FOSSIL WOOD OF BIG BEND NATIONAL PARK, BREWSTER COUNTY, TEXAS: PART IV—WOOD STRUCTURE, NODULES, PALEOSOLS AND CLIMATE

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Abstract

The various charcoalified and petrified wood samples collected from the Dawson Creek region of Big Bend National Park are examined optically and by scanning electron microscopy. No discernible growth rings were detected in the specimens. Also the nodules collected are examined by scanning electron microscopy. Possible past climate change in the Big Bend region is discussed.

Key Words: Charcoalified Wood; Silicified Wood; Paleoclimate Fluctuation; Dawson Creek, Big Bend National Park.

Introduction

Several specimens of silicified and charcoalified wood were collected from the Upper Cretaceous Javelina and Aguja formations in the Dawson Creek area of Big Bend National Park by permission of the National Park Service (Williams and Howe, 1993). The mechanisms of silicifaction and possible rapid petrifaction of fossil woods were discussed (Williams, 1993). Various chemical tests were performed on the samples and a model for the preservation of the charcoalified wood was offered (Williams et al., 1993). This Part provides more information on the various fossil woods and other geological studies in Big Bend National Park. Also some creationist applications are suggested.

Fossil Wood

Lehman (1989, p. 199) reported that of the well-preserved petrified logs found in the flood-plain deposits of Trans-Pecos, Texas ". . .61% were conifers, 31% were dicotyledonous angiosperms and 8% were palms." Three-quarters of the conifers have ". . . distinct or indistinct growth rings . . ." However only about one-half of the dicot specimens contained growth rings.

Wheeler (1991a, 1991b) examined petrified wood from the Javelina and Aguja formations as well as from the Paleocene Black Peaks formation. Wheeler (1991a, p. 41) explained:

> The Cretaceous wood assemblages of Big Bend that are dominated by dicotyledons are distinct from Cretaceous wood assemblages of higher latitudes most of which are dominated by conifers.
>
> The Big Bend Cretaceous angiosperm woods lack distinct growth rings and have other characteristics that today characterize woods of tropical forests, by [sic] none to date resemble any single extant family. Characteristics of the vessels in these woods may be of value in tracking climate changes during the Late Cretaceous.

In her work on Paleocene dicotyledonous trees from Big Bend National Park, Wheeler (1991b) described the characteristics of *Paraphyllanthoxylon abbottii* n. sp. and cf. *Plataninium haydenii* Felix from the Black Peaks formation. These are the first Paleocene dicotyledonous woods from North America whose anatomy has been studied. The *Paraphyllanthoxylon* trees do not have distinct tree rings and Wheeler suggested that they ". . . grew in a climate without marked seasonality" (1991a, p. 41). She claimed that the anatomy of the *Paraphyllanthoxylon* trees is similar to the Cretaceous woods from the Javelina formation as well as the Cretaceous woods from Arizona and New Mexico.

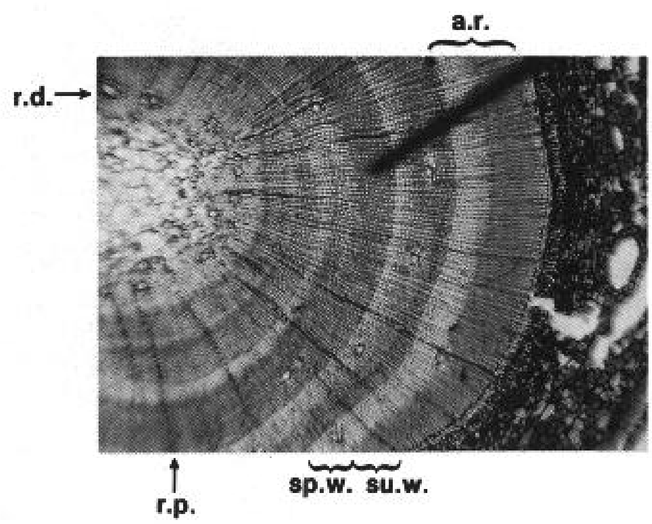

Figure la. Cross section of a modern pine twig, *Pinus* sp. The bracket a.r. surrounds one annual ring of xylem production. The region of "springwood" tracheids with a larger diameter (sp.w.) and "summer wood" tracheids (su.w.) are also visible. Resin ducts (r.d.) occur in the wood of pines and certain other modern gymnosperms. These cross sectional views of pine wood structure will serve as a basis of contrast with the cross sections of fossil charcoalified and silicified woods in later figures. The lines of cells appearing like spokes in a wheel are ray parenchyma cells, thought to store starch and to conduct materials in a radial direction throughout the stem (r.p.). Magnification—40X.

Note that some of our petrified woods lack distinct growth rings (see Figure 2). If these were pre-Flood trees washed into the Big Bend region by Flood waters, possibly there was no *marked* seasonality before the Flood or simply the trees grew in a tropical pre-Flood region. If the specimens are from early post-Flood trees which grew in the Big Bend area, it indicates possibly a tropical climate there immediately after the Flood.

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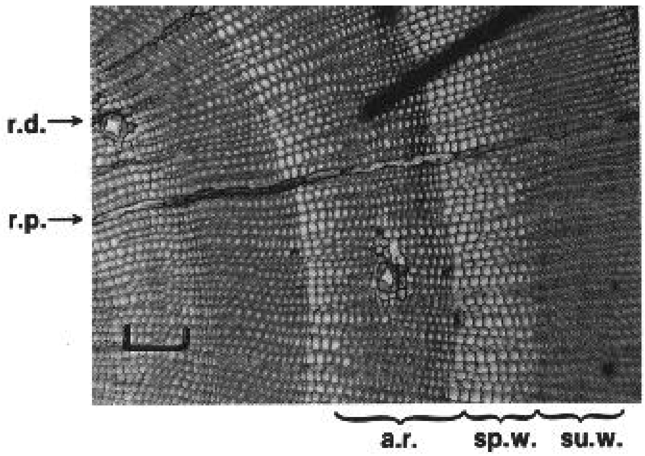


Figure lb. Cross section of a modern pine twig at higher magnification. Annual rings, spring wood tracheids, summer wood tracheids, ray parenchyma, and resin ducts are labeled as in Figure la. Note again the distinct nature of annual rings. Scale bar—100µm.

