ARCHAEOLOGICAL AND GEOLOGICAL FEATURES AT FALLING WATERS STATE RECREATION AREA, FLORIDA: A YOUNG-EARTH FLOOD MODEL PERSPECTIVE

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Abstract

The Florida Panhandle provides numerous examples of solutional limestone features, also referred to as karst. Archaeological evidence indicates that paleo-Indian cultures used many of these sites as both water sources and communal areas. One specific site, the Falling Waters State Recreation Area, is a locale where paleo-Indians are suggested to have once hunted mammoth. Additionally, this site provides a location where several different types of karst features are observed. Uniformitarians suggest that all of these karst features formed over the course of tens to hundreds of thousands of years. In following the Young-Earth Flood Model we would suggest that these features developed over the course of a few thousand years. We would interpret these features as probably originating at the close of the Flood with continued development extending throughout the single Ice Age Timeframe. Wet weather conditions coupled with changes in sea-level were the greatest factors in forming this karstic terrain.

Introduction

Falling Waters State Recreation Area (FWSRA), located in Washington County in the Florida Panhandle, boasts several interesting geological features (Figures 1 and 2). The centerpiece of this area is the 100-foot deep by 20-foot wide cylindrical Falling Water Sink (Figures 3 through 5). During wet seasons a small stream cascades into this feature and disappears into the subsurface (Rupert and Lane, 1992). Adjacent to the waterfall are a series of sinkholes which interconnect in the subsurface forming a small cave network (Figures 6 and 7). These limestone solution features, also referred to as karst, are somewhat common to sections of the Florida Panhandle due to the presence of limestone layers immediately beneath the thin cover of clastic strata and surficial soils. Uniformitarians suggest that all of these karst features formed over the course of tens to hundreds of thousands of years. In following the Young-Earth Flood Model we would suggest that these features have formed over the course of a few thousand years. We would interpret these features as probably originating with local tectonic uplift during the late stages of the Flood coupled with changes in sea-level caused by the ensuing ice age. Additionally, we suggest that the wet climate associated with the approximate 700 year single ice age (Oard, 1990, p. 191) provided sufficient time and the necessary conditions to further develop these karstic features into what we observe today.

Area Geomorphology

The FWSRA lies within a broadly dissected area commonly referred to as the Marianna Lowlands Province (Maddox, 1993, p. 3; Rupert and Lane, 1992; Scott, 1991, 1992; Vernon, 1942). This province is believed to

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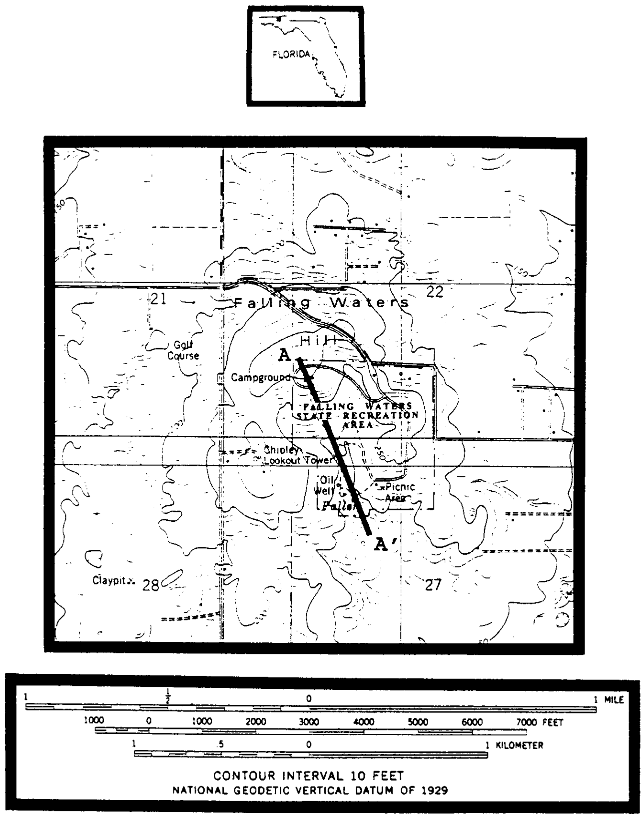

Figure 1. U.S. Geological Survey map showing the general area surrounding Falling Waters State Recreation Area. Note the arcuate shape of the Falling Waters Hill surrounding the sinkhole area. The topography serves to funnel surface waters and associated groundwater into this limited area and probably has served to accelerate the formation of the solutional features found in the limestone. The cross-sectional line is presented in Figure 2.

have formed as a result of uplift associated with the Chattahoochee Anticline, located to the northeast of FWSRA (Chen, 1965, pp. 1-3; Scott, 1991, p. 5; 1992, p. 8). However, Patterson and Herrick (1971) have suggested that the Chattahoochee Anticline is much more localized and is more properly identified as the Gordon Anticline (Figure 8). Even more recently the Chattahoochee Anticline has been projected as a NE-SW trend, splitting the middle between the previously identified N-S and E-W trends (Maddox, 1993, p. 6; Rupert, 1994, p. 4; Schmidt, 1984). Hence, the subsurface structure of this anticlinal feature beneath this area of the Tri-States remains somewhat unresolved in terms of its exact size and direction. However, there is sufficient evidence to suggest that some uplift has occurred within the area and has resulted in the formation and development of the Marianna Lowlands Province.

The former erosion and removal of the clastic strata within this general area has served to expose carbonate rock at earth's surface. The timing of this interplay of geologic forces remains unclear, but it appears to correlate to the middle/late Eocene. Following the removal of clastic overburden, broad areas of limestone rock exposed within the Marianna Lowlands appear to have undergone extensive erosion. The weathering of the limestone surface along with the solutional enlargement of joints and fractures resulted in the development of a karst topography. Today surface precipitation continues to enter the limestones of the Marianna Lowlands via joints and fractures, it then migrates south and southwestward following the dip of the limestone formations and the hydrologic pressure gradient (Schmidt and Coe, 1978, p. 4).

