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# Timing of Cache Creek Ocean closure: insights from new Jurassic radiolarian ages in British Columbia and Yukon and their significance for Canadian Cordillera tectonics

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1 *Title:* Timing of Cache Creek Ocean closure: insights from new Jurassic radiolarian ages in  
2 British Columbia and Yukon, and their significance for Canadian Cordillera tectonics.

3

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19

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21 British Columbia and Yukon, and their significance for Canadian Cordillera tectonics.

22

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24

## 25 **Abstract**

26 The closure of the Cache Creek Ocean during the Jurassic led to the structuration of the Canadian  
27 Cordillera. To reassess the timing of this major tectonic event, this study proposes a  
28 biochronological review of all the youngest radiolarian-bearing localities of the Cache Creek  
29 Terrane in British Columbia and Yukon using updated radiolarian biozonations and taxonomy,  
30 complemented by new data from the type locality. The results show that all ages are Early  
31 Jurassic and fairly homogenous along the entire terrane. All the youngest siliceous rocks are  
32 restricted to the Late Sinemurian–Early Toarcian interval (~195–180 Ma). The youngest well-  
33 dated pelagic cherts are Early Pliensbachian, with slightly younger siliceous argillites of  
34 Pliensbachian and possibly Early Toarcian age. These results suggest that Cache Creek deep  
35 pelagic sedimentation ceased fairly synchronously along the entire belt, probably during the  
36 Pliensbachian (~191–183 Ma), predating the final closure of the basin when Cache Creek units  
37 were thrust over Stikinia and Quesnellia in the Middle and Late Jurassic. This apparent  
38 synchronicity should result in re-evaluating the tectonic mechanism of the Cache Creek  
39 “entrapment model” in its present form. The study also shows that pelagic sedimentation ceased  
40 22 to 31 m.y. earlier in the Cache Creek Terrane than in the Bridge River Terrane, confirming the  
41 stratigraphic discrepancy between the two terranes during the Jurassic.

## 42 **Résumé**

43 La fermeture de l'océan Cache Creek au Jurassique a conduit à la structuration de la Cordillère  
44 Canadienne. Afin de réévaluer la chronologie de cet événement tectonique majeur, l'étude  
45 propose une synthèse biochronologique de toutes les plus jeunes localités à radiolaires du terrane  
46 de Cache Creek en Colombie-Britannique et au Yukon grâce aux nouvelles biozonations et à une  
47 taxonomie actualisée, avec en complément de nouvelles données pour la localité-type. Les  
48 résultats montrent que tous les âges sont du Jurassique inférieur et sont homogènes pour  
49 l'ensemble du terrane. Toutes les roches siliceuses les plus jeunes sont comprises dans l'intervalle  
50 Sinémurien supérieur–Toarcien inférieur (~ 195–180 Ma). Les plus jeunes cherts pélagiques sont  
51 du Pliensbachien inférieur, avec des argilites siliceuses légèrement plus jeunes du Pliensbachien  
52 et peut-être du Toarcien inférieur. Ces résultats suggèrent que la sédimentation pélagique  
53 profonde de l'océan Cache Creek a cessé de manière relativement synchrone sur toute sa  
54 longueur, probablement pendant le Pliensbachien (~191–183 Ma), avant la fermeture finale du  
55 bassin lorsque les unités de Cache Creek ont été charriées sur la Stikinia et la Quesnellia au  
56 Jurassique moyen et supérieur. Ce synchronisme apparent devrait conduire à réévaluer les  
57 modalités du modèle tectonique en ciseau sous sa forme actuelle. L'étude montre aussi que la  
58 sédimentation pélagique a cessé 22 à 31 Ma plus tôt dans le terrane de Cache Creek que dans  
59 celui de Bridge River, confirmant la différence stratigraphique entre les deux unités au  
60 Jurassique.

61

62 *Mots-clés* : terrane de Cache Creek, Radiolaria, Jurassique, Cordillère canadienne, radiolarite,  
63 terrane de Bridge River

64

## 65 **Introduction**

66

67 The Canadian Cordillera (Fig. 1) is a complex collage of arc and oceanic terranes which has been  
68 the subject of a vast amount of studies and literature in the past 50 years. Various models  
69 describing the tectonic history of the orogen are still debated (Monger & Gibson 2019 and  
70 references therein) but they all point to the importance of the Cache Creek Terrane, considered as  
71 one major evidence for a large Mesozoic ocean basin in the Canadian Cordillera. One important  
72 issue is the timing of the ocean closure during the Jurassic period which led to collision with  
73 Stikinia and Quesnellia volcanic arcs, contributing to the structuration of the Cordillera (Nelson  
74 and Mihalynuk 1993, Colpron et al. 2015, Monger & Gibson 2019).

75 To determine the age of the Cache Creek Terrane, radiolarian biostratigraphy has been applied  
76 over the last 40 years to its deep ocean strata with a particular focus on the youngest localities  
77 considered to predate the final stages of convergence. The youngest Jurassic unit of the Cache  
78 Creek Terrane was originally found in its type locality in southern British Columbia (Cordey et  
79 al. 1987). At the time, it contradicted the scenario in which amalgamation of the Cache Creek and  
80 Quesnellia terranes occurred in the Late Triassic (Monger 1981, Monger et al. 1982). Further  
81 investigations confirmed the occurrence of Jurassic radiolarian-bearing oceanic strata in all  
82 segments of the Cache Creek Terrane in British Columbia and Yukon (Fig. 2; Cordey et al. 1991,  
83 Cordey & Struik 1996, Cordey 1998, Orchard et al. 2001, Struik et al. 2001, Mihalynuk et al.  
84 2004). Although most of these localities are Early Jurassic, some confusion remained due to the  
85 “Early or Middle Jurassic” age of the youngest Cache Creek rocks in the type locality. This  
86 question also led to conflicting interpretations in comparisons between the Cache Creek Terrane  
87 and other Paleozoic-Mesozoic oceanic units of the Canadian Cordillera such as the Bridge River  
88 and Hozameen terranes (Cordey et al. 1987, Cordey & Schiarizza 1993, Mihalynuk et al. 1994,  
89 Cordey 1998, Monger 2014).

90 To clarify the stratigraphy of the youngest Cache Creek strata, the goal of this study is to review  
91 all the youngest radiolarian localities and, when possible, improve and refine previous ages with  
92 new Jurassic radiolarian biozonations and taxonomy (Baumgartner et al. 1995, Carter et al. 1988,  
93 1998, 2010, Goričan et al. 2006, 2018, O'Dogherty et al. 2009). The results reveal that the  
94 youngest ages are fairly homogenous along the entire Cache Creek belt, which provides some  
95 clues regarding the accuracy of current tectonic models such as the Cache Creek Terrane  
96 entrapment in its present form (Mihalynuk et al. 1994). Finally, the study provides some new  
97 elements for stratigraphic comparison of the Cache Creek Terrane with other main oceanic units  
98 of the Canadian Cordillera during the Jurassic (Cordey and Schiarizza 1993, Monger and Gibson  
99 2019).

100

101

## 102 **Material and Methods**

103

104 The radiolarian assemblages presented in this paper are part of a large dataset of Devonian to  
105 Jurassic radiolarian samples collected and studied in several terranes of the Canadian Cordillera  
106 since the 1980s. Among them, the youngest Jurassic assemblages of the Cache Creek Terrane  
107 were found at eight localities from southern British Columbia to southern Yukon (Fig. 2: J1,  
108 Pavilion; J2, Alkali Lake; J3, Blackwater; J4, Pinchi Lake; J5, French Range; J6-J8, Teslin  
109 Plateau). The geological setting and lithostratigraphy of these localities are described in detail in  
110 former publications (J1: Mortimer 1987, Cordey et al. 1987, Cordey 1998; J2: Read 1993,  
111 Cordey, unpub. data; J3: Cordey and Struik 1996, Orchard et al. 2001; J4: Orchard et al. 2001,  
112 Struik et al. 2001; J5: Mihalynuk et al. 2004; J6-J8: Cordey et al. 1991).

113 The radiolarian faunas from the Cache Creek Terrane are usually poorly or moderately preserved  
114 due to silica recrystallization as a result of diagenesis associated with P/T conditions during

115 tectonic emplacement and local magmatic intrusions. To maximize the quality of the  
116 microfossils, the samples were selected with specific field detection techniques applied to pelagic  
117 strata from orogenic belts, using a strong hand lens and investigating specific microfacies such as  
118 argillaceous layers within chert beds (Cordey & Krauss 1990, Cordey 1998). Radiolarians were  
119 then extracted by repetitive leaching of samples with low-concentration hydrofluoric acid (HF)  
120 and then hand-picked and mounted on aluminum stubs for SEM observation and taxonomical  
121 identifications (Tabletop SEM Phenom ProX, Laboratoire de Géologie de Lyon).

122 Although most radiolarian assemblages presented here are described in previous publications,  
123 new SEM images have been obtained for a selection of samples to improve the quality of  
124 previous illustrations and complement former studies with new taxa.

