3-2-2013

Geology of the Western Llano Uplift, Fredericksburg to Mason, Texas

R. LaRell Nielson
Stephen F Austin State University, rnielson@sfasu.edu

Chris Barker
Stephen F Austin State University, cbarker@sfasu.edu

Texas Academy of Science, 2013, Field Trip:

Geology of the Western Llano Uplift, Fredericksburg to Mason, Texas

March 2, 2013

Bear Mountain Pluton

Field Trip Leaders:

R. LaRell Nielson and Chris A. Barker

Department of Geology
Stephen F. Austin State University
Nacogdoches, Texas

This page intentionally left blank

Texas Academy of Science, 2013, Field Trip:

Geology of the Western Llano Uplift, Fredericksburg to Mason Texas

March 2, 2013

Folds in the Packsaddle Schist south of Mason, Texas

Field Trip Leaders:

R. LaRell Nielson and Chris A. Barker

Department of Geology
Stephen F. Austin State University
Nacogdoches, Texas

Acknowledgements

The writers are grateful to the Geology Department at Stephen F. Austin State University for providing the opportunity to conduct geological research and to lead field trips to the Hill Country for many years. Thanks goes to the Department of Geology for partially funding these field trips and research projects and to our students who have helped us learn more about the area through their questions.

A great deal of thanks and appreciation is given to our spouses (Sylvia and Anne) for their support and encouragement to complete this project.

One of the large stromatolitic (crytic) bioherms along the south bank of the Llano River at White’s Crossing south of Mason Texas.

Table of Contents

Acknowledgements 4

Introduction 9

STOP 1: **Bear Mountain Pluton** 14

STOP 2: **Crab Apple Creek – Hickory Sandstone** 17

STOP 3: **Gypsum Mine** 19

STOP 4: **Cherry Spring – Precambrian – Cambrian Nonconformity** 22

STOP 5: **Packsaddle Schist Folds south of Mason Texas** 24

STOP 6: (A, B, and C): **Whites Crossing Stromatolites** 28

STOP 7: **Cooper's Bar-B-Que** 35

References 35

Table of Figures

Figure 1 – Index map to TAS 2013 Stops 10

Figure 2 – Sloss Cycles...11

Figure 3 – Generalized Stratigraphic Section for Llano Uplift..............................12

Figure 4 – Geologic Map for Stops 1 - 4...13

Figure 5 – Geologic Map for Stops 1 - 3...15

Figure 6 – Geologic Map of Bear Mountain...16

Figure 7 – Hickory Sandstone along Crab Apple Creek 18

Figure 8 – Ripple Marks, Hickory Sandstone, Crab Apple Creek 18

Figure 9 – Mudcracks, Hickory Sandstone, Crab Apple Creek 19

Figure 10 – Stratigraphic Section Fredericksburg Gypsum Mine 20

Figure 11 – Stuart City Reef trend in relation to the Kirschberg Lagoon 21

Figure 12 – Stuart City Reef Trend 21

Figure 13 – Model for the Stuart City Reef trend and Kirscherg Lagoon............22

Figure 14 – Geologic Map, Stop 4...23

Figure 15 – Photo, Precambrian-Cambrian Farm Road 2323 24

Figure 16 – Photo, Folds, Comanche Creek, Mason, Texas...............................25

Figure 17 – Photo, Folds, Comanche Creek, Mason, Texas...............................27

Figure 18 – Photo, Folds, Comanche Creek, Mason, Texas...............................26

Figure 19 – Geologic Map for Comanche Creek and White's Crossing 27

Figure 20 – Photo, Bioherm, Llano River, White's Crossing................................30

Figure 21 – Geologic Map White's Crossing 31

Figure 22 – Geologic Map White's Crossing 32

Figure 23 – Photo, Bioherm, Llano River, White's Crossing................................33

Figure 24 – Photo, Bioherm, Llano River, White's Crossing................................33

Figure 25 – Photo, Bioherm, Llano River, White's Crossing................................35

Figure 26 – Photo, Nautiloid, Llano River, White's Crossing...............................34

This page intentionally left blank

Introduction

This year's Texas Academy of Science Geology Field Trip will visit six interesting locations in the Texas Hill Country (Figure 01). At Bear Mountain quarry, former location of Balanced Rock, the contact between the Precambrian Bear Mountain Pluton and surrounding Cretaceous Edwards Group will be examined. Along Crab Apple Creek, south of Enchanted Rock, excellent exposures of the Hickory Sandstone provide the opportunity to study sedimentary structures and cross-bedding that represent the Sauk sequence deposited during the Cambrian Period (Figure 02). Next we will look at a Gypsum Mine and deposits of evaporites from the Cretaceous Kirschberg Lagoon (Figure 03 and 04). We will then take the back roads of the Llano Uplift to an interesting exposure of the Precambrian- Cambrian boundary represented by a nonconformity that shows the transgression of Cambrian seas (Sauk Sequence) across the eroded Precambrian Cherry Springs Pluton (Town Mountain). Next, we will stop at Comanche Creek south of Mason, Texas, to study complex folds in the Packsaddle Schist. These folds represent deformation of the Llano Uplift area during the Greenville Orogeny 1.2 Ga years ago. The last stop on the field trip will be at White’s Crossing near the Llano River, to ponder the origin and development of spectacular stromatolites exposed by uplift along faults in the area and down cutting of the Llano River. And finally, since no trip to the Llano Uplift is complete without a stop at a Coopers BBQ, we will have lunch at the Coopers in Mason, Texas.

Index Map to 2013 TAS Geology Field Trip

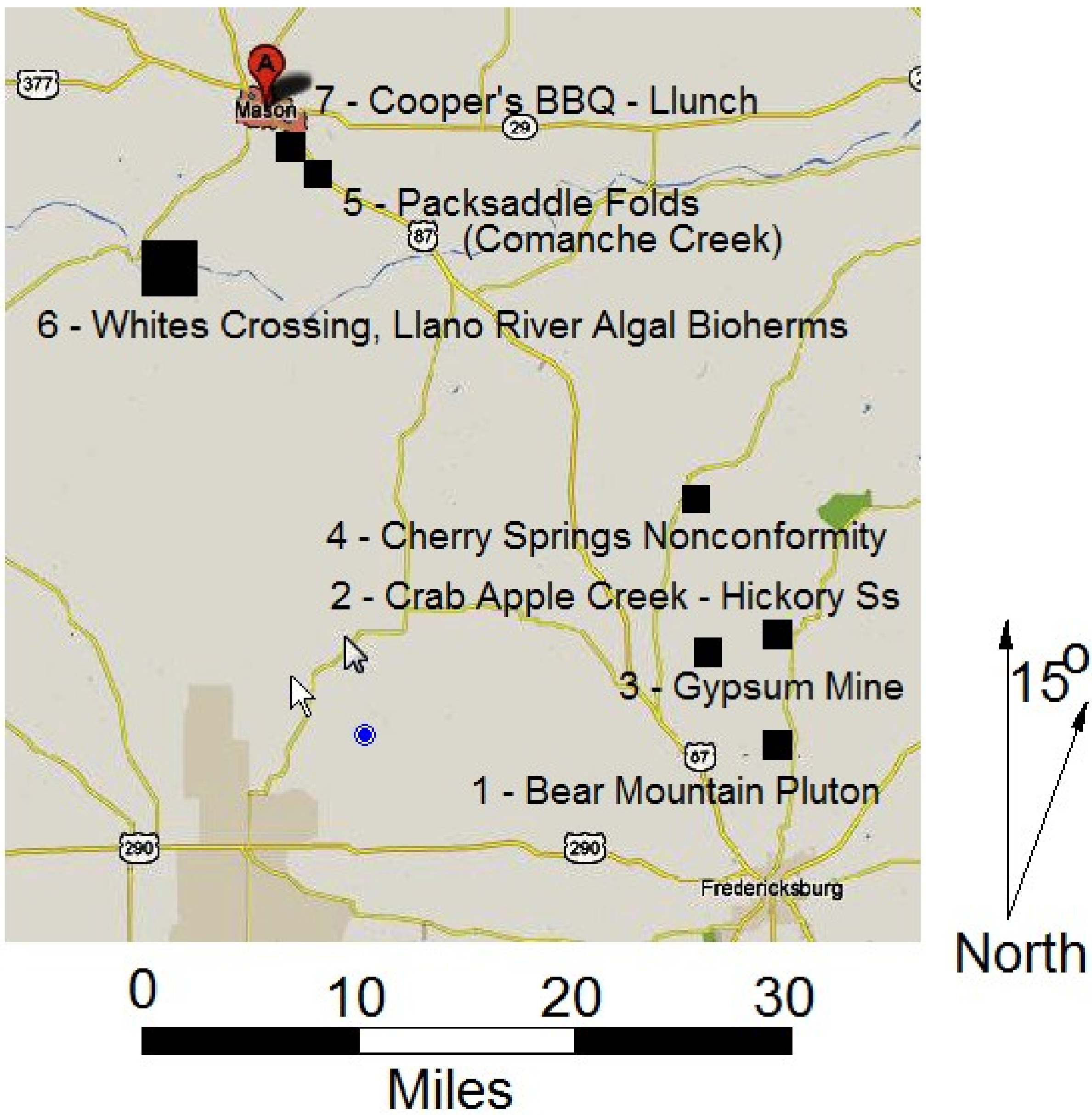

Figure 01. Index to 2013 Texas Academy of Science field Trip.

