

Assessment of fossil vertebrate tracks and associated plant remains on Wishbone Hill

Anne D. Pasch and Kevin C. May

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ASSESSMENT OF FOSSIL VERTEBRATE TRACKS AND ASSOCIATED PLANT REMAINS ON WISHBONE HILL



The Chickaloon forest as it might have looked 55 million years ago
with a *Coryphodon* walking across damp silty surface.

Anne D. Pasch & Kevin C. May
June 2001

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ASSESSMENT OF FOSSIL VERTEBRATE TRACKS
AND
ASSOCIATED PLANT REMAINS ON WISHBONE HILL
North Jones Reclamation Area near Sutton, Alaska

Submitted to:

Brian McMillen, AML Program Manager
Division of Mining & Water Management
Department of Natural Resources
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by

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June 2001

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TABLE OF CONTENTS

	page no.
INTRODUCTION	1
TRACKS AND TRACKWAYS	4
WHICH VERTEBRATES MADE THE TRACKS?	20
ASH SAMPLE DATING	35
PALYNOMORPHS	36
SPECIMENS DONATED TO THE UNIVERSITY OF ALASKA	40
FOSSIL STUMP "FOREST"	43
AMBER	50
REFERENCES CITED	52
APPENDIX	

LIST OF FIGURES

	page no.
Cover The Chickaloon forest as it might have looked 55 million years ago with a <i>Coryphodon</i> walking across a damp silty surface.	
Fig. 1 Geographic location of the North Jones Mining Complex reclamation project.	2
Fig. 2 Contour map of North Jones Mining Complex project area. Fossil stump plot outlined in red in Center Pit.	3
Fig. 3 Important late Paleocene / early Eocene land mammal localities (modified from Lockley et al. 1999, Lucas 1998a, & Rose 1981).	4
Fig. 4 Track depression (mold) in sandstone in Center Pit of North Jones Mining Complex area.	6
Fig. 5 An individual sandstone track cast from float.	6
Fig. 6 Sandstone casts that lack well defined morphologies formed on a trampled surface. Cast horizon in lower photo on dip slope of footwall in Center Pit. Coalified stump in center background.	8
Fig. 7 Mammal and bird morphologies found in the Chickaloon Formation. Bars = 10 cm (modified from May 2001).	9
Fig. 8 Natural sandstone casts of two five-digit mammal prints. The track cast in upper photo is 25 cm long and 18 cm wide. Track cast in lower photo is 18 cm long and 22 cm wide.	11

Fig. 9	Casts of two three-digit mammal prints. The upper one is a natural sandstone track cast 14 cm long and 20 cm wide. The lower one is a silicone peel taken from a print found in a road cut along the Glenn Highway. It is 6 cm long and 9 cm wide.	12
Fig. 10	Two three-digit bird print casts on the sole of a sandstone block.	13
Fig. 11	Natural sandstone casts of a four-digit mammal print 19 cm long and 20 cm wide.	14
Fig. 12	Natural sandstone cast of a "duck-like" track. Note similarity to tracks of a duck- or flamingo-like bird found in Utah at a 45 million-year old site (middle Eocene) (drawing from Lockley et al. 1991).	15
Fig. 13	Cross-section of a mammal track cast at a sandstone/siltstone contact.	16
Fig. 14	Mammal trackway exposed on a footwall with a sequence of three left prints and three right prints.	17
Fig. 15	Preparation of a silicone rubber cast of a trackway slab in the field.	18
Fig. 16	Comparison of a modern trackway with one from the North Jones Mining Complex area. Upper photo is a sequence of oval depressions in a moose trackway seen in dry fluvial sand along the shore of the Matanuska River. Note the overprint. Lower photo shows a sequence of depressions on the weathered surface of a sandstone in Center Pit.	19
Fig. 17	Stratigraphic framework for the Chickaloon Formation and the North American Land Mammal Ages (NALMA).	21
Fig. 18	Reconstruction of archaic animals which are the best candidates for the track-making animals in the Chickaloon Formation. Art work by Steve Trimble.	28-31
Fig. 19	The left manus of a coryphodontid (Patterson 1939). Note the short blunt toes. If covered with tissue this foot would probably make an oval depression. Impressions of toes might be visible.	32

Fig. 20	Polar projection of the northern hemisphere during late Paleocene/early Eocene time showing principal coryphodontid localities and a migration route between the Bighorn Basin in Wyoming and Asia through Alaska. Modified from Lucas 1998a.	32
Fig. 21	<i>Diatryma</i> , a large flightless bird of early Wasatchian age. Drawn by Steve Trimble.	34
Fig. 22	Palynomorphs recovered from the Chickaloon Formation. (A) Taxodiaceapollenites hiatus (<i>Metasequoia</i>) (B) Caryapollenites sp. ("hickory") (C) Cycadopites follicularis (cycad) (D) Polyadosporites suescae (fern) (E) Inapertisporites variabilis (spore of primitive plant) (F) Nothofagus tschudyi Elsie ("beech") (G) Polypodiisporonites favus (fern) (H) Tricolpites reticulata (unknown angiosperm).	39
Fig. 23	Sandstone slab containing track depressions on display in the University of Alaska Anchorage Rock Garden.	41
Fig. 24	Coalified stump rooted in footwall of Center Pit.	43
Fig. 25	Overview of fossil stump field on footwall of coal seam 7 in Center Pit. View north in top photo. Lower photo is an oblique view toward the west.	44
Fig. 26	Location of tree stump field (outlined in red) mapped on footwall of coal seam 7 in Center Pit.	45
Fig. 27	GPS survey of stump field <i>in situ</i> on footwall of coal seam 7 in Center Pit.	47
Fig. 28	Spacing of coalified tree stumps located on the footwall of coal seam 7 in Center Pit of the North Jones Mining Complex area.	48
Fig. 29	Amber specimens collected as float. Scale bar = 1 cm.	50
Fig. 30	Amber specimens shown <i>in situ</i> in coalified wood.	51

LIST OF TABLES

	page no.
Table 1. Genera of large archaic mammals most likely to have made the tracks in the Chickaloon Formation.	22
Table 2. Orders of birds present during late Paleocene / early Eocene time.	33
Table 3. Fossiliferous boulders placed in the University of Alaska Anchorage rock garden.	40
Table 4. Petrified wood specimens from the North Jones Mining Complex area given to the University of Alaska Museum in Fairbanks.	42
Table 5. Mean diameters of stumps mapped in situ.	49

APPENDIX

GPS Coordinates of the 53 stumps mapped in situ in Center Pit.

ASSESSMENT OF FOSSIL VERTEBRATE TRACKS AND ASSOCIATED PLANT REMAINS ON WISHBONE HILL

North Jones Reclamation Area near Sutton, Alaska

INTRODUCTION

Paleontological studies done under the auspices of the Alaska Department of Natural Resources reclamation program at the North Jones Mining Complex area (Fig. 1) in exposures of the Chickaloon Formation on Wishbone Hill continue to generate new and important information. This report is a follow-up to the 1997-98 work that is summarized in a report submitted to Brian McMillen, AML Program Manager, Division of Mining & Water Management, Department of Natural Resources for the State of Alaska titled "Wishbone Hill Fossil Recovery Project" (Pasch 1998).

As work continued on the project, significant paleontological specimens from exposures in the North Jones Mining Complex were recovered. Vertebrate track casts and trackways were discovered and collected, 53 fossil stumps representing a portion of an *in situ* forest were mapped, pollen samples were collected and processed and ash samples were collected and submitted for $^{40}\text{Ar}/^{39}\text{Ar}$ dates. Over 2,000 specimens of amber were collected. They contain insect parts and other organic remains that are the first reported for this type of preservation in Alaska. Three fossiliferous boulders were added to the University of Alaska campus rock garden in Anchorage. A large collection of petrified wood specimens was transported to the University of Alaska Museum in Fairbanks that will be part of an outdoor exhibit when the new museum expansion project is completed. Although several exposures in the Sutton area were examined for tracks, most of this work was done in the Center Pit in the North Jones Mining Complex area (Fig. 2). Strip mining activity that provided outcrops and exposed surfaces of individual beds provided the opportunity to locate these spectacular discoveries.

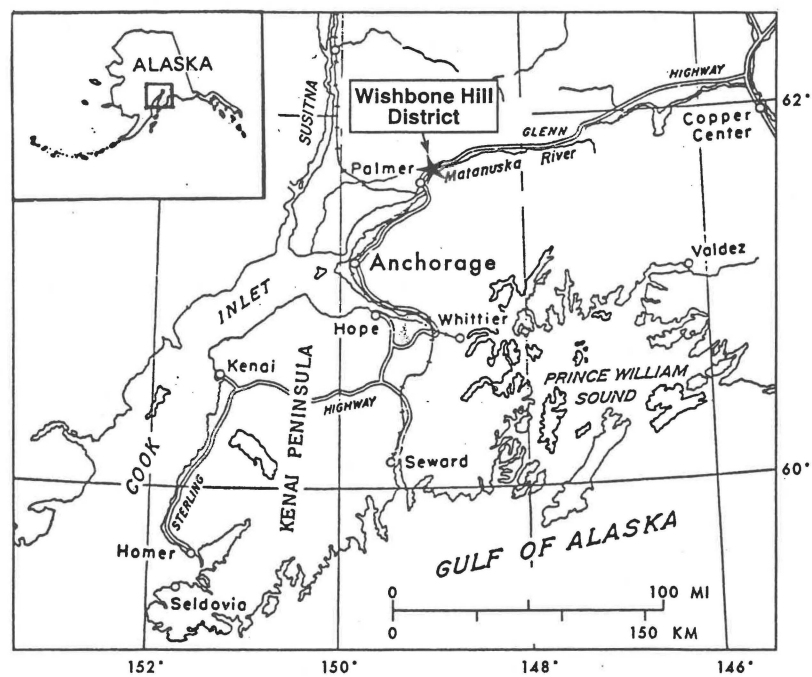


Figure 1. Geographic location of the North Jones Mining complex reclamation project.

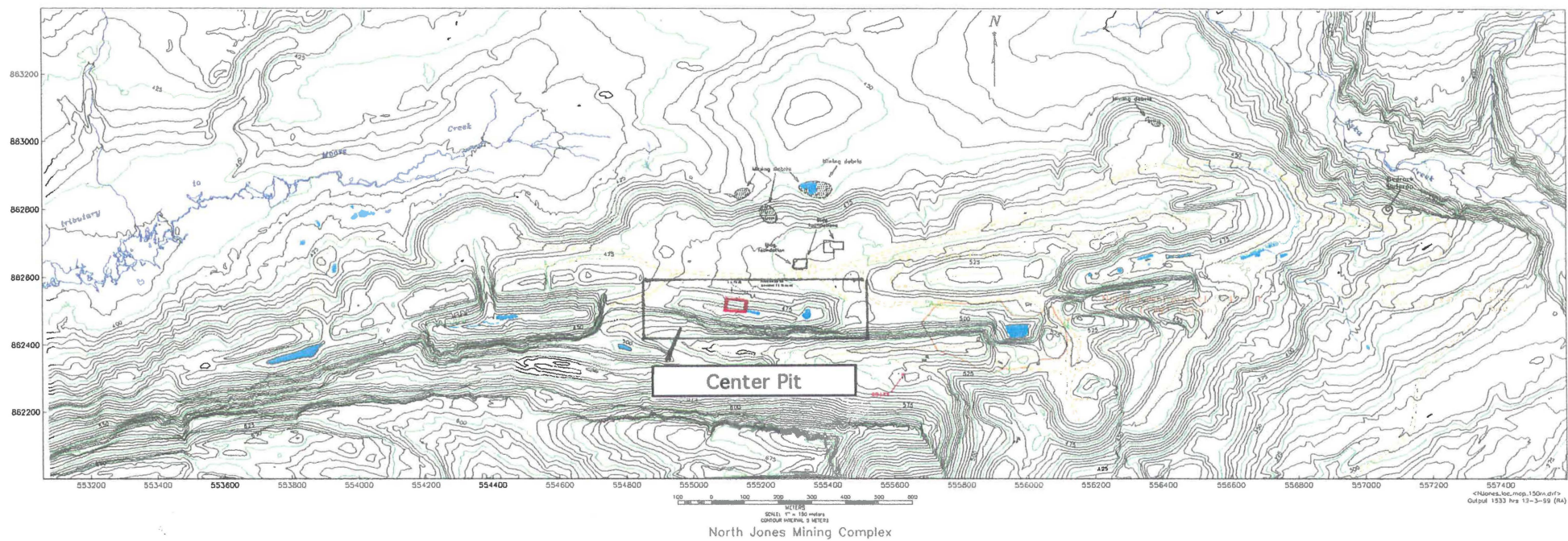


Figure 2. Contour map of North Jones Mining Complex project area. Fossil stump plot outlined in red in Center Pit.

TRACKS AND TRACKWAYS

The most significant discovery of the 2000-2001 season was documenting the presence of vertebrate track casts and trackways on bed surfaces and along bed contacts. These ichnofossils are important because they constitute the first documented evidence for Tertiary mammals in the state of Alaska. They are also among the first tracks in North America that can be attributed to archaic mammals of late Paleocene/early Eocene age. They fill in a huge gap in the Paleocene/Eocene record by adding a locality to the biogeographic province for mammals that extended across Europe, North America and Asia at this time (Lucas 1998a). They provide a new link between the important Chinese/Mongolian and Wyoming localities for archaic mammals (Fig. 4). They are the first evidence that a diverse assemblage of terrestrial vertebrates utilized the rich plant resources of the "Chickaloon" subtropical forest. The Chickaloon Formation track site also makes a considerable impact on the total number of fossil mammalian track sites known. None are known from Mesozoic sites (Lockley, 1991) and only a few from Paleogene sites (Gunnell & Bartels 1999). In those, mammal tracks are more rare than bird tracks (Lockley 1991).