Several limestone outliers and ridges exist within the Marianna Lowlands Province which attain several hundred feet difference in elevation from the surrounding limestone plain (Schmidt and Coe, 1978, p. 1: Vernon, 1942, p. 37). It is in these higher areas that there is the most pronounced development of solutional pits and caves. According to Maddox (1993, p. 3), Falling Waters Hill is one of these erosional outliers in eastern Washington County, within the Holmes Creek watershed. He further states:

> Elevated carbonates of the Miocene Chattahoochee Formation and underlying Oligocene Suwannee Limestone provide the host rock, where solution has progressed downward along major vertical joints and fractures. These resulting vadose cave passages are deep for Florida, due to the thickness of limestone existing above the relatively low potentiometric surface of the upper Floridan aquifer system.

The dip of the limestone layers within the Marianna Lowlands Province reflects the effect of the uplift from the northeast. This uplift created fractures and joint sets which directly contribute to the development of karst within this province (Kastning, 1984). Within

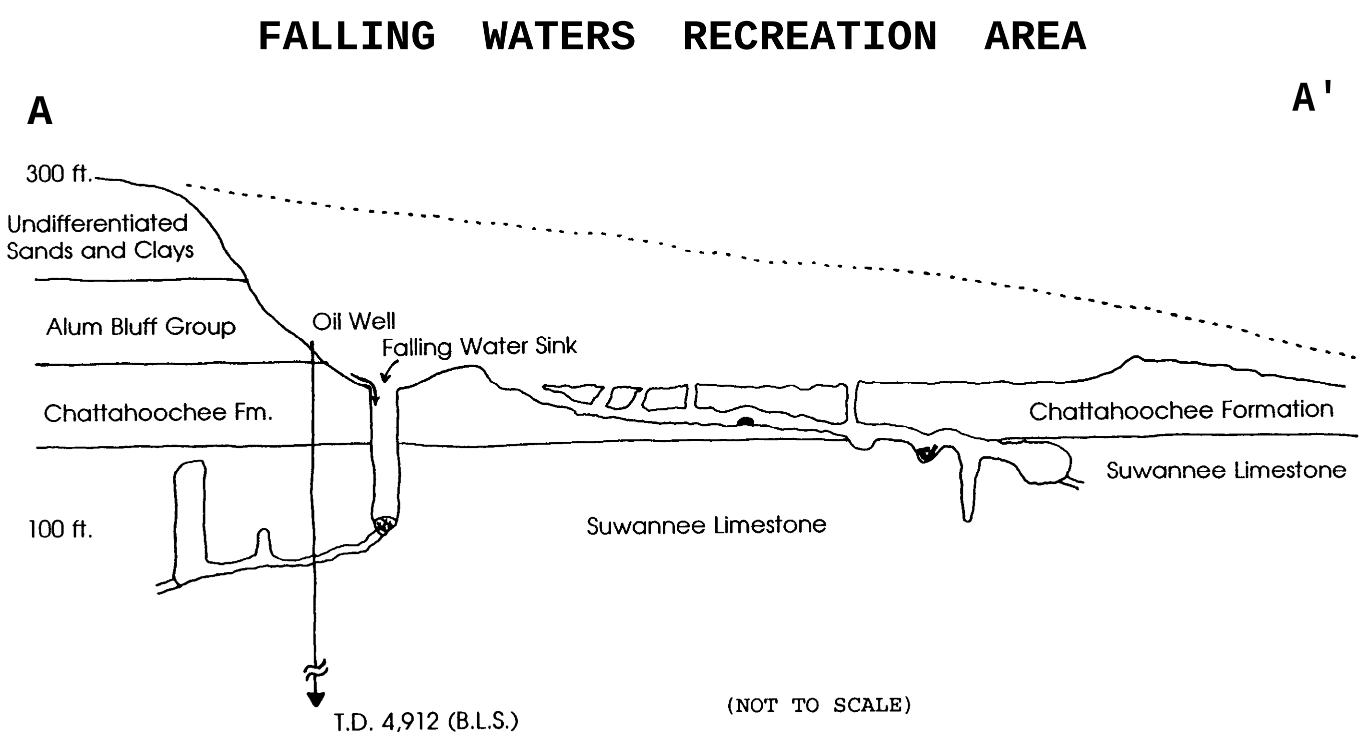

Figure 2. Generalized cross-section (not to scale) showing the Falling Waters Sink and adjacent cave network. Both of the cave systems end where waters flow beneath limestone ledges. The dotted line represents the general slope of the Falling Waters Hill surrounding the sinkhole area. Trees and associated debris wash from the surrounding area into the sinkhole and cave systems and are displayed as the black elongated features in the pits and depressions. All but the uppermost sections of the stratigraphy for the Falling Waters area probably represent Floodwater deposits. See text for additional explanation.

the FWSRA the limestone layers are only exposed in certain places due to the elimination of the overlying undifferentiated sands and clays, and the Alum Bluff Group sediments (Figure 2). This concept and its interplay on the formation of karst at FWSRA will be developed later within this paper.

