GEOLOGY OF THE SOUTH MASON AREA, TEXAS

A Thesis

By

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Approved as to style and content by

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Chairman of Committee

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Maps and equipment used in the project were the property of the Department of Geology of the Agricultural and Mechanical College of Texas.

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ABSTRACT

Rocks of pre-Cambrian, Upper Cambrian, and Lower Ordovician age are present in the South Mason area, Mason County, Texas. Strata belonging to the Upper Cambrian series are divided into two formations, the Riley and the Wilberns. The seven members of these two formations were mapped in detail in the South Mason area.

The Riley formation which includes all the Cambrian strata in central Texas beneath the Wilberns formation, is separated into the Hickory sandstone, the Cap Mountain limestone, and the Lion Mountain sandstone members. This formation is about 650 feet thick in the South Mason area. Pre-Cambrian granite and metamorphic rocks cropping out in the northern and eastern parts of the area are overlain unconformably by the Hickory sandstone. The Hickory is essentially a coarse-grained, yellowish-brown to dark reddish-brown, nonglauconitic sandstone. The lower part of the Cap Mountain limestone member is made up of calcareous sands alternating with arenaceous, brown limestones. Limestone beds comprising the upper portion of the Cap Mountain are gray, granular, slightly glauconitic, and fossiliferous. The highly glauconitic Lion Mountain sandstone member overlies the Cap Mountain limestone. Limestone beds near the base of the Lion Mountain are composed essentially of trilobites.

The Wilberns formation is subdivided into the Welge sandstone, the Morgan Creek limestone, the Point Peak shale, and the San Saba limestone members. These members have an average total thickness of about 653 feet in the South Mason area. The Welge is essentially a

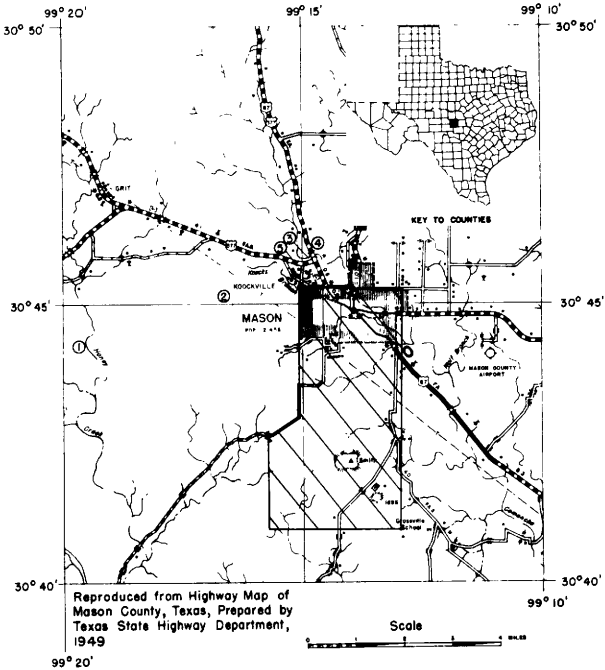
yellowish-brown to brown, nonglauconitic sandstone. The lower part of the Morgan Creek is characterized by reddish to purple, very arenaceous limestone beds which grade upward into greenish-gray, coarse-grained, glauconitic, and very fossiliferous limestones. Overlying the Morgan Creek limestone member are the interbedded green, calcareous shales, siltstones, limestones, and conglomerates of the Point Peak shale member. The thick stromatolitic bioherm zone at the top of the member is mapped as a separate unit throughout the South Mason area. Calcareous sands and arenaceous, granular, fossiliferous limestones make up the San Saba limestone member.

Sedimentation continued across the Cambrian-Ordovician boundary without any apparent interruption. Rocks of the Ellenburger group are exposed in the southern part of the South Mason area. The group was not subdivided into formations but was mapped as one unit. The Ellenburger rocks are primarily white to gray, sublithographic, and nonglauconitic.

The formations in the area strike northeast-southwest and dip about 8 degrees to the southeast. Faulting in the area took place near the close of Paleozoic time. The faults are normal and trend northeast-southwest. They are high angle faults which range in throw from somewhat less than 100 feet to over 1300 feet. All major faults in the South Mason area branch into fault slivers. A change in strike and dip of the beds from their normal, regional values is noted along the major faults.

Indirect evidence points toward a very gentle folding of the Paleozoic rocks.

Ground water is a very important natural resource of the area. The most important aquifers in the Central Mineral region are the Hickory sandstone and the Ellenburger limestone. Weathered granite in the South Mason area is used for road metal. Hickory sandstone and Cap Mountain limestone have been used in the area as building stone. There is little possibility for oil or gas production in the South Mason area.



Reproduced from Highway Map of Mason County, Texas, Prepared by Texas State Highway Department, 1949

INDEX MAP OF SOUTH MASON AREA, MASON COUNTY, TEXAS

GEOLOGY OF THE SOUTH MASON AREA, TEXAS

INTRODUCTION

STATEMENT OF PROBLEM

The primary purpose of this paper has a twofold aim: (1), to determine the structure and stratigraphy of the Upper Cambrian strata in the South Mason area; and (2), the preparation of a geologic map of the area based on data gathered in the field. Secondary considerations of considerable importance are: (1), the structural development of the area; (2), the relationship of the Upper Cambrian strata to the underlying pre-Cambrian granite and metamorphics and to the overlying basal Ellenburger group of Ordovician age; (3), the geologic history of the area; and (4), a résumé of the economic geology of the area.

LOCATION

The South Mason area, approximately twelve square miles in extent, is located in Mason County on the southwestern flank of the Llano Uplift in central Texas. The city of Mason lies in the northern part of the area.

ACCESSIBILITY

The city streets of Mason, U. S. Highway 87, and State Highway 29 provide ready access to the northern part of the area. Mill Springs road, having an all-weather caliche surface, forms the west boundary of the area. Farm Road 1723 provides paved access along the east margin. Unpaved, but all-weather, James River road continues southward to the Llano River from its junction with Farm Road 1723 approximately two miles south of Mason. Rough but passable ranch roads provide access to the interior portion of the area. In the extreme southern and southwestern region, where the topographic relief is greatest, these ranch roads are few in number and exist as mere rock-studded trails.

METHODS OF FIELD WORK

The field work was carried out between June 16 and August 3, 1951. The mapping was done on acetate paper covering contact prints of vertical aerial photographs prepared by the U. S. Department of Agriculture. The approximate scale of the photographs is one inch equals 1667 feet. The area mapped is within photographs 88, 89, 90, and 91 of series DFZ-3E, dated November 2, 1948. Most of the formation contacts and faults were walked out and the geology plotted on the photographs in the field with the aid of a stereoscope. Other contacts and faults were determined from a stereoscopic examination of the photographs. Their locations were then checked by closely spaced traverses.

The dips and strikes of the formations as plotted on the map represent an average of several readings made with a Brunton compass in the immediate vicinity of each point. A magnetic declination of ten degrees to the east was set on the compass.

The measured and described sections represent the best exposures that are to be found in the area mapped and in the area covered by the adjacent photograph west of Mason (DFZ-5E-188).

All sections were measured as nearly as possible in a direction perpendicular to the strike, and the dips were averaged. Stratigraphic thicknesses were measured with a Brunton compass. The average angle of dip of the strata was set on the vernier, and readings were made on a graduated rod.

A plane table traverse was made along one section (Plate I, A-A') in order to obtain exact horizontal distances and elevations for a cross section along the same route. Horizontal distances for two other cross sections were scaled from the aerial photographs. Relative elevations were estimated by using a stereoscope.

REVIEW OF THE LITERATURE

The first scientific account of the geology of the region bordering the Llano uplift in central Texas was the early work of Dr. Ferdinand Roemer (1846). In this paper Roemer gave an account of the area adjacent to the Central Mineral region on the south. Concerning the central area, Roemer called attention to "the enchanted rock" about twenty miles north of Fredericksburg, which he assumed to be part of the crystalline mass of the Rocky Mountains. Although this and other conclusions on the inner area were erroneous, they were based on information given to him by others. Roemer had not seen the area. Two years later the results of more extended observations by Roemer (1848), over a wider area, were published. He called attention to a belt of igneous rocks and Paleozoic strata cropping out between the Pedernales and San Saba rivers. From fossils present in these rocks he called the latter Silurian[1] strata and Carboniferous limestone. Roemer was the first to deny the existence of a prominent mountain range which had been shown on previous maps to exist in the San Saba region. His descriptions of the geology of this region of Texas were the first to be published. Later field studies led to the appearance in 1849 and 1852 of Roemer's most famous and historic volumes relating his explorations and observations in the Indian country of central Texas. The first of these two great works represents the first published report on the stratigraphy and paleontology of the Paleozoic in the Central Mineral region of Texas. In this report Roemer (1849) gave a vivid account of the general geology of the Central Mineral region and prepared the first geologic map of Texas. The map is crude and inaccurate, but it contains all the definite information known at that time. The Cretaceous rocks of Texas were outlined and described in this paper. Roemer was the first to note the absence of Devonian strata in the central area. He is given credit for first announcing the existence in this region of Lower Silurian and Carboniferous rocks, and he was the first to describe characteristic fossils of these strata. Roemer announced the discovery of these beds in 1848, but he considered this earlier work to be of a preliminary or reconnaissance nature. Roemer (1852) gave a more detailed account of the Texas Cretaceous in the second paper. This monograph also

1 These Silurian strata are now referred to as the Ellenburger group of Lower Ordovician age.

contains excellent pictures of Cretaceous fossils with complete and exacting descriptions.

Travelling with an expedition of Army engineers in 1855 and 1856, Dr. G. G. Shumard (1886) gave a brief description of the geology along their route through the San Saba River valley to Fort Mason and Fredericksburg.

In a letter to the Corresponding Secretary of the St. Louis Academy of Science, B. F. Shumard (1859) reported the extensive development in Burnet County of Lower Silurian rocks equivalent to the Potsdam sandstone (Upper Cambrian) and Calciferous sandrock of the New York System. These are the basal limestones referred to by Roemer (1848) as Lower Carboniferous. B. F. Shumard (1861) is given credit for the initial description of the Potsdam group and its fossils. He was also the first to do reliable stratigraphic work in the Primordial Zone of Texas. "The Primordial Zone of Texas," so states Shumard (p. 214), "may be described as a series of light colored, pure and impure dolomites, limestones, gritstones and conglomerate, presenting an aggregate thickness of from eight to ten hundred feet, and separable into two well marked divisions, of which the superior represents the Calciferous sand group and the inferior the Potsdam sandstone of the northwest." At that time the presence of these rocks were noted in Burnet, San Saba, Llano, McCulloch, Mason, and Lampasas counties. Roemer's paleontologic data was revised by Shumard in this paper. Several measured sections were given, and nine new species of Cambrian fossils were described.

S. B. Buckley (1874), State Geologist in 1874, arbitrarily classified all granites in the Llano region as Azoic (p. 15). He further stated that these granites are younger than the metamorphic rocks with which they are associated. The mineral resources and general geology of the region were briefly discussed.

Ten years later Walcott (1884) visited the Central Mineral region, studied the rocks, and established the Upper Cambrian age of the Potsdam group. To the Lower Cambrian strata Walcott gave the name Llano group. He assigned a pre-Potsdam age to the masses of granite in western Burnet County and all through Llano County. He believed these granites were "extruded" near the close of erosion of the Llano group and before deposition of the Potsdam.

R. T. Hill (1887), in a review of Texas geology, mentioned briefly the Llano region and noted especially the importance of the work of Roemer and Walcott. In a later paper Hill (1889) assigned a late Carboniferous or post Carboniferous age to the granite of southwest Burnet County (p. 291), the same granite which he believed Walcott had stated to be of pre-Potsdam age. It was also the opinion of Hill that the alleged Devonian of B. F. Shumard (1859, p. 673) is identical to the Carboniferous limestone of North Texas. The erosion of Lower and Upper Cretaceous sediments from the central area was discussed by Hill (1890) in the first of two papers pertaining to the geographic features of Texas.

The Geological and Mineralogical Survey of Texas was created out of the Geological Survey of Texas by act of the Special Session of the Twentieth Legislature of 1888. The purpose of this survey was to report on the mineral and other natural resources of the State.

E. T. Dumble (1890), in his report as State Geologist and Director of the project, gave a review of Texas geology as developed by the survey. It was at this time that the first comprehensive geological examination of the Central Mineral region was made. T. B. Comstock (1890) reported on the geology and mineral resources of the area. Comstock divided the pre-Paleozoic metamorphics and granites of the Archean and Eparchean eras into the Burnetan, Fernandan, and Texan periods (oldest to youngest). Rocks of these periods were noted in Mason County, chiefly in the northern and eastern portions. He was the first to name the Valley Spring series (acid and basic schists) and the Packsaddle series (marbles and shaly beds). These strata were included in Walcott's original Llano group of Cambrian age. Comstock stated that granitic intrusions and extrusions occurred throughout the Eparchean era; granitic protrusions took place during Cambrian time. Comstock called attention to the fact that Hill's Carboniferous granite in Burnet County did not include the earlier pre-Potsdam extrusions of Walcott. The Llano (Lower Cambrian) strata of Walcott was defined as Middle Texas (Eparchean), and a considerable portion of Walcott's Potsdam group was included in the Hickory series.

Comstock divided the Cambrian system into the Hickory series (Lower Cambrian?), the Riley series (Middle Cambrian?), and the Katemcy (Potsdam) series (Upper Cambrian?). He noted the occurrence of the Hickory series and the Riley series in Mason County between the city of Mason and the Llano River. The Katemcy series was subdivided, by lithologic evidence, into three units: (1), the Potsdam sandstone; (2), the Potsdam flags; and (3), the Potsdam limestone.

Concerning the Silurian system, Comstock made the following statement (p. 294): "The lithologic and paleontologic transition from Cambrian to Silurian is not violent; at the same time there is an evident stratigraphic unconformity in most sections." Because the paleontologic separations did not correspond to the stratigraphic breaks, Comstock tentatively subdivided the Silurian into the Leon series (Canadian?) below overlain by the San Saba series (Trenton?). Reef limestone beds containing Stromatopora are exposed in the north bank of San Saba River east of the Mason-Brady highway bridge. Comstock placed these beds in the Hinton division of the San Saba series.

In the section pertaining to the economic geology of the region, Comstock discussed precious and base metals, manganese and iron ores, rare minerals and precious stones, building and refractory materials, materials for paints, and miscellaneous economic products.

Ralph S. Tarr (1890) wrote a paper on the origin of some topographic features of central Texas and their relation to the later history of the superimposed drainage system. This drainage began on Cretaceous strata in Tertiary time. After the removal of these soft, fairly horizontal strata, it found itself superimposed upon the harder, underlying Paleozoic rocks. Proof of this, according to Tarr, is seen in the central Paleozoic area where the cover has only partially been removed and denudation of the Cretaceous is still in progress. In a second paper published the same year, Tarr (1890) presented further evidence supporting the superimposition theory for the origin of the drainage system. The base levelling action of the Colorado River has been retarded by the presence of hard Silurian rocks. Everywhere are signs of attempts at rejuvenation. Tarr gave an explanation for the divide separating the drainage systems of the Colorado River and the Brazos River and related why this divide is closer to the Colorado River.

The Second Annual Report of the Texas Geological Survey (Dumble, 1891) is concerned primarily with the mineral resources of the State. Comstock (1891) made no important modifications in the preliminary classification of the strata as reported in the First Annual Report. He commented on the provisional existence--a designation which he inferred may not hold after the characteristic fossils are identified--of limited areas of Devonian rocks. Special emphasis was given to the economic aspects of the region. Various mining areas and potential mining areas were discussed; cross sections illustrating complicated structural conditions were included.

E. T. Dumble (1898) discussed the geologic history of Texas, devoting a section to the Central Mineral region. He commented on the Granite Highlands (p. 482), a mountain system varying in elevation from seven to eight hundred feet and fringed by Paleozoic rocks, extending from Burnet County westward through Llano County and into the eastern part of Mason County.

R. T. Hill (1901) made this statement, in a paper written at the turn of the century, concerning the Cambrian strata of the Central Mineral region: "These rocks were originally reconnoitered by Roemer, and were further studied by Shumard (B. F.), but Walcott presented the first classification, showing their unconformity upon the underlying Algonkian, giving measurements of their thickness, and demonstrating that they represent only the Middle and Upper Cambrian stages. Comstock has later given much detail of the distribution of these rocks, but has erroneously assigned their basal portion to the Lower Cambrian."

Sidney Paige (1911) named and described the Wilberns, Cap Mountain, and Ellenburger "formations." He discussed the economic resources of the Llano-Burnet region and gave an excellent description of the pre-Cambrian geology. The Packsaddle schist and Valley Spring gneiss—units originally named by Comstock—were redefined and regarded as Algonkian rocks. Paige believed these pre-Cambrian strata to be of sedimentary origin. He used the term Hickory sandstone instead of Comstock's term Hickory series. The geology of the Llano and Burnet quadrangles were mapped in detail by Paige (1912).