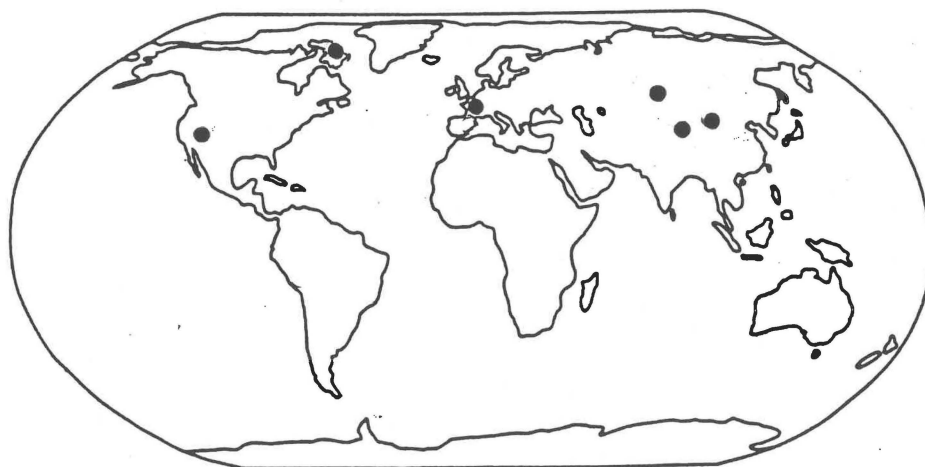


Figure 3. Important late Paleocene / early Eocene land mammal localities (modified from Lockley et al. 1999, Lucas 1998a, & Rose 1981).

While dinosaur tracks and trackways are very common (tens of thousands have been described), mammal tracks and trackways are not. Mammal tracks are very difficult to recognize because mammals are lighter and less likely to make track impressions, mammalian feet are smaller and lack the large distinctive toes of dinosaurs. They commonly leave irregular circular depressions difficult to distinguish from soft sediment deformation or loading. The best-documented evidence for early Tertiary bird and mammal tracks comes from the late Eocene of West Texas (Sarjeant & Langston 1994). Hamblin et al. (1999) briefly described 10 mid to late Eocene vertebrate footprint sites in Utah. They include small mammal, large ungulate and bird tracks. Bird tracks have also been described from the Green River Formation of late Eocene age (Gunnell & Bartels 1999). While two entire volumes are devoted to dinosaur tracks (Lockley 1991 and Gillette & Lockley 1989), references to mammal tracks and trackways are almost nonexistent.

The size and configuration of the Chickaloon ichnofossils indicate that some are bird tracks and some could only have been made by fairly large mammals. The search for Alaska Tertiary mammals has been conducted in earnest since the 1960's as Tertiary terrestrial strata are well known and well exposed in numerous coal-bearing formations, especially in areas where strip mining has occurred. The coal bed plant megafossil assemblage proves that subtropical forests flourished in southcentral Alaska during late Paleocene/early Eocene time. This ecosystem was surely exploited by the ancestors of modern mammals. However, until this study was done, the Tertiary vertebrate record in Alaska consisted only of a few fresh water fish and one turtle.

The presence of tracks was predicted by Kevin May after visiting several dinosaur track sites in Alaska and Canada which are associated with coal beds which have striking stratigraphic similarities to the Chickaloon Formation. In all cases these units contained sandstones interbedded with mudstones, carbonized plant material, tracks and trackways of large terrestrial vertebrates, and lacked skeletal remains. The dinosaur beds throughout North America demonstrate this trend: if tracks and trackways are present, there are carbonized plant remains but normally no bones; conversely, if bones are present there are rarely tracks.

After track casts were located in the North Jones Mining Complex area, the search was expanded to other nearby coal mines. Evidence for tracks was found at 25 different localities between Hicks Creek and Buffalo Mine. A few isolated occurrences were found in roadcuts along the Glenn Highway. They occur as depressions (molds) (Fig. 4) in sandstone and



Figure 4. Track depression (mold) in sandstone in Center Pit of North Jones Mining Complex area.



Figure 5. An individual sandstone track cast from float.

siltstone and as sandy or silty infillings (casts)(Fig. 5). The casts are dark gray to gray concretions often with orange iron staining. Most lack distinctive features. Many form a planar mass of irregular concretions that may represent trampled surfaces (Fig. 6). The majority of specimens were recovered from float in the North Jones Mining Complex area. Of the 105 samples collected, 60 are too badly weathered, fractured, or indistinct to merit description. They range in size from 4 x 5 to 20 x 20 cm.

The remaining 45 tracks reveal the existence of at least several recognizable morphotypes shown in Figure 7. Well-documented morphotypes include of two types of mammal tracks and one bird-like track. There are mammal tracks with five blunt digits approximately 25 cm long and 18 cm wide (Fig. 8) and those with three blunt digits approximately 14 cm long and 20 cm wide (Fig. 9). Bird-like tracks, 9 cm long and 6 cm wide have three distinct digits (Fig. 10).

Five of the morphologies are represented by a single specimen or poorly preserved specimens. Two are mammalian, two are avian, and one is problematic. Two sizes of mammalian prints have four blunt toes: a larger one approximately 19 cm long and 20 cm wide (Fig. 11) and a smaller one approximately 5 cm long and 4 cm wide. One bird track with three digits resembles a duck track in shape and size. The morphology of this track is very similar to tracings of tracks of duck- or flamingo-like birds with webbed feet found in Utah (Fig. 12). They are tracks of middle Eocene age, however, about 10 million years younger than the Wishbone Hill tracks. A larger three-digit print may or may not be avian. It is 20-25 cm long. The fifth three-digit print, 10 cm long and 7 cm wide is problematic in origin. Another sedimentary structure found on an enormous boulder in the reclamation area resembles a posthole about 4 cm in diameter. Its shape is not diagnostic. However, the spacing of several casts do suggest the geometry of a trackway.

Tracks can also be identified *in situ* along contacts where they are well exposed. These are cross-sections of casts visible between beds (Fig. 13). They are typically in the form of sandstone concretions overlying finer-grained beds and represent infillings of track depressions. They have been located in the highwalls of the North Jones Mining Complex area and in roadcuts along the Glenn Highway.

The most unequivocal evidence for vertebrate activity is a sequence of left and right footprints forming a trackway. Careful searching has revealed the presence of at least several trackways in the North Jones Mining area Complex. They can be detected on weathered bed surfaces during early morning or late evening when the sun angle is low. The depressions are faint, but do show tracks in series. Two slabs have been recovered with multiple tracks.



Figure 6. Sandstone casts that lack well defined morphologies formed on a trampled surface. Cast horizon in lower photo on dip slope of footwall in Center Pit. Coalified stump in center background.

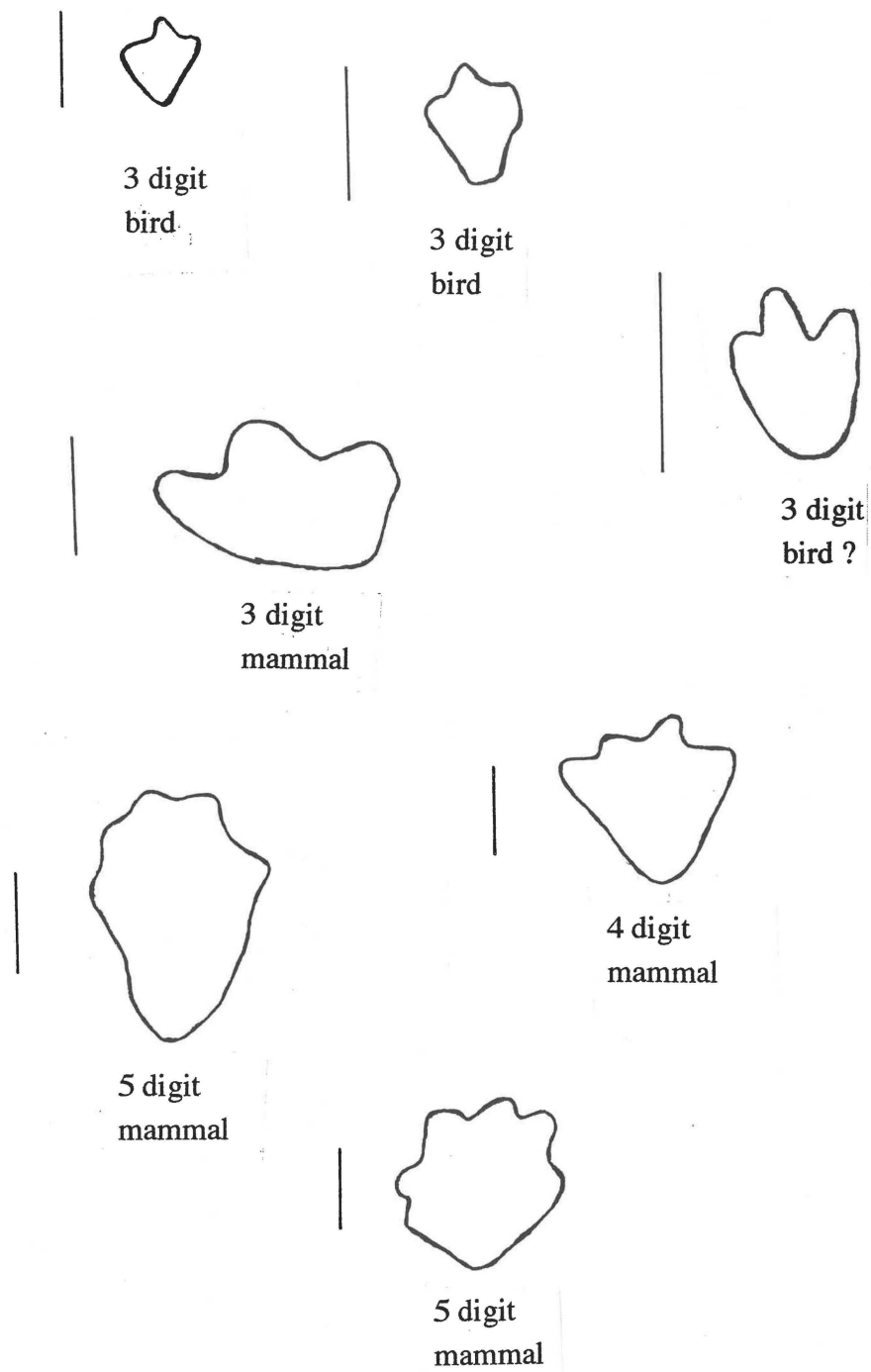


Figure 7. Mammal and bird track morphologies found in the Chickaloon Formation.
Bars = 10 cm (modified from May 2001).

One (approximately 100 x 150 cm and 20 cm thick) contains 11 prints, 6 of which form a mammalian trackway sequence. A second (approximately 80 x 100 cm and 35 cm thick) shows 4 to 6 mammalian tracks in a sequence (Fig. 14). Six peels have been made of four tracks and two of the trackways using latex and polysiloxane (Fig.15).

Detailed descriptions of the tracks and trackways have yet to be made. Meaningful analysis is complicated by many factors. A single animal can leave many different types of impressions. The fore and hind feet may be different sizes, different shapes, and have different numbers of digits. The weight of the track-maker may not be evenly distributed between the front and hind legs. One step may generate several prints either because the layers below the surface are deformed (underprints or "ghost" prints) or because the sediment above the print is "draped" into the track depression creating an infilling (Lockley 1998).

The degree of weathering of the print before or after preservation may modify its shape. However, in the Wishbone Hill exposures, the weathering process seems to enhance the track shapes and patterns, so weathered surfaces are a good place to look for them.

The nature of a print varies greatly with the sediment size and the water content. Dry coarse sand will not hold any detail other than a depression (Fig. 16), whereas moist mud may retain details such as skin impressions, claw marks, and fleshy footpad impressions. The moisture content will greatly affect the strength of the substrate and thus the depth of the track. Tracks may be partially destroyed by overprinting when a hind foot steps into the track of a front foot (Lockley 1998). Several animals may be represented in a trampled zone. They may or may not be the same species and may or may not have been there at the same time. Distinctive features such as skin impressions and claw marks are proof that a track impression was made on a surface. However, though tens of thousands of dinosaur tracks have been described, these features are very rarely found in them. Therefore, Lockley (1989) states that a large per cent of tracks preserved in the fossil record are underprints or infillings and not true footprints.

Additional fieldwork and collecting is needed, especially as newly exposed surfaces are weathered. Analysis of these trace fossils will be a challenging task, not only because they are very subtle features, but also because guidelines for standardization of terms, nomenclature, techniques, and quantification of data have yet to be written (Lockley, 1991).