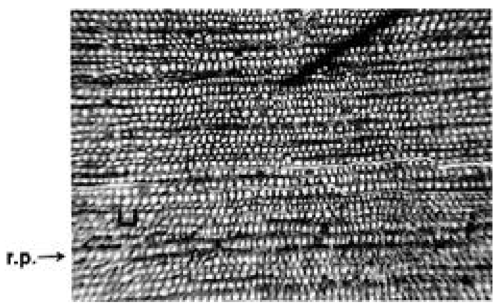


Figure lc. Cross section of modern pine twig at great magnification. Cell diameter decreases and cell wall thickness increases when moving from springwood tracheids (center at pointer tip, to summerwood tracheids (far right or far left). Note three elongated ray cells stretching across the center. Tracheid cell diameters range from 10-15 µm, about three times smaller than cell diameters in the fossil wood 19, Figure 2d. Scale bar—100µm.

Structures of Charcoalified and Petrified Wood Samples

We have examined thin sections and scanning electron photomicrographs of the samples of fossil-wood we collected. Structural features of the specimens will be noted and compared to thin sections of modern pine trees. The reader is urged to consult Williams et al. (1993) for specific illustrations of many of the samples in situ.

Figure 1 shows various magnifications of a cross section of a modern pine twig for comparison with the fossil woods. Various microscopic views of a fossil wood specimen that may have been charcoalified somewhat before silicifaction are seen in Figure 2. More chemical analysis work will be performed on this sample (19). [See Williams et al., 1993, Figures 5,6, 8 and Table II.] Scanning electron photomicrographs of a silicified specimen 19 (Figure 3) should be compared with Figure 2 (optical microscopy). The structure of two charcoalified wood samples Williams et al., 1993, pp. 169-172) are shown in Figures 4-7. Scanning electron photomicrographs of silicified specimen 25 (Williams et al., 1993, pp. 172-175) are given in Figure 8. All of the data collected thus far in this investigation are summarized in Table I.

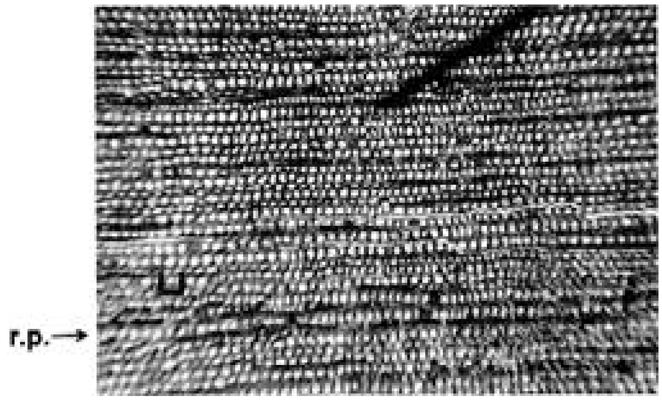


Figure 2a. Cross section of a silicified wood sample 19 that may have been charcoalified somewhat before petrifaction (low power). Further chemical analysis will be-performed on this sample. See Figures 5, 6 and 8 (Williams et al., 1993) for representative illustrations of this fossil wood. This photograph has the same low magnification as the pine tissues in Figure la. In this fossil wood the tracheids are of much larger diameter than in pine. Likewise there are no pronounced "annual rings" as in modern pine stems nor does this fossil wood have resin ducts. It is a gymnosperm wood rather than an angiosperm wood because it has no "xylem vessels" and its water conduction was thus limited to tracheids, as in the pine. Ray parenchyma cells (r.p.) are clearly visible. Scale bar—100µm.

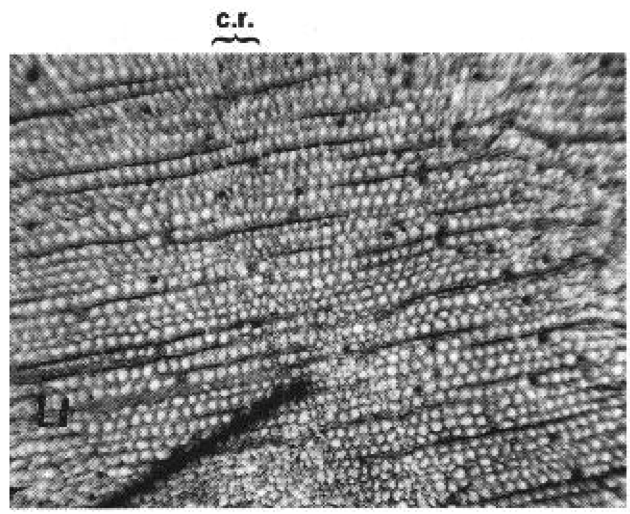


Figure 2b. Cross section of fossil wood specimen 19 showing slight circumferential ring not comparable to an annual ring. This photograph has the same low magnification as Figure 1a an 2a. One area of this slide manifests a faint circumferential ring (c.r.) containing slightly smaller than average tracheids. This may indicate a minor shift in climate for a short time period. This ring is not nearly as pronounced as the annual rings in a modern pine branch—Figure la. Scale bar—100µm.

