

Evidence from charcoal of fire regimes in the Cretaceous of Alberta, Canada

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Summary: Charcoal is recorded from late Cretaceous sediments of Dinosaur Provincial Park, Alberta, Canada and represents the first documented observations of charcoal at this locality despite over one hundred years of research. Abundant charcoal deposits have been recorded throughout the 1.7 million year sediment sequence indicating multiple fire events within this locality. Fire appears to be a major influencing factor within this Cretaceous ecosystem and may have affected the life of the inhabiting dinosaurs. The occurrence of charcoal allows reconstruction of the burned vegetation at multiple locations within Dinosaur Provincial Park. The charcoal assemblage is comprised of gymnosperm wood only, which may be a reasonable representation of the local vegetation; however it could be the result of a taphonomic bias. The absence of additional plant types within the charcoal assemblage may also be due to certain species being preferentially burnt owing to a more fire prone nature.

Key words: wildfire, charcoal, gymnosperm, wood, Cretaceous

INTRODUCTION

Fire plays a major role in modern ecosystems, greatly influencing plant communities (Bowman *et al.*, 2009). The anatomical preservation of charcoal makes it a highly useful tool that allows reconstruction of plants, and therefore the vegetation of specific localities. Charcoal is often overlooked in ancient sediments, potentially due to a lack of recognition (Scott, 2010). Charcoal deposits found in Cretaceous sediments globally indicate that fire was an important ecosystem process during this Period, however, there is still little knowledge regarding fire-prone vegetation within the Cretaceous. Current research being carried out in Dinosaur Provincial Park, Alberta, Canada aims to address this through sedimentological and palaeobotanical analyses, enabling vegetation reconstruction to be undertaken.

SEDIMENTOLOGY OF DINOSAUR PROVINCIAL PARK

Dinosaur Provincial Park covers an area of 72 km² and contains well exposed mid-late Campanian sediments (Currie and Koppelhus, 2005). Despite the area having been extensively researched for over one hundred years, due to the abundance of both articulated and disarticulated dinosaur remains, charcoal deposits had never been reported. Two formations are exposed within the park, the Oldman Formation and the Dinosaur Park Formation, which represent a 1.7 million year interval of the mid-late Campanian. The Oldman Formation is comprised of very fine sandstones, mudstones and shales that can be interpreted to represent palaeochannels. The Dinosaur Park Formation is comprised of medium grained sandstones, mudstones and shales interpreted to represent the lateral accretion of point bars from a meandering river (Thomas *et al.*, 1987).

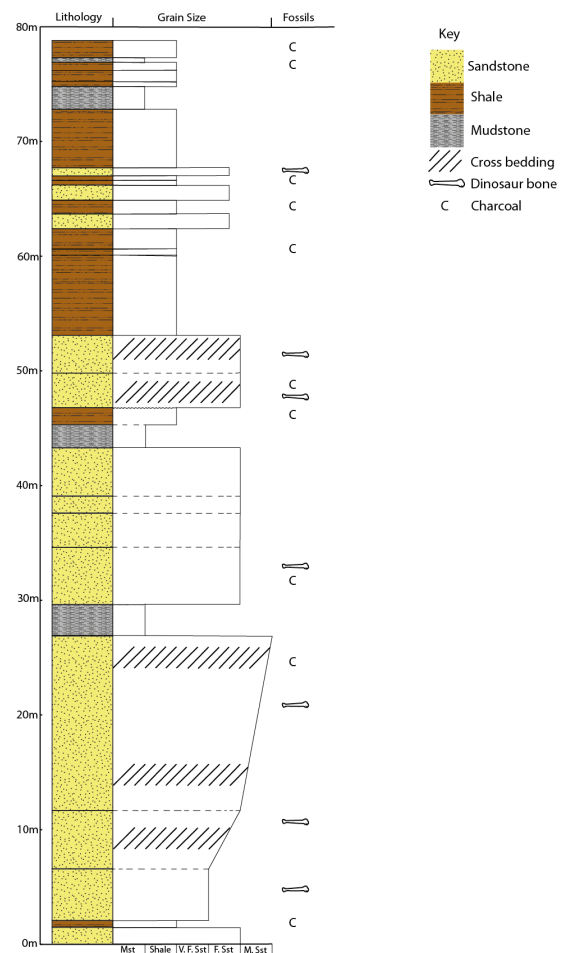


FIGURE 1. Sedimentary log of Oldman and Dinosaur Park Formations showing abundant charcoal presence.