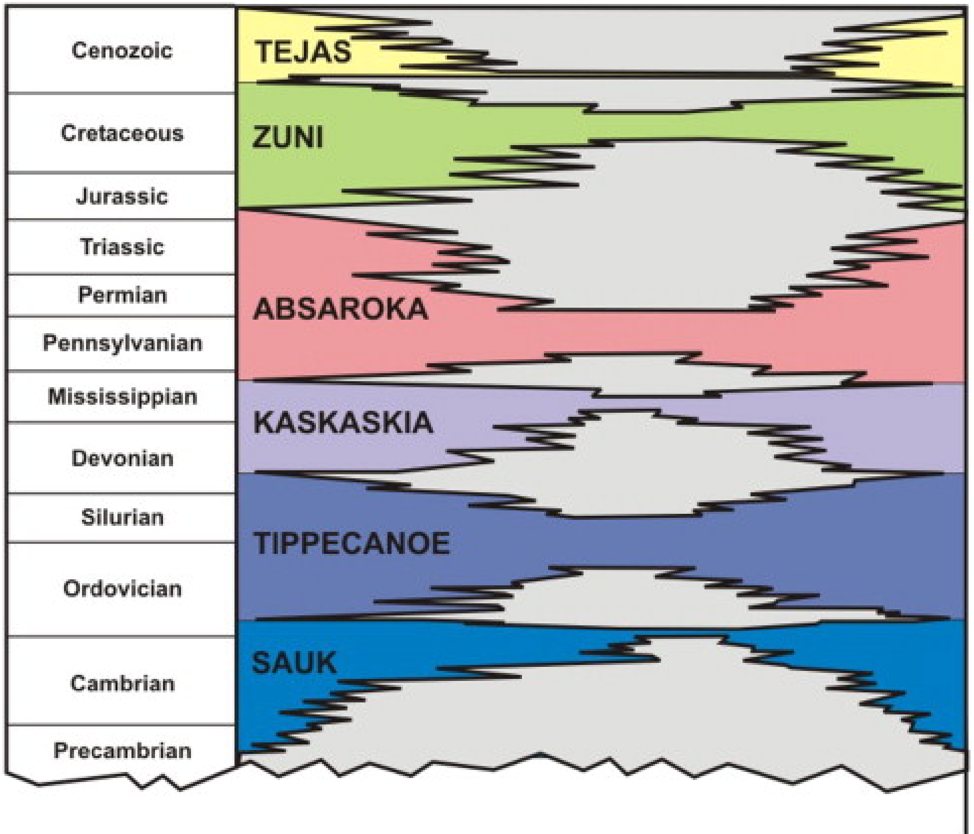

Figure 02. Sloss (1963) cycles - after Donovan (2010 p. 24)

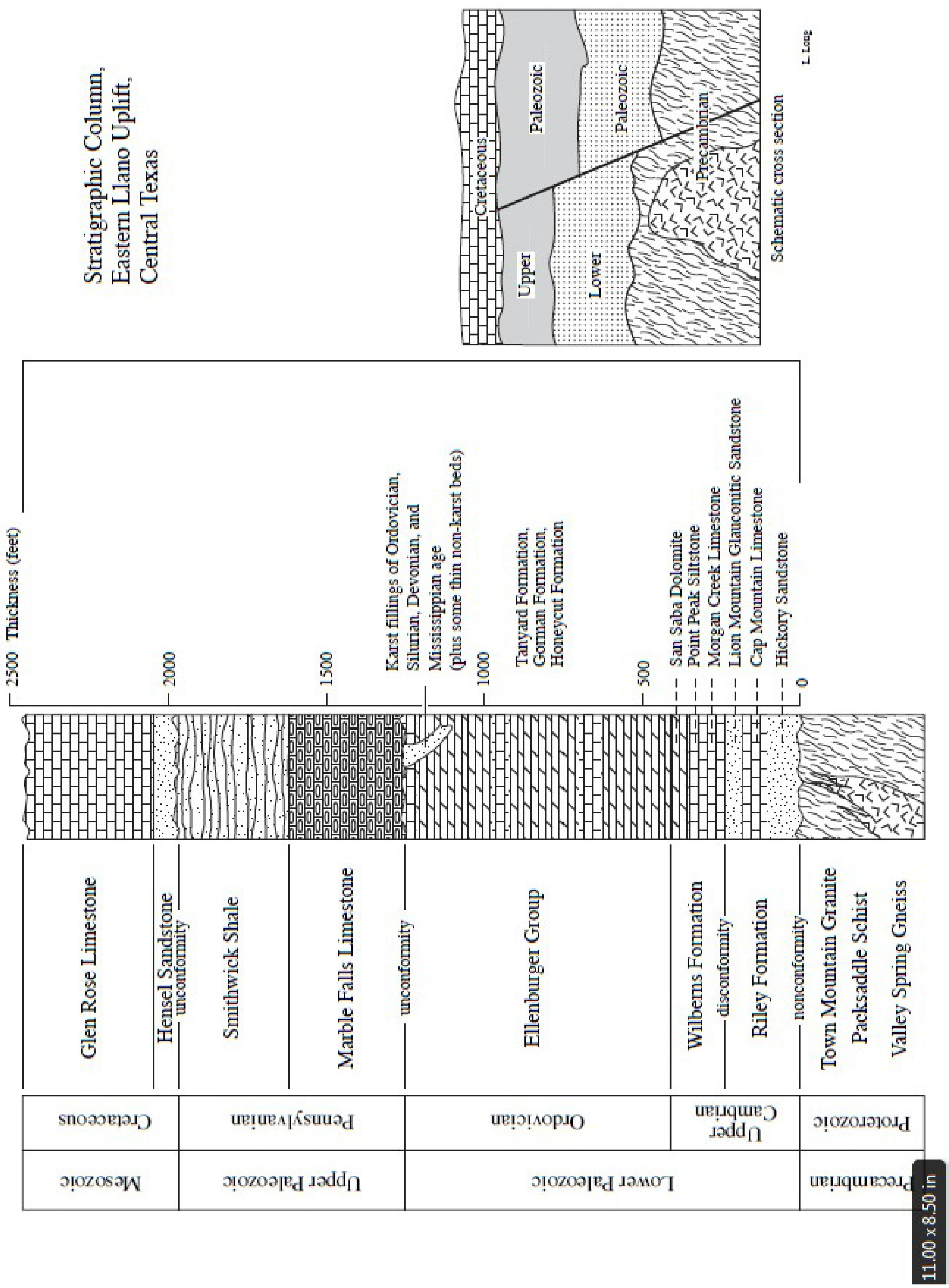

Figure 03. Generalized stratigraphic section showing units present in the Llano Uplift (L. Long 2010).

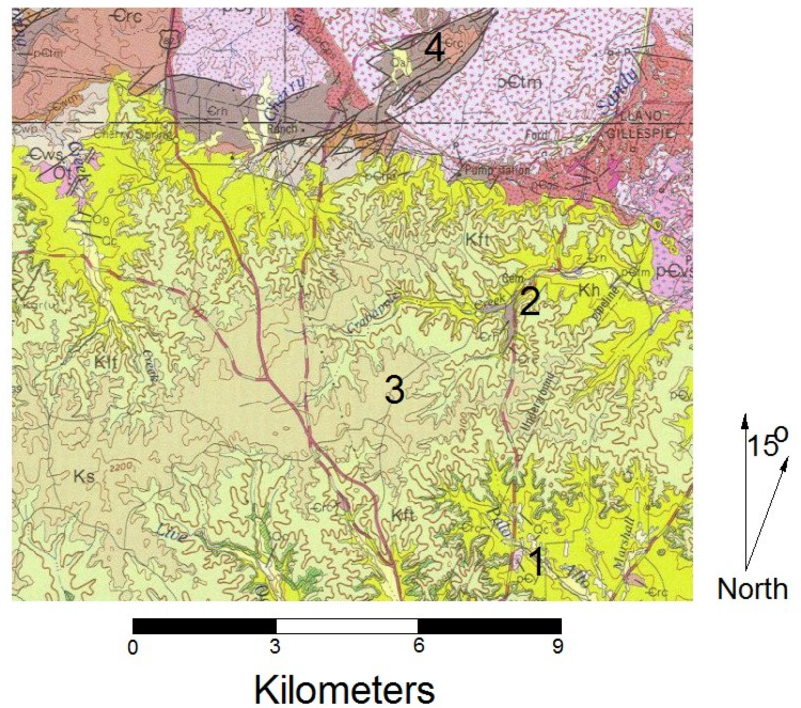

Figure. 04. Geologic map of Stops 1-4 showing the geology at each stop (Geologic Atlas of Texas, Llano Sheet, Barns, 1986). Map symbols: pCtm – Town Mountain, pCps – Packsaddle Schist, Crh – Riley Formation, Hickory Sandstone, Crc- Riley Formation – Cap Mountain Limestone, Cwp – Point Peak Member, Cws – Wilberns Formation, San Saba Member, Ot – Tanyard Formation, MD –Devonian and Mississippian, IPmf – Marble Falls Limestone, IPsw – Smithwick Formation, Kh – Hensell Sandstone, Kgr – Glen Rose Limestone, Kw – Walnut Formation, Kft – Fort Terrett Formation, and Ks Segovia Formation

