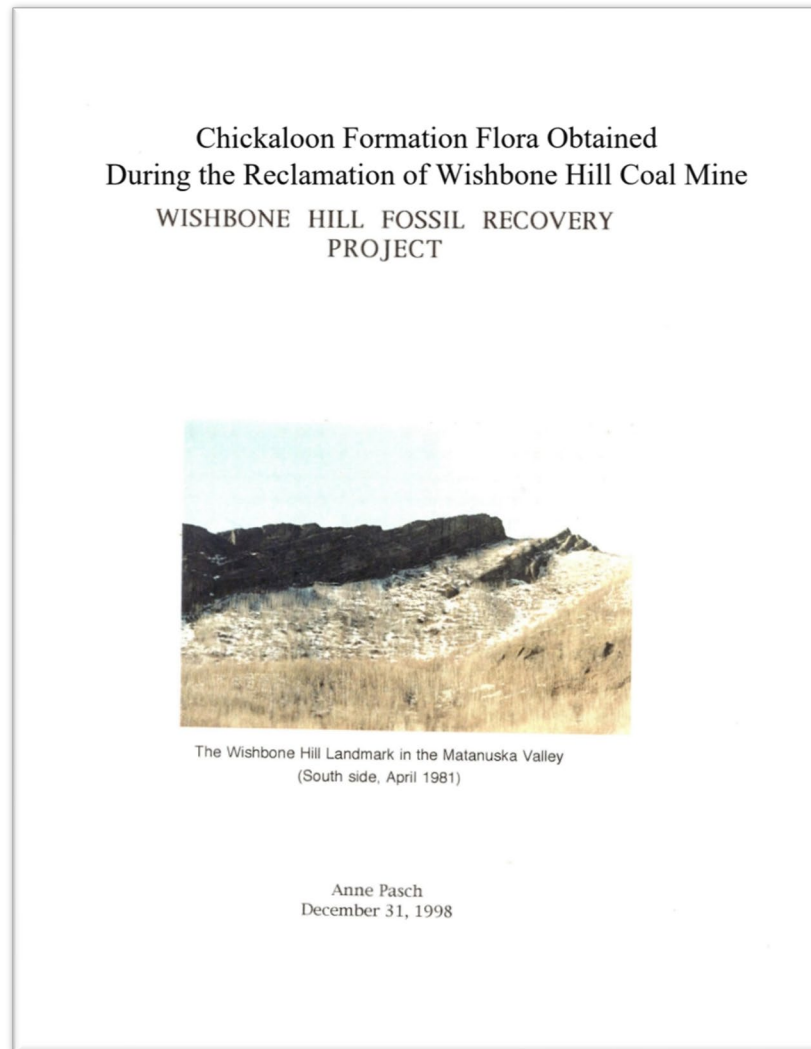


Chickaloon Formation flora obtained during the reclamation of the Wishbone Hill coal mine, Wishbone Hill fossil recovery project

Anne D. Pasch

MP 179B



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Chickaloon Formation Flora Obtained
During the Reclamation of Wishbone Hill Coal Mine
WISHBONE HILL FOSSIL RECOVERY
PROJECT



The Wishbone Hill Landmark in the Matanuska Valley
(South side, April 1981)

Anne Pasch
December 31, 1998

Chickaloon Formation Flora Obtained
During the Reclamation of Wishbone Hill Coal Mine
WISHBONE HILL FOSSIL RECOVERY PROJECT

Dates of Project: May 1, 1997 - Dec. 31, 1998

Submitted to:

Brian McMillen, AML Program Manager
Division of Mining & Water Management
Department of Natural Resources
The State of Alaska

by

Anne Pasch, Professor Emeritus
Department of Geology
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December 31, 1998

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THE WISHBONE HILL FOSSIL RECOVERY PROJECT

North Jones Reclamation Area near Sutton, Alaska

INTRODUCTION

Coal deposits are a significant natural resource in the state of Alaska. They are one of the world's storehouses with an estimated two to five trillion short tons and constitute over 40% of the nation's total known deposits (Quinlan, 1980). All of the coals known in the southcentral part of the state are associated with plant fossils (Fig. 1) and are Tertiary in age (Fig. 2). These Tertiary plant remains have aroused interest for over 200 years, ever since Captain Cook collected specimens on his voyage into Cook Inlet. They are evidence of an extensive fossil forest which covered a broad belt rimming the northern Pacific Ocean 55 million years ago. They represent a mixed coniferous/deciduous forest containing redwood-size trees which provide a sharp contrast to the boreal forests of the region which exist today.

The first systematic descriptions of the Tertiary flora in Cook Inlet were made by a Swiss paleobotanist, Oswald Heer, in 1869. Hollick described them in greater detail in 1936 and noted their similarity to assemblages in Greenland, Iceland, Spitsbergen and Siberia. Later workers have found equivalent floras in the western part of the United States and Canada (Wolfe et al., 1966) and also on the opposite side of the Pacific in China, Korea, and Japan (Hu and Chaney, 1940). Remnants of this rich, mesic ecosystem exist today in the Pacific northwest (Wolfe, 1977 and Axelrod, 1966) and in Siberia, China, and Malaysia (Hu and Chaney, 1940). These enigmatic plant assemblages generated an interesting question: how did seemingly temperate and subtropical forests thrive at such high latitudes? In light of the current debate over the importance of global climatic changes, finding the answer to this once arcane concern may be more significant than once thought. This forest of deciduous and coniferous giants also marks the onset of the "Age of Flowering Plants." The diverse flora of the Paleocene is significant from an evolutionary standpoint as it preceded the expansion of mammals providing the dietary basis for their radiation and the establishment of our current global terrestrial ecosystem.

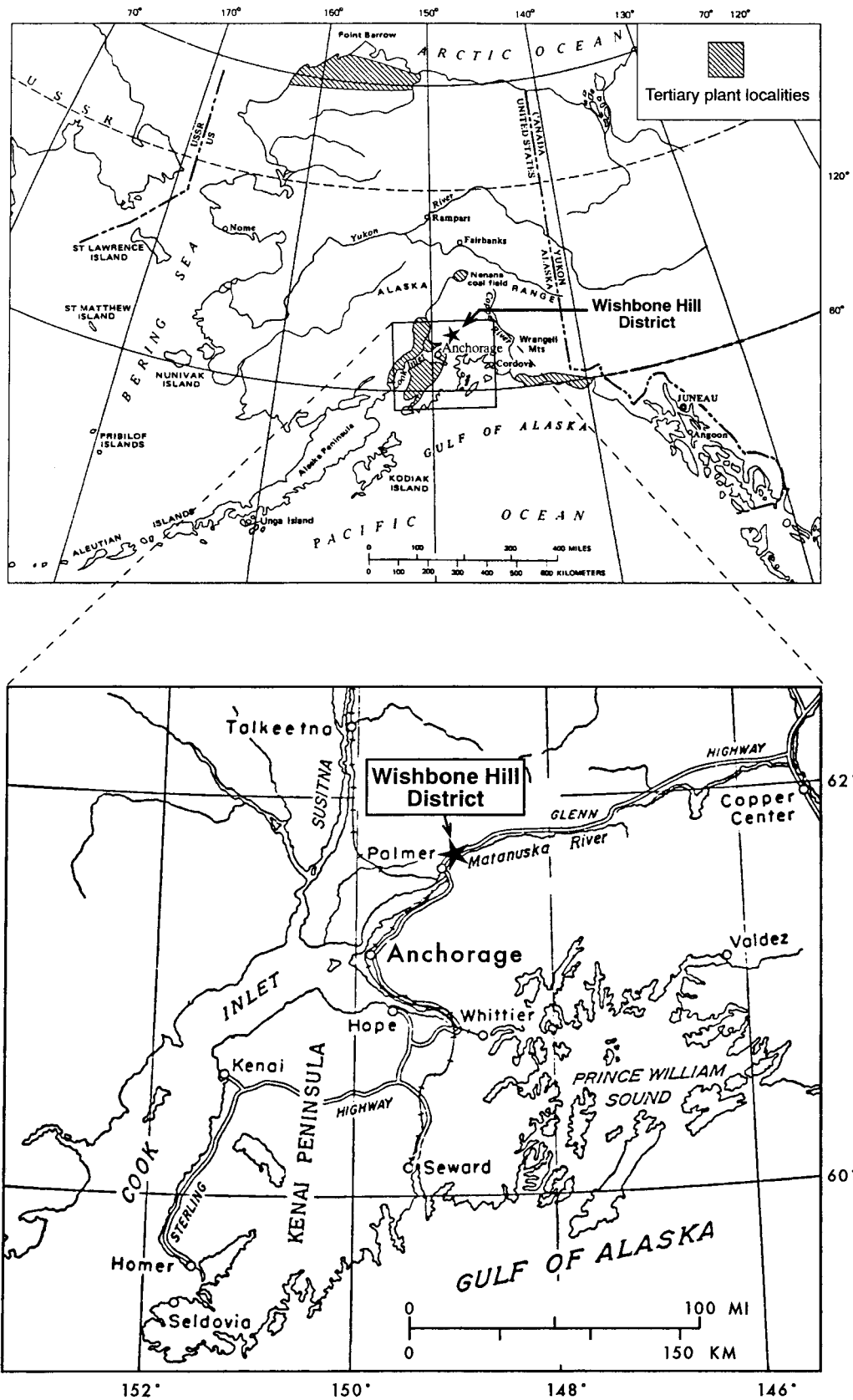


Fig. 1. Map of Alaska showing location of Wishbone Hill and other major Tertiary plant fossil assemblages in the state (from Wolfe, 1977).

AGE (Ma)	SYSTEM	SERIES	FLORAL STAGE	COAL-BEARING FORMATION
3 5	TERTIARY	Pliocene	Clamgulchian	Sterling Fm
10 20		Miocene	Homerian	Beluga Fm
			Seldovian	Tyonek Fm
25 35		Oligocene		
40 55		Eocene		
60 65		Paleocene	Unnamed	Chickaloon Fm

Fig. 2. Ages of major coal-bearing formations in the Cook Inlet region (modified from Conwel et al., 1981; Magoon et al., 1976; & Palmer, 1983).

The Chickaloon Formation in the Wishbone Hill area provides the oldest, most diverse, and most exotic assemblage of Tertiary plant fossils in the state. It flourished during the Paleocene and Early Eocene (Wahrhaftig et al., 1994). This flora is significant because it is a time period for which there are few fossil localities and a paucity of literature describing them.

The strip mining activities on the north side of Wishbone Hill have provided outstanding exposures of the fossil beds. Since the 1950's they have been one of the very few fossil sites within easy driving distance of Anchorage. They have provided opportunities for instructive geology field trips, fossil collections for teaching, exposures which demonstrate excellent examples of stratigraphic principles, sedimentary features, depositional basins, geologic structures, plate tectonic principles, and data important to terrane analysis, economic geology, and mining techniques. Specimens from this area constitute a popular "fossil forest" exhibit at the local natural history museum in Eagle River. UAA faculty and students welcomed the opportunity to participate in this fossil recovery effort because:

- It preserved a plant fossil assemblage from the most important early Tertiary coal field in Alaska.
- It established the fact that the exposures on Wishbone Hill contain one of the rarest fossil forests in the world.
- It resulted in the placement of spectacular specimens of petrified wood from this world-class deposit be placed in the University of Alaska's Geologic Rock Garden (Ph. 1).
- It implemented the first systematic collection of the Chickaloon paleoflora which has been made in the past 35 years.
- It provided new documentation for a rich and diverse fossil riparian ecosystem which thrived in a subtropical to temperate climate during the Early Eocene in south-central Alaska.
- It provided material for comparison with the present plant ecosystem and climate.
- It provided the only reference collection of this fossil assemblage in the State of Alaska (at the University of Alaska Museum).
- It provided the first documented evidence for the occurrence of Tertiary amber in Alaska.
- It has provided a collection of reproductive structures which have not been previously described from the Chickaloon Formation. They represent the ancestors of extant woody angiosperms.

REVIEW OF PROJECT

Title: Wishbone Hill Fossil Recovery

Dates: May 1, 1997 - December 31, 1998



Ph. 1. UAA student Heather Pierce with petrified wood showing growth rings in UAA Geologic Rock Garden (10/22/98).

Location: The project area is situated on Wishbone Hill in the west end of the Matanuska Valley approximately 59 miles northeast of Anchorage and approximately 3 miles north of Sutton on the Glenn Highway (Fig. 3). It originally encompassed the 1997 North Jones project area, an irregular 16.2 acre polygon located in the open pit mining area on the northeast side of Wishbone Hill (Fig. 4). However, in 1998 the field area was expanded to include fossiliferous horizons to the east and west.

Purpose: To obtain systematic stratigraphic information with an associated collection of fossils from the Tertiary coal-bearing units now exposed in the strip mine pit on Wishbone Hill before they become inaccessible due to planned reclamation activities. It is part of the North Jones Phase II 1997 reclamation project, one of several being conducted by the Alaska Department of Natural Resources in order to reduce the hazardous nature of open strip mine pit topography.

The field work was to be done during the summer of 1997 before the pits were covered and revegetated. This provided an opportunity to procure fossils from this exposure which was a unique and large outcrop in the Sutton area coal beds.

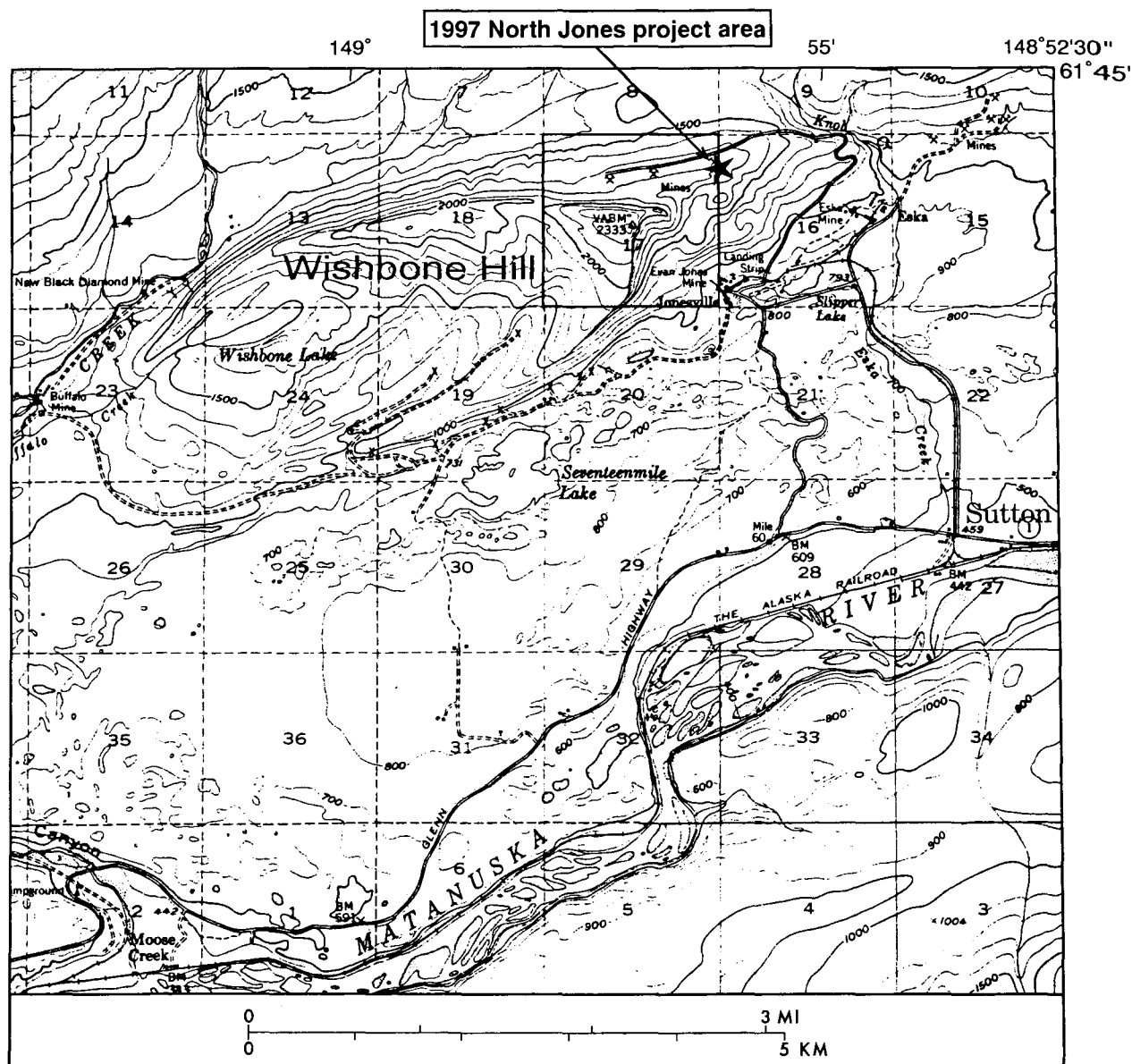


Fig. 3. Northeast portion of Anchorage (C-6) quadrangle showing Wishbone Hill and location of North Jones contract area. 1:63,360

Goals:

1. Complete a measured geologic section of the upper portion of the Chickaloon Formation in the North Jones reclamation area.
2. Determine which beds are fossiliferous.
4. Devise a systematic fossil collecting plan to obtain a representative sample for each important stratum wherever possible. In some cases the steepness of the terrain will preclude collection.
5. Compile a cataloged reference collection of fossils from the Chickaloon Formation for accession in the University of Alaska Museum.
6. Identify the fossil plants as accurately as possible from existing literature.

BACKGROUND

Introduction: Exposures of coal in the Matanuska Valley may have been noted and utilized by indigenous people long before the arrival of Europeans. Intensive exploitation of the coal deposits was stimulated in 1931 when Congress authorized the construction of the Alaska Railroad generating a market. Of a total of seven million metric tons of coal mined during the period from 1917 to 1970, three million tons was mined from the open pits in the Wishbone Hill District (Wahrhaftig et al., 1994). It was used mainly to power locomotives for the Alaska Railroad and in the power plants of the Elmendorf and Fort Richardson military bases in Anchorage. Conversions to oil and natural gas in the 1950's and 1960's reduced the demand for coal. There was very little mining activity during the 1980's and 1990's although significant deposits still remain.

The area is noted for its scenic beauty and has a history of use for recreational purposes. Since a road from Jonesville to the pit area was built in 1953, it has been a popular area for hunting, horseback riding, hiking, photography, skiing, and more recently snow-machining and four-wheeling. The abundance of spoil piles and unweathered exposures of

bedrock make it one of the most popular fossil-collecting areas of the state. Most of this collecting is done without permit as the public has had open access to the area over the past five decades.

The excellent exposures in the strip mine pits have also provided outstanding opportunities for research related to the region's geology. Most of the detailed stratigraphic and structural data has been collected for coal resource evaluation, but paleomagnetic and paleontological studies have also been done. The research on these unique exposures has contributed not only to a better understanding of the geology and tectonics of the region as a whole, but to the understanding of other parts of the state containing oil, gas and coal deposits.

Geologic & Tectonic Setting: The 1997 North Jones project area is part of the Wishbone Hill coal-mining district. It lies in a 100 km. segment of the Matanuska Valley graben between the Talkeetna Mountains to the north and the Chugach Mountains to the south, and between Moose Creek on the west and Anthracite Ridge to the east. The graben is bounded by the Border Ranges fault to the south and the Castle Mountain fault to the north (Reger and Updike, 1983).

The Wishbone Hill coal units were deposited in a Cenozoic basin which developed on a Mesozoic shelf of Jurassic and Cretaceous rocks which were part of the early Mesozoic Talkeetna arc, an island arc subduction zone of about 1,500 kilometers in extent (Nokleberg et al., 1994). These older rocks are part of the allochthonous Wrangellia Composite Terrane (WCT) which began a northward migration during the Triassic, moving north approximately 25° - 30° (Plafker & Berg, 1994) or 3,000 kilometers (Hillhouse, 1994). It was emplaced against the continental margin in the Late Cretaceous and reached its present latitude by the Paleocene or early Eocene (Plafker & Berg, 1994; Hillhouse & Coe, 1994; Nokleberg et al., 1994).

Cook Inlet Coal Fields: The Matanuska coal field is one of 36 major coal occurrences in Alaska and the second most commercially significant coal deposit in the state. It is part of the Southern Alaska-Cook Inlet province which includes the Nenana coal fields currently being mined and other coal deposits which have potential but have never been developed on a commercial basis (Wahrhaftig et al., 1994).

Stratigraphy: The Wishbone Hill coals of the Matanuska coal field occur in the Chickaloon Formation Late Paleocene/Early Eocene age (Wahrhaftig et al., 1994). This non-marine sedimentary sequence, approximately 1,500 m. thick, consists of interbedded mudstone, siltstone, sandstone, and coal (Flores & Stricker, 1993). It overlies the Matanuska Formation of marine Cretaceous sedimentary rocks on an angular unconformity and is overlain by the Wishbone Formation of Eocene age, a massive conglomerate at least 900 m thick (Wahrhaftig et al., 1994). The aerial extent of these units is shown in Fig. 4.

Other coal groups in south-central Alaska, with the exception of those in the Cantwell Formation, are younger. The Susitna province (north of the Castle Mountain fault and west of the Talkeetna Mountains includes coal in the Kenai Group of Eocene to Pliocene age. The Cook Inlet province coals of the Tyonek, Beluga, and Sterling Formations which underlie the Cook Inlet/Susitna Lowland to the west are Miocene and Pliocene in age. A Paleocene age for the Chickaloon Formation was confirmed by Wolfe (1966) who conducted a detailed analysis of 50 collections of plant fossils correlating them with the Fort Union flora of the northern Great Plains and the Atanikerdlak flora of northwestern Greenland. However, using radiometric dating techniques, Triplehorn and others (1984) calculated an average date of 55 Ma for tonstein beds within the Premier coal group in the upper part of the formation. Therefore the exposures in the 1997 North Jones project area which encompass Bed 5 are Early Eocene in age.

Depositional Environment: The Matanuska coal beds were formed on an alluvial plain which was an extension of a major drainage which occupied what is now the Cook Inlet/Susitna Lowland. The trunk stream flowed south into the Pacific Ocean (Wahrhaftig et al., 1994). The plant flora collected occurs in carbonaceous shale, mudstone, siltstone and to a lesser extent, in feldspathic sandstone of the Premier coal group. These lithologies are part of the Premier-Jonesville facies sequence profile described in detail by Flores and Stricker (1993). The coal zones occur in fluvial sequences suggesting development of topogenous mires in vertically and laterally aggrading fluvial systems. Plant debris accumulating in the associated mires eventually formed the coal deposits. Other material was preserved in channels, crevasse-splays, and abandoned meander belts. Rapid burial is suggested by “curled” leaves in the siltstones, the preservation of delicate leafy shoots, and the vertical or

near vertical position of numerous tree trunks as much as 8 m. in length (Flores & Stricker, 1993). The presence of whole leaves and delicate branches suggest local deposition in a low energy environment, not subject to reworking or long distance transport (Spicer, 1980). Flores and Stricker (1993) suggest aggradation resulted from subsidence on a local level due to compaction of sediments or on a regional level, perhaps due to tectonic subsidence of the Matanuska Valley graben. A riparian ecosystem such as this is important because it is one of the most diverse in the world and an indicator of environmental change (Nilsson et al., 1997).

Preservation: Preservation of plant material requires special conditions. During early diagenesis, physical, chemical, and microbiological changes occur within the top one to two meters of soil. The least resistant plants parts are degraded, but fossilization may result if some organic matter remains. Later changes occur at a slower rate as burial under additional sediments results in dewatering and compaction. Final results are controlled by the original composition of organic matter, environment of deposition, microbes present, the nature of the chemical changes, temperature, pressure, nature of ground water solutions, loss of volatile elements, and thermal alterations. Carbonization involves the breaking of carbon bonds resulting in smaller organic molecules. This process begins in the early stages of diagenesis. As burial depths increase and temperatures rise organic matter metamorphoses to methane and carbon. (Brooks et al., 1980)

Conspicuous by their absence are vertebrate remains. Invertebrates are present, but rare in the Chickaloon Formation. The highly productive forest of this paleocommunity would certainly have supported a variety of animals. However, the acidic soils which kill bacteria preventing the decay of plant matter would dissolve the bones of vertebrates and shells of invertebrates. Oxidizing soils in which vertebrate remains occur would provide a chemical environment in which the plant material would decompose (Spicer & Parrish, 1987). A few mollusks, fresh-water bivalves and gastropods, are known from exposures along Moose Creek and on Wishbone Hill east of the reclamation area. In 1977 a fossil turtle was brought to the author's attention. It was found by three high school students in an exposure along Moose Creek and has been identified as a *Protochelydra sp.*, a forerunner of the fresh-water snapping turtle. No animal remains were found in the reclamation area.