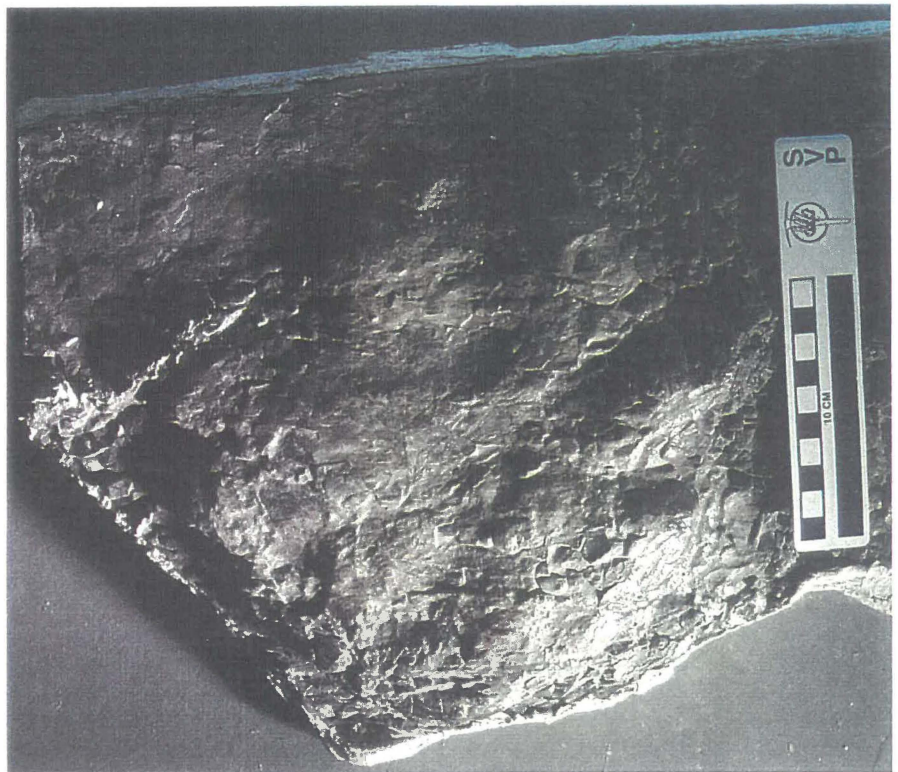
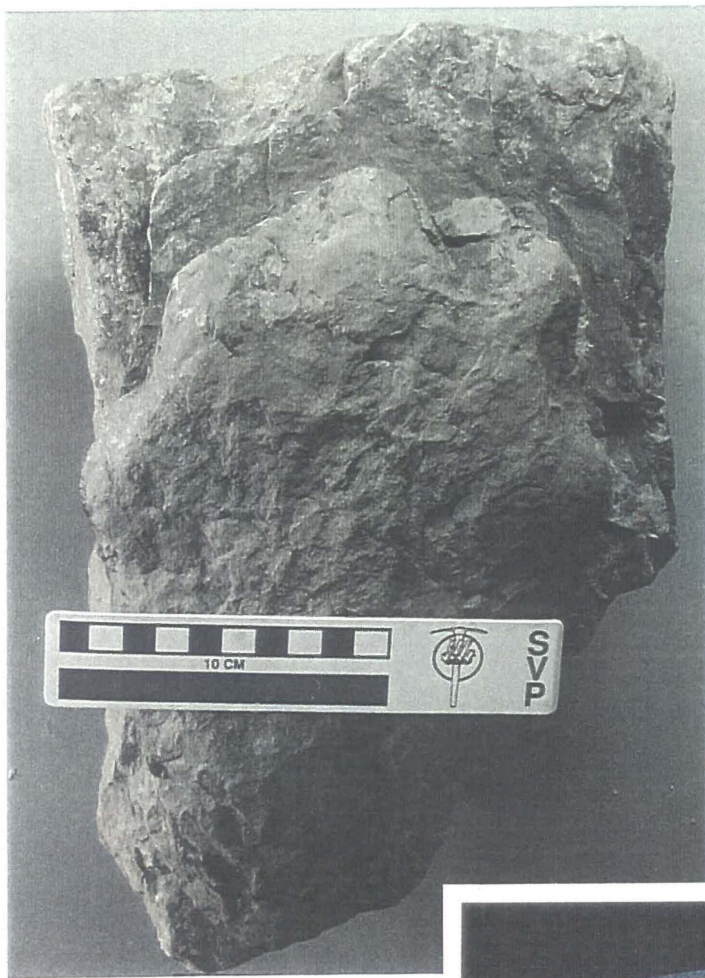


Figure 8. Natural sandstone casts of two five-digit mammal prints. Track cast in upper photo is 25 cm long and 18 cm wide. Track cast in lower photo is 18 cm long and 22 cm wide.



Figure 9. Casts of two three-digit mammal prints. The upper one is a natural sandstone track cast 14 cm long and 20 cm wide. The lower one is a silicone cast taken from a print found in a road cut along the Glenn Highway. It is 6 cm long and 9 cm wide.



Figure 10. Two three-digit bird print casts on the sole of a sandstone block.

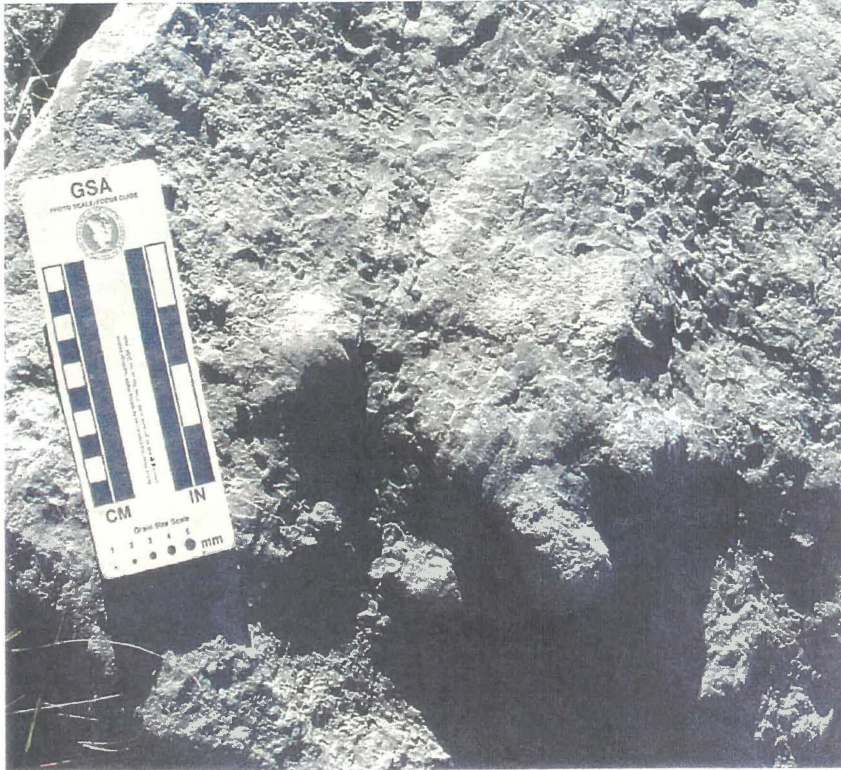


Figure 11. Natural sandstone casts of a four-digit mammal print 19 cm long and 20 cm wide.

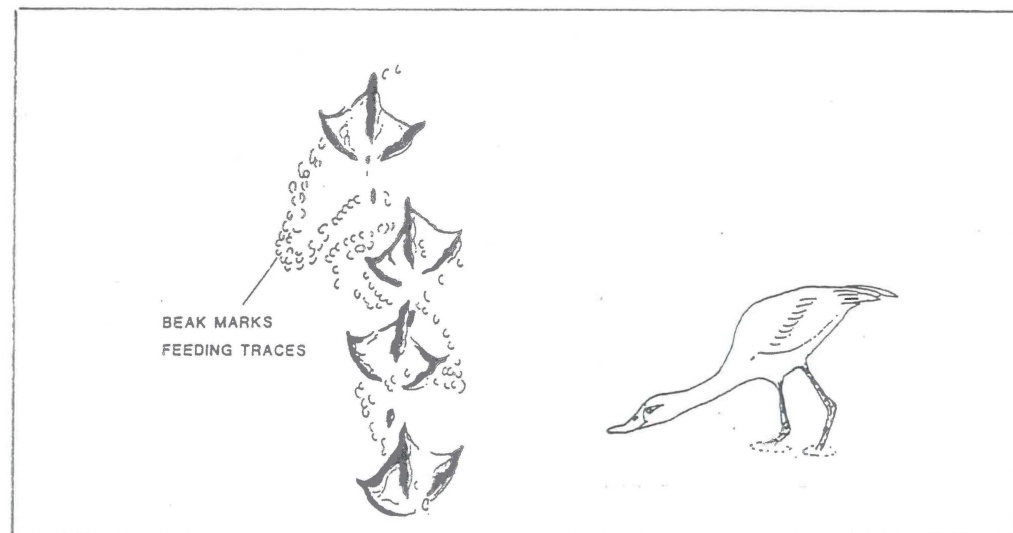


Figure 12. Natural sandstone cast of a “duck-like” track. Note similarity to tracks of a duck- or flamingo-like bird found in Utah at a 45 million-year old site (middle Eocene) (drawing from Lockley et al. 1991).



Figure 13. Cross-section of a mammal track cast at a sandstone/siltstone contact.

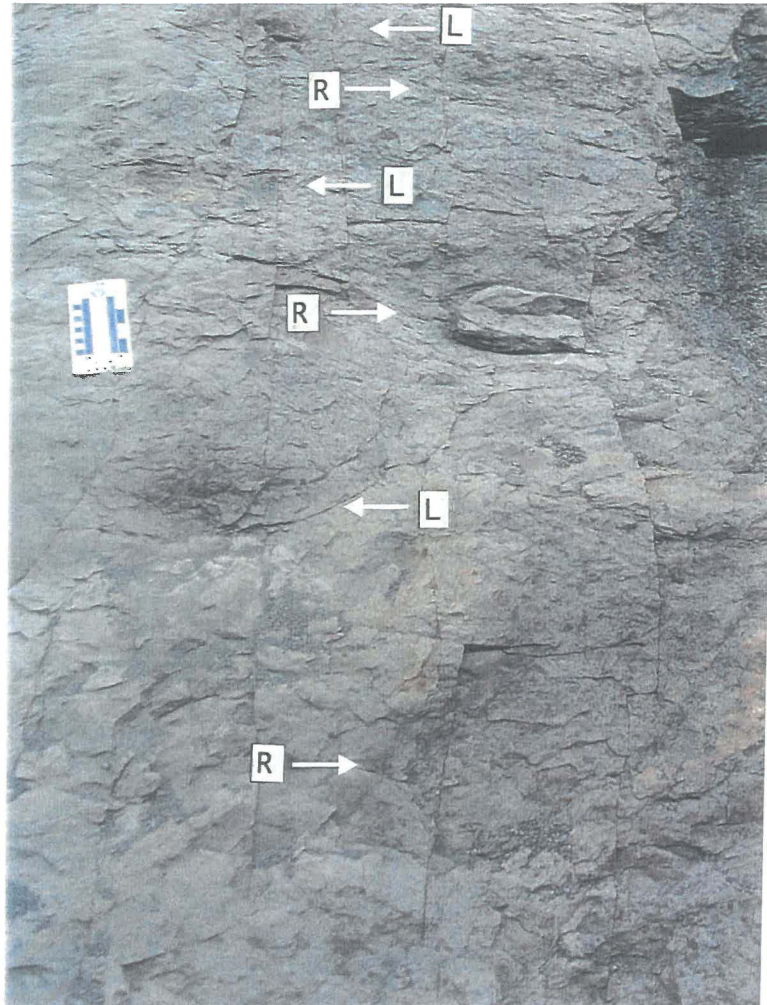


Figure 14. Mammal trackway exposed on a footwall with a sequence of three left prints and three right prints.



Figure 15. Preparation of a silicone rubber cast of a trackway slab in the field.



Figure 16. Comparison of a modern trackway with one from the North Jones Mining Complex area. Upper photo is a sequence of oval depressions made by a moose walking across dry alluvial sand along the shore of the Matanuska River. Note the overprint. Lower photo shows a sequence of depressions on the weathered surface of a sandstone in Center Pit.

WHICH VERTEBRATES MADE THE TRACKS?

It is impossible to view the tracks without speculation as to what animals produced them. They can be compared with those of modern vertebrates that clearly suggest they were made by mammals and birds. Reptiles are unlikely candidates because of their size and gait.

One can also examine the fossil record to see what birds and mammals existed during "Chickaloon" time. Triplehorn et al. (1984) provided a $^{40}\text{K}/^{40}\text{Ar}$ date for volcanic ash partings taken from coal beds within the Premier Group at the Evan Jones mine of $53.3 \pm 1.5\text{Ma}$ to $55.8 \pm 1.7\text{Ma}$. This places the Paleocene/Eocene boundary within the Chickaloon Formation. However, The age of the Paleocene/Eocene boundary is not well defined (Hartman & Roth, 1998). Its position on the global chronostratigraphic scale is based on unconformable contacts in marine rocks in the London and Paris Basins (Lucas 1998a). Biostratigraphic, chemostratigraphic, and paleomagnetic data have also been used to date the boundary (Gunnell 1998a). It has been assigned various ages including 55 Ma (Wing 1998), and 57.8 Ma (Dockery 1998). Berggren et al. (1998) define a Paleocene/Eocene boundary interval between 56.5 and 54.37 Ma (Fig. 17).