Area Archaeology

Archaeological and paleontological evidence indicates an interesting history for the Florida Panhandle. Excavation sites across this area suggest that early Indians hunted mammoths in the area as late as 7500 years ago* (Boxrud, 1995). Such archaeological associations are rather typical for exposed karst formations in Florida. This same information can also help young-earth creationists in placing the geologic formation of Falling Waters and similar karstic sites in Florida within the context of the Flood Event/Ice Age time frames (Froede, 1995a). Archaeologists and paleontologists have for years been studying the human and animal remains found in such Florida karst formations (Bense, 1994; Clausen et al., 1979; Purdum, 1992; Rosenau, Faulkner, Hendry, and Hull, 1977; Rucker, 1996, p. 219; Rupert, 1988; Stamm, 1994, p. 70). Recent work along the Aucilla River (east of FWSRA) and other sites in Florida has unearthed early Indian artifacts with mammoth, mastodon, bison, and other megafauna fossils from the Pleistocene (Faught, 1988; "The Tusk . . . ," 1995). Even the remains of possible prehistoric butchering sites have been discovered (Dunbar, 1995; Hoffman, 1983; Neill, 1964; Richardson, 1988; Serbousek, 1983). Some of the spear points found in association with these sites suggest that the early American Indians may have migrated from Asia to lower latitudes through an Eastern North American passage rather than through the Far West as traditionally viewed (Wilford, 1994).

Florida's paleontologists have long realized that the presence of fossil animal remains in the present-day river environment is the result of drastic sea-level changes in the past, particularly during the ice age, when sea-level in Florida was much lower. In fact, a number of inundated sinkholes with paleontological and archaeological features have been located off the coast of Florida on the continental shelf. These submarine sites hold potentially valuable artifacts (Anuskiewicz, 1988; Dunbar, 1988a, 1988b; Faught, 1988; Lazarus, 1965; Serbousek, 1988; "Underwater site. . . ," 1995). Attempts have been made by paleontologists to reconstruct the late Pleistocene and early Holocene environments of Florida, and the results suggest a diverse paleoclimate, with wet and dry environments

Figure 3. Small surface stream discharges into the Falling Water Sink. Note person in lower left for scale. This stream is the result of both overland flow and groundwater discharge.

coexisting in close proximity. Sea-level also changed rapidly during this time due to the waxing and waning of the continental glaciers. Paleo-Indian hunters tracked animal herds across many areas of Florida. Today, several of these "kill" or "butchering" sites have been located in places that are now underwater (Carbone, 1983).

Several items pertinent to creationist research can be drawn from these developments alone. The ice age, at least in the Southeastern United States, is believed to have promoted diverse fauna on a relatively grassy landscape. In the stages of regrowth following the Flood, along with the climate changes of the single ice age (Oard, 1990, pp. 78-91, 127-128; Vardiman, 1993, 1994; Whitcomb and Morris, 1961, pp. 288-326), these extensive grasslands would seem very plausible. This environmental setting could also explain the prevalence of so many large grazers—mammoths, mastodons, bison, horses, camels, giant land tortoises, glyptodonts, and ground sloths. Evidences suggest that Indians were already utilizing many sinkholes and karst formations as freshwater supplies as they hunted game across the area; thus, it appears that some of these karst

*Note—The authors accept neither the philosophical assumptions nor the vast time frames of the uniformitarian worldview. Later we will suggest an interpretation following the Young-Earth Flood Model using the creationist geological timescale previously suggested by Froede (1995a).

features were already in existence, or in the late stages of development due to hydrological changes brought on by the ice age.

American Indians remained near the Falling Waters site until the 1800s. Early American settlers reported that the Indians utilized the colorful rocks found in the vicinity of the sinks. These rocks were also collected by the early settlers. According to Carswell (1991, pp. 433-434), a historian of the region:

> Early settlers came from miles around to pick rocks with desirable color characteristics for use in making dyes. The rocks provided the pioneer housewife with a dazzling selection of color shades and blends. . . . A few (rocks) resemble the coconut somewhat in color, shape and size. The outer shell may be broken to reveal a fine-grained, reddish, dry, heavily pigmented substance inside. That is the substance early settlers used as dye. The fine-grained substance is powdery-dry and will burn, but not with explosive force. (parenthesis ours)

In the mid 19th century a local resident harnessed the waters of the stream to power a grist mill for grinding corn. These waters were also utilized for a legal whiskey distillery established in the late 1800s. Between 1919-1921, a wildcat oil well was drilled at the site, going to a depth of 4,912 feet below the land surface (Figure 9). The accounts of the "burning rocks" apparently prompted the wildcatters to drill in what they believed to be oil bearing sands. While not striking oil, the drilling project did net a wealth of information about the geologic nature of the Falling Waters site (Carswell, 1991, pp. 433-437, 443; Rupert and Lane, 1992, p. 3; Vernon, 1942, p. 33).

In the 1950s local efforts were made to turn the waterfall and adjoining sinks into a park, which was finally accomplished in the early 1960s (Carswell, 1991, pp. 437-442). A series of caves and passageways through the limestone connect the sinks in the park (Figure 2). Spelunkers have explored many of these passages. Before 1906 a large underground lake (approximately l-3 acres) was located somewhere below the falls, but modern spelunkers have observed no trace of it. The underground stream at the base of the falls, however, has apparently changed course in fairly recent times. Rock falls and debris may have blocked the former route to the underground lake. Spelunkers have also reported the absence of stalactites and stalagmites in the caves, evidence which suggests these passageways have recently formed (Carswell, 1991, p. 436; Rupert and Lane, 1992, pp. 7-9). Additionally, the small sizes reported for the cave passageways suggests that surface abrasion by sediments prevents the development of speleothem features (Maddox, 1993).

Figure 4. Surface stream waters pour into the Falling Water Sink. Note the horizontal jointing in the side walls of the Suwannee Limestone.

