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Comment

Comment on Mustoe, G.E.; Beard, G. Calcite-Mineralized Fossil Wood from Vancouver Island, British Columbia, Canada. *Geosciences* 2021, *11*, 38

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We are impressed with the detailed work Mustoe and Beard [1] have undertaken in assessing the geochemistry of calcite-mineralized wood from the Cretaceous and Paleocene of Vancouver Island, British Columbia. As Mustoe and Beard note, reports of calcite-mineralized wood are relatively rare in the paleontological literature, and its abundance on Vancouver Island in rocks ranging in age from the Early Cretaceous to Paleocene is thus impressive and intriguing. Their suggestion that the permineralized Vancouver Island wood is possibly resultant from elevated Cretaceous seawater acidity is of potential interest in paleoecological and paleoenvironmental assessments. In addition, we find their hypothetical modeling of concretion formation enlightening and informative.

Although not materially impacting the geochemical conclusions of their study, Mustoe and Beard's contribution does, however, include several incorrect assignments of stratigraphic unit and age for their fossil wood localities that we believe should be clarified. A number of these clarifications were provided by one of us (JWH) as a courtesy to Mustoe and Beard prior to publication but, unfortunately, their contribution was already in press at that time and the changes could not be incorporated. We thus wish to note that some of the stratigraphic assignments made by Mustoe and Beard were not necessarily made at the suggestion of one of us (JWH), as intimated in the Acknowledgments of their article.

Regarding Mustoe and Beard's [1] discussion of Early Cretaceous wood from northern Vancouver Island, the strata in the vicinity of Apple Bay in Holberg Inlet consist of intercalated non-marine and marine rocks including coaly siltstone, greywacke, arkosic sandstone, and conglomerate, which were assigned by Jeletzky [2] to his "Longarm Formation Equivalents" unit, based on similarities to age-equivalent strata present on Haida Gwaii (formerly Queen Charlotte Islands). Jeletzky [2] subdivided this unit into his informal "Barremian Variegated Clastic Unit" (of Barremian (?) and latest Hauterivian age) and "Coarse Arenite Unit" (of Aptian age), based on poorly constrained biostratigraphic data. It is not certain from which of Jeletzky's two informal units Mustoe and Beard's wood was obtained, but it is presumed to be from the Barremian Variegated Clastic Unit, as it is more fossiliferous. Gröcke (pers. comm. in Hernandez-Castillo et al., 2006 [3] and Stockey et al., 2006 [4]), suggested that these strata have an age at the Valanginian–Hauterivian boundary (as noted approximately by Mustoe and Beard, 2021), based on isotopic analysis, although these data remain unpublished. This isotopic date would seem to contradict the regional stratigraphic analysis, however, as no strata of biostratigraphically constrained Valanginian age have been recognized elsewhere in the Holberg Inlet area [5]. The final assessment of the age of the Apple Bay section remains in question pending the publication of the isotopic data, but we can summarize that the strata which are presumably the source of Mustoe and Beard's (2021) fossil wood from this area are of general Early Cretaceous age, probably Valanginian–Aptian.

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Twenty-five km to the northeast of Apple Bay, Upper Cretaceous shallow marine clastic strata of the informal Suquash basin of Muller and Jeletzky [6] are found in the area of Port Hardy and Port McNeil on northeastern Vancouver Island and the adjacent islands [7]. These strata are presumably the source of Mustoe and Beard's "Port Hardy" fossil locality [1] (Table 2, Entry 1) and are of mid-Campanian age [6], c.a. 75 Ma.

The bulk of Mustoe and Beard's fossil wood occurrences are from the Upper Cretaceous Nanaimo Group of southeastern Vancouver Island. As Mustoe and Beard [1] state, this succession is composed of widely varying clastic lithologies [6]. Within the succession, we note that the age of the Shelter Point locality [1] (Figure 1, Locality 2) is early Campanian, however, not Maastrichtian. These strata were first described in detail by Richards [8] in a contribution on fossil crabs found in the succession, and were assigned by him to the Maastrichtian Spray Formation of the Nanaimo Group. Ward et al. [9] recognized that the Shelter Point succession is appreciably older, however, and they assigned it to the early middle Campanian. More recent fossil collections by the authors from this section have firmly established its age as late early Campanian, although these data were not available to Mustoe and Beard [1]; given its age, the Shelter Point locality is better assigned to the Cedar District Formation.

Farther southeast on Vancouver Island, in the Nanaimo area, the research of Pearson and Hebda [10] has assigned Mustoe and Beard's Cranberry Arms fossil locality [1] (Figure 1, Locality 9) to the Protection Formation rather than the Cedar District Formation, to which it was assigned by Mustoe and Beard [1], and this assignment has been followed by subsequent workers studying this flora (e.g., [11], which was not available to Mustoe and Beard). This stratigraphic level is thus somewhat farther down in the Campanian, and is more likely late early Campanian in age.

To summarize the discrepancies we have noted above, we provide in Table 1 revised stratigraphic and biostratigraphic data bearing on the Vancouver Island fossil wood localities discussed by Mustoe and Beard [1]. This table also updates the ages and depositional environments of other Nanaimo Group stratigraphic units not necessarily discussed directly by Mustoe and Beard [1].