This boundary is of great significance in terrestrial strata because it represents a fundamental change with an overwhelming restructuring of mammalian faunas from archaic orders to modern ones (Berggren et al. 1998 and Gunnell 1998a). The timing of the faunal turnover is controversial because of the difficulty in correlating various data sets derived from marine strata and the fossil record from non-marine strata (Berggren et al. 1998). The North American Land Mammal Ages (NALMA) which bracket the Paleocene/Eocene boundary were defined by the faunal assemblages described in the Bighorn Basin of Wyoming (Wing et al. 1991 & Lucas 1998a). They can be correlated with faunal zones in the Paris Basin in Europe and the Nemegt Basin in Mongolia (Rose 1981 & Bown et al. 1994). This boundary is bracketed by the Clarkfordian (late Paleocene) Land Mammal Age (LMA) and the Wasatchian (early Eocene) LMA and has been placed above, at or below the contact based on marine biostratigraphy (Wing 1998). Because of the confusion surrounding the age of the Eocene/Paleocene boundary, both Clarkfordian and Wasatchian land vertebrate assemblages were examined, and a list of possible mammal track makers compiled from both of these early Tertiary faunas (Table 1).

Ma	PERIOD	EPOCH (Berggren & Aubry, 1998)	NALMA (Archibald, 1998, Lucas, 1998b, Gunnell, 1998b)	STRATI - GRAPHIC UNIT (Triplehorn et al., 1984)	FLORAL ZONE (Wing, 1998)
52	Tertiary	(early) Eocene	Wasatchian		
53					
54		P / E Boundary Interval	? — Clarkfordian	Chickaloon Formation	Metasequoia Zone
55					
56					
57		(late) Paleocene	Tiffanian		

Figure 17. Stratigraphic framework for the Chickaloon Formation and the North American Land Mammal Ages (NALMA).

CARNIVORE ORDER	HERBIVORE ORDER	REPRESENTATIVE GENERA
	Condylarthra	Chriacus*
		Ectocion
		Ectoconus*
		Hypsodus
		Meniscotherium
		Phenacodus*
	Pantodonta	Barylambda
		Coryphodon*
	Dinocerata	Probathyopsis
	Mesonychia	Dissacus
		Pachyhyaena
	Taeniodonta	Stylindon*
	Tillodontia	Esthonyx
		Trogosus*
	Artiodactyla	Diacodexis*
	Perissodactyla	Hyracotherium*
Creodonta		Arfa
		Oxyaena*
Carnivora		Didymictis
		Miacis
		Viverravus

Table 1. Genera of large archaic mammals most likely to have made the tracks in the Chickaloon Formation. Those starred are illustrated in Figure 18.

The Clarkfordian was dominated by four extinct orders of archaic mammals (Dinocerata, Mesonychia, Notoungulata, and Plesiadspiformes) while the Wasatchian was dominated by three extant orders (Perissodactyla, Artiodactyla and Primates). Animal migrations between Asia and North American are required to explain the faunal changes at this time. Alaska is in an excellent geographic position to provide evidence for these migrations. Global warming during the late Paleocene would have facilitated migrations of mammals between Asia and North America across a high latitude land bridge (Wing 1998).

The Clarkfordian fossil assemblage from the Bighorn Basin is an ecological match for the Chickaloon Formation in that it contains a fossil flora indicative of a subtropical climate with a mixture of coniferous and angiosperm trees. Five megafloral genera listed by Rose (1981) are also found in the Chickaloon Formation (*Glyptostrobus*, *Metasequoia*, *Cercidophyllum*, *Platanus*, and *Equisities*)(Pasch 1998). Gastropods and fresh water clams (Unionidae) are also found in both localities. The depositional setting of the Clarkfordian, a fluvial environment with swamps, levees, floodplains, and overbank deposits, is also a near equivalent to that of the Chickaloon Formation. This type of environment is ideally suited to the preservation of tracks. Wherever the water table coincides with the depositional surface, the potential for formation and preservation of tracks exists (Lockley 1989). Therefore, because of the similarities in age, climate, flora, and depositional environment, the Bighorn Basin fauna provides a reasonable model for that of the Chickaloon.

There are also other indicators of age. A major change in non-marine gastropods across the Clarkfordian/Wasatchian boundary has been noted in the Bighorn Basin of Wyoming. Mesogastropods showed a dramatic reduction in the diversity at the close of the Clarkfordian, and a dramatic increase in the diversity of terrestrial prosobranchs and pulmonates (air-breathing snails) in the early Wasatchian (Hartman & Roth, 1998). A few gastropods have been found in the North Jones Mining area Complex. They have not yet been studied or identified, however.

The presence of the primitive snapping turtle, *Protochelydra*, suggests a Clarkfordian age for the Chickaloon. A single specimen discovered by three high school students along Moose Creek near the Glenn Highway was identified by Howard Hutchinson (pers. comm.) This same species occurs in the Clarkfordian, but not in the lower Wasatchian in the Bighorn Basin (Hutchinson 1998).

The fossil meagafloral assemblage of the Chickaloon Formation was studied extensively by Wolfe (1966) who assigned a Paleocene age to it. This would suggest the associated tracks would be Clarkfordian. Wing (1998) who has analyzed the Bighorn Basin flora states that

the last appearance of the *Metasequoia occidentalis* and *Carya antiquorem* can be no younger than 54 Ma. Both species are dominant components of the Chickaloon flora. The disappearance of these subtropical trees is attributed to a global cooling event in the earliest Eocene when plant diversity declined.

Mammals: The record for archaic terrestrial mammals of late Paleocene/early Eocene age is relatively poor and consists mainly of jaws and teeth. Taxonomy is based on tooth structure, which demonstrates that the distinction between carnivores and herbivores had not yet been clearly established. Tooth morphology is not as specialized as that seen in mammals today suggesting more generalized dietary habits. Brain capacity, where known, is considerably less than that of extant counterparts. Some gave rise to the orders of mammals seen on earth today while others were dead ends. Evolutionary relationships are not well established resulting in taxonomy that is in a state of flux. Herbivores sometimes had claws and carnivores sometimes had hooves. Complete skeletons, which provide foot morphology, are very rare. Even when known, footprint morphology may be very different from skeletal morphology, because of the influence of flesh and padding. This is especially true with larger animals that have more soft tissue (Lockley 1989).

The track-makers of the Chickaloon must represent a very low per cent of the total faunal assemblage that existed at that time, as most mammals of the period were small. A list of late Paleocene/early Eocene fauna from Europe compiled by Hooker (1998) included estimated body weights for each genus. Of the 127 listed, only eight were larger than 10 kg (6%) and only two were larger than 180 kg (<2%). Many genera are represented by teeth with no associated post-cranial material. Therefore, foot morphology and type of locomotion is unknown (Hooker 1998). Some groups, such as rodents and primates were present and dominant during this time, but they were not considered here because of their small size. Ten orders, representing animals of reasonable size and gait were examined. Eight of the ten are composed of herbivores and two are carnivores. They are:

Condylartha	Taeniodonta	Credonta
Pantodonta	Tillodontia	Carnivora
Dinocerata	Artiodactyla	
Mesonychia	Perissodactyla	

A brief description of each group is given below. Reconstructions of representative genera are illustrated in Figure 18.

The condylarths are a wastebasket group of archaic ungulates first described by Cope in 1881. It includes several families some with hooves and some with claws. The most important, Phenacodontidae, consists of primitive herbivorous ungulates with one of the best fossil records of archaic mammals. One genus, *Phenacodus* (Fig. 18 A), is an environmental indicator because of its preference for fruits and foliage; it was adapted to a closed canopy forest (Schankler 1981). Some post-cranial material of sheep-size animals exists. Their bodies were heavily built with long tails. They had short stout limbs with five toes terminating in hooves. Some are thought to have traveled in herds (Carroll 1988). Its family gave rise to the Perrisodactyls. Another family, Arctocyoniidae, consisted of more carnivore-like animals, but this was a dead-end group. The genus *Chriacus* is illustrated in Figure 18 B. Both *Phenacodus* and *Chriacus* straddle the late Paleocene/early Eocene boundary (Archibald 1998). *Ectoconus* (Fig. 18 C) is another possible track maker because of its great size. It is one of the few Paleocene mammals known from a nearly complete skeleton. The body is very primitive except for its size, which extends to 2 m with the tail. The feet have five digits with short narrow, pointed hooves (Carroll 1988).

The pantodonts, described by Cope in 1873, make up a dead-end order, but include the largest and most abundant vertebrate animals of their time. They are diverse herbivorous ungulates ranging from sheep to rhinoceros-size. Their teeth show little signs of wear suggesting they fed on soft plant material. The few skeletons known demonstrate a primitive structure with no fusion or loss of bone elements. Digits may terminate in either claws or hooves. *Coryphodon* (Fig. 18 D), the largest and most successful one is found in both Clarkfordian and Wasatchian strata. It is common in fluvial and lacustrine deposits. About the size of a tapir (150-300 kg), it had a large skull with prominent tusk-like canines, sharp incisors, and short stout legs. The feet are short and broad with five short digits with small hooves (Fig. 19). This genus is widespread, having been found in Europe, western North America, and Asia so that an Alaskan occurrence would be reasonable (Fig. 20). It is also associated with subtropical forests (Carroll 1988 & Lucas 1998b). This association along with the distribution, abundance, skeletal and foot structure make *Coryphodon* the strongest track-making candidate. For this reason this genus is shown in the reconstruction of the "Chickaloon Forest" (cover illustration).

The dinocerates are more commonly known as the unintatheres. The most primitive types of late Paleocene/early Eocene age are much smaller and less specialized than their well known descendents which were hippo-sized graviportal herbivores characterized by distinctive skulls with a variety of bony protuberances. The feet are short and blunt with five toes ending in short hooves. The group is known from both Asia and North America

and was another “dead-end.” It flourished during the middle and late Eocene, but was extinct by the end of the epoch (Carroll 1988 & Gunnell 1998b).

The last three orders, Mesonychids, Taeniodonts, and Tillodonts are somewhat obscure groups of archaic mammals and fossil remains of these groups are rare. Taeniodonts and Tillodonts became extinct by the close of the Eocene. Mesonychids were ungulates with wolf-like bodies, good stereo vision, crushing molars and strong canines. They had high sagittal crests for strong jaw muscles. They may have been dietary generalists feeding on carrion, mollusks, and tough plants. They were still relatively small during the early Eocene. The taeniodonts and tillodonts were animals that attained bear-size proportions. Their teeth were highly specialized for processing very tough abrasive vegetation. The taeniodonts had very powerful forelimbs, feet with five digits ending in long well-developed claws that may have been used for digging. The genus, *Stylinodon* (Fig. 18 E) was plantigrade and slow (Carroll 1988 & Hamilton 1972). A representative tillodont, *Trogosus* (Fig. 18 F), was plantigrade on five toes which terminated in short claws. Both *Trogosus* and *Stylinodon* are of the Wasatchian LMA (Carroll 1988).

The artiodactyls (even-toed ungulates) and perissodactyls (odd-toed ungulates) are the first modern herbivore orders in the fossil record. They appear in the lower Wasatchian (Gingerich 1980). They would be possible track-makers only if the Clarkfordian/Wasatchian boundary lies within or below the Chickaloon Formation. During the early Wasatchian, they along with the condylarths, are the most important herbivores. The tiny famous “dawn horse,” *Hyracotherium* (Fig. 18 G) is one of the most abundant mammals in North America at this time (Carroll 1988). It was a browser, and lived in forests and swamps. It was a hare-like animal with slender limbs. Its characteristic feet with four hoofed toes on the front and three on the hind feet would leave diagnostic tracks. If found, they would prove the Chickaloon Formation is of the Wasatchian Land Mammal Age and not the Clarkfordian (Carroll 1988 & Hamilton 1972).

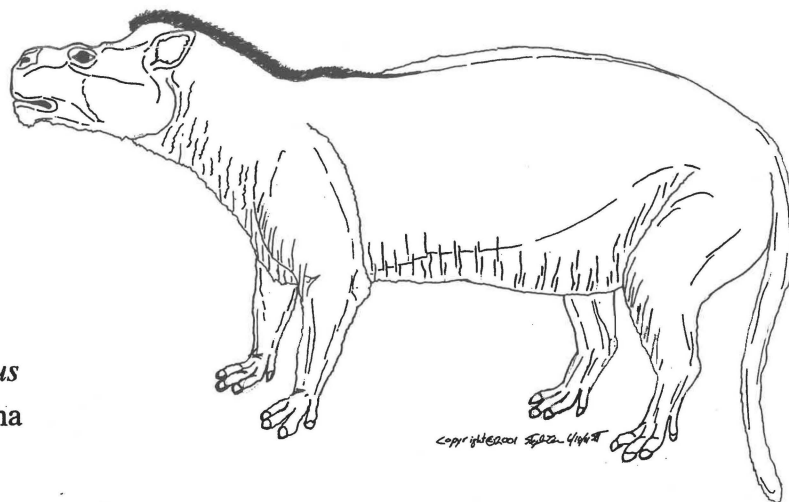
The oldest artiodactyl known is *Diacodexis* (Fig. 18 H), a rabbit-sized animal of the lower Eocene. It was the most cursorial animal of its time and was probably capable of leaping, as its hind limbs were substantially longer than the front ones. It retained five digits on all limbs (Carroll 1988). A leaping animal would leave a diagnostic trackway, but the small size of this animal makes it an unlikely track-making candidate for the prints found to date.

Creodonts were the first large recognizable carnivores. They were the dominant flesh-eating mammals during this period (Hamilton 1972) and were widely distributed in western North America (Janis et al. 1998). They had strong jaws and slow sloping skulls, but better brains than the contemporaneous herbivores. They differ from Carnivora in the retention of

all five digits, which also end in claws. Claw marks would be distinctive in a track. One group, the oxyaenids, had long bodies with short limbs and attained the size of wolverines. Another group had affinities in form and habits to dogs and hyaenas. The genus, *Oxyaena* (Fig. 18 I) is known from this time period. Its plantigrade stance with spreading toes would make it a possible track maker.