Karstic Development

According to Uniformitarians, the development of karstic terrain is usually viewed as taking tens to hundreds of thousands of years based on the extrapolation of today's weathering processes and limestone dissolution rates back in time (Beck, Ceryak, Jenkins, Scott, and Spangler, 1984, pp. 18; Ford and Williams, 1989, p. 420; Goudie, 1995, p. 64; Palmer, 1990, p. 189,1991, pp. 4-5; White, 1990, pp. 162-164). Even though it is recognized that limestone dissolution is dependent on many variable factors only a few factors are actually considered relevant to the process. Within the uniformitarian model it is suggested that mildly acidic water (carbonic and / or sulfuric), marine (ionic) waters, and biogenic factors are the primary factors in carbonate dissolution (Goudie, 1995, p. 61; James and Choquette, 1984, p. 165; White, 1988, p. 297-301; Wright and Smart, 1994, p. 477). Joints and fractures within the lithified limestone layers serve as zones of weakness and allow for greater rates of dissolution as compared to the whole rock surface. However, changes in precipitation levels and in the water chemistry (e.g., carbon dioxide, water temperature, ionic species, hydrogen sulfide, etc.) can drastically increase the rate that calcium carbonate is dissolved in the subsurface. Hence, the formation of karst can be accelerated based on these changes and therefore decrease the amount of time necessary to form these limestone dissolution features.

Presently, there are three models* used to explain the formation and development of caves and conduits within limestone layers (Ford, Palmer, and White, 1988, p. 408; Ford and Williams, 1989, pp. 261-265; White, 1988, pp. 264-271). However, Ford and Ewers (1978) caution that these three models are oversimplifications of an extremely complex process in the formation and development of karst and the processes involved in karst formation remain poorly understood. All of the karst developmental models suggest the dissolution of the calcium carbonate by water (both groundwater and surface precipitation). Changes in the regional groundwater base level is viewed as providing the greatest role in the development of karst features (Ford and Ewers, 1978, pp. 1792-1793; Ford, Palmer, and White, 1988, p. 408; Ford and Williams, 1989, p. 496-504; Mylroie, 1984; Palmer, 1984, 1990; White, 1988, p. 294-295; Worthington, 1991, p. 127). We believe that this is one of the most important aspects within our interpretation of how these features form. A creationist model for cavern and subsequent speleothem formation in relation to the Flood can be found in Williams, E. L. and R. J. Herdklotz, 1977, Solution and Deposition of Calcium Carbonate in a Laboratory Situation II. *CRSQ* 13:197-199.

The development of speleothems (i.e., stalactites and stalagmites) within limestone solution conduits depends upon the regional position of the groundwater table. The limestone opening must be above the water-table (i.e., not underwater) in order to allow for the formation and development of these features. In that no speleothems are reported at the FWSRA they will not be expanded on here further.

FWSRA within the Young-Earth Flood Model

We suggest that the majority of the sediments which compose the FWSRA stratigraphic section were deposited in marine conditions when Floodwaters still covered this area (Froede, 1995b; Froede, in review). This interpretation is based on the presence of marine fossils which occur throughout the stratigraphic column for this area. Hence, the marine fossils require a marine setting and the only time in earth's past when we view these conditions as present was when Floodwaters once covered this area (based on this elevation). Only the uppermost clastic strata around the FWSRA suggest a freshwater environment. This freshwater environment was only initiated following the withdrawal of the marine Floodwaters from this area. Hence, we would suggest that the boundary marking the Upper Flood Event from the Lower Ice Age Timeframe, for this particular locale, would occur where marine strata end and freshwater strata begin (based on lithology, paleontology, sedimentary structure, mapping, etc.—see Froede, in review). The lowering of the regional base-level of groundwater (concomitant with Floodwater withdrawal) also served to enhance the formation of karstic features in the limestone rock in the subsurface.

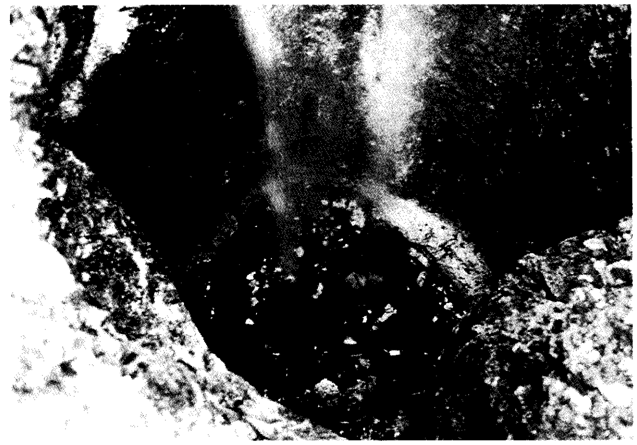

Figure 5. A closeup of the bottom of Falling Water Sink. The water falls on wooden debris derived from the former grist mill and dead trees washed into the sink. This wooden material now serves to block the passage.

Precipitation associated with much of the Ice Age created erosional conditions in which the overlying unlithified clastic sediments were subject to large-scale erosion. Additionally, the erosion was not limited to only the clastic overburden, but included much of the limestone exposed at the surface as well as in the subsurface within sections of the Marianna Lowlands. This is displayed in the highly dissected karstic plain which covers the Marianna Lowlands Province today and also by the relief expressed by the surrounding upland areas (Figure 8).

Within our interpretive framework we view the original limestones (i.e., Suwannee and lower portions of the Chattahoochee) as forming from calcium carbonate rich muds derived mainly from algae and microfossils. This flora and fauna lived in the relatively shallow Floodwaters while they covered this section of the North American continent (see Puri and Collier, 1967, p. 359) during the Upper Flood Event Timeframe. Water currents operating during this period of time served to occasionally mix these algal/microfossil derived carbonate muds with various isolated invertebrate communities in this shallow marine environment (e.g., Chen, 1965, pp. 88-91; Huddlestun, 1993, pp. 108-114).