The first comprehensive geologic map of Texas was published in 1916 by the Bureau of Economic Geology and Technology (Udden, et al, 1916). This map, essentially a compilation of other publications, was drawn on a scale of 1 : 1,500,000. On it the Ellenburger, Wilberns, Cap Mountain, and Hickory are shown as one unit. Pre-Cambrian rocks are undifferentiated.

The occurrence of algal limestone in the Wilberns shales in Mason County was noted by Deen (1931).

Cuyler (1931) wrote a paper in which he stressed the usefulness of vegetation as an indicator in mapping geologic structure. His investigations leading to this paper were carried out in the Cretaceous rocks of central Texas.

Dake and Bridge (1932) used faunal evidence to correlate

Ellenburger limestone in the Camp San Saba area in northern Mason County with similar strata of the Ozark region in Missouri. Although a lithologic sequence within the Ellenburger was recognized, no formational boundaries were proposed at that time. After an examination of the Cryptozooan reef beds in the Upper Wilberns of the Camp San Saba region, it was generally felt by the authors that these beds might be designated a separate formation at some later date. "If . . . a new name is desired, the authors feel that it would be wise to revive and redefine Comstock's poorly defined and now completely abandoned term 'San Saba' formation (Comstock, 1890, p. 307), as especially appropriate, . . ." (p. 729).

The pre-Cambrian, Cambrian, and Ordovician systems of the Llano region were reviewed briefly by Sellards (1932) in his report on the stratigraphy of Texas. Stenzel (1932) redefined the Valley Spring gneiss and stated that it is of igneous origin and intrusive in the Packsaddle schist. Sellards (1934) discussed the deformation of the Llano region during Paleozoic time in his report on the structure and economic geology of Texas. In the same report Stenzel (1934) reviewed the pre-Cambrian structural conditions in the Llano region.

Stenzel (1935) reported on pre-Cambrian unconformities in Llano County. He used the term unconformity loosely to include the time interval between various structural and intrusive breaks. The nature of the granitic intrusives at Sixmile quarry in Llano County led to the assumption . . . "that the time intervals between some, if not all, intrusions of different structural type were large (p. 116)."

Darton checked formation outcrops in the uplift area in 1933, collected unpublished geological information on the area, and constructed a new State geologic map (Darton, et al, 1937). On this map were plotted, for the first time, the outcrop areas of Hickory sandstone, Wilberns and Cap Mountain limestones, and Ellenburger limestone.

The Lion Mountain sandstone member of the Cap Mountain formation was named and described by Bridge (1937). Rocks on the western side of the uplift were examined by him, and many of Roemer's type localities were redescribed.

Bridge and Girty (1937) redescribed the Paleozoic fossils from the Central Mineral region originally described by Roemer in 1849 and 1852. The original localities of Roemer were reestablished, and the stratigraphic horizons were accurately determined.

The first description of ventifacts occurring in the basal Hickory sandstone of central Texas was presented by Barnes and Parkinson (1939). The report contains a map of Hickory sandstone outcrop areas in central Texas showing ventifact localities situated in Mason, Llano, and Blanco counties.

The abstracts of two unpublished manuscripts by H. B. Plummer on the origin of travertine deposits in the Llano region were published by the Geological Society of America (Plummer, 1939 and 1945). Another of his abstracts on the same subject was published by the Texas Academy of Science (Plummer, 1944). These abstracts state that travertine originates from the precipitation of calcium carbonate from aerated spring water that has become saturated with calcium bicarbonate.

Barnes (1940) gave an outline of the pre-Cambrian geology of the

Llano uplift in a report covering the proceedings of a field trip to the region; most of this data was quoted from Stenzel (1934). Paleozoic and Mesozoic geology were discussed briefly, and a sketch map of the Llano uplift on a scale of 1 : 937,500 was included. Barnes considered the Ellenburger to be Cambro-Ordovician in age. In a similar field trip report Plummer (1940) discussed briefly the geologic history of the Llano region. He commented on the regional structure and listed seven classes of local structure. The age of folding and the effect of local structure on topography were also discussed. Plummer placed the Ellenburger in the Ordovician system. A major portion of the report was devoted to a description of the geology at numerous stops along the route of the field trip.

The larger bodies of pre-Cambrian, coarse-grained granites in the Llano-Burnet uplift were studied by Keppel (1940). He was particularly concerned with the structure and texture of these granite masses.

An unpublished report written by Bridge and Barnes on the stratigraphy of the Upper Cambrian strata in the Llano uplift was given before the Geological Society of America at the December, 1941, meeting in Dallas, Texas. In the published abstract of this paper Bridge and Barnes (1941) indicated that the Wilberns formation is made up of four members--no names were proposed. These members are a basal sandstone, a glauconitic limestone, a green calcareous shale, and a limestone at the top. The authors stated that Cambrian dolomites formerly mapped as Ellenburger in the northeastern and eastern parts of the uplift are equivalent to a portion of the youngest members of the Wilberns formation.

Plummer (1943) wrote a short paper on the discovery of a new white quartz sand near the middle part of the Wilberns formation in northwestern Mason County. This exceptionally pure sand was found in a bluff on Leon Creek southeast of the town of Erna.

Barnes (1944) published the previously named Upper Cabrian units in the Llano uplift. Pre-Wilberns units were given formational rank with the exception of the Lion Mountain sandstone, which Barnes designated as a member of the Cap Mountain limestone. The Wilberns formation was divided into four members: Welge sandstone, Morgan Creek limestone, Point Peak shale, and the San Saba and Pedernales dolomite (equivalent facies). Descriptions of these units were not given, but Barnes referred to an unpublished manuscript by Bridge and Barnes wherein these members were named.

A progress report on the stratigraphy of the Ellenburger group in central Texas was prepared in 1945 by Cloud, Barnes, and Bridge (1945). "The present report," so state the authors, "was prepared and is issued as a progress report, in order to make available to the petroleum industry at the earliest date consistent with sound geologic practice results of a joint study of the Ellenburger group (p. 133)." The Ellenburger limestone was revised to the Ellenburger group and restricted to the Lower Ordovician. The three formations of the group, Tanyard, Gorman, and Honeycut, were named for the first time, and descriptions of their stratigraphy were presented. The name Riley formation was proposed for Upper Cambrian strata of pre-Wilberns age, with the Hickory sandstone, Cap Mountain limestone, and Lion Mountain sandstone designated as members. A brief description was given of the Upper Cambrian stratigraphy at several localities.

The importance of the Hickory sandstone and the Ellenburger group as aquifers in the Llano uplift was discussed by Plummer (1946) in his report on the water resources of Texas.

Bridge, Barnes, and Cloud (1947) provided a standard reference to the seven members and two formations of the Upper Cambrian in the Llano uplift. All the units were named and redefined, and the stratigraphy of each was thoroughly described.

Cloud and Bridge (1948) presented a basic study of outcropping Ellenburger rocks occurring in central Texas in their final report on these strata. Emphasis was placed on features having a possible significance in the search for new sources of petroleum. Portions of the preliminary report (Cloud, Barnes, and Bridge, 1945) were repeated while other sections were used after appropriate revision. Pre-Ellenburger strata were briefly described at several localities throughout the Llano region.

Plummer (1950) briefly reviewed the pre-Carboniferous stratigraphy of central Texas in his report on problems of Carboniferous stratigraphy and paleontology in this region.

Blank (1951) discussed degradational processes in operation on the granitic masses cropping out in the Central Mineral region.

G E O G R A P H Y

CLIMATE

The South Mason area is located in a semi-arid region of Texas. The rainfall averages about 22.5 inches per year in Mason County; there is considerable variation in the precipitation from year to year. United States Weather Bureau statistics for contiguous counties indicate that most of the rainfall in Mason County comes between April and November; however, it is often very unevenly distributed throughout the year. It is not unusual for heavy rains to bring one-third of the annual precipitation to the county in a single week.

The mean annual temperature is about 64° F. Average normal temperatures for January and July are 47.4° F. and 83° F. respectively, while the extreme temperatures for winter and summer range from a minimum of -5° F. to a maximum of 110° F. Diurnal temperature ranges may be as much as 30 degrees in both winter and summer. The average temperature during the hot, dry, summer days is about 90° F.

VEGETATION

The vegetation belongs to hardy plant types typically found in areas where the terrain is rocky, where the precipitation is moderate, and where temperature ranges are rather severe.

Plant life is rather uniformly distributed over the uncultivated portions of the pre-Cambrian terrain. The dark sandy loam soils developed from pre-Cambrian rocks support a variety of shrubs, mesquite, scrub live oak, and black jack oak.

Many types of vegetation grow on the Paleozoic strata. The limestone formations support an abundance of oak, cedar, prickly pear, Spanish bayonet, catclaw, agerita, and Mexican persimmon. Mesquite, bee-brush, and catclaw are common on the shale and sandstone formations. Pecan, sycamore, willow, and elm trees are found along Comanche Creek and its tributaries. Grasses present throughout the area are buffalo, needle, curly mesquite, and crowfoot.

INDUSTRY

The chief industry in Mason County is medium-scale ranching and stock farming. Beef cattle is the leading income producer; sheep and wool production is second. Secondary agricultural products consist of corn, wheat, peanuts, hay, barley, watermelons, fruits and vegetables. The city of Mason is the retail and shipping center for the livestock industry.

P H Y S I O G R A P H Y

PHYSICAL FEATURES

The South Mason area lies on the southwestern flank of the Llano uplift in central Texas. Post-Cambrian strata of the region have been bowed upward by pre-Cambrian batholithic intrusions to form a large structural dome. This doming is indicated by the great gaps in the sedimentary record. The absence in the region of Lower and Middle Cambrian strata, as well as sediments of Silurian, Devonian, Mississippian, Jurassic, and Triassic age, all indicate the presence of a land area in the region during much of Paleozoic and Mesozoic time. Pre-Cambrian basement rocks have been exposed by erosion, thus forming a broad topographic basin surrounded by a rim of Paleozoic and Cretaceous strata which protrude at isolated areas into the basin. The relief in the Llano region is about 1600 feet. The highest point, between Mason and Fredericksburg, is somewhat over 2200 feet above sea level. The highest point in the South Mason area, approximately 3600 feet northwest of Tod Mountain (Plate I), is about 1800 feet above sea level.

Basement pre-Cambrian rocks in the South Mason area are present in the north and along the eastern margin, while Paleozoic rocks occupy the remainder of the area. The maximum relief throughout the South Mason area is about 300 feet.

Where pre-Cambrian rocks are exposed erosion has produced topography of low relief. Distinction between the physiographic features resulting from the presence of metamorphic and granitic rocks is not pronounced in the South Mason area. Careful examination, however, will show that weathering of metamorphic rocks has formed crescent-shaped hills of low relief. The general configuration of the land surface underlain by granite is flat to slightly undulating.

The lowermost sandstones of Upper Cambrian age generally erode to form flat-lying areas. The more resistant dark, finer grained sandstones higher in the section form northeast trending cuestas having steep escarpment slopes and gentle dip slopes. Upper Cambrian limestones also form prominant northeast trending ridges separated by the gentle slopes of weathered shale.

The Lower Ordovician rocks have no definite alignment as do those of the Upper Cambrian sequence, but instead tend to form a rolling type of topography. With the exception of Tod Mountain, which is composed of dark, resistant sandstone in the upper part of the Hickory sandstone member of the Riley formation, relief is greater on the Ellenburger than on the older Paleozoic and pre-Cambrian strata.

EROSIONAL AGENCIES

Where vegetation is meager, processes of denudation have had their maximum effect upon the topography of the South Mason area. Running water, following heavy rains of short duration, has been the most effective agent of erosion. In areas where the vegetation is scarce or absent the effect of the wind as an erosional agent is evident.

Development of the physiographic features has been aided by the system of parallel, northeast-southwest trending, normal faults. Movement along these breaks has brought the less resistant pre-Cambrian strata on the upthrown side under the more active influence of wind and rain. Consequently, the structurally high upthrown blocks have been reduced to the topographically low areas, leaving the Paleozoic strata on the downthrown blocks standing in relief.

DRAINAGE

The principal streams in the Llano region are the San Saba and Colorado rivers on the north and east, Llano River in the central part, and Pedernales River on the south. These are consequent streams which have been superimposed upon the domed Paleozoic strata. Tarr (1890) pointed out that the drainage pattern of the major streams began in Tertiary time on an eastward-tilted plain of Cretaceous strata. After the soft, fairly horizontal strata were removed the streams became superimposed upon the harder pre-Cambrian and Paleozoic strata with no great change in their original courses. The tributary streams, however, are adjusted to local structure.

Drainage in all but the extreme southwestern portion of the South Mason area is directed eastward to Comanche Creek by Koocks Branch, Gamels Creek, and other subsequent streams. Comanche Creek, the only consequent stream in the area, crosses the northeastern corner and flows southward across pre-Cambrian and Paleozoic terrain to the Llano River. Southward flowing tributaries of Llano River drain the southern portion of the South Mason area.

Short, obsequent streams are found dissecting the scarp slopes of the limestone and sandstone ridges in the area.

All streams in the area are intermittent, flowing only during periods of heavy rainfall. Comanche Creek carries a heavy load of pre-Cambrian wash obtained from the basement rocks through which it flows.

STRATIGRAPHY

GENERAL STATEMENT

Rocks of pre-Cambrian and Paleozoic age crop out in the South Mason area. An unconformity marks the boundary between the pre-Cambrian and Cambrian systems. Rocks younger than Lower Ordovician are not present in the area. The geologic column for the area is as follows:

- Paleozoic era
  - Ordovician system
    - Lower Ordovician
      - Ellenburger group
  - Cambrian system
    - Upper Cambrian
      - Wilberns formation
        - San Saba limestone member
        - Point Peak shale member
        - Morgan Creek limestone member
        - Welge sandstone member
      - Riley formation
        - Lion Mountain sandstone member
        - Cap Mountain limestone member
        - Hickory sandstone member
- Pre-Cambrian systems
  - Igneous and metamorphic basement complex

PRE-CAMBRIAN SYSTEMS

Igneous and metamorphic rocks of pre-Cambrian age crop out in the northern and northeastern parts of the South Mason area. The exposures consist for the most part of gneiss and schist, with minor amounts of quartzite, granite, and pegmatite vein quartz.

Metamorphic rocks

To the series of metamorphosed sedimentary rocks exposed in the Llano uplift Walcott (1884, p. 431) applied the term Llano group. He assigned this group to the Lower Cambrian system. Comstock (1890) divided the group into two units, the Valley Spring series (acid and basic schists) and the Packsaddle series (marbles and shaly beds). These units were redefined and named formations by Paige (1911). The type locality for the Valley Spring gneiss is at Valley Spring in Llano County, while that for the Packsaddle schist is at Packsaddle Mountain in Llano County.

Some disagreement exists in regard to the age of the two formations. Paige (1911, p. 25) and Sellards (1932, p. 32) believe the Valley Spring gneiss to be the older. Stenzel (1932, pp. 143-144) redefined the formations and stated that ". . . the gneiss as redefined by the writer is an orthogneiss of conformable contacts intrusive in the schist series..."

According to Sellards (1932, p. 32), the separation of the Valley Spring gneiss from the overlying Packsaddle schist "is based in part on the more massive character of the gneiss, and in part upon its greater content of acidic materials. The gneiss, however, not only contains schist, but grades into the schist in such a way as to make definite separation at many localities difficult or impossible." This is especially true on the west flank of the Llano uplift. At many places in the South Mason area the gneiss grades imperceptibly into schist. Nowhere in the area are the two so well developed as are the same formations on the eastern flank of the uplift. Consequently, no attempt was made to separate these formations in the South Mason area.

Granitic gneiss

This is a holocrystalline rock, pink to gray in color and weathering yellowish-brown to grayish-black. The rock is massive, highly fractured, and fine- to medium-ggrained. A megascopic examination reveals the rock to be composed primarily of quartz, hornblende, biotite, feldspar, and magnetite in their order of abundance. A marked increase in the biotite content gives to the rock a schistose appearance.

The banded gneissic structure is rough to moderately well-developed; consequently, the rock does not part readily along the foliation planes. The best samples show narrow, straight bands of unoriented fine-grained hornblende and biotite alternating with slightly thicker bands of fine-grained, colorless to milky quartz and minor amounts of pink feldspar. The subrounded to rounded crystals in the lighter bands give the rock a sugary texture.

Scattered subhedral grains of black magnetite, from 1-2 millimeters along their greatest dimension, form metacrysts. These magnetite grains are surrounded by quartz.

On the property of Kitty Rowe, southeast of Mason, weathered exposures of gneiss are not unlike medium-grained granite in appearance. Northwest of Mason in a roadcut on State Highway 29, gradation to schist can be seen.

Schist

A hand specimen of this rock is dark green--almost black--weathering greenish-brown. The rock is composed almost entirely of medium-grained, prismatic crystals of tremolite-actinolite. The grains are oriented in one plane to give a well developed foliate structure. Quartz is present in monor amounts. The rock is strongly coherent and is broken with difficulty even along the planes of schistosity.

Square to rectangular metacrysts up to 8 millimeters in longest dimension are common. These metacrysts, of finely crystalline, yellow-green material, appear to have formed at the expense of the tremolite-actinolite mineral grains, as evidenced by the presence of some grains of the primary mineral protruding into the metacrysts, while others terminate sharply against the inclusions.