Field Trip Stops

Stop 1:

Bear Mountain Pluton North of Fredericksburg, Texas

GPS Location: Latitude, N 30°19'35.6", Longitude, W 098°51'31.6", Elevation, 1717
Stop located 4.8 miles north of Fredericksburg, Texas on Farm Road 965.

Bear Mountain is a monadnock, an isolated erosional remnant of leucogranite about 10 km south of the main exposures of igneous rocks in the Llano Uplift (Figure. 05 and 06). Barker and Reed (2010) describe it as a compositionally unique, undated granite that recrystallized at lower temperatures than other Llano area granites.

This pluton may have been emplaced into the Coal Creek Domain (Barker and Reed, 2010), and, if it is younger than other granites, the intrusion may have occurred after the main Llano Orogeny. The dimensions of this pluton have been mapped by geophysical methods according to Barns et al (1954). The rock at this location is a medium grained, equigranular, porphyritic granite with traces of fluorite and cataclastic features. At this location, an interesting nonconformity between the granite and the on-lapping Cretaceous Walnut, Comanche Peak and Fort Tarrett formations can be seen. In some areas the pluton is extensively jointed. Spheroidal weathering along the joints allowed development of rounded hoodoos.

A number of years ago part of this location was known as Balanced Rock because of a unique large pinnacle rock produced by differential erosion. In 1996 Balanced Rock fell, an event that some locals attributed to foul play and the use of explosives. Quarry operations started in the 19th century after the founding of Fredericksburg in 1846. The granite makes an excellent building stone because it retains it high luster (See Cover Photo).

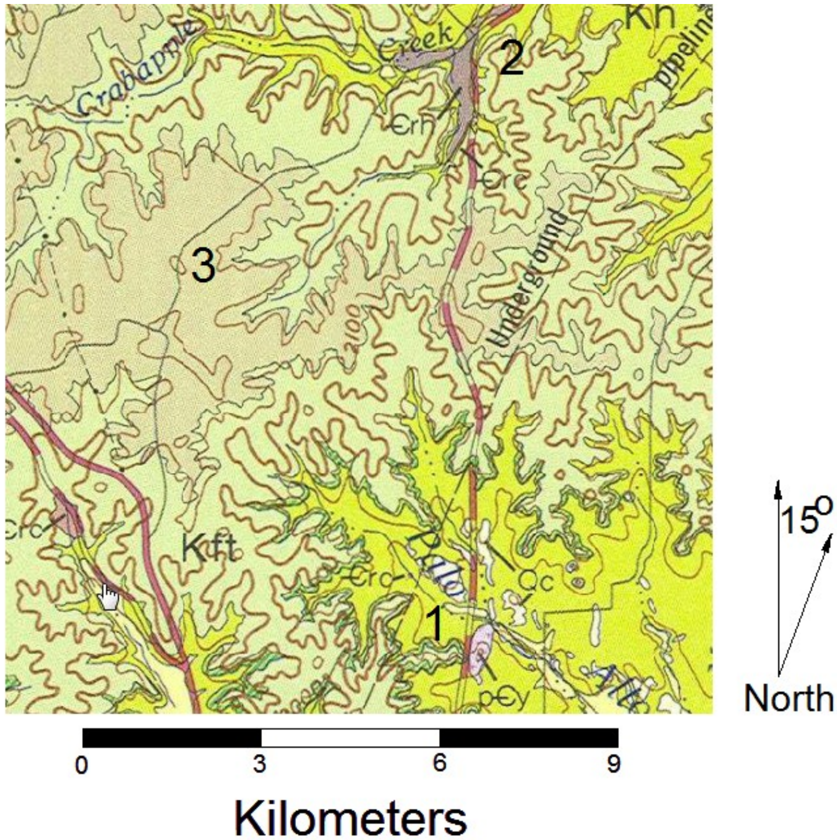

Figure 05. Geologic map showing the location of stops 1, 2 and 3 (Barns, 1986). Map symbols: pCtm – Town Mountain, pCps – Packsaddle Schist, Crh – Riley Formation, Hickory Sandstone, Crc- Riley Formation – Cap Mountain Limestone, Cwp – Point Peak Member, Cws – Wilberns Formation, San Saba Member, Ot – Tanyard Formation, MD –Devonian and Mississippian, IPmf – Marble Falls Limestone, IPsw – Smithwick Formation, Kh – Hensell Sandstone, Kgr – Glen Rose Limestone, Kw – Walnut Formation, Kft – Fort Terrett Formation, and Ks Segovia Formation

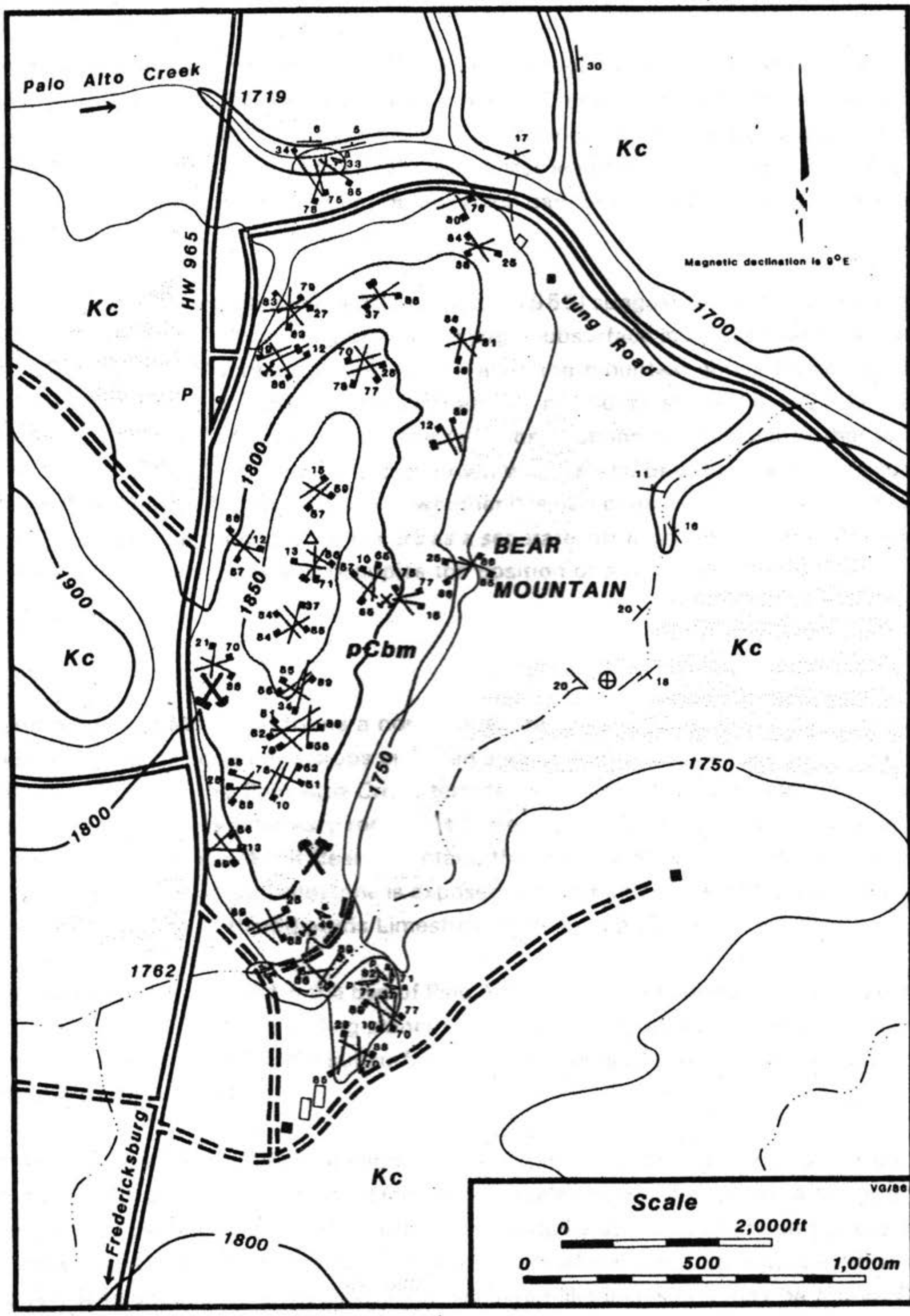

Figure 06. Geologic map of Bear Mountain showing joint measurements (Gobel, 1986 p. 43).