True carnivores were fairly common and widespread during "Chickaloon time" in western North America. The earliest were small (cat-size), and they are the ancestors of all extant carnivores. They had larger brains and were capable of greater speeds than creodonts. Their more highly specialized skeletal structures included fused wrist bones and digit I reduced to a dewclaw leaving four functional toes ending in claws (Carroll 1988). Some were arboreal making the chances for preservation of skeletal material and tracks very poor. No track casts found to date are likely made by these animals because of their small size. Late Paleocene carnivores never exceeded 9% of the population (Gunnell 1998a) so chances of preservation of any types are certain to be less than those for the more numerous herbivores.

A. *Phenacodus*
Condylartha



B. *Chriacus*
Condylartha

C. *Ectoconus*
Condylartha

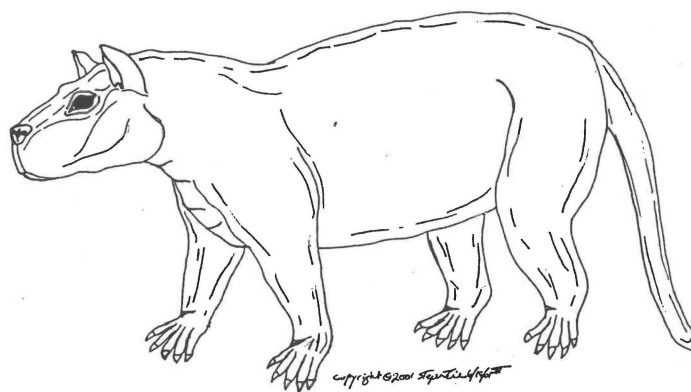
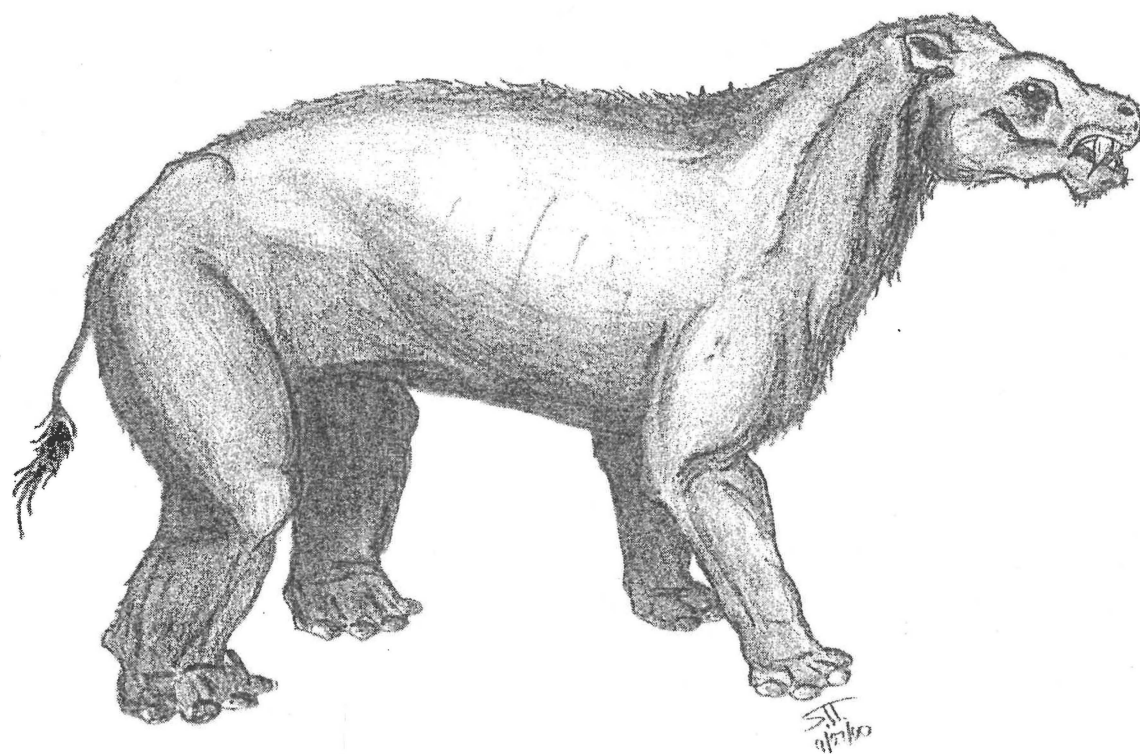
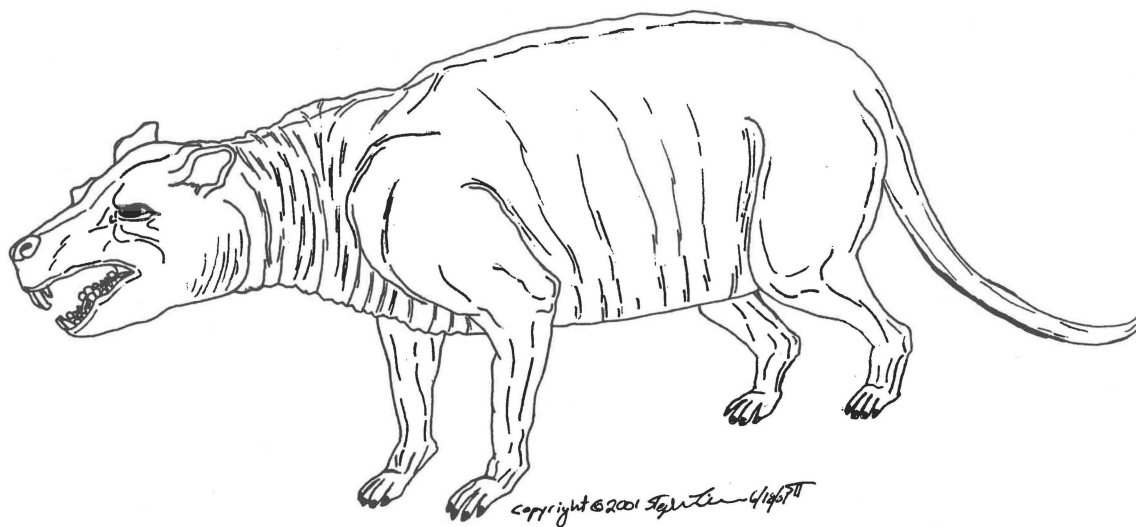


Figure 18. Reconstruction of archaic animals which are the best candidates for the track-making animals of the Chickaloon Formation. Art work by Steve Trimble.



D. Coryphodon
Pantodonta

Figure 18 (cont'd). Reconstruction of archaic animals which are the best candidates for the track-making animals of the Chickaloon Formation. Art work by Steve Trimble.

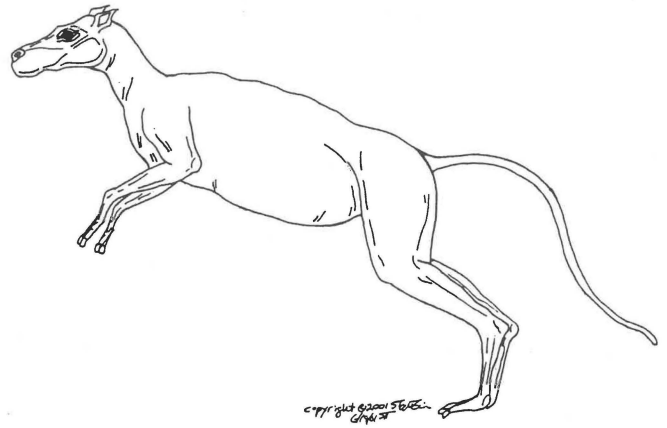


F. Trogosus
Tillodontia

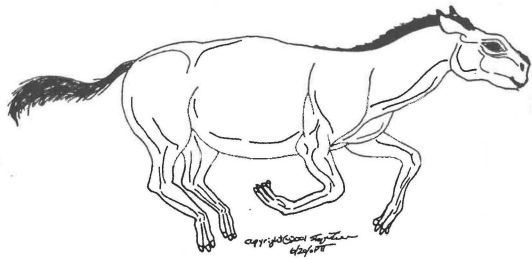


E. Stylindon
Taeniodonta

Figure 18 (cont'd). Reconstruction of archaic animals which are the best candidates for the track-making animals of the Chickaloon Formation. Art work by Steve Trimble.



H. *Diacodexis*
Artiodactyla



G. *Hyracotherium*
Perissodactyla



I. Oxyaenid
Creodonta

Figure 18 (cont'd). Reconstruction of archaic animals which are the best candidates for the track-making animals of the Chickaloon Formation. Art work by Steve Trimble (G. & H.) and Zach Miller (I.).

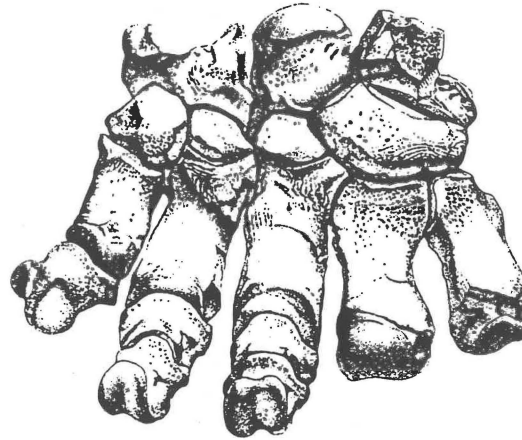


Figure 19. Left manus of a coryphodontid (Patterson 1939). Note the short blunt toes. If covered with tissue this foot would probably make an oval depression. Impressions of toes might be visible.

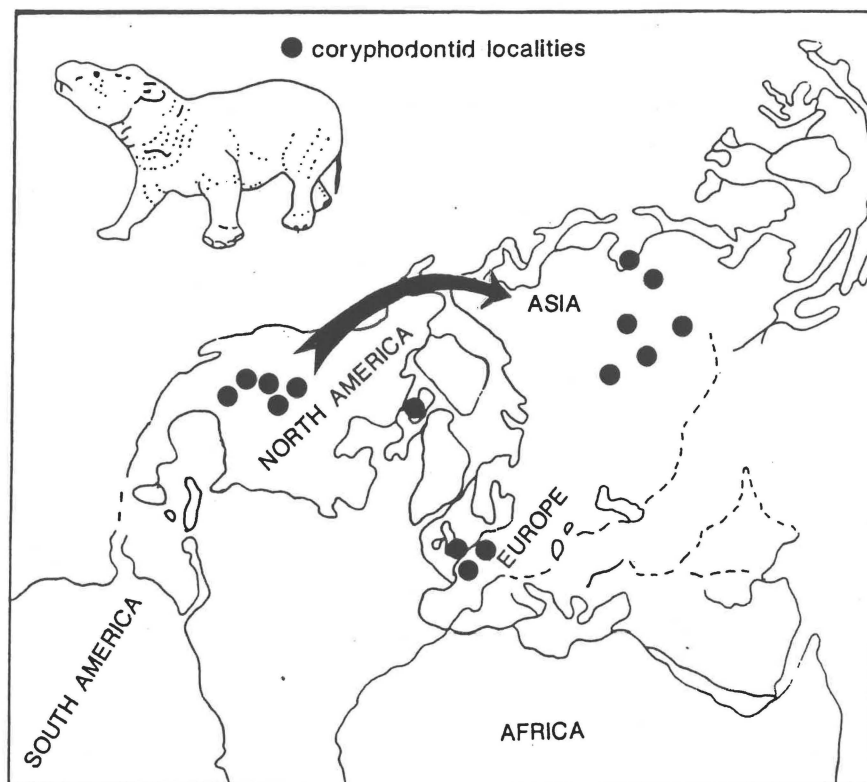


Figure 20. Polar projection of the northern hemisphere during late Paleocene / early Eocene time showing principal coryphodontid localities and a migration route between the Bighorn Basin in Wyoming and Asia through Alaska. Modified from Lucas 1998a.

Birds: Six orders of birds were definitely established by Clarkfordian time (Table 2). However, fossil remains, especially in terrestrial environments are fragmentary and very rare. Bits of eggshell and bone have been found in Clarkfordian strata in Wyoming, but no taxonomic information can be obtained from them. The tridactyl morphology of some of the tracks found strongly resembles that of bird tracks. Little can be inferred from them other than size. Two of the orders are now extinct. One is an unnamed group characterized by the structure of a primitive palate, but crane-like in structure. The other is an order of flightless birds, which includes the famous *Diatryma* (Fig. 21). It is a good candidate for a track-maker with its giant size (2 m tall) and feet with three long toes ending in massive claws. It is also widespread as fossils are known from China, North America, and Europe (Carroll 1988).

Four modern orders of birds with a fossil record which extends to the Paleocene are the Coraciiformes (kingfishers), Strigiformes (owls), Charadriiformes (gulls and shorebirds), and Procellariiformes (albatrosses). The first (kingfishers) were the dominant arboreal perching birds in the early Tertiary, but a type not likely to be fossilized or spending a lot of time on the ground (Carroll, 1988). Of the remaining three orders, the gulls and shorebirds would be the most likely types to have left tracks on a muddy floodplain.

BIRD ORDER	BIRD TYPE
unnamed (extinct)	crane-like bodies
Diatrymiformes (extinct)	Diatryma, a giant flightless bird
Coraciiformes (extant)	kingfishers
Strigiformes (extant)	owls
Procellariiformes (extant)	albatrosses
Charadriiformes (extant)	gulls and shorebirds

Table 2. Orders of birds present during late Paleocene / early Eocene time.



