the rate of erosion varies from formation to formation, producing a distinctive topography which is an aid in mapping.

The upper contact of the Knox Group is disconformable; that is, it is a surface once exposed to erosion, then covered by sediments, with no significant variation between the dip and strike of the layers beneath the erosional surface and those above. In some places, the relief on this surface is rather high, as indicated by the irregular contact line on the map where it is well defined for some distance. (See map, B-10.) The Knox Group-Chickamauga Limestone contact is usually distinct, owing to the sharp contrast between the dolomite and the overlying basal beds of the Chickamauga; also, springs are common along or near the contact, especially in East Fork Valley.

The Knox weathers to form a deep residual mantle held in place by the abundant chert on the surface. The surface of the bedrock beneath the soil mantle is very irregular; outcrops generally represent the tops of pinnacles of bedrock projecting through the soil.

The Knox Group underlies broad ridges generally having fairly gentle slopes on the southeastern side and steeper slopes on the northwestern

side. Variation in resistance to erosion leads to the development of a saddle shape in profile viewed parallel to strike.

The dolomite of the Knox is very soluble and caverns are common, some of them of large size. Sinkholes are a persistent topographic feature of the group.

Fossils are not common in the Knox, but small coiled gastropods were found in a limestone bed in the upper part of the group on the northern side of McKinney Ridge. The age of the Knox is Late Cambrian and Early Ordovician. The total thickness is about 3000 feet.

Chickamauga Limestone and Reedsville Shale.-- The Chickamauga Limestone underlies Bethel Valley (grid sections F-1 to F-19), East Fork Valley (grid sections Band C, 1-19), and a narrow belt northwest of Pine Ridge (grid sections D-8 to D-10).

Lithologically, the Chickamauga is extremely variable, although the entire sequence is calcareous. In the two major valleys underlain by the formation, East Fork Valley, where a complete section is present, and Bethel Valley, where the upper 500 feet or more have been faulted out, the stratigraphic succession of beds within the formation is dissimilar.

In East Fork Valley, the lowermost beds of the Chickamauga are composed of discontinuous thin layers of bentonitic material, gray clay shale with obscure bedding, thin bedded, maroon, calcareous siltstone up to 50 feet thick, and gray, calcareous, micaceous siltstone. The lateral continuity of these basal beds is irregular, and, in places, this sequence is absent. Locally, the basal layers contain fragments of chert derived from the underlying Knox Group. A sequence of limestone

approximately 1500 feet thick lies above these layers. The limestone is dominantly light to medium gray and blue gray, dense to finely crystalline, shaly, and thin bedded, and contains variable amounts of chert. These layers generally contain fragmentary, small fossil brachiopods, bryozoans, corals, and crinoid stems. The character of these beds changes along strike and similar lithologies recur in various zones, making division into units difficult. Near the top of this limestone sequence are two bentonite beds which lie about 50 feet apart, stratigraphically. Above the upper bentonite is a 40-foot sequence of yellow and maroon, calcareous siltstone beds, at the top of which is an apparently small disconformity. Blue-gray limestone, which is coarsely crystalline, extremely fossiliferous, relatively pure, and more massively bedded than the underlying limestones, lies above the disconformity. Unlike the layers of shaly limestone below, this lithology is relatively homogeneous along strike.

The coarsely crystalline limestone grades upward into the Reedsville Shale, a calcareous, tan to orange-brown, fissile, thin-bedded, fossiliferous shale, which is the uppermost unit of the Chickamauga Limestone. This unit is 200 to 250 feet thick.

Lithologic differences within the formation are more distinct and the stratigraphic sequence is more easily defined in Bethel Valley than in other parts of the area. The residual mantle is generally thinner and outcrops of the beds are more common than in East Fork Valley. Also, the beds are persistent in character along strike and each unit has more diagnostic features. The Chickamauga in Bethel Valley can be divided into at least eight units (Stockdale, 1951). Three of these units

consist of redbeds: one about 120 feet above the base, another near the middle of the formation, and another at or near the top. These redbeds apparently are not represented in East Fork Valley, although the thin, discontinuous redbeds at the base of the formation in this belt may correspond to the lower redbeds of Bethel Valley. No bentonites have been observed in Bethel Valley; apparently the Copper Creek fault displaced beds somewhat below the bentonites.

In other respects, the beds of gray, shaly limestone in Bethel Valley are similar to those of East Fork Valley in color, bedding characteristics, and chert and fossil content.

In East Fork Valley the Chickamauga Limestone-Sequatchie Formation contact is placed below the lowest occurrence of maroon, calcareous siltstone. The contact generally is covered by residuum and has to be approximated in most areas.

The soil produced by weathering of the Chickamauga typically consists of yellow, light red-orange, or red clay containing variable amounts of chert. Chert is abundant enough in the lower layers to cause development of a line of low hills on the northwestern sides of the valleys. This is more pronounced in Bethel Valley, where the basal material is composed of alternating siltstone beds and beds of blocky chert.

The surfaces of the valleys underlain by the formation are irregular, the more silty and cherty layers underlying low ridges and hills. Sinkholes are present, but these are not as numerous or as large as those in the Knox Group.

Fossils are common throughout the formation, and include brachiopods, bryozoans, gastropods, cephalopods, crinoid stems, corals, and trilobites.

The age of the Chickamauga Limestone is Middle and Upper Ordovician. The boundary between Middle and Upper Ordovician rocks in this area is drawn at the base of the Reedsville Shale. The thickness of the Chickamauga in East Fork Valley is about 2400 feet and in Bethel Valley about 1750 feet.

Sequatchie Formation.-- The Sequatchie Formation crops out on the flanks of East Fork Ridge (grid sections G-7 to G-13) and Pilot Knob (grid sections G-17 and 18) and in a small isolated area near Gum Hollow southeast of East Fork Ridge (grid section C-10).

The Sequatchie is predominantly maroon calcareous siltstone and maroon, silty and shaly limestone mottled with green. The formation contains a minor quantity of gray shaly limestone. The beds are uniform and generally from 2 to 6 inches thick, although there are more massive beds. There is a striking similarity between the maroon siltstones of this formation and those of the Chickamauga in Bethel Valley.

The formation is best exposed in grid section C-18 where the upper contact with the Rockwood Formation is represented by a 1- to 2-foot-thick dark-gray shale overlain by a massive bed of sandstone of the Rockwood Formation. This is the only place where the shale was observed, and nothing is known of its lateral continuity. The contact generally is covered by residuum and has to be approximated on the basis of the highest outcrops of maroon siltstone.

The residuum derived from the Sequatchie is typically dark maroon, fairly thin, silty clay. The Sequatchie is not topographically distinctive in the Oak Ridge area, although it does underlie small knobs at the southwestern end of Pilot Knob and the northeastern end of East

Fork Ridge, and in the small outcrop area near the southeastern end of Gum Hollow it also forms a small knob.

Fossils are not abundant in the Sequatchie except in the thin beds of gray limestone, which contain large brachiopods, colonial corals, and bryozoans. The Sequatchie represents the Richmond, or latest Ordovician stage. Its thickness is about 360 feet.

Silurian System

Rockwood Formation.-- The Rockwood Formation caps Pilot Knob and the exterior ridges of East Fork Ridge.

The lithology of the Rockwood is variable. Alternating thin (1 to 3 inches) beds of siltstone and shale form the bulk of the formation. Beds of massive, medium-grained, iron-stained, well-cemented sandstone are present near the base. The upper half of the formation contains thin ferruginous layers which are of two general types: oolitic, shaly and silty iron oxide containing many crinoid stem fossils, up to 10 inches thick; and conglomeratic, pyritic, sandy layers up to 3 feet thick. Both have been derived by weathering of ferruginous limestone which does not occur in outcrop in an unweathered condition. The ferruginous layers are interbedded with shale and siltstone which are yellow to tan and light brown. Weathering of the Rockwood produces a shallow sandy and silty soil containing many scattered chips of shale and siltstone. Large boulders of sandstone are scattered along the ridge tops, and the slopes are covered with sandstone talus in places.

The Rockwood Formation-Chattanooga Shale contact is disconformable. At Pilot Knob the uppermost layers of the Rockwood have been removed by faulting.

The Rockwood underlies ridges somewhat similar to those of the Rome Formation in that they are narrow and steepsided, but wind and water gaps are not as closely spaced.

The age of the Rockwood is Early Silurian. Its thickness in the Oak Ridge area is approximately 690 feet.

Devonian and Mississippian Systems

Chattanooga Shale and Maury Formation.-- The Chattanooga Shale crops out in the central part of East Fork Ridge.

This formation is composed of black, bituminous, fissile, pyritiferous shale which in places is sandy. Above the Chattanooga Shale lies a 2-foot-thick layer of blue-green phosphatic shale known as the Maury Formation.

The upper contact of the Maury is gradational over a short distance into the siliceous limestone of the Fort Payne Chert and is rarely exposed in the Oak Ridge area owing to soil cover. The Chattanooga and the Maury weather to produce a thin, dark, silty residuum containing scattered flakes of black shale. Topographically, these formations are not distinctive, as their total thickness does not exceed 25 feet.

The Chattanooga Shale is generally considered to be both Devonian and Mississippian in age in this region. The Maury Formation is Early Mississippian in age.

Fort Payne Chert.-- The Fort Payne Chert crops out in the southwestern part of East Fork Ridge. In most of its extensive area of outcrop in the southeast, the formation is an extremely siliceous limestone or dolomite which commonly appears in outcrop as bedded chert which is

white, porous, fractured, and contains many casts of crinoid stems. In the Oak Ridge area, however, the Fort Payne Chert is composed primarily of very dense chalcedonic chert which is blue gray, massive, and contains few fossils. Thin, irregular beds of sand and silt, interbedded with white chert, are fairly common southwest of Gum Hollow; these layers contain the only fossils observed in the formation in the Oak Ridge area. Geodes are common throughout the formation.

The Fort Payne underlies narrow, steepsided, knobby ridges much like those underlain by the Rome Formation. The residuum derived from the Fort Payne is very sandy, silty, light-colored clay, containing abundant chips and blocks of chert.

The formation is Early Mississippian in age and is correlated with the Osage series. Ordinarily the formation is about 150 feet thick in this region, but its topographic position in East Fork Ridge has resulted in the removal of much of the upper beds, leaving a maximum thickness of about 90 feet.

Structure

The western part of the Tennessee section of the Valley and Ridge province is structurally characterized by major subparallel thrust faults that trend northeast and dip southeast. Along most of these faults, the Rome Formation has been thrust over younger formations.

Deformation of the strata of the area resulted from compressional forces originating to the southeast of the Valley and Ridge province. The strata reacted to the pressure by developing faults and folds.

Principal structural features of the Oak Ridge area are two major thrust faults, a doubly plunging syncline, generally southeast-dipping strata, and several subsidiary faults.

Copper Creek Fault

The trace of the Copper Creek fault appears along the northwestern flank of Haw Ridge. The fault extends northeastward across the entire width of the State and brings the Rome Formation to the surface throughout its length. In the Oak Ridge area, the Rome is thrust over the middle units of the Chickamauga.

The fault has an average strike of N. 55° E. in the Oak Ridge area. The dip of the fault zone is not measurable, but it is thought to be at an angle of 45° or more to the southeast, a considerably higher angle than that of the beds some distance stratigraphically above the fault. Near the fault, the beds of the Rome are deformed by small folds and faults and generally dip at a high angle to the southeast. Above the deformed zone, the remaining beds of the fault block dip at an average angle of 20° SE. The stratigraphic displacement caused by the Copper Creek fault is approximately 7200 feet.

Whiteoak Mountain Fault

In the Oak Ridge area the Whiteoak Mountain fault is a complexly branching thrust fault along which lower shales of the Rome Formation have been thrust over Middle Cambrian and younger rocks. The Whiteoak Mountain fault originates about 4 miles northeast of the Oak Ridge

reservation near Clinton by the merging of the Hunter Valley and Wallen Valley faults. The fault extends southwestward across the State, and throughout its length the Rome Formation has been thrust over younger formations.

The shale beds of the lower Rome southeast of the fault are vertical or dip steeply to the southeast and northwest. The excessive thickness of this formation in parts of the area suggests that a considerable amount of faulting has occurred within the shale, but sufficient work has not been done as yet to establish a stratigraphic sequence in the shale. Thus, no faults have been indicated in this unit on the accompanying geologic map.

Beds of typical Rome lithology lie above the shale. These beds have been thrust over the underlying shale and deformed by small folds and faults. Above the deformed zone the remaining beds of the fault block dip at an average angle of 35° SE.

The structure of the area from Pine Ridge to the southeast is simple in comparison to the complexity of the belt between Pine Ridge and East Fork Valley, where the strata have been disrupted by several faults of varying displacement, and folded into a syncline.

East Fork Ridge-Pilot Knob syncline.-- A persistent feature of the Whiteoak Mountain fault is the development of synclinal structures northwest of the fault. There are several such structures southwest of the Oak Ridge area and one within the area, which will be referred to as the East Fork Ridge-Pilot Knob syncline. Owing to the structure, rocks as young in age as Mississippian have been preserved.

A branch of the Whiteoak Mountain fault, along which rocks of the middle part of the Chickamauga have been thrust up, truncates the

southeastern limb of the syncline in the vicinity of Pilot Knob (Sec. A-A). The branch fault extends southwestward in a direction more or less parallel to the syncline to merge with the Whiteoak Mountain fault near the northeastern end of East Fork Ridge. In this vicinity, the strata of the southeastern limb of the syncline have been complexly faulted and a part of the limb has been faulted out. Another fault is exposed in the Mill Branch gap (grid section C-12), where the Rockwood Formation is thrust over the Chattanooga Shale.

The East Fork Ridge-Pilot Knob syncline is doubly plunging, forming a structural feature known as a saddle, which is defined as an upfold along the axis of a syncline. The syncline plunges to the northeast and southwest, from an area in the vicinity of grid section C-15.

The upfolding along the axis of the syncline indirectly resulted in the 3-mile-long lowland which separates East Fork Ridge and Pilot Knob. When the area was undergoing deformation, the rocks underlying the present lowland were raised to higher elevations than they were in other parts of the syncline. During subsequent peneplanation the upper resistant rocks in this area were exposed to erosion and removed. Later uplift was followed by erosion which removed the relatively nonresistant Sequatchie Formation and the uppermost strata of the Chickamauga Limestone down to the present altitude.

Slices of Dolomite of the Knox Group Along the Whiteoak Mountain Fault.-- Another characteristic feature of the Whiteoak Mountain fault is the occurrence of slices of dolomite of the Knox Group along the fault. Two such slices are in the Oak Ridge area in grid sections C-14 to C-19.

Structure at McKinney Ridge.-- Southwest of East Fork Ridge and within the East Fork Ridge-Pilot Knob syncline are exposures of the Knox Group

and the Conasauga Group. The area underlain by these groups is bounded on the southeast by the Whiteoak Mountain fault and on the southwest and northwest by a branch fault, but on the northeastern side is in stratigraphic contact with the Chickamauga Limestone. Within this area the Knox underlies McKinney Ridge (grid sections C-5 and C-6). The complexity of the structure of McKinney Ridge is indicated by exposures in the quarry on the southwestern end of the ridge, where there are a fault of unknown displacement and several folds.

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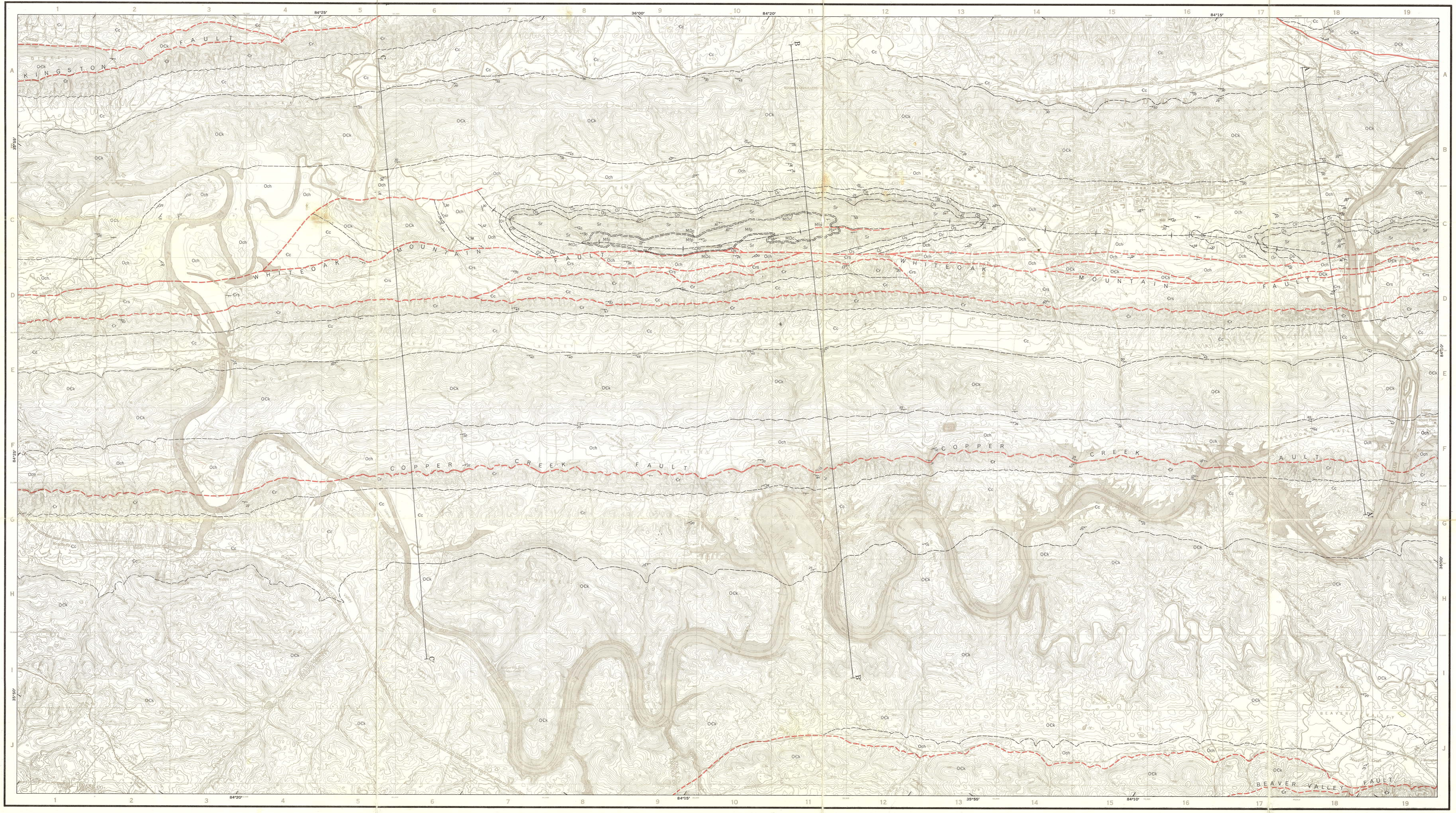
UNITED STATES
ATOMIC ENERGY COMMISSION

GEOLOGIC MAP

OAK RIDGE AREA
ANDERSON-ROANE-LOUDON-KNOX COUNTIES
TENNESSEE



EXPLANATION

MISSISSIPPIAN — LOWER MISSISSIPPIAN

Mfp — **Fort Payne Chert**
Limestone, extremely siliceous; weathers to beds of dense blue-white to white chert, less than 80 feet in thickness.

DEVONIAN — UPPER DEVONIAN

MDc — **Chattanooga Shale and Maury Formation**
Shale, black, bituminous, fissile; disconformity at base, 25 feet in thickness.

SILURIAN — LOWER SILURIAN

Sr — **Rockwood Formation**
Siltstone, shale, sandstone, brown, tan, and yellow; thin beds of hematitic limestone in upper half, 690 feet in thickness.

ORDOVICIAN — UPPER ORDOVICIAN

Os — **Sequatchie Formation**
Limestone, silty and shaly, maroon, maroon and green, and gray; calcareous maroon siltstone, 360 feet in thickness.

Or — **Reedsville Shale**
Shale, with thin limestone lenses in lower half; tan to orange-brown, with black stains, about 200 feet in thickness.

MIDDLE ORDOVICIAN

Och — **Chickamauga Limestone**
Limestone, shaly and silty; cherty; dense to crystalline; gray to gray-blue; fossiliferous; thin to medium beds; disconformity within formation and at base, about 2200 feet in thickness.

LOWER ORDOVICIAN — UPPER CAMBRIAN

O€k — **Knox Group**
Dolomite, cherty; dense to crystalline; light to medium gray; thin to massive beds, 3000 feet in thickness.

CAMBRIAN — MIDDLE CAMBRIAN

€c — **Conasauga Group**
Shale, siltstone, with thin limestone layers in lower two-thirds, massive limestone in upper third, 1500 feet in thickness.

LOWER CAMBRIAN

€r, €rs — **Rome Formation**
€r, siltstone, shale, sandstone, variegated; thin to medium, even beds; primary structures common, over 800 feet in thickness. €rs, shale, pure to silty; minor amounts of sandstone; chalcedonic chert cobbles strewn on surface, thickness unknown.

Contact
Dashed where approximately located

Fault
Dashed where approximately located

Strike and dip of beds
35
normal
vertical

Syncline
Showing trace of axial plane

CARTOGRAPHY BY MAPS AND SURVEYS BRANCH, TENNESSEE VALLEY AUTHORITY. PREPARED FOR THE RESEARCH AND DEVELOPMENT DIVISION, OAK RIDGE OPERATIONS OFFICE, ATOMIC ENERGY COMMISSION. BASE MAP WAS ASSEMBLED FROM TVA-USGS 1:24,000 TOPOGRAPHIC MAPS, REVISED IN PART IN JULY, 1959. MELTON HILL RESERVOIR IS SHOWN AS IT WILL APPEAR AFTER DAM IS COMPLETED.

Scale 1:31,680

1 ½ 0 1 2 3 Miles

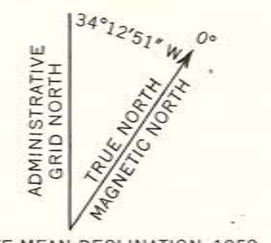
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

POLYCONIC PROJECTION. 1927 NORTH AMERICAN DATUM

GRID REFERENCE TT4-W (USGS 1934) LAT. 36°00′46.23″ N. LONG. 84°09′38.41″ W.

GRID LOCATION 22178.105 FEET NORTH AND 86877.589 FEET EAST

DECLINATION OF GRID 34°12′51″ W OF TRUE NORTH GRID INTERVAL 5000 FEET



APPROXIMATE MEAN DECLINATION, 1959
NO ANNUAL CHANGE

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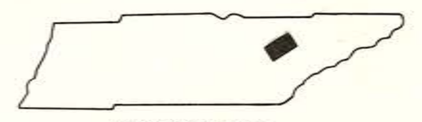
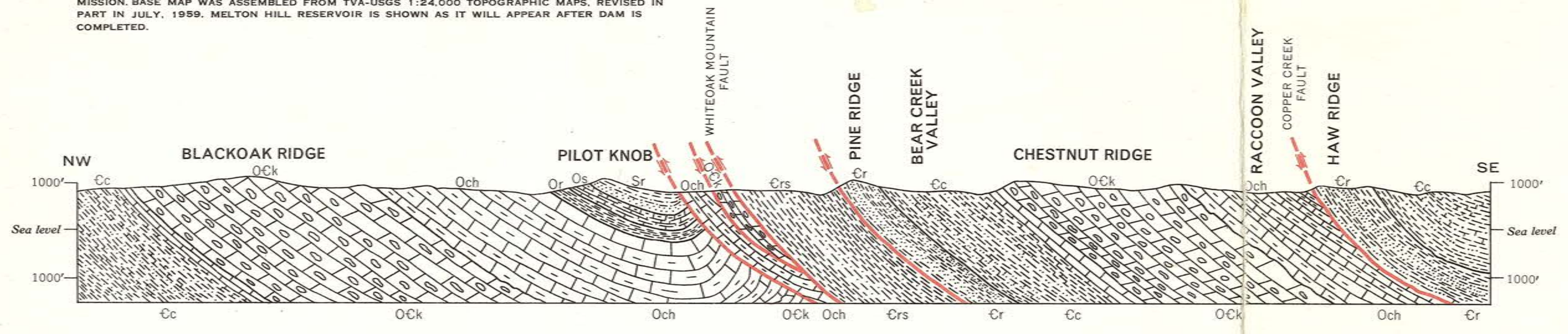
Geology by W. M. McMaster, U. S. Geological Survey, 1958. Prepared in cooperation with the United States Atomic Energy Commission.



LOCATION MAP



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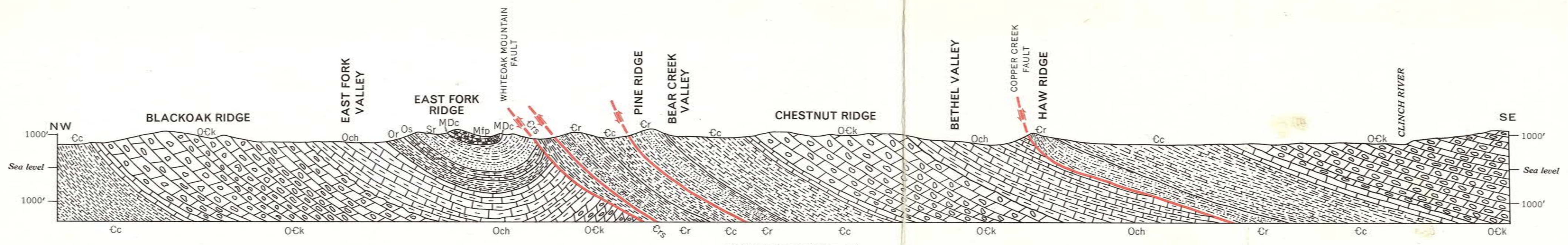

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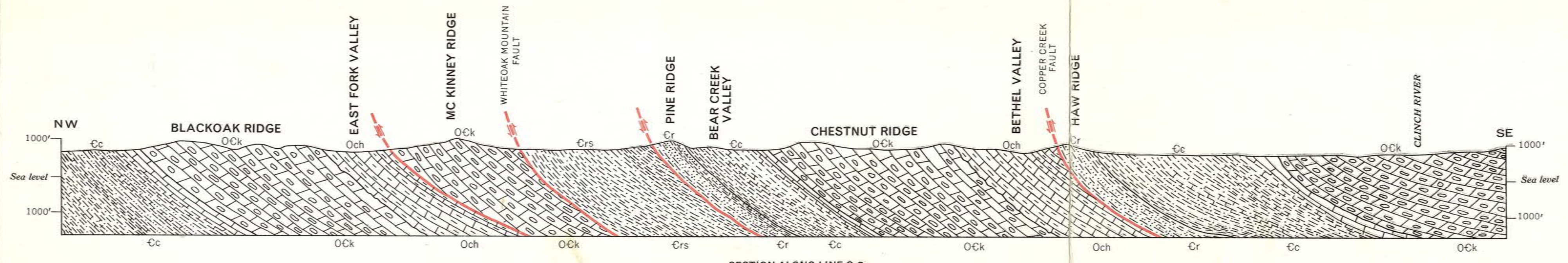

SECTION ALONG LINE C-C′

GEOLOGIC MAP OF THE OAK RIDGE AREA TENNESSEE

FEBRUARY 1962