Stop 2:

Cambrian Hickory Sandstone at Crab Apple Creek, south of Enchanted Rock State Park, Texas

GPS Location: Latitude, N 30^{o}25'49.5", Longitude, W 098^{o}51'30.3" Elevation, 1790
Stop Location is on Keese road which turns off Farm Road 965, 12.5 miles north of Fredericksburg, Texas.

Exposures of the Cambrian Hickory Sandstone are seen along Crab Apple Creek 400 m north of the junction of Gypsum Mine and Keese roads Figure 07). The Hickory Sandstone at this location contains excellent sedimentary structures such as mudcracks, a wide variety of ripple marks and trough cross bedding (Figure 08 and 09). The Hickory Sandstone at this location was reported by Barns (1954) to contain little feldspar and be a well sorted quartz sandstone (arenite to wacky). Development and preservation of mud cracks suggests that some layers of the sediment contain a significant amount of clay. In order for the mud cracks to be preserved there must be sufficient clay to bind the sand together during drying to allow the mudcracks to form. This was followed by mud being deposited in the crack. The ripple marks, mudcracks and trough cross bedding suggest deposition in a beach environment. No dune type structures or cross bedding have been noted in these beds which suggests that a dune complex did not develop behind the beach, or was not preserved. This could be due to the lack of land plants during the Cambrian to stabilize sand behind the beach. Deposition of the Hickory Sandstone occurred during the Sauk transgression of the seas in the Cambrian Period. Evidence of this transgression is seen in sedimentary rocks across North America.

Figure 07. Exposures of the Hickory Sandstone along Crab Apple Creek contain well developed trough cross-bedding, ripple marks and mudcracks deposited during the Cambrian System in a beach environment.

Figure 08. Ripple Marks in Hickory Sandstone along Crab Apple Creek. These ripples are typical of ripple marks found on a modern beach.

Figure 09. Mudcracks in Hickory Sandstone along Crab Apple Creek south east of Enchanted Rock Natural Area. Mud cracks like these are typically found in the back beach areas. The presence of mudcracks indicates a high content of clay in the Hickory Sandstone.

Stop 3:

Gypsum Mine, north of Fredericksburg, Texas (Kirschberg Sediments)

GPS Location: Latitude, N 30°24'12.9", Longitude, W 098°54'03.7", Elevation, 2101
Stop is located 4.2 miles west of the intersection of Farm Road 965 and Gypsum Mine Road on Gypsum Mine Road.

The Standard Gypsum Corp is a Temple-East Tex Company that has been producing gypsum from this location since 1962. J. P. Boone spent a period of time studying the gypsum-bearing deposits in Gillespie County before he starting mining the deposits in this area. 100,000 tons of gypsum are produced per year and reserves are estimated at 30,000,000 tons and the market is considered to be a 300-mile radius around the mine.

Rose (1972) studied the Cretaceous Edwards Group that forms the Edwards Plateau (Figure 10). He divides the Edwards Group into two formations: the upper unit is the Segovia Formation and the lower is the Fort Terrett Formation (Figure 10). These gypsum sediments are part of the Fort Terrett Formation and were deposited in the upper most part of supertidal flats that would have been similar to modern Persian Gulf tidal flats. Gypsum nodules were precipitated in dolomite rich carbonate mud to form layers of nodules surround by dolomicrite. All sediments reflect deposition in the tidal flat environment. The gypsum deposits have been interpreted to have formed in the Kirschberg lagoon that occupied a large part of central Texas during the Cretaceous (Figure 11. 12, and 13).

In the quarry, the gypsum is in irregular nodular masses interbedded with layers of dolomite. Stalactitic masses of gypsum have been noted through the quarry indicating that gypsum was deposited by ground water in the section. Dissolution of gypsum has led to the development of karst topography within the mine property. Barns (1952) noted the presence of a number of gypsum caves in the Cherry Mountain. The caves tend to be small and form a maze like pattern within the quarry.

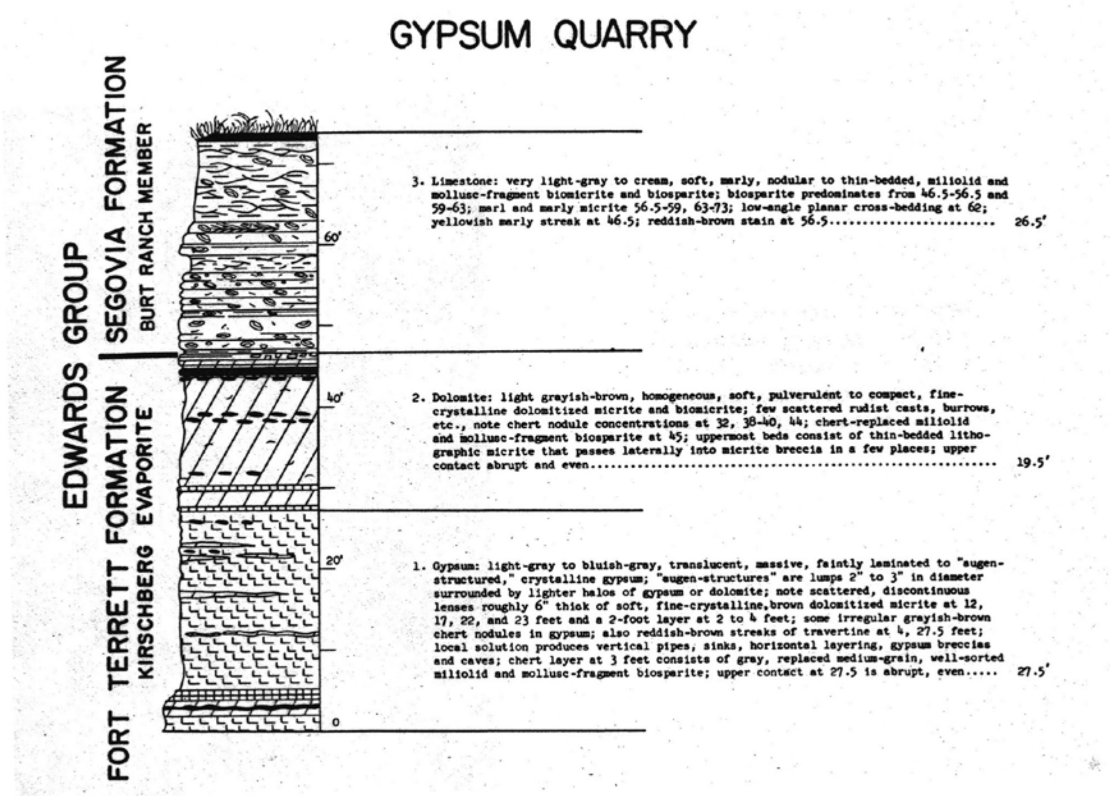

Figure 10 Stratigraphic section for the Cretaceous units present in the Gypsum Mine. Note that the gypsum is present in the Fort Terrett Formation of the Edwards Group. Section from Barns, Kaiser, Maclay and Young 1976 p. 14.