125 When microfossil assemblages are not well-preserved, radiolarians are usually identified at the  
126 genus level only (J1, J2, J5, J7, J8; Table 1). In this case, the age is established from overlapping  
127 ranges of genera (O'Dogherty et al. 2009). Other assemblages show a better state of preservation  
128 with radiolarians identified at the species level (J3, J4, J6), allowing correlations to more precise  
129 biozones (Carter et al. 1988, Cordey 1998, Whalen and Carter 2002, Goričan et al. 2006, Carter  
130 et al. 2010). A selection of biostratigraphically-significant radiolarians is presented in Figures 5  
131 and 6. Radiolarian assemblages and ages are synthesized in Table 1.

132

133

## 134 **Results**

135

### 136 **New radiolarian assemblage from the type locality**

137 In southern British Columbia, the Cache Creek Terrane is divided into three belts (Figs. 3, 4)  
138 (Duffell and McTaggart 1952, Trettin 1980, Shannon 1981, Monger and McMillan 1984, Monger  
139 1985, Mortimer 1987). The central belt is composed of massive limestone and marble of the

140 Marble Canyon Formation where schwagerinid fusulinids of Late Permian age (*Colania*  
141 assemblage) belong to a Tethyan faunal province and are cited as evidence that carbonate units of  
142 the Cache Creek Terrane are far-travelled (Monger and Ross 1971; Monger et al. 1982; Danner  
143 1985; Orchard et al. 2001). To the west of Marble Canyon, the western belt contains the youngest  
144 strata of the type locality as shown by Early or Middle Jurassic radiolarians found in siliceous  
145 argillites above Hambrook Creek (“R2”, Cordey et al. 1987, Cordey 1998).

146 With the aim of improving this previous radiolarian dating, this locality was resampled (NEO-R2,  
147 Figs. 3, 4). A new radiolarian assemblage J1 (Table 1) is composed of the following taxa:

148 *Archaeodictyomitra* sp., *Homoeoparonaella* sp. cf. *reciproqua* Carter, *Hsuum* sp.,  
149 *Pseudocrucella?* sp., *Thurstonia* sp., *Trillus* sp., *Xiphostylus?* sp., *Triactoma* sp., and *Zartus* sp..

150 The previous collection was dated as Pliensbachian–Bajocian based on the age range of *Zartus*  
151 sp. (Cordey et al. 1987). In the new sample NEO-R2, the co-occurrence of *Thurstonia* sp., *Trillus*  
152 sp. and *Zartus* sp. provides an age restricted to the Early Pliensbachian–Early Toarcian interval  
153 (O’Dogherty et al. 2009). Although the preservation of the assemblage is poor, the specimens of  
154 *Thurstonia* sp. display well-developed nodes at pore frame intersections (Fig. 5, no. 1), showing  
155 affinities with *Thurstonia* specimens from the northern part of the Cache Creek Terrane (J6, Fig.  
156 5, no. 3) as well as *Thurstonia* sp. B documented in Early Jurassic radiolarian assemblages from  
157 the Bridge River and Hozameen terranes (Cordey 1998).

158

### 159 **Refined Jurassic radiolarian ages**

#### 160 *Southern British Columbia*

161 An Early Jurassic radiolarian assemblage was found in gray-green radiolarian chert of the Riske  
162 Creek Formation in the Alkali Lake map area (locality J2, Fig. 2) as a result of mapping and  
163 sampling by Read (1993). Such as J1, it is located within the western belt of the terrane. This  
164 assemblage is composed of *Canutus* sp., *Lantus* sp., *Orbiculiformella* sp., *Parahsuum* sp. and



165 *Praeconocaryomma* sp. (Table 1). Originally dated as Sinemurian or Pliensbachian, its age is  
 166 refined to the Early Pliensbachian–Early Toarcian interval (Table 1) based on co-occurrence of  
 167 the genera *Canutus* sp. and *Lantus* sp.. (O’Dogherly et al. 2009). It is noteworthy that the age  
 168 ranges of J1 and J2 assemblages are identical, although based on different radiolarian taxa.

169

#### 170 *Central British Columbia*

171 Geological mapping of the Cache Creek Terrane in central British Columbia (Struik et al. 2007  
 172 and references therein) resulted in an important number of Paleozoic and Mesozoic radiolarian  
 173 collections (Cordey and Struik 1996, Struik 1998, Orchard et al. 2001). The youngest radiolarian  
 174 chert succession of this region is exposed along the Blackwater River in Punchaw Lake map area  
 175 (J3, Fig. 2), 25 km to the south-southwest of the town of Prince George (Cordey and Struik 1996,  
 176 Orchard et al. 2001, Struik et al. 2001). This succession is broadly continuous and contains  
 177 Middle Triassic, Late Triassic, and Early Jurassic radiolarians. The youngest radiolarian  
 178 assemblage found near the top of the section was initially dated as Pliensbachian (Cordey and  
 179 Struik 1996, Orchard et al. 2001). Complementary chemical processing and new SEM images  
 180 reveal an abundant and well-preserved assemblage (Table 1) composed of *Atalantria* sp.,  
 181 *Beatricea? argescens* Cordey, *Bipedis japonicus* Hori, *Broctus* sp., *Canoptum rugosum* Pessagno  
 182 & Poisson, *Canoptum* sp. cf. *dixonii* Pessagno & Whalen, *Charlottea* sp., *Katroma* sp. cf.  
 183 *elongata* Carter, *Lantus* sp. cf. *praeobesus* Carter, *Laxtorum* sp., *Orbiculiformella? trispina* s.l.  
 184 (Yeh), *Orbiculiformella* sp., *Palaeosaturnalis* sp., *Parahsuum simplum* Yao, *Parahsuum*  
 185 *vizcainoense* Whalen & Carter, *Praeconocaryomma* sp. cf. *sarahae* Carter, *Thurstonia* sp. and  
 186 *Spumellaria* gen. sp. indet. (Figs. 5, 6). This assemblage corresponds to the interval from the  
 187 middle part of the *Canutus tipperi* – *Katroma clara* Zone to the base of the *Gigi fustis* – *Lantus*  
 188 *sixi* Zone of Early Pliensbachian age (Carter et al. 2010).

189

190 In the Fort-St-James area, the Tezzeron succession (originally called the Pinchi succession by  
191 Struik et al. (1996) and Cordey and Struik (1996)) is exposed to the north of Stuart and Pinchi  
192 lakes and bears some similarities with clastic assemblages from the upper part of the Cache Creek  
193 Terrane in southern British Columbia (Shannon 1981, Monger 1985) and in Yukon (Cordey et al.  
194 1991, Gordey and Stevens 1994). It is interpreted as belonging to the Cache Creek Terrane  
195 (Bellefontaine et al. 1995, Struik et al. 1996, Orchard et al. 2001, Struik et al. 2001).

196 Within the Tezzeron succession, a limy siltstone unit located near the south end of Pinchi Lake  
197 contains an Early Jurassic radiolarian assemblage (J4, Fig. 2, Table 1) previously reported by  
198 Orchard et al. (2001) and Struik et al. (2001). It is composed of *Emiluvia?* sp. A (Carter et al.  
199 1988), *Hsuum lucidum* Yeh (formerly interpreted as *H. sp. cf. optimum* Carter), *Paronaella*  
200 *grahamensis* Carter, *Praeconocaryomma decora* gr. Yeh (formerly *P. sp. A*), and  
201 *Praeparvicingula tlellensis* Carter (formerly *Parvicingula sp. E*, Carter et al. 1988). This  
202 assemblage was originally assigned to the biozones 2 to 5 of Carter et al. (1988). It correlates  
203 with the *Elodium pessagnoii* – *Hexasaturnalis hexagonus* Zone of Carter et al. (2010) of Middle-  
204 Late Toarcian age. The corresponding sample, which is a limy siltstone, cannot be considered  
205 part of “deep ocean” Cache Creek strata. It shows, however, that radiolarian pelagic input lasted  
206 until the Toarcian, at least locally.

207

#### 208 *Northern British Columbia*

209 In the French Range to the west of the Dease Lake area, a unit belonging to the Cache Creek  
210 Terrane is composed of cherty argillites with local tuffaceous layers that contain Middle Triassic  
211 and Early Jurassic radiolarians (Mihalynuk et al. 2004). This succession is correlative to the rocks  
212 on the Teslin Plateau, ~200 km to the north (Cordey et al. 1991). One Early Jurassic radiolarian  
213 assemblage (J5, Fig. 2, Table 1) was extracted from a black cherty argillite exposure located 2.5  
214 km to the north of Slate Creek. It is from blueschists, and therefore places a maximum age limit

215 on blueschist mineral formation ((Mihalynuk et al. 2004). The assemblage is composed of  
 216 *Parahsuum izeense* (Pessagno & Whalen) (formerly *Canutus izeensis* Pessagno & Whalen),  
 217 *Orbiculiformella? trispina* s.l. (Yeh) (formerly *Orbiculiforma silicatilis* Cordey),  
 218 *Praeconocaryomma* sp. cf. *sarahae* Carter (formerly *P. aff. media* Pessagno & Poisson),  
 219 *Praeconocaryomma* sp., and *Thurstonia* sp. (Table 1). Initially, the radiolarian assemblage was  
 220 dated as Pliensbachian–Toarcian (Mihalynuk et al. 2004). The age is revised to the  
 221 Pliensbachian–Early Toarcian based on the occurrence of *Parahsuum izeense* Pessagno &  
 222 Whalen and the refined range of *Thurstonia* (Table 1). The presence of *Praeconocaryomma* sp.  
 223 cf. *sarahae* Carter suggests that this assemblage could be restricted to the Pliensbachian (Carter et  
 224 al. 2010), but this cannot be confirmed due to the incomplete nature of the specimen.