Mineral Nodules

Williams et al. (1993, pp. 173-175) collected and chemically analyzed some samples of nodules/calcified wood (?) from the Javelina and Aguja formations. One of the specimens appeared to have some wood struc-

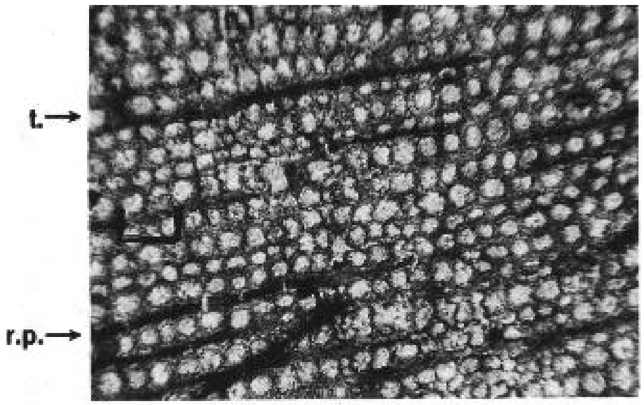


Figure 2c. Cross section of fossil wood specimen 19 at same medium magnification as Figure lb. Note tracheid cell (t.) diameter is up to 40µm which is 3-4 times larger than cell diameters in modern pine tracheids (Figure lb). There are no hints of annual rings in this fossil wood. Large tracheid diameters and absence of well defined annual rings fit with the theory that these trees grew where there was a rather uniform annual climate devoid of seasonal fluctuations in either rainfall or temperature. Ray parenchyma (r.p.) cells form the dark line across the center. Scale bar—100µm.

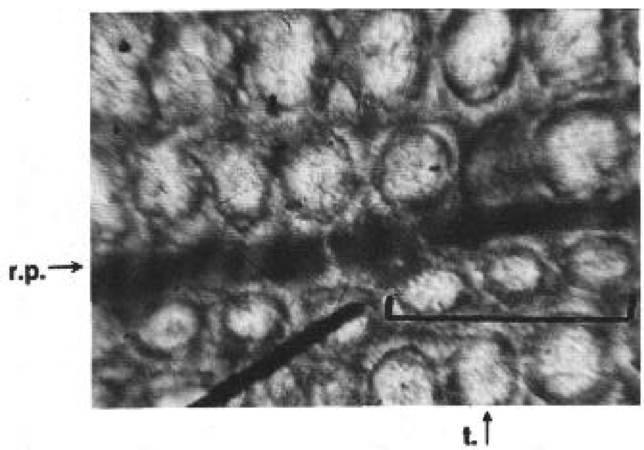


Figure 2d. Cross section of fossil wood specimen 19 at the same magnification as in Figure 1c. Ray cells are dark colored; tracheids have light open centers. No annual rings are evident nor are resin ducts seen. Cell diameter of tracheids in this fossil wood is easily three times larger than in the largest tracheid diameters of the modern pine twig, Figure 1c. Scale bar—100µm.

ture under scanning electron microscopy (Figure 10). However this conjecture remains uncertain until an examination of the sample by an authority on wood structure is completed. Interestingly Kraus (1988, pp. 888-893) examined some calcareous nodules found in Bighorn Basin, Wyoming and deduced that they were nodular remains of early Tertiary forests even though no well-preserved wood structure could be found.

Pieces of the nodules (Williams et al., 1993, pp. 174-175, Figures 13-15) found in the Dawson Creek region of Big Bend National Park tend to tear apart in wedge sections. This reminds one of certain seed plants such as cycads. Perhaps the nodules are organs from fossil cycads or cycadeoids (also known as Bennettitales). Possibly some of our readers would care to comment on the nature and identity of such cone-like nodules.

Lehman (1989, pp. 193-198) examined different types of nodules collected from the Upper Cretaceous paleosols in Trans-Pecos, Texas. None of these petrocalcic nodules appear to be similar to the ones collected by Williams et al. (1993) but Lehman's work may be of interest to many readers.

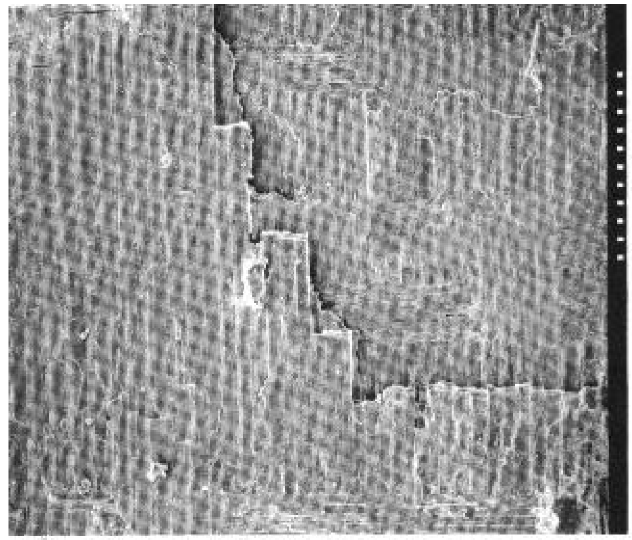


Figure 3a. Scanning electron photomicrograph of silicified wood specimen 19. Compare with Figure 2. A broad band of ray parenchyma is visible (lower center) and numerous tracheids are positioned vertically. In vertical (radial) sections like these, the tracheids look like long, vertical rectangles and the rays look like multicellular ribbons at right angles to the tracheids. Scale bar (dotted line)—500µm.