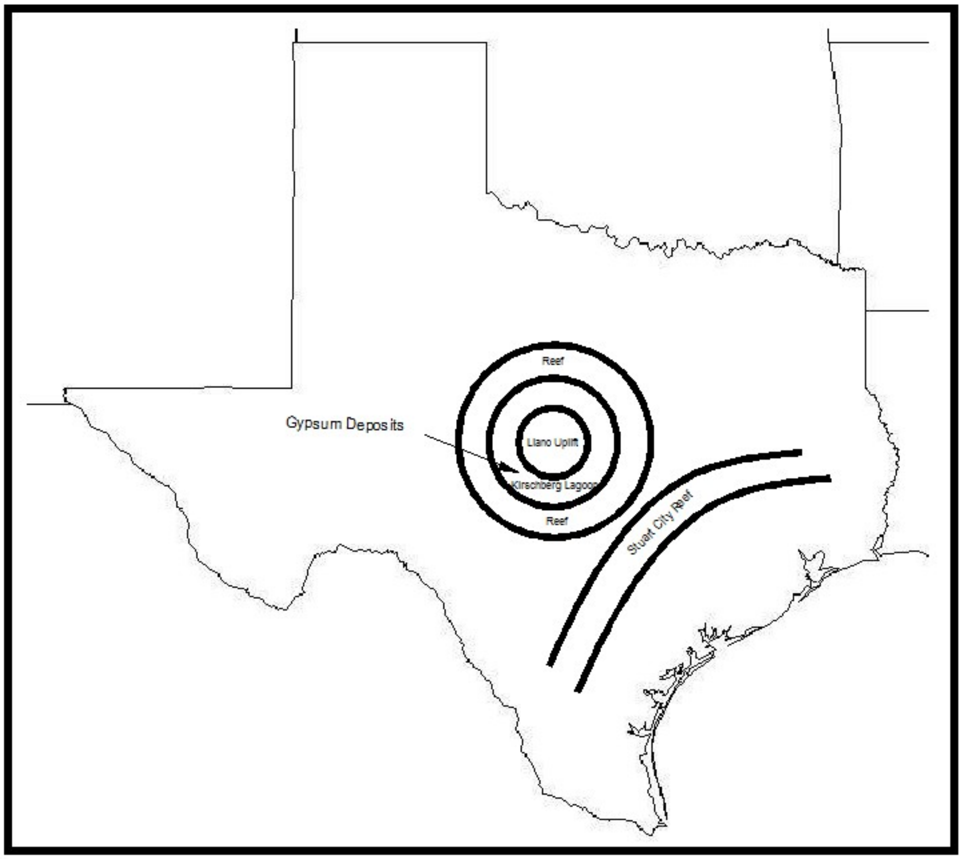

Figure 11. Generalized map for the Stuart City Reef trend in relation to the Kirschberg Lagoon.

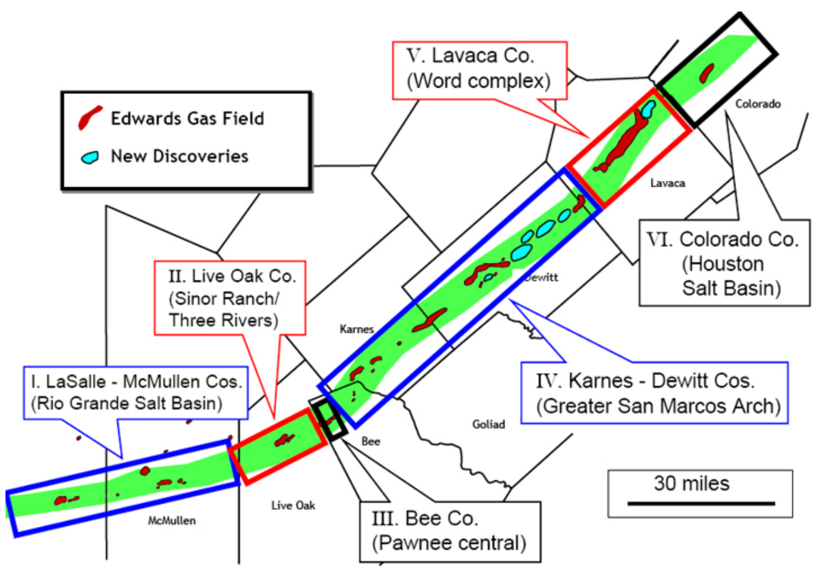

Figure12. Stuart City Reef Trend from Waite (2009 p. 10).

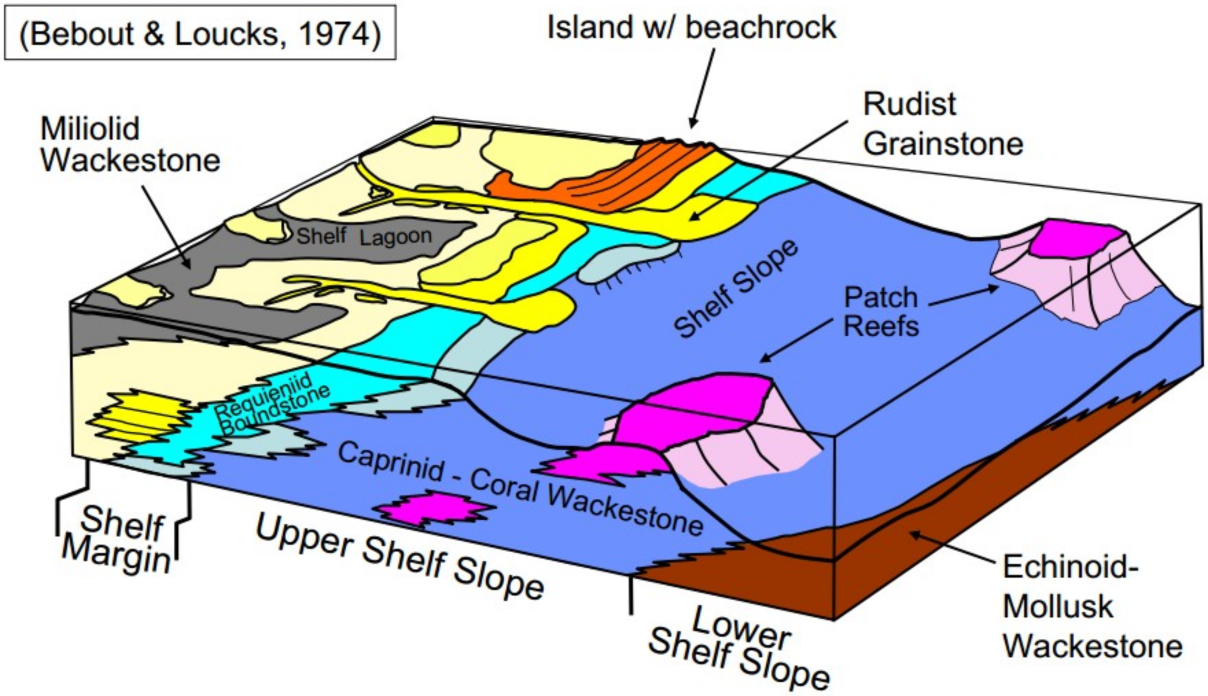

Figure13. Depositional Model for the Stuart City Reef trend and Kirscherg Lagoon (Bebout and Loucks, 1974).

Stop 4:

Precambrian-Cambrian Nonconformity east of Cherry Springs, Texas on Farm Road 2323

GPS Location: Latitude, N 30°30'18.9", Longitude, W 098°56'17.3", Elevation, 1679
Section is located 5.2 miles east of the junction of U.S. 87 and Farm Road 2323 on Farm Road 2323.

The classic nonconformity exposed at this road cut juxtaposes Cambrian sandstone over Precambrian granite. The underlying Proterozoic Cherry Mountain granite (a Town Mountain pluton with a probable age of about 1.1 billion years; Reese and others, 2000) is unconformably overlain by Cambrian Hickory Sandstone (Figure 14). The Cambrian sandstone is probably no older than about 540 million years, so approximately half a billion years of Earth's history is missing between the granite and the sandstone.

At this location the underlying Cherry Mountain granite is a deeply weathered grus, a saprolitic paleosoil horizon that was produced when the granite was exposed during the late Precambrian and/or early Cambrian (Figure 14). The overlying, cross-bedded Hickory Sandstone is actually a basal conglomerate with cobble size inclusions of the granite in the bottom part of the sedimentary unit (Figure 15). The Hickory Sandstone, as mentioned at Stop 2, was deposited during the Cambrian Sauk transgression that eventually brought a shallow sea across present day North America. The cross bedding in the Hickory Sandstone represents reworking of the granite grus sediment. The Hickory Sandstone here is arkosic (feldspath arenite) because of the high percentage of feldspar from the grus.