The Chickaloon Flora: Early Tertiary floras in Alaska occur in the upper Cook Inlet area, the northern foothills of the Brooks Range, on the Alaska Peninsula, and in the southeastern part of the state. The Tertiary plant fossils in the Cook Inlet area have been described in detail only by Hollick (1936) and Wolfe and others (1966). Wolfe studied 50 collections of fossil plants in the Cook Inlet Region and concluded that they documented a gradual cooling trend in the area from the Paleocene to the Pliocene. He used leaf morphology (smooth leaf margins, drip tips, and palmate venation) as indicators for a warm temperate climate lacking frost. He also compared the degree of diversity in three plant divisions (Fig. 5) showing that there was a correlation between decreasing plant diversity and decreasing temperatures.

	Wolfe (1966)	Pasch (1998)
Vascular Plants		
Seedless plants	Fillicinae (ferns)	Sphenophyta (horsetails) Fillicinae (ferns) Cycadophyta (cycads) ?
Seed plants	Gymnospermae (conifers) Angiospermae (flowering plants)	Gymnospermae (conifers) Angiospermae (flowering plants)
Invertebrates	Mollusca (fresh water pelecypods and gastropods)	Mollusca (fresh water pelecypods and gastropods)*
Vertebrates		Chordata (fresh water turtle)*

*not part of the Contract I Wishbone Hill Collection

Fig. 5. Diversity of Chickaloon paleoflora: fauna, divisions and phyla.

Wolfe described four floral stages in the Cook Inlet region from older to younger: 1) an unnamed stage from the Chickaloon Formation, 2) the Seldovian, 3) Homerian and 4) Clamgulchian. The Seldovian flora, named for exposures near Seldovia, represents less diversity than the Chickaloon, but still contain a rich, diverse, flora containing deciduous dicots which do not currently grow in Alaska. They suggest a warm temperate climate similar to that of east-central Asia and the southeastern United States today. The Homerian assemblage (named after an exposure near Homer) shows a marked decrease in diversity during the Miocene/Pliocene. Only one of the dominant families is not extant. Wolfe interprets this flora as evidence of a dramatic shift to cool-temperate conditions. The youngest is the Clamgulchian of Pliocene(?) age named after exposures in a bluff along the eastern side of Cook Inlet near Clam Gulch. This flora has the least diversity and though dominated by willow and birch of the extant forest, is still not an exact match. It represents the ancestors of the modern tree taxa living in a cool temperate climate.

The changes in Alaskan vegetation are shown quite dramatically by comparing the modern vegetation units (Fig. 6) with those suggested by Wolfe for the Miocene (Fig. 7). An early Eocene reconstruction would provide an even greater contrast with the extant coastal coniferous forests of Alaska. These changes cannot be attributed to a position at a lower (and warmer) latitude as there has been no significant change of latitude for southern Alaska relative to North America since the Paleocene (Hillhouse & Coe, 1994).

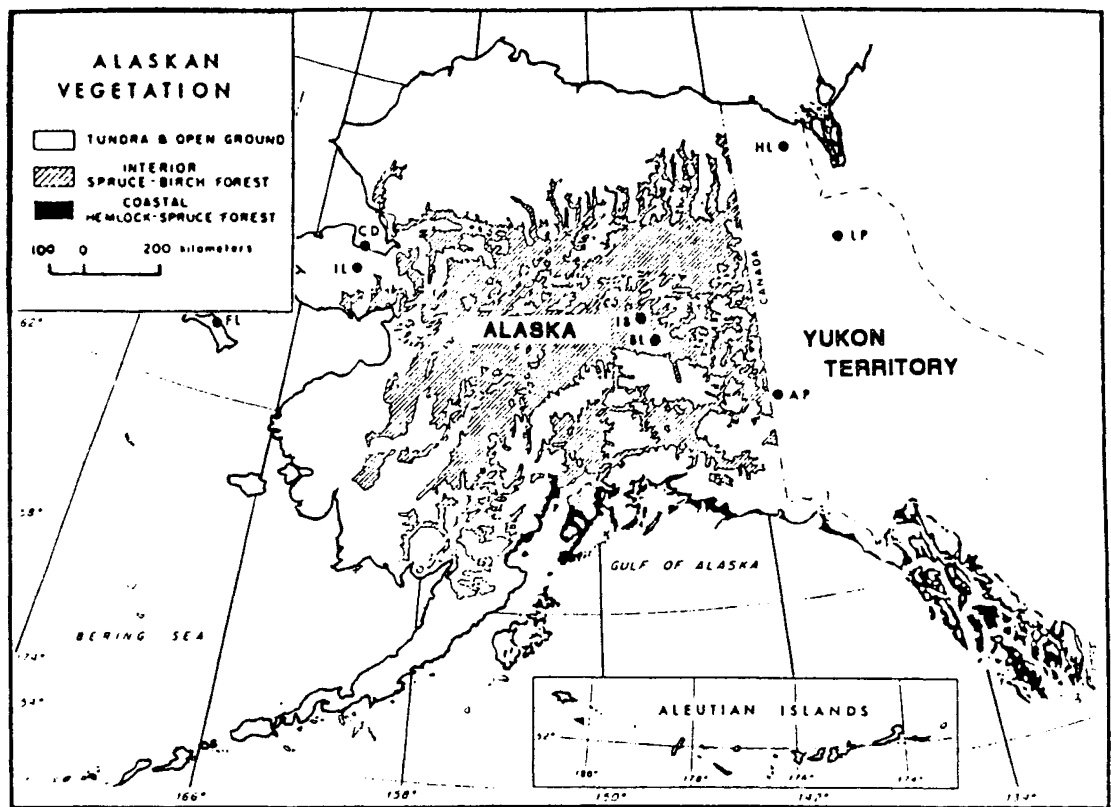


Fig. 6. Distribution of modern vegetation types in Alaska (Heusser, 1983).

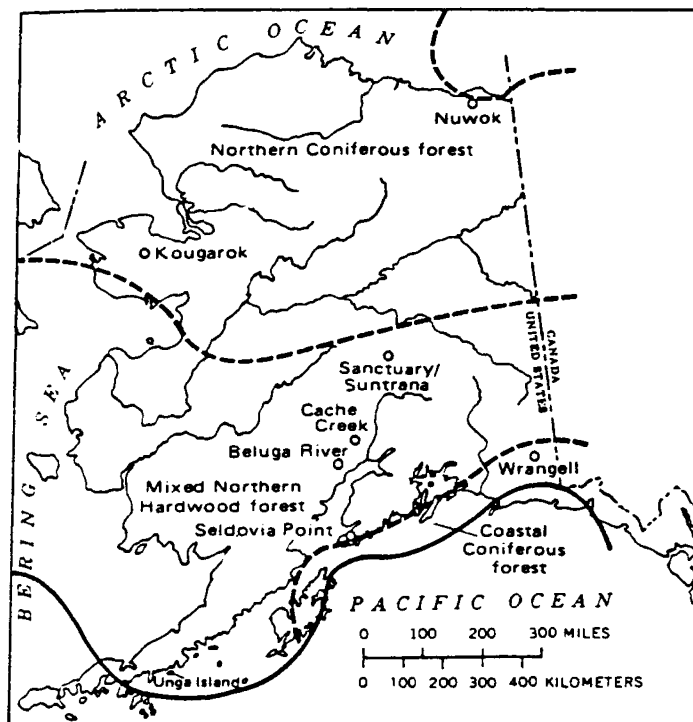


Fig. 7. Suggested distribution of vegetation types in Alaska during the Miocene (Wolfe, 1980).

METHODOLOGY

Field work was carried out during the summer months of 1997 and 1998. It included measurement of a composite geologic section, collection of amber, plant fossils, mapping petrified trees which were in situ, and measurements of fossil wood float. All work was done by volunteers under the supervision of Anne Pasch. Most were UAA students. A 1997 Field Archaeology Permit (97-05) was obtained from the State Archaeologist as required by the Alaska Historic Preservation Act, Sec. 41.35.080. It was renewed for the 1998 season.

The contractor did not complete the reclamation activities within the six-week period allotted. Therefore, the collecting phase had to be extended from June 30 to September 30 of 1977. Fossil collection and stratigraphic field work was restricted to Sundays when the reclamation contractor was not working as his use of heavy equipment precluded safe collection of fossil material. The area was not always accessible even on Sundays as sometimes rainy periods made the access road impassable. The steepness of the walls in the reclamation area precluded measurement of a complete stratigraphic section.

As the contractor began moving material into the pit, systematic collection became impossible as stratigraphic horizons were either too dangerous, buried, or destroyed by bulldozing operations. As the upper bedrock units were "ripped" into a jumble of boulders, precise stratigraphic position of fossils could not be determined. However, all can be located within the Premier coal zone in the upper 160 meter interval of the Chickaloon Formation (Barnes and Paine, 1956).

As reclamation work progressed, bedrock exposures were buried and more and more collecting had to be done in the rubble which was a chaotic jumble of boulders. Many large boulders were covered with a profusion of outstanding carbonized leaf impressions. However, these unweathered boulders were so highly indurated, it was nearly impossible to obtain specimens from them. An attempt was made to retrieve portions of these boulders using a gas powered concrete saw, but this was very difficult and time consuming (Ph. 2 & Ph. 3). All specimens listed in unit "Roger's Rock" were procured from this one boulder. There were dozens of other fossiliferous boulders which were buried before they could be examined.



Ph. 2. Roger Allely attacking fossiliferous boulder with diamond saw (6/29/97).



Ph. 3. Fossiliferous boulder of laminated siltstone with disceet fossiliferous layers after removal of specimens using diamond saw (6/29/97).

At the end of the 1997 field season, seven of the largest and best specimens of petrified wood were selected for transport to Anchorage. The combined weight of these specimens exceeded 50,000 pounds. The largest boulder was estimated to be over 10 tons making it a likely candidate for the largest fossil ever collected in North America. These petrified logs were transported by low-boy to the University of Alaska Anchorage where they became the nucleus of UAA's Geologic Rock Garden (Ph. 4).



Ph. 4. Sid Richards supervising the loading of a 12 ton piece of petrified wood (8/28/97).

The large petrified logs presented to the university were selected from boulders which had been stockpiled during the North Jones Reclamation Project. Their stratigraphic positions could not be determined as the exposures of origin were buried. However, it was apparent that other petrified trees were still in place in high walls to the east and west of the North Jones area. Therefore, a UAA student volunteered to make a survey of the logs that were still in situ. During the summer of 1998 she attempted to rappel over the cliffs in order to take accurate measurements, but that proved to be too dangerous due to falling debris. She scanned the exposures with binoculars to locate logs. Each was assigned a number and photographed in a scene which included the stratigraphic horizons and a 25 foot surveyor's rod. Horizontal distances were measured with a 300 foot tape and GPS readings. The stratigraphic position and dimensions of inaccessible logs were estimated from photographs using the rod for scale. Accessible trees were measured directly.

As a suite of specimens was retrieved from a known bedrock unit, it was given an informal designation. These "units" include Units 1 - 7, Joe's ss, Simeon ss, Janet ss, and Kurt ss. While specimens cannot be placed into an exact stratigraphic framework, we know that all those within a given "unit" came from a common lithologic horizon. Unit 1 is the oldest and lies at the bottom of Section A, Joe ss lies within Section A, Simeon ss and Janet ss lie within section B and Kurt ss lies above Section C.

When the abundance of fossil trees was discovered, they were mapped in the highwalls east and west of the North Jones reclamation area during the summer of 1998.

All hand specimens were transported to the geology lab at UAA where they were sorted, washed, dried, and coated with a protective film of polyvinylacetate (commonly known as vinac)(Ph. 5). They were numbered consecutively, given a preliminary identification and the lithologic type noted. Specimens were then moved to a UAA biology lab where an extended arm binocular microscope aided in more careful examination. Identification of specimens was done during the spring and fall of 1998 by Marilyn Barker and Anne Pasch. As this is the first collection from the Chickaloon ever made for the state of Alaska, all identification was done

using existing literature. Most of the taxonomy was based on figures and descriptions in the following publications: Brown (1962), Hollick (1936), Newberry (1898), Wolfe 1977) and Wolfe and others (1966).



Ph. 5. Carbonized leaves being treated with preservative (6/23/97).

The assigned generic and specific names must be considered preliminary until the specimens can be compared with the hypotypes, holotypes and paratypes which are all located outside Alaska. In some cases identification could be accurately done, but in many the descriptions were incomplete, figures unclear, or the Wishbone Hill specimens were incomplete or too poorly preserved to exhibit features seen in the figures. The taxonomy of these fossil plants is in great need of revision and there are many equivalent genera and species described by different paleobotanists.

Three geologic sections were measured, one along the edge of a talus cone and two on the upper portions of the highwall using rappelling techniques. The two uppermost portions have since been ripped away and the lower section buried during the regrading process.

RESULTS

Overview: The results of this project include the discovery of one of the largest fossil forests in the world. A substantial and diverse collection of lower Eocene plant fossils has been procured for accession at the University of Alaska Museum. It includes foliar elements and reproductive structures of primitive plants, gymnosperms and angiosperms, as well as wood (Fig. 8). Two of the most spectacular specimens are the flower-like *Hydrangia* and a compound leaf with 12 attached leaflets of the fern *Anemia*. The presence of Tertiary amber deposits in the state has been documented for the first time. Eight unusual boulders of petrified wood have been placed in UAA's Rock Garden. Over 61 fossil trees which are in situ in the Chickaloon Formation have been measured and mapped documenting the presence of a rare fossil forest.

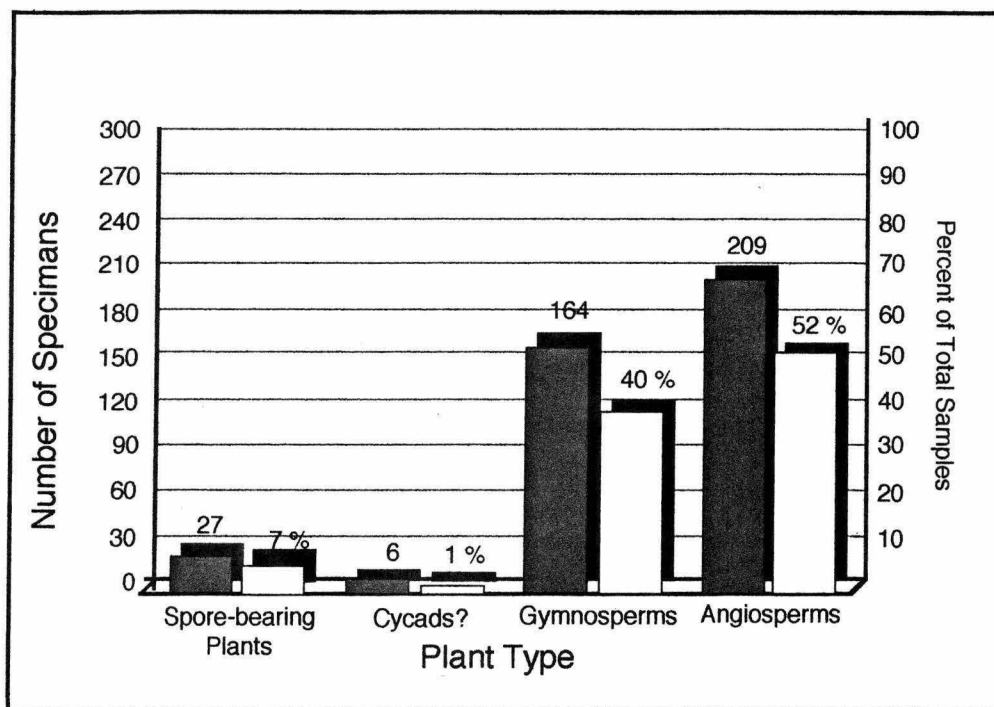


Fig. 8. Distribution of plant fossil types in 555 samples, 1997 North Jones project.

Assessment of the goals listed on page 8 show that the unusual occurrence of fossilized stumps and amber had not been anticipated. There were some shortcomings in that exact stratigraphic data for fossiliferous horizons could not be determined for reasons outlined above. We found ourselves in a race against the bulldozers and they were in a race against the clock. A composite measured section of accessible exposures in the North Jones reclamation area were completed, it was determined that all facies were fossiliferous, a reference collection was made and identified for the University of Alaska Museum.

Measured Section: The three sections measured were made: along the margin of the talus cone on the west wall of the pit (section A), along the upper portion of the high wall south of the impoundment (section B), and on the high wall west of the impoundment (section C). Approximate locations of the measured sections are shown on the map in Fig. 9 and in photographs 6 - 15. The sections are given in Fig. 10. During examination of these highwalls the presence of very large in situ stumps were noted. Five such specimens were observed near the top of the high wall in the North Jones reclamation area. Two were measured during rappels down the slope. One was measured near the base of the high wall above the impoundment. Two contained strange expansions or bulb-like structures on the upper end. A stump which was not measured appeared to have roots extending into the bed below. All these in situ stumps have since been destroyed or buried in the grading process during reclamation activities.

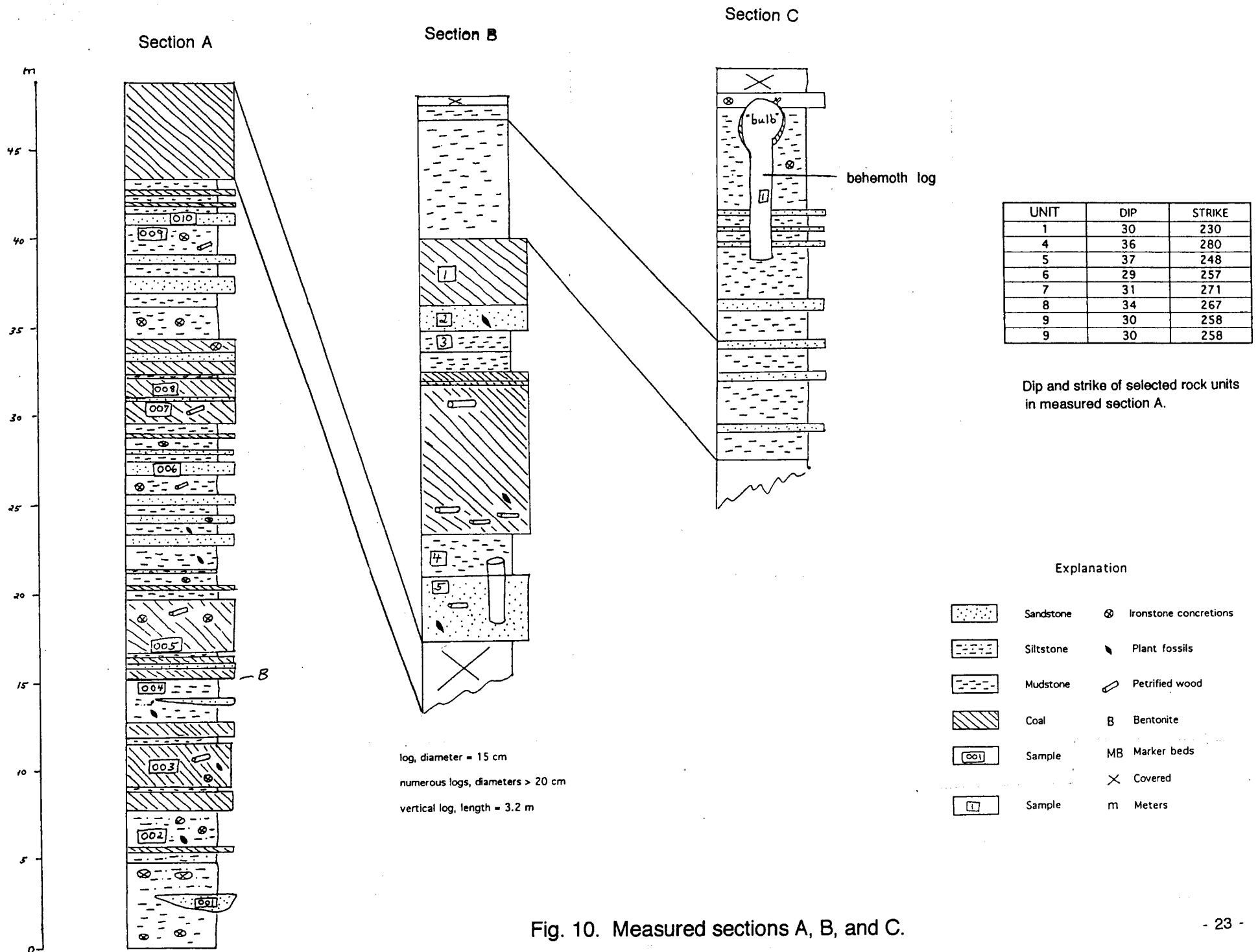


Fig. 10. Measured sections A, B, and C.

During the measurement of Section C, rappelling techniques made it possible to measure and photograph the behemoth log located near the top of the highwall in the West Center Pit. The measurements are given in Fig. 17 and it is shown in photographs 16-1, 16-2, 16-3, 16-4, and 16-8. Reference positions for the photographs are given in Fig. 11.

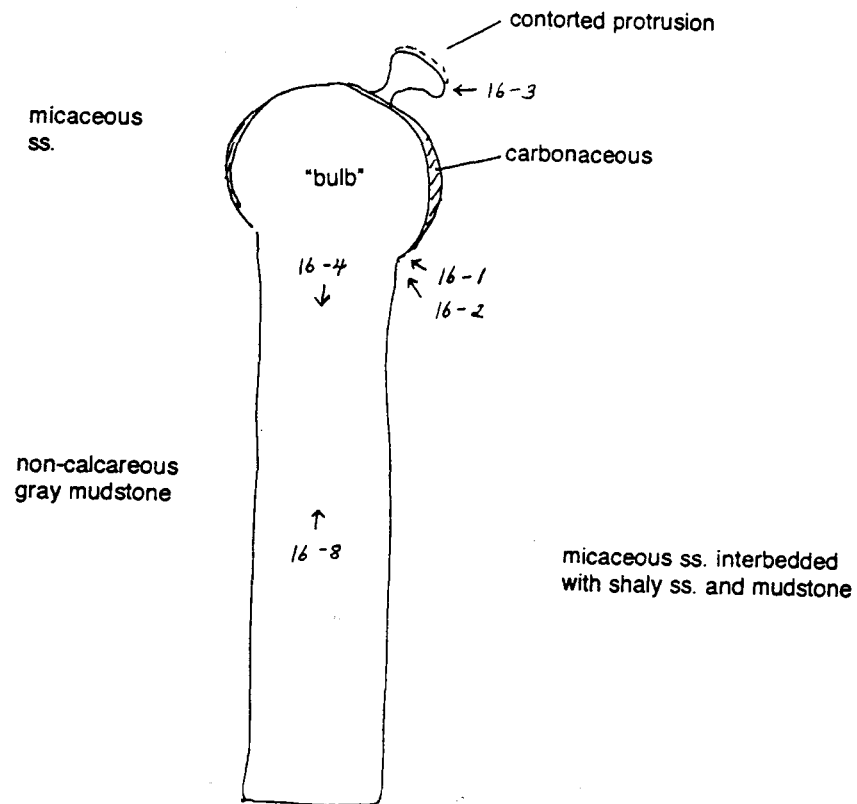


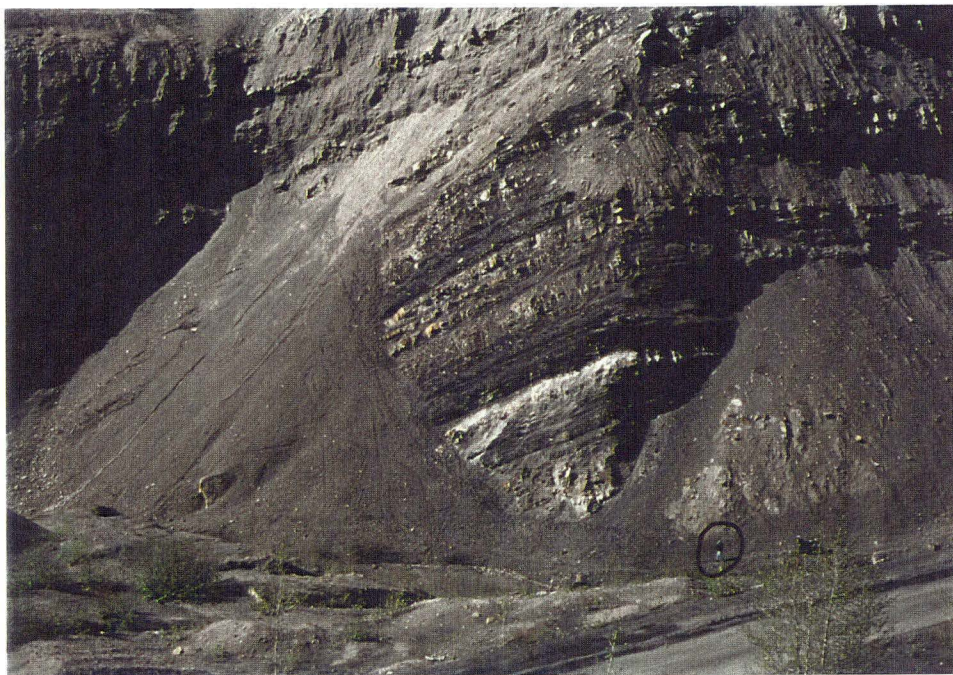
Fig. 11. Index for photographs of "behemoth log" measured in section C.