A laboratory analysis was made of a portion of the finely ground rock to determine the identity of the primary constituent. The immersion method was used to determine the indices of refraction of the mineral. The sample was examined with a petrographic microscope, using medium and high power lenses. Along one direction of extinction the index of refraction of the mineral was slightly above 1.650; it was slightly below 1.650 parallel to the second direction of extinction. This indicated the mineral being tested to be tremolite-actinolite.

Other petrographic data, which further indicated the primary mineral to be tremolite-actinolite, are listed below.

Color: Green to pale green in the thinnest fragments; faintly pleochroic.

Cleavage: Longitudinal fragments show cleavage parallel to the length.

Birefrengence: Moderate; maximum interference colors in middle second order.

Extinction: In longitudinal sections the maximum angle of extinction is 22° measured against the cleavage.

Interference Figure: Biaxial negative with a large axial angle.

The fragments contain many inclusions of a black, isotropic, subhedral mineral, possibly magnetite.

Many exposures of schist are present in the bed of and along the banks of Comanche Creek north of Mason (Plate IV). A good example of schist intruded into gneiss is exposed in the roadcut on U. S. Highway 87 about 200 yards north of the bridge over Comanche Creek, northwest of the city (Plate V).

Quartzite

The quartzite ranges in color from grayish-white to greenish-brown. It is composed of subangular to subrounded, milky quartz grains. Interstices between grains are filled with a powdery substance, possibly kaolin, stained brown with iron oxide. The presence of this quartzite as narrow veins in the basement complex would indicate its origin to be metamorphic, as distinguished from sedimentary quartzite.

Pre-Cambrain Schist in bed of
Comanche Creek north of Mason
(III - 3)

Figure 1

Schist (center) intruded into gneiss

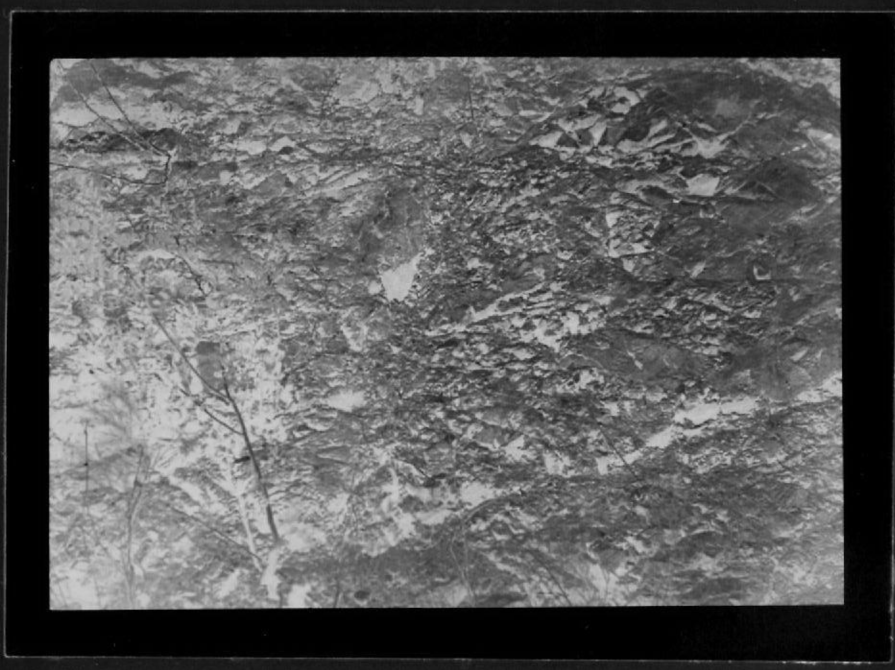


Figure 2

Close-up of right side of Figure 1
showing sharp contact between
Schist and intruded gneiss
(III - 4)

The rock also occurs as a fine-grained variety, tan in color and weathering dark grayish-black. This rock contains an appreciable amount of some black ferromagnesian mineral, and minor amounts of magnetite as tiny grains which give the rock a "salt and pepper" texture.

Igneous rocks

Granite

Long before the first Upper Cambrian seas covered the Llano region, the pre-Cambrian rocks of the region were intruded by granitic magmas, chiefly acidic in composition. Present exposures of these intrusives have been divided into three groups and described by Stenzel (1932, pp. 143-144; 1934, p. 75).

Exposures of granite in the South Mason area are limited to the southeastern border, where it is light pink to gray, weathering to rather smooth, grayish-brown surfaces generally covered with lichen. The rock is coarse-grained and composed of milky quartz, large pink feldspar fragments, brown biotite, and black hornblende. In the weathered zone the granite has a granular texture. Deep weathering is evident in the granite quarry (Plate VI) south of Mason at the junction of Farm Road 1723 and James River road.

Pegmatite vein quartz

Quartz occurs as veins and veinlets in schist (Plate VII) and as fragments scattered on the surface near the pre-Cambrian-Upper Cambrian contact. A large circular mass of quartz is present west of Avenue F and north of the Arnold Zesch residence (Plate I - 21). This

Figure 1

Granite quarry south of Mason
(I - 1)

Figure 2

Eroded granite in quarry south
of Mason
(I - 1)

quartz is massive (Plate VIII), white, intensely fractured, and stained brown with iron oxide.

Figure 1

Figure 2

Vein quartz intruded in Schist
(III - 5)

Massive quartz
(I - 21)

CAMBRIAN SYSTEM

Rocks of Upper Cambrian age in the South Mason area are those sediments belonging to the Riley and Wilberns formations. These formations consist of alternating sandstones and limestones, with some shale and stromatolitic bioherms near the top of the Wilberns. Bridge, Barnes, and Cloud (1947) provided a standard reference to the Upper Cambrian strata of the Llano uplift when they redefined and thoroughly described the two formations and seven members.

Riley Formation

The Riley formation contains the lowermost Paleozoic strata of the Llano uplift. The name Riley formation should not be confused with an earlier name, Riley series, used by Comstock and Dumble (Comstock, 1890) for rocks involving only a portion of the present formation. Cloud, Barnes, and Bridge (1945, p. 154) used the term Riley formation to include "all of the Cambrian strata in central Texas beneath the Wilberns formation. It includes, from base to top, ...the Hickory sandstone, the Cap Mountain limestone, and the Lion Mountain sandstone members..."

The formation was named for the Riley Mountains in southeastern Llano County, where excellent exposures of the members were measured by Cloud and found to total 780 feet in thickness. Great variation in the thickness of the Riley formation throughout the Llano region, as explained by Bridge, Barnes, and Cloud (1947, p. 110), was caused, in part, by the topographic irregularity of the pre-Cambrian surface of deposition. The total thickness is slightly under 200 feet in northwestern San Saba County, where the Cap Mountain limestone rests directly on pre-Cambrian. In southeastern Llano County, however, the three members total almost 800 feet. The average thickness of the formation is about 680 feet. Several sections measured within the formation in the South Mason area and the adjacent area to the west indicate the total thickness of the three members to be slightly less than 650 feet.

Hickory sandstone member

Definition and thickness:

Comstock and Dumble (Comstock, 1890) first used the term Hickory series for the exposures on Hickory Creek in Llano County. Paige (1911) revised the name to Hickory sandstone. In redefining the unit, Cloud, Barnes, and Bridge (1945) lowered the upper boundary, thereby cutting out some of the beds allotted to the Hickory sandstone by Paige.

"In thickness," so stated Bridge, Barnes, and Cloud (1947, p. 112), "the Hickory sandstone member averages about 350 feet and ranges from about 415 feet to a feather edge, variations being attributable to topography of the invaded area, irregularities in deposition, and lateral gradation to limestone of the upper beds." The nature of the exposures in the South Mason area preclude measurement of the complete member, but the total thickness in the area is slightly over 400 feet.

Lithology:

At its contact with the pre-Cambrian rocks in the South Mason area the Hickory sandstone is generally white to light yellowish-brown, very well indurated and very coarse-grained (Plate IX). The large subrounded

Figure 1

Figure 2

Coarse-grained Hickory Sandstone
contact with weathered pre-Cambrian
granite
(I - 2)

to rounded quartz grains and the numerous small fracture fillings of fine-grained sandstone stand out in relief on weathered surfaces. Concentration of the larger grains in uneven bands gives the rock an inequigranular texture. Ventifacts (Plate X) are present at several localities near the contact with the pre-Cambrian (Plate I). Large remnants of very hard, massive sandstone with very rough to honeycombed weathered surfaces (Plate XXXVI, Figure 2) are present near the contact at two localities in the area. One such place is located about 30 feet east of where Avenue F crosses the fault contact; the second locality is south of Mason between James River road and Farm Road 1723.

Almost every stratigraphic feature of the Hickory sandstone is variable. Its color ranges from white at the base, through tan, yellowish-brown, to dark reddish-brown in the upper part of the member. The massive portion of the Hickory is generally confined to the lower part. Well developed cross-bedding (Plate XI) is also limited to this massive unit. Bedding in the middle and upper portions varies from thin to thick. Grain size, in general, ranges from very coarse at the base to fine at the top. However, a layer of very coarse-grained sandstone occurs near the middle of the member just below the beds of intraformational conglomerate. Most of the quartz grains are subrounded to rounded, translucent, and stained with varying amounts of iron oxide. The rock is soft and friable to very hard--almost quartzitic--depending on the abundance of cementing material. The middle and upper portions of the Hickory contain phosphatic brachiopod shell fragments.

Figure 1

Figure 2

Ventifacts from base of Hickory sandstone
(I - V)

Figure 1

Figure 2

Cross-bedding in Hickory sandstone
(I - 3)

Thinly-bedded silty layers (Plate XII) were found near the middle Hickory overlying the cross-bedded sandstone in the lower Hickory. These silty layers are overlain by beds of intraformational conglomerate. Fragments of the conglomerate are very hard and are found scattered over the surface in the absence of bedded exposures.

A shallow water environment of deposition is indicated for the upper Hickory by the presence of large fragments of coarse-grained brown sandstone having surface features which suggest ripple marks (Plate XXXIX, Figure 2). The crests and troughs are symmetrical and oriented parallel to each other as they would be if made by wave action.

Topography and vegetation:

Relief on the lower Hickory is generally low. Much of this flat land is used for stock farming to raise livestock and crops. Immediately south of Mason is a northeast-southwest trending cuesta (Plate XIII) formed by the middle and upper Hickory. Tod Mountain (Plate XXXVIII), in the southeastern part of the area, is a monadnock of middle and upper Hickory.

Much of the Hickory lowlands have been cleared of vegetation for cultivation. Spanish persimmon, prickly pear, and mesquite are found in variable abundance on the uncultivated portions of the lower and middle Hickory. Dense thickets of bee-brush and mesquite are common on the middle and upper Hickory. (Plate XIV)

Figure 1
(I - 3)

Figure 2

Silty beds in Hickory Sandstone
(I - 4)

Figure 1
(I - 5)

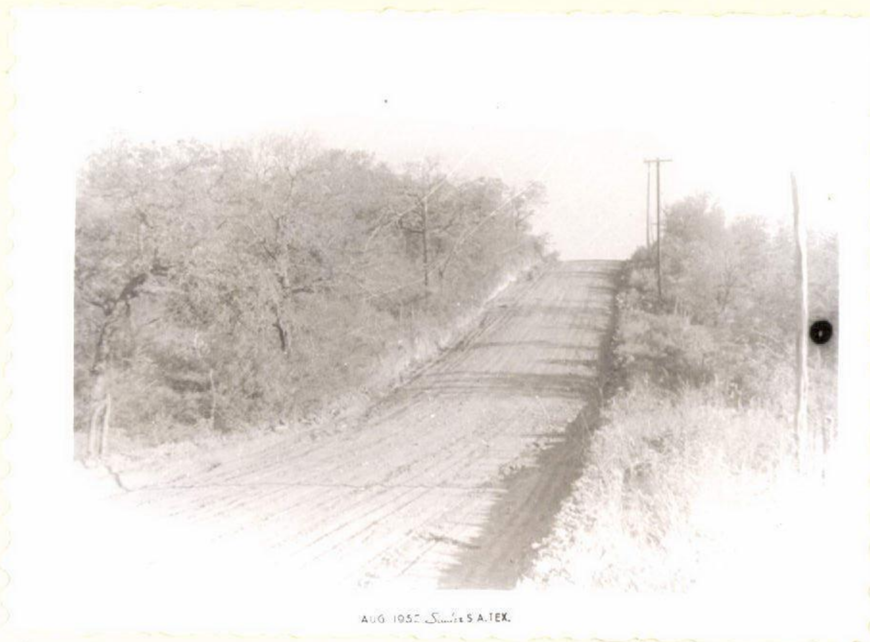


Figure 2

Ridge of Hickory Sandstone
(I - 6)

Dense vegetation on middle hickory
(I - 7)

Cap Mountain limestone member

Definition and thickness:

The Cap Mountain limestone member, as redefined by Cloud, Barnes, and Bridge (1945, p. 154), contains more beds at the base than was included in the original description of the Cap Mountain formation of Paige (1911).

The type locality is at Cap Mountain in Llano County. Bridge, Barnes, and Cloud (1947, p. 113) state that the member "ranges from about 135 to 455 feet thick, with an average thickness near 280 feet, and with variation due principally to lateral gradation to sandstone of the lower beds." The average thickness in the South Mason area is slightly under 170 feet. An average dip of 5 degrees was set on the Brunton compass to measure this member. In the West Mason area, where a dip of 10 degrees was used, slightly under 200 feet was measured.

Lithology:

The boundary with the Hickory sandstone member is gradational and is generally placed at a distinct topographic as well as vegetational break which shows up well on aerial photographs. This boundary is placed at the top of a noncalcareous sandstone zone and beneath a zone of reddish-brown calcareous sandstone. The member is limited at the top by the Lion Mountain sandstone member.

The lower Cap Mountain is composed of dark reddish-brown, calcareous sandstone having a medium-to coarse-grained texture and medium bedding, alternating with and grading laterally into light gray, fine-grained, arenaceous limestone. These beds grade upward into a series of dark brown, medium-grained, slightly fossiliferous limestones alternating with tan, fine-grained, noncalcareous sandstones. Higher in the section calcium carbonate becomes increasingly abundant forming tan, thick-bedded to massive limestone containing thin stringers and pockets of fine-grained, brownish-yellow sand. Occasional nodules of iron oxide are found weathered out on the surface.

The massive ledges of limestone comprise the greater part of the Cap Mountain limestone member. Figure 2 of Plate XV shows the rough, honeycombed weathered surface so typical of the thick limestone ledges in the West Mason area. In the South Mason area, however, the honeycombed surfaces are nowhere so well developed. Rough surfaces exhibiting small scale sharp ridges and wide shallow depressions are more characteristic of the thick bedded to massive units.

In the upper part of the Cap Mountain member, light gray to brown, medium-grained to granular, glauconitic, fossiliferous limestone predominates. These beds weather easily so that few good exposures remain.

Topography and vegetation:

In the South Mason area the lower zones of calcareous sandstone and arenaceous limestone generally weather out as dip slopes on the cuesta formed by the underlying Hickory. An exception occurs on the Edgar Leifesti property, south of Mason, where the lower portion is more resistant to erosion and forms a ridge of low relief. Elsewhere, this lower portion is often cultivated and used for the raising of crops. The massive limestone, which weathers to give a thinly-bedded appearance, forms prominent ridges having steep scarp slopes

Figure 1

Cap Mountain limestone

Figure 2

Honey-combed weathered surface of cap
Mountain limestone
(III - 2)

(Plate XVI, Figure 1).

Vegetation on the Cap Mountain limestone member is rather thick and evenly distributed (Plate XVII). Scrub oak, mesquite, Spanish persimmon, prickly pear, turkey pear, Spanish bayonet, and catclaw grow in abundance. South of Mason, between Mill Springs road and the Schmidt fault, the contact with the underlying Hickory occurs in a cultivated field. Consequently, the sharp vegetational contrast which normally occurs at the contact is not present. West of Mason this contact shows up well on aerial photographs as a dark band.

Lion Mountain sandstone member

Definition and thickness:

Bridge (1937) named the Lion Mountain sandstone as the top member of the Cap Mountain "formation" from Lion Mountain in the northwestern part of the Burnet quadrangle. As stated earlier, Cloud, Barnes, and Bridge (1945) redefined the Cap Mountain as a member in the Riley formation; present usage recognizes the Lion Mountain sandstone as the top member of the Riley formation. It is limited above by the Welge sandstone member of the Wilberns formation.

The Lion Mountain sandstone, according to Bridge, Barnes, and Cloud (1947, p. 114), varies in thickness from about 20 feet at the type locality to a maximum of 50 feet elsewhere in the Llano uplift. The unusual thickness of 106 feet, as measured in the West Mason area along section A-A' (Plate I), is partially due to inaccuracies in measurement, and to the fact that the contact between the Cap Mountain and the Lion Mountain could not be determined accurately.

Figure 1
(I - 10)

Figure 2

Cap Mountain Scarps
(III - 2)

Vegetation on Cap Mountain limestone
(I - 11)

South of Mason and immediately west of the Schmidt fault 51.6 feet of Lion Mountain was measured.