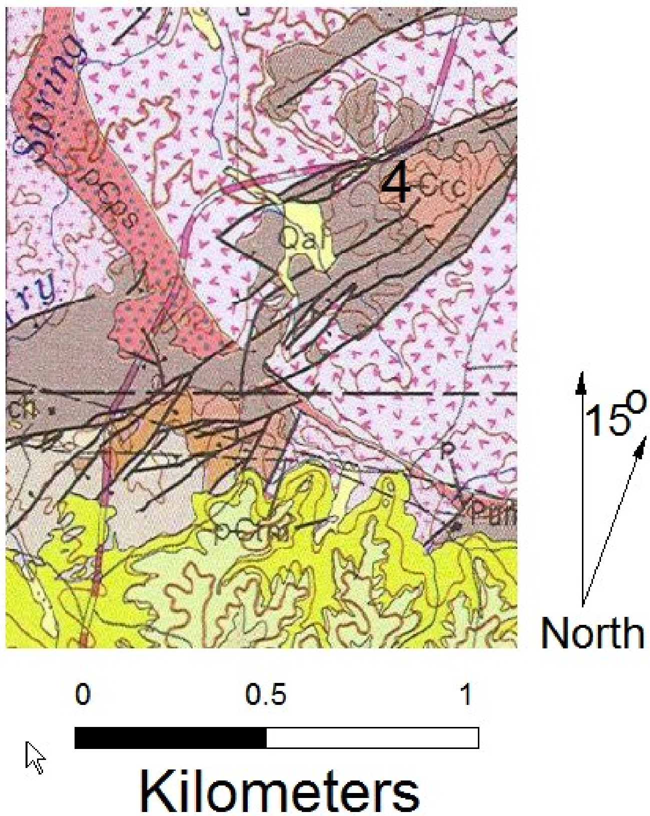

Figure 14. Geologic map of the area around stop 4 which is approximately 20 km east of Cherry Springs (Barns, 1986). Map symbols: pCtm – Town Mountain, pCps – Packsaddle Schist, Crh – Riley Formation, Hickory Sandstone, Crc- Riley Formation – Cap Mountain Limestone, Cwp – Point Peak Member, Cws – Wilberns Formation, San Saba Member, Ot – Tanyard Formation, MD –Devonian and Mississippian, IPmf – Marble Falls Limestone, IPsw – Smithwick Formation, Kh – Hensell Sandstone, Kgr – Glen Rose Limestone, Kw – Walnut Formation, Kft – Fort Terrett Formation, and Ks Segovia Formation

Figure15. Precambrian–Cambrian boundary showing grayish grus (in the lower part of the photo) that developed by weathering of Cherry Mountain pluton. Clasts of the granite are present in the overlying Hickory Sandstone.

Stop 5:

Packsaddle Schist Folds South of Mason, Texas

GPS Location: Latitude, N 30°43'13.2", Longitude, W 099°11'57.6", Elevation, 1464
Stop is located on U.S Highway 87, 2.8 miles south of Mason, TX, courthouse.

This location is a roadcut on Highway 87 immediately north of Comanche Creek bridge. It has excellent exposures of folds, dikes and sills in the Proterozoic Packsaddle schist. In most areas this schist weathers to a non-descript grayish soil, so this outcrop affords a unique glimpse into the complex history of the Llano Uplift.

The Packsaddle schist is the country rock into which many of the granites of the Llano Uplift were intruded. The Packsaddle schist (1.25 billion years old; Reese and others, 2000) was already regionally metamorphosed when post-tectonic granites were intruded about 1.1 billion years ago (Reese and others, 2000) during the Grenville orogeny that deformed the eastern and southern parts (present coordinates) of the

Laurentian plate. The Packsaddle schist is thought to have originally been sedimentary deposits, probably eroded from mafic rocks.

There are a large number of tight to open folds present along the road cut. These folds probably formed at depth where the rock was undergoing ductile deformation as indicated by a variety of mylonitic features (Figure 16, 17, and 18). A main foliation, here referred to as S1, is prominent throughout the schist and is mostly vertical to subvertical. Later deformation folded the S1 foliation into synforms and antiforms. Some of the similar to parallel folds have chevron hinges, cuspate morphology or box folding, with interlimb angles from isoclinal to open. A distinctive second foliation, S2, has formed perpendicular to S1 in parts of the outcrop. In places, a later foliation has been caused by a pronounced crenulation of the earlier foliation. Rotated, winged, elongated porphyroblasts, pseudostratigraphy and intrafolial folds indicate a ductile mylonitic fabric. Multiple generations of cross-cutting felsic dikes and sills intrude into or divide the biotite- and amphibole-rich schist zones (Figure 18 and 19). S-folds are seen in rocks on the west side of the highway, and mostly z-folds are seen on the east side.

Mosher and others (2008) interpret the deformation in the western Llano Uplift to be the result of continent-continent collision, rather than continent-arc-continent collision (as in the eastern Uplift). This series of outcrops along Highway 87 gives us a rare view of the results of this continental collision.

Figure 17. Folds on the east side of U.S.87, about 2.8 miles south of Mason near Comanche Creek.

Figure18. Synform on the west side of U.S.87.

Figure 19. Small folds on the west side of U.S.87.

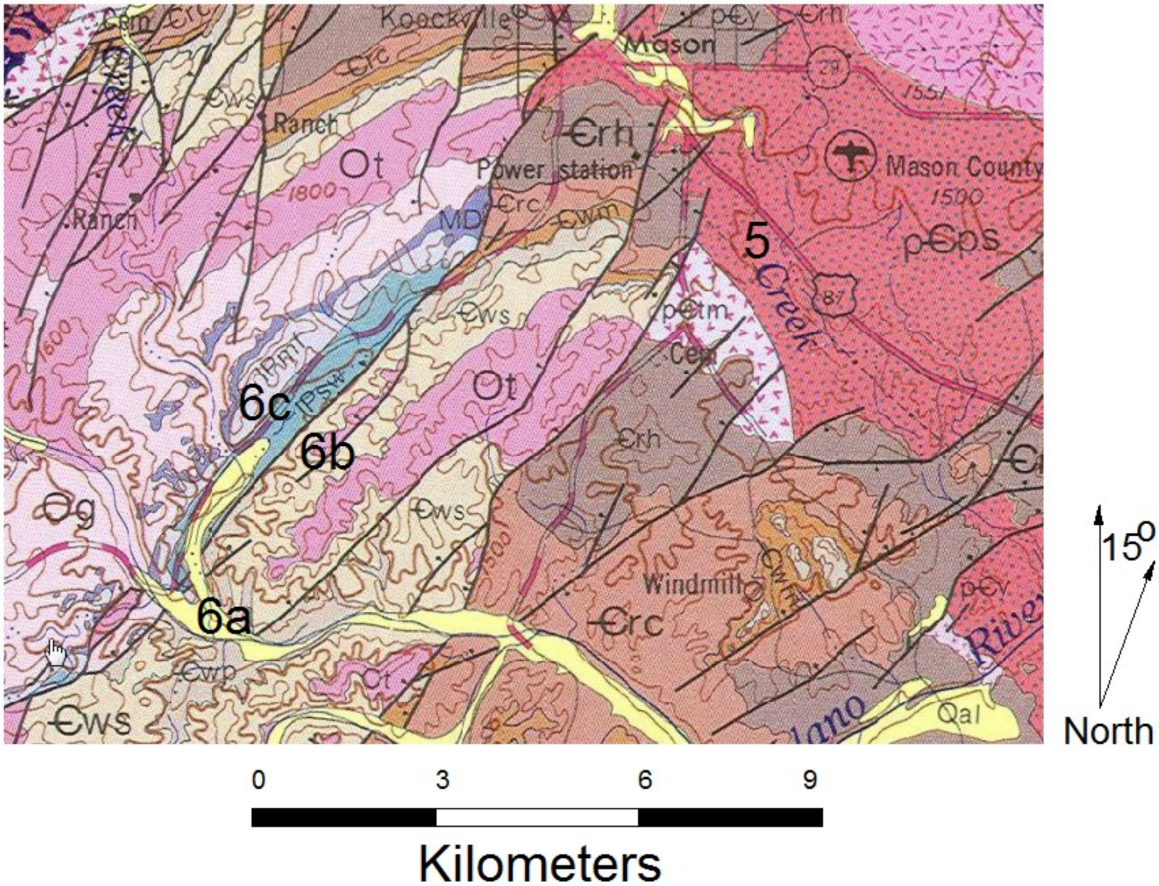

Figure19. Geologic map of the areas near Comanche Creek (Stop 5) and White's Crossing (Stop 6). A regional northeast trend of faults can be seen on this map. Map symbols: pCtm – Town Mountain, pCps – Packsaddle Schist, Crh – Riley Formation, Hickory Sandstone, Crc- Riley Formation – Cap Mountain Limestone, Cwp – Point Peak Member, Cws – Wilberns Formation, San Saba Member, Ot – Tanyard Formation, MD –Devonian and Mississippian, IPmf – Marble Falls Limestone, IPsw – Smithwick Formation, Kh – Hensell Sandstone, Kgr – Glen Rose Limestone, Kw – Walnut Formation, Kft – Fort Terrett Formation, and Ks Segovia Formation

Stop 6:

White's Crossing on the Llano River South of Mason, Texas

Stop 6a - GPS Location: Latitude, N 30°39'05.0", Longitude, W 099°18'27.6", Elevation, 1435
Stop 6b - GPS Location: Latitude, N 30°39'28.3", Longitude, W 099°18'47.1", Elevation, 1383
Stop 6c - GPS Location: Latitude, N 30°39'30.8", Longitude, W 099°19'11.9", Elevation, 1469
White's Crossing is located 9.3 miles south of Mason Texas on Ranch Road 1871 where It crosses the Llano River.