Ph. 6. 5/25/97



Ph. 7. 6.29/97



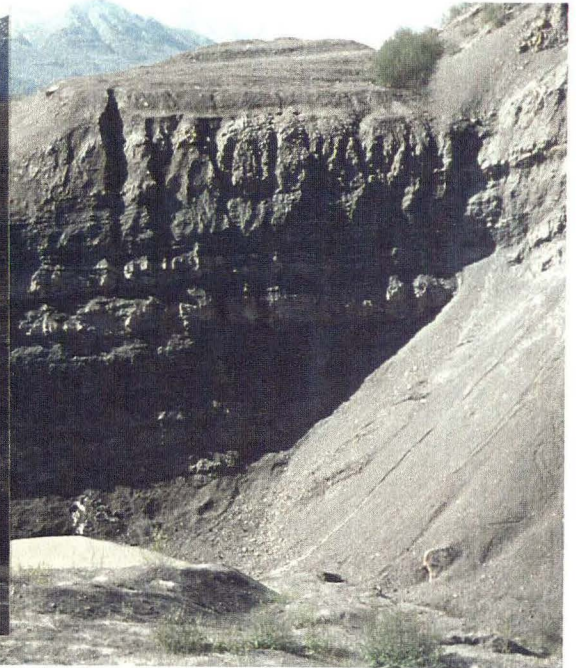
Ph. 8. 5/25/97

note geologist
for scale

Ph. 6,7, & 8. East-facing high wall west of impoundment and location of section A.



Ph. 9. 5/11/97



5/25/97



Ph. 10. 6/15/97

Ph. 9 & 10. Composite photos of north-facing highwall south of impoundment and location of section B.

behemoth log



Ph. 11. 5/25/97

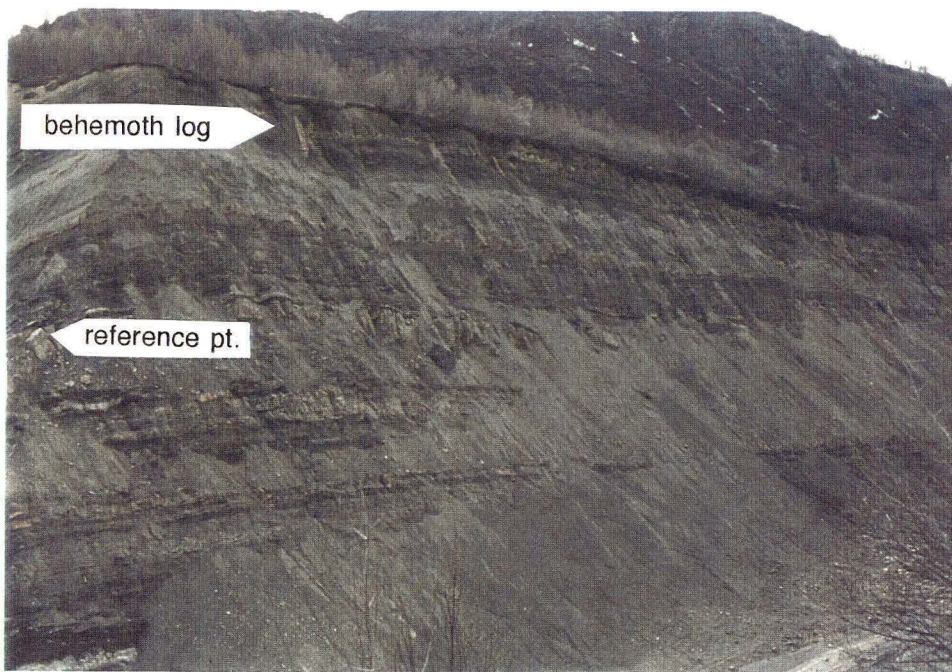
behemoth log



Ph. 12. 5/25/97

Note geologist
for scale.

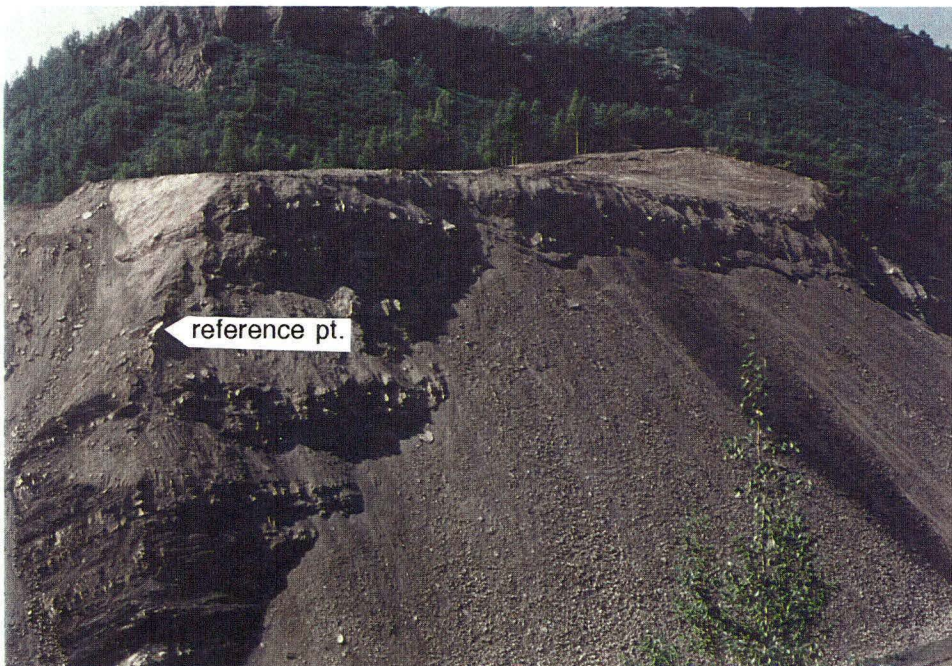
Ph. 11 & 12. North-facing highwall west of impoundment and location of
measured section C.



Ph. 13. 5/11/97



Ph. 14. 6/15/97



Ph. 15. 6/29/97

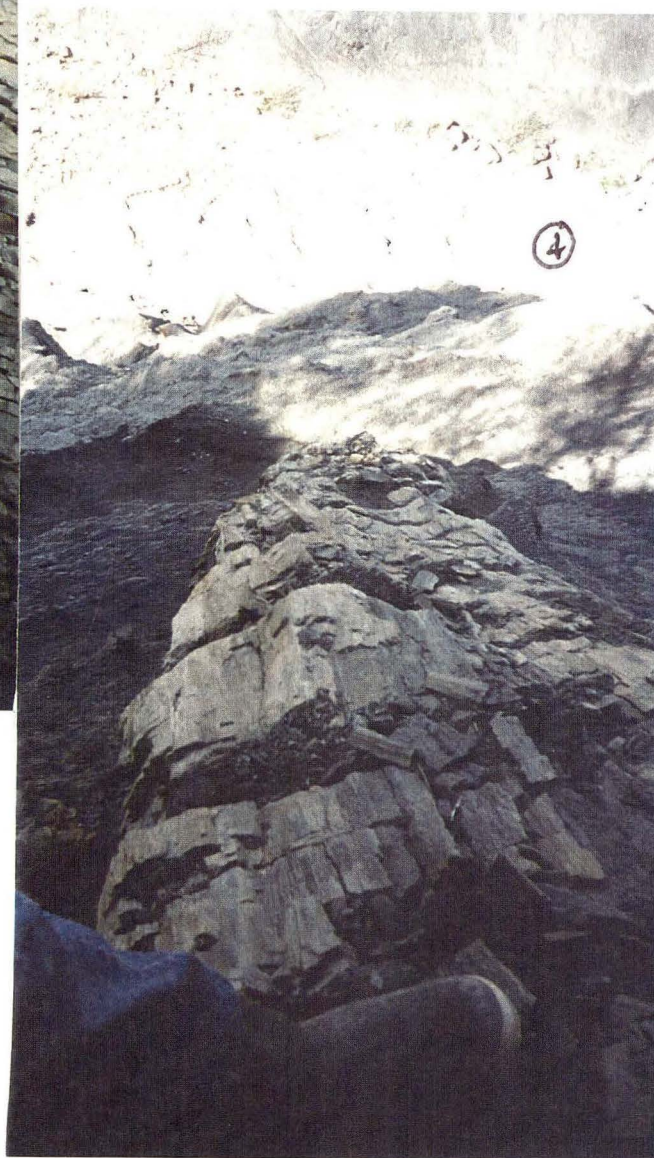
North-facing highwall
west of impoundment
containing buried
forest.



Ph. 16-1 & 16-2. Two views of "bulb" of behemoth log measured in section C. (5/25/97)



Ph. 16-3. View of contorted extension of behemoth log.
(5/25/97).



Ph. 16-4. View looking down behemoth log (5/25/97).



1.25 m.

Ph. 16-8. View up jointed trunk of behemoth log (5/25/97).

Reference Plant Collection: The reference collection, representing a substantial and diverse flora, was assembled from 555 individual specimens. Of these, 27 represent lithologic samples retrieved from measured section A, 445 represent plants fossils, 45 were wood or roots, and 84 were discarded or provided no identifiable fossils (Fig. 12). Most of the material with no identifiable plants was discarded except for a few which have a potential for pollen and other microfossils due to a high organic content. A total of 43 genera representing 28 families were identified as shown below in Fig. 13. This represents the highest number of species ever reported from one location in the Chickaloon Formation.

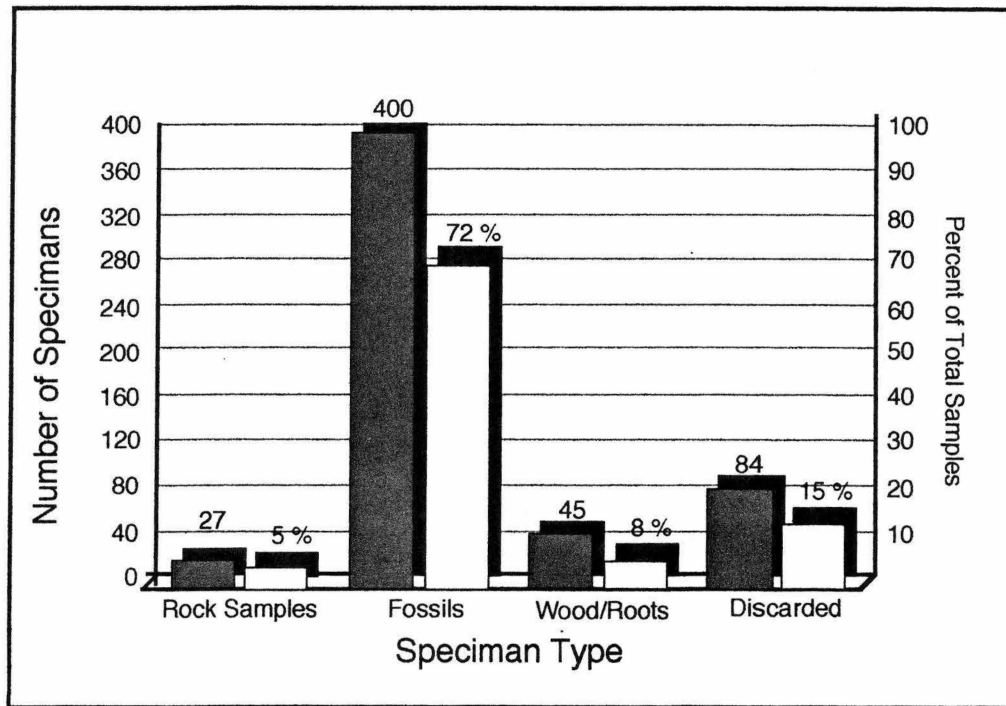


Fig. 12. Overall composition of the Wishbone Hill reference collection.

Samples were assigned 378 sequential numbers. Some included multiple parts represented by letters after the numbers and some contained 1 to 4 identified fossils. These are indicated by the numbers following a dash after the sample number. The 555 specimens identified in the 378 samples are listed in alphabetical order by genus in Appendix A. Photographs of a representative sample of fossil plants in the collection are given in Appendix B. The label on each includes the genus or other taxonomic group, the last three digits of the specimen number, and a centimeter bar.

The distribution of major plant types in Fig. 14 show that angiosperms and gymnosperms dominate the collection and provide evidence that a mixed forest was present. The identification of the five cycad specimens is open to question as the material is fragmentary. The presence of cycads would be significant as they grow only in frost-free climates and have never before been reported in rocks of this age in Alaska. Only 27 of the 406 specimens are spore-bearing plants. They are dominated by Equisetites with a few ferns.

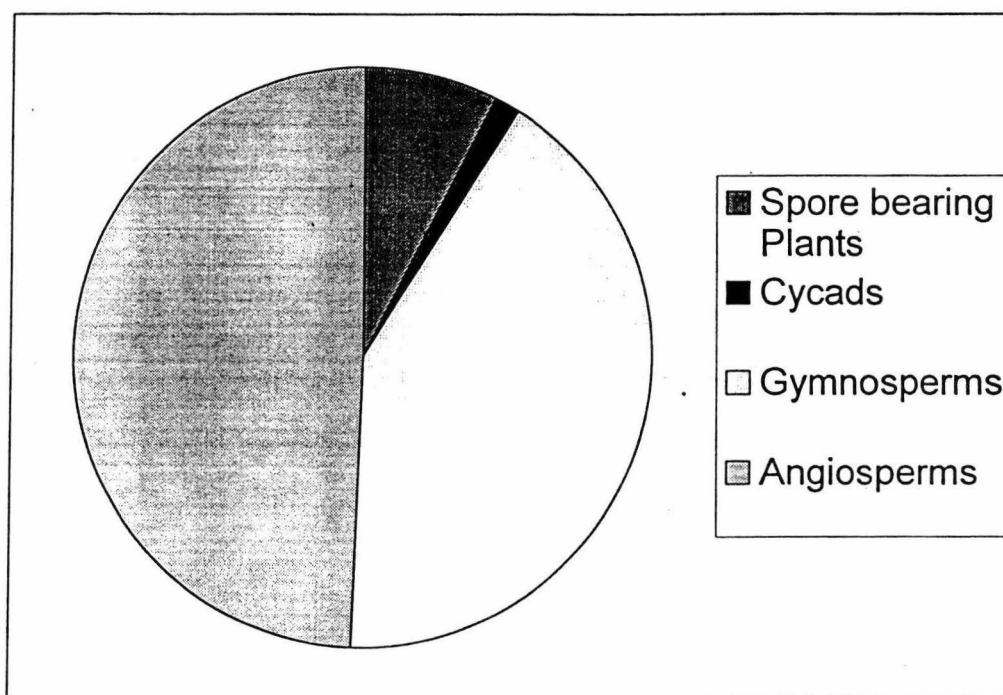


Fig. 14. Distribution of major taxonomic groups in the Wishbone Hill reference collection.

Most specimens were identified to genus, many identified to species, and a few assigned only to orders (Cycadales and Coniferales). As shown in Fig. 13, a total of 41 genera in 28 families was identified. A generic list showing relative abundance is given in Table 1.

Genus	No.	Genus	No.
Abietites	1	Hicoria	5
Acer	2	Hydrangia	1
Alnus	4	Matonia	1
Ampelopsis	1	Hedera	2
Anemia	1	Metasequoia foliage	111
Astralopteris	1	Metasequoia cones	21
Carpinus	2	Nyssidium	1
Carya	51	Parataxodium	1
Celastrus	1	Planera	3
Coccolobis	1	Platanus	7
Cocculus	8	Populus	25
Coniferales	5	Pterocarya	1
Cycadales ?	5	Pterospermites	4
Dicotylophyllum	10	Quercus	11
Dillenia	3	roots	6
Dioon	1	Rulac	1
Equisetites	24	Sophora	1
Eucommia	3	Spiraea	1
Ficus	1	Taxodium	8
Flabellaria	1	Ulmus	1
Fraxinus	3	Viburnum	2
fruit/seed	21	"Xenoxylon" (wood)	39
Glyptostrobus	12	unknown	25
Grewia	1		

Table 1. Genera found in the Premier coal group of the Chickaloon Formation on Wishbone Hill.

The deciduous leaves represent a wide variety of simple leaves and many leaves without petioles suggesting they are leaflets of compound leaves. Many broad leaves are very large and intact suggesting they were freshly abscised prior to burial and not transported very far. The large size of leaves suggests growth in warm and humid conditions.

Floral associations within the collection area seem to be divided into discreet groups: monospecific *Equisetites* zones, coniferous zones, deciduous zones, and mixed coniferous/deciduous zones. This suggests segregation of different plant communities which represent distinct stages of plant succession or different ecosystems. The *Equisetites* zones may represent topographic lows or areas of poor drainage too wet for other plants or possibly the first stages of plant succession on a recently formed alluvial bar. Mixed deciduous and large coniferous tree remains may represent older bars and/or a climax forest. The succession of these plant communities could well have been controlled by the factors such as fluctuations in water levels, erosion of the substrate, nutrient release and dispersal mechanisms described by Nilsson and others (1997). These factors were likely to have been present in the fluvial environment of deposition of these fossil-bearing beds described by Flores and Stricker (1993).

Fossil Matrix: Fossil material occurs in all sedimentary facies of the Premier coal group: sandstone, siltstone, and mudstone (which includes carbonaceous shale, claystone, ironstone concretions, and coal).

Foliar elements are the most commonly preserved plant parts and are most abundant in the dark-gray mudstone which contain masses of plant debris. The low percent shown occurring in mudstone in Fig. 15 is due to a collecting bias because upon removal from the field this material desiccates and disintegrates making recovery of identifiable material nearly impossible. Felspathic iron-stained sandstones also contain impressions of leaves and other plant parts, but details are poor and venation is generally not visible. The abundance of leaf debris and leaves which are “rolled” suggest that deposition was rapid and the material not reworked or subject to long-distance transport. The presence of a mixture of seeds, cones, leaves, and branch and root fragments also suggests rapid burial in flood deposits (Spicer, 1980). The more poorly indurated sandstones with calcium carbonate cement are not highly fossiliferous.

Siderite concretions and knobby lenses within the sandstones sometimes contain nearly perfect deciduous leaves but are so highly indurated that obtaining a hand specimen is difficult. The best preservation occurs in laminated gray to light gray siltstones which provide good detail and stability (Ph. 17). Some of the bedding surfaces are nearly covered with plant impressions, some of them are monospecific. The abundance of material in discrete layers suggests periods of high productivity or a succession of plants in a rapidly changing environment. (Spicer, 1980). The three major facies represent deposition of sediments in channels, crevasse splays, overbank deposits and mires in fluvial and floodplain, channel-fill and overbank environments favorable to peat formation (Spicer & Parrish, 1987 and Flores & Stricker, 1993).

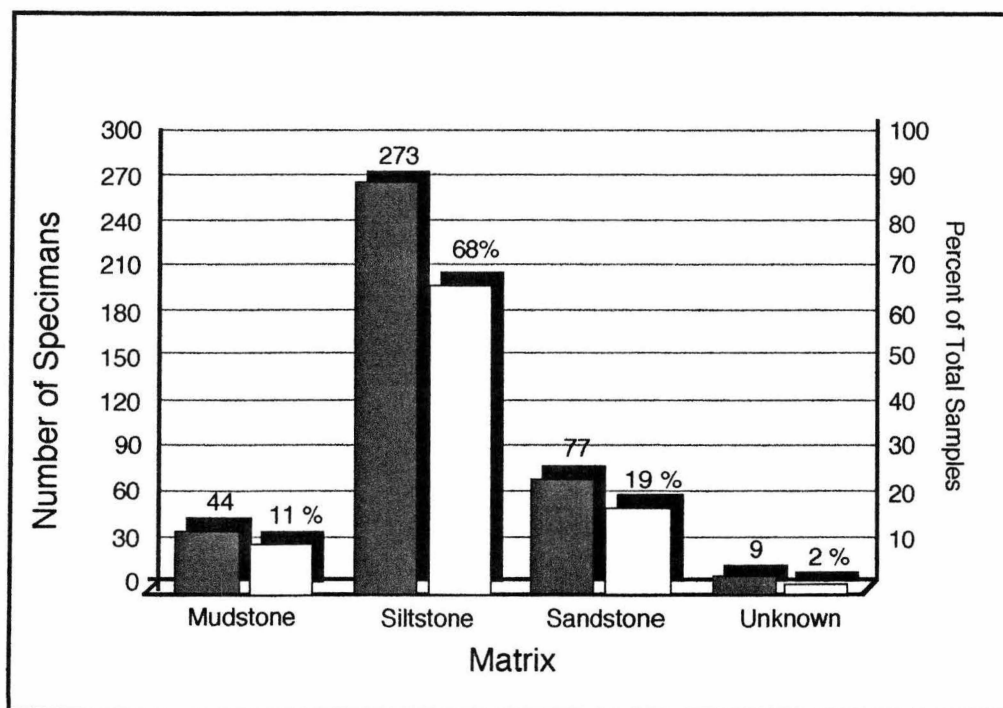
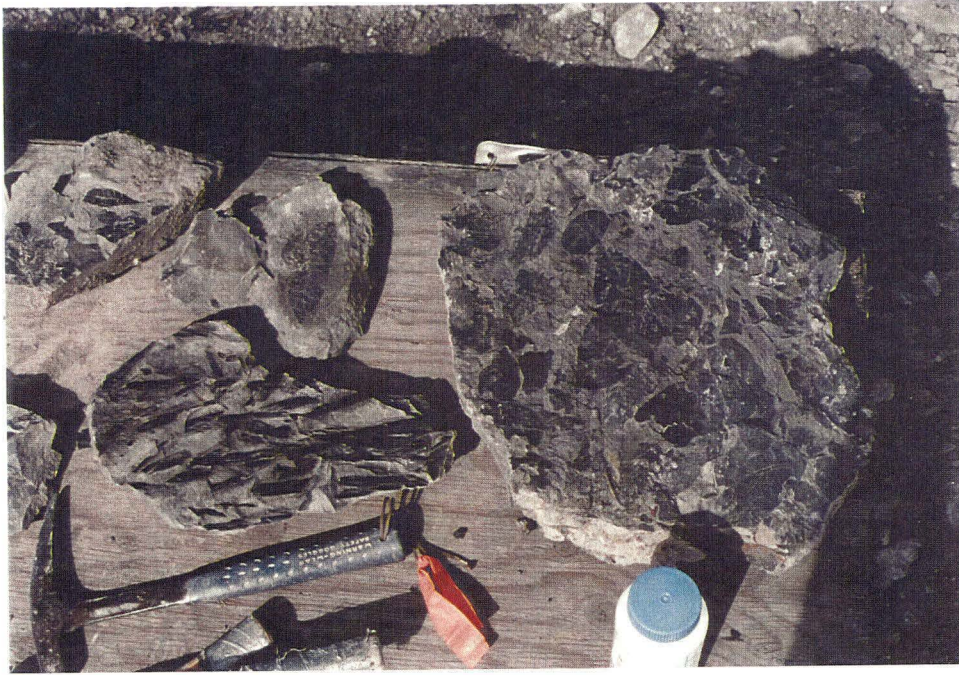


Fig. 15. Distribution of matrix lithologies in the fossil reference collection.



Ph. 17. Laminated siltstone slabs with *Equisitites* and deciduous leaves (6/15/97).

Reproductive Structures: A total of 45 reproductive structures were noted. About half were gymnosperms, those being 100% *Metasequoia* cones. Most of the remaining half: angiosperm seeds, nuts, or fruits have not previously been described. They were very diverse and with two exceptions could not be identified to genus. The rare *Hydrangia* flower and the *Acer* samara (maple seed) show outstanding preservation. The angiosperm structures are part of a world-wide sequence which marks the expansion of this important group on earth (Wing & Sues, 1992).

Amber: The amber recovered is notable for both its age and Taxodiaceae origin. No amber of Tertiary age has been previously reported for Alaska (Fig. 16). Amber described from the Alaskan coastal plain is of Cretaceous age, is chemically variable, and is thought to have both Araucarian and Taxodiaceae origins (Laginheim, 1990). In Laginheim's list of 30 amber deposits which have been studied, only three are Paleocene/Eocene in age and only two originated from members of Taxodiaceae (Table 2).