Figure 21. Diatryma, a large flightless bird of early Wasatchian age. Drawn by Steve Trimble.

ASH SAMPLE DATING

In 1984 Triplehorn and others dated volcanic ash partings in coal seams 5 and 8. Their $^{40}\text{K}/^{40}\text{Ar}$ dates range from 53.3 ± 1.5 Ma to 55.8 ± 1.7 Ma. These dates indicate a late Paleocene/early Eocene age for the pollen-bearing strata. As the age of this boundary is equivocal and critical to the determination of the Land Mammal Age, three additional tonstein samples were collected in the summer of 2000 in order to bracket the age of the Chickaloon Formation. Some grain separation problems were encountered in preparation of the samples. However, they have been solved and Paul Layer of the University of Alaska Fairbanks has promised results from the dating analysis by the summer of 2001. Minimum and maximum dates for the Chickaloon strata would be very useful if they could delineate one or other of the Land Mammal Ages (Clarkfordian or Wasatchian). They could also place definitive dates on the palynomorphs.

PALYNOMORPHS

Palynomorphs were recovered from three samples of coal. They were taken from a Premier Coal Seam exposure now buried due to reclamation activities. This member is composed of 30 m of gray to tan claystone, siltstone and sandstone, and six closely spaced coal seams. One sample was collected from coal seam 7 and two were taken from a dark gray siltstone approximately 10 m above seam 7 as described by Triplehorn et al. (1984).

Samples were processed at the University of Alaska Fairbanks laboratory. All three yielded recognizable palynomorph grains. The largest number of grains and the most diverse assemblage were recovered from a coal sample. The two siltstones produced a high but less diverse number of grains. Eight taxa representing deciduous broad-leaved trees (hickory and beech), an unknown angiosperm, a conifer (*Metasequoia*), a cycad, two ferns and an unknown angiosperm were identified. In addition, there were fungal spores of an unknown genus (Fig. 23).

Systematic Paleontology:

Genus *Taxodiaceapollenites* Kremp 1949

Taxodiaceapollenites hiatus Potonie' 1958

Fig. 22 A

Comments: The grains are approximately 28 to 35 microns in diameter and are ovoid to circular. The exine is smooth with micro-reticulate sculpture. Many grains exhibit a split in the exine.

Genus *Caryapollenites* Raatz 1938

Caryapollenites sp.

Fig. 22 B

Comments: The grains observed are approximately 25 to 30 microns in diameter, oblate, and circular to sub-triangular. They are triporate with the pores positioned subequatorially. Secondary folding of the exine is noted in polar view. The exine is psilate.

Genus *Cycadopites* Wodehouse 1933
Cycadopites follicularis (Wilson & Webster 1946)

Fig. 22 C

Comments: The grains are approximately 20 to 25 microns long, ellipsoidal, and approximately 10 to 12 microns wide. They possess a single furrow that extends the full length of the grain, gaping at both ends. The exine is smooth with a granular sculpture.

Genus *Polyadosporites* Van der Hammen 1954
Polyadosporites suescae (Van der Hammen 1954)

Fig. 22 D

Comments: The grains are polyads approximately 35 to 40 microns in diameter, roughly spherical, with individual cells united along multiple axes. Individual cells exhibit psilate exine.

Genus *Inapertisporites* Van der Hammen 1954
Inapertisporites variabilis (Van der Hammen 1955)

Fig. 22 E

Comments: The grains are approximately 18 to 25 microns in diameter and spherical. They possess no pores and are aseptate. The exine is thick and psilate.

Genus *Nothofagus* Blum
Nothofagus tschudyi (Elsik 1974)

Fig. 22 F

Comments: The grains are approximately 28 to 33 microns in diameter and circular. They possess 6 to 7 pores with short colpi. The colpi are difficult to discern and appear as tear-like slits. The exine is thin and scabrate.

Genus *Polypodiisporonites* Potonie' 1931
Polypodiisporonites favus (Potonie' 1931)

Fig. 22 G

Comments: The grains are approximately 58 to 60 microns long and "bean-shaped." They are monolete. The sculpture is composed of large closely spaced, verrucae. The spacing of the verrucae gives the impression that the sculpture is in fact reticulate.

Genus Tricolpites Cookson 1947
Tricolpites reticulata (Cookson 1947)

Fig. 22 H

Comments: The grains are approximately 20 microns long and 15 microns wide and are sub-spherical. They possess three broad colpi. The exine is finely reticulate and thickens near the colpi.

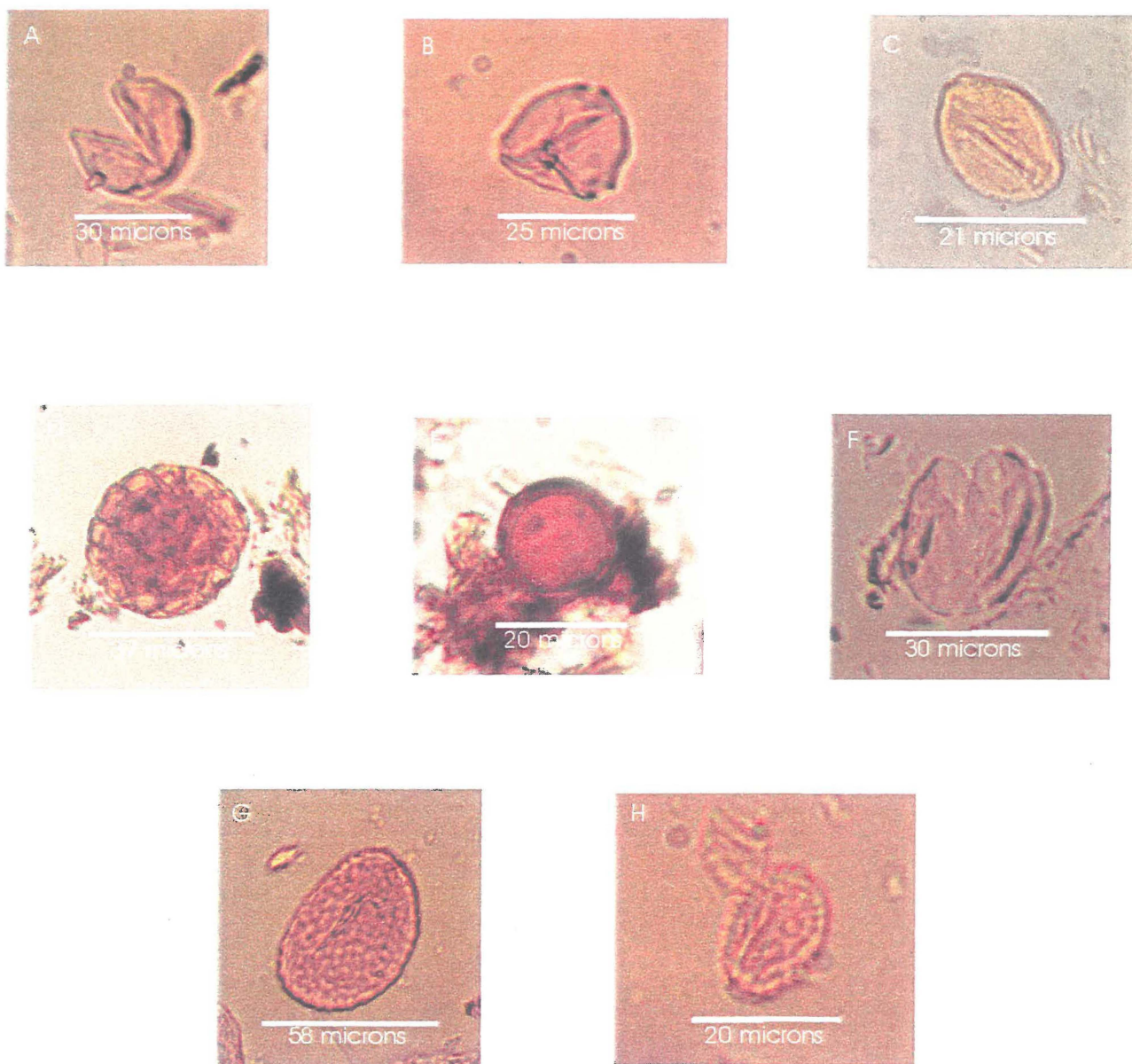


Figure 22. Palynomorphs recovered from the Chickaloon Formation.

- (A) *Taxodiaceapollenites hiatus* (Metasequoia)
- (B) *Caryapollenites* sp. ("hickory")
- (C) *Cycadopites follicularis* (cycad)
- (D) *Polyadosporites suescae* (fern)
- (E) *Inapertisporites variabilis* (spore)
- (F) *Nothofagus tschudyi* ("beech")
- (G) *Polypodiisporonites favus* (fern)
- (H) *Tricolpites reticulata* (unknown angiosperm).

SPECIMENS DONATED TO THE UNIVERSITY OF ALASKA

In the fall of 2000, a several new contributions were made to the University of Alaska. Three large fossiliferous boulders were transported to the Anchorage campus (Table 3). The grounds department staff mounted them in concrete with the fossiliferous horizons on a vertical plane which will reduce deterioration due to weathering (Fig. 23). Thus they area permanent additions to the rock garden that contains the large boulders of petrified wood placed there in 1997.

Boulder Dimensions (cm)	Description
18 x 70 x 84	siltstone with Metasequoia shoot impressions
12 x 76 x 106	sandstone with track impressions
28 x 43 x 56	sandstone with track impressions

Table 3. Fossiliferous boulders placed in the University of Alaska Anchorage rock garden.



Figure 23. Sandstone slab containing track depressions on display in the University of Alaska Anchorage Rock Garden.

Four large specimens or “logs” of petrified wood were transported to the University of Alaska Museum in Fairbanks. These specimens, ranging in size from 600 to 3,630 kg, will become part of a rock garden exhibit when the new museum expansion is completed. Twenty-one other specimens, each less than 150 kg, were added to the University of Alaska Museum collections. The conspicuous “spherules” in the wood are dolomite crystals. The wood has been permineralized and in part replaced by dolomite and siderite.

No.	Tree Part	Weight (kg)
1	trunk	~ 3,630
1	trunk	~ 2,270
1	trunk	~ 600
1	stump	~ 1,000
21	misc. pieces	each < 150

Table 4. Petrified wood specimens from the North Jones Mining Complex area given to the University of Alaska Museum in Fairbanks.

FOSSIL STUMP “FOREST”

In the summer of 2000 a large number of coalified stumps were located on the footwall of the Center Pit (Fig. 24). The vertical axes of these petrified stumps were perpendicular to the bedding plane and roots could be traced into the underlying units (Fig. 25). Weathering may have accentuated their outlines. Since these structures represented true spatial relationships of the trees in their living positions, they provided a view of the forest as it stood 55 million years ago. The 53 stumps were mapped in an area approximately 25 x 65 m. Location of the plot is shown in Figure 26.



Fig. 24 Coalified stump rooted in footwall in Center Pit.



Figure 25. Overview of fossil stump field on footwall of coal seam 7 in Center Pit (view north in top photo). Lower photo is oblique view toward the west.

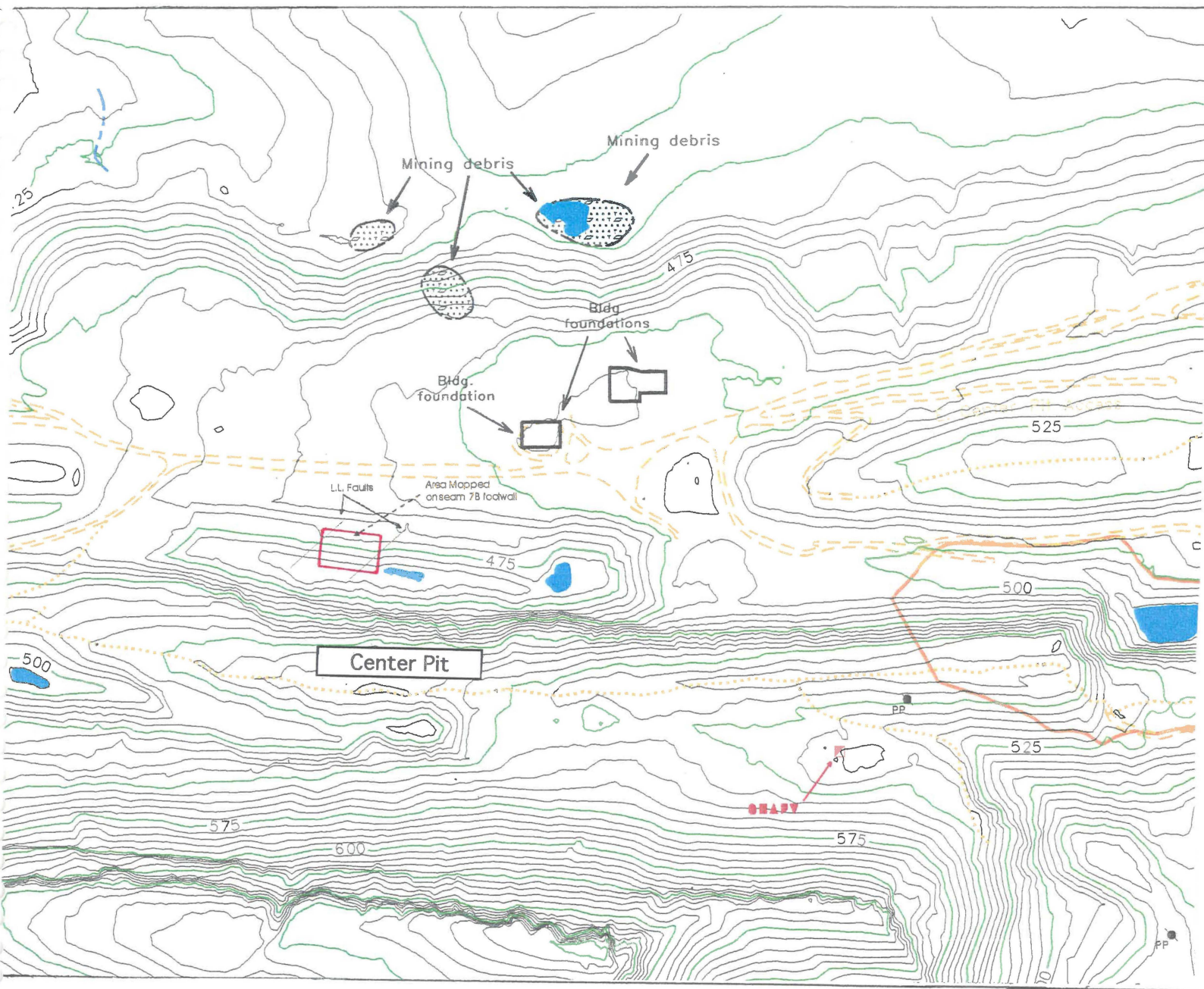


Figure 26. Location of tree stump field (outlined in red) mapped on footwall of coal seam 7 in Center Pit.