White's Crossing is located 9.1 miles south of Mason, Texas on Ranch Road 1871 where it crosses the Llano River (Figure 19). The first two stops in this area are on Camp Holland Road, a dirt road on which we will turn east (left) 800 meters (1/2 mile) before the low river crossing (Figure 20). The third stop will be at the top of the hill north of the Llano River in the road cut on RR 1871.

White's Crossing is bounded by two faults. One fault trends northeast and southwest through the west end of the low water crossing (Figure 19, 21 and 22). The up-thrown side of the fault is on the west where Ordovician, Gorman Formation is brought in contact with Marble Falls Limestone. This exposes the Marble Falls Limestone in the road cut on the north side of the river just before the low river crossing. To the southeast of White's Crossing, this fault splits and one trace goes to the southwest and the other goes south. A second fault to the east called the Honey Creek Fault runs north-south along Honey Creek. Its up-thrown side is on the east bringing the lower part of the Wilberns Formation in contact with the Point Peak Member of the Wilberns Formation. As a result of these structural relationships, the rocks at White's Crossing are preserved in a down dropped block of a graben. Preserved in this graben are: Smithwick Shale, Marble Falls Limestone, Barnett Formation, Chappel Limestone, Ives Breccia, that are Carboniferous in age, Zesch and Bear Springs Formations, Devonian in age, Gorman Formation (Staendebach Member and Threadgill Member) that are Ordovician in age, and the Wilberns Formation which includes the Point Peak Member that are Cambrian in age.

Stromatolitic bioherms are wide spread in Llano uplift in the Cambrian System. These stromatolites are present in the lower part of the San Saba and Point Peak members. Two other places where they are well exposed is on the San Saba River north of Mason near Camp San Saba on US Highway 87 and along Park Road 4, 1 km (3/4 miles) west of Longhorn Caverns.

The principle reason for coming to this location is to examine the large well exposed stromatolitic (cyanobacteria) bioherms that are present in the south bank of the Llano

River (Stop 6 A). They are about 15 m. (50 ft.) high and 25 m. (80 ft) across (Figure 20 and Page 4 of this book). Photos of these structures have appeared on the cover of the AAPG Bulletin and in many textbooks. Unfortunately, they are very inaccessible but well worth looking at, even at a distance. Much discussion has been given as to whether these are reefs or bioherms. Ahr (1971) felt that there was a lack of structure which suggests that they are bioherms. Examination of these structures in the cut bank of the Llano River suggests that they did have some positive relief and show erosion on one side and not as much on the other which would indicate that they may be considered as reefs. Fortunately, there are some smaller well developed stromatolitic (cyanobacteria) bioherms that are exposed along Honey Creek (Stop 6 B) (Figure 23). The bioherms in this area were studied by Ahr (1971) where he identified the cyanobacteria (algae) as *Renaicis*. The bioherms along Honey Creek consist of heads that are conical shaped ranging in size between 25 cm (1 ft.) and 100 cm (3 ft.) across. Beds are up to a meter (3 ft.) in thickness (Figure 24). The heads are in groups that are about 2 m. (6 ft.) to 9 m. (30 ft.) across (Figure 25). Associated with the heads are sheets and wedges of fossil debris and cyanobacteria (algal) fragments which were removed from the heads during high energy events (Figure 26). Chafetz (1973), writing about stromatolites south of Johnson City, Texas noted that earliest forms are discrete club shaped mounds with a simple non-branching concentric structure. He noted that the middle forms a digitate internal structure and near the top contained the largest mounds with a biconvex lens shape. The mounds at this location exhibit all three forms but their form is controlled by the location of the mound in relation to the margin of the buildup. It appears that there are round and larger heads near the margin of the buildup and the digitate forms are found in the middle of the buildup. The larger heads are also on the edge of the buildup. These sheet exibit extensive dolomitization with large dolo-rhombs developing over the fossils and cyanobacteria (algal) fragments. Several different sizes of heads are present. These smaller heads range from 4 cm down to small heads seen in thin sections.

If time permits, a stop will be made at the junction between Farm Road 1871 and New Holland Road to examine the Carboniferous section. There has been much discussion about the stratigraphic units present in the road cut. The typical stratigraphic section across the Llano uplift consist of Elenburger Limestone overlain by a thin Chappel Limestone with Barnett Formation on top. At White's Crossing the Ellenberger Group is overlain by the thin Chappel Limestone. Above the Chappel Limestone is a coarse white crinoidal fossiliferous mudstone that changes to dense gray micrite. The white crinoid limestone has been given the name "**White's Crossing Coquina**" for the pelmatozoan columnals that characterize the bulk of the rock. Hess (1953) places this unit in the Barnett Formation rather than the Chappel Limestone based on the conodonts he collected. Barns (1977) suggested that the white limestone be split off as a separate stratigraphic unit that he called the White's Crossing Limestone. Near the northeast end of the road cut there is a nautaloid fossil that has been partly chisled out of the rock (Figure 26).

One additional location in the White's Crossing area is the "Decker Graptolite locality 100 meters up Honey Creek where the Point Peak Shale is down thrown against the

Morgan Creek Limestone. At this location a number of interesting features are present, including graptolites, intraformational conglomerate, minute ripple marks, large ripple marks, trails, burrows and a few trilobite fragments.

Figure 20. Large stromatolitic (cyanobacteria) bioherms exposed on the south bank of the Llano River in the San Saba Member of the Wilburn Formation. Note that the bedding does not thicken toward the bioherms. This suggests that the bioherms may not have exhibited much relief.

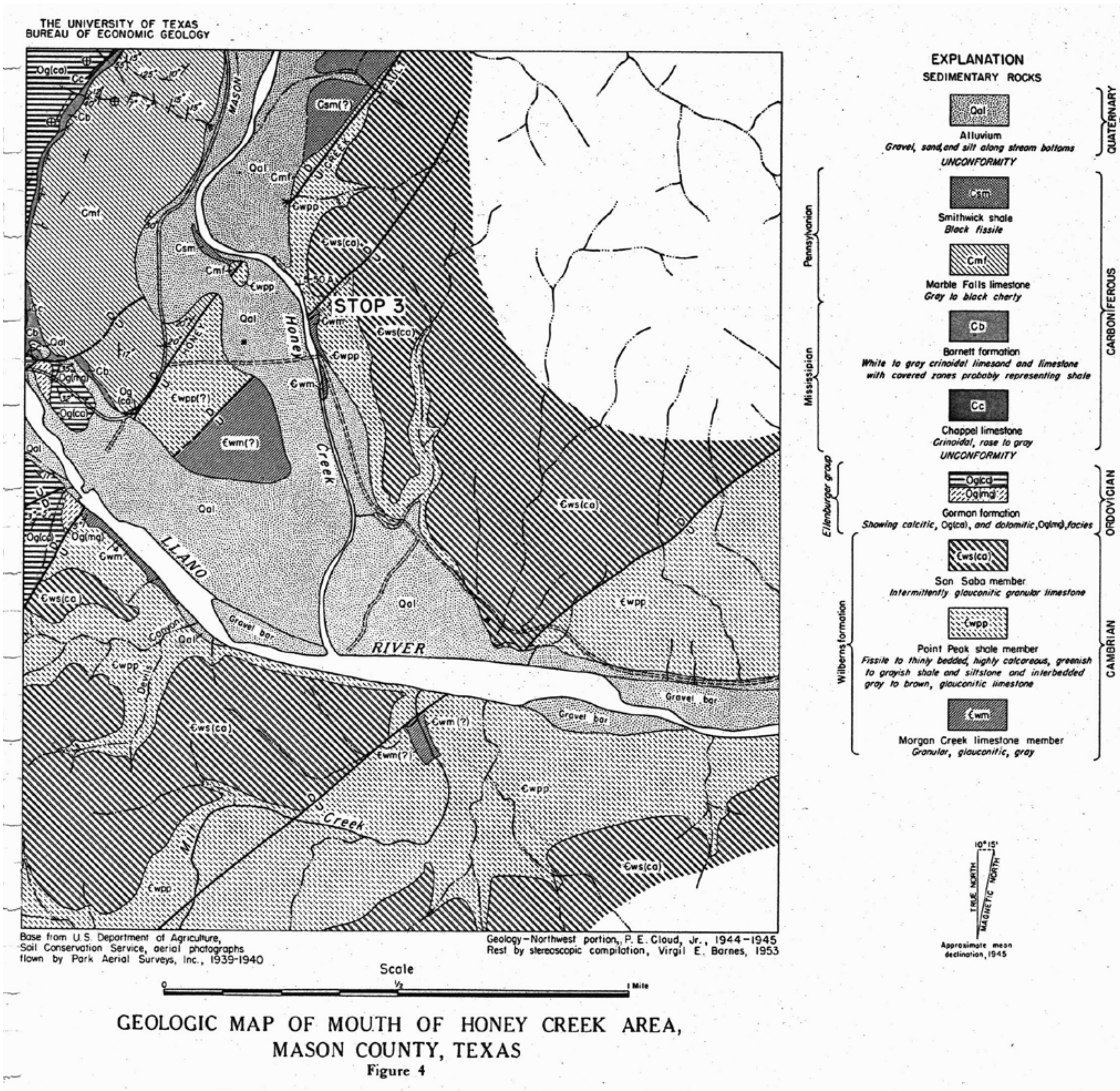

Figure21. Geologic map of the White’s Crossing area from Barnes and Bell 1954, p.19.