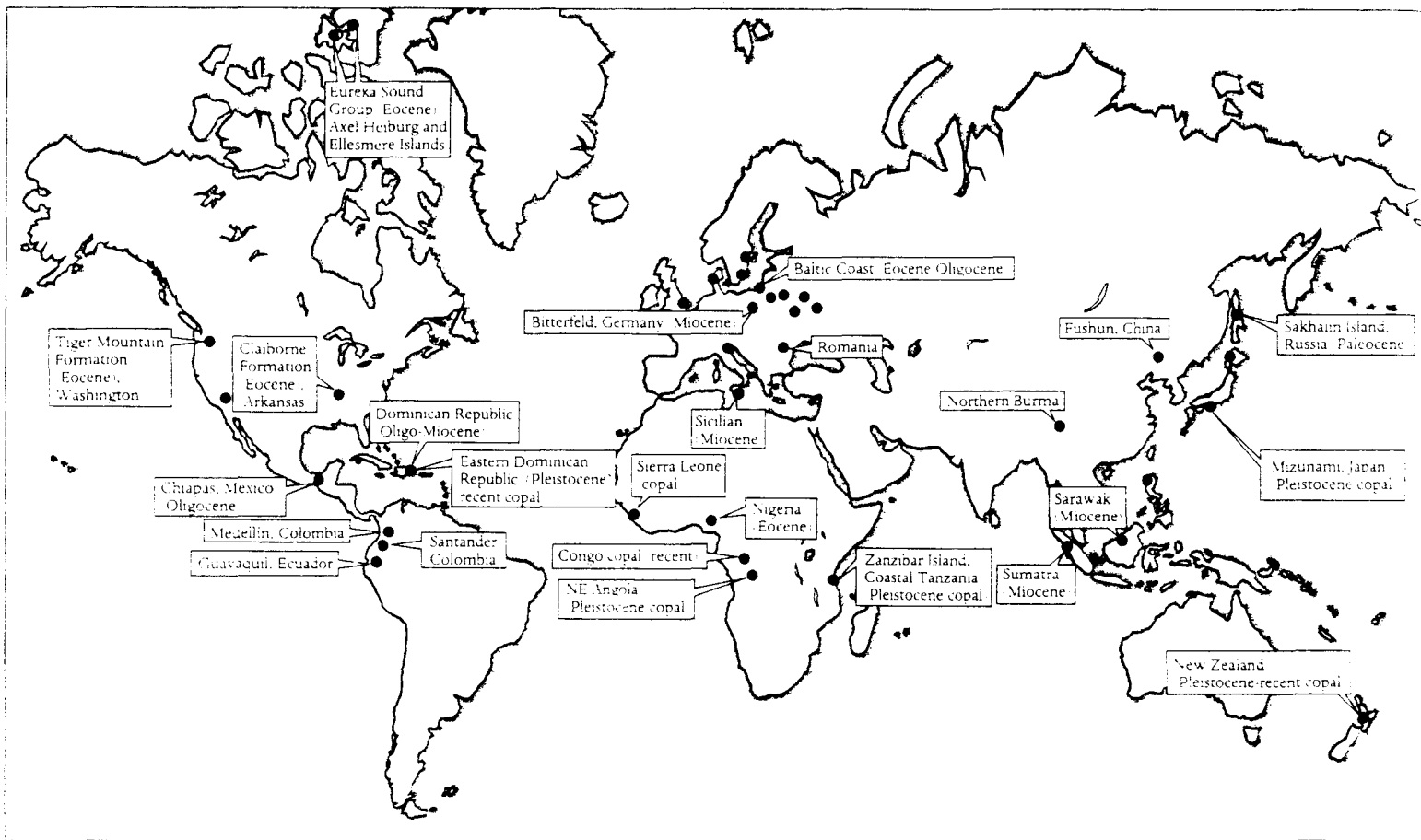


Fig. 16. World-wide localities of Tertiary amber (Grimaldi, 1996).

Age	Location of deposit	Botanical source	Has been studied in detail?
Eocene	British Columbia	Taxodiaceae (conifers)	Yes
Eocene	Washington	Taxodiaceae (conifers)	Yes
Eocene	Wishbone Hill, Alaska	Taxodiaceae (conifers)	No
Paleocene-Eocene	England	Burseraceae (angiosperms)	Yes
Late Cretaceous	Alaskan Arctic Coastal Plain	Araucariaceae (conifers)	Yes
		Taxodiaceae (conifers)	

Table 2. Lower Tertiary and Alaskan amber deposits (modified from Laginheim, 1990).

Amber is fossilized resin, a sticky plant secretion that hardens when exposed to air. All conifers produce resin, especially those living in tropical and subtropical climates. However, it is thought that resin is formed only in members of the Taxodiaceae family as a reaction to disease or injury as its production often follows mechanical injury (Laginheim, 1990). Seward (1966) suggests its chemical nature promotes the unusual preservation of fossil conifers such as those found in Florissant National Monument and Yellowstone Park. The presence of amber then may explain why the fossil wood in the Chickaloon Formation is so exquisitely preserved.

Amber can be classified as internal or external. Internal amber is formed in resin canals or ducts within the wood. It occurs as irregular masses with no specific shape or structure. External amber is formed on the exterior surfaces of tree trunks and is characterized by bark impressions and “flow structures” formed as the viscous liquid oozes out of the tree. Inclusions of bits of debris, insects, and sometimes even small vertebrates occur in this type. Both types are classified into primary and secondary forms, the former being that which is in situ and the latter having been transported by a geologic agent such as running water (Laginheim, 1990).

Hundreds of pieces of amber were recovered on Wishbone Hill. They include tiny fragments less than 1 mm across to larger pieces 10 x 12 x 15 mm. They occur as small rough lumps embedded in bits of coal or coalified wood. Color varies from pale yellow to pale orange to deep orange. Most are clear or translucent with some being opaque. Freshly broken surfaces are common. Some pieces are rounded. No inclusions or internal air bubbles were noted.

As most of the Wishbone Hill amber occurs as rough lumps devoid of inclusions it would appear that it is the internal type. However, differences in the index of refraction data suggest that both types are present (Table 3). The irregularity of the pieces and their juxtaposition with fossilized stumps (Ph. 18) argue that it is primary and has not been transported more than a few feet from the source.

	Internal		External	
shape	irregular masses		droplets	
transparency	transparent		frosted	
color	reddish yellow		reddish yellow	
tint	light	dark	light	dark
index of refraction	1.546	1.544	1.544	1.542

Table 3. Characteristics of amber found in the Chickaloon Formation (Reineke, pers. comm.).

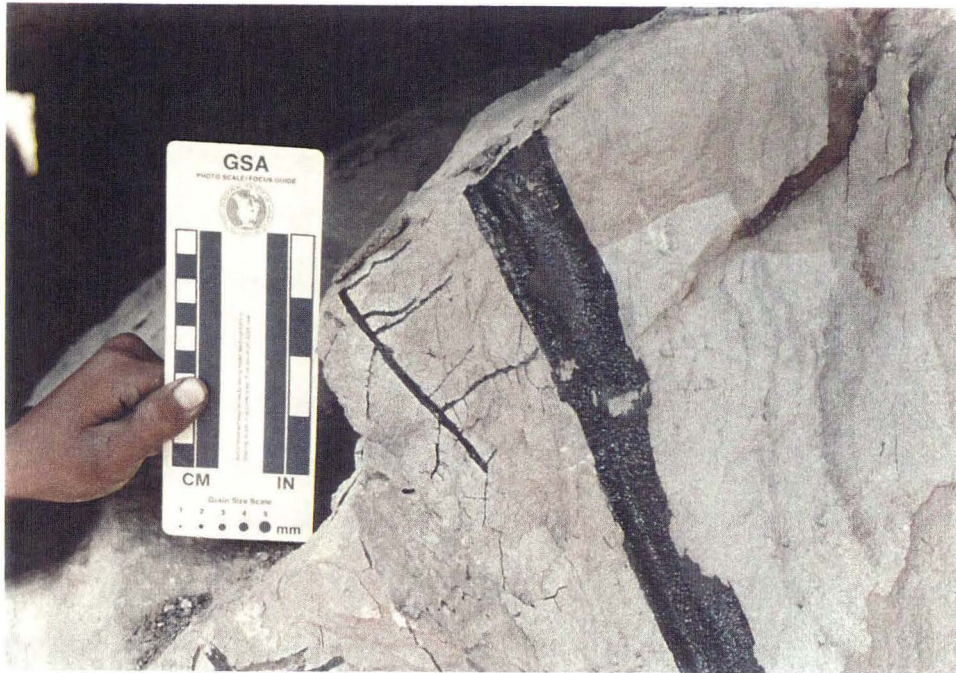


Ph. 18. Fossilized stump in growth position just north of reclamation area where most of the amber was recovered (5/25/97).

The presence of numerous resin canals is characteristic of pine trees, however, no fossil evidence of the pine family was found at the site. No amber was found within woody tissue either in the field or in thin section. However, the fact that resins are formed by two genera of trees which are abundant in the area (*Sequoia* and *Metasequoia*) and that these genera are members of the Taxodiaceae family (Grimaldi, 1966) provides circumstantial evidence that the fossil conifer wood is the source of the amber. The index of refraction data suggest there are two different types of amber that occur in both internal and external forms. The variation could also be due to production by two different species of conifers within the Taxodiaceae family as foliar elements of at least four different genera have been found in the Chickaloon Formation. The two types could be explained by differences in the cause such as disease or stress due to flooding or drought.

A more detailed chemical analysis of the amber using spectral and chromatographic techniques might help determine the genus of the wood.

Wood and in situ Stumps: The woody material occurs as coalified remains of tree trunks (Ph. 19), branches, twigs, and roots (Ph. 20). The close association with foliar elements of *Metasequoia* (dawn sequoia), *Sequoia* (redwood), *Glyptostrobus* (Chinese swamp cypress), and *Taxodium* (bald cypress) and the cellular structure as seen in thin section strongly suggest that all are members of the Taxodiaceae. The extant relatives of these trees grow well in poorly drained, swampy habitats of southeast Asia in a subtropical climate similar to that seen in Florida today (Basinger, 1988). They have a tolerance for saturated, poorly aerated soils.



Ph. 19. Small specimen of petrified wood now in UAA Geologic Rock Garden (6/29/97).



Ph. 20. Carbonized roots (?) in siltstone boulder. Maximum width 5 cm (6/29/97).

Several permineralized wood specimens have preserved cell wall structures and growth rings. All cell structures observed, with with a hand lens or in thin section have the uniform size and radial arrangement of tracheids characteristic of conifers (Tidwell, 1998). No resin canals were observed. Septate tracheids typical of members of the *Taxodium* family are present in the three tangential thin section made (from specimens 97WH036A, 97WH156B, and 97WH156J). There are few anatomical characters which can be used to separate the genera which are represented by associated foliar elements (*Sequoia*, *Taxodium*, and *Metasequoia*) (Tidwell, 1998). Many of the tree trunks exhibit growth rings. They are very distinct and vary in width from < 1 mm to 5 mm in those that were measured. They suggest growth periods which ceased abruptly due to seasonality between warm and cool temperatures or fluctuations in precipitation levels. The large size of the taxideaceans and thickness of growth rings suggest a very productive swamp ecosystem with trees of heights greater than 50 meters (Wing, 1992). Growth ring patterns are among the best recorders of non-marine climate and climatic variability on an annual time-scale (Keller & Hendrix, 1997).

The most significant result of this study may be the extent to which petrified tree stumps occur in situ in the Premier coal group. Six were observed in the North Jones reclamation area, and numerous pieces of petrified wood, some of very large dimensions, were stockpiled from ripped bedrock. The largest appeared to have been buried in growth position as they were perpendicular to bedding. Trees with dimensions such as the ones shown in Fig. 17 are exceptional (Spicer & Parrish, 1987). The preservation of these unusually long tree trunks indicate that burial was very rapid in geologic terms. Spruce killed from the great fire on the Kenai Peninsula in 1949 remain standing today. Some spruce killed by the invasion of sea water after the 1964 Earthquake also remain standing. If these relatively small spruce can remain upright for nearly half a century, it would seem very reasonable for the fossil giants to have remained standing for a century or two at the most. If so, six to seven meters of sediment had to accumulate in that period of time.

The unusual nature of the petrified wood material prompted the Alaska Department of Natural Resources personnel to provide for the transport of several specimens to UAA's Geologic Rock Garden where they could be preserved and seen by the general public. The specimens were officially presented to the university by Commissioner of the Alaska Department of Natural Resources, John Shively, on August 29, 1997.

Petrified logs seen in highwalls during the 1997 North Jones project				
Specimen	Length m	Diameter		
		Greatest --	Shortest --	"Bulb"
Vertical tree just above pond	6.50	> 1.60	1.60	?
Log in measured section B	?	.15	-	-
“ (several)	?	> .20	-	-
“	3.2	?	-	-
Vertical tree in measured section C	8.6	1.25	-	2.0

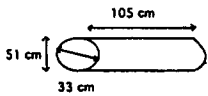
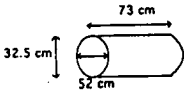
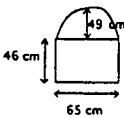
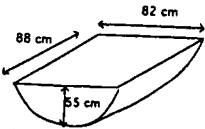
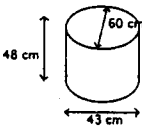
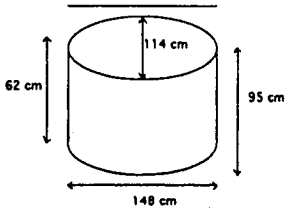
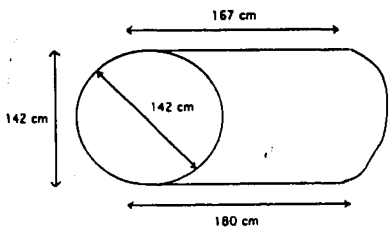
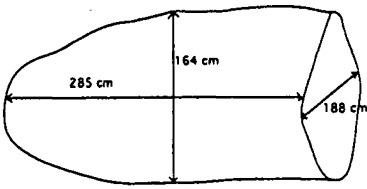
Petrified Logs Placed in the UAA Rock Garden			
No.	Shape	Comments & Dimensions in cm.	Sketch
1.	Narrow cylinder	Good cell structure 140 growth rings 105 x 51 x 33	
2.	Long cylinder	Good cell structure 130 growth rings 73 x 52 x 32.5	
3.	Half-cylinder	Poor cell structure Good growth rings 89 annual rings 46 x 65 x 49	
4.	Half-cylinder	Some cell structure Excellent growth rings 156 annual rings 88 x 82 x 55	
5.	Short cylinder	Some cells, scattered 70 growth rings 48 x 60 x 43	
6.	Large cylinder	Good cell structure Convuluted growth rings 132 annual rings 95 and 62 x 148 x 114	
7.	Large cylinder	Pith off center Coalified bark Asymmetrical growth rings 301 annual rings 180 and 167 x 142 x 142	
8.	Large irregular mass	No cells or rings visible Rhizomorph-like structures suggest preservation of rotted wood Interlaced with 2 cm thick bands of coal Scattered calcite crystals in vugs 285 x 164 x 188	

Fig. 17. Dimensions of selected logs of petrified wood found on Wishbone Hill.

The survey of the highwalls adjacent to the North Jones reclamation area done in the summer of 1998 by UAA student Heather Pierce produced spectacular results. In situ stumps and logs were observed in the high walls of the East Center, West Center, and Deep Pits along a total distance of 1.9 km. A total of 61 stumps in four stratigraphic horizons were found as shown in Table 4. Forty-seven stumps are perpendicular to bedding, four are leaning, and eight are parallel to bedding. The positions of two could not be determined. The range of all in situ trees measured during the past two years is .2 to 3.6 m in width and .3 to 8.6 m in length.

Location	No. of stumps in situ	No. of stratigraphic horizons
East Pit Highwall	35	3
West Center Pit Highwall	18	4
Deep Pit Highwall	8	3

Table 4. Number of trees mapped in situ on Wishbone Hill in 1998

Fossil forests are rare and most are found in remote locations as shown in the brief descriptions given in Table 5. Of the eight listed for comparison purposes, only two others are Late Paleocene/Early Eocene in age, only two others show multiple stratigraphic horizons, and only four others have stumps with diameters greater than one meter. This list is not meant to be inclusive, but it does indicate that the petrified stumps on Wishbone Hill represent a world-class fossil forest.

Location	Age	Description	Source
South-central AK Wishbone Hill	Eocene/Paleocene Chickaloon Fm	58 stumps 3 stratigraphic horizons diam. > 1.6 m hgt. to 8.6 m 89-301 growth rings ring width < 1 - 5 mm	this report
North Slope, AK Colville River valley	Late Cretaceous Nunashuk Group	stumps in growth position diam. 20-50 cm 6-47 growth rings ring width .4-12.9 mm	Spicer, Parrish, & Grant, 1992
North Slope, AK Lookout Ridge Quad Lili Creek valley	mid-Cretaceous Corwin Fm	6 preserved trees diam. 10-70 cm hgt. to 4.5 m	Decker et al., 1997
South LA	Pliocene/Pleist Citronelle Fm/ Sicily Island Loess	fossil tree root-casts 187 cylinders in growth position diam. to 70 cm hgt. to 100 cm	Mossa & Schumaker, 1993
Florissant Fossil Nat'l Monument, CO	Oligocene	Sequoia stumps diam. to 7 m most fossil material removed prior to protection	Wallner, 1976
Bison Basin, WY	Late Paleocene Fort Union Fm	1 tree trunk	Gemmill & Johnson
SE Mongolia Gobi Desert	Late Jurassic Tsagaan Tsav Fm	72 coniferous stumps 1 stratigraphic horizon diam. to 1.75 m 9-109 growth rings ring width .4-4.6 mm	Keller & Hendrix, 1997
Yellowstone N.P. Lamar River valley Specimen Ridge, WY	Early Eocene Absaroka Volcanic Supergroup	numerous tree trunks 27 stratigraphic horizons diam. to 3 m hgt. to 9 m 1,600 growth rings	Dorf, 1964, Seward, 1966, Yuretich, 1984
Axel Heiberg Island Canadian High Arctic	Late Eocene Buchanan Lake Fm	dozens of mummified stumps 19 stratigraphic horizons diam. > 1.5 m growth rings	Basinger, 1988

Table 5. World-wide in situ fossil tree localities

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APPENDIX A

Floral specimens of the Wishbone Hill reference collection

Catalogue #	Latin Name	Lithology	Preliminary ID	"Unit"	Date Coll.
97WH051-1	Abietes sp.		lacy strange branch, deteriorated conifer		1-Jun
97WH345-1	Acer ?	siltstone	fruit/seed		7-Sep
97WH333-1	Acer sp.	siltstone	seed/ half of a samara		7-Sep
97WH200-2	Alnus alaskana	mudstone	mixed		
97WH033B-1	Alnus alaskana?	mudstone			25-May
97WH252-2	Alnus alaskana?	sandstone	deciduous	Float	29-Jun
97WH360	Alnus alaskana?	siltstone	mixed equisetum?/deciduous		7-Sep
97WH196	Ampelopsis acerifolia	siltstone		Float	Jun-97
97WH182A	Anemia gunni	siltstone	fern, compound leaf*		
97WH182B	Anemia gunni	siltstone	counterpart of 182A		
97WH211B-1	Astralopteris sp.	siltstone	fern?	Simeon ss	
97WH034B-2	Carpinus cobbi ?	mudstone	deciduous		25-May
97WH143A	Carpinus grandis	siltstone	deciduous		21-Jun
97WH143B	Carpinus grandis	siltstone	counterpart/deciduous		21-Jun
97WH033A-1	Carya antiquorum	mudstone	deciduous leaves	Joe's ss	25-May
97WH033D-2	Carya antiquorum	mudstone			25-May
97WH038-2	Carya antiquorum	siltstone	deciduous lvs	Simeon ss	1-Jun
97WH045-1	Carya antiquorum	siltstone	deciduous and conifer leaves	Simeon ss	1-Jun
97WH047C-2	Carya antiquorum	sandstone	deciduous/conifers	Simeon ss	1-Jun
97WH056	Carya antiquorum	sandstone	deciduous	Janet ss	8-Jun
97WH061	Carya antiquorum	siltstone	deciduous leaves	Janet ss	8-Jun
97WH064	Carya antiquorum	siltstone	deciduous	Janet ss	8-Jun
97WH065-1	Carya antiquorum	siltstone	deciduous	Janet ss	8-Jun
97WH067	Carya antiquorum	siltstone	deciduous, conifer fragments	Janet ss	8-Jun
97WH071-2	Carya antiquorum	siltstone	deciduous leaf w drip tip, conifer	Janet ss	8-Jun
97WH072-2	Carya antiquorum	siltstone	deciduous, conifers	Janet ss	8-Jun
97WH073-1	Carya antiquorum	sandstone	deciduous, walnut or prunus? conifer	Janet ss	8-Jun
97WH074	Carya antiquorum	siltstone	deciduous	Janet ss	8-Jun
97WH076A	Carya antiquorum	siltstone	deciduous	Janet ss	8-Jun
97WH076B	Carya antiquorum	siltstone	deciduous	Janet ss	8-Jun
97WH076C	Carya antiquorum	siltstone	deciduous	Janet ss	8-Jun
97WH076D-1	Carya antiquorum	siltstone	deciduousw/ cone on back; some conifer	Janet ss	8-Jun
97WH085-2	Carya antiquorum	siltstone	conifer	Janet ss	8-Jun
97WH093	Carya antiquorum	siltstone	deciduous	Janet ss	8-Jun
97WH094	Carya antiquorum	siltstone	deciduous	Janet ss	8-Jun
97WH095	Carya antiquorum	siltstone	deciduous	Janet ss	8-Jun
97WH096-1	Carya antiquorum	sandstone	deciduous	Kurt ss	15-Jun
97WH118-2	Carya antiquorum	siltstone	mixed deciduous		15-Jun
97WH124-2	Carya antiquorum	siltstone	mixed	Pit Float	15-Jun
97WH136	Carya antiquorum	siltstone	deciduous		21-Jun
97WH160-2	Carya antiquorum	siltstone	deciduous		
97WH192A-2	Carya antiquorum	siltstone	mixed	Float	
97WH192B-1	Carya antiquorum	siltstone			
97WH205-1	Carya antiquorum	siltstone	lg deciduous leaf	Float	Jun-97
97WH228-2	Carya antiquorum	siltstone	deciduous	Roger's rk	29-Jun
97WH233-2	Carya antiquorum	siltstone	conifer/ wood, deciduous	Roger's rk	29-Jun
97WH240-2	Carya antiquorum	siltstone	conifer/deciduous	Roger's rk	29-Jun
97WH241-2	Carya antiquorum	sandstone	conifer/deciduous	Roger's rk	29-Jun
97WH247-2	Carya antiquorum	siltstone	deciduous	Roger's rk	29-Jun
97WH259-1	Carya antiquorum	siltstone	seed/deciduous	Float	8-Aug
97WH261A	Carya antiquorum	siltstone	deciduous	Float	8-Aug
97WH267A	Carya antiquorum	siltstone	deciduous	Float	8-Aug
97WH276C	Carya antiquorum	siltstone	deciduous, counterpart of 97WH280		4-Aug
97WH280E-1	Carya antiquorum	siltstone	deciduous		4-Aug
97WH288	Carya antiquorum	siltstone	deciduous		22-Aug
97WH308-1	Carya antiquorum	siltstone	lg slab deciduous 40x20cm	Float	
97WH314-1	Carya antiquorum	siltstone	deciduous		7-Sep