*The three places where caves and conduits are suggested as forming are: 1) in the carbonate rocks above the groundwater table (i.e., vadose zone), 2) in the shallow groundwater zone (i.e., shallow phreatic zone), and 3) in the very deep groundwater zone (i.e., deep phreatic zone).

Nearby fluvial sources occasionally contributed clastic sediments forming thin layers between the carbonate rich muds as the Floodwaters continued to slowly recede toward the Gulf of Mexico Basin. This shift from a shallow marine carbonate mud to a freshwater clastic environment, with the slow withdrawal of the marine Floodwaters, is reflected in the vertical stratigraphic section exposed at the Falling Waters site. In support of our interpretation we will now review the stratigraphic section found at FWSRA.

The Suwannee Limestone is the lowest exposed stratigraphic unit at the FWSRA. However, as it is exposed specifically at Falling Waters it is not exactly the same limestone, either in composition or paleontology, as the type section farther to the southeast. Vernon (1942, p. 56) stated that the identification of several marine molluscan fauna led to the identification of the carbonate rock layers in Washington County as Suwannee Limestone; he adds:

> It was impossible to establish mappable units within the Suwannee in Washington and Holmes Counties.
>
> It may be that the unit mapped as Suwannee Limestone in Holmes and Washington Counties is not the precise equivalent of the Suwannee in its type area. The writer, however, feels that the identification of Suwannee mollusks from some of the localities in Holmes and Washington Counties justifies the correlation.

Additionally, Vernon (1942, p. 59) describes the Suwannee Limestone as:

> . . . characterized by solution topography with numerous sinks and irregularities which pre-empt or capture surface drainage.
>
> The Suwannee is a light-gray to buff, porous, extremely fossiliferous limestone. Locally the bed is a mass of large and small foraminifers. Partial weathering produces crystallization and a pink tint due to the incorporation of iron oxide. The limestone contains many silicified masses which remain in the residual clays (following the weathering of the limestone mass) and some have been included as boulders in alluvial deposits. Some of these Suwannee boulders . . . were originally calcareous, highly fossiliferous sandstones. (parenthesis ours)

According to Yon and Hendry (1969, p. 12) the Suwannee is additionally described as: ". . . a light yellowish orange, abundantly microfossiliferous, partially recrystallized, soft to hard, granular limestone (calcarenite)."

At the Falling Water Sink, Vernon (1942, p. 61) reported the Suwannee Limestone as composing the lower 73 feet of exposed section. Overlying the Suwannee Limestone and also exposed along the sidewalls of the Falling Water Sink is the Chattahloochee Formation (Tampa Limestone equivalent) which has been described by Reves (1961, p. 67) as: ". . . 11.5 feet of light gray, indurated massive chalky, sandy, silty, argillaceous, fossiliferous limestone . . . containing lenses and seams of blue-green clay."

Figure 6. An opening to the underlying cave system immediately adjacent to Falling Water Sink. Note how easily that vegetation can be washed into the cave system.

In the early to mid 1960's an extensive limestone resource drilling program was conducted in Washington County, with several wells drilled near the FWSRA. The testing of the composition of the various limestone layers revealed that the Chattahoochee Limestone was almost pure calcium carbonate (95%), with the remaining 5% being magnesium carbonate (Shirley and Sweeney, 1965, p. 132). Drilling records revealed a porous and vuggy upper surface of the Chattahoochee Limestone immediately beneath the clastic overburden. This type of highly weathered zone (i.e., subcutaneous or epikarstic zone) serves to enhance the dissolution of the limestone. According to Ford and Williams (1989, p. 120) drainage into the subsurface within this zone is initially diffuse but then moves along preferred paths as it drains into the subsurface. Additionally they state: "Therefore it is probable that corrosion within the epikarst is greatest where flow paths converge above the more efficient percolation routes."

Hence, the Chattahoochee Limestone serves to funnel water down into the underlying Suwannee Limestone in a manner which directly enhances the formation of subsurface conduits.

The reader will note that the previous descriptions of the Suwannee and Chattahoochee Limestones do not suggest an original coral reef environmental setting. Rather, these limestone units better support a Bahamian shallow-water-carbonate bank-margin type of depositional environment (Halley, Harris, and Hine, 1983; Hine and Neumann, 1977; Lasemi and Sandberg, 1984; Milliman, Freile, Steinen, and Wilber, 1993; Purdy, 1963a, 1963b; Strasser and Davaud, 1986). This depositional setting has a direct bearing on the time and manner in which these limestones would develop, with the shallow-water-carbonate bank-margin environment developing much more rapidly than a true coral reef environment. We note that not every limestone deposit reflects a former coral reef environment and this fact has great implications as we reinterpret carbonates in the stratigraphic record within the framework of the Young-Earth Flood model (Dunham, 1970; Nevins, 1972; Whitcomb and Morris, 1961; Woodmorappe, 1980, 1982). The Bahamian shallow-water-carbonate bank-margin type of depositional environment is typical for most of the Cenozoic carbonates found in the Western Florida Panhandle.

The Alum Bluff Group which immediately overlies the Chattahoochee Limestone marks a major change in sedimentation. Carbonate sedimentation ended as near-by terrigenous sources deposited elastic sediments in the marine environment. Schmidt and Coe (1978, p. 12) reported the Alum Bluff Group deposits as:

> They tend to include sandy clays and clayey sands with abundant mollusk shells (marine varieties) being preserved. . . . there is a thin veneer of sands which exists as a blanket deposit covering all lithologies. These sands can be found at various elevations, **traceable to ancient sea level fluctuations.** (parenthesis and emphasis ours)

Immediately above the Alum Bluff Group are undifferentiated clastics which reflect a freshwater setting. These sediments were deposited after the marine waters withdrew from this area. This layer is probably derived from reworked Alum Bluff Group sediments as well as sediments derived from upland areas.