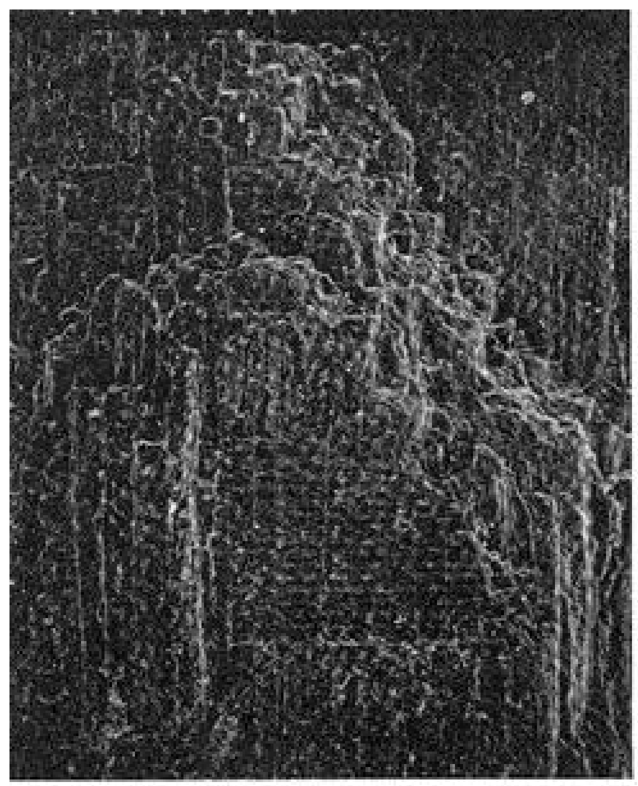


Figure 3b. Scanning electron photomicrograph of radial section from silicified wood specimen 19. Vertical cells are tracheids; cross bands are rays (composed of ray parenchyma cells). Scale bar (dotted line)—380µm.

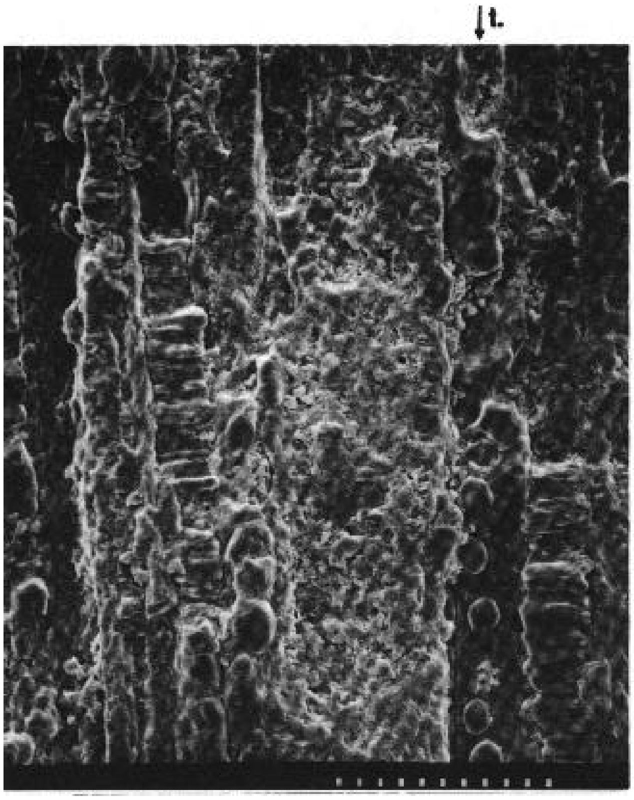


Figure 3c. Scanning electron photomicrograph of silicified wood specimen 19; radial section. Vertical cells are tracheids (t). At this high magnification, pits (p) are visible in one tracheid seen below the arrow. Scale bar (dotted line)—75µm.

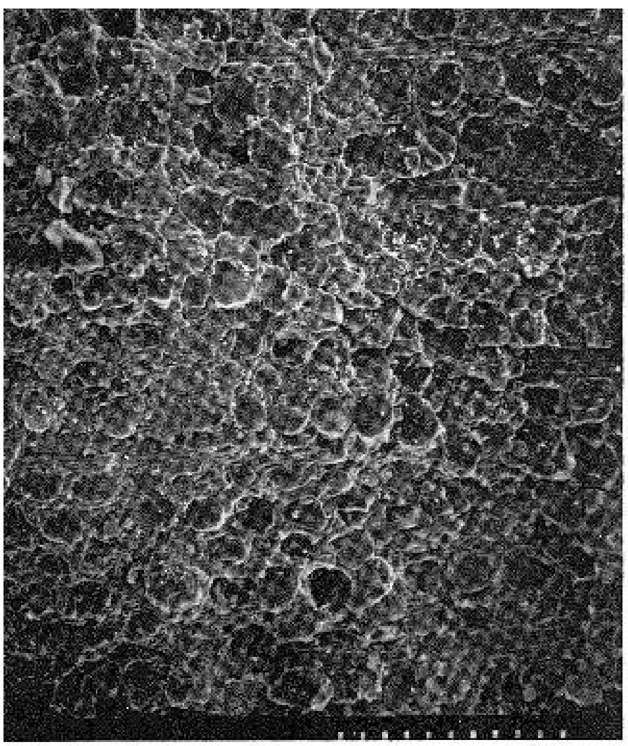


Figure 3d. Scanning electron photomicrograph of silicified wood specimen 19 in cross section. Many tracheids are visible. Scale bar (dotted line)—200µm.

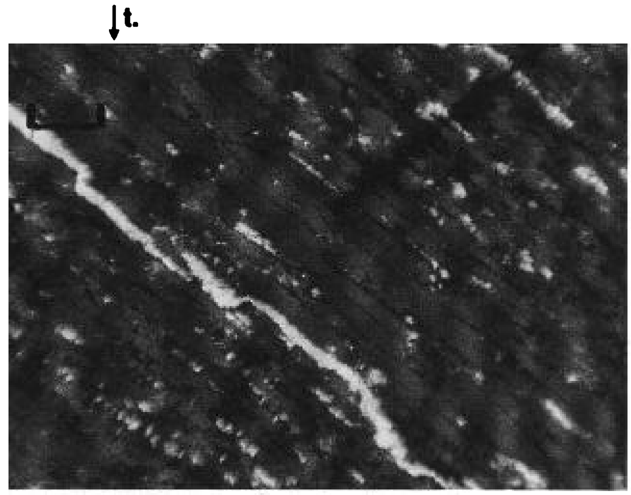


Figure 4. Radial section of the charcoalified wood limb specimen which was illustrated in Figure 1, p. 170, Williams et al. (1993). Tracheids are seen as spindle-shaped objects (t). Scale bar—100µm.