A GPS Pathfinder ProXR made by Trimble, was used to map the positions of the trees on the 40° dip slope (Fig. 27). An ArcView program was used to convert the data points from the slope to a horizontal plane to generate the map given in Figure 28. This restores the spacing of those trees in their living positions. The GPS data are given in the Appendix.

Of the 53 fossils mapped, 38 definitely represent once standing trees, 10 appeared to be “logs” parallel to the ground surface, and the remaining 5 were too badly weathered to determine their configuration. Maximum and minimum diameters of stumps and logs were measured. The diameters of 48 specimens ranged from 26 to 152 cm. The mean diameter ($\frac{\text{max diam} + \text{min diam}}{2}$) of the 48 specimens was 76 cm (Table 5).

2

The spacing of the trees in a 25 x 65 m plot is:

$$\frac{.03 \text{ trees or } 1 \text{ tree.}}{\text{m.}^2} \quad 30 \text{ m.}^2$$

Clearly this represents a mature forest.

Stump height was not measured, but all were shorter than one meter and appeared to have been truncated at about the same level in the overlying coal bed (which had been mined). As the plant macrofossils in the Chickaloon Formation include both broad-leafed deciduous trees and conifers, the stumps could be either or a mixture of the two. The structure of the original tissue has been obliterated by its conversion to coal. Without tree rings or cell structure no identification could be made. However, they are smaller in diameter than the 85 conspicuous metasequoia tree trunks mapped in 1997. The mode of preservation is also different as they lack the dolomite and siderite permineralization and recrystallization of the conspicuous woody remains. These stumps may have been coalified because they were smaller, in a wetter environment, or because they lacked the resistance to rot that is characteristic of the Sequoia group.



Figure 27. GPS survey of stump field *in situ* on footwall of coal seam 7 in Center Pit.

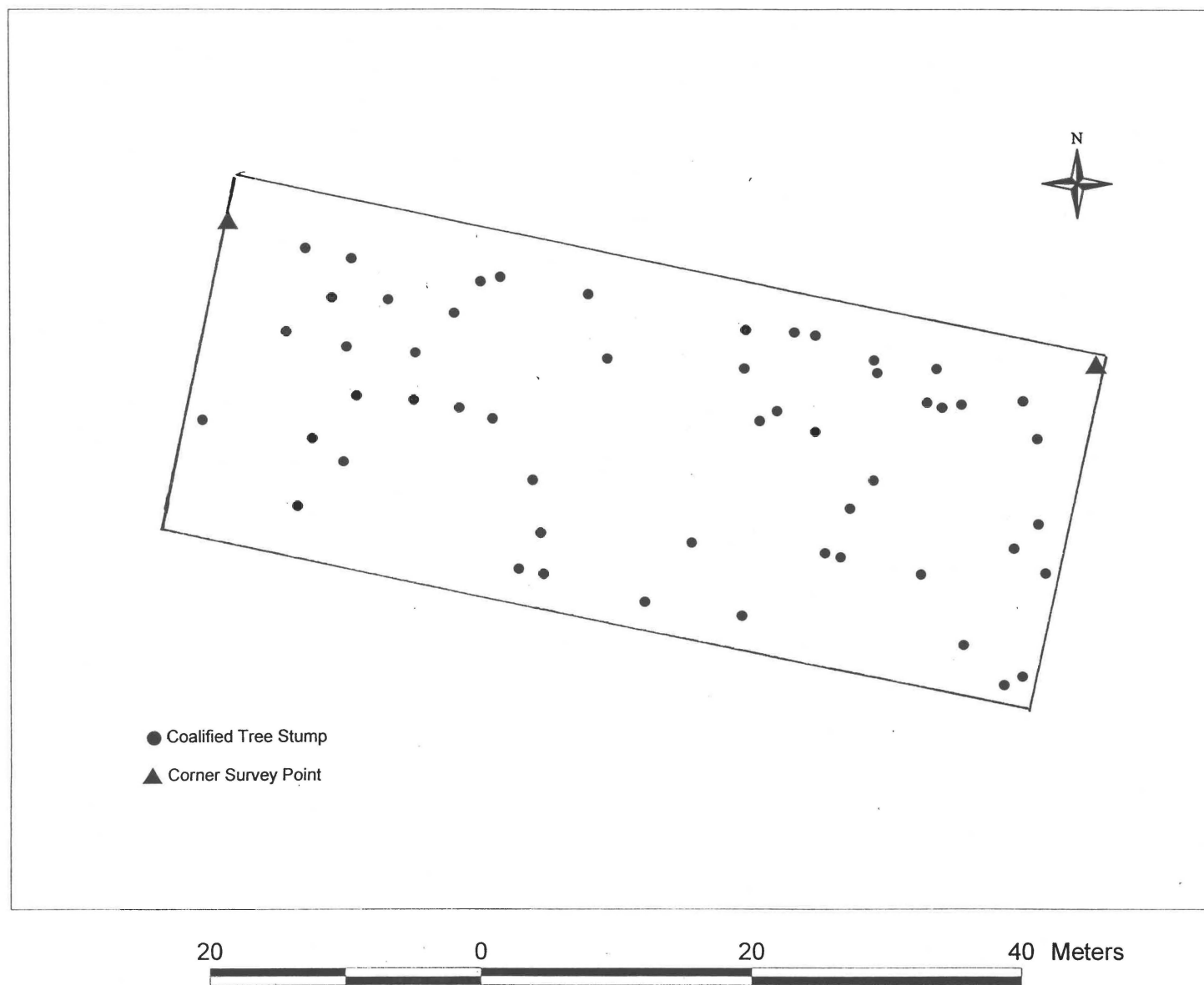


Figure 28. Spacing of coalified tree stumps located on the footwall of coal seam 7 in Center Pit of the North Jones Mining Complex area.

No.	Tree Part	Mean Diameter (cm)	No.	Tree Part	Mean Diameter (cm)
1	stump	105	28	stump	50
2	stump	63	29	stump	62
3	stump	37	30	stump	113
4	stump	63	31	stump	44
5	stump	26	32	stump	124
6	stump	86	33	log	90
7	stump	52	34	log	35
8	stump	84	35	log	100
9	stump	63	36	stump	98
10	stump	59	37	stump	78
11	log	56	38	log	52
12	stump	40	39	stump	90
13	stump	98	40	stump	152
14	stump	88	41	log	104
15	stump	144	42	?	-
16	log	110	43	stump	42
17	stump	86	44	?	-
18	stump	119	45	?	-
19	log	63	46	stump	61
20	stump	76	47	stump	36
21	stump	88	48	stump	56
22	stump	150	49	stump	67
23	stump	85	50	stump	82
24	stump	55	51	stump	70
25	log	62	52	?	-
26	log	40	53	?	-
27	stump	44			

Table 5. Mean diameters of stumps mapped *in situ*.

AMBER

Since 1997 amber specimens have been noted and collected from the North Jones area strip mining sites. Both internal and external forms are present (Fig. 29). Most have been collected as float, but some has been found to occur within the petrified woody tissue of tree stumps (Fig. 30). Over 2000 specimens, ranging in diameter from < 1 mm to 20 mm have been collected and are being studied by Lizzie Williams. To date she has found over 30 specimens in the collection which contain fragments of organic material. Most are insect parts, but pieces of primitive plants and mites (?) also occur.



Figure 29. Amber specimens collected as float. Scale bar = 1 cm.

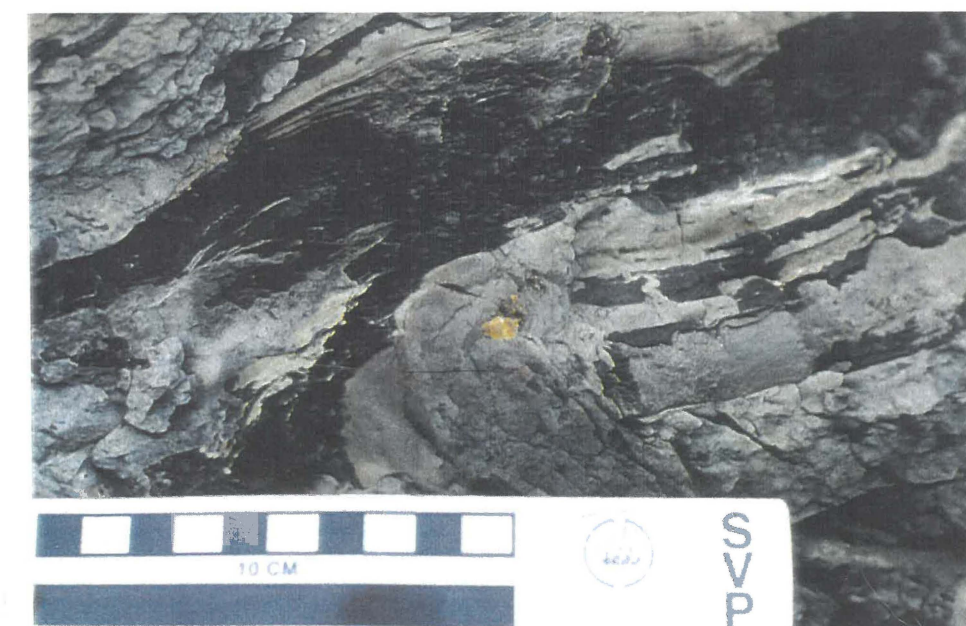
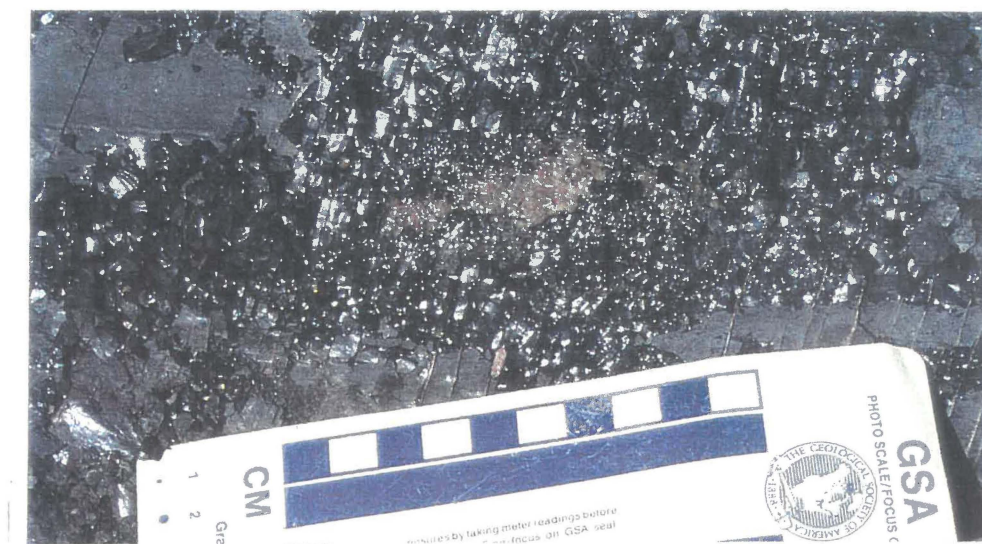


Figure 30. Amber specimens shown *in situ* in coalified wood.

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APPENDIX

Coordinates of the 53 stumps mapped in situ in Center Pit.