Lithology:

The gradational contact of the Lion Mountain member with the underlying Cap Mountain limestone member is most conveniently mapped at the lower edge of the topographic bench marking a distinct vegetational break between these members.

The Lion Mountain is essentially a coarse-grained, highly glauconitic sandstone. The lower portion contains thinly bedded, light greenish-gray limestone beds composed almost entirely of trilobite shell fragments. This "trilobite hash" is overlain by beds of limestone containing phosphatic brachiopod shells.

Black pebbles of hematite are scattered over the glittering soil of the Lion Mountain. This hematite is thought to be a product of weathering of the glauconite present in the member.

Topography and vegetation:

The Lion Mountain sandstone member is marked topographically by a bench of variable width (Plate XVIII).

Vegetation on the Lion Mountain is sparse, consisting primarily of large mesquite trees and needle grass. Small amounts of scrub oak and cacti are also present. This zone is easily seen on aerial photographs as a narrow, light band.

Wilberns Formation

Sidney Paige (1911) named the Wilberns formation for Wilberns Glen in Llano County. The upper boundary was redefined by Cloud,

Lion Mountain bench
(I - 12)

Barnes, and Bridge (1945) and placed at the top of the Cambrian system, and the lower boundary as defined originally by Paige was retained.

According to Bridge, Barnes, and Cloud (1947, p. 110), the Wilberns formation ranges in thickness from 540 feet to 610 feet through most of the Llano uplift. Erosion at the top, in the southeastern corner of the region, has reduced the thickness to about 360 feet, while the average thickness is about 580 feet. Sections measured in the South Mason area and the West Mason area indicate the thickness to be about 655 feet.

Bridge, Barnes, and Cloud (1947) made the first detailed descriptions of the five members of the Wilberns formation.

Welge sandstone member

Definition and thickness:

Barnes (1944, p. 34) named the Welge sandstone member of the Wilberns formation from the Welge land surveys in Gillespie County. At the type section on Squaw Creek, half a mile north of the Gillespie County line, the Welge is 27 feet thick; the thickness throughout the Llano uplift ranges from 9 to 35 feet and averages 18 feet. Twenty six feet of Welge was measured and described in an exposure on the Walter Schmidt ranch south of Mason. A thickness of 29 feet was measured and described at a locality west of Mason.

Lithology:

South of Mason the contact of the Welge with the underlying Lion Mountain sandstone is abrupt. Elsewhere in the Mason area, however, the contact is difficult to distinguish and was mapped at the upper limit of the sparsely vegetated Lion Mountain bench.

The Welge is a yellowish-brown to brown, essentially nonglauconitic, slightly fossiliferous sandstone. The member is massive for the most part and slightly cross-bedded, the cross-bedding being well developed in the brown, coarse-grained, argillaceous sandstone near the Lion Mountain contact (Plate XXXV, Figure 1). Angular to subrounded quartz grains make up this medium- to coarse-grained sandstone. The presence of many quartz grains having recomposed faces gives to the member a sparkling appearance. Near the top the beds become calcareous and contain scattered phosphatic brachiopod shell fragments.

Topography and vegetation:

There is little topographic change between the Lion Mountain member and the overlying Welge sandstone. South of Mason the Welge is cliff forming, due to the action of a consequent stream cutting through the member parallel to its strike (Plate XXXV, Figure 2). In other areas a slight rise in the surface configuration is noticed as one walks from the Lion Mountain bench onto the Welge.

The most apparent difference between the surface outcrops of these two members is the rather abrupt change from the sparsely vegetated Lion Mountain to the more dense vegetation of the Welge. Scrub oak, Mexican persimmon, and turkey pear are abundant and well developed.

Morgan Creek limestone member

Definition and thickness:

Bridge (1937) named the Morgan Creek limestone member of the Wilberns formation from exposures on the north and south forks of

Morgan Creek in Burnet County. At the type section, just north of the junction of the two streams, the member is 110 feet thick. The member ranges in thickness from 70 to 160 feet with an average of about 120 feet (Bridge, Barnes, and Cloud, 1947, pp. 114-115). A thickness of 179.2 feet was measured in the South Mason area.

Lithology:

The Morgan Creek is a medium- to coarse-grained, highly glauconitic, well bedded limestone. The contact with the underlying Welge sandstone member is gradational. For purposes of mapping it is placed at the base of the first reddish to purple, coarse-grained, granular, arenaceous limestone bed. These medium-bedded sandy layers at the base are easily eroded so that only indistinct ledges remain. The red and purple tones diminish upward and finally grade into gray and greenish-gray limestone which is coarse-grained, highly glauconitic, abundantly fossiliferous and, in general, well bedded in ledges of rather uniform thickness. A zone of conaspid fauna, containing Eoorthis texana, is present about 60 feet above the base. The remaining beds of Morgan Creek are greenish-gray to yellowish-brown, abundantly glauconitic, medium- to coarse-grained, rather evenly bedded limestone; the fossil content decreases toward the top. Thin zones of argillaceous limestone and gray shale are present in the upper portion. Small isolated masses of gray, stromatolitic bioherm reef are occasionally found near the upper margin of the Morgan Creek (Plate III).

Topography and vegetation:

A distinct topographic and vegetational break occurs between the

Welge sandstone and Morgan Creek limestone members. The Morgan Creek forms a ridge which varies in relief from 30 to 50 feet in the South Mason area (Plate XX, Figure 1).

Vegetation is heavy and rather evenly distributed. Scrub oak trees are abundant and well developed; turkey pear, agerita, and Spanish dagger are the most common shrub and cacti (Plate XX, Figure 2).

Point Peak shale member

Definition and thickness:

The Point Peak shale member of the Wilberns formation was named by Bridge (1937) from Point Peak, an isolated hill about 4 miles northeast of Lone Grove, Llano County. On the south side of Point Peak the member measures 270 feet in thickness (Bridge, Barnes, and Cloud, 1947, p. 115). The member is thinnest on the southeastern flank of the uplift and reaches its maximum thickness at the type section on the northeastern flank of Point Peak. The average thickness is about 160 feet. A thickness of about 260 feet was measured in the South Mason area.

Lithology:

The Point Peak shale member was mapped in the South Mason area as lower and upper zones. The contact of the lower zone with the underlying Morgan Creek limestone member is transitional but easily recognized by a distinct topographic and vegetational break. The lower zone, about 140 feet in thickness, is composed of grayish-green, thin-bedded, soft to moderately well indurated, calcareous shales. Interbedded with the shales are thin-bedded, brownish-gray, very

Figure 1

Ridge of Morgan Creek limestone
(I - 16)

Figure 2

Vegetation on Morgan Creek limestone
(I - 15)

fine-grained to granular, slightly fossiliferous limestone, and thin to medium beds of resistant intraformational conglomerate. Scattered individual reef colonies of gray, very dense, lithographic limestone are present about 26 feet above the base. The layers of compact intraformational conglomerate are crowded with flat, fine-grained, yellowish-green limestone pebbles embedded in a matrix of brown, medium-grained limestone. The average maximum dimension of the pebbles is about 2 inches. The entire zone weathers readily so that good exposures are limited to the fairly resistant limestone beds above the conglomerate.

The upper zone is represented by a thick interval of stromatolitic bioherms interbedded with limestone (Plate XXI). The Point Peak bioherms are present as gray, microgranular to sublithographic, very hard limestone which weathers to rounded boulders, large blocks, and circular reticulated masses (Plate XXII). Thin-bedded, yellowish-brown to gray, fine- to medium-grained limestone occurs interbedded with the reef. This limestone is non-fossiliferous and non-glauconitic, hard, and fairly well bedded though discontinuous laterally. It weathers to thin slabs and fragments.

Topography and vegetation:

A narrow bench is characteristic of the shale beds in the lower portion of the Point Peak member. More resistant strata above form a steeper slope (Plate XXIII) capped by the ridge-forming bioherms (Plate XXIV) and limestone beds of the upper zone. Relief on the bioherm zone is slight, but the outcrop surface is very rough (Plate

Figure 1

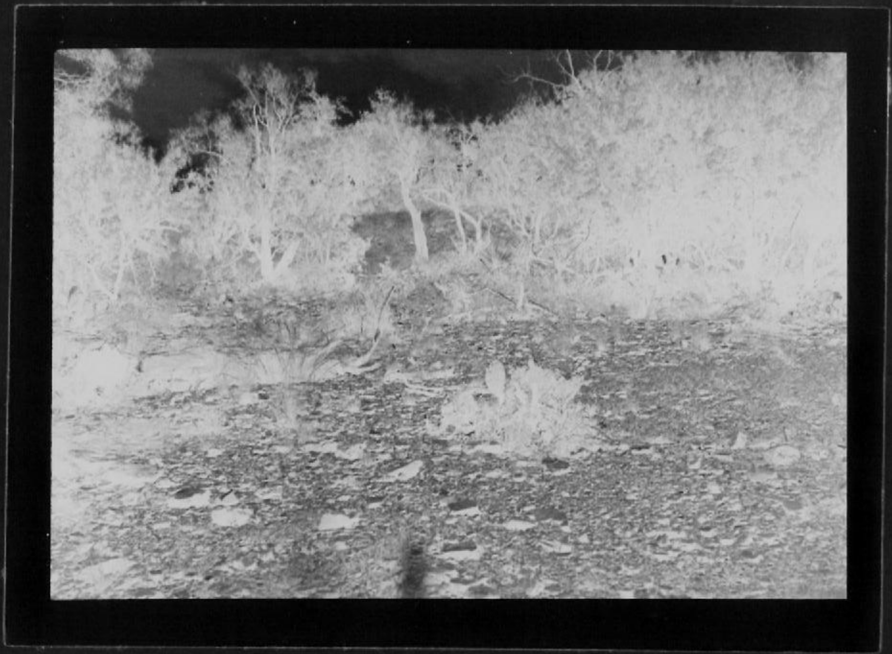
Point Peak
bioherms along
Honey Creek
(III - 1)

Figure 2

Figure 1

Figure 2

Point Peak bioherm structure
(I - 17)



Gentle slope above lower
Point Peak bench
(I - 18)

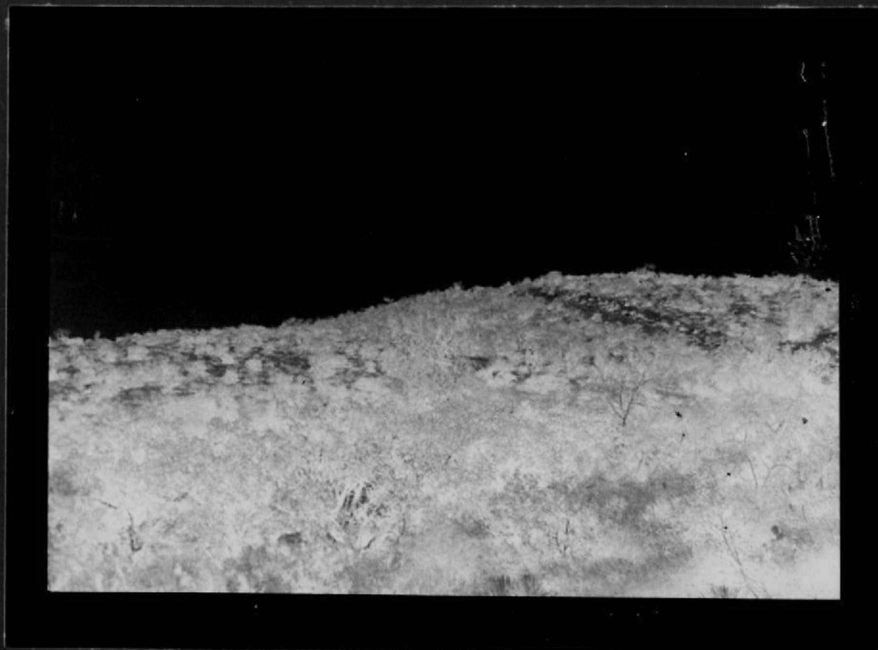


Figure 1
(I - 19)

Figure 2

Point Peak ridge
(I - 20)

XXV).

Light green mesquite trees are well developed on the Point Peak bench. Their distinctive color enables one to recognize the zone even at great distances. Scrub oak is abundant on the densely vegetated steep slope. This zone is easily seen on aerial photographs as a dark band next to the light band representing the underlying bench. Prickly pear, catclaw, Spanish bayonet, and Mexican persimmon, grow in profusion on the bioherm zone (Plate XXV). Scrub oak and agerita are also common.

San Saba limestone member

Definition and thickness:

Comstock (1890) first used the name San Saba as a series term for at least some of the beds exposed on both sides of San Saba River, northeast of Camp San Saba, McCulloch County. Dake and Bridge (1932) believed these beds to be of post-Wilberns age, and further stated that Comstock's term San Saba might well be used for part of them. Bridge (1937) revised the rocks of the San Saba series, as defined by Comstock, to member status. According to Bridge, Barnes, and Cloud (1947, p. 117), "the name is now applied to the entire series of more or less glauconitic limestone overlying the Point Peak shale member of the Wilberns formation and underlying the Threadgill member of the Tanyard formation."

The member is 280 feet thick at the type section, which begins at the San Saba bridge on the Mason-Brady highway and extends northward on both sides of the highway for 0.7 mile. Using an average dip of 8 degrees, a thickness of 190 feet was measured in the South Mason

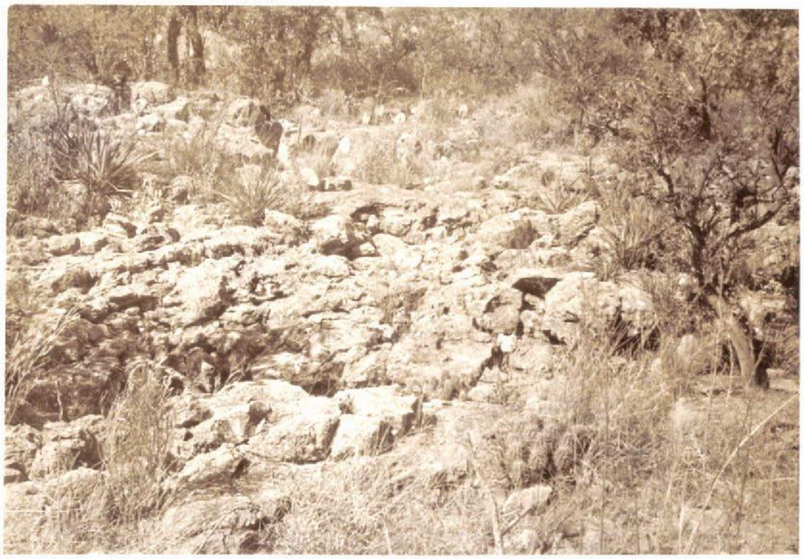


Figure 1
(I - 23)

Figure 2

Rough terrain of Point Peak
bioherm zone
(I - 24)

area. A thickness of 175 feet was measured on the Alex Durst property west of Mason. One hundred and fifty feet was measured on Honey Creek (Plate III - 1). The Honey Creek section of San Saba is cut by a normal fault of unknown displacement near the top of the member.

Lithology:

The presence of bioherm masses at the top of the Point Peak shale member throughout the South Mason area results in a distinct contact with the overlying San Saba limestone. This sharp boundary is not present, however, in areas where the bioherm reef is replaced by shales interbedded with thin limestone layers.

The limestones of the San Saba member (Plate XXVI) are essentially thin- to thick-bedded, medium- to coarse-grained and granular; some beds are sublithographic in their upper portions. A wide range of colors are represented, the predominant ones being gray to greenish-gray, and yellowish-brown to brown. Glauconite is present throughout in varying amounts, gradually decreasing to minor quantities near the top. The member is fossiliferous throughout except near the top, containing trilobites, gastropods, and brachiopods.

Differential weathering has given a thin-bedded appearance to some of the massive limestones in the lower part of the member (Plate XXVI, Figure 2). Thin nodular limestone stringers near the base are interbedded with calcareous sandstone.

According to Bridge, Barnes, and Cloud (1947, p. 121), "sandstone and calcareous sandstone are common in the San Saba limestone member along and near Llano River in western Mason County." This holds true

Figure 1

Cross-bedded, arenaceous San Saba limestone along Honey Creek

Figure 2

San Saba limestone
along Honey Creek
(III - 1)

for the South Mason area where the limestones are interbedded with buff-colored, fine-grained, calcareous sands. Lateral gradation to very sandy limestone is common in many of the pure limestone layers. Cross bedding is evident in some of the more arenaceous limestone (Plate XXVI, Figure 1). In the Bear Spring area of Mason County Cloud and Barnes (1948, p. 156) report the presence of a persistent sandstone sequence 7 feet thick which maintains a position from 25 to 35 feet below the San Saba-Ellenburger contact. Poor exposures prevented recognition of this unit in the South Mason area. If it is present in the area west of Mason on the Irvin Geistweidt ranch, it has been dropped out of the Honey Creek section by a fault occurring about 20 feet below the Cambrian-Ordovician contact.

Flaggy limestone ledges are common in the upper part of the member. These are primarily sublithographic, nonfossiliferous and sparingly glauconitic. The first intraformational conglomerate is present as a thin bed about 26 feet above the base. From 95 feet above the base to the top of the member these conglomerate beds are more numerous, interbedded with thinly-bedded limestone and calcareous sandstone.