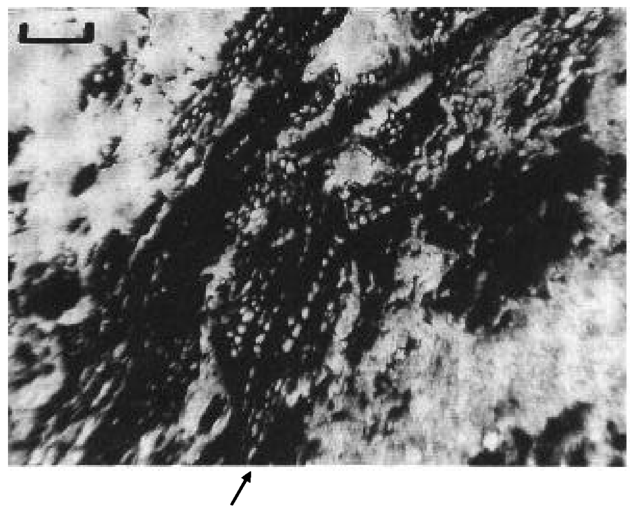


Figure 5. Mineralized surface of charcoalified wood specimen a (Williams et al., 1993, pp. 169-172). Cellular detail in charcoalified region is evident as clear dots in a row—see arrow. The other areas of the slide where no cellular detail is visible are mineralized. Compare with Figure 3. The surface cellular structure may have been distorted by the heat from volcanic action and/or fire and later mineralized. Scale bar—100µm.

Climatic Changes

Based on his studies of the Upper Cretaceous paleosols, Lehman (1989, p. 201) speculated that the ". . . climate in the Trans-Pecos region must have oscillated between periods of humid and semiarid character." He (1989, p. 188) suggested that the climatic cycles could be attributed to Milankovitch cycles. An excellent creationist evaluation of Milankovitch cycles was given by Oard (1984a; 1984b; 1985) and the author offered much evidence against the concept. Creationists interested in possible past climate changes are urged to read this series.

Lehman (1990, pp. 362-364) examined the paleosols at the Cretaceous/Tertiary transition in the Big Bend region and postulated that:

Table I. Collection Sites, Chemical Analysis and Structure of Fossil Woods—Dawson Creek Region, Big Bend National Park, Texas.

Specimen Designation	Location	Typical In Situ Fossil Wood	Collected Specimens	Quantitative Analysis*	EDX Analysis	Infrared Analysis	Structure of Wood
Charcoalified Wood-a interior	Fig. 1a, b- Part I	Fig. 1a, b, c- Part III	Fig. 1d- Part III	59%C	N.D.	p. 171- Part III	Fig. 4, 7- Part IV
Charcoalified Wood-a Mineralized Surface	Fig. 1a, b- Part I	Fig. 1a, b, c- Part III	——	——	Si, Al, S, K, Ca, Fe	——	Fig. 5- Part IV
Charcoalified wood-b interior and surf ace	Fig. 1a, b- Part I	Fig. 2- Part I	——	——	——	——	Fig. 6- Part IV
Silicified Wood 19	Fig. 1a, b- Part I	Fig. 5, 6- Part III	Fig. 8, 9- Part III	94-97% SiO_2	Si, Al, S, K, Ca, Fe	——	Fig. 2, 3- Part IV
Silicified Wood 25	Fig. 1c- Part I	Fig. 11- Part III Fig. 9- Part IV	Fig. 12- Part III	91% SiO_2	Si, Al, Mn	——	Fig. 8- Part IV
Calcified Wood / Nodules? (CN)	Fig. 1c- Part I	Fig. 13, 14- Part III	Fig. 15- Part III	52% CaO 5% SiO_2	Ca, Si, Al, Mn, Fe	——	Fig. 10- Part IV

EDX—Energy dispersive x-ray analysis.
N.D.—No elements detected.
*—Refer to Part III for more exact percentages.
Part I — *CRSQ* 30:47-54; Part II — *CRSQ* 30:106-111; Part III — *CRSQ* 30:169-176.

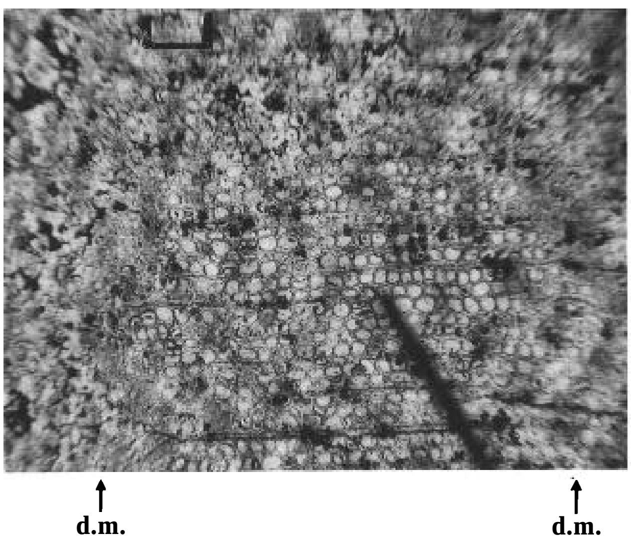


Figure 6a. Cross section of a small charcoalified wood sample b with a mineralized exterior. Sample b has similar microscopic appearance as 19 (Figure 2). Comparing sample b with sample 19, it is obvious that sample b has undergone disturbance noted here by dm (disturbed morphology). This sample was likely heated by volcanic action and/or fire and later mineralized possibly causing cellular distortion. Scale bar—100µm.