Following the deposition of the various stratigraphic layers within the area around the FWSRA, precipitation then served to begin the erosion of these elastic sediments and the underlying strata. Additional erosion and removal of the undifferentiated sands and clays, the Alum Bluff Group, and portions of the underlying limestone layers would follow the drop in the regional groundwater base-level. This drop in the groundwater level would directly correlate with the drop in sea-level conditions associated with the waxing and waning of the continental glaciers during the single ice age and possibly include some tectonic input. The dropping of the regional groundwater base-level is the same sort of phenomenon that was suggested as contributing to the formation of caves and solution conduits in the Clayton Limestone along the Chattahoochee River in Georgia (Froede, 1994), Additional carbonate dissolution would occur due to the production of volcanic aerosols during the single ice age (Oard, 1990, p. 67). These volcanic products would have served to increase the acidic strength of precipitation and groundwater and therefore increase the dissolution rate of the limestones. Organic materials decomposing in the subsurface would also contribute to the dissolution of carbonate rock by leaching organic acids into the groundwater and thus enhance the dissolution rate of the calcium carbonate (James and Choquette, 1984). Hence, there are many factors which affect the dissolution of carbonate rock and they all would serve to accelerate (at varying degrees) the process of karst formation. This then suggests that karst features can develop more rapidly than the uniformitarian model currently recognizes and at a rate that works well within our short time frame.

Figure 7. Another series of openings separated by a small limestone ridge. In many places these openings follow the joint set of the Chattahoochee and underlying Suwannee Limestones.

The greatest rates of carbonate dissolution would occur where freshwater and saltwater would mix in the subsurface. This mixing of these waters within the subsurface would have occurred as the Floodwaters slowly withdrew from this area. Additionally, any transgression/regression events during this time (associated with continued but lessening tectonism and repeated glaciation-see Reed, Froede, and Bennett, 1996) would have served to repeat this corrosive environment.

Within the mixing zone the limestone dissolution features would have rapidly developed as the marine Floodwaters mixed in the subsurface with freshwater flowing southward along limestone joints and fractures (see Back, Hanshaw, and Van Driel, 1984; Beck, Ceryak, Jenkins, Scott, and Spangler, 1984, pp. 17; Ford, Palmer, and White, 1988, p. 411; Land, Paull, and Hobson, 1995; Mylroie and Carew, 1988; Plummer, 1975; Runnels, 1969; Steinen and Matthews, 1973; White, 1990; Wicks, Herman, Randazzo, and Jee, 1995). According to Back, Hanshaw, and Van Driel (1994, p. 286) this subsurface mixing of marine and freshwater should be viewed as more common than currently realized; they state:

> Geologic significance of subsaturation can be emphasized by remembering that every marine limestone now containing freshwater has been subjected to dissolution and diagenesis caused by the mixing zone phenomenon at least once. Most have probably undergone the effects of this process repeatedly. For example, at any stand of sea level, the zone of dispersion (mixing zone) will occupy a certain position within the limestone aquifer. As sea level drops, the zone of dispersion will follow the lowering sea level, thereby subjecting additional carbonate rocks to these processes. Subsequent rise of sea level will permit the zone of dispersion to migrate back up through the aquifer and cause the limestone to undergo additional diagenesis and differential dissolution. (parenthesis ours)

This repeated intermixing of freshwater and marine waters within the limestones would have enhanced and accelerated the formation of solutional features. The enlargement of these features would have increased the rate of overlying clastic sediment removal, which could have culminated in the collapse of the clastics into the solutional cavities. These sediments would then wash through the solutional conduits and enlarge