It should also be clarified that the Cretaceous deposits of northern and southern Vancouver Island represent independent basinal successions, a point which is not noted by Mustoe and Beard [1]. The southernmost Cretaceous exposures on northern Vancouver Island are located approximately 180 km northwest of the northernmost Cretaceous deposits of more southerly Vancouver Island, separated by the topographic high and geo-logic uplift of central Vancouver Island and the Johnstone Strait. Jeletzky [2] recognized that the Lower Cretaceous strata of northern Vancouver Island had direct correlatives with those of Haida Gwaii located approximately 350 km to the north. Although Muller and Jeletzky [6] noted the similarity in age and lithology of the Campanian rocks of northern Vancouver Island to the Nanaimo Group succession of southeastern Vancouver Island, these strata are now known to also have correlatives on Haida Gwaii [12]. Indeed, Haggart [13] suggested that all of the Cretaceous strata of northern Vancouver Island, including both the Lower and Upper Cretaceous deposits, represent the southern margin of the Cretaceous Hecate basin of Queen Charlotte Sound, Hecate Strait, and Haida Gwaii.

Table 1. Stratigraphy of the Vancouver Island Cretaceous and Paleocene plant fossil localities of Mustoe and Beard [1].

Fossil Locality		Stratigraphic Unit	Biostratigraphic Age	Lithologies	Depositional Environment
NORTH VANCOUVER ISLAND (Hecate Basin)					
Port Hardy		Unnamed strata	Mid-Campanian	Sandstone, siltstone, conglomerate	Shallow marine
Apple Bay		Longarm Fm Equivalents	Valanginian–Aptian	Sandy siltstone	Nearshore marine
SOUTH VANCOUVER ISLAND (Nanaimo Basin)					
Oyster Bay		Oyster Bay fm	Late early Paleocene	Sandstone, siltstone	Nearshore marine
? possible unconformity ?					
Hornby Island	NANAIMO GROUP	Gabriola Fm	Maastrichtian	Sandstone	High-energy submarine fan channel
		Spray Fm	Early Maastrichtian	siltstone, mudstone	Low-energy submarine fan turbidites
		Geoffrey Fm	Campanian–Maastrichtian	Conglomerate, sandstone	High-energy submarine fan channel
		Northumberland Fm	Late Campanian	Mudstone, siltstone	Low-energy outer shelf
		De Courcy Fm	Mid-Campanian	Conglomerate, sandstone	High-energy submarine fan channel
Shelter Point		Cedar District Fm	Late early Campanian	siltstone, mudstone	Mid- to outer shelf
Cranberry Arms		Protection Fm	Early Campanian	Sandstone, conglomerate, siltstone	Shallow marine to submarine fan
		Pender Fm	Early Campanian	siltstone, mudstone	Low-energy outer shelf
		Extension Fm	Santonian–Campanian	Sandstone, conglomerate, coal	Nearshore marine, deltaic
		Haslam Fm	Late Santonian–Earliest Campanian	siltstone, mudstone	Low-energy outer shelf
Puntledge River		Comox Fm	Santonian	Sandstone, conglomerate, coal	Nearshore marine and fluvio-deltaic
Possible unconformity?					
Eden Main		Unnamed strata	Turonian–Coniacian	Sandstone, mudstone, coal	Shallow marine and fluvio-deltaic

Finally, although it is not at all related to their study, we wish to note that Mustoe and Beard's [1] suggestion that bivalves of the genus *Teredo* (family Teredinidae) may have been responsible for the numerous holes carved in the fossil wood of the Vancouver Island Cretaceous and Paleocene is not a definitive conclusion. The genus *Teredo* has an uncertain stratigraphic range, and the suggestion that the Teredinidae appeared before the Cenozoic

is somewhat speculative [14]. We suggest instead that Mustoe and Beard's [1] fossil wood was perhaps bored by some undetermined pholadid bivalve (both Pholadidae and Teredinidae are in the superfamily Pholadoidea, of which many members are xylophagous), and indeed the pholadid *Martesia clausa* Gabb 1864 was reported by Whiteaves [15] (p. 137, pl. 17, Figure 2, 2a, 2b) from the "Productive Coal Measures, Division A, of Northwest Bay," while *Martesia* (?) *parvula* Whiteaves 1903 was described in the "Extension mine, near Nanaimo" [16] (p. 372–273, pl. 45, Figure 10). Whiteaves [17] (p. 373) later equivocated whether *M. clausa* is a true *Martesia*, but Stewart [17] (p. 295) synonymized both of Whiteaves' pholadid taxa with *M. clausa*, retaining the taxon in *Martesia*. Further study of the bored wood of the Lower and Upper Cretaceous and Paleocene of Vancouver Island may shed light on this interesting paleoecological and evolutionary problem. We therefore thank Mustoe and Beard [1] for noting the presence of such bored wood in their study.

We recognize that it was not Mustoe and Beard's [1] objective to present a tightly age-constrained summary of the fossil wood of Vancouver Island, but we have provided the comments above in order that workers can place the fossil wood localities discussed by Mustoe and Beard [1] into a more appropriate stratigraphic context, and for future work. We wish to reiterate that we are impressed with the geochemical analysis of the fossil wood that they have undertaken. Mustoe and Beard's conclusion that the calcite-mineralization characteristic of all of the Cretaceous fossil wood of Vancouver Island raises intriguing questions. Could the active forearc tectonic setting of the Cretaceous basins of Vancouver Island be influencing calcite versus siliceous fossilization in some manner? Such tectonically active settings are typified by clastic deposition of nearby uplifted areas, whereas carbonate deposition is more common along passive margins, especially in tropical and temperate latitudes; thus, the abundance of calcite mineralization in the Vancouver Island Cretaceous is even more intriguing. We await further geochemical work by Mustoe and Beard which might better resolve these engaging questions.

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