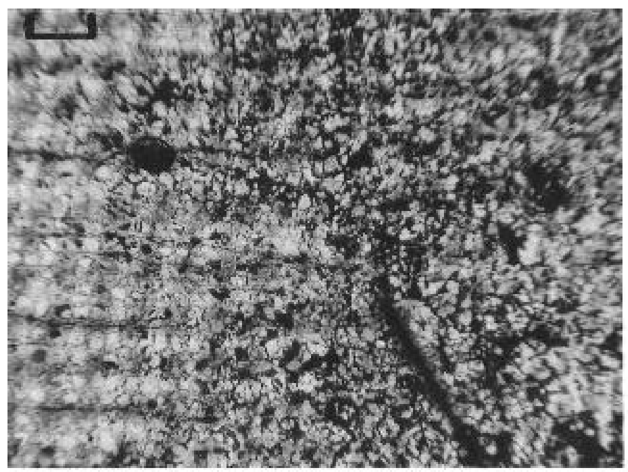


Figure 6b. Another cross section of charcoalified wood sample b—disturbed area. Note at the pointer tip that the usual rows of tracheids are missing and whatever cellular structure that exists is disorganized. A greater degree of such disorganization of original tissues can be seen in Figure 5 of the mineralized exterior of charcoalified sample a. Scale bar—100µm.

> . . . comparison with modern soils suggest that early Paleocene soils developed under conditions of higher rainfall and cooler temperatures than did Late Cretaceous soils (p. 362).

If a post-Flood ice age postulated by Oard (1990) occurred, any soils that formed at that time in the Big Bend region might indicate cooler temperatures with increased precipitation. See Oard (1993, pp. 42-44). All speculated events would occur in rapid succession compared to a uniformitarian time schedule.

Summary and Conclusions

Study of the fossil woods from the Dawson Creek region of Big Bend National Park indicate that they grew in a climate different from the present in that location. Likewise the fossil wood structure appears to be different from modern woody plants and the specimens we examined had no distinct growth rings which agree with the observations of Wheeler (1991a, 1991b) concerning Cretaceous and Paleocene woods of Big Bend National Park.*

We are impressed by the clarity of cellular and subcellular detail evident in the petrified wood and charcoalified wood. We suggest that such exquisite preser-

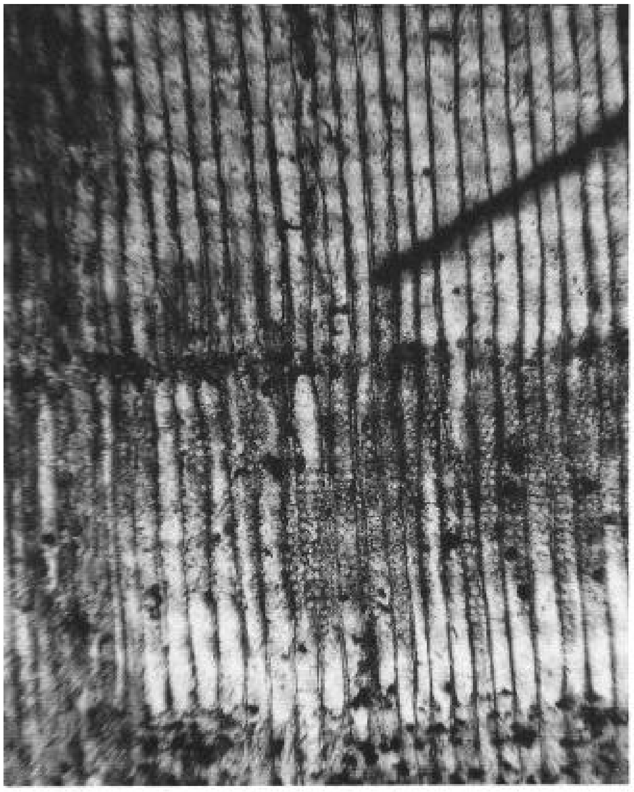


Figure 6c. Longitudinal section of charcoalified wood sample b. Tracheids in vertical section are long and spindle-shaped. Examination of the tracheids below the pointer tip reveals small openings (pits) which connect tracheids with other tracheids allowing water conduction in living stems. There is an amazing degree of cellular detail still present in this fossil wood. Scale bar same as 2c.

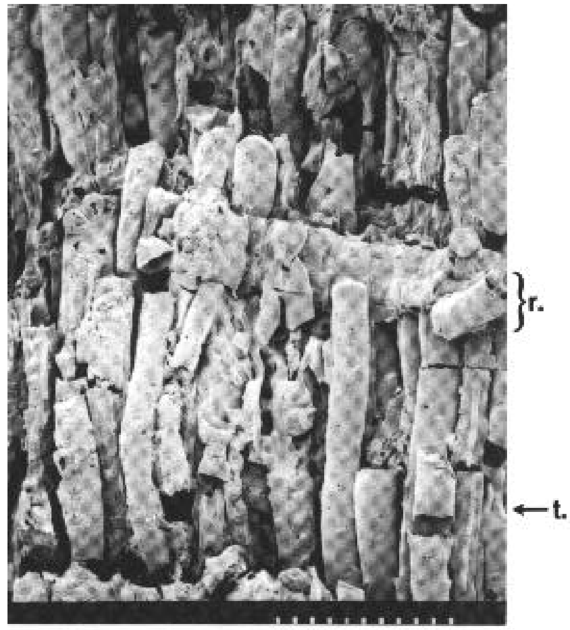


Figure 7b. Scanning electron photomicrograph at greater magnification of a charcoalified fossil wood specimen in radial view. A narrow ray is visible to the right of the bracket as are the highly magnified tracheids. Small dots on tracheids are likely pit pores. Scale bar (dotted line)—120µm.

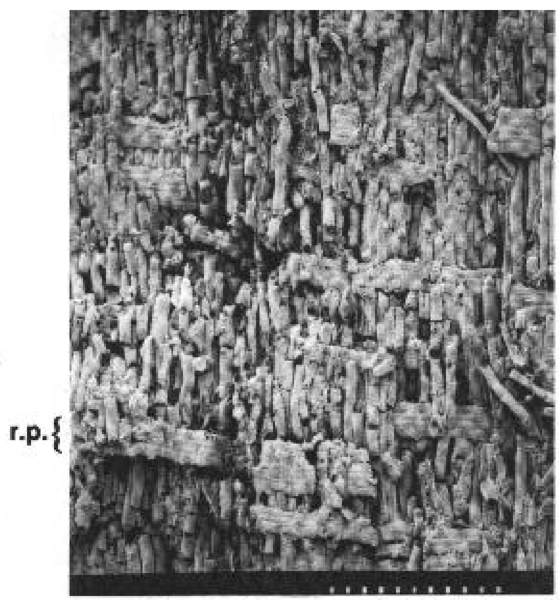


Figure 7a. Scanning electron photomicrograph of fossil charcoalified wood specimen a (radial view). There are bands of ray parenchyma cells weaving between the upright tracheids. Compare with Figure 4. This specimen is shown in situ in Figure 1 of Williams et al. (1993, p. 170). Scale bar (dotted line)—430µm.

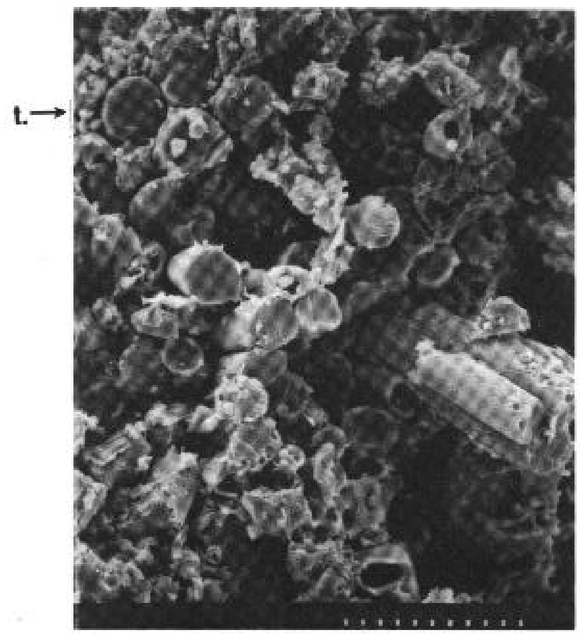
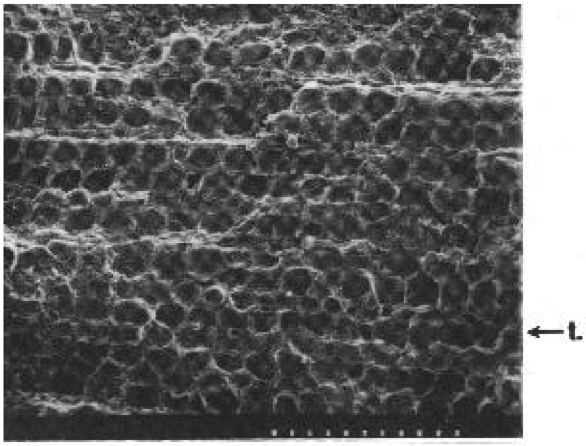
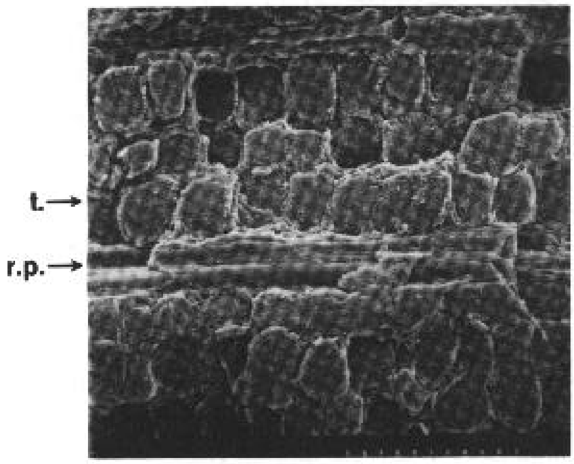


Figure 7c. Scanning electron photomicrograph of charcoalified fossil wood specimen a (cross or horizontal section). Tracheid cells are protruding from the plane of the section, giving a three-dimensional aspect. Scale bar (dotted line)—100µm.

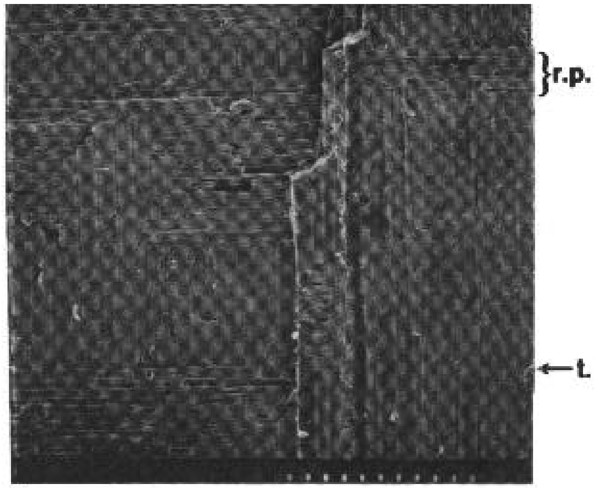


a.



b.

Figure 8a and 8b. Scanning electron photomicrographs of silicified fossil wood—sample 25 (Williams et al., 1993, pp. 173-174 especially Figures 11, 12 and Table II). It is shown here at two different magnifications in cross section. Tracheids are visible in both and ray parenchyma can be seen in 8b as horizontal lines. Scale bar in 8a is 300µm and scale bar in 9b is 100µm.



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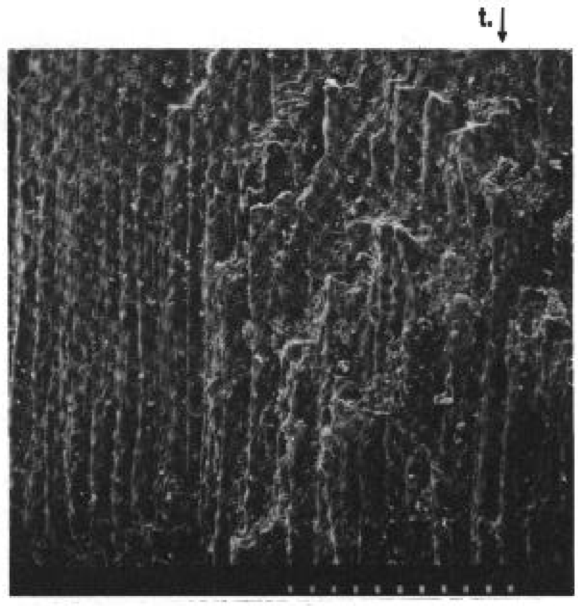

d.

Figures 8c and 8d. Scanning electron photomicrographs of silicified fossil wood sample 25—radial section. Tracheids are visible as uprights cells and ray parenchyma cells are in bands of various heights running crosswise. Scale bar (dotted line)—380µm.

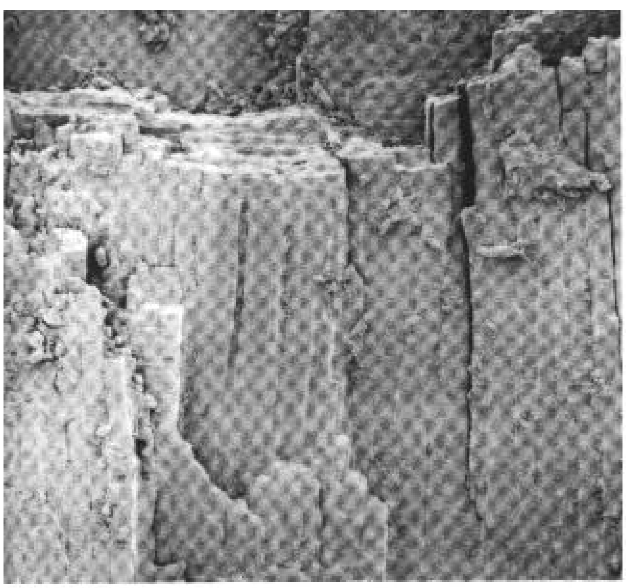

Figure 8e. Scanning electron photomicrographs of silicified fossil wood sample 25. Tracheids and rays are both visible in this view.

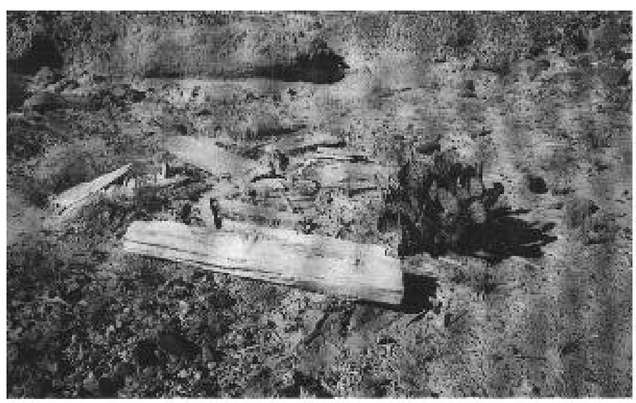

Figure 9a. Scattered silicified wood sections (specimen 25). See Williams and Howe (1993, p. 49 especially Figure 1c) for more description and other photograph of the collecting area.

Figure 9b. Smaller pieces of silicified wood (specimen 25) that were scattered over the desert pavement.

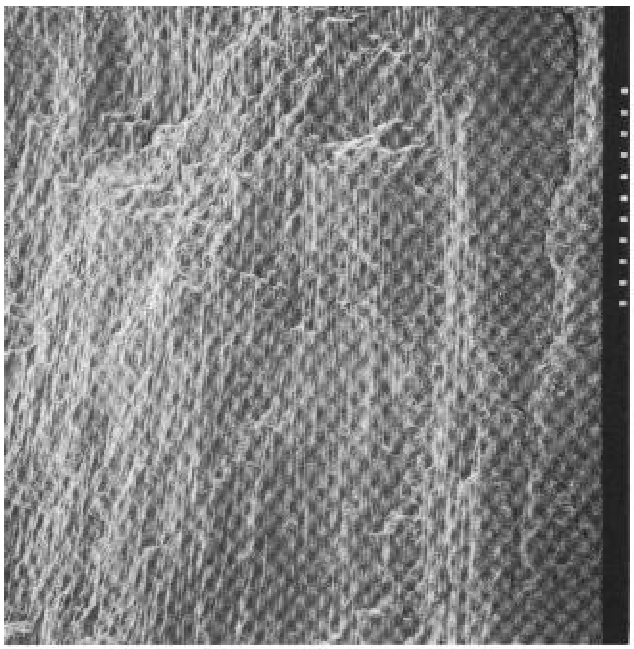

Figure 10a. Scanning electron photomicrograph of calcified wood/nodule? (CN) [Williams et al., 1993, pp. 173-175, Figures 13-16 and Table II]. These are cone-like structures that fall apart easily into wedge-shaped chunks. We speculate that they may be fossilized stems from cycads. But they may instead be only calcium-rich nodules. Complex structure is visible but it is not possible to determine if these are cells or mineral crystal structures. Scale bar—300µm.

vation of detail fits well with the creationist belief that fossils were formed rapidly and recently.

The nodules we collected and examined have some structural features that resemble wood but we have been unable to determine if the material is calcified wood or mineral nodules. Work will continue on this project concerning chemical analyses of the clays in which the fossil wood was found, hopefully to shed some light on how the wood was buried at Dawson Creek.

*M. J. Oard, commenting on Lehman's remarks concerning the fossil wood with and without growth rings found in Trans-Pecos, Texas, suggested that possibly a mixture of woods from different climates was transported to this location by Flood waters.

Figure 10b. Scanning electron photomicrograph of calcified wood/nodule? (CN). Even at this higher magnification, we were not able to determine if the structure is cellular or a crystal growth pattern. Scale bar—60µm.

Acknowledgments

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