97WH332-3	Carya antiquorum	siltstone			7-Sep
97WH348	Carya antiquorum	siltstone	deciduous		7-Sep
97WH356-3	Carya antiquorum	siltstone	deciduous		7-Sep
97WH363-2	Carya antiquorum	siltstone	deciduous		7-Sep
97WH367E-1	Carya antiquorum	siltstone	mixed		7-Sep
97WH368A-1	Carya antiquorum		deciduous		7-Sep
97WH376	Carya antiquorum	siltstone	deciduous		
97WH185-1	Carya antiquorum ?	sandstone	deciduous/conifers	Simeon ss	15-Jun
97WH231-2	Carya antiquorum ?	siltstone	deciduous/conifer	Roger's rk	29-Jun
97WH361-2	Celastrus comparabilis	siltstone	deciduous		7-Sep
97WH362-1	Celastrus comparabilis	siltstone	counterpart to 361		7-Sep
97WH318	coal	coal			7-Sep
97WH332-2	Coccolobis chapini	siltstone	deciduous		7-Sep
97WH097-2	Cocculus ?	sandstone	mixed	Kurt ss	15-Jun
97WH192B-2	Cocculus ?	siltstone			
97WH145	Cocculus flabella	siltstone	deciduous		21-Jun
97WH255-2	Cocculus flabella	siltstone	deciduous	Float	8-Aug
97WH298-1	Cocculus flabella	siltstone	deciduous	Float	
97WH301	Cocculus flabella	siltstone	deciduous	Float	
97WH165-2	Cocculus flabella ?	siltstone	conifer, deciduous		
97WH260A-2	Cocculus sp.	mudstone	deciduous	Float	8-Aug
97WH260B-2	Cocculus sp.	mudstone	counterpart deciduous	Float	8-Aug
97WH023C	Coniferales	siltstone/sh		Measured Se	25-May
97WH023F	Coniferales	siltstone/sh	conifer fragments	Measured Se	25-May
97WH027A	Coniferales	claystone	conifers	Measured Se	25-May
97WH051-3	Coniferales		conifer branch		1-Jun
97WH058	Coniferales	sandstone	conifer-Juniper type	Janet ss	8-Jun
97WH122-1	Cycadales ?	siltstone	stems?	Pit Float	15-Jun
97WH168-2	Cycadales ?	siltstone	Dioon?		
97WH286	Cycadales ?	siltstone	Equisetum? see 287		22-Aug
97WH287	Cycadales ?	siltstone	Equisetum? see 286		22-Aug
97WH335-1	Cycadales ?	siltstone			7-Sep
97WH175	Dicotylophyllum alaskana	mudstone	deciduous		
97WH179	Dicotylophyllum alaskana	ms/siltst	Wolfe p B11		
97WH234	Dicotylophyllum alaskana	siltstone	deciduous	Roger's rk	29-Jun
97WH328-1	Dicotylophyllum alaskana	siltstone	mixed		7-Sep
97WH282	Dicotylophyllum flexuosa	siltstone	deciduous		22-Aug
97WH308-3	Dicotylophyllum flexuosa	siltstone	lg slab deciduous 40x20cm	Float	
97WH331	Dicotylophyllum flexuosa	siltstone	deciduous		7-Sep
97WH343	Dicotylophyllum flexuosa	siltstone	deciduous		7-Sep
97WH353	Dicotylophyllum flexuosa	siltstone	deciduous		7-Sep
97WH375	Dicotylophyllum flexuosa	siltstone	deciduous		
97WH053	Dillenia alaskana ?	siltstone	deciduous leaves/conifer/seed?	Janet ss	8-Jun
97WH066	Dillenia alaskana ?	siltstone	deciduous	Janet ss	8-Jun
97WH350	Dillenia alaskana?	siltstone	deciduous		7-Sep
97WH377	Dioon?	concretion	cycad?		
97WH223	Equisetites ?	siltstone	Equisetum, poor sample		15-Jun
97WH003B	Equisetites sp.	mudstone	sm fragments with deciduous leaf fragme	Measured Se	14-May
97WH033B-2	Equisetites sp.	mudstone			25-May
97WH034A-1	Equisetites sp.	mudstone	deciduous leaves		25-May
97WH034B-1	Equisetites sp.	mudstone	deciduous leaves		25-May
97WH082-1	Equisetites sp.	sandstone	Equis/conifer/deciduous	Janet ss	8-Jun
97WH122-2	Equisetites sp.	siltstone	stems?	Pit Float	15-Jun
97WH123	Equisetites sp.	siltstone			15-Jun
97WH139	Equisetites sp.	siltstone	Equisetum		21-Jun
97WH168-1	Equisetites sp.	siltstone	Equisetum		
97WH226	Equisetites sp.	siltstone			15-Jun
97WH260A-1	Equisetites sp.	mudstone	deciduous	Float	8-Aug

97WH260B-1	Equisetites sp.	mudstone	counterpart, deciduous	Float	8-Aug
97WH309	Equisetites sp.	mudstone	Equisteum	Float	
97WH311-3	Equisetites sp.	siltstone		Float	
97WH334	Equisetites sp.	siltstone			7-Sep
97WH335-2	Equisetites sp.	siltstone			7-Sep
97WH033C	Equisetites sp.	mudstone			25-May
97WH052	Equisetites sp.	siltstone		Janet ss	8-Jun
97WH119	Equisetites sp.	siltstone			15-Jun
97WH153	Equisetites sp.	siltstone			21-Jun
97WH157	Equisetites sp.	siltstone			
97WH159	Equisetites sp.	siltstone	deciduous		
97WH162	Equisetites sp.	siltstone			
97WH163	Equisetites sp.	siltstone			
97WH181B	Equisetites sp.	siltstone	seed counterpart of 181A		Jun-97
97WH293	Equisetites sp.	siltstone		Float	
97WH158	Eucommia serrata	siltstone	deciduous		
97WH320	Eucommia serrata	siltstone	deciduous leaf		2-Sep
97WH340	Eucommia serrata	siltstone	deciduous		7-Sep
97WH354	Ficus ratonensis	siltstone	deciduous		7-Sep
97WH304	Flabellaria alaskana ?	siltstone	compressed palm leaf?	Float	
97WH279A	Fraxinus inordinata	siltstone	deciduous		4-Aug
97WH218	Fraxinus juglandina	siltstone	deciduous		15-Jun
97WH033B-3	Fraxinus lateralis	mudstone			25-May
97WH030D	fruit/seed	shale	seed		25-May
97WH030E	fruit/seed	shale	seed		25-May
97WH031	fruit/seed	sandstone	seed?		25-May
97WH039	fruit/seed	siltstone	seed?	Simeon ss	1-Jun
97WH043	fruit/seed	siltstone	cast of seed pod	Simeon ss	1-Jun
97WH049A	fruit/seed	siltstone	equisities/seed cast	Janet ss	1-Jun
97WH049B	fruit/seed	siltstone	counterpart to 49A	Janet ss	1-Jun
97WH100A	fruit/seed	sandstone	seed pod? cone	Kurt ss	15-Jun
97WH100B	fruit/seed	sandstone	counterpart of 100A	Kurt ss	15-Jun
97WH101	fruit/seed	sandstone	seed pod	Kurt ss	15-Jun
97WH102	fruit/seed	sandstone	seed pod	Kurt ss	15-Jun
97WH104	fruit/seed	sandstone	cones/seed pod/stem	Kurt ss	15-Jun
97WH129	fruit/seed	sandstone	seed/poor cone	Float	22-Jun
97WH151-1	fruit/seed	siltstone			21-Jun
97WH166	fruit/seed	siltstone	fruit, conifer		
97WH181A	fruit/seed	siltstone	seed		June
97WH183	fruit/seed	mudstone	seed		4-Aug
97WH215	fruit/seed	siltstone	seed		15-Jun
97WH239-2	fruit/seed	siltstone	mixed, seed pod?	Roger's rk	29-Jun
97WH259-2	fruit/seed	siltstone	seed/deciduous	Float	8-Aug
97WH264-1	fruit/seed	mudstone	deciduous	Float	8-Aug
97WH266	fruit/seed	siltstone	seed ?	Float	8-Aug
97WH316-1	fruit/seed	mudstone	conifer		7-Sep
97WH028B	Glyptostrobus europaeus	claystone			25-May
97WH028D	Glyptostrobus europaeus	claystone			25-May
97WH040A	Glyptostrobus europaeus	sandstone	branch	Simeon ss	1-Jun
97WH040B	Glyptostrobus europaeus	sandstone	counterpart?	Simeon ss	1-Jun
97WH149-2	Glyptostrobus europaeus	siltstone	conifer/cone		21-Jun
97WH207	Glyptostrobus europaeus	sandstone	conifer	Simeon ss	15-Jun
97WH222-1	Glyptostrobus europaeus	sandstone	mixed		15-Jun
97WH244-2	Glyptostrobus europaeus	siltstone	conifer/cones deciduous (on reverse)	Roger's rk	29-Jun
97WH296	Glyptostrobus europaeus	mudstone	conifer	Float	
97WH305-1	Glyptostrobus europaeus	siltstone	conifer + deciduous fragment	Float	
97WH313	Glyptostrobus europaeus	siltstone	conifer	Float	
97WH324-2	Glyptostrobus europaeus	siltstone	mixed		7-Sep

97WH347-1	Glyptostrobus europaeus	siltstone	deciduous		7-Sep
97WH356-4	Grewia orbiculata ?	siltstone	deciduous		7-Sep
97WH029A-1	Hedera sp.	siltstone	cocculus and conifers		25-May
97WH361-1	Hedera sp.	siltstone	deciduous		7-Sep
97WH362-2	Hedera sp.	siltstone	counterpart to 361		7-Sep
97WH229-1	Hicoria magnifica	siltstone	deciduous/conifer	Roger's rk	29-Jun
97WH332-1	Hicoria magnifica	siltstone	deciduous		7-Sep
97WH346	Hicoria magnifica	mudstone	deciduous		7-Sep
97WH351	Hicoria magnifica	siltstone	mixed		7-Sep
97WH329-1	Hicoria magnifica ?	mudstone	deciduous		7-Sep
97WH055	Hydrangea cf. H. alaskana	siltstone	flower	Janet ss	8-Jun
97WH073-2	Juglandicarya	sandstone	fruit/seed	Janet ss	8-Jun
97WH160-1	Juglans ?	siltstone	deciduous		
97WH278B-2	Juglans nigella	siltstone	deciduous		4-Aug
97WH134	Juglans salicifolia ?	sandstone	deciduous	Pit Float	15-Jun
97WH378	Matonia ?	siltstone	fern ?		
97WH048	Metasequoia cone	siltstone	cone with peduncle	Simeon ss	1-Jun
97WH050	Metasequoia cone	sandstone	conifer cone	Simeon ss	1-Jun
97WH065-2	Metasequoia cone	siltstone	deciduous	Janet ss	8-Jun
97WH076D-2	Metasequoia cone	siltstone	deciduousw/ cone on back; some conifer	Janet ss	8-Jun
97WH089	Metasequoia cone	sandstone	cone	Janet ss	8-Jun
97WH090	Metasequoia cone	sandstone	cone	Janet ss	8-Jun
97WH096-2	Metasequoia cone	sandstone	deciduous	Kurt ss	15-Jun
97WH098	Metasequoia cone	sandstone	cones	Kurt ss	15-Jun
97WH099	Metasequoia cone	sandstone	cones, see WH103	Kurt ss	15-Jun
97WH103	Metasequoia cone	sandstone	counterpart of 099/ plant debris	Kurt ss	15-Jun
97WH107	Metasequoia cone	sandstone	cones	Kurt ss	15-Jun
97WH108	Metasequoia cone	sandstone	conifers/cones/stems	Kurt ss	15-Jun
97WH113	Metasequoia cone	sandstone	cones/stems	Kurt ss	15-Jun
97WH187	Metasequoia cone	sandstone	cones, wood fragments		
97WH192B	Metasequoia cone	siltstone	counterpart much smaller	Float	
97WH192B-3	Metasequoia cone	siltstone	cone with peduncle		
97WH201	Metasequoia cone	sandstone	cone	Simeon ss	15-Jun
97WH205-3	Metasequoia cone	sandstone	conifer/cones, some deciduous	Simeon ss	15-Jun
97WH208	Metasequoia cone	sandstone	cone	Simeon ss	15-Jun
97WH244-3	Metasequoia cone	siltstone		Roger's rk	
97WH254-1	Metasequoia cone	sandstone		Float	29-Jun
97WH368A-2	Metasequoia cone		deciduous/cones		7-Sep
97WH105	Metasequoia cone	sandstone	cones/debris	Kurt ss	15-Jun
97WH020	Metasequoia occidentalis	siltstone/sh	conifer branches	Bobby sandst	25-May
97WH023A	Metasequoia occidentalis	siltstone/sh	conifer fragments	Measured Se	25-May
97WH023D	Metasequoia occidentalis	siltstone/sh	conifer fragments	Measured Se	25-May
97WH023E	Metasequoia occidentalis	siltstone/sh	conifer fragments	Measured Se	25-May
97WH023G	Metasequoia occidentalis	siltstone/sh	conifer fragments	Measured Se	25-May
97WH024A	Metasequoia occidentalis	siltstone	conifer fragments	Measured Se	25-May
97WH024B	Metasequoia occidentalis	siltstone	wood fragments	Measured Se	25-May
97WH025B	Metasequoia occidentalis	siltstone	conifers, Amanda mud	Measured Se	25-May
97WH028A	Metasequoia occidentalis	claystone	juniper?		25-May
97WH029A-2	Metasequoia occidentalis	siltstone	cocculus and conifers		25-May
97WH029C	Metasequoia occidentalis	siltstone			25-May
97WH033A-3	Metasequoia occidentalis	mudstone	deciduous leaves	Joe'ss	25-May
97WH033D-1	Metasequoia occidentalis	mudstone			25-May
97WH037	Metasequoia occidentalis	siltstone	conifers w deciduous fragments, 3 cones	Simeon ss	1-Jun
97WH038-1	Metasequoia occidentalis	siltstone	deciduous lvs	Simeon ss	1-Jun
97WH042A	Metasequoia occidentalis	siltstone	cone	Simeon ss	1-Jun
97WH042C	Metasequoia occidentalis	siltstone	branch	Simeon ss	1-Jun
97WH044A	Metasequoia occidentalis	siltstone	cone	Simeon ss	1-Jun
97WH044B	Metasequoia occidentalis	siltstone	cone	Simeon ss	1-Jun

97WH044C	Metasequoia occidentalis	siltstone	branch	Simeon ss	1-Jun
97WH045-2	Metasequoia occidentalis	siltstone	mixed	Simeon ss	1-Jun
97WH047A	Metasequoia occidentalis	sandstone	conifers, deciduous frags	Simeon ss	1-Jun
97WH047B	Metasequoia occidentalis	sandstone	conifers	Simeon ss	1-Jun
97WH047C-1	Metasequoia occidentalis	sandstone	deciduous/conifers	Simeon ss	1-Jun
97WH054	Metasequoia occidentalis	siltstone	conifer	Janet ss	8-Jun
97WH059	Metasequoia occidentalis	siltstone	conifer	Janet ss	8-Jun
97WH062	Metasequoia occidentalis	siltstone	conifer	Janet ss	8-Jun
97WH063	Metasequoia occidentalis	siltstone	conifer	Janet ss	8-Jun
97WH068	Metasequoia occidentalis	siltstone	deciduous/conifers	Janet ss	8-Jun
97WH069-1	Metasequoia occidentalis	siltstone	deciduous, conifers, cone?, twig or stem/	large slab, Ja	8-Jun
97WH071-1	Metasequoia occidentalis	siltstone	deciduous leaf w drip tip, conifer	Janet ss	8-Jun
97WH072-1	Metasequoia occidentalis	siltstone	deciduous, conifers	Janet ss	8-Jun
97WH077	Metasequoia occidentalis	siltstone	conifer	Janet ss	8-Jun
97WH078	Metasequoia occidentalis	charcoal	conifer, mixed, stems	Janet ss	8-Jun
97WH079	Metasequoia occidentalis	sandstone	conifer mixed	Janet ss	8-Jun
97WH080	Metasequoia occidentalis	sandstone	conifer/stems	Janet ss	8-Jun
97WH085-1	Metasequoia occidentalis	siltstone	conifer	Janet ss	8-Jun
97WH086	Metasequoia occidentalis	siltstone	conifer	Janet ss	8-Jun
97WH087	Metasequoia occidentalis	siltstone	conifer	Janet ss	8-Jun
97WH088	Metasequoia occidentalis	siltstone	conifer	Janet ss	8-Jun
97WH091	Metasequoia occidentalis	sandstone	mixed>deciduous	Janet ss	8-Jun
97WH097-1	Metasequoia occidentalis	sandstone	fruit/seed ?	Kurt ss	15-Jun
97WH106	Metasequoia occidentalis	sandstone	conifer	Kurt ss	15-Jun
97WH109	Metasequoia occidentalis	sandstone	conifer/debris	Kurt ss	15-Jun
97WH110	Metasequoia occidentalis	sandstone	mixed	Kurt ss	15-Jun
97WH111	Metasequoia occidentalis	sandstone	mixed	Kurt ss	15-Jun
97WH118-1	Metasequoia occidentalis	siltstone	mixed deciduous		15-Jun
97WH124-1	Metasequoia occidentalis	siltstone	mixed	Pit Float	15-Jun
97WH142	Metasequoia occidentalis	siltstone	conifer, deciduous		21-Jun
97WH146	Metasequoia occidentalis	siltstone	conifer		21-Jun
97WH149-1	Metasequoia occidentalis	siltstone	conifer/cone		21-Jun
97WH151-2	Metasequoia occidentalis	siltstone	conifer, seed?		21-Jun
97WH154	Metasequoia occidentalis	siltstone	conifer		21-Jun
97WH165-1	Metasequoia occidentalis	siltstone	conifer, deciduous		
97WH167	Metasequoia occidentalis	siltstone	conifer		
97WH174	Metasequoia occidentalis	siltstone	deciduous		
97WH177A-2	Metasequoia occidentalis	siltstone			
97WH185-2	Metasequoia occidentalis	sandstone			
97WH186-1	Metasequoia occidentalis	siltstone	mixed		
97WH192B-4	Metasequoia occidentalis	siltstone			
97WH197	Metasequoia occidentalis	sandstone	deciduous, conifer scraps	Pit Float	
97WH199-1	Metasequoia occidentalis	sandstone	mixed	Pit Float	17-Jun
97WH205-2	Metasequoia occidentalis	sandstone		Simeon ss	
97WH206-1	Metasequoia occidentalis	sandstone	conifer	Simeon ss	15-Jun
97WH209	Metasequoia occidentalis	sandstone	conifer	Simeon ss	15-Jun
97WH210	Metasequoia occidentalis	siltstone	deciduous		15-Jun
97WH211A	Metasequoia occidentalis	sandstone	lg deciduous	Simeon ss	
97WH211B-2	Metasequoia occidentalis	sandstone	counterpart, fern on backside	Simeon ss	
97WH213	Metasequoia occidentalis	sandstone	conifer	Simeon ss	15-Jun
97WH214	Metasequoia occidentalis	sandstone	conifer	Simeon ss	15-Jun
97WH222-2	Metasequoia occidentalis	sandstone	conifer, deciduous (on reverse)		15-Jun
97WH228-1	Metasequoia occidentalis	siltstone	deciduous	Roger's rk	29-Jun
97WH229-2	Metasequoia occidentalis	siltstone	deciduous/conifer	Roger's rk	29-Jun
97WH230	Metasequoia occidentalis	siltstone	deciduous/conifer	Roger's rk	29-Jun
97WH231-1	Metasequoia occidentalis	siltstone	deciduous/conifer	Roger's rk	29-Jun
97WH232	Metasequoia occidentalis	siltstone	deciduous/conifer	Roger's rk	29-Jun
97WH233-1	Metasequoia occidentalis	siltstone	conifer/ wood, deciduous	Roger's rk	29-Jun

97WH236	Metasequoia occidentalis	siltstone	conifer	Roger's rk	29-Jun
97WH237	Metasequoia occidentalis	siltstone	conifer/deciduous	Roger's rk	29-Jun
97WH238	Metasequoia occidentalis	siltstone	conifer, deciduous	Roger's rk	29-Jun
97WH239-1	Metasequoia occidentalis	siltstone	mixed, seed pod?	Roger's rk	29-Jun
97WH240-1	Metasequoia occidentalis	siltstone	conifer/deciduous	Roger's rk	29-Jun
97WH241-1	Metasequoia occidentalis	sandstone	conifer/deciduous	Roger's rk	29-Jun
97WH242	Metasequoia occidentalis	siltstone	conifer	Roger's rk	29-Jun
97WH244-1	Metasequoia occidentalis	siltstone	conifer/cones deciduous (on reverse)	Roger's rk	29-Jun
97WH247-1	Metasequoia occidentalis	siltstone	deciduous	Roger's rk	29-Jun
97WH248	Metasequoia occidentalis	siltstone	conifer	Roger's rk	29-Jun
97WH249	Metasequoia occidentalis	siltstone	deciduous	Roger's rk	29-Jun
97WH250-2	Metasequoia occidentalis	siltstone	deciduous	Roger's rk	29-Jun
97WH252-1	Metasequoia occidentalis	sandstone	deciduous	Float	29-Jun
97WH254-2	Metasequoia occidentalis	sandstone	conifer + cones	Float	29-Jun
97WH257	Metasequoia occidentalis	mudstone	conifer	Float	8-Aug
97WH269C	Metasequoia occidentalis	siltstone	conifer	Float	8-Aug
97WH280E-2	Metasequoia occidentalis	siltstone	counterpart of 97WH276, deciduous		4-Aug
97WH283	Metasequoia occidentalis	siltstone	conifer		22-Aug
97WH292	Metasequoia occidentalis	siltstone	conifer	Float	
97WH297-1	Metasequoia occidentalis	mudstone	deciduous/conifer	Float	
97WH300	Metasequoia occidentalis	mudstone	conifer	Float	
97WH308-2	Metasequoia occidentalis	siltstone	lg slab deciduous 40x20cm	Float	
97WH311-1	Metasequoia occidentalis	siltstone		Float	
97WH314-2	Metasequoia occidentalis	siltstone	deciduous		7-Sep
97WH315	Metasequoia occidentalis	siltstone	conifer		7-Sep
97WH316-2	Metasequoia occidentalis	mudstone	conifer		7-Sep
97WH319	Metasequoia occidentalis	siltstone	conifer		7-Sep
97WH324-1	Metasequoia occidentalis	siltstone	mixed		7-Sep
97WH336	Metasequoia occidentalis	siltstone	mixed		7-Sep
97WH347-2	Metasequoia occidentalis	siltstone	deciduous		7-Sep
97WH355	Metasequoia occidentalis	siltstone	base of branchlet		7-Sep
97WH358	Metasequoia occidentalis	siltstone	cone		7-Sep
97WH363-1	Metasequoia occidentalis	siltstone	deciduous		7-Sep
97WH365	Metasequoia occidentalis		unidentified objects		7-Sep
97WH328-2	Metasequoia occidentalis	siltstone	mixed		7-Sep
97WH338	Nyssidium ekmani	mudstone	fruit/seed		7-Sep
97WH082-2	Parataxodium sp.	sandstone		Janet ss	8-Jun
97WH033A-2	Planera microphylla	mudstone	deciduous leaves	Joe'ss	25-May
97WH173	Planera microphylla	siltstone	deciduous		
97WH130	Planera microphylla	siltstone	deciduous	Float	?
97WH021	Platanus aceroides latifolia	siltstone/sh	conifer, deciduous scraps leaves, wood		25-May
97WH325	Platanus aspera ?	siltstone	deciduous		7-Sep
97WH177B	Platanus nobilis	siltstone			
97WH126	Platanus rectinervis	siltstone	deciduous	Pit Float	15-Jun
97WH176B	Platanus sp.	ms/siltst	deciduous branch?		
97WH255-1	Platanus sp.	siltstone	deciduous	Float	8-Aug
97WH328-3	Platanus sp.	siltstone	mixed		7-Sep
97WH081	Populus ?	sandstone	deciduous	Janet ss	8-Jun
97WH202	Populus ?	sandstone	conifer/deciduous	Simeon ss	15-Jun
97WH204	Populus ?	sandstone	deciduous stems?	Simeon ss	15-Jun
97WH227	Populus ?	siltstone	deciduous	Float	
97WH356-2	Populus ?	siltstone	deciduous		7-Sep
97WH278B-1	Populus acerifolia	siltstone	deciduous		4-Aug
97WH285	Populus amblyrhyncha ?	siltstone	deciduous		22-Aug
97WH303	Populus amblyrhyncha ?	siltstone	deciduous	Float	
97WH306	Populus amblyrhyncha ?	sandstone	deciduous	Float	
97WH364	Populus glandulifera	siltstone	1 deciduous leaf		7-Sep
97WH148	Populus latior	siltstone	deciduous/conifers		21-Jun