Feature name	northing (meters)	easting (meters)	mean sea level (meters)	latitude	longitude
Survey point ne corner	6846902.764	396691.223	477.082	61 44 28.292773899 +	148 57 21.728249140 -
Survey point nw corner	6846913.488	396627.236	477.506	61 44 28.576946312 +	148 57 26.108714600 -
Tree 1	6846897.208	396686.958	473.538	61 44 28.109171268 +	148 57 22.007387530 -
Tree 2	6846899.755	396681.424	474.894	61 44 28.186068466 +	148 57 22.389525240 -
Tree 3	6846899.536	396679.997	474.730	61 44 28.177606176 +	148 57 22.486337580 -
Tree 4	6846899.903	396678.879	474.831	61 44 28.188378274 +	148 57 22.563210470 -
Tree 5	6846902.130	396675.129	476.596	61 44 28.256650369 +	148 57 22.823216130 -
Tree 6	6846903.058	396674.901	476.970	61 44 28.286401580 +	148 57 22.840642880 -
Tree 7	6846905.161	396669.033	477.138	61 44 28.348631816 +	148 57 23.244673920 -
Tree 8	6846902.464	396665.333	475.068	61 44 28.257903144 +	148 57 23.491172620 -
Tree 9	6846905.317	396665.447	477.105	61 44 28.350186317 +	148 57 23.489221760 -
Tree 10	6846903.233	396655.283	473.548	61 44 28.272985818 +	148 57 24.177241010 -
Tree 11	6846908.022	396653.881	477.016	61 44 28.426286345 +	148 57 24.282619960 -
Tree 12	6846909.278	396647.323	476.346	61 44 28.460474814 +	148 57 24.731878670 -
Tree 13	6846908.953	396645.863	476.195	61 44 28.448578691 +	148 57 24.830626330 -
Tree 14	6846906.629	396643.913	474.452	61 44 28.371623916 +	148 57 24.958719850 -
Tree 15	6846907.640	396639.011	474.592	61 44 28.399509665 +	148 57 25.294695470 -
Tree 16	6846907.806	396634.891	474.299	61 44 28.400870471 +	148 57 25.575678780 -
Tree 17	6846910.654	396636.327	476.829	61 44 28.494247331 +	148 57 25.483689730 -
Tree 18	6846911.404	396632.974	476.994	61 44 28.515204806 +	148 57 25.713631500 -
Tree 19	6846904.134	396635.948	472.018	61 44 28.283280148 +	148 57 25.496114180 -
Tree 20	6846905.283	396631.530	471.346	61 44 28.316092356 +	148 57 25.799414480 -
Tree 21	6846900.493	396636.664	470.817	61 44 28.166401815 +	148 57 25.439894490 -
Tree 22	6846900.183	396640.881	471.277	61 44 28.160487532 +	148 57 25.152020880 -
Tree 23	6846903.676	396641.015	473.393	61 44 28.273417855 +	148 57 25.150076320 -
Tree 24	6846899.583	396644.271	471.220	61 44 28.144404443 +	148 57 24.919894110 -
Tree 25	6846898.793	396646.721	470.829	61 44 28.121267956 +	148 57 24.751366860 -
Tree 26	6846898.563	396666.445	472.748	61 44 28.132999694 +	148 57 23.407378080 -
Tree 27	6846899.298	396667.735	473.430	61 44 28.158000175 +	148 57 23.321052270 -
Tree 28	6846897.767	396670.539	472.719	61 44 28.111285048 +	148 57 23.126904120 -
Tree 29	6846894.166	396674.828	471.760	61 44 27.999140847 +	148 57 22.827419940 -
Tree 30	6846890.919	396687.019	471.186	61 44 27.906102065 +	148 57 21.990340470 -
Tree 31	6846889.129	396685.231	469.994	61 44 27.846556596 +	148 57 22.108490230 -

height above ellipsoid (meters)	attribute value	receiver type	date	time	file name
491.703		Pro XR	8/23/2000	10:43:57am	R082311A.cor
492.123		Pro XR	8/23/2000	05:13:32pm	R082311A.cor
488.158	117x93cm	Pro XR	8/23/2000	11:31:46am	R082311A.cor
489.515	70x56cm	Pro XR	8/23/2000	11:39:54am	R082311A.cor
489.350	49x25cm	Pro XR	8/23/2000	11:42:10am	R082311A.cor
489.451	66x60cm	Pro XR	8/23/2000	11:44:57am	R082311A.cor
491.215	22x30cm	Pro XR	8/23/2000	05:06:22pm	R082311A.cor
491.590	78x94	Pro XR	8/23/2000	10:59:47am	R082311A.cor
491.758	55x50cm	Pro XR	8/23/2000	11:05:31am	R082311A.cor
489.687	79x90cm	Pro XR	8/23/2000	12:00:49pm	R082311A.cor
491.725	60x66cm	Pro XR	8/23/2000	11:08:46am	R082311A.cor
488.167	56x62cm	Pro XR	8/23/2000	12:05:18pm	R082311A.cor
491.635	log length 112cm width 56cm	Pro XR	8/23/2000	11:14:33am	R082311A.cor
490.965	40x39cm	Pro XR	8/23/2000	12:12:23pm	R082311A.cor
490.814	146x50cm	Pro XR	8/23/2000	12:14:54pm	R082311A.cor
489.070	110x65cm	Pro XR	8/23/2000	12:18:25pm	R082311A.cor
489.210	156x131cm	Pro XR	8/23/2000	12:21:23pm	R082311A.cor
488.916	length 180 width 110cm log	Pro XR	8/23/2000	12:25:53pm	R082311A.cor
491.447	98x74cm	Pro XR	8/23/2000	11:27:07am	R082311A.cor
491.612	140x98	Pro XR	8/23/2000	11:20:32am	R082311A.cor
486.635	log 183 length 63 width cm	Pro XR	8/23/2000	12:33:09pm	R082311A.cor
485.963	96x57cm	Pro XR	8/23/2000	12:41:16pm	R082311A.cor
485.434	94x81cm	Pro XR	8/23/2000	02:38:17pm	R082311A.cor
485.894	207x92cm	Pro XR	8/23/2000	02:43:27pm	R082311A.cor
488.011	104x66cm	Pro XR	8/23/2000	02:46:39pm	R082311A.cor
485.837	68x42cm	Pro XR	8/23/2000	02:51:46pm	R082311A.cor
485.447	log length 153cm width 62cm	Pro XR	8/23/2000	02:53:59pm	R082311A.cor
487.367	111length x40width cm	Pro XR	8/23/2000	11:56:47am	R082311A.cor
488.049	52x35cm	Pro XR	8/23/2000	11:54:41am	R082311A.cor
487.338	52x47cm	Pro XR	8/23/2000	11:50:31am	R082311A.cor
486.379	89x35cm	Pro XR	8/23/2000	03:01:33pm	R082311A.cor
485.805	143x83	Pro XR	8/23/2000	03:19:32pm	R082311A.cor
484.614	28x60cm	Pro XR	8/23/2000	03:21:53pm	R082311A.cor

total positions	horizontal precision (meters, 68% confidence level)	vertical precision (meters, 68% confidence level)
23	0.250	0.500
26	0.241	0.307
31	0.235	0.635
25	0.236	0.496
24	0.237	0.519
30	0.233	0.539
24	0.239	0.299
23	0.245	0.438
24	0.239	0.409
25	0.239	0.797
28	0.263	0.474
37	0.233	0.831
24	0.248	0.492
28	0.238	0.843
24	0.241	0.812
24	0.240	0.763
23	0.240	0.699
23	0.240	0.650
23	0.240	0.554
26	0.239	0.511
24	0.238	0.590
23	0.239	0.610
31	0.238	0.515
26	0.232	0.326
24	0.233	0.336
25	0.233	0.344
44	0.224	0.361
24	0.238	0.708
23	0.238	0.663
24	0.237	0.601
26	0.234	0.388
24	0.238	0.411
62	0.220	0.386

Tree 32	6846887.321	396687.544	469.117	61 44 27.790418849 +	148 57 21.947211970 -
Tree 33	6846887.254	396678.375	468.218	61 44 27.779319798 +	148 57 22.571642740 -
Tree 34	6846888.531	396672.366	468.099	61 44 27.814741403 +	148 57 22.983504860 -
Tree 35	6846888.835	396671.213	468.341	61 44 27.823428078 +	148 57 23.062708380 -
Tree 36	6846889.612	396661.434	467.512	61 44 27.839037271 +	148 57 23.730369260 -
Tree 37	6846890.360	396650.261	466.645	61 44 27.852337879 +	148 57 24.492990830 -
Tree 38	6846894.254	396649.669	468.607	61 44 27.977512412 +	148 57 24.541249130 -
Tree 39	6846895.639	396635.698	467.549	61 44 28.008673098 +	148 57 25.495767490 -
Tree 40	6846897.355	396633.443	468.458	61 44 28.061903484 +	148 57 25.652882160 -
Tree 41	6846898.729	396625.304	468.452	61 44 28.098376495 +	148 57 26.210024760 -
Tree 42	6846892.363	396632.334	465.165	61 44 27.899592814 +	148 57 25.718185710 -
Tree 43	6846887.723	396648.633	464.766	61 44 27.765575164 +	148 57 24.598448430 -
Tree 44	6846887.362	396650.450	464.703	61 44 27.755680526 +	148 57 24.473922350 -
Tree 45	6846885.285	396658.000	464.488	61 44 27.695943196 +	148 57 23.955403990 -
Tree 46	6846884.232	396665.092	464.662	61 44 27.668808514 +	148 57 23.470162990 -
Tree 47	6846882.030	396681.530	464.912	61 44 27.613675520 +	148 57 22.345983150 -
Tree 48	6846879.051	396684.488	463.156	61 44 27.520326274 +	148 57 22.138411520 -
Tree 49	6846879.687	396685.818	463.612	61 44 27.542181920 +	148 57 22.049164120 -
Tree 50	6846904.913	396670.570	477.054	61 44 28.342111078 +	148 57 23.139419780 -
Tree 51	6846902.408	396679.585	477.074	61 44 28.269969401 +	148 57 22.520273280 -
Tree 52	6846900.011	396685.904	476.266	61 44 28.198669836 +	148 57 22.084922670 -
Tree 53	6846892.098	396673.077	470.567	61 44 27.930649260 +	148 57 22.942435400 -
Area Feature-Perimeter	6846913.542	396627.226	477.499	61 44 28.578667381 +	148 57 26.109490770 -
Area Feature-Perimeter	6846891.299	396621.879	463.282	61 44 27.855079872 +	148 57 26.428115220 -
Area Feature-Perimeter	6846875.218	396690.081	460.280	61 44 27.401963142 +	148 57 21.749578600 -
Area Feature-Perimeter	6846903.422	396691.231	478.028	61 44 28.314006854 +	148 57 21.729062830 -
Area Feature-Perimeter	6846913.542	396627.226	477.499	61 44 28.578667381 +	148 57 26.109490770 -
Metadata					

483.736	187x60	Pro XR	8/23/2000	03:28:52pm	R082311A.cor
482.837	log 129 length 90cm width	Pro XR	8/23/2000	03:32:04pm	R082311A.cor
482.717	log 170x35cm	Pro XR	8/23/2000	03:44:42pm	R082311A.cor
482.960	log length 200 width 100cm	Pro XR	8/23/2000	03:46:50pm	R082311A.cor
482.130	113x82cm	Pro XR	8/23/2000	03:49:53pm	R082311A.cor
481.262	85x70cm	Pro XR	8/23/2000	03:57:14pm	R082311A.cor
483.224	log 112x52cm	Pro XR	8/23/2000	04:03:13pm	R082311A.cor
482.165	100x79cm	Pro XR	8/23/2000	04:05:40pm	R082311A.cor
483.075	130x175cm	Pro XR	8/23/2000	04:11:21pm	R082311A.cor
483.068	log length 153cm width 104cm	Pro XR	8/23/2000	04:17:17pm	R082311A.cor
479.780		Pro XR	8/23/2000	04:28:39pm	R082311A.cor
479.383	47x38cm	Pro XR	8/23/2000	04:32:57pm	R082311A.cor
479.320		Pro XR	8/23/2000	04:35:22pm	R082311A.cor
479.105		Pro XR	8/23/2000	04:39:42pm	R082311A.cor
479.279	54x68cm	Pro XR	8/23/2000	04:43:36pm	R082311A.cor
479.530	20x52cm	Pro XR	8/23/2000	04:45:52pm	R082311A.cor
477.774	50x61cm	Pro XR	8/23/2000	04:52:38pm	R082311A.cor
478.230	87x47cm	Pro XR	8/23/2000	04:56:39pm	R082311A.cor
491.674	95x70	Pro XR	8/23/2000	11:02:35am	R082311A.cor
491.694	94x46cm	Pro XR	8/23/2000	10:56:18am	R082311A.cor
490.887		Pro XR	8/23/2000	10:50:33am	R082311A.cor
485.186		Pro XR	8/23/2000	03:11:47pm	R082311A.cor
492.117		Pro XR	12/7/2000	11:18:46am	R082311A.cor
477.897		Pro XR	12/7/2000	11:18:46am	R082311A.cor
474.898		Pro XR	12/7/2000	11:18:46am	R082311A.cor
492.649		Pro XR	12/7/2000	11:18:46am	R082311A.cor
492.117		Pro XR	12/7/2000	11:18:46am	R082311A.cor

24	0.241	0.448
25	0.241	0.468
24	0.244	0.510
24	0.239	0.466
25	0.239	0.476
24	0.238	0.436
27	0.236	0.439
31	0.234	0.434
27	0.236	0.433
26	0.239	0.493
24	0.244	0.542
26	0.242	0.506
23	0.243	0.480
24	0.242	0.453
24	0.242	0.421
32	0.232	0.325
23	0.239	0.333
24	0.239	0.330
23	0.242	0.436
24	0.247	0.460
28	0.246	0.468
27	0.235	0.432
	average horizontal precision (meters, 68% confidence level)	average vertical precision (meters, 68% confidence level)
	0.294	0.472
	0.294	0.472
	0.294	0.472
	0.294	0.472
	0.294	0.472

Coordinate System: UTM				
Coordinate Zone: 6 North				
Datum: NAD 1983 (Alaska)				
Vertical Datum?: Geoid 99				
Corrected against Accupoint, Anchorage, AK				
see file "cor0825a.txt" for differential correction information				
Dip 40 degrees south				
Strike average of 100-105 degrees				