Very rough weathered surfaces are common among the bedded limestones and arenaceous limestones (Plate XXVI).

Good exposures of the entire member are not present in the South Mason area. Recognition of the member is dependent to a great extent upon the abundance of small, thin, brownish-yellow slabs of limestone which are present throughout the outcrop area (Plate XXVII).

Topography and vegetation:

The topography of the San Saba limestone member is for the most

San Saba limestone
(I - 25)

part gently rolling with no appreciable local relief.

Vegetation on the San Saba is generally scattered (Plate XXVII), consisting primarily of prickly pear, scrub oak, cedar, Mexican persimmon, and turkey pear, in their order of abundance. The vegetation is somewhat thicker near the contact with the underlying Point Peak shale member.

ORDOVICIAN SYSTEM

Ellenburger Group

General statement:

Paige (1911) named the Ellenburger limestone from the Ellenburger Hills in southeastern San Saba County. Cloud, Barnes, and Bridge (1945) revised the term to the Ellenburger group and restricted it to beds of Lower Ordovician age. They also divided the group into three formations. From bottom to top these formations are the Tanyard, Gorman, and Honeycut.

No attempt was made to delineate the formations of the Ellenburger group in the South Mason area, and only a brief description of the rocks is given in this report.

Lithology:

The limestones of the Ellenburger are very hard, thin- to thick-bedded, white to steel gray, sublithographic, and nonglauconitic. They weather to large, discontinuous blocks and ledges (Plate XXVIII) having rough, solution pitted to smooth surfaces. Dolomite in the lower part of the group is generally yellowish-gray to gray, vuggy, and irregularly bedded. Chert is fairly abundant, in place, as nodular and irregular inclusions (Plate XXIX), and as float.

The Cambrian-Ordovician contact was very difficult to place in the South Mason area. For mapping purposes the boundary was chosen between the highest glauconite and the first appearance of the uncoiled gastropod _Lytospira gyrocera_.

Ellenburger limestone
(I - 26)

Figure 1

Figure 2

Chert in Ellenburger limestone
(I - 27)

Topography and vegetation:

No well defined bedding trends are present on the Ellenburger. A hilly terrain is characteristic with the maximum relief expressed as an upland flat.

On aerial photographs the Ellenburger does not show the vegetation alignment so characteristic of Upper Cambrian strata, but the irregular pattern is easily recognized. Cedar, scrub oak, prickly pear, bee brush, and Mexican persimmon are common.

STRUCTURAL GEOLOGY

GENERAL STATEMENT

Paleozoic rocks of the Llano uplift have been disturbed by a complicated series of normal tensional faults which range in dip from 60 to 90 degrees and which trend, for the most part, northeast-southwest (Cloud and Barnes, 1948, p. 118). These faults are downthrown to the northwest. Beds unaffected by faulting strike approximately N 70° E and dip about 8 degrees to the southeast.

MAJOR FAULTS

Three major faults are present in the South Mason area. Plummer (1950, map) named one of these the Mason fault. The writer has named the others the Schmidt fault and the Simons fault.

These faults are roughly parallel to each other and trend north-northeast to northeast. They range in throw from approximately 450 feet to well over 1300 feet; all are downthrown to the northwest.

The Mason fault passes through the northwest corner of the South Mason area. Displacement along this fault, on the order of 1300 feet, has brought the Hickory-pre-Cambrian contact against the basal part of the Ellenburger group. Northeast of Avenue F, where the lower Hickory is in fault contact with pre-Cambrian metamorphics, the amount of throw cannot be estimated accurately. That the pre-Cambrian rocks have been cut by this fault is indicated by the absence of basal Hickory on the downthrown side, and by the presence of a pre-Cambrian fault breccia adjacent to the fault between Koocks Branch and U. S. Highway 87. This brecciated zone is exposed as a low ridge about 30 feet long and 6 feet wide. A megascopic examination of samples taken from this zone reveals the presence of fragments of fine-grained black schist. The primary minerals are very coarse-grained, angular fragments of white calcite, and subhedral grains of pink feldspar.

The Schmidt fault passes through the eastern edge of the city of Mason. In the southern part of the South Mason area, where the base of the Ellenburger group is in contact with the base of the Point Peak shale member, this fault has a throw of about 450 feet. The amount of throw decreases northeastward along the fault; no evidence was found for the fault north of U. S. Highway 87.

The Simons fault, in the southeastern portion of the area, has a throw comparable to that of the Mason fault. On the Walter Schmidt ranch this fault has brought the pre-Cambrian-Upper Cambrian boundary very close to the Upper Cambrian-Ordovician boundary. Talus on the upthrown side parallel to the fault has covered the Hickory-pre-Cambrian contact in this area so that only an inferred location for this boundary is possible west of James River road.

Generally, the strike and dip of beds against the large faults vary somewhat from that of strata in their normal position. In many localities, however, this anomaly is not present, thus making the detection of faulting by this criterion impossible. South of Mason on the P. E. Grosse property vertical beds of Hickory sandstone (Plate XXX) are in contact with Morgan Creek limestone along the Schmidt fault. Further north limestone ledges in the Cap Mountain have a strike near the fault plane ranging from N 45° E to N 75° W and a below average dip of 5 degrees to the southwest.

Along the southern portion of the Simons fault there are few

Vertical beds of Hickory sandstone
in fault contact with Morgan Creek
limestone
(I - 30)

ledges in place on which the strike and dip can be determined. However, in a draw west of the Walter Schmidt ranch house and next to the fault on the downthrown side, beds of Ellenburger limestone strike N 70° E and dip 25 degrees to the northwest (Plate XXXI).

Much of the San Saba and Ellenburger in the fault zone has been brecciated. These breccias are often the only clues to the faulting where there has been little disturbance to strike and dip. This is especially true in the Ellenburger strata.

Further north along the Simons fault there is an elliptical-shaped block between pre-Cambrian granite and upper Cambrian rocks of Riley age. The presence of Hickory sandstone and Lion Mountain sandstone remnants in this block could mean that it was either dropped into an opening along the zone of movement, or that more faults are present within the block.

MINOR FAULTS

All major faults in the South Mason area have split, somewhere along their length, into fault slivers. Other minor faults are present as a lone fault in the west central portion of the area, and as a cross-fault in the northwest corner in the area.

The fault slivers range in strike from slightly west of north to northeast, while the other minor faults strike slightly west of north. Displacement along the faults is less than 100 feet. There is no uniformity as to the direction of throw. Four of the minor faults are downthrown to the east or southeast, while the remainder have their downthrown blocks in the opposite quadrants.

The recognition of these minor faults was, in some instances,

Steeply dipping Ellenburger
limestone along Simons fault
(I - 28)

very difficult. The abrupt termination of a single key bed, or the presence of brecciated material were sometimes the only indication of their presence in a specific area (Plate XXXII).

MOVEMENT ALONG FAULTS

There is no field evidence to indicate horizontal movement along the faults in the South Mason area. Vertical movement is inferred by the presence of the elliptical-shaped block, previously mentioned, along the Simons fault, and by the repetition and omission of strata northwest of the Mason fault and west of Avenue F.

If displacement along the faults had been in a horizontal direction the topography of the region would be very different. It is quite likely that the Llano uplift would not only be a structural high, but also a topographic high. Erosion would have removed the cover of Paleozoic rocks at the same rate over the entire area of the Central Mineral region. There would have been no accelerated disintegration of the uplifted blocks which are now topographically low.

DETECTION OF FAULTING

Mapping of the major faults in the South Mason area was preceded by a stereoscopic examination of the aerial photographs to locate alignments and offsets in the vegetational patterns (Plate XXXIII, Figure 1). Field observations were then made to verify or to amend the location of faults indicated by these patterns. Criteria applied in the field for the location of minor faults were the abrupt termination of key beds along their trend, the repetition and omission of

Brecciated material in
Ellenburger limestone
(I - 29)

Figure 1

Vegetation alignment along Mason fault

Figure 2

Vertical beds of hickory sandstone along Mason fault (I - 31) strata, and the abnormal strike and dip of strata (Plate XXXIII, Figure 2).

Although the faults are rather sharply defined and easily followed through the Upper Cambrian strata, their location in rocks of the Ellenburger group is rather difficult. Here vegetational alignments, if any, are faint and unreliable, and there is often no variation in the strike and dip of the beds. As stated on the previous page, the presence of narrow zones of brecciated material in line with a fault trend is the only evidence in some areas of movement along fractures.

AGE OF FAULTING

Faulting in the South Mason area occurred after deposition of the youngest sediments present there. Cloud and Barnes (1948) found faults involving the Smithwick shale and rocks of the Strawn group, and according to them (1948, p. 121), "in the western part of the Llano uplift, in the vicinity of Calf Creek, unfaulted beds of Canyon age overlap faulted beds of Ellenburger age. The major late Paleozoic faulting is thus indicated to have taken place before Canyon time."

CAUSE OF FAULTING

According to Cloud and Barnes (1948, pp. 118-119), "the rocks of the Llano uplift are thought to have comprised a relatively resistant mass, around the eastern and southern sides of which developed the geosynclinal area (Llanoria geosyncline of Sellards, 1933) containing the Ouachita facies. The faulting in the Llano region probably accompanied the late Paleozoic folding that involved the sediments of the Llanoria geosyncline, movement in the geosynclinal area to the east and to the south placing the Llano area under torque and causing it to fracture. The theoretical tensional couples developed by active compression from east and south would result in fractures aligned dominantly in the northeast quadrant, as faulting in the Llano region is."

These tensional couples could also have been responsible for the change in the regional strike of strata from an expected northwest-southeast trend in the southwest flank of the uplift to the present alignment in the northeast quadrant.

FOLDING

Preliminary observations between the South Mason area and the Llano River by Dr. H. R. Blank and the writer indicate that the south-eastward dipping beds of Hickory sandstone in the southeastern corner of the area may be part of the northwest flank of a gentle fold whose axis trends northeast-southwest. The dip of the beds becomes more gentle toward the Llano River; south of the river the Paleozoic strata begin to dip gently to the northwest.

Small folds are present in the Point Peak shale at the excellent outcrop (Plate XXXIV) located in the abandoned road metal ditch on the Alex Durst property. These folds are very tight and affect only a few feet of strata at the most. Cloud and Barnes (1948, p. 121) found similar folds, some of which extend upward into the San Saba member.

SUMMARY OF GEOLOGIC HISTORY

Pre-Cambrian History

The pre-Cambrian sediments of the Llano region appear to be of marine origin as indicated by the presence of limestones and sandstones. The presence of graphite in many of the crystalline rocks may represent metamorphosed carbonaceous material.

Extensive igneous intrusions, with attendant metamorphism, occurred subsequent to the induration of these sedimentary deposits. The coarse-grained texture of the granitic intrusions indicate deep-seated crystallization of the magma.

That these granite masses were intruded before deposition of the overlying Cambrian sediments is indicated by the fact that at no place, according to Sellards (1932, pp. 35-36), do the intrusives cut the younger rocks. Furthermore, pre-Cambrian disintegration and decay of the granite may be observed (Plate XXXVI, Figure 1) where the Cambrian rests directly upon the granite. The time of intrusion of the granitic magma, therefore, was after the formation of the sedimentary series but prior to the deposition of overlying Cambrian sediments.

Following the intrusion of the magma and the pronounced folding which developed as a result of batholithic intrusions, the region was subjected to extensive erosion. During this long period of denudation, marked by a great complexity of events, the uppermost rocks were removed, the folds were levelled off, and the granite was exposed. Upon these exposed granites and truncated folds, the Upper Cambrian sediments were deposited.

Paleozoic History

Following pre-Cambrian time and before Upper Cambrian time, the Llano area was a positive region where erosion had reduced the area to a rough surface having a maximum relief of about 800 feet (Bridge, Barnes, and Cloud, 1947, p. 113). This extended period of erosion lasted through Lower and Middle Cambrian times. Consequently, the first Paleozoic beds encountered are Upper Cambrian in age.

It is believed that during Paleozoic time the Llanoria land mass occupied a position south and east of the Llano uplift so that much of the Paleozoic rock of central Texas originated from this uplifted area (Sellards, 1932, p. 21). This great land mass, now covered by Cretaceous and post-Cretaceous sediments, contributed sediments to the Llanoria geosyncline which swings southwestward around the Llano uplift to unite with the Columbia geosyncline of northern Mexico.

Wells drilled near the inner margin of the Gulf Coastal Plain indicate that the Ouachita geosyncline extended southwestward into Texas; the sediments entered in this region are similar to the Paleozoic sediments found in the geosyncline in Arkansas and Oklahoma. Since shallow Paleozoic seas lay to the west, these sediments could have come only from the east or southeast, indicating a land mass in the coastal plain of Texas and Louisiana.

The first Paleozoic sea to invade central Texas, according to Cloud and Barnes (1948, p. 111), "reworked sands of eolian origin into the base of the Hickory sandstone member of the Riley formation, but whether a part of the Hickory actually represents eolian sedimentation is not known." An environment suitable for eolian deposition during early Hickory times is indicated further by the presence of ventifacts in the basal portion. Barnes and Parkinson (1940, p. 668) found dreikanters 4 feet above the base and pointed out that "this outcrop demonstrates that dreikanters continued to form after the deposition of Hickory was well under way, and that they were not all formed on the old pre-Cambrian surface and then incorporated in water-laid sediments."

Transgression of Paleozoic seas over the southwestern flank of the uplift before middle Hickory time is indicated by the presence of marine fossils in the middle and upper portions of the member in the South Mason area. Ripple marks near the top of the Hickory indicate a shallow water environment.

By middle Riley time the lands had been reduced greatly in elevation, and the Cap Mountain limestone member formed in a shallow and relatively cool sea. In late Riley and early Wilberns time the lands again supplied sediments to the regressive-transgressive sand zones comprising the Lion Mountain-Welge sequence. That the supply of sediments decreased upward in the members of the Wilberns formation is indicated in the Morgan Creek member by the granular, arenaceous limestones which grade upward into massive limestones. The great abundance of glauconite and marine fossils indicates deposition in a neritic environment. Warm shoal waters are suggested for at least part of this period of deposition by the presence in the member of stromatolitic bioherms.

During middle Wilberns time argillaceous material accumulated in the sea to form the Point Peak shale member. Sidney Paige (1912, p. 79) states that, "near the upper portion of the Wilberns thin alternating shale and limestone beds, numbers of shale-pebble conglomerates, ... suncracked surfaces and fragments, ... suggest the presence of wide-spread flats alternately flooded by the tide and dried by the sun." Eastward the shale is replaced by dolomitized and rather pure carbonate rocks, indicating that in that direction lay warm shoal waters barred from terrigenous sediments. Intermittent shoaling and warming of the water is also indicated by the presence of extensive stromatolitic bioherms in the upper portion of the Point Peak shale member. Sandy limestones and sandstones throughout the San Saba limestone member on the western flank of the uplift are indicative of a nearby land mass. The increasing proportion of limestone and dolomite eastward, as evidenced by the transformation of the San Saba limestone member to the Pedernales dolomite member eastward, indicates a general shoaling of the region in that direction. Marine conditions probably persisted to the west with sedimentation being continuous from Cambrian into Ordovician time.

During early Ordovician time the Llano region remained relatively stable. Limestones of the Ellenburger group were deposited in warm shoal waters deepening to the northwest. Cloud and Barnes (1948, p. 32) state that the limestones "are commonly although not generally stromatolitic, indicating an at least partial algal origin and generally a shallow water environment. Deposition in shallow waters is also indicated by ripple marks and intraformational breccias; and local, temporary sub-aerial exposure is suggested by the presence of contraction polygons in some of the more thinly-bedded limestones."

Lower Ordovician sedimentation was followed by a wide gap in the geologic record. General emergent conditions, accompanied by erosion, are suggested during Upper Ordovician and Silurian times since rocks of these periods are not present in the Llano region.

Probably the longest period of Paleozoic emergence of the Llano region occurred before Devonian time as the Ellenburger rocks were truncated. "This truncation," so state Cloud and Barnes (1948, p. 113), "was at a maximum in the western part of the uplift, whereas the oldest Devonian strata known are in the east and the youngest in the west. From these data one may provisionally infer that the region was tilted to the east and largely truncated before Devonian time, followed by an east to west Devonian marine invasion and continuing truncation of the emergent areas." Irregularities in the Devonian overlap and temporary withdrawal of the sea are suggested by the occurrence of Devonian rocks as pocket and crack-fillings below the Stribling formation.

"Rocks of Mississippian age, though locally discontinuous, are widespread in the Llano region and are much more persistant laterally than beds of known Devonian age." (Cloud and Barnes, 1948, pp. 42, 46). These beds show a definite thinning toward the Llano uplift, indicating eastward uplift during Mississippian time. This regional uplift probably began in Devonian or Silurian time.

According to Sellards (1934, pp. 22-23), early Pennsylvanian strata in central Texas are represented by the Bend group consisting of the Marble Falls and Smithwick formations. These sediments probably represent continuous deposition with, however, some shifting of depositional conditions.

Following deposition of the Bend group extensive diastrophism occurred in the foreland region of Texas. At this time the Llano region was re-elevated and severely eroded. This erosion is known to have removed the Smithwick formation allowing the Strawn to be deposited on the Marble Falls formation.