97WH225	Populus latior	sandstone	ex. deciduous	Simeon ss	15-Jun
97WH305-2	Populus latior	siltstone	conifer + deciduous fragment	Float	
97WH152-3	Populus latior ?	sandstone	deciduous		21-Jun
97WH298-2	Populus obscura	siltstone	deciduous	Float	
97WH180	Populus richardsoni	siltstone	deciduous leaf-good margin		June
97WH195	Populus richardsoni	concretion	good leaf		
97WH251	Populus richardsoni	sandstone	deciduous	Float	29-Jun
97WH277D	Populus richardsoni	siltstone	deciduous		4-Aug
97WH307	Populus richardsoni	mudstone	deciduous	Float	
97WH311-2	Populus richardsoni	siltstone		Float	
97WH115	Populus richardsoni ?	siltstone	deciduous (poor)		15-Jun
97WH193	Populus richardsoni ?	siltstone	deciduous	Float	
97WH298-3	Populus richardsoni ?	siltstone	deciduous	Float	
97WH291	Populus sp.	siltstone	deciduous	Float	
97WH060	Pterocarya septentrionale	siltstone	cone, deciduous leaves	Janet ss	8-Jun
97WH310	Pterospermites cf P. dentatus	siltstone	deciduous	Float	
97WH250-1	Pterospermites ?	siltstone	deciduous	Roger's rk	29-Jun
97WH263C	Pterospermites conjunctivus	siltstone	deciduous	Float	8-Aug
97WH186-2	Pterospermites cordatus	siltstone	mixed		
97WH022	Quercus ?	siltstone	highly fossiliferous		25-May
97WH057A	Quercus banksiaefolia ?	sandstone	deciduous part	Janet ss	8-Jun
97WH057B	Quercus banksiaefolia ?	sandstone	counterpart, deciduous	Janet ss	8-Jun
97WH367E-2	Quercus cf Q. greenlandica	siltstone	mixed		7-Sep
97WH258	Quercus elliptica?	siltstone	deciduous	Float	8-Aug
97WH046	Quercus gronlandica	siltstone	deciduous	Simeon ss	1-Jun
97WH330	Quercus juglandina ?	mudstone	deciduous		7-Sep
97WH114	Quercus pseudocastanea	sandstone	deciduous	Kurt ss	15-Jun
97WH177A-1	Quercus sp.	siltstone	deciduous		
97WH144A	Quercus sullyi	siltstone	deciduous		21-Jun
97WH144B	Quercus sullyi	siltstone	counterpart/deciduous		21-Jun
97WH217	Quercus sullyi	siltstone	deciduous		15-Jun
97WH333-2	Quercus sullyi	siltstone	counterpart of 97WH345		7-Sep
97WH345-2	Quercus sullyi	siltstone	deciduous		7-Sep
97WH190	root	siltstone	root system? good specimen*		
97WH220	root	sandstone	root system	Simeon ss	15-Jun
97WH245	root	siltstone	root system/wood	Roger's rk	29-Jun
97WH246	root	siltstone	root system	Roger's rk	29-Jun
97WH256	root	siltstone	root system	Float	8-Aug
97WH268B	root	siltstone	root system	Float	8-Aug
97WH041-2	Rulac crataegifolium ?	sandstone	very nice deciduous leaves w margins	Simeon ss	1-Jun
97WH216	Sophora cf S. multiformis	siltstone	deciduous		15-Jun
97WH289	Spiraea sp.	siltstone	deciduous	Float	
97WH243	Taxodium ?	siltstone	deciduous	Roger's rk	29-Jun
97WH356-1	Taxodium ?	siltstone	deciduous		7-Sep
97WH169	Taxodium ?	siltstone	deciduous, conifers, cone?, twig or stem/	large slab, Ja	8-Jun
97WH051-2	Taxodium dubium longifolium		lacy strange branch, deteriorated conifer		1-Jun
97WH137	Taxodium sp.	siltstone	conifer		21-Jun
97WH172	Taxodium sp.	siltstone	conifer		
97WH192A-1	Taxodium sp.	siltstone	mixed	Float	Jun-97
97WH295	Taxodium sp.	mudstone	conifer	Float	
97WH041-1	Ulmus newberryi	sandstone	very nice deciduous leaves w margins	Simeon ss	1-Jun
97WH200-1	Viburnum ?	mudstone	mixed		
97WH281	Viburnum sp.	siltstone	deciduous		22-Aug
97WH023B	unknown	siltstone/sh	deciduous/conifer	Measured Se	25-May
97WH025A	unknown	siltstone	deciduous/conifers, Amanda mud	Unit 5	25-May
97WH027D	unknown	claystone		Measured Se	25-May
97WH029B	unknown	siltstone	deciduous leaves		25-May
97WH032	unknown	sandstone	plan hash	base of Unit 2	25-May

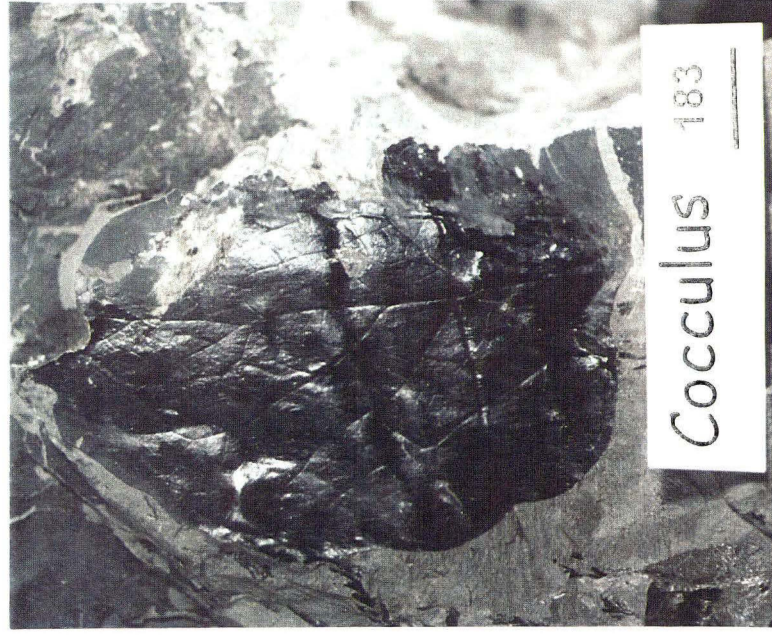
97WH034A-2	unknown	mudstone	deciduous		7-Sep
97WH075	unknown	siltstone	deciduous	Janet ss	8-Jun
97WH120	unknown	siltstone	deciduous		15-Jun
97WH125	unknown	siltstone	deciduous	Float	15-Jun
97WH127	unknown	siltstone	deciduous	Pit Float	15-Jun
97WH135	unknown	siltstone	deciduous		21-Jun
97WH138	unknown	siltstone	deciduous		21-Jun
97WH140	unknown	siltstone	deciduous		21-Jun
97WH141	unknown	siltstone	Equisetum/deciduous		21-Jun
97WH147	unknown	siltstone	deciduous		21-Jun
97WH170	unknown	siltstone	deciduous		
97WH176A	unknown	ms/siltst	deciduous branch?		
97WH178	unknown	siltstone	deciduous		
97WH198	unknown	siltstone	lg deciduous leaf	Float	Jun-97
97WH199-2	unknown	sandstone	deciduous	Pit Float	17-Jun
97WH206-2	unknown	sandstone	deciduous	Simeon ss	15-Jun
97WH221	unknown	sandstone	deciduous/conifer		15-Jun
97WH255-3	unknown	siltstone	deciduous	Float	8-Aug
97WH260A-3	unknown	mudstone	deciduous	Float	8-Aug
97WH264-2	unknown	mudstone	deciduous	Float	8-Aug
97WH297-2	unknown	mudstone	deciduous	Float	
97WH312	unknown	sandstone	deciduous	Float	
97WH329-2	unknown	mudstone	deciduous		7-Sep
97WH339	unknown	siltstone	deciduous		7-Sep
97WH342	unknown	siltstone	deciduous		7-Sep
97WH352	unknown		deciduous		7-Sep
97WH359	unknown	siltstone	deciduous leaf		7-Sep
97WH019	unknown	sandstone	seed pod? Plant hash	Measured Se	25-May
97WH026	unknown plant hash	shale	plant fragments	Measured Se	25-May
97WH012A	wood	coal/wood			14-May
97WH016A	wood		from measured log above pond, 1.6 m diam., 7 m long		14-May
97WH036A-1	wood		outer 6" w cellular structure	Graham's sec	25-May
97WH036A-2	wood		outer 6" w cellular structure	Graham's sec	25-May
97WH036B	wood			Graham's sec	25-May
97WH036D	wood			Graham's sec	25-May
97WH131	wood		wood		?
97WH132	wood		wood		?
97WH133	wood		wood		?
97WH156A	wood		wood		21-Jun
97WH156B	wood		wood		21-Jun
97WH156C	wood		wood		21-Jun
97WH156D	wood		wood		21-Jun
97WH156E	wood		wood		21-Jun
97WH156F	wood		wood		21-Jun
97WH156G	wood		wood		21-Jun
97WH156H	wood		wood		21-Jun
97WH156I	wood		wood		21-Jun
97WH156J	wood		wood		21-Jun
97WH156K	wood		wood		21-Jun
97WH156L	wood		wood		21-Jun
97WH188	wood		bark imprint?		
97WH194	wood		possible woody tissue	Float	
97WH253	wood	sandstone	good rings & cell structure	Float	29-Jun
97WH270	wood		may have original woody tissue	Float	29-Jun
97WH273	wood	siltstone	scraps from "Fill" /wood		28-Aug
97WH274	wood		wood broken from SAMONH's display wood		28-Aug
97WH275	wood		fragments of coalified bark from "Fill"		28-Aug
97WH317	wood		fragment from wood in UAA rock garden off low-boy		12-Sep

97WH327A	wood	siltstone	root or branch		7-Sep
97WH327B	wood	siltstone	counterpart		7-Sep
97WH369	wood		small slab cut for a thin section	from a Dan Long specimen	
97WH370	wood		small slab cut for a thin section	from a Dan Long specimen	
97WH371	wood		small slab cut for a thin section	from a Dan Long specimen	
97WH372	wood		from specimen #3 in UAA rock Garden (3rd largest log)		22-Jan
97WH373	wood		from specimen #2 UAA Rock Garden, for	from 2nd larg	22-Jan
97WH374	wood		poor quality pieces from #2 "log"		
97WH036C	wood			Graham's sec	25-May
97WH070	wood		petrified wood	Janet ss	8-Jun
97WH001		siltstone	no fossils	Measured Se	14-May
97WH002		sandstone	conifer fragments	Measured Se	14-May
97WH003A		mudstone		Measured Se	14-May
97WH003C		mudstone		Measured Se	14-May
97WH003D		mudstone		Measured Se	14-May
97WH003E		mudstone		Measured Se	14-May
97WH003F		mudstone		Measured Se	14-May
97WH003G		mudstone		Measured Se	14-May
97WH004		siltstone	w deciduous leaf fragments	Measured Se	14-May
97WH005A		sandstone		Measured Se	14-May
97WH005B		sandstone	conifer fragments	Measured Se	14-May
97WH005C		sandstone	deciduous leaf fragments	Measured Se	14-May
97WH005D		sandstone	root?	Measured Se	14-May
97WH006		sandstone		Unit 2	14-May
97WH007		siltstone	plant hash	Unit 3	14-May
97WH008		coal		Unit 3	14-May
97WH009		bentonite		Unit 5	14-May
97WH010		coal		Unit 6	14-May
97WH011		sandstone	deciduous leaves	Unit 7	14-May
97WH012B		coal/wood			14-May
97WH013		ss/siltstone	seed pod(?)/plant fragments		14-May
97WH013		coal			14-May
97WH014		sandstone			14-May
97WH015A		coal			14-May
97WH015B					14-May
97WH015C					14-May
97WH016B			from measured log above pond, 1.6 m diam., 7 m long		14-May
97WH017			seed?		25-May
97WH018					25-May
97WH027B		claystone		Measured Se	25-May
97WH027C		claystone		Measured Se	25-May
97WH027E		claystone		Measured Se	25-May
97WH027F		claystone		Measured Se	25-May
97WH027G		claystone		Measured Se	25-May
97WH028C		claystone			25-May
97WH030A		shale	good pollen sample? In discard box		25-May
97WH030B		shale	good pollen sample? In discard box		25-May
97WH030C		shale	good pollen sample? In discard box		25-May
97WH035			deciduous		25-May
97WH083			deciduous	Janet ss	8-Jun
97WH084		siltstone	deciduous	Janet ss	8-Jun
97WH092		siltstone	deciduous	Janet ss	8-Jun
97WH112		sandstone	stems, deciduous	Kurt ss	15-Jun
97WH116		siltstone	float/deciduous		15-Jun
97WH117		siltstone	deciduous		15-Jun
97WH121		ironstone	deciduous float, fragment of large leaf.		15-Jun
97WH128		sandstone	deciduous		19-Jun
97WH150		siltstone	conifer		21-Jun

97WH155		sandstone	deciduous		21-Jun
97WH161		siltstone	deciduous inc		
97WH164		siltstone	fern? poor		
97WH171		siltstone	?		
97WH184		siltstone	poor deciduous		June
97WH189A		mudstone	conifer/deciduous scraps		
97WH189B			conifer/deciduous scraps		
97WH189C			conifer/deciduous scraps		
97WH191		siltstone	mixed	Float	Jun-97
97WH203		sandstone	deciduous	Simeon ss	15-Jun
97WH212		mudstone	deciduous		15-Jun
97WH219		sandstone	deciduous	Simeon ss	15-Jun
97WH224		sandstone	cones, lg deciduous (on reverse)	Simeon ss	15-Jun
97WH235		siltstone	deciduous	Roger's rk	29-Jun
97WH262B		siltstone	deciduous/conifer	Float	8-Aug
97WH265		mudstone	deciduous	Float	8-Aug
97WH271		siltstone	deciduous		4-Aug
97WH272A		siltstone	seed part		4-Aug
97WH272B		siltstone	counterpart		4-Aug
97WH284		siltstone	deciduous		22-Aug
97WH290		siltstone	deciduous	Float	
97WH294		mudstone	deciduous	Float	
97WH299		siltstone	deciduous	Float	
97WH302		siltstone	deciduous	Float	
97WH321		siltstone	deciduous		7-Sep
97WH322		siltstone	deciduous		7-Sep
97WH323		siltstone	deciduous		7-Sep
97WH326		siltstone	deciduous		7-Sep
97WH337		siltstone			7-Sep
97WH341		siltstone	deciduous		7-Sep
97WH344		siltstone	deciduous		7-Sep
97WH349		siltstone	poor deciduous		7-Sep
97WH357		mudstone	deciduous		7-Sep
97WH366			junk? 2 pieces		2-Sep

APPENDIX B

Reference photographs from the fossil plant collection



Cocculus 183



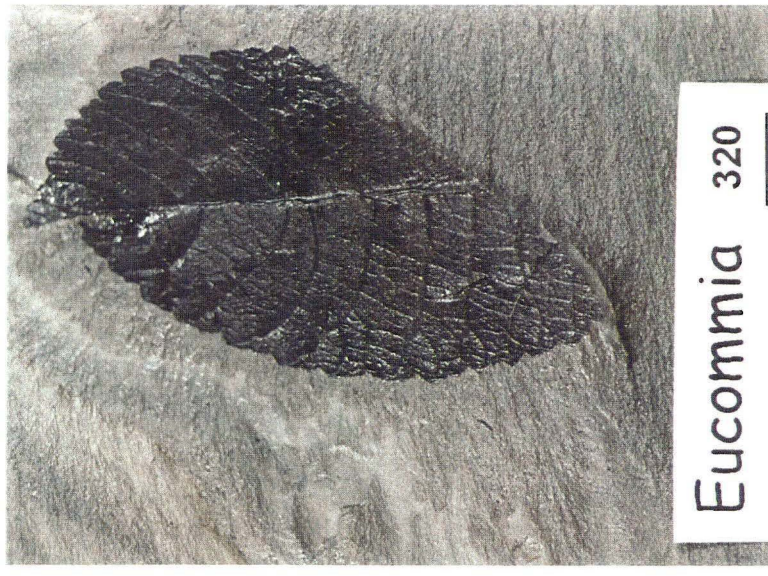
Ampelopsis 196



Carpinus 34B



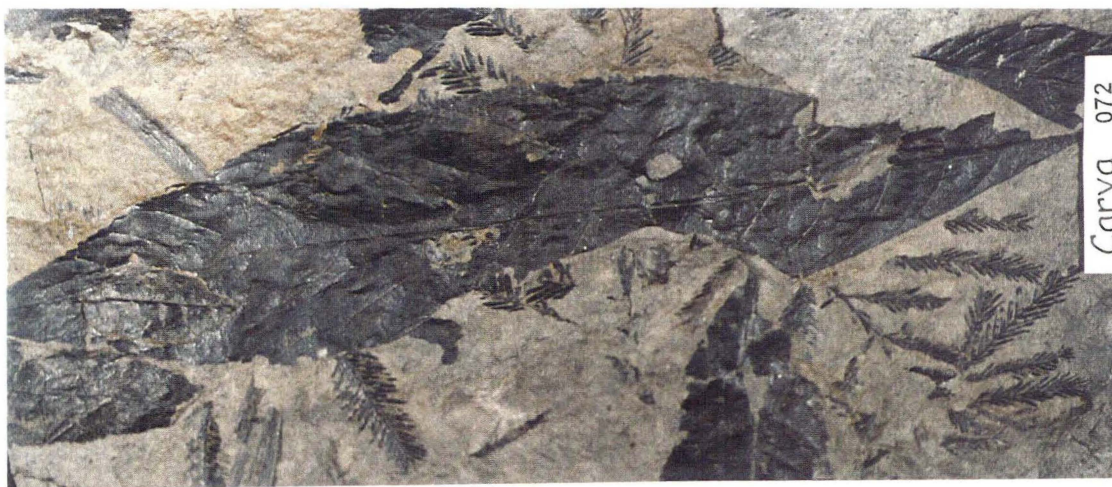
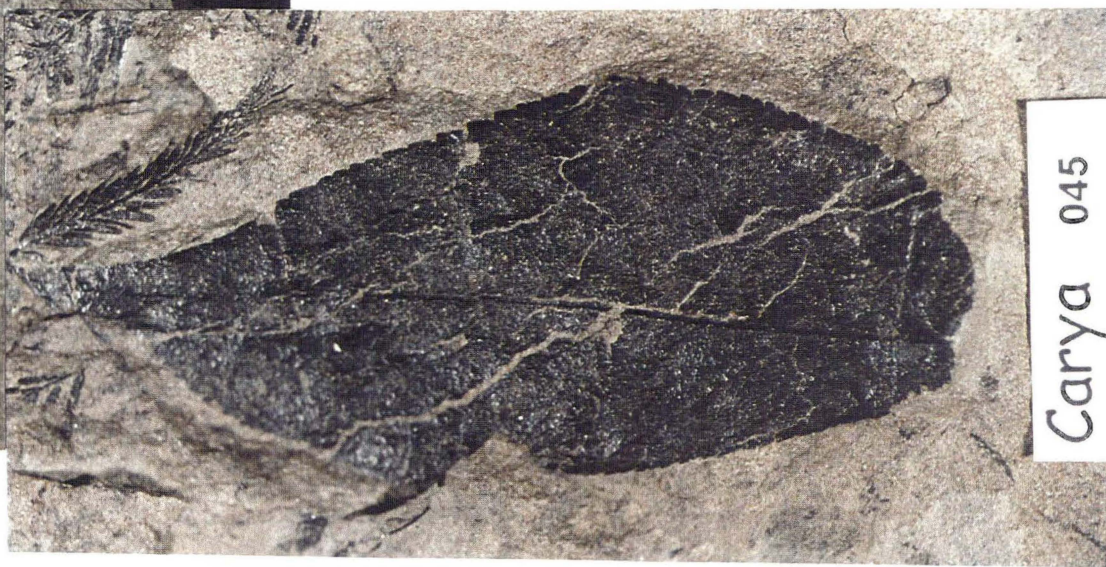
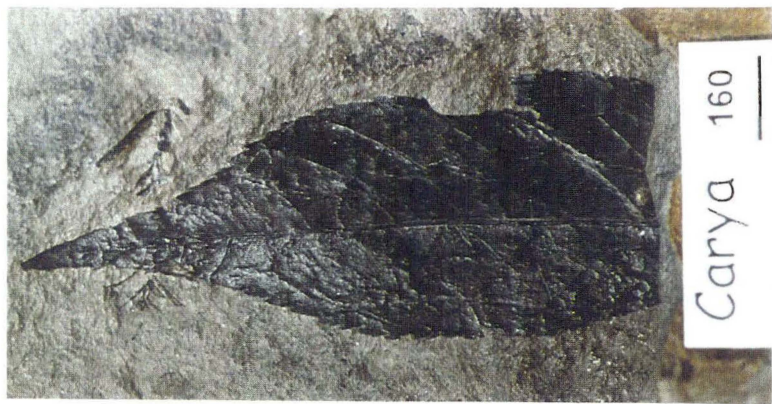
Alnus 360