225

226 *Yukon*

227 An assemblage composed of radiolarian cherts and fine-grained clastic rocks is exposed on the  
 228 Teslin Plateau, ~20 km to the north of the British Columbia-Yukon border (Gordey 1991). This  
 229 succession has previously been called the Lewes River assemblage (Wheeler et al. 1991, Gordey  
 230 1991) or Teenah Lake assemblage (Jackson 1992), and is equivalent in part to the Kedahda  
 231 Formation of Monger (1975). Several localities with Middle Triassic, Late Triassic, and Early  
 232 Jurassic radiolarian assemblages were discovered along a five-kilometre-long ridge north of  
 233 Mount Bryde and Sterlin Lake (Gordey 1991, Cordey et al. 1991). The ridge consists of  
 234 successive outcrops and isolated sections of stacked radiolarian chert, argillite and graywacke  
 235 previously described and discussed in detail (Cordey et al. 1991).

236 The first Early Jurassic radiolarian assemblage J6 (Fig. 2, Table 1) is from siliceous argillite  
 237 interbedded with graywacke that contain *Bipedis* sp., *Broctus* sp., *Canoptum anulatum* Pessagno  
 238 & Poisson, *Canoptum* sp., *Hagiastrum majusculum* Whalen & Carter (formerly called *H. sp. A*,  
 239 Cordey 1998), *Homoeoparonaella* sp., *Lantus sixi* Yeh, *Napora cerromesaensis* Pessagno,

240 Whalen & Yeh, *Pantanellium cumshewaense* Pessagno & Blome, *Parahsuum izeense* (Pessagno  
241 & Whalen) (formerly described as *Canutus giganteus* Pessagno & Whalen), *Praeconocaryomma?*  
242 sp. cf. *yakounensis* Carter (formerly interpreted as *Praeconocaryomma*. sp. aff. *P.* sp. B Yeh),  
243 *Thurstonia* sp., and *Wrangellium* sp.. This assemblage was originally dated as  
244 Pliensbachian–Early Toarcian (Table 1). It is now correlated with the base of the *Gigi fustis* –  
245 *Lantus sixi* Zone to the middle part of the *Eucyrtidiellum nagaiiae* – *Praeparvicingula tllellensis*  
246 Zone (Unitary associations UA 12-22) (Carter et al. 2010), establishing a late Early Pliensbachian  
247 to Late Pliensbachian age.

248 The second youngest Early Jurassic sample on the Teslin Plateau (J7, Fig. 2, Table 1) is from a  
249 radiolarian chert succession located 4 km to the south of J6 (Cordey et al. 1991). It was  
250 previously dated as Sinemurian–Toarcian (Cordey et al. 1991). It is composed of *Beatricea?*  
251 *argescens* Cordey, *Canoptum* sp. cf. *anulatum* Pessagno & Poisson (previously interpreted as  
252 *Wrangellium* sp. cf. *thurstonense* Pessagno & Whalen), *Canoptum* sp., *Praeconocaryomma* sp.  
253 cf. *immodica* Pessagno & Poisson, and *Wrangellium* sp. (Table 1). The age is here refined to the  
254 Late Sinemurian–Late Pliensbachian interval based on the co-occurrence of *Beatricea* sp. and  
255 *Wrangellium* sp..

256 The third sample (J8, Fig. 2, Table 1) is part of the same radiolarian chert succession and location  
257 as J7. The radiolarian assemblage is composed of *Beatricea? argescens* Cordey, *Bipedis* sp.,  
258 *Canoptum* sp. cf. *dixonii* Pessagno & Whalen, *Gorgansium* sp., *Pantanellium* sp., *Parahsuum* sp.,  
259 *Praeconocaryomma* sp., and *Wrangellium* sp.. It was previously dated as Sinemurian–Toarcian  
260 (Cordey et al. 1991). It is here refined to the Late Sinemurian–Late Pliensbachian interval, based  
261 on the co-occurrence and refined ranges of *Beatricea* sp., *Bipedis* sp. and *Wrangellium* sp. (Table  
262 1).

263

264

## 265 **Discussion**

266

### 267 **Homogeneity of youngest Cache Creek ages**

268 Revised Jurassic radiolarian ages reveal that the youngest Cache Creek ages are fairly  
269 homogenous along the entire Canadian Cordillera (Fig. 7). These ages are comprised within the  
270 Late Sinemurian–Late Toarcian interval (~195–174 Ma, Cohen et al. 2013). The siliceous rocks  
271 (radiolarian chert and siliceous argillite) are restricted to the Late Sinemurian–Early Toarcian  
272 interval (~195–180 Ma), including error margins. The most precise age determinations from  
273 central British Columbia and Yukon (Fig. 7) indicate that the youngest true radiolarian cherts (=

274 devoid of clastic intercalations) are Pliensbachian in age (J3), and the youngest siliceous argillites  
275 may also be Pliensbachian in age, possibly reaching the Early Toarcian (J1, J5, J6). The youngest  
276 Jurassic age obtained on a limy siltstone in the Tezzeron succession (J4) suggests that radiolarian  
277 pelagic input possibly lasted until the Middle or Late Toarcian in central British Columbia,  
278 although chert sedimentation might have ceased. To date, no pelagic sedimentary strata of Middle  
279 Jurassic age have been found in the Cache Creek Terrane.

280

### 281 **Cache Creek Terrane and overlap assemblages**

282 Some of the youngest Cache Creek strata have locally been interpreted as overlap assemblages,  
283 for instance the chert-argillite-graywacke successions exposed on the Teslin Plateau (Lewes  
284 River assemblage, Wheeler et al. 1991, Gordey 1991; Teenah Lake assemblage, Jackson 1992).  
285 More recently, all post-Middle Triassic sequences were proposed to represent overlap  
286 assemblages on top of already assembled terranes including the Paleozoic units of the Cache  
287 Creek Terrane (Zagorevski et al. 2017).

288 The notion of an “overlap assemblage” implies that marine sedimentation ceased prior to the  
289 deposition of clastic sediments on top of exhumed oceanic units. Regarding the Cache Creek

290 Terrane, this view is not consistent with the occurrence of radiolarian chert sedimentation as  
291 young as Pliensbachian or of Middle Jurassic blueschists with in part Early Jurassic sedimentary  
292 protoliths (Mihalynuk et al. 2004), which demonstrate that deep ocean sedimentation persisted  
293 between Stikinia and Quesnellia until the end of the Early Jurassic. In central British Columbia  
294 (Blackwater; Figs. 7, 8), a Triassic–Early Jurassic chert succession also suggests that Cache  
295 Creek marine sedimentation was continuous prior to the closure of the basin. However, pelagic  
296 and clastic regimes are interrelated: in the northern part of the Cache Creek Terrane, the argillites  
297 and graywackes are locally intercalated with Late Triassic radiolarian cherts (Cordey et al. 1991).  
298 More recently, a Hettangian age ( $199.5 \pm 2.0$  Ma) was obtained on detrital zircons from a Cache  
299 Creek graywacke east of Carcross (Colpron et al. 2015) and interpreted as a probable distal  
300 equivalent of the Richtofen Formation (Laberge Group), showing a probable link between the  
301 Cache Creek Terrane and the Whitehorse trough as early as the end of the Triassic or the  
302 beginning of the Jurassic. The input of clastic sediments within Cache Creek pelagic strata may  
303 be a result of the geometry of the terrane at this time, flanking the Yukon-Tanana Terrane to the  
304 north during the counterclockwise rotation of Stikinia (“isolation stage” of Mihalynuk et al. 1994;  
305 Colpron et al. 2015). These transitional regimes evolved towards a narrowing Cache Creek basin  
306 incorporating thicker and coarser siliciclastic sediments associated with tectonic convergence in  
307 the form of synorogenic piggyback basins (Colpron et al. 2015, Bickerton et al. 2020).  
308 Numerous examples of pelagic to clastic successions are found in other segments of the circum-  
309 Pacific ranges such as in Japan and Siberia where the Permian-Jurassic oceanic terranes display  
310 Jurassic intercalations of radiolarian chert, siliceous argillite and sandstone interpreted as ocean  
311 environments within the depositional influence of one continental margin or flanking sources  
312 (Isozaki et al. 1990, Matsuoka et al. 1996). In general, the intercalations and lateral facies  
313 changes between pelagic and clastic rocks make it difficult to delineate a clear boundary where  
314 oceanic terrane sedimentation ends and where clastic assemblages begin. This is true for the

315 Cache Creek Terrane in the Yukon, but also in southern British Columbia (Mortimer 1987,  
316 Cordey et al. 1987). The composite nature of Cordilleran oceanic terranes, i.e. the likelihood for  
317 these terranes to be the end-result of juxtaposed basinal entities, has previously been suggested  
318 for the Bridge River Terrane (Cordey and Schiarizza 1993, Cordey 1998) and the Cache Creek  
319 Terrane (Golding 2018) but these hypotheses do not challenge the interpretation that these  
320 terranes were dominantly oceanic until the final stages of convergence.