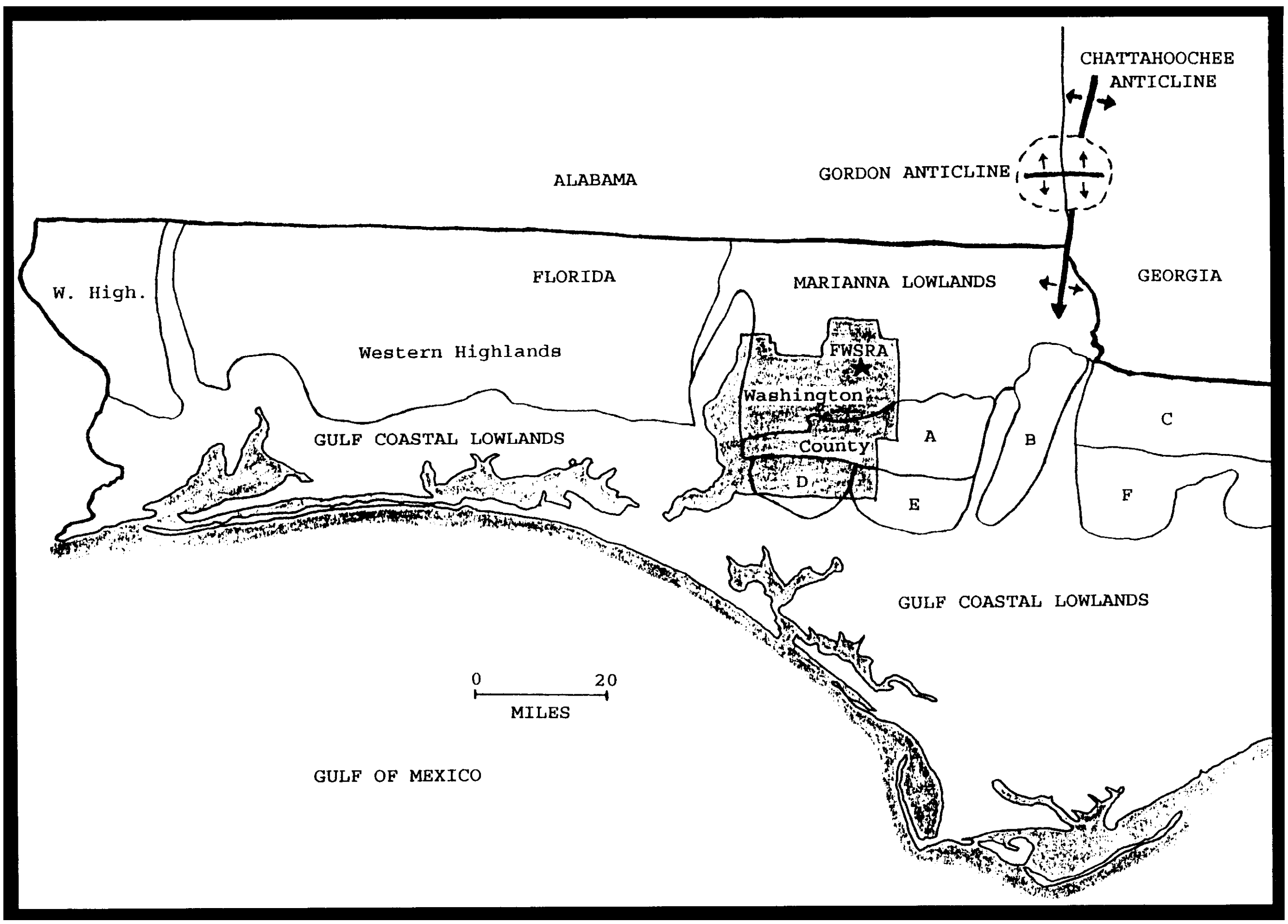

Figure 8. Geomorphic features of the western Florida Panhandle. The Falling Waters State Recreation Area lies toward the northern end of Washington County within the Marianna Lowlands Province. Also note the Marianna Lowlands in relationship to the other higher geomorphic provinces. The uplifted area most commonly identified as the Chattahoochee Anticline lies to the northeast of Falling Waters. The areas represented by letters show adjacent but separate geomorphic areas: A) New Hope Ridge, B) Grand Ridge, C) Tallahassee Hills, D) Greenhead Slope, E) Fountain Slope, F) Beacon Slope. This figure is compiled from Chen, 1965: Fernald and Purdum, 1992, p. 22; Patterson and Herrick, 1971: Rupert, 1994: Scott, 1991, 1992; Scott, Lloyd, and Maddox, 1991.

the passageways through abrasion. Ultimately these clastics would discharge at downgradient seeps and springs.

The development of vegetation (specifically trees) in the soils which directly overlie the limestones would have also contributed to the further development of sinkholes during the Ice Age Timeframe. Following the death and rotting of the tree, the former root system could provide a preferential drainage conduit from the surface directly to the top of the underlying limestone. Waters would then rapidly drain into the subsurface and flow toward any solutional features already existing within the limestone. Eventually, and as a function of the rate of water influx through the root conduit, the limestone sinkhole would erode away overlying sediments until it became exposed directly to the surface (Newton, 1987, pp. 24-25). The authors observed this root conduit phenomenon first-hand at FWSRA.

The complete lack of speleothems within any of the caves of FWSRA suggests that these caves and sinks probably formed in subaqueous conditions (i.e., within the Phreatic Zone). This would require the regional groundwater table to have existed at a higher level than present, which directly correlates to a higher-than-present sea-level position. We would suggest that the FWSRA limestone solutional conduits were probably initiated at an early stage perhaps starting under phreatic conditions with the withdrawal of the Floodwaters and the influx of freshwater. The uplift of the area in and around the Marianna Lowlands coupled with the drop in sea-level would have served to contribute to the rapid erosion of the overlying clastic sediments and upper sections of the limestones. Groundwater during this time would have served to drain through rapidly developing solution channels within the limestone at depth. Eventually, the clastic overburden would have been removed from many areas within the Marianna Lowlands by both overburden collapse and from erosion via overland flow. The constant influx of plant and clastic materials through the solutional passageways probably served to prevent the formation and development of speleothems within the various cave systems once the area existed above the groundwater table.

The circular shape of the area immediately surrounding FWSRA suggests that sinkhole collapse was a primary cause in the removal of the clastic overburden. A drop in the regional groundwater level probably initiated the final stages of removal of the limestone and clastic materials overlying these sinkhole features. The occurrence of a thin layer of sedimentary clastic cover which still remains over the present sinkhole/cave network serves to reinforce our interpretation of the “from the bottom up” development of this karstic landscape (i.e., sinkhole collapse) [see Sinclair and Stewart, 1985]. Rupert and Lane (1992) also proposed this same manner

Figure 9. All that remains of the original oil well drilling project is this surface casing which is filled with cement.

of formation for the Falling Water Sink. While overland flow served to wash away some of the clastic sediments covering this area of the Marianna Lowlands, it probably was not a major factor in forming these sinkholes and cave systems. Today, surface water run-off from the area immediately surrounding these sinkholes continues to channel water into the subsurface and wash both clastics and plant debris into the sinkholes and caves. The mapping of the FWSRA cave systems has revealed a complicated drainage pattern following fractures and joints within the limestone (Lane, 1986, pp. 53-57; Maddox, 1993, pp. 15-17; O’Hara, 1984). The poor development of the cave network, the narrow passageways, and the lack of any speleothems within the caves suggest that the FWSRA cave system formed within the past few thousand years. Our interpretation is counter to the uniformitarian model of the development of these features over the course of a much greater time span.