Mesozoic History

Pennsylvanian time was followed by widespread emergent conditions so that by Cretaceous time the Llano region was reduced to a surface of low relief. As the Cretaceous seas invaded the region horizontal beds of variable thickness were deposited throughout the area. In the Llano region these sediments were deposited on the truncated edges of the Paleozoic and pre-Cambrian rocks so that Cretaceous strata can rest on almost any older beds.

Cenozoic History

Following Cretaceous deposition a gentle doming and vertical uplift occurred in the area with no faulting or folding.

During Tertiary time the area was apparently above sea level since no Tertiary strata are present in the Llano region.

E C O N O M I C   G E O L O G Y

The most important resource in this semi-arid region of Texas is water. The Hickory sandstone is one of the most important aquifers in the State. Water wells drilled into the Hickory sandstone and spring water issuing from the Ellenburger limestone provide the principal sources of ground water in the South Mason area. Flowing artesian wells south of the area have provided a continuous supply of this vital natural resource even through periods of drouth when many of the springs in the area ceased to flow.

Oil production in the Mason area is very improbable. Cloud and Barnes (1948, p. 33) state that "petroleum will probably not be found by drilling in the Llano region because of the complex faulting of the potential source beds and their present exposure to the atmosphere."

Pre-Cambrian granite from the South Mason area is used for road metal. Some of the resistant sandstone in the upper portion of the Hickory has also been used locally as building stone. Many of the early settlers, in clearing land for cultivation, used limestone and sandstone float to build fences; most of these fences are still being used.

According to Cloud and Barnes (1948, p. 127, 129) rocks of the Ellenburger formations can be used for crushed stone suitable for railroad ballast, road metal, and concrete aggregate. However, since Mason is not serviced by a railroad, transportation difficulties have prevented utilization of Ellenburger rocks in the South Mason area for such purposes.

REFERENCES CITED

Barnes, V. E. (1940) Pre-Cambrian of the Llano region with emphasis on tectonics and intrusives, Excursions 53d annual meeting of the Geol. Soc. Am. and affiliated societies, December 26-28, 1940, pp. 44-49.

__________ (1944) Gypsum in the Edwards limestone of central Texas, Univ. Texas Pub. 4301, pp. 35-46.

__________, and Parkinson, G. A. (1939) Dreikanters from the basal Hickory sandstone of central Texas, Univ. Texas Bull. 3945, pp. 665-670.

Blank, H. R. (1951) Exfoliation and weathering on granite domes in central Texas, Texas Jour. Sci., Vol. 3, no. 3, pp. 376-390.

__________ (1951) "Rock doughnuts," a product of granite weathering, Am. Jour. Sci., Vol. 249, pp. 822-829.

Bridge, Josiah (1937) The correlation of the Upper Cambrian sections of Missouri and Texas with the section in the upper Mississippi Valley, U. S. Geol. Survey Prof. Paper 186-L, pp. 233-237.

__________, and Girty, G. H. (1937) A redescription of Ferdinand Roemer's Paleozoic types from Texas, U. S. Geol. Survey Prof. Paper 186-M, pp. 239-271.

__________, and Barnes, V. E. (1941) Stratigraphy of the Upper Cambrian, Llano uplift, Texas (abst.), Geol. Soc. Am., Bull., Vol. 52, p. 1996.

__________, __________, and Cloud, P. E., Jr. (1947) Stratigraphy of the Upper Cambrian, Llano uplift, Texas, Geol. Soc. Am. Bull., Vol. 58, pp. 109-124.

Buckley, S. B. (1874) First Annual Report of the Geological and Agricultural Survey of Texas, Houston.

Cloud, P. E., Jr., Barnes, V. E., and Bridge, Josiah (1945) Stratigraphy of the Ellenburger group of central Texas--a progress report, Univ. Texas Pub. 4301, pp. 133-161.

__________, and Barnes, V. E. (1948) The Ellenburger group of central Texas, Univ. Texas Pub. 4621, 473 pp., 8 figs., 45 plates.

Comstock, T. B. (1890) A preliminary report on the geology of the Central Mineral region of Texas, Texas Geol. Survey, 1st Ann. Rept. (1889), pp. 235-391.

__________ (1891) Report on the geology and mineral resources of the Central Mineral region of Texas, Texas Geol. Survey, 2d Ann. Rept. (1890), pp. 553-664.

Cuyler, R. H. (1931) Vegetation as an indicator of geologic formations, Am. Assoc. Petr. Geol., Bull., Vol. 15, pp. 67-78.

Dake, C. L., and Bridge, J. (1932) Faunal correlations of the Ellenburger limestone of Texas, Geol. Soc. Am., Bull., Vol. 43, pp. 725-748.

Darton, N. H., Stephenson, L. W., and Gardner, Julia (1937) Geologic map of Texas, U. S. Geol. Survey.

Deen, A. H. (1931) Cambrian algal reefs of Texas (abst.), Geol. Soc. Am., Bull., Vol. 42, p. 368.

Dumble, E. T. (1890) Report of the State Geologist for 1889, Texas Geol. Survey, 1st Ann. Rept. 1889, pp. xvii-lxxv, map.

____________ (1891) Report of the State Geologist for 1890, Texas Geol. Survey, 2d Ann. Rept. 1890, p. xv.

____________ (1898) Physical geography, geology, and resources of Texas, in Wooten, D. G., A comprehensive history of Texas, Vol. 2, pp. 471-516, Dallas, Texas, William G. Scarff, 1898.

Hill, R. T. (1887) The present condition of knowledge of the geology of Texas, U. S. Geol. Survey, Bull., Vol. 45, 95 pp.

____________ (1889) A portion of the geologic story of the Colorado River of Texas, Am. Geol., Vol. 3, pp. 287-299.

____________ (1890) Classification and origin of the chief geographic features of the Texas region, Am. Geol., Vol. 5, pp. 9-29, 68-80.

____________ (1901) Geography and geology of the Black and Grand prairies, Texas, U. S. Geol. Survey, Ann. Rept. 21, pt. 7, pp. 1-666.

Jones, R. A. (1929) The Paleozoic of the Pedernales Valley in Gillespie and Blanco counties, Texas, Univ. Texas Bull. 2901, pp. 95-130.

Keppel, D. (1940) Concentric patterns in the granites of the Llano-Burnet region, Texas, Geol. Soc. Am., Bull., Vol. 51, no. 7, pp. 971-999.

Paige, Sidney (1911) Mineral resources of the Llano-Burnet region, Texas, with an account of the pre-Cambrian geology, U. S. Geol. Survey, Bull., Vol. 450, 103 pp., 22 figs., 5 plates, maps.

____________ (1912) Description of the Llano and Burnet quadrangles, U. S. Geol. Survey, Geol. Atlas, Llano-Burnet folio No. 183, 16 pp.

Plummer, F. B. (1939) Springs and spring deposits of Llano uplift area in central Texas (abst.), Geol. Soc. Am., Bull., Vol. 50, p. 1927.

Plummer, F. B. (1940) Paleozoic of the Llano region, Excursions 53d annual meeting of the Geol. Soc. Am. and affiliated societies, December 26-28, 1940, pp. 56-65.

__________ (1943) A new quartz sand horizon in the Cambrian of Mason County, Texas, Univ. Texas, Bur. Econ. Geol., Min. res., Cir. 22.

__________ (1944) Origin of the travertine deposits of the Llano region (abst.), Texas Acad. Sci., Proc. and Trans. 1943, Vol. 27, p. 140.

__________ (1945) Formation of travertine from spring water in central Texas (abst.), Geol. Soc. Am., Bull., Vol. 56, p. 1191.

__________ (1946) Texas water resources, Univ. Texas Bull. 4301, pp. 301-312.

__________ (1950) The Carboniferous rocks of the Llano region of central Texas, Univ. Texas Bull. 4329, 117 pp., 14 figs., 22 plates, 4 charts.

Roemer, Ferdinand (1846) A sketch of the geology of Texas, Am. Jour. Sci. (2), Vol. 2, pp. 358-365.

__________ (1848) Contributions to the geology of Texas, Am. Jour. Sci. (2), Vol. 6, pp. 21-28.

__________ (1849) Texas, mit besonderer Rucksicht auf deutsche Auswanderung und die physischen Verhaltnisse des Landes, 464 pp., Bonn.

__________ (1935) Texas, with particular reference to German immigration and the physical appearance of the country (Translation by Oswald Mueller), 301 pp., Standard Printing Company, San Antonio, Texas.

__________ (1852) Die Kreidelbildungen von Texas und ihre organischen Einschlusse, 110 pp., 11 plates, Bonn, Adolph Marcus.

Sellards, E. H. (1932) The pre-Paleozoic and Paleozoic systems in Texas, in The Geology of Texas, Vol. I, Stratigraphy, Univ. Texas Bull. 3232, pp. 15-238.

__________ (1934) Major structural features of Texas east of Pecos River, Univ. Texas Bull. 3401, pp. 11-136.

Shumard, B. F. (1859) Trans. Acad. Sci., St. Louis, Vol. I, No. 4, 1860, p. 672.

__________ (1861) The Primordial Zone of Texas, with descriptions of new fossils, Am. Jour. Sci., (2), Vol. 32, No. 95, pp. 213-221.

Shumard, G. G. (1886) A partial report on the geology of western Texas, 145 pp., State Printing Office, Austin, Texas.

Stenzel, H. B. (1932) Pre-Cambrian of the Llano Uplift, Texas, Geol. Soc. Am., Bull., Vol. 43, pp. 143-144.

______________ (1934) Pre-Cambrian structural conditions in the Llano region, Texas, Univ. Texas Bull. 3401, pp. 74-79.

______________ (1935) Pre-Cambrian unconformities in the Llano region, Univ. Texas Bull. 3501, p. 115f.

Tarr, R. S. (1890) Origin of some topographic features of central Texas, Am. Jour. Sci. (3), Vol. 39, no. 232, art. 39, pp. 306-311.

______________ (1890) Superimposition of the drainage in central Texas, Am. Jour. Sci. (3), no. 239, art. 40, 45 pp. 359-362. (Nov. 1890) (3d ser, v.40)

Udden, J. A., Baker, C. L., and Böse, Emil (1916) Review of the geology of Texas, Univ. Texas Pub. 44, 164 pp.

Walcott, C. D. (1884) Notes on Paleozoic rocks of central Texas, Am. Jour. Sci. (3), Vol. 28, pp. 431-433.

A P P E N D I X

Section of the Riley and Wilberns formations beginning in the upper Hickory on the Alex Durst ranch at the northwest corner of the cultivated field about 1000 feet N 45° E of the H. F. Kothmann ranch house. The section continues in a general S 20° E direction to the San Saba-Ellenburger contact on the Dorothy Kothmann property (A-A' on Plate I).

	Thickness of Interval Feet
Riley formation:	
Hickory sandstone member:	
Cultivated field, red soil........................	115.0
Cap Mountain limestone member:	
1. Sandstone, calcareous, medium- to coarse-grained, dark reddish-brown to brown; contains rounded, equigranular quartz grains which are coated with reddish-brown iron oxide, probably hematite. Lowermost portion spotted by earthy, reddish-brown grains of hematite which have formed by the oxidation of glauconite pellets. Fragments of brachiopod shells are scattered through the lower portion; thin- to medium-bedded, weathers to moderately indurated ledges which have a dull brown to reddish-brown color.........	43.9

	Feet
2. Limestone, arenaceous, fine- to medium-grained, light brown to dark grayish-brown; nonfossiliferous; small hematite pellets in lower portion gradually diminishing to insignificant amounts. Fine-grained, tan to yellow-brown sand is present as streaks and cavity fillings. Weathered surface musty gray and rough due to small scale, irregular depressions separated by resistant ridges held up in relief by sand grains......................	79.4
3. Limestone, brown, medium-grained crystalline, arenaceous in lower portion resulting in a thinly laminated appearance. This unit is glauconitic and essentially nonfossiliferous. Irregular iron oxide stain present throughout--except in lower 8 inch bed--may represent altered glauconite. Brownish-gray in middle portion with minor amounts of brown sand as thin stringers; brown lime in upper portion. Medium-bedded, weathers to brown to brownish-gray ledges about 3 inches thick with hard smooth surfaces. Ledges are separated by an interval of soil..............................	13.2

	Feet
4. Limestone, white to gray, coarse-grained crystalline, glauconitic, fossiliferous, moderately indurated, weathering to occasional gray, thin, smooth surfaced ledges which are separated by several feet of soil. Near the top two 3 inch ledges of greenish-brown, very fossiliferous limestone are separated by an interval of greenish-gry, medium-grained, nonfossiliferous limestone.........	47.4
Total measured thickness of Cap Mountain limestone member................	183.9
Lion Mountain sandstone member:	
5. Limestone, arenaceous, brown to green, medium- to coarse-grained, thin- to medium-bedded where ledges resist erosion. Lower portion forms a gentle, sparsely vegetated dip slope with no outcrops. This is overlain by a brown limestone interbedded with green, fine-grained, arenaceous limestone exposed as ledges in the creek bed. The arenaceous limestone weathers out to soil elsewhere................................	74.6

Feet

6. Limestone, greenish-gray, containing one thin ledge of trilobite hash. Fragments of this highly fossiliferous limestone are scattered on the surface as float.................................... 14.7

7. Sandstone, weathered slope, no outcrops; covered with float from overlying Welge sandstone, probably arenaceous near contact. Surface covered with flat boulders of Welge sandstone and black hematite pebbles; soil sparkles due to presence of recomposed quartz grains........ 17.2

Total measured thickness of Lion Mountain sandstone member................. 106.5

Wilberns formation:

Welge sandstone member:

8. Sandstone, multi-colored from greenish-black to reddish-brown to yellow brown to tan. The texture is medium-grained; bedding indistinct; noncalcareous except near the upper boundary, nonglauconitic, contains a minor amount of phosphatic brachiopod fragments. Dark greenish-black fragments are present as float in the lower Welge and on the underlying Lion Mountain limestone. Flat boulders

Feet

of sandstone with very rough surfaces contain an abundance of iron oxide as cementing material. Iron oxide is also present as thin streaks and as a thin coating on the surface. Recomposed quartz grains impart a sparkle to the soil and to the sandstone fragments; reddish-brown to brown soil. Near the upper border the Welge is fine- to coarse-grained and calcareous, weathering to rough, tan or mottled surfaces. As a unit the Welge weathers to a gentle scarp slope with few good exposures......... 29.6

Total measured thickness of Welge sandstone.............................. 29.6

Morgan Creek limestone member:

9. Limestone, tan with green to purple tinge, granular, arenaceous; nonfossiliferous, contains green glauconite pellets and coarse, rounded quartz grains; friable. The weathered surface is grayish-green with the quartz grains weathered out in relief. The ledges crumble easily along exposed edges. Upper portion slightly fossiliferous and only slightly arenaceous.. 28.4

Feet

10. Limestone, greenish-gray, medium-grained and slightly granular; abundantly glauconitic, nonfossiliferous, only moderately resistant to erosion. Weathers to discontinuous, smooth-surfaced ledges............................ 7.1

11. Limestone, greenish-gray to reddish-brown, medium to coarsely crystalline; abundantly glauconitic, fossiliferous containing crinoid stem fragments, trilobite shells and other fossil shells. Weathers to moderately resistant ledges............................. 7.8

12. Limestone, gray, fine-grained crystalline, well indurated; fossiliferous containing crinoids, gastropods, brachiopods and others, also glauconitic. Distinct bedding, weathering to gray ledges. In the upper portion the limestone takes on a green tinge due to the abundance of glauconite. Here it becomes granular and more fossiliferous with an abundance of trilobites................................ 16.3

13. Limestone, greenish-gray, coarsely crystalline to granular, richly glauconitic, partly altered to reddish-brown hematite

Feet

stain. Abundantly fossiliferous containing, primarily, Eoorthis texana. In some ledges the brachiopods are weathered out in relief. This moderately resistant unit forms medium-bedded, inconsistant ledges.......... 13.5

14. Limestone, light gray, coarsely crystalline, moderately resistant, poorly bedded; very fossiliferous containing brachiopods and trilobites; slightly glauconitic. Weathers to inconsistant ledges............ 5.2

15. Limestone, green, medium to coarsely crystalline, poorly bedded; abundantly glauconitic and only slightly fossiliferous in lower portion, becoming less glauconitic and more fossiliferous in upper portion. Contains recrystallized calcite. The weathered intervals between the inconsistant limestone ledges possibly shale or friable arenaceous limestone............... 10.2

16. Limestone, light greenish-gray to brown, coarsely crystalline, well indurated, well bedded and broken into large blocks; variable amount of glauconite,

Feet

slightly fossiliferous in lower greenish-gray ledge. Above this is a very fossiliferous horizon containing brachiopods, gastropods, trilobites, and crinoid stems. The crinoid stem fragments appear in cross section as scattered colonies on the weathered surface.................... 3.3

17. Limestone, greenish-brown, medium-grained, arenaceous containing fine angular quartz grains; abundantly glauconitic, nonfossiliferous, occurring as one resistant ledge.............. 0.3