321

### 322 **Cache Creek closure: fast entrapment?**

323 Several models have been proposed for the tectonic mechanism of Cache Creek Ocean closure  
324 (see Golding 2018 for a recent review). The consensus model of Cache Creek “entrapment” from  
325 Nelson and Mihalynuk (1993) and Mihalynuk et al. (1994) proposes that the terrane became  
326 enclosed between the Stikinia and Quesnellia terranes leading to Cache Creek oceanic crust being  
327 subducted during an oroclinal bending event, with a progressive “scissor-like” closure from north  
328 to south, and the Yukon-Tanana Terrane acting as the hinge. In this scenario, the Whitehorse  
329 trough is considered a northern precursor to the Bowser Basin (Ricketts et al. 1992, Evenchick et  
330 al. 2010) accompanying the final stages of convergence and closure (Colpron et al. 2015).

331 The entrapment model implies a diachronous closure of the Cache Creek Ocean, with the  
332 youngest oceanic sedimentary rocks progressively younging to the south (basin isolation  
333 followed by closure, Mihalynuk et al. 1994). The updated radiolarian ages suggest instead a  
334 relative synchronicity in the cessation of pelagic sedimentation along the entire Cache Creek  
335 Terrane. While Yukon hemipelagic rocks (J6) are Pliensbachian in age, a similar age  
336 (Pliensbachian–Early Toarcian) is obtained on siliceous argillites 1200 km to the south in the  
337 type locality (J1). Additionally, radiolarian cherts from central British Columbia (J3) and Yukon  
338 (J8) could have a common Pliensbachian age, even though they are ~1000 km apart.

339 One could argue that the speed and geometry of the counterclockwise oroclinal bending of

340 Stikinia towards Quesnellia are not precisely known. One way to reconcile the entrapment model  
341 with the relative synchronicity of the youngest Cache Creek oceanic strata is through very rapid  
342 tectonic rotation. In northern British Columbia, Mihalynuk et al. (1994, 2004) assessed that the  
343 final closure of the Cache Creek Terrane in the north occurred before 171 Ma (late Aalenian or  
344 early Bajocian, Cohen et al. 2013), the age of the post-kinematic Fourth of July batholith that  
345 intrudes deformed Cache Creek units in the Atlin Lake area (Mihalynuk et al. 1992). The  
346 minimum age of Cache Creek extrusion in the French Range was constrained to ~174.5–172 Ma  
347 (latest Toarcian or Aalenian, Cohen et al. 2013), using the interval between the youngest  
348 blueschists and the oldest intrusions (Mihalynuk et al. 2004). In the south, the Cache Creek  
349 Terrane was thrust eastward over Quesnellia in the Late Jurassic ( $\leq 160$  Ma) (Travers 1978).  
350 The most precise ages of the youngest Cache Creek Terrane strata are Pliensbachian and found in  
351 central British Columbia (J3) and Yukon (J6). The Early Pliensbachian chert J3 (Figs. 7, 8) found  
352 at the top of a Triassic-Early Jurassic succession along the Blackwater River in central British  
353 Columbia is a good time proxy for the age of the youngest and still truly oceanic Cache Creek  
354 sedimentation at the center of the Cache Creek belt, suggesting that the youngest sustained  
355 hemipelagic sedimentation in southern British Columbia could be slightly younger, possibly Late  
356 Pliensbachian or Early Toarcian, predating the final closure of the Cache Creek Ocean. In this  
357 case, the final phase of the counterclockwise rotation of Stikinia must have occurred within 8  
358 m.y. (the interval between late Early Pliensbachian and Early Toarcian, ~188–180 Ma, Cohen et  
359 al. 2013).

360

### 361 **Comparison between youngest Cache Creek and Bridge River ages**

362 Since the 1980s, geological and paleontological studies have established that the oceanic strata of  
363 the Cache Creek and the Bridge River terranes (Fig. 1) share fairly similar Carboniferous-Jurassic  
364 stratigraphic ages (Cordey et al. 1987, Mihalynuk et al. 1994, Monger 2014). The Hozameen



365 Terrane exposed in southern British Columbia and northern Washington (Fig. 1) is considered as  
366 a southern continuation of the Bridge River Terrane (Monger 1985).

367 Early Jurassic radiolarian assemblages found in the Cache Creek Terrane are also present in the  
368 Bridge River and Hozameen terranes which contain Pliensbachian and Toarcian radiolarian  
369 cherts (Cordey and Schiarizza 1993, Cordey 1998). However, the cherts of the Bridge River  
370 Terrane document a pelagic sedimentation that lasted significantly longer: the youngest  
371 radiolarian assemblages are from the Noaxe Creek area (Cordey and Schiarizza 1993, Cordey  
372 1998) where six localities are Middle Jurassic (Aalenian–Bajocian, Early–Middle Bathonian,  
373 Late Bathonian–Middle Callovian, Late Bathonian–Late Callovian), and one locality is Middle  
374 or Late Jurassic (Late Callovian–?Middle Oxfordian) based on biozonations for the Middle-Late  
375 Jurassic (Baumgartner et al. 1995, Matsuoka 1995, Goričan et al. 2018). This Bridge River  
376 radiolarian chert succession probably grades into Late Jurassic and earliest Cretaceous clastic  
377 rocks of the Tyaughton-Methow basin (Mahoney and Journeay 1993, Cordey 1996, Monger  
378 2014, Monger and Gibson 2019).

379 It is hypothesized here that the youngest radiolarian chert of the Cache Creek Terrane is Early  
380 Pliensbachian in age (~191–187 Ma, Cohen et al. 2013) based on the well-constrained  
381 assemblage at the Blackwater section in central British Columbia (J3, Figs. 7-8). In the Bridge  
382 River Terrane, the youngest age for a radiolarian chert is within the “Late Callovian – Middle  
383 Oxfordian” interval (~165–160 Ma, Cohen et al. 2013). These ages imply that the Cache Creek  
384 Terrane oceanic sedimentation had ceased since 22 to 31 m.y. (minimum and maximum possible  
385 durations due to the error margins of biostratigraphic data, corresponding to “Late  
386 Pliensbachian–Late Callovian” and “Early Pliensbachian–Middle Oxfordian” intervals,  
387 respectively) while the Bridge River Ocean was still recording pelagic sedimentation in the  
388 Middle Jurassic and possibly the early Late Jurassic.

389

**390 Cache Creek and Bridge River terranes: one or two sutures?**

391 The question whether the Cache Creek and Bridge River terranes mark two distinct sutures or are  
392 the remnants of a single oceanic domain has long been debated (Monger et al. 1972, Coney et al.  
393 1980, Monger et al. 1982, Monger 1985, Cordey 1986, Cordey et al. 1987, Monger et al. 1994,  
394 Nokleberg et al. 2000, Dickinson 2004, Johnston and Borel 2006, Gehrels et al. 2009). This issue  
395 has been revived by Sigloch and Mihalynuk (2013, 2017) who combined high-resolution  
396 tomography, plate reconstructions and the concept of vertical slab walls. Their analysis of the  
397 North American Cordillera implies that a cryptic suture zone existed between the Insular and  
398 Intermontane superterrane. In this model, the Bridge River Terrane corresponds to the land  
399 remnant of an intraoceanic domain identified in the subducted Mezcalera slab wall (named from  
400 the Mezcalera oceanic plate hypothesized in Mexico by Dickinson and Lawton 2001).

401 However, some authors question the accuracy of this “two-sutures” model which also implies a  
402 west-dipping subduction zone inboard of Wrangellia (see the recent discussion by Pavlis et al.  
403 2019). Monger (2014) and Monger and Brown (2016) have proposed instead that the Bridge  
404 River and Hozameen terranes are the southern continuation of the Cache Creek Terrane, prior to  
405 dextral displacements of ~115 km on the latest Cretaceous–Paleocene Yalakom Fault (Umhoefer  
406 and Schiarizza 1996) and ~140 km of Eocene movement on the Fraser-Straight Fault (Monger  
407 and Brown 2016). The age discrepancy between the two terranes is interpreted by implying that  
408 the Bridge River Terrane faced open ocean to the west until it was trapped in the Early  
409 Cretaceous ( $\leq 130$  Ma) behind the arc rocks in the southwestern Coast Mountains, whereas in  
410 northern British Columbia, the Cache Creek Terrane was thrust southwestward over Stikinia in  
411 the earliest Middle Jurassic (~174 Ma) (Mihalynuk et al. 2004), and in southern British Columbia  
412 was thrust eastward over Quesnellia probably in the Late Jurassic ( $\leq 160$  Ma) (Travers 1978).

413 The likelihood of differentiating the two terranes based on provincial radiolarian signatures has  
414 been discussed by Cordey (1998) and Orchard et al. (2001) and present some limitations. Some

415 elements of correlation with Tethyan assemblages may be found in older Paleozoic and Triassic  
416 assemblages of the Cache Creek Terrane (Cordey 1998, Orchard et al. 2001), but also in the  
417 Bridge River Terrane (Cordey and Schiarizza 1993, Cordey 1996, Cordey 1998). During the  
418 Jurassic, one can only demonstrate that the Bridge River Terrane has a longer record of chert  
419 sedimentation than the Cache Creek Terrane.