Eucommia 320

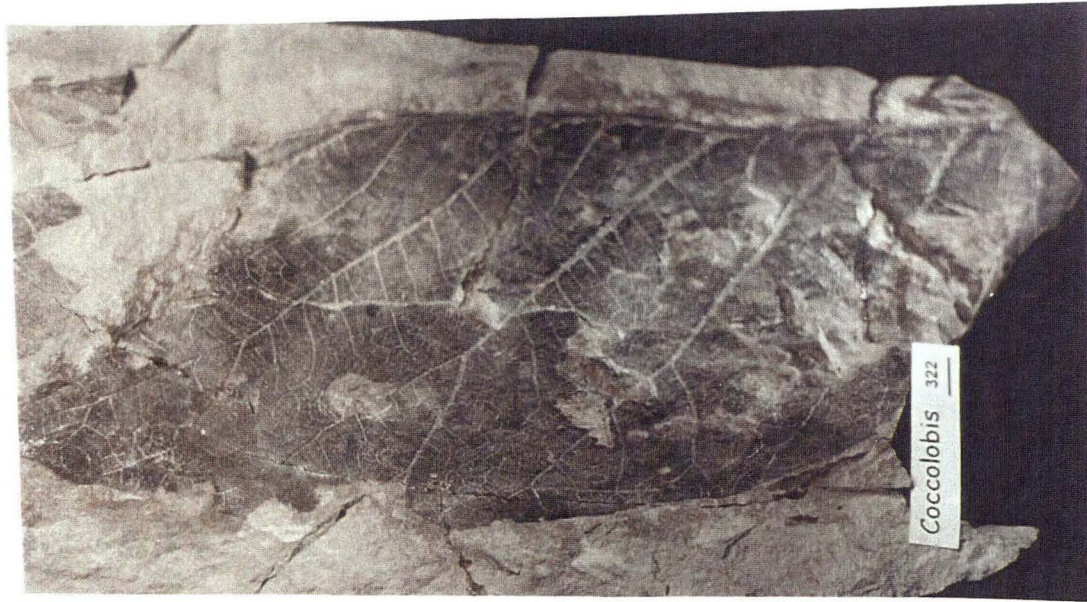


Dillenia? 053





Unknown 198



Coccolobis 322



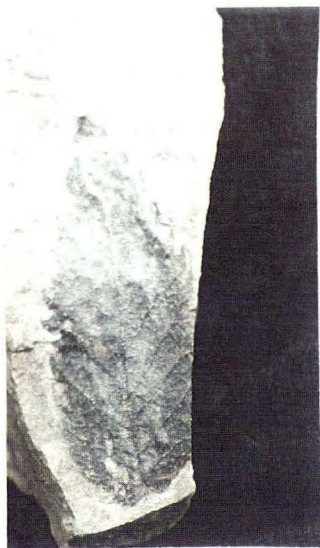
Cocculus 255



Dicotylophyllum 179



Dicotylophyllum 384



Rhus? 173



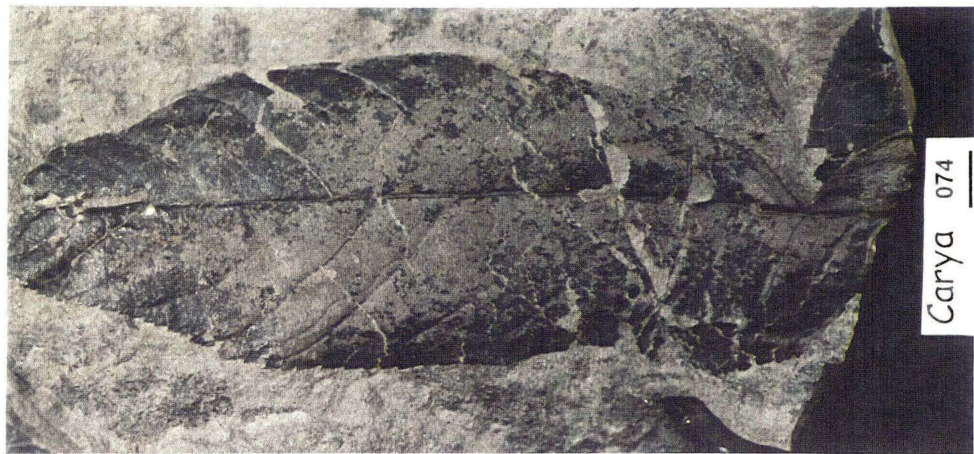
Viburnum 281



Dicotylophyllum 175



Ficus 354



Carya 074



Hedra 362



Spiraea? 289



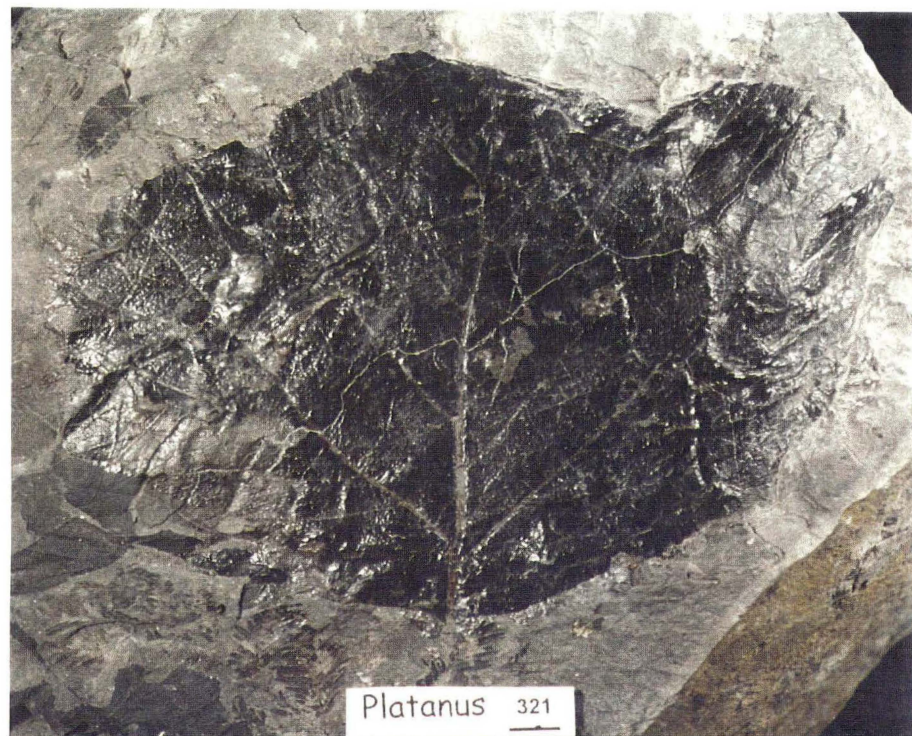
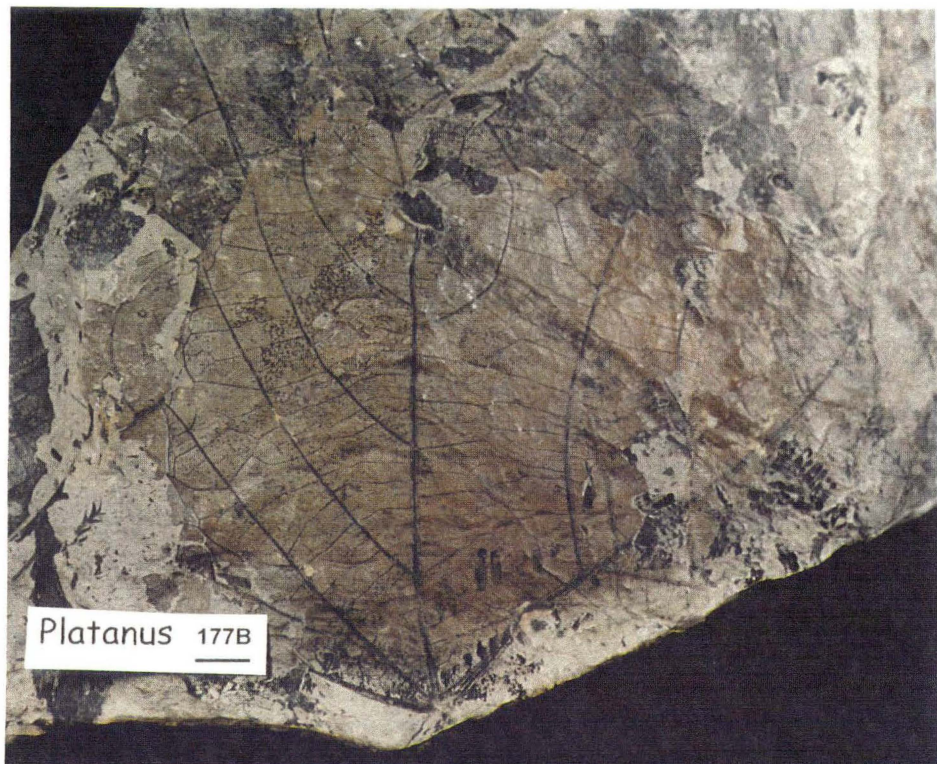
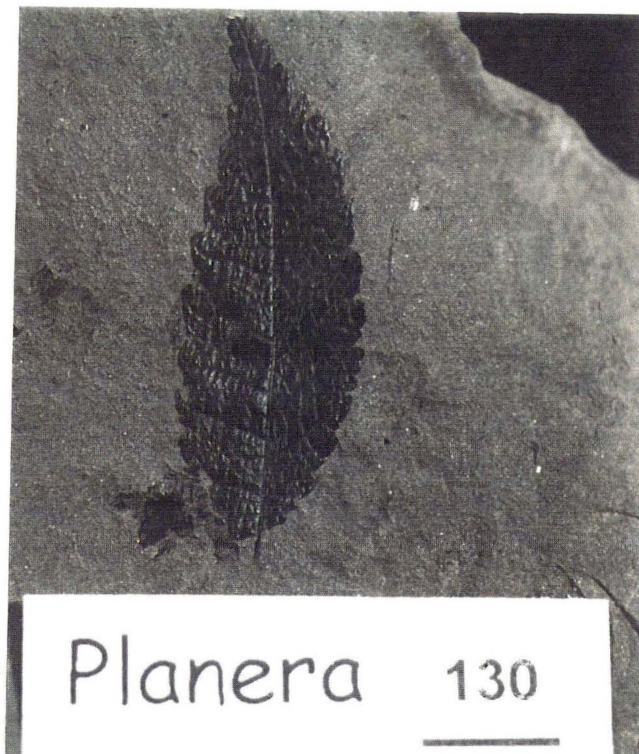
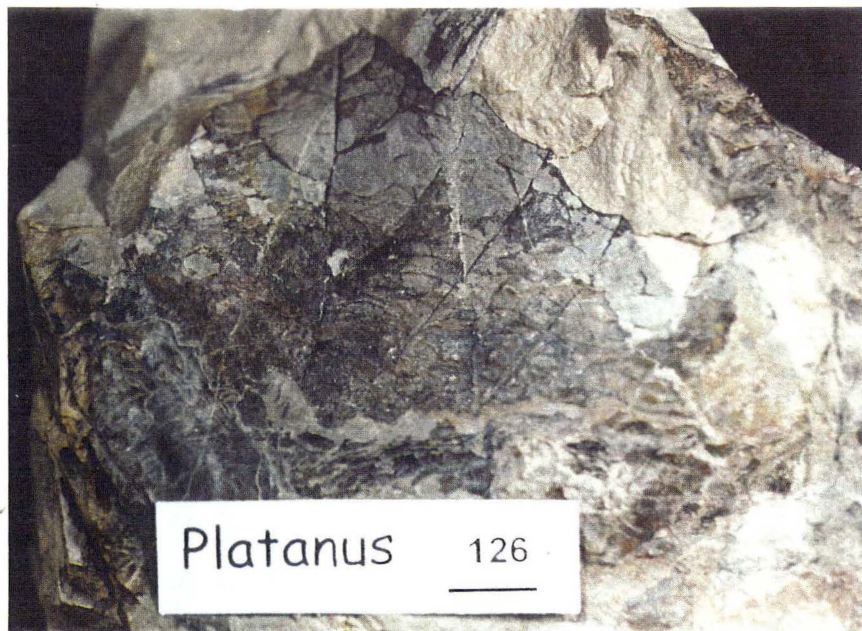
Hedra 362



Hicoria 351



Hicoria 350

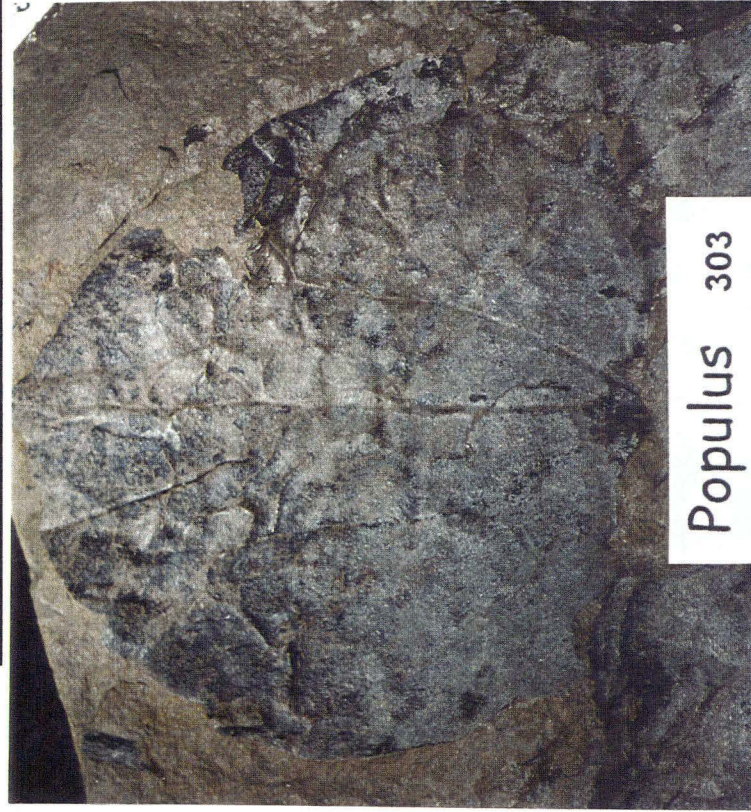




Populus 195



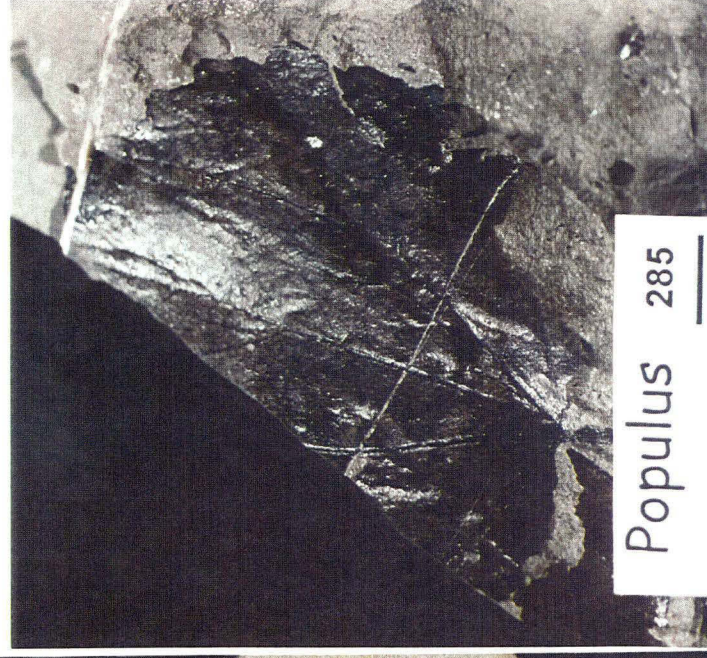
Populus 193



Populus 303



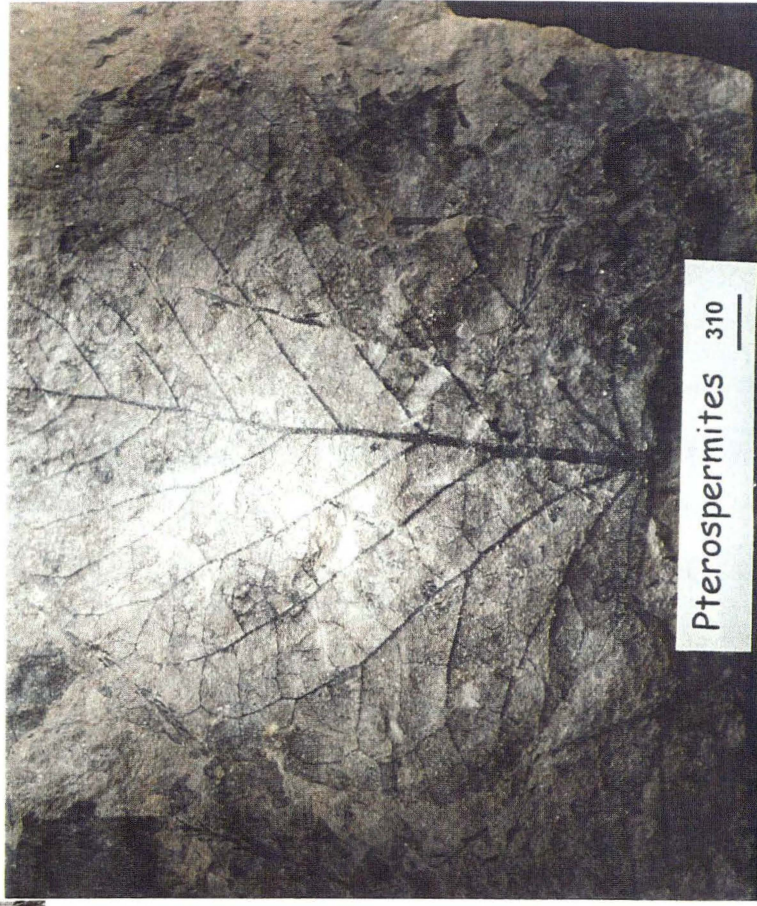
Populus 145



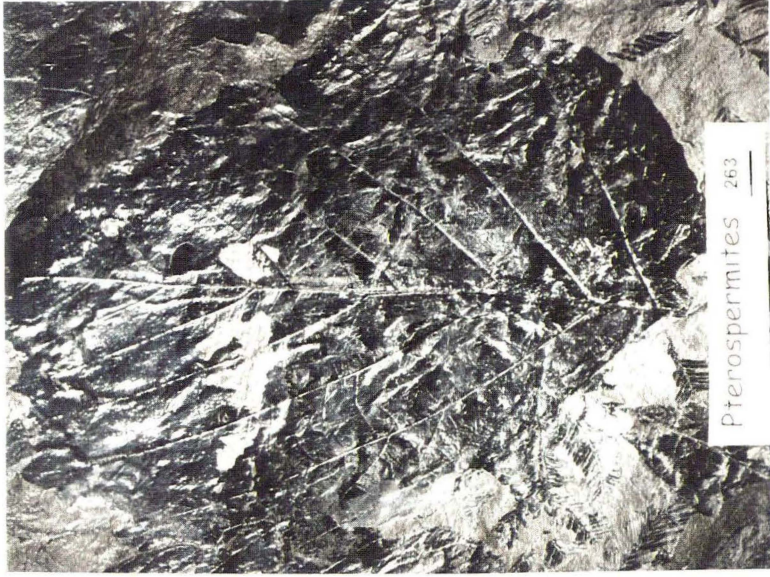
Populus 285



Pterospermites 186



Pterospermites 310



Pterospermites 263



Quercus 057

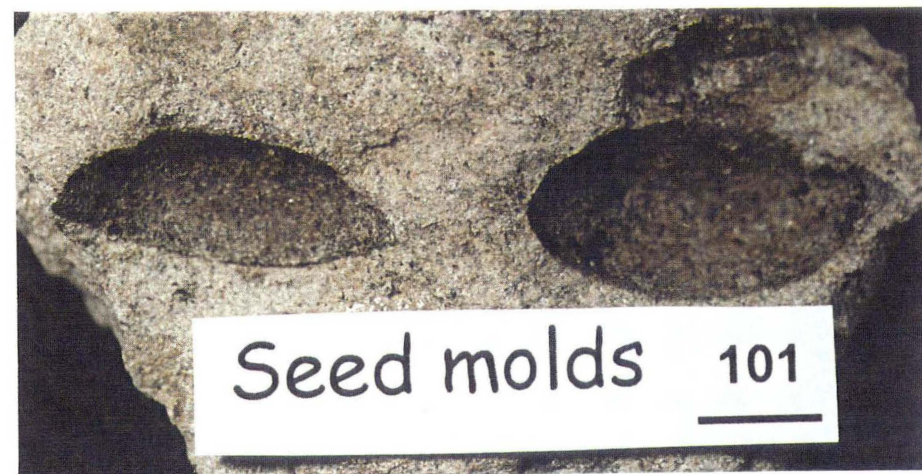


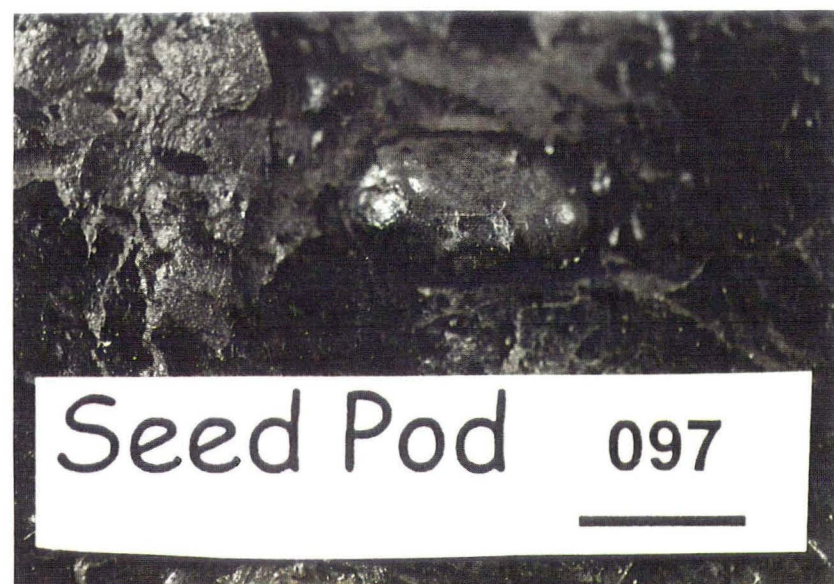
Quercus 114



Quercus 250

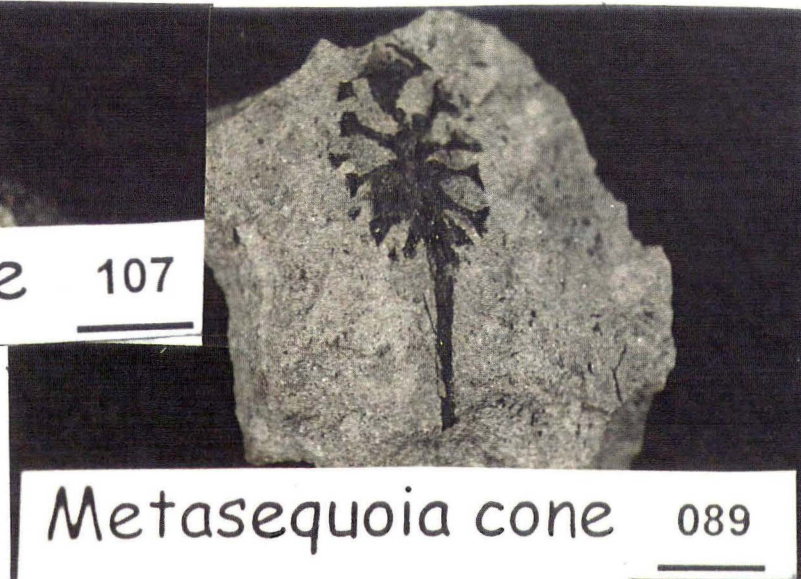




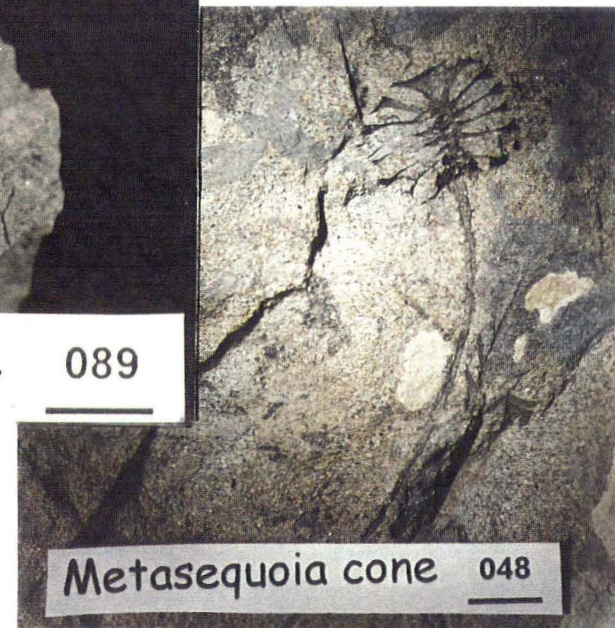




Metasequoia cone 107



Metasequoia cone 089



Metasequoia cone 048



Metasequoia 085

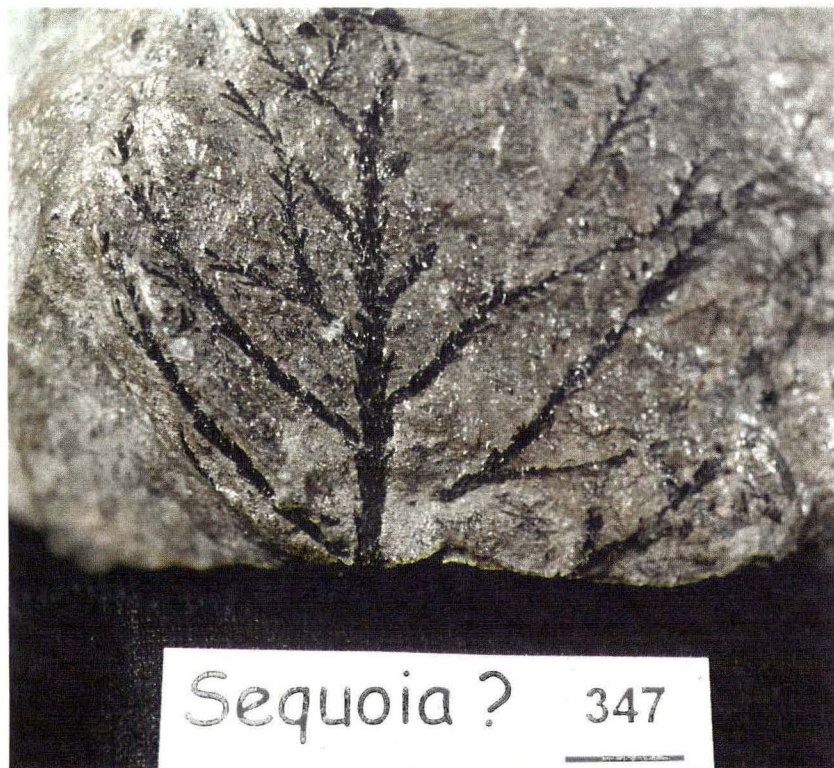


Metasequoia 166



Metasequoia 174





Sequoia ? 347



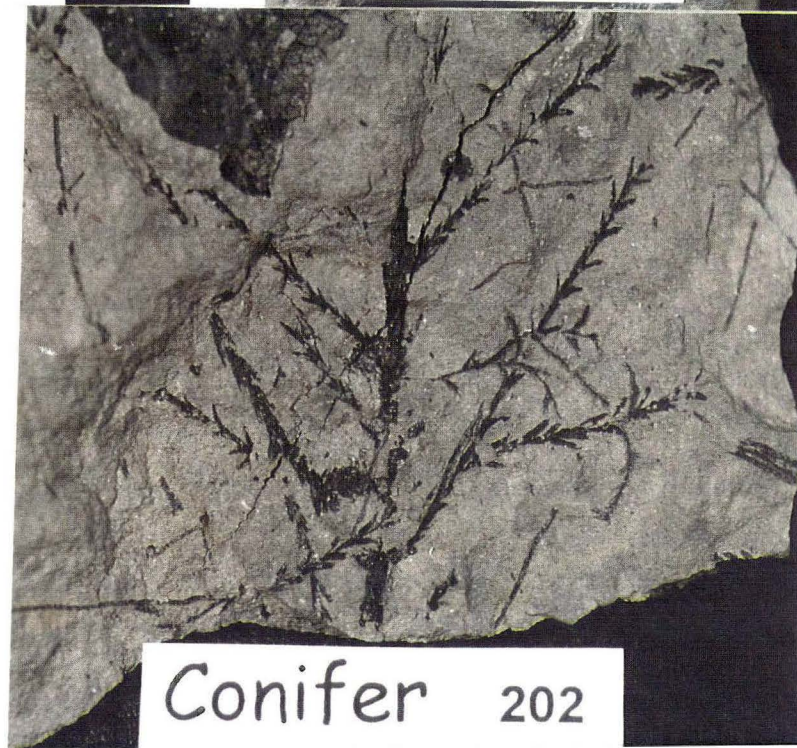
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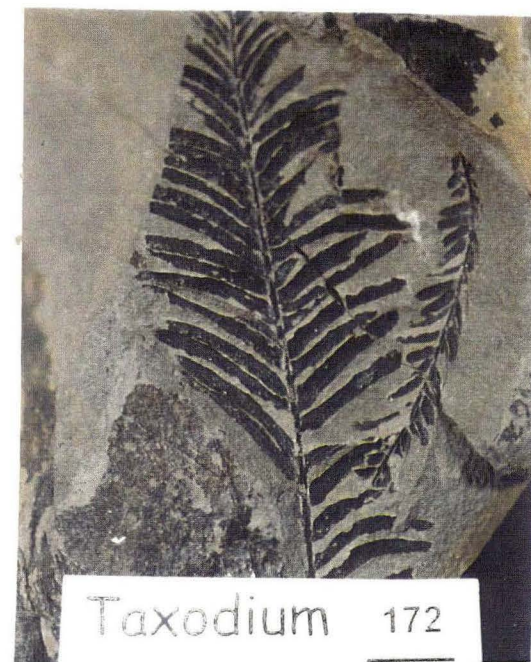
Parataxodium 082