Waters entering these sinkholes follow the regional dip of the limestone layers. The waters would ultimately discharge where openings (i.e., seeps and springs) formed and developed (usually near coastal areas). When sea-level would drop the groundwater would continue to move in the subsurface following the regional dip of the limestone layers and again create springs farther downgradient. With a drop in sea-level and the corresponding drop in the regional groundwater base level, areas once containing springs would turn into sinks as groundwater by-passed these areas for lower areas to discharge. It is these springs and sinkhole areas which served the paleo-Indian cultures as they moved across the Southeastern United States. A drop in the sea-level and regional groundwater table, during a stade within the single ice age, might have forced these early cultures to move ever southward seeking reliable sources of water at seeps and springs. The subsequent rise in sea-level, associated with an interstade within the single ice age, would restore the former seeps and springs at their higher elevations.

Due to the relief surrounding the sinkholes and cave network around the FWSRA, we would suggest that this area was never a site for a spring (Figure 2). The topography of the site does not suggest that a spring or river ever flowed from this site. While there probably was some overland flow across this area in the past, there is no evidence of any stream which emanated from this collection of caves or sinkholes. Additionally, the FWSRA cave system has not been reported to contain any megafauna typical of historical water source sites. Rather, only wood and clastic sediments are reported as found within the cave systems (Maddox, 1993, p. 15). If in the future there is discovered the remains of some Pleistocene creature within one of the caves, further investigation could then be initiated to determine how it may have come to be within the cave.

Conclusions

The karstic features displayed within the Marianna Lowlands Province provide interesting testimony to the dissolution of limestone rock. It has been suggested that following the uplift of this area clastic sediments and underlying limestone layers were subject to erosion. According to uniformitarian estimates, the limestone layers dissolved away over the course of many thousands of years leaving sinkholes and caves.

The use of many of these karst features by paleo-Indian cultures suggests that they were already formed. Various relics found at many of these karst sites indicate that the paleo-Indian cultures used them. Megafossils and other archaeological evidence suggest that many of these areas were also used by animals.

In following the time frames of the Young-Earth Flood Model, we would suggest that by changing the precipitation rates along with a few groundwater parameters the solution of the limestone rock could have occurred in a much more rapid fashion. Probably the most important factor in the dissolution of the limestone was the mixing of fresh and salt water as the Floodwaters slowly receded from the area. Changes in sea-level (as a result of tectonics and glaciation) directly impacted regional groundwater levels. The drop in sea-level and corresponding drop in groundwater base level would enhance the further development of the existing sinkholes and subsurface conduits (i.e., caves) from which surface waters would drain. Sediments overlying these sinkhole features would eventually collapse (a process identified as soil arch failure), exposing the underlying limestone sinkholes. This same phenomenon is reported today where groundwater pumping rates in karst aquifers lower the water table to the point where the surrounding soil arches, vugs, and solution features can no longer support the weight of the overlying sediments, resulting in catastrophic collapse (Beck, 1986; Bonacci, 1987, pp. 168; Newton, 1987; Rosenshein and Back, 1988).

The description of the narrow cave passages which follow the joint and fracture sets within the FWSRA limestones reflects a poorly developed cave system. We would suggest that the cave systems at FWSRA reflect relatively recent development (i.e., within the past few thousand years as opposed to one which has been developing over the course of tens to hundreds of thousands of years). We interpret the solutional conduits within the FWSRA limestones as initiating with the mixing of marine and freshwater with the draining of the Floodwaters. Enlargement of these solutional features likely occurred due to abrasion from the clastic sediments which washed through these features with the drop in groundwater base level. The continued flushing of the conduits by water-driven plant and clastic materials has prevented the formation of any speleothems. The FWSRA was never the location of a spring simply because it only became exposed as the regional groundwater table dropped (following the drop in sea-level). Hence, we suggest that it has always been a sinkhole site.

Migrating paleo-Indian cultures which lived within this area used the flora and fauna to support their existence. Evidence to support this interpretation has been gathered and studied by uniformitarian archaeologists. We agree with their findings but reject the uniformitarian time frames. We view the paleo-Indian cultures as also providing us with additional information about the timing of sea-level rise and fall during stades and interstades of the single Ice Age. This subject will be addressed in a later article (Rucker and Froede, in review).

Found within the Marianna Lowlands Province, FWSRA represents an outlier of carbonate rock and overlying clastic sediments where changes in sea-level and groundwater have resulted in the formation of a number of karstic features. The small-scale development of the caves within this area suggest to us that they have only been in existence for three to four thousand years, since the withdrawal of the Floodwaters. Further development of these karst features has occurred in association with the wet weather conditions of the ice age. Minor development has continued since then. Today, we believe that FWSRA provides testimony to earth's short history and global Flood.

Glossary

Interstade — A warmer substage of a glacial stage, marked by a temporary retreat of the ice (Bates and Jackson, 1987, p. 341). Our definition of this term would suggest that we only experienced one ice age with many warm periods (i.e., interstades). This period would result in a sea-level rise.

Karst — A type of topography that is formed on limestone by dissolution, and that is characterized by sinkholes, caves, and underground drainage (Bates and Jackson, 1987, p. 356).

Phreatic Zone — Also known as the zone of total water saturation; this subsurface zone is where all the pores spaces are filled with water under pressure greater than one atmosphere (Bates and Jackson, 1987, pp. 500, 749).

Stade — A substage of a glacial stage marked by a glacial readvance (Bates and Jackson, 1987, p. 639). Our definition of this term would suggest that we only experienced one ice age with many glacial readvances (i.e., stades). This period would result in a sea-level fall.

Vadose Zone — The zone of aeration or area above the groundwater surface (Bates and Jackson, 1987, p. 717).

Vug — A small cavity in a vein or in rock (Bates and Jackson, 1987, p. 728).

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Trust in the Lord with all your
heart
and lean not to your own
understanding;
In all your ways acknowledge him,
and he will make your paths
straight.

Proverbs 3:5-6 HOLY BIBLE, NEW INTERNATIONAL VERSION

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