420

421

## 422 **Conclusions**

423

424 So far as known, all the youngest radiolarian assemblages of the Cache Creek Terrane are Early  
425 Jurassic in age, including in the type locality in southern British Columbia. All refined ages of the  
426 youngest radiolarian cherts and siliceous argillites are within the Late Sinemurian–Early Toarcian  
427 interval (~195–180 Ma) with a possible Pliensbachian common age (~191–183 Ma). Well-dated  
428 Early Pliensbachian radiolarian cherts are exposed in the central part of the terrane and may  
429 correspond to the youngest pelagic strata. These results suggest that Cache Creek deep pelagic  
430 “true chert” sedimentation ceased fairly synchronously along the entire belt, probably during the  
431 Pliensbachian, followed by hemipelagic sedimentation in the Pliensbachian and/or the Toarcian,  
432 predating the final closure of the basin that occurred by tectonic thrusting of Cache Creek units  
433 over Stikinia and Quesnellia in the Middle and Late Jurassic.

434 These results should lead to re-evaluating the tectonic mechanism of the Cache Creek entrapment  
435 model in its present form, either in speed or geometry. In addition, the study shows that pelagic  
436 sedimentation ceased ~22 to 31 m.y. earlier in the Cache Creek Terrane than in the Bridge River  
437 Terrane, confirming the stratigraphic discrepancy between the two terranes during the Jurassic.

438 These refined chronological data now need to be more precisely taken into account by the current  
439 tectonic models which integrate the two terranes and the suture(s) they represent at the core of the

440 discussion.

441

442

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454

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755 Stikinia bedrock report of activities, British Columbia and Yukon: GEM 2 Cordillera. Geological

756 Survey of Canada, Open File 8329, pp. 1–15. doi.org/10.4095/306144



757 Table 1. Jurassic radiolarian taxa and ages from the Cache Creek Terrane

Locality, Region	Subterranean or unit, map area & UTM coordinates	Lithology, Sample, GSC locality number when available	Radiolarian assemblage	Original age, Reference(s)	New or revised age	Generic assemblage or correlation to biozones (when applicable)
J1 southern British Columbia	western belt Pavilion NTS 092113 UTM zone 10 581045E 5646753N	siliceous argillite NEO-R2 GSC C-300438 (previously R2, Cordey et al. 1987, Cordey 1998)	<i>Archaeodictyomitra</i> sp., <i>Homoeoparonaella</i> sp. cf. <i>reciproqua</i> , <i>Hsuum</i> sp., <i>Pseudocrucella</i> ? sp., <i>Thurstonia</i> sp., <i>Trillus</i> sp., <i>Xiphostylus</i> ? sp., <i>Zartus</i> sp.	Early Jurassic (Pliensbachian- Bajocian) (Cordey et al. 1987, Cordey 1998)	Early Jurassic (Early Pliensbachian - Early Toarcian)	Co-occurrence of <i>Thurstonia</i> , <i>Trillus</i> and <i>Zartus</i> (O'Dogherty et al. 2009)
J2 southern British Columbia	western belt Alkali Lake NTS 092016 UTM zone 10 548240E 5749410N	gray-green radiolarian chert 92-PBR-C92-78F GSC C-210033	<i>Canutus</i> sp., <i>Lantus</i> sp., <i>Orbiculiformella</i> sp., <i>Parahsuum</i> sp., <i>Praeconocaryomma</i> sp.	Early Jurassic (Sinemurian- Pliensbachian) (Cordey, unp. data; Read 1993)	Early Jurassic (Early Pliensbachian - Early Toarcian)	Co-occurrence of <i>Canutus</i> and <i>Lantus</i> (O'Dogherty et al. 2009)
J3 central British Columbia	Blackwater River Punchaw Lake NTS 093G6 UTM zone 10 490750E 5904150N	gray radiolarian chert 95FC-21-4 GSC C-303032	<i>Atalantria</i> sp., <i>Beatricea</i> ? <i>argescens</i> , <i>Bipedis japonicus</i> , <i>Broctus</i> sp., <i>Broctus</i> ? sp., <i>Canoptum rugosum</i> , <i>Canoptum</i> sp. cf. <i>dixonii</i> , <i>Charlottea</i> sp., <i>Katroma</i> sp. cf. <i>elongata</i> , <i>Lantus</i> sp. cf. <i>praeobesus</i> , <i>Laxtorum</i> sp., <i>Orbiculiformella</i> ? <i>trispina</i> s.l. (Yeh), <i>Orbiculiformella</i> sp., <i>Palaeosaturmalis</i> sp., <i>Parahsuum</i> <i>simplum</i> , <i>Parahsuum vizcainoense</i> , <i>Praeconocaryomma</i> sp. cf. <i>sarahae</i> , <i>Thurstonia</i> sp., <i>Spumellaria</i> gen. sp. indet.	Early Jurassic (Pliensbachian) (Cordey and Struik 1996, Orchard et al. 2001)	Early Jurassic (Early Pliensbachian)	Interval from the middle part of the <i>Canutus tipperi</i> – <i>Katroma clara</i> Zone to the base of the <i>Gigi fustis</i> – <i>Lantus sixi</i> Zone (Unitary associations UA 04-12) (Carter et al. 2010).
J4 central British Columbia	Tezzeron succession Pinchi Lake NTS 093K9 UTM zone 10, 418200E 6049406N	limy siltstone 97-SCB-3602 GSC C-209935	<i>Emiluvia</i> ? sp. A, <i>Hsuum lucidum</i> , <i>Paronaella grahamensis</i> , <i>Praeconocaryomma decora</i> gr., <i>Praeparvicungula tiellensis</i>	Early Jurassic (Toarcian) (Struik et al. 2001, Orchard et al. 2001)	Early Jurassic (Middle - Late Toarcian)	Interval represented by the <i>Elodium pessagnoii</i> – <i>Hexasaturmalis</i> <i>hexagonus</i> Zone (Carter et al. 2010)
J5 northern British Columbia	French Range Little Dease Lake NTS 104J09 UTM zone 10, 419000E 6508000N	siliceous argillite MMI99-34-12	<i>Parahsuum izeense</i> , <i>Orbiculiformella</i> ? <i>trispina</i> s.l., <i>Praeconocaryomma</i> sp. cf. <i>sarahae</i> , <i>Praeconocaryomma</i> sp., <i>Thurstonia</i> sp.	Early Jurassic (Pliensbachian- Toarcian) (Mihalynuk et al. 2004)	Early Jurassic (Pliensbachian - Early Toarcian)	Co-occurrence of <i>Parahsuum izeense</i> and <i>Thurstonia</i> (Carter et al. 2010, O'Dogherty et al. 2009).
J6 Yukon	Teslin Plateau Mount Bryde NTS 105C03 UTM zone 10, 599028E 6676847N	siliceous argillite interbedded with sandstone 90FC-56-6 GSC C-177569	<i>Bipedis</i> sp., <i>Broctus</i> sp., <i>Canoptum</i> <i>anulatum</i> , <i>Canoptum</i> sp., <i>Hagiastrum majusculum</i> , <i>Homoeoparonaella</i> sp., <i>Lantus sixi</i> , <i>Napora cerromesaensis</i> , <i>Pantanellium cumshewaense</i> , <i>Parahsuum izeense</i> , <i>Praeconocaryomma</i> ? sp. cf. <i>yakounensis</i> , <i>Thurstonia</i> sp., <i>Wrangellium</i> sp.	Early Jurassic (Pliensbachian- Early Toarcian) (Cordey et al. 1991)	Early Jurassic (late Early Pliensbachian - Late Pliensbachian)	Interval from the base of the <i>Gigi fustis</i> – <i>Lantus</i> <i>sixi</i> Zone to the middle part of the <i>Eucyrtidiellum</i> <i>nagaiae</i> – <i>Praeparvicungula tiellensis</i> Zone (Unitary associations UA 12-22; Carter et al. 2010)
J7 Yukon	Teslin Plateau Mount Bryde NTS 105C03 UTM zone 10, 600094E 6673025N	black radiolarian chert 90FC-63-2 GSC C-177580	<i>Beatricea</i> ? <i>argescens</i> , <i>Canoptum</i> sp. cf. <i>anulatum</i> , <i>Canoptum</i> sp., <i>Praeconocaryomma</i> sp. cf. <i>immodica</i> , <i>Wrangellium</i> sp.	Early Jurassic (Sinemurian- Toarcian) (Cordey et al. 1991)	Early Jurassic (Late Sinemurian - Late Pliensbachian)	Co-occurrence of <i>Beatricea</i> and <i>Wrangellium</i> (O'Dogherty et al. 2009)
J8 Yukon	Teslin Plateau Mount Bryde NTS 105C03 UTM zone 10, 600094E 6673025N	dark gray radiolarian chert 90FC-63-9 GSC C-177587	<i>Beatricea</i> ? <i>argescens</i> , <i>Bipedis</i> sp., <i>Canoptum</i> sp. cf. <i>dixonii</i> , <i>Gorgansium</i> sp., <i>Pantanellium</i> sp., <i>Parahsuum</i> sp., <i>Praeconocaryomma</i> sp., <i>Wrangellium</i> sp.	Early Jurassic (Sinemurian- Toarcian) (Cordey et al. 1991)	Early Jurassic (Late Sinemurian - Late Pliensbachian)	Co-occurrence of <i>Beatricea</i> , <i>Bipedis</i> , and <i>Wrangellium</i> (O'Dogherty et al. 2009)

759 **Figure captions**

760 Figure 1 (colour online and printed). Paleozoic to early Mesozoic terranes of the Canadian  
 761 Cordillera and location of the Cache Creek Terrane. Modified from Piercey and Colpron (2009).