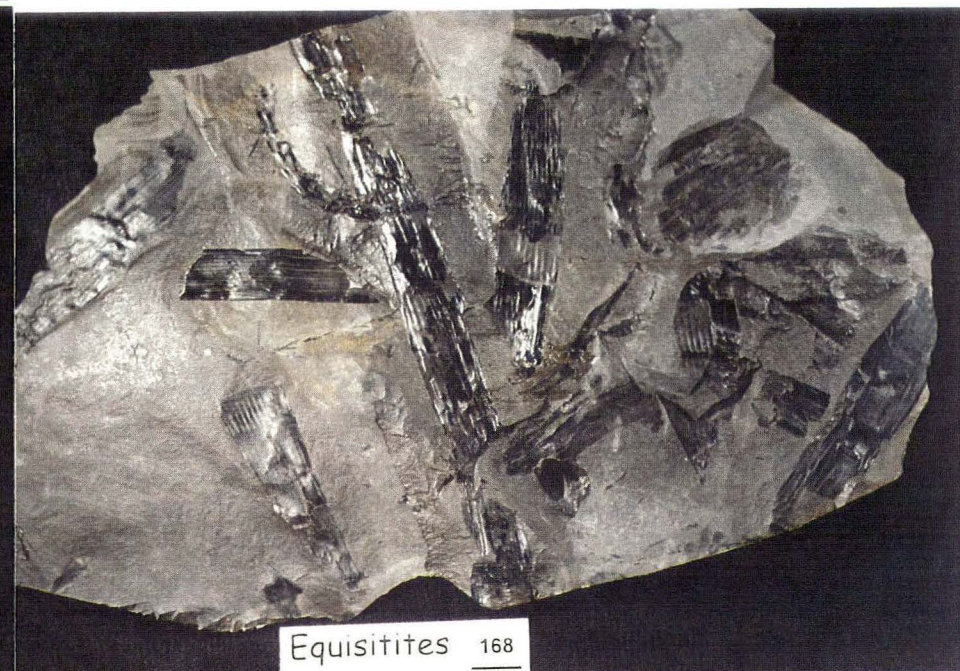
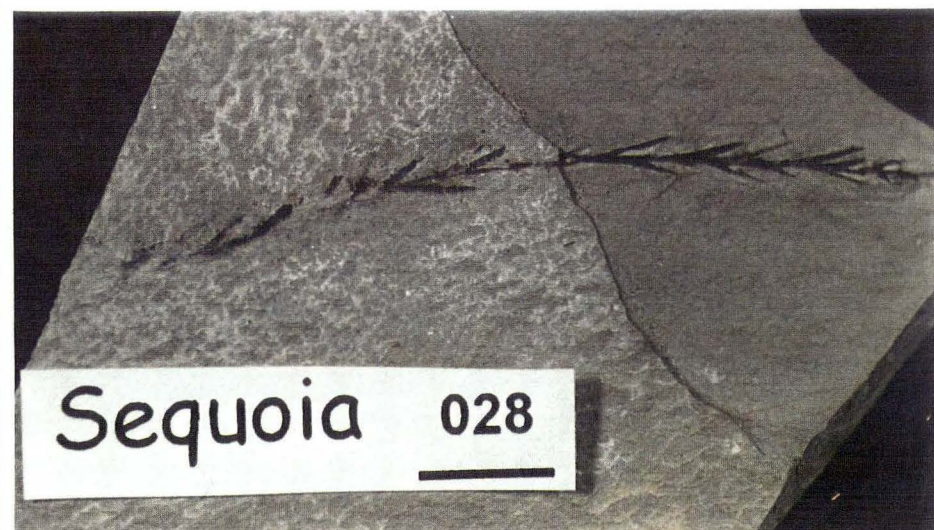
Sequoia 324

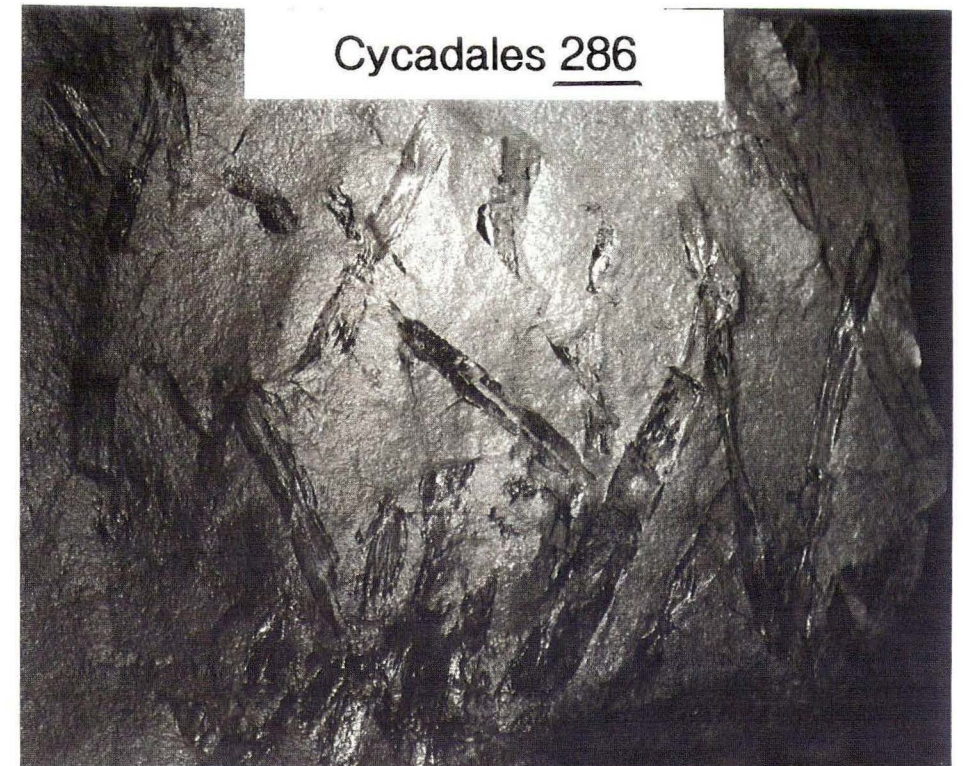
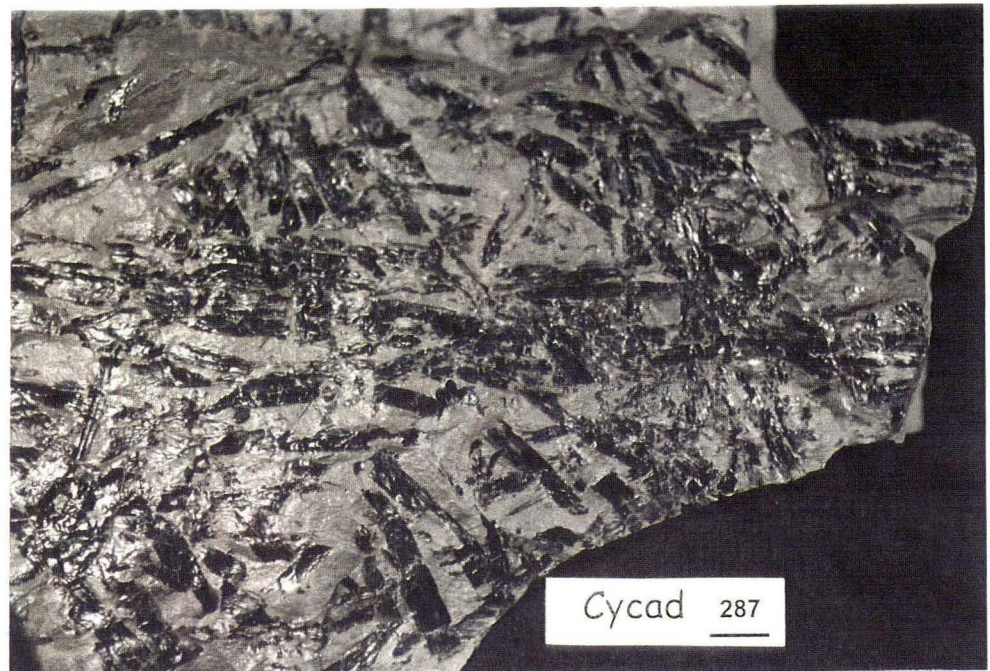
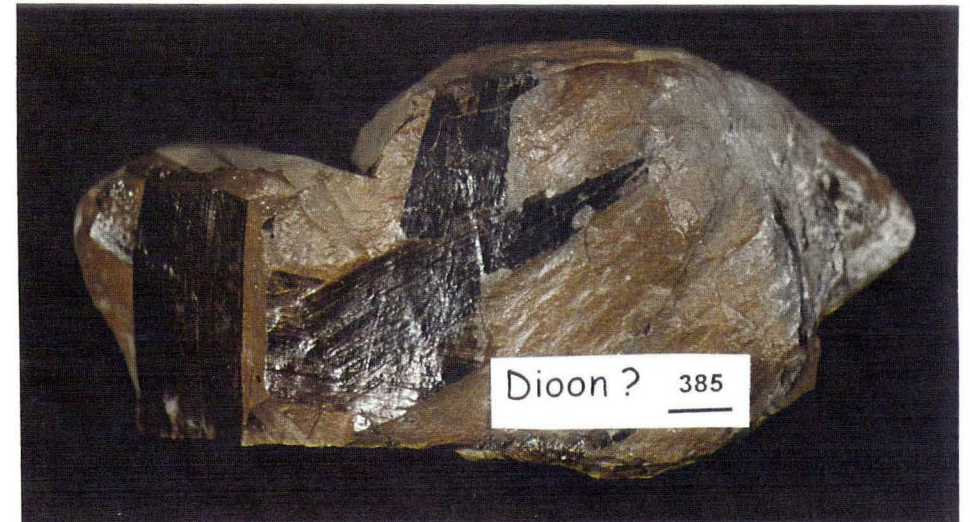


Conifer 202

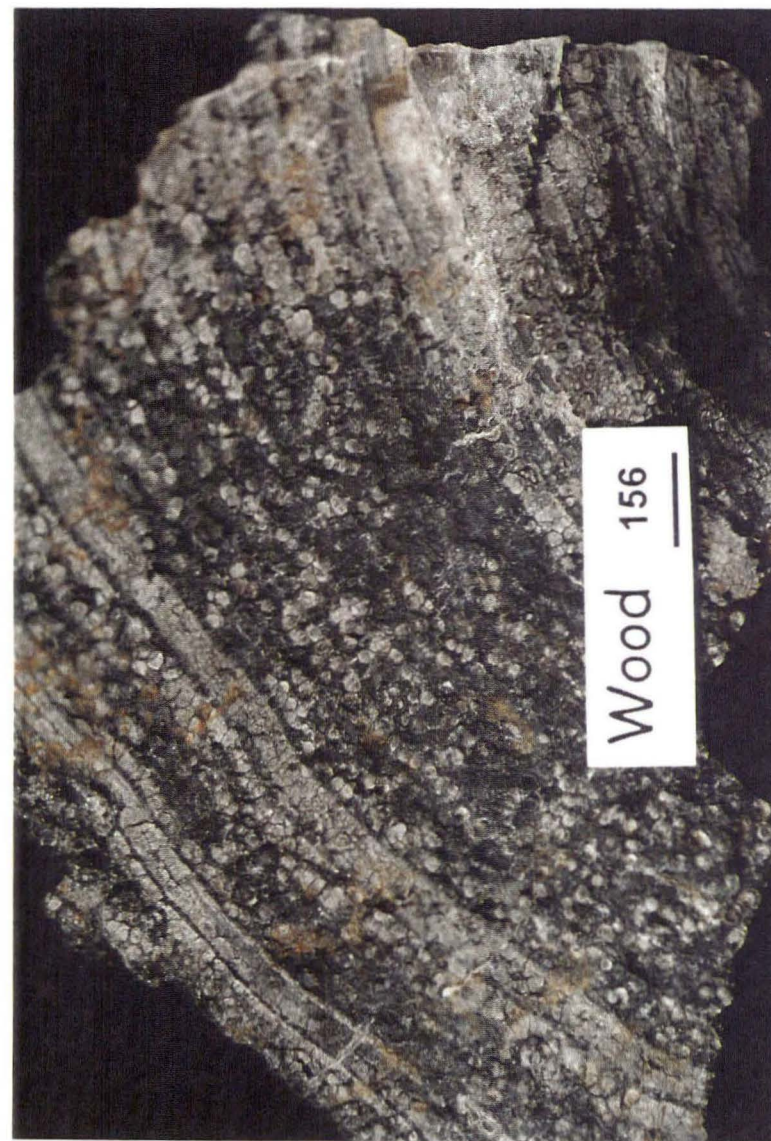
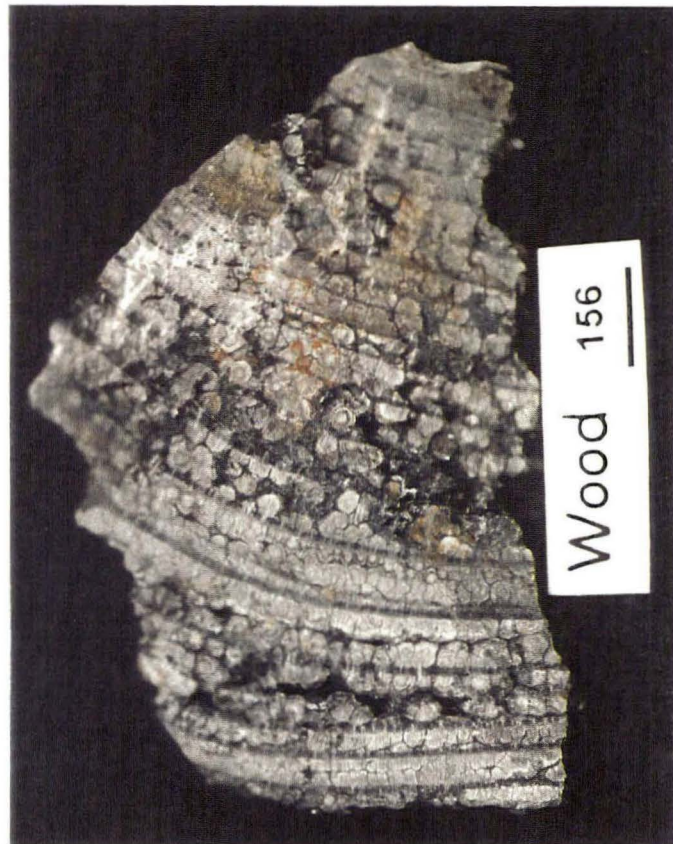
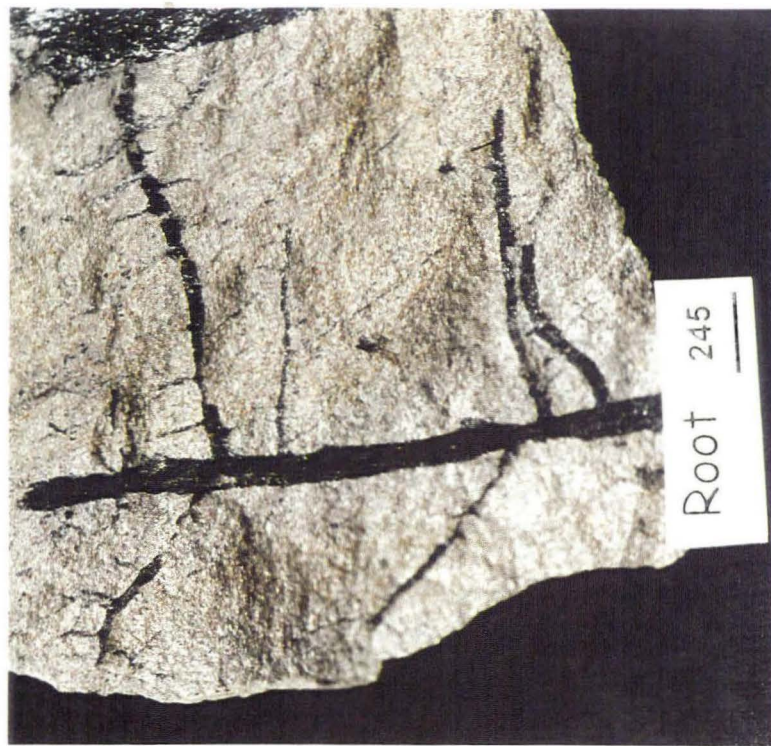


Taxodium 172









APPENDIX C

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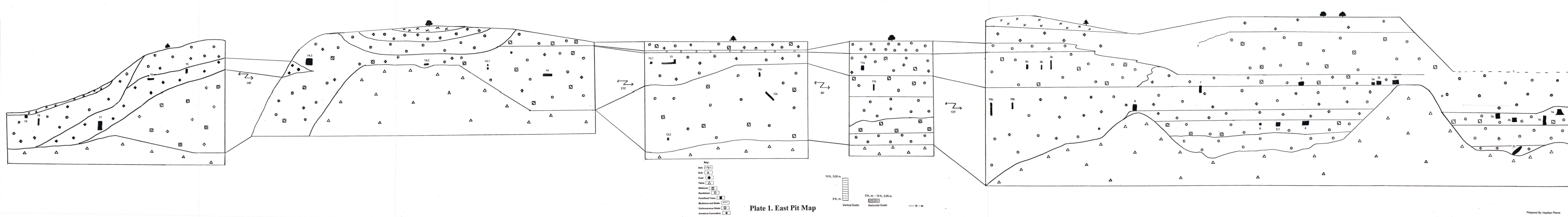
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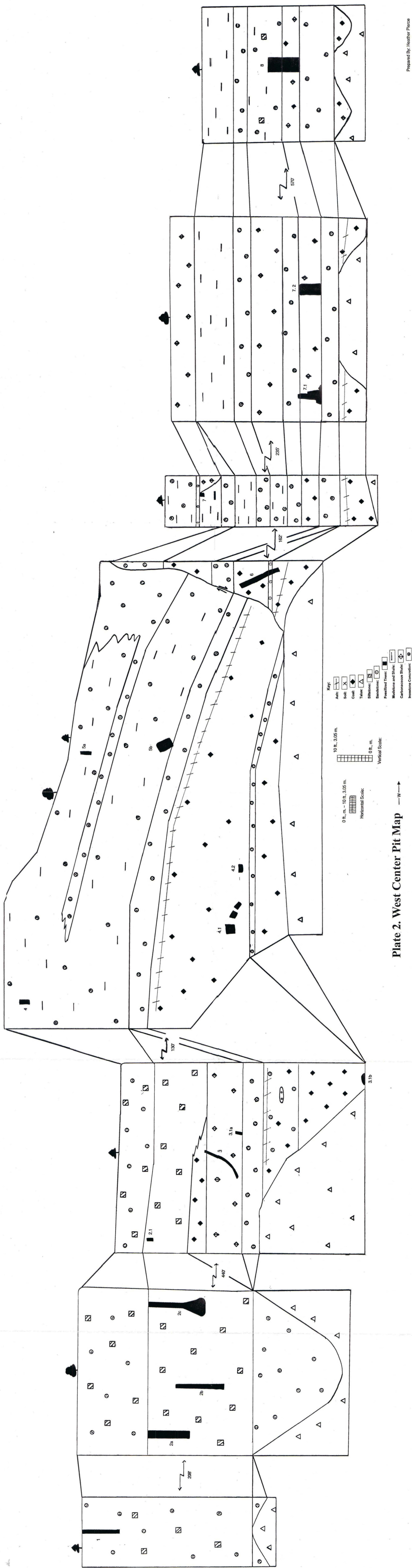
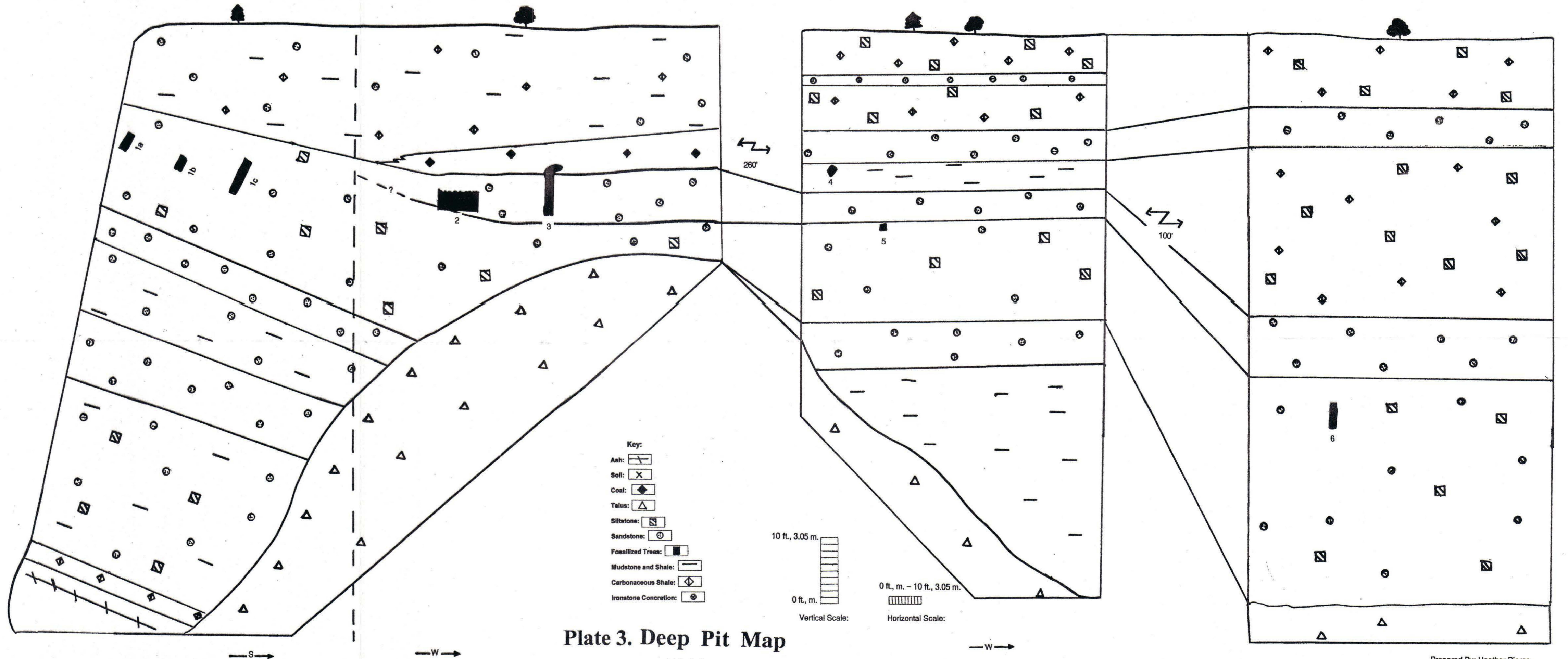
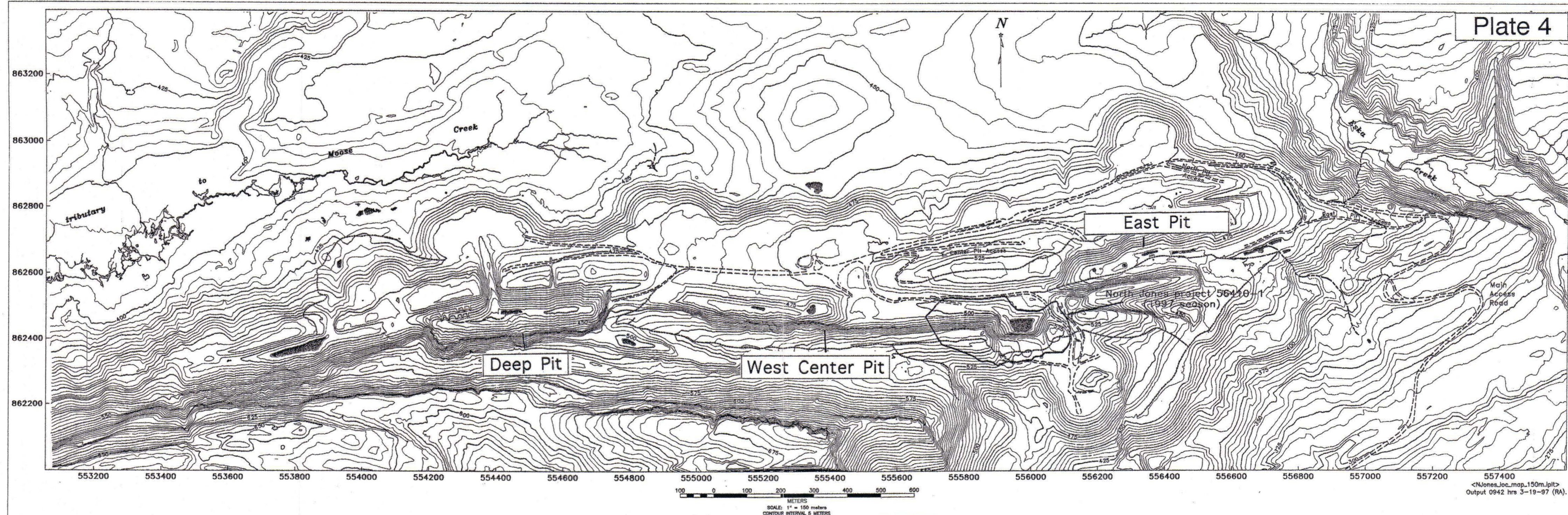


Plate 2. West Center Pit Map





Strip Mine Pits on Wishbone Hill

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