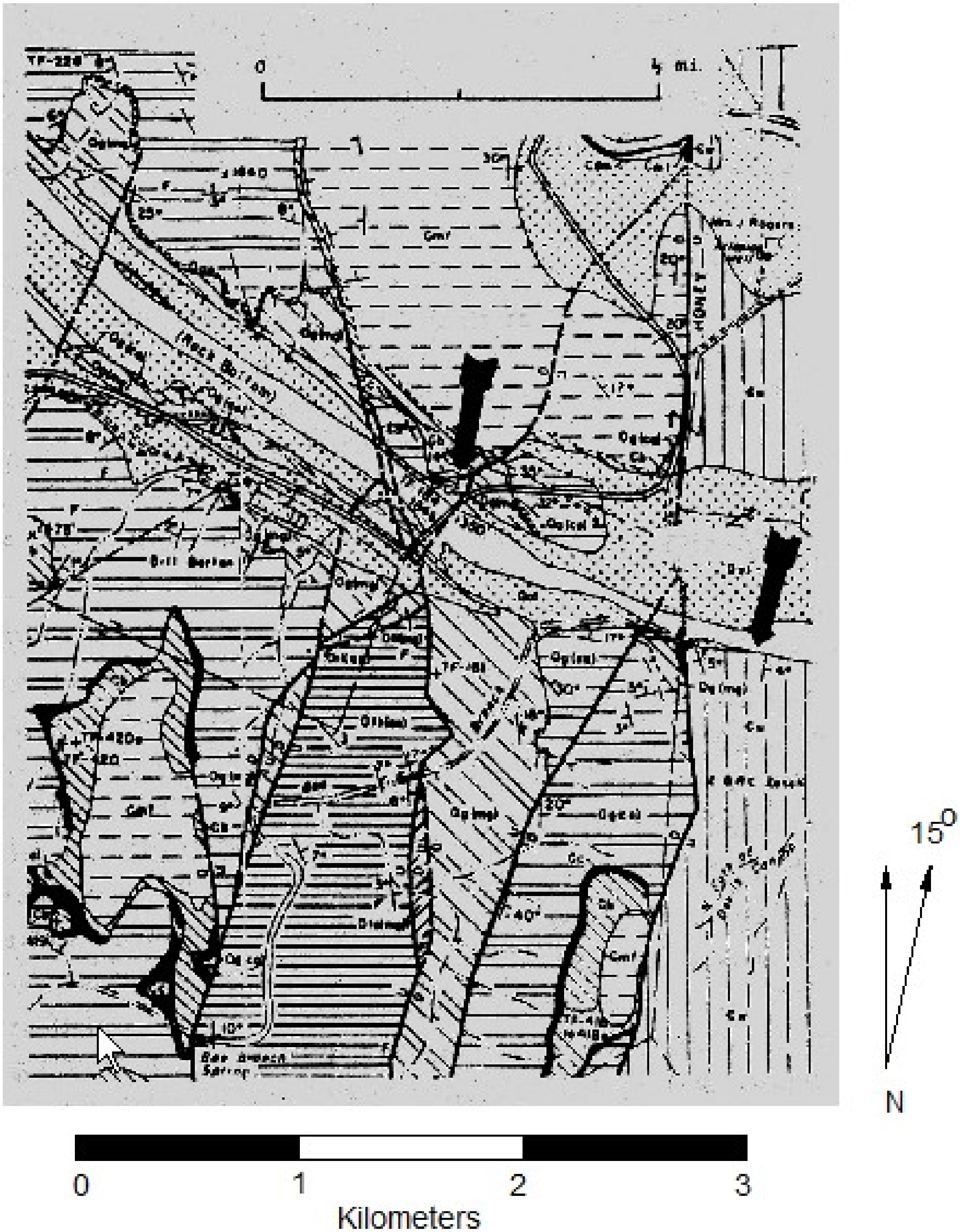

Figure 22. Geologic map of White's Crossing from BEG Publication No. 4621.

Figure23. Overview of the smaller stromatolitic (cyanobacteria) bioherms in the San Saba Member of the Wilberns Formation.

Figure 24. Large cone shaped stromatolitic (cyanobacteria) bioherms along Honey Creek in the San Saba Member of the Wilberns Formation.

Figure 25. Smaller bioherms present near the middle of the bioherms San Saba Member of the Wilberns Formation.

Figure 26. Nautiloid present in the Pennsylvanian, Marble Falls Limestone(?) at White's Crossing at Stop 6c. The nautiloid has been eroded which reveals its chamber pattern and shape.

Stop 7:

Lunch at Coopers BBQ in Mason, Texas

Lunch will be at Cooper's Barbeque in Mason. It is consistently rated as one of the best barbeque restaurants in Texas by Texas Monthly and other periodicals.

References

Ahr , W. 1967, Origin and Paleoenvironment of some Cambrian Algal reefs, Mason County Area Texas: Unpublished Ph.D. Dissertation, Rice University, Houston Texas, 104 p.

Barker, D. S. and Reed, R. M., 2010, Proterozoic granites of the Llano Uplift, Texas: A collision–related suite containing rapakivi and topaz granites: GSA Bulletin v. 122, no. 1-2, p. 253-264.

Barnes, V. and Bell, W. C., 1954, Cambrian Field Trip Llano Area 1954, West Texas Geological Society, p.139.

Barnes, V., Bell, W. C., Clabaugh, S. E., Rodda, P. U. and Young K., 1972, Geology of the Llano Region and Austin Area, Field Excursion: Guidebook Number 12, Bureau of Economic Geology, p.75.

Barnes, V., Kaiser, William, Maclay, Robert, and Young, Keith, 1976, Economic Geology of South Central Texas, South Texas Geological Society, San Antonio, TX p. 104.

Barnes, V. and Bell, W. C. 1977, Cambrian Field Trip Llano Area, San Angelo Geological Society, p.139.

Barnes, V., 1986, Geological Atlas of Texas: Llano Sheet, Scale 1:250,000, Texas Bureau of Economic Geology, http://www.twdb.state.tx.us/groundwater/aquifer/GAT/.

Bridge, J., Barnes, V., and Cloud, P., Jr., 1947, Stratigraphy of the Upper Cambrian, Llano Uplift, Texas, Geological Society of America Bulletin, v. 56., no. 1, p. 109-123.

Bebout, D.G. and R.G. Loucks, 1974, Stuart City trend, Lower Cretaceous, south Texas: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations 78.

Chafetz, H., 1972, Morphologic Evolution of Cambrian Algal Mounds, Texas with Changing Depositiona Environment: AAPG Bulletin vol. 56, no. 3, p. 608

Chafez, H., 1973, Morphologic Evolutionof Cambrian Algal mounds in response to change in Depositional Environment: Journal of Sedimentary Petrology, Vol. 43, no. 2., p. 435-446.

Donovan, A., 2010, Application of Modern Stratigraphic Techniques, SEPM Special Publication 95. P. 134.

Gobel, V. G. 1986, Geologic Overview for Bear Mountain, Gillespie County, Southern Llano Uplift, Central Texas: GSA Guidebook field Trip 13, San Antonio (1986) p. 42-50.

Long, L., 2010, Town of Burnet: Vanishing Texas River Cruise: http://uts.cc.utexas.edu/~rmr/road-log-VTRC-public.pdf

Mosher, S., Levin, J. S. F., and Carlson, W. D., 2008, Mesoproterozoic plate tectonics: A collisional model for the Grenville-aged orogenic belt in the Llano Uplift, central Texas: Geology, v. 36, no. 1, p. 55-58.

Reese, J. F., Mosher, S., Connelly, J. and Roback, R., 2000, Mesoproterozoic chronostratigraphy of the southeastern Llano Uplift, central Texas: GSA Bulletin, v. 112, no. 2, p. 278-291.

Rose, P., 1972, Edwards Group, Surface and Subsurface, Central Texas: Report of Investigations, Bureau of Economic Geology, P 197.

Waite, L. E. 2009, Edwards (Stuart City) Shelf Margin of South Texas: New Data, New Concepts: http://www.searchanddiscovery.com/documents/2009/10177waite/images/waite.pdf

Yu, Andrey, Wood, Z., and Wood, R., 1995, Lower Cambrian Reefal Cryptic Communities: Palaeontology, Vol. 38 Pt. 2, p. 443 -470.