762  
 763 Figure 2. Geographic location of Jurassic radiolarian assemblages from the Cache Creek Terrane  
 764 (J1 to J8, Table 1). Black frame: Fig. 3a (type locality of the terrane).

765  
 766 Figure 3. a: Distribution of Paleozoic and Mesozoic rock units in the type locality of the Cache  
 767 Creek Terrane and position of the study area for locality J1 (Fig. 2). Geology from Monger  
 768 (1985). b: Geological map of the Pavilion area and location of the Early Jurassic radiolarian  
 769 sample NEO-R2. Geology from Monger and McMillan (1984), Mortimer (1987), and Cordey et  
 770 al. (1987).

771  
 772 Figure 4. Synthetic lithostratigraphic successions of the Cache Creek Terrane in its type locality  
 773 (southern British Columbia). The locality numbers (C-) refer to the Geological Survey of Canada  
 774 database and the radiolarian localities from Cordey (1998). Black lines (eastern belt): age of  
 775 blocks (Cache Creek mélange). Conodont data from Orchard (1981, 1984), Beyers and Orchard  
 776 (1989, 1991); fusulinid data from Monger and Ross (1971). Geological time scale from Cohen et  
 777 al. (2013). G: Guadalupian; L: Lopingian. LO: Lower.

778  
 779 Figure 5. Early Jurassic radiolarians from the Cache Creek Terrane. For each picture: taxon,  
 780 sample, locality (Table 1), length of scale bar. 1. *Thurstonia* sp., NEO-R2, J1, 150 µm. White  
 781 arrows point to fifth and sixth spines. 2. *Thurstonia?* sp., NEO-R2, J1, 170 µm. 3-7: *Thurstonia*  
 782 sp.; 3-5: 90FC-56-6, J6, 160 µm; 6: MMI99-34-12, J5, 110 µm; 7: 90FC-56-6, J6, 180 µm. White

783 arrows point to sixth spine. 8-9. *Spumellaria* gen. sp. indet., 95FC-21-4, J3, 165 and 140  $\mu\text{m}$ . 10.  
 784 *Pantanellium cumshewaense* Pessagno & Blome, 90FC-56-6, J6, 110  $\mu\text{m}$ . 11-12. *Trillus* spp.,  
 785 NEO-R2, J1, 120  $\mu\text{m}$ . 13. *Zartus* sp., NEO-R2, J1, 115  $\mu\text{m}$ . 14. *Charlottea* sp., 95FC-21-4, J3,  
 786 115  $\mu\text{m}$ . 15. *Palaeosaturnalis* sp., 95FC-21-4, J3, 160  $\mu\text{m}$ . 16. *Hagiastrum majusculum* Whalen  
 787 & Carter, 90FC-56-6, J6, 170  $\mu\text{m}$ . 17. *Homoeoparonaella* sp. cf. *reciproqua* Carter, NEO-R2, J1,  
 788 220  $\mu\text{m}$ . 18. *Homoeoparonaella* sp., 90FC-56-6, J6, 140  $\mu\text{m}$ . 19. *Orbiculiformella* sp., 95FC-21-  
 789 4, J3, 170  $\mu\text{m}$ . 20. *Orbiculiformella? trispina* s.l. (Yeh), 95FC-21-4, J3, 150  $\mu\text{m}$ . 21. *Beatricea?*  
 790 *argescens* Cordey, 90FC-63-2, J7, 160  $\mu\text{m}$ . 22. *Praeconocaryomma?* sp. cf. *yakounensis* Carter,  
 791 90FC-56-6, J6, 150  $\mu\text{m}$ . 23-24. *Praeconocaryomma* sp. cf. *sarahae* Carter; 23: 95FC-21-4, J3,  
 792 130  $\mu\text{m}$ ; 24: MMI99-34-12, J5, 160  $\mu\text{m}$ .

793

794 Figure 6. Early Jurassic radiolarians from the Cache Creek Terrane. For each picture: taxon,  
 795 sample, locality (Table 1), length of scale bar. 1. *Lantus sixi* Yeh, 90FC-56-6, J6, 110  $\mu\text{m}$ . 2.  
 796 *Lantus* sp. cf. *praeobesus* Carter, 95FC-21-4, J3, 110  $\mu\text{m}$ . 3. *Broctus* sp., 95FC-21-4, J3, 100  $\mu\text{m}$ .  
 797 4. *Broctus* sp., 90FC-56-6, J6, 130  $\mu\text{m}$ . 5. *Xiphostylus?* sp., NEO-R2, J1, 140  $\mu\text{m}$ . 6. *Katroma* sp.  
 798 cf. *elongata* Carter, 95FC-21-4, J3, 150  $\mu\text{m}$ . 7. *Parahsuum vizcainoense* Whalen & Carter, 95FC-  
 799 21-4, J3, 90  $\mu\text{m}$ . 8. *Parahsuum izeense* (Pessagno & Whalen), 90FC-56-6, J6, 140  $\mu\text{m}$ . 9.  
 800 *Canoptum* sp., 95FC-21-4, J3, 100  $\mu\text{m}$ . 10. *Canoptum rugosum* Pessagno & Poisson, 95FC-21-4,  
 801 J3, 90  $\mu\text{m}$ . 11-12. *Canoptum* spp., 90FC-56-6, J6, 120  $\mu\text{m}$ . 13. *Broctus?* sp., 95FC-21-4, J3, 110  
 802  $\mu\text{m}$ . 14. *Canoptum* sp. cf. *anulatum* Pessagno & Poisson, 90FC-63-2, J7, 120  $\mu\text{m}$ . 15. *Canoptum*  
 803 sp. cf. *dixonii* Pessagno & Whalen, 95FC-21-4, J3, 120  $\mu\text{m}$ . 16. *Atalantria* sp., 95FC-21-4, J3, 120  
 804  $\mu\text{m}$ . 17. *Laxtorum* sp., 95FC-21-4, J3, 130  $\mu\text{m}$ . 18. *Wrangellium* sp., 90FC-56-6, J6, 120  $\mu\text{m}$ . 19.  
 805 *Hsuum* sp., NEO-R2, J1, 110  $\mu\text{m}$ . 20. *Archaeodictyomitra* sp., NEO-R2, J1, 130  $\mu\text{m}$ . 21. *Bipedis*  
 806 sp., 90FC-56-6, J6, 110  $\mu\text{m}$ . 22. *Bipedis japonicus* Hori, 95FC-21-4, J3, 130  $\mu\text{m}$ . 23. *Napora*  
 807 *cerromesaensis* Pessagno, Whalen & Yeh, 90FC-56-6, J6, 105  $\mu\text{m}$ .

808

809 Figure 7. Synthesis of the youngest Jurassic radiolarian ages of the Cache Creek Terrane.  
810 Previous age determinations: J1: Cordey et al. (1987), Cordey (1998); J2: Read (1993), Cordey  
811 (unpub. data); J3: Cordey and Struik (1996), Orchard et al. (2001); J4: Struik et al. (2001),  
812 Orchard et al. (2001) ; J5 : Mihalynuk et al. (2004) ; J6-J8 : Cordey et al. (1991).

813

814 Figure 8. Radiolarian age ranges and correlations of youngest Cache Creek strata in British  
815 Columbia and Yukon. The hatched band materializes the youngest common age range of  
816 siliceous rocks (radiolarian cherts and siliceous argillites); limy siltstones at J4 are not included in  
817 the correlation. The gray band shows the hypothetical age range of the youngest siliceous  
818 argillites overlying the youngest well-dated radiolarian cherts (J3, Early Pliensbachian). The  
819 oblique line represents the maximum age difference of the youngest well-dated hemipelagic  
820 rocks (siliceous argillites) between southern British Columbia (J1) and Yukon (J6); this interval  
821 (late Early Pliensbachian to Early Toarcian) is ~8 m.y. (~188–180 Ma, Cohen et al. 2013).

822

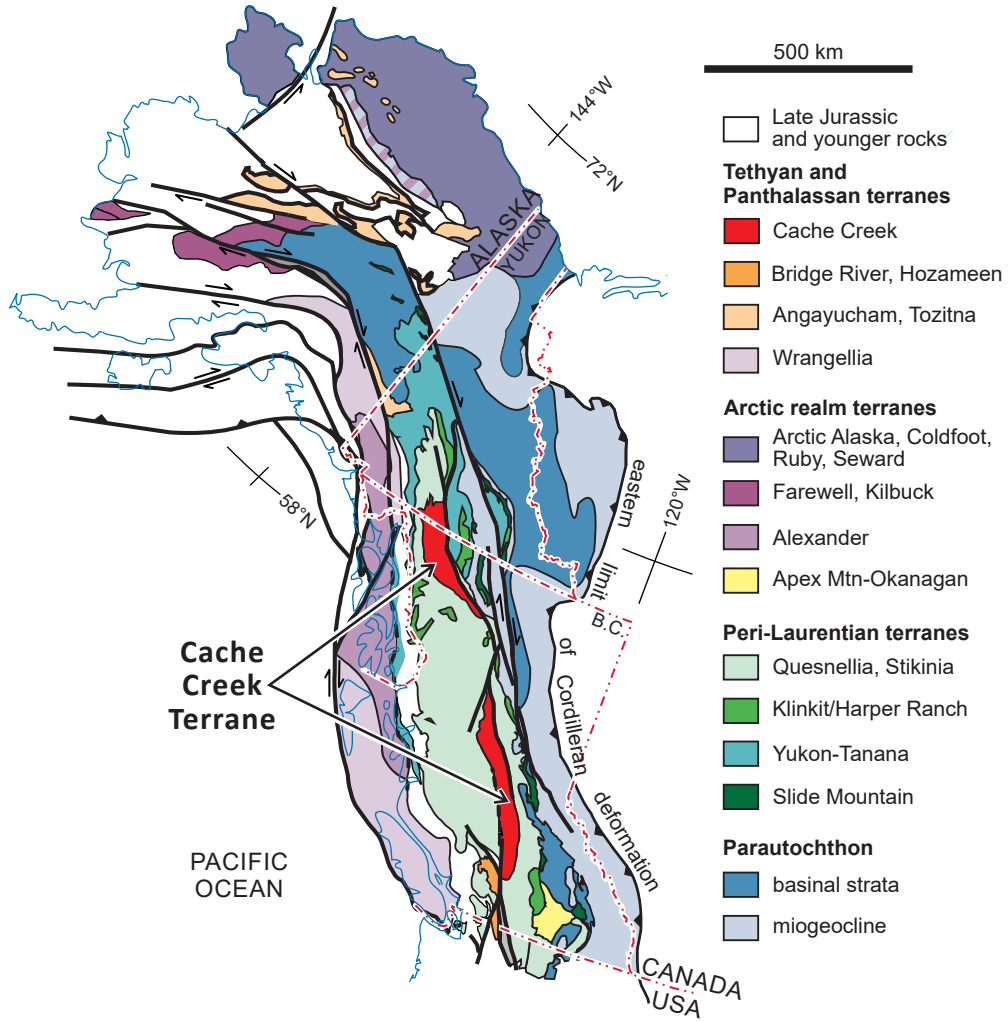


Figure 1

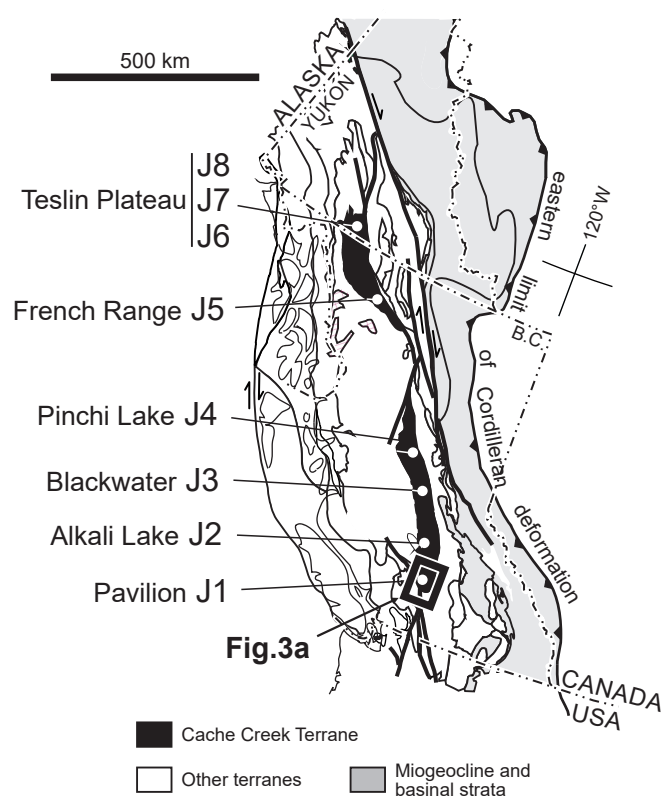


Figure 2

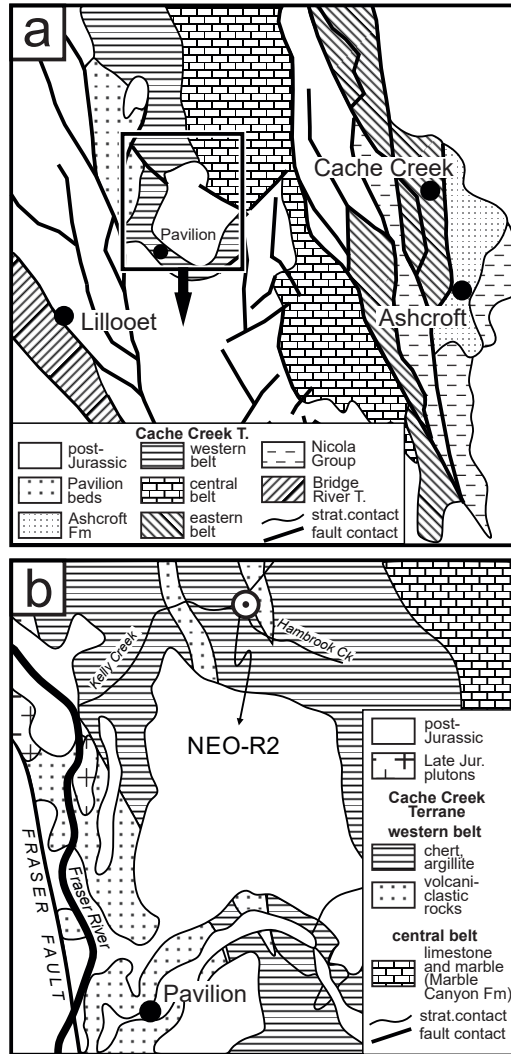


Figure 3

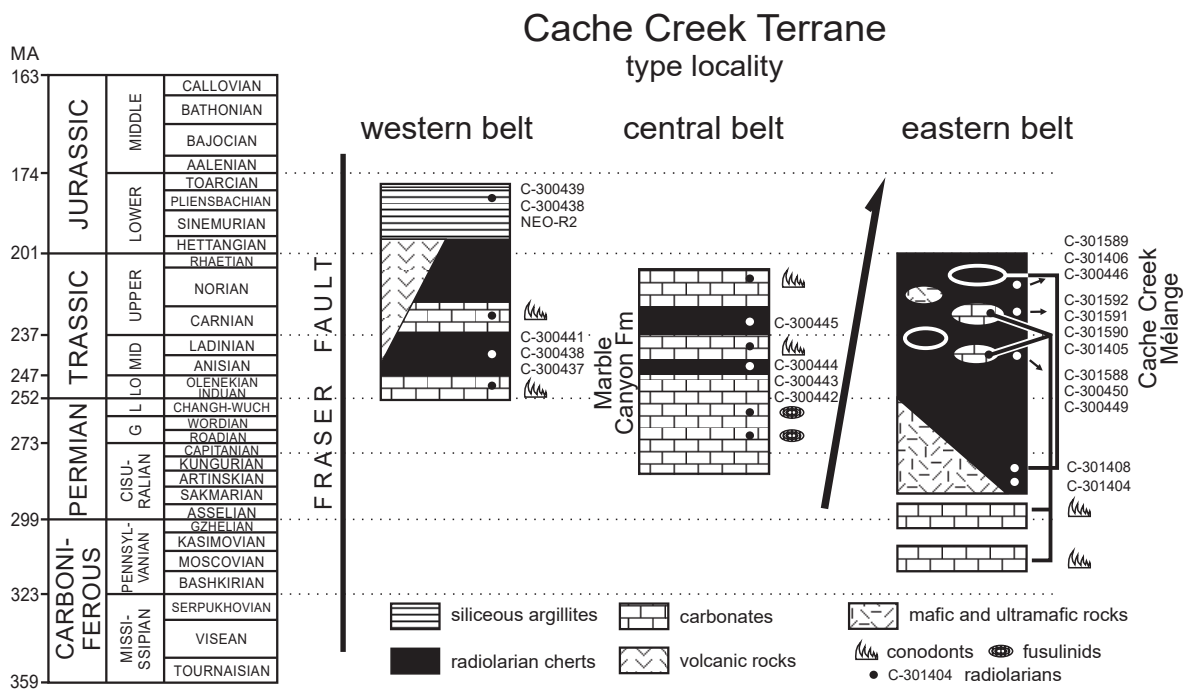


Figure 4



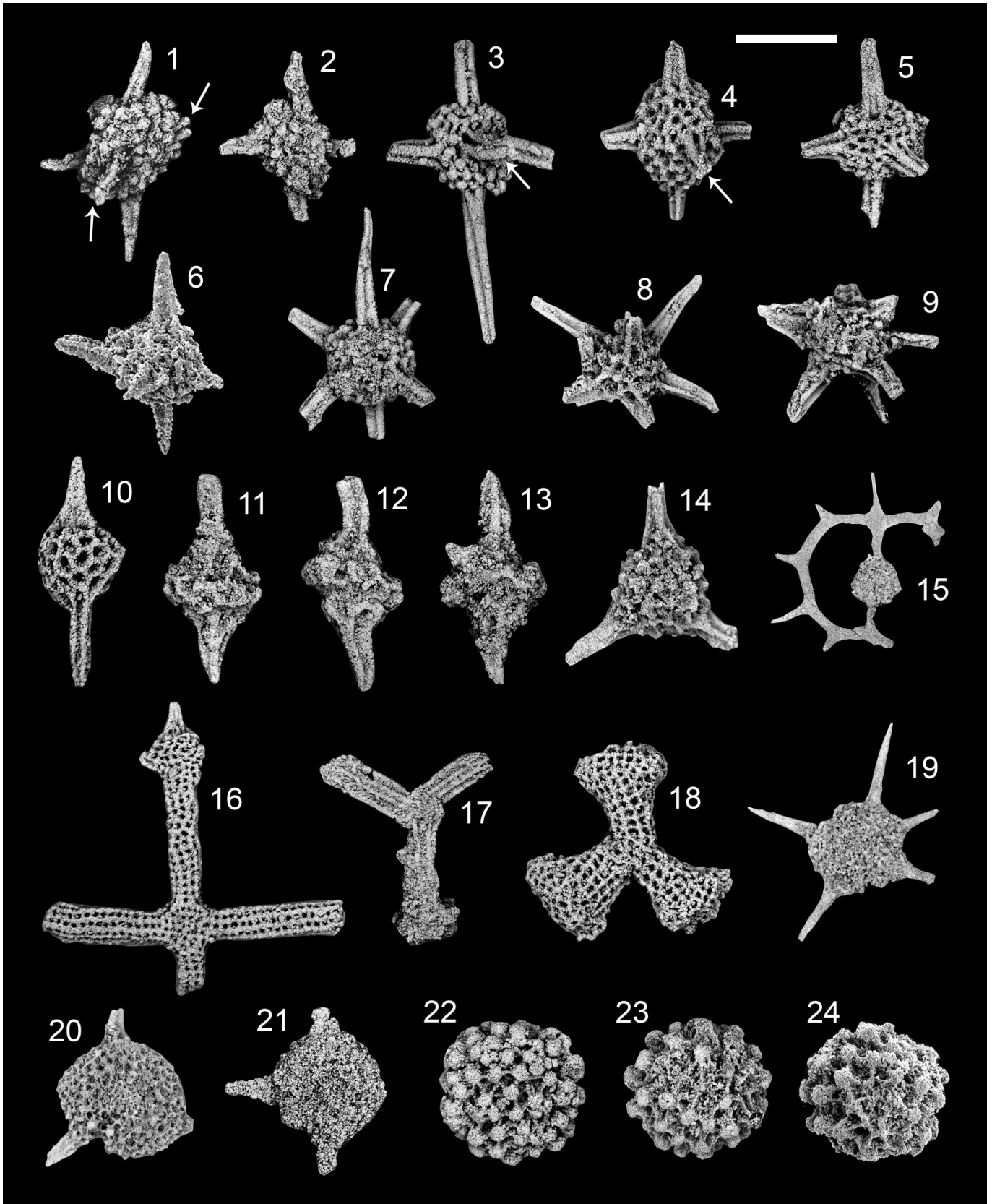


Figure 5

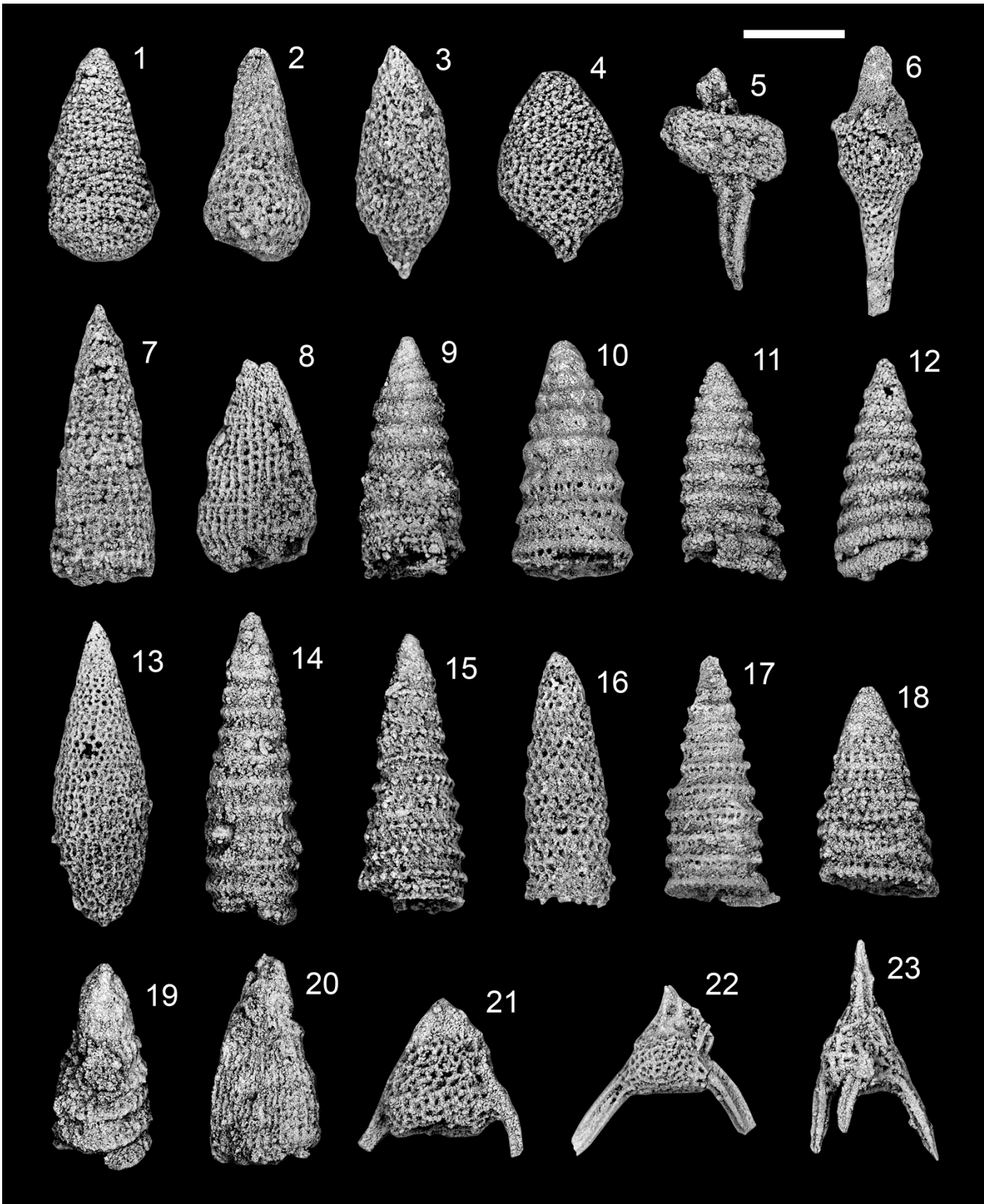


Figure 6

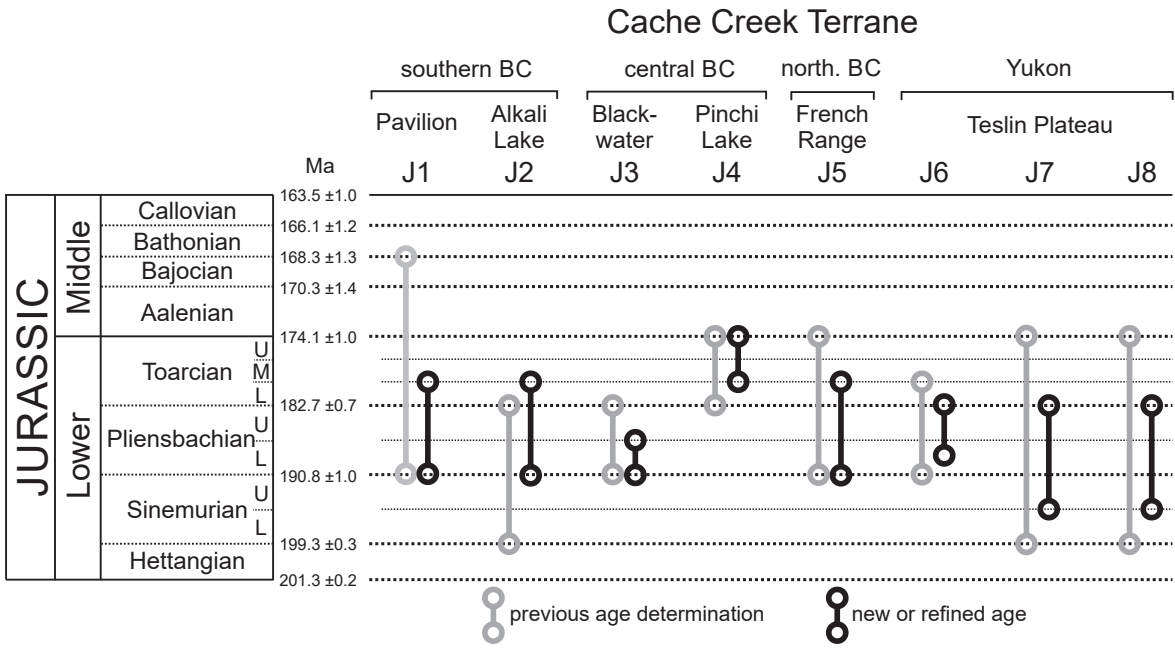


Figure 7