18. Limestone, yellowish-brown, coarsely crystalline, medium-bedded, moderately resistant to erosion. Contains glauconite partially altered to iron oxide, thus giving the rock a spotted appearance. Also contains coarse, green calcite crystals; slightly arenaceous and fossiliferous. Weathered surfaces greenish-gray and rough. Upper portion weathers to a gentle slope where thin shale layers separate the limestone ledges............... 4.2

19. Limestone, dark greenish-gray, weathering to gray, scattered yellowish-brown

Feet

limonite stains; well bedded but covered by talus; coarse-grained, abundantly glauconitic, slightly fossiliferous, well indurated.............. 0.3

20. Limestone, yellowish-brown to greenish-brown, medium- to coarse-grained, thin-bedded at base to thick-bedded at the top, moderately indurated, abundantly glauconitic with concentrated pellets occurring as thin bands. Weathers to greenish-brown consistant ledges. Those ledges near the top show false cross-bedding which could result from compaction during deposition. A narrow zone at the top of this unit is composed of dull brown, lithographic, slightly argillaceous limestone coated in places with fine, white gypsum crystals..... 7.5

21. Limestone, dark greenish-gray, medium-grained, glauconitic throughout, stained brown with iron oxide which is concentrated in a 3 inch layer near the top where the weathered surface has a brown color; elsewhere weathered surface is greenish-gray;

Feet

slightly fossiliferous. Grassy slope between ledges probably weathered shale. Grass covered slope 2.6 feet thick in upper portion capped by a 4 inch thick ledge of dark greenish-gray, medium-grained limestone stained brown with iron oxide................................ 10.0

22. Limestone, tan to greenish-gray, medium- to coarse-grained, medium-bedded at base and top, center portion principally small isolated remnants of former ledges. Glauconite content variable, becoming very abundant in places. Fossiliferous with an abundance of crinoid stems and small gastropod shells in the lower 3.5 feet, decreasing upward. Small isolated area of cabbage head reef, composed of gray, hard, lithographic limestone, exposed on the lower slope but was not found elsewhere along the strike. The limestone in this unit is interbedded with gray shale which has weathered out to form gentle grass covered slopes............................ 31.8

	Feet
Total measured thickness of Morgan Creek limestone member....................	145.9

Point Peak shale member:

		Feet
23.	Shale, forming a flat, sparsely vegetated bench weathered from thinly bedded, greenish-gray siltstone interbedded with shale. The siltstone is calcareous, nonglauconitic and nonfossiliferous..................................	13.8
24.	Intraformational conglomerate composed of flat, yellow green to tan, sublithographic limestone pebbles embedded in medium-grained, greenish-gray to reddish-gray limestone. These pebbles are about 4 inches in greatest dimension, with an average of 2 inches................................	3.6
25.	Shale, same as 23.............................	9.2
26.	Limestone, gray, hard, lithographic, occurring as scattered individual reef colonies about 4 feet from border to border..........................	7.6
27.	Shale, same as 23.............................	19.2
28.	Limestone, interbedded with shale, outcrops rare except near the top where thin to thick bedded ledges are	

Feet

present. The limestone is gray to brownish-gray, very fine-grained to granular, slightly fossiliferous, nonglauconitic; contains minor amounts of small, flat limestone pebbles. Shale weathered to talus covered slopes..... 72.3

29. Stromatolitic bioherm, gray, microgranular to sublithographic, very hard, massive. The weathered surface is gray to **black** with a rough, reticulated pattern. Cabbage head structure is scattered in this area. Some weathered boulders are circular in outline while others are flat-surfaced, irregular blocks which are discontinuous laterally. Thinly bedded, yellowish-brown to gray, fine- to medium-grained limestone occurs interbedded with the reef. This lime is nonfossiliferous and nonglauconitic, hard, fairly evenly bedded though discontinuous laterally, and weathers out to form thin slabs which are distributed on the surface as float.............. 130.0

Total measured thickness of Point Peak shale member....................... 255.7

Feet

San Saba limestone member:

30. Limestone, poorly exposed with few distinct ledges; broken up by weathering into large blocks and small fragments; for the most part gray, greenish-gray, brown and yellowish-brown weathered fragments; soil brownish-yellow; micro-granular to coarsely crystalline, moderately hard, glauconitic; fossiliferous throughout, containing trilobites, brachiopods, and gastropods..............................175.0

Total measured thickness of section.......1011.6

Section of the San Saba limestone occurring as a bluff on the west bank of Honey Creek in Mason County, Texas. Section begins one mile downstream from the Irvin Geistweidt ranch house on the old Junction road west of Mason (Plate III-1).

	Thickness of Interval Feet
Wilberns formation:	
Point Peak bioherm reef (Plate XX, Fig. 2):	
San Saba limestone member:	
1. Limestone, yellow brown to brown, weathered grayish-tan, bedded in ledges varying in thickness from 2 feet at the base to 3 inches in the upper portion. Coarsely crystalline to granular depending on the fossil content, becomes heavily fossiliferous in some layers. Weathers to thin slabs with rough surfaces, forming a gentle slope......................	7.3
2. Limestone, white to light tan, weathers grayish-black; coarsely crystalline and somewhat granular near the base, thin- to thick-bedded, ledge forming; abundantly fossiliferous, glauconite present in monor amounts throughout, more concentrated in narrow stringers.	

		Feet
	Grades upward into medium-grained limestone interbedded with brown, arenaceous lenses which weather to thin, nodular layers. As the limestone layers become arenaceous downdip they become thin-bedded....................	4.2
3.	Covered by talus..............................	1.0
4.	Limestone, buff colored, weathers to dull grayish-black ledges. Medium-grained, slightly fossiliferous, contains scattered glauconite pellets; very well indurated.........................	3.0
5.	Limestone, green, weathered dull tan, medium-grained, glauconitic. Occurs as thin layers about 3/4 inch thick separated by tan, fine grained, friable sand...............................	0.4
6.	Limestone, light gray, weathered light tan, coarse-grained, slightly fossiliferous, contains thin stringers of tan, glauconitic, calcareous sand................	0.6
7.	Limestone, gray, medium-grained, occurring as thin unevenly bedded layers varying in thickness from 1/4 inch to one inch. Interbedded with tan, fine-grained, friable, glauconitic,	

	Feet
calcareous sand............................	0.6
8. Limestone, reddish-gray near the base to light gray in the upper part, weathered tan. Coarsely crystalline, fossiliferous, glauconitic; contains tan, fine-grained, glauconitic sand; weathers to ledges which range in thickness from 3 inches to one foot. Contains minor amounts of recrystallized calcite; weathered surface rough, somewhat nodular due to presence of sand; generally well bedded.........	1.6
9. Limestone, brown, fine-grained, hard, occurring as thin stringers up to one inch thick separated by green, compact, medium-grained, glauconitic and calcareous sand.........................	0.5
10. Limestone, light gray weathered tan, to yellowish-brown weathered dull brownish-black. Coarse-grained, fossiliferous, hard, well bedded in two 3 inch layers......	0.5
11. Limestone, predominantly yellow brown, weathered brown to grayish-black. Contains varying amounts of sand as medium-grained, angular to sub-angular quartz grains; glauconite is present	

	Feet
in varying amounts. The bedding varies laterally with the composition, becoming more massive as the beds become more calcareous. The lower calcareous bed grades laterally into a black, coarse-grained to granular limestone which has a speckled appearance due to the presence of fine white fragments of phosphate. Arenaceous limestone layers tend to weather out to thin slabs which grade laterally into thick-bedded brown limestone ledges. The beds vary in thickness from 1/4 inch in the arenaceous limestone to 3.5 feet in the pure limestone beds.........	5.5
12. Sandstone, calcareous, tan, weathered brownish-black; compact, fine-grained, massive; contains thin stringers of dark brown glauconite......................	1.3
13. Limestone, buff-colored, fine to coarsely crystalline, sparingly fossiliferous with minor amount of glauconite. Three inch layer of intraformational conglomerate near the center of the unit is composed of flat limestone pebbles. Porous texture due to cavities many	

Feet

of which are lined with iron oxide. Upper portion coarsely crystalline limestone which grades laterally into cross-bedded pockets of tan, arenaceous limestone. The top 1.5 feet of coarse-grained, cross-bedded, friable, arenaceous lime weathers to rough surfaces....... 5.5

14. Limestone, color varies from tan to gray to brown, predominantly coarsely crystalline but varying to sublithographic in upper portion, thin- to thick-bedded with individual layers varying from one inch to 2 feet in thickness. Sand and glauconite are present in greater or less amounts producing lateral variations in bedding and weathering (Plate XXVI). Fossiliferous with some fossils weathering out in relief. Thin layers of silty material separate thin limestone beds in the lower 3 feet............. 19.0

15. Limestone, yellowish-brown, finely crystalline, thin-bedded; individual beds are separated by friable, buff colored, calcareous sand containing glauconite. The variable thickness is probably due to deposition on an

	Feet
uneven surface..............................	0.5
16. Limestone, yellow brown and coarsely crystalline at the base to grayish-brown and finely crystalline near the top. Fossiliferous throughout with abundant brachiopods and gastropods, essentially non-glauconitic, colorless, recrystallized calcite present in minor amounts. Weathers to ledges which vary in thickness in a direction perpendicular to the strike........................	5.1
17. Limestone, brown, fine- to medium-grained, thin-bedded in tabular layers varying in thickness from 1/2 inch to 2 inches. The thickness of individual beds varies in a direction normal to the strike.........	0.6
18. Limestone, varying in color from reddish-brown near the base to tan to green to brownish-yellow near the top; weathered dull gray to brown. The texture varies from coarsely crystalline to fine to granular. Massive but weathering to give a thin-bedded appearance. Scattered layers are highly fossiliferous, variable quantities of glauconite. Fossils are weathered out in relief on the surface......	19.4

	Feet
19. Limestone, yellow brown, coarsely crystalline, highly fossiliferous in restricted layers, less so elsewhere, essentially nonglauconitic. Ledges from one inch to one foot thick contain thin arenaceous layers which grade to limestone downdip.....	8.7
20. Limestone, dark grayish-green, weathered buff to dull gray, crystalline, fine-grained, occurring as ledges which vary in thickness from 1/4 inch to 1.5 feet. Sparingly glauconitic, nonfossiliferous; contains thin layers of edgewise conglomerate which weather to resistant ledges about 6 inches thick. Thin layers of knobby limestone 1/8 inch to 1/2 inch thick interbedded with fine-grained, calcareous sand to form a zone about 6 inches thick between 8 inch limestone layers. Thin layers of friable, fine-grained, buff-colored, calcareous sand are present throughout. The limestone is compact, hard and highly fractured with parallel breaks trending roughly N 30° E..................................	45.3

Feet

21. Fault, displacement unknown, downthrown on south side or downstream.

22. Limestone, dark gray to greenish-gray, weathered musty gray to buff, predominantly sublithographic, some crystalline and fine grained. The lower 4 inch bed is limestone conglomerate containing flat limestone pebbles of variable size up to 2 inches in greatest dimension embedded in coarse grained matrix spotted with limonite stain. Lower 2 feet medium-bedded, ledge forming lime. Coarse-grained limestone conglomerate at the top is underlain by thinly bedded limestone ledges varying in thickness from 1/4 inch to 18 inches.................. 20.2

Total thickness measured.................. 150.8

Ellenburger limestone:

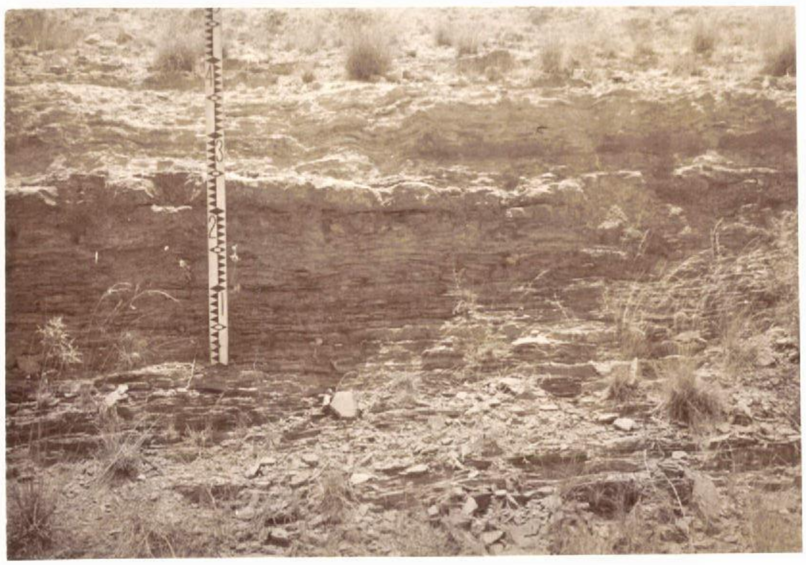
Section within the Point Peak shale. This exposure is found as the south bank of an abandoned road ditch at the base of the steep scarp slope N 45° W of the Walter Zesch residence on the Alex Durst ranch (Plate I, D-D').

Thickness of Interval
Feet

Wilberns formation:

Point Peak shale member:

1. Limestone reef, dark purple-gray, sublithographic limestone containing iron oxide inclusions. Isolated, circular remnants are present in the bed of the ditch..........................
2. Shale (Plate XXXIV), green to grayish-green probably due to the great abundance of fine-grained glauconite; calcareous, laminated to thin-bedded in layers which range in thickness from a fraction of an inch to one inch. The siltstone is very hard and brittle in the lower portion becoming slightly friable higher in the section. Small scale folding possibly a result of the tectonic movements associated with the faulting in this area. The siltstone is interbedded with a resistant ledge



Point Peak shale
(I - 22)

	Feet
forming intraformational conglomerate; the individual layers vary in thickness from 3 inches to 8 inches. The conglomerate is composed of flat, yellowish-brown pebbles as large as 5 inches in greatest dimension embedded in a brown, fine- to medium-grained crystalline limestone. Numerous thin-bedded, grayish-green, finely crystalline, hard limestone layers are also present in the outcrop. Worm trails are abundant on the bedding planes of the siltstone......	26.4
3. Caliche and thinly bedded intraformational conglomerate forms the slope of the hill above the ditch. The conglomerate is present as occasional boulders except near the top where ledges are fairly well preserved.......................	47.9
Total thickness measured.................	74.3

Section within the Welge sandstone (Plate XXXV, Figure 2) measured in a stream-cut bluff on the Walter Schmidt ranch south of Mason. The exposure is located 1.6 miles south on Farm Road 1723 from its junction with U. S. Highway 87 at the Mason County Fairgrounds, then 0.78 mile west of Farm Road 1723 (Plate I - 13).

	Thickness of Interval Feet
Wilberns formation:	
Welge sandstone member:	
1. Sandstone, reddish-brown, weathered brown, medium- to coarse-grained composed of subangular to subrounded quartz grains cemented with iron oxide; moderately indurated, weathering to resistant, massive to thickly bedded ledges with rough surfaces due to the unequal concentration of cementing material; cliff forming at this locality. One layer owes its resistance to erosion to the presence of silica as the cementing material. Two layers of yellowish-brown, friable, argillaceous sandstone are present near the base..................	20.0
2. Sandstone, yellowish-brown, medium-grained, friable, slightly cross-bedded; rough honeycombed surface;	

Figure 1

Cross-bedded sandstone near base of Welge

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Figure 2

Cliff forming Welge sandstone (I - 13)

		Feet
	contains a few scattered fossils; weathers to resistant ledges........................	3.7
3.	Sandstone, calcareous, light brown, coarse-grained, well indurated; contains inclusions of dark reddish-brown iron oxide, possibly hematite................	0.3
4.	Sandstone, dark brown, coarse-grained, containing angular to subrounded quartz grains, slightly friable; slightly fossiliferous, ledge forming, weathering to rounded boulders.........	0.5
5.	Sandstone, tan, coarse-grained, calcareous, moderately indurated, green and yellowish-brown iron oxide stain........	0.4
6.	Sandstone, same as 4.........................	1.1
	Total thickness measured....................	26.0

Morgan Creek limestone member:

Section of Cap Mountain limestone measured on the H. F. Kothmann ranch. Section begins approximately 1870 yards N 83° W of the ranch house and proceeds in a general S 20° E direction (Plate III - 2).