CHARCOAL OCCURENCE

Charcoal has been observed to be highly abundant throughout Dinosaur Provincial Park, and represents the first documented observation at this locality. Sampling

was undertaken throughout the Park, at ten different locations, with abundant charcoal observed in each. Figure 1 indicates the presence of charcoal throughout both the Oldman and Dinosaur Park Formations from one locality within Dinosaur Provincial Park. The charcoal is comprised of gymnosperm wood only, some of which displays growth rings (Fig. 2).

There is no correlation between the charcoal abundance and the sediment type in which it is contained. Currently there does not appear to be a relationship between the amount of charcoal within a sedimentary unit and its stratigraphic position.

IMPLICATIONS FOR VEGETATION RECONSTRUCTION

The presence of only gymnosperm wood charcoal is of particular interest, as this would not be expected when compared with the palynological data. Angiosperms were present at Dinosaur Provincial Park at this time in the Cretaceous, with the palynology indicating multiple species and a high abundance. The absence of angiosperms poses an interesting question as to whether this was a gymnosperm dominated environment with weedy angiosperms and ferns only present in minor numbers, or whether there is a preservational bias in charcoal favouring gymnosperm wood.

Initial results indicate a bias within the charcoal record, as with a gymnosperm dominated environment additional organs, such as leafy shoots and cone scales, would be expected to occur. Dinosaur Provincial Park was a fluvially dominated system during the Campanian, which may have resulted in some abrasion to the charcoal causing it to fragment and may result in some of the smaller charcoal size fraction being transported outside the boundaries of the field area; however this would be highly unlikely to remove all angiosperm, fern and additional gymnosperm organs.

CONCLUSIONS

The presence of abundant charcoal throughout the sedimentary succession in multiple localities throughout Dinosaur Provincial Park provides the first record of charcoal within this dinosaur rich environment, and indicates that wildfire played a major role in this

ecosystem during the Campanian. This charcoal record is highly important as it not only allows vegetation reconstruction in this area, but also indicates that wildfire, due to its abundance, would have impacted on the inhabiting dinosaurs.

The charcoal composition may reflect the local vegetation, however it is possible that a true reflection of the ancient vegetation may not be preserved posing a problem for vegetation reconstruction. It is, however, evident from the data that gymnosperms were an important component of the flora at this time. The presence of growth rings on some larger charcoal pieces enables tentative comments to be made regarding seasonality within Alberta during the late Campanian. The charcoal data also suggests that there is no increase in wildfire abundance throughout the Campanian.

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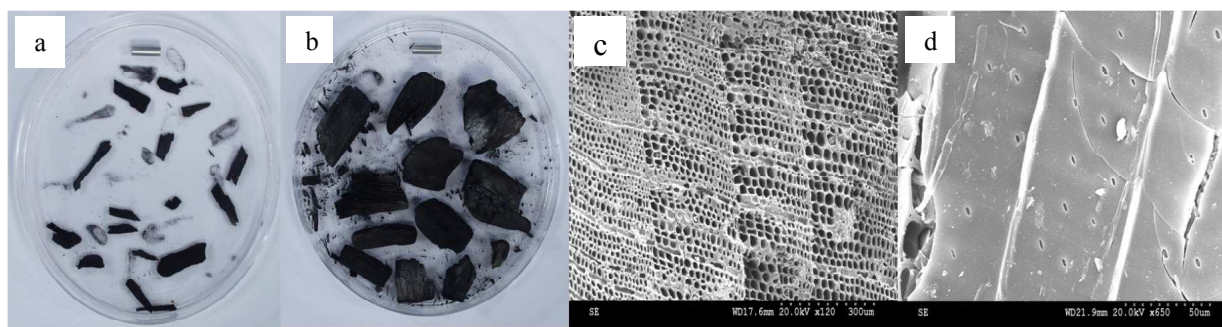


FIGURE 2: Examples of charcoal from Dinosaur Provincial Park. a. Charcoal sample containing a small size fraction. b. Charcoal sample containing a large size fraction. c. SEM image of gymnosperm wood displaying growth rings. d. SEM image of gymnosperm wood.