	Thickness of Interval Feet
Riley formation:	
Hickory sandstone member:	
Cap Mountain limestone member:	
1. Sandstone, calcareous, dark reddish-brown, medium- to coarse-grained, slightly fossiliferous, consisting of rounded quartz grains stained with iron oxide and cemented with iron oxide and calcium carbonate. The quartz grains weather out in relief. This unit is poorly bedded. In the lower zone there is a lateral gradation to a gray arenaceous limestone, fine-grained, well indurated, nonfossiliferous and nonglauconitic...........	32.6
2. Limestone, brown, crystalline and medium-grained, moderately fossiliferous, weathers to unevenly bedded ledges. The boundary between the sandstone and the limestone is sharp and distinct.....	28.6

Feet

3. Limestone, brown, dense, medium- to coarse-grained; fossiliferous, evenly bedded in layers up to one foot in thickness. The weathered surface is brown and smooth....... 9.2

4. Limestone, arenaceous, yellowish-brown, fine-grained with brown, fossiliferous nonglauconitic limestone. The dense arenaceous limestone weathers to thick-bedded ledges up to two feet in thickness which have rough honeycombed surfaces (Plate XIV, Figure 2). The limestone layers are thin- to medium-bedded; iron oxide weathers out on the surface to narrow bands and dark brown patches. Occasional thin layers of brown, coarsely crystalline, slightly fossiliferous, glauconitic limestone are also present; grades laterally to arenaceous limestone. This unit forms the top of a north facing scarp slope (Plate XV, Fig. 2).................................... 109.3

5. Limestone, greenish-gray, coarsely crystalline; glauconitic, moderately fossiliferous, contains large trilobites; moderately hard, unevenly bedded. Scattered thin ledges crop

		Feet
	out on the dip slope......................	9.0
6.	Limestone, light gray, crystalline, medium-grained, dense; contains scattered glauconite grains, stained brown in arenaceous portions with iron oxide; nonfossiliferous; some recrystallized calcite is present as cavity fillings. Weathers to fractured ledges having flat, fairly smooth surfaces....................................	13.3
7.	Limestone, same as 5.........................	21.6
8.	Limestone, greenish-brown, crystalline, fine-grained, slightly fossiliferous with thin shelled fauna; moderately glauconitic; dark purple streaks in this unit, poorly bedded, broken into blocks. Weathered surface green, rough, and pitted.........................	1.5
9.	Limestone, gray, crystalline, medium-grained, glauconite concentrated in thin layers, slightly fossiliferous, dense, poorly bedded......................	1.1
10.	Limestone, light brown, coarsely crystalline, abundantly fossiliferous, glauconitic, poorly bedded; weathered surface grayish-brown and granular,	

	Feet
friable....................................	5.1
11. Limestone, arenaceous, tan, fine-grained, some brown iron oxide stain, poorly bedded....................................	4.4
Total thickness measured..................	235.7

Lion Mountain sandstone member:

Description of basal Hickory sandstone at pre-Cambrian contact (Plate XXXVI, Fig. 1) on Walter Schmidt ranch, north of ranch house along south bank of creek, 425 feet east of creek crossing on James River road, 0.7 mile from junction of James River road with Farm Road 1723, 1.9 miles from junction of Farm Road 1723 with U. S. Highway 87 opposite Mason County Fairgrounds, southeast of Mason.

Riley formation:

Hickory sandstone member:

1. Sandstone, white to yellowish-brown weathering to grayish-brown; weathered surface very rough to honeycombed (Plate XXXVI, Fig. 2); massive, very coarse-grained; grains subangular to rounded, maximum dimension about 0.6 inch, average about 0.2 inch; larger grains and small scale sandstone dikes as fracture fillings stand out in relief on weathered surfaces ventifacts (Plate X), 1/2 inch to 2 inches in maximum dimension, found scattered on the weathered outcrop.

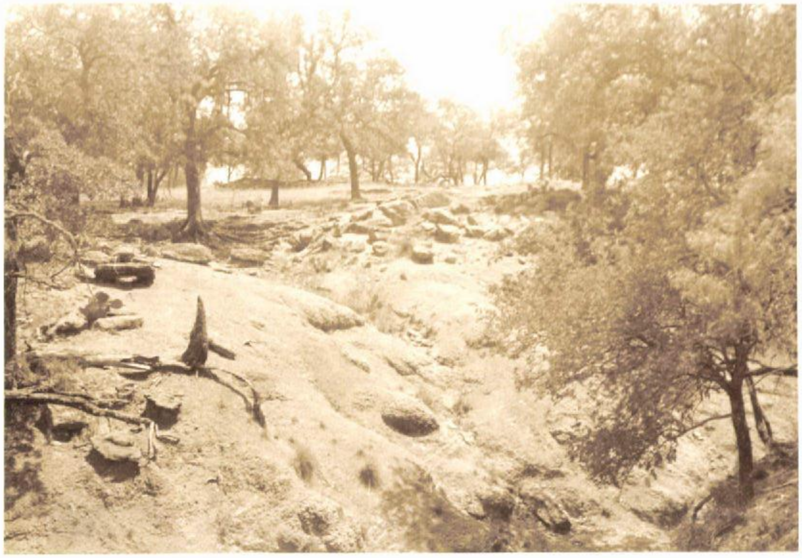


Figure 1

Pre-Cambrain granite-Hickory sandstone contact

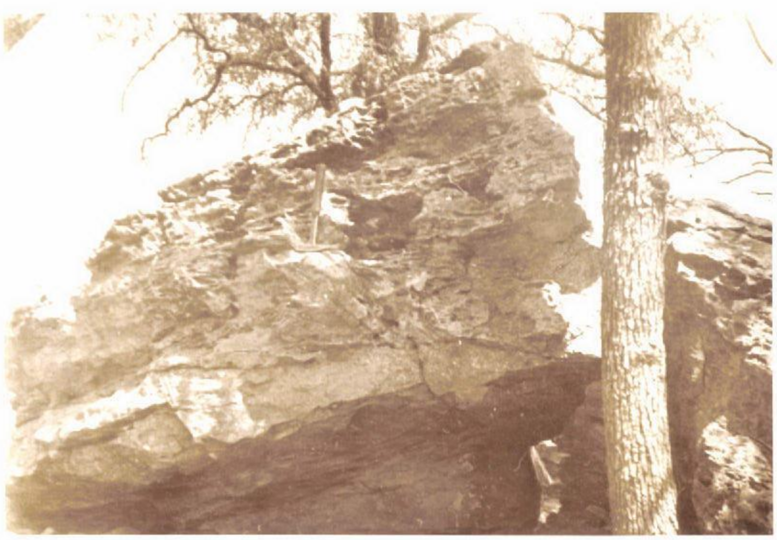


Figure 2

Hickory sandstone remnant at contact
with pre-Cambrain granite
(I - 2)

Section measured within lower Hickory sandstone beginning in creek bed at base of earthen tank dam west of the Alvin Zesch ranch house. Sections extends in a S 55° E direction to the gradual slope at the top of the vertical bluff (Plate XXXVII, Fig. 1) forming the south bank of the creek (Plate I, E-E').

	Thickness of Interval Feet
Riley formation:	
Hickory sandstone member:	
1. Sandstone, occurring in vertical stream-cut bluff, brown to very light tan, almost white, medium-grained in general but containing inconsistant stringers of coarse, rounded, smoky quartz grains as large as 1/4 inch in diameter, average diameter 1/8 inch. Massive and cross-bedded (Plate XXXVII, Fig. 2), grades upward into medium-grained, colorless, angular to sub-angular quartz grains. Thin layers varying in thickness from 1/4 inch to 3/4 inch composed of very fine quartz and silt which gives the appearance of shale. These beds weather to form talus slope. Massive beds at the top of bluff are hard and coarse grained..............................	52.3

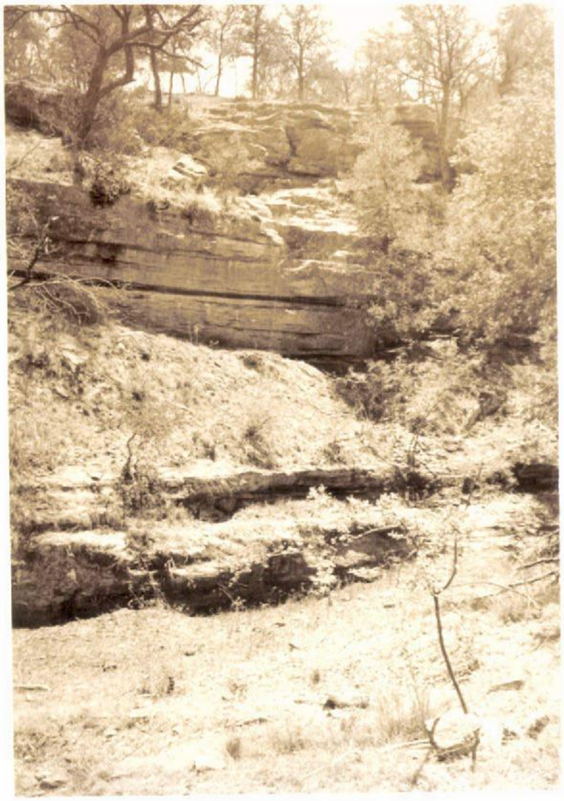


Figure 1

Hickory sandstone
(I - 3)

Figure 2

	Feet
2. Sandstone, occurring as dark brown to reddish-brown, flat slabs scattered on gradual, grass covered slope. Float material weathers to very rough surfaces....................................	33.3
Total thickness measured..................	85.6

Section beginning in lower Hickory sandstone at the southeast corner of cultivated field 1700 feet S 25° E of the Dorothy Kothmann ranch headquarters and proceeding S 20° E to the Cap Mountain contact (Plate I, F-F').

Thickness of Interval

Feet

Riley formation:

Hickory sandstone member:

1. Sandstone, containing yellowish-brown, moderately indurated, medium-bedded intraformational conglomerate having very rough weathered surfaces mottled grayish-black to dark tan. The flattened conglomerate pebbles are composed of fine- to medium-grained quartz cemented with iron oxide and have an average maximum dimension of 1-1/2 inches. The fossiliferous zone contains phosphatic brachiopod shell fragments embedded in a coarse-grained, reddish-brown, fairly well indurated sandstone containing scattered sandstone pebbles. The color deepens to dark brown higher in the unit with the concentration of shell fragments varying

Feet

throughout from low to high. Near the top, where the sandstone is deep brown with darker bands highly charged with iron oxide, the fossil fragments are small and scarce.......................... 67.2

2. Sandstone, grayish-brown to purple brown, weathered grayish-brown; fine-grained, quartz grains sparkle on fresh fracture; bedding indistinct, weathers to slabs having rough surfaces. Higher in the unit the rock takes on a dull speckled appearance due to the presence of black iron oxide; has a weathered appearance even on fresh fracture. Soil is brown with a slight reddish tinge................ 26.7

3. Sandstone, dull tan, mottled in places by concentration of iron oxide, fine- to medium-grained; contains abundant clear, subrounded quartz grains. Moderately indurated, weathers to angular boulders and small brown to tan slabs having irregular, rough surfaces. Undulating surface on 8 inch ledge exposed in ditch possibly ripple marks. Smooth black pebbles of hematite are scattered over the

Feet

surface. Weathered surfaces are coated with yellowish-brown and black lichen. The upper portion of the section forms a dip slope in a sparsely vegetated area where outcrops are generally non-existent. Occasional fragments of resistant sandstone is present as float on the russet-red soil. Near the Cap Mountain contact the soil becomes light brown.. 42.2

Total thickness measured.................. 136.1

Cap Mountain limestone member:

Section within the Hickory sandstone (Plate XXXVIII) beginning near the base in draw at head of earthen stock tank between James River road and the Walter Schmidt ranch house and proceeding south to the top of Tod Mountain (Plate I, G-G').

	Thickness of Interval Feet
Riley formation:	
Hickory sandstone member:	
1. Gentle slope of gray, sandy soil, grass covered, sparsely vegetated................	91.8
2. Sandstone, light buff to brown, weathered musty gray to grayish-black. Thin- to thick-bedded, lower portion weathering to moderately resistant ledges having rough surfaces. Some thin-bedded, medium-grained ledges containing silty material are interbedded with coarser grained sandstone. Cross-bedding is very common in the thickly bedded ledges. Talus covers much of the thin-bedded unit; entire sequence weathers to a moderately steep slope........	91.8
3. Sandstone, tan, fine-grained, moderately indurated; contains very small flakes of pale bronze yellow mica flakes,	

Hickory sandstone forming
Tod Mountain
(I - 8)

	Feet
possibly weathered biotite, sufficiently abundant to impart a sparkle to the rock on either eroded surfaces or on fresh fractures. This unit weathers to medium-bedded ledges which are interbedded with thinly-bedded, fine grained, silty sandstone....................................	13.4
4. Sandstone, predominantly tan, light near the base to brown at the top; friable to moderately indurated, thin to thick-bedded, occasional ledges in place. Grain size variable from fine to very coarse with a few stringers of very coarse brown sand similar to that found near the base of the Hickory sandstone member. The interval between ledges is masked by talus.............	53.3
5. Sandstone, brown conglomerate composed of flat sandstone pebbles made up of fine-grained quartz grains stained brown with iron oxide. These pebbles, coated with a very thin layer of black material, presumably iron oxide, have an average maximum diameter of 2 inches with some pebbles as much as 4 inches along the greatest dimension. These	

Figure 1

Hickory sandstone float

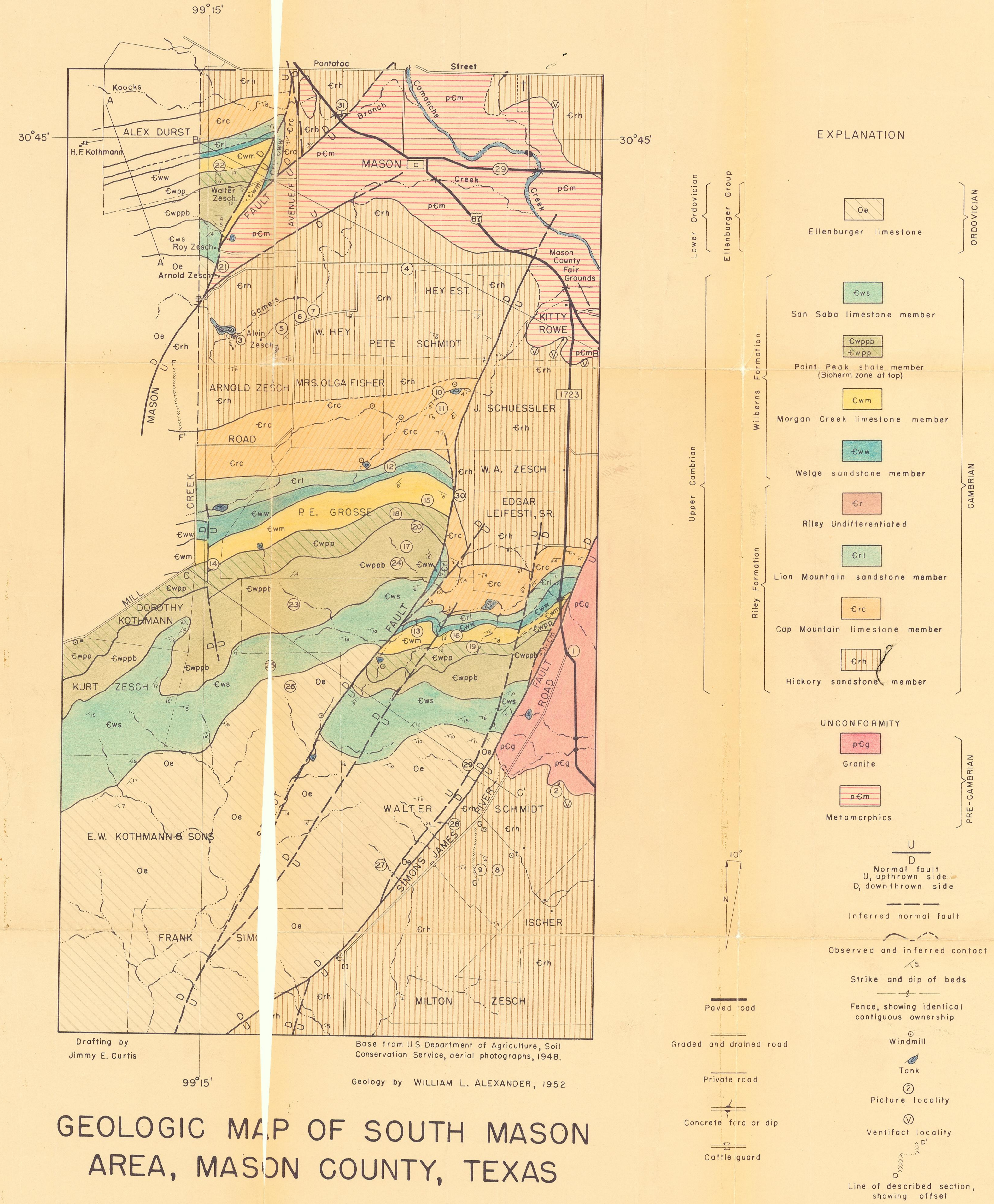
Figure 2

Ripple marks on Hickory sandstone
(I - 9)

Feet

conglomerate fragments are essentially scattered on the surface as float (Plate XXXIX, Fig. 1) in slabs about 6 inches thick with the pebbles weathered out in relief. Occasional fragments of conglomerate and coarse-grained, brown sandstone have ripple marked surfaces with the ridges essentially parallel (Plate XXXIX, Figure 2). The average distance between ridges is about 10 inches. Scattered fragments of dark brown sandstone are present as float on the upper slope of the mountain and contain brachiopod shell fragments. The crest of Tod Mountain is covered with fragments of coarse-grained, dark brown to greenish-brown sandstone containing an abundance of iron oxide as cementing material. This iron oxide is often concentrated near the surface of the weathered fragments to form a hard thin layer............................ 50.2

Total thickness measured................. 267.6



GEOLOGIC MAP OF SOUTH MASON AREA, MASON COUNTY, TEXAS

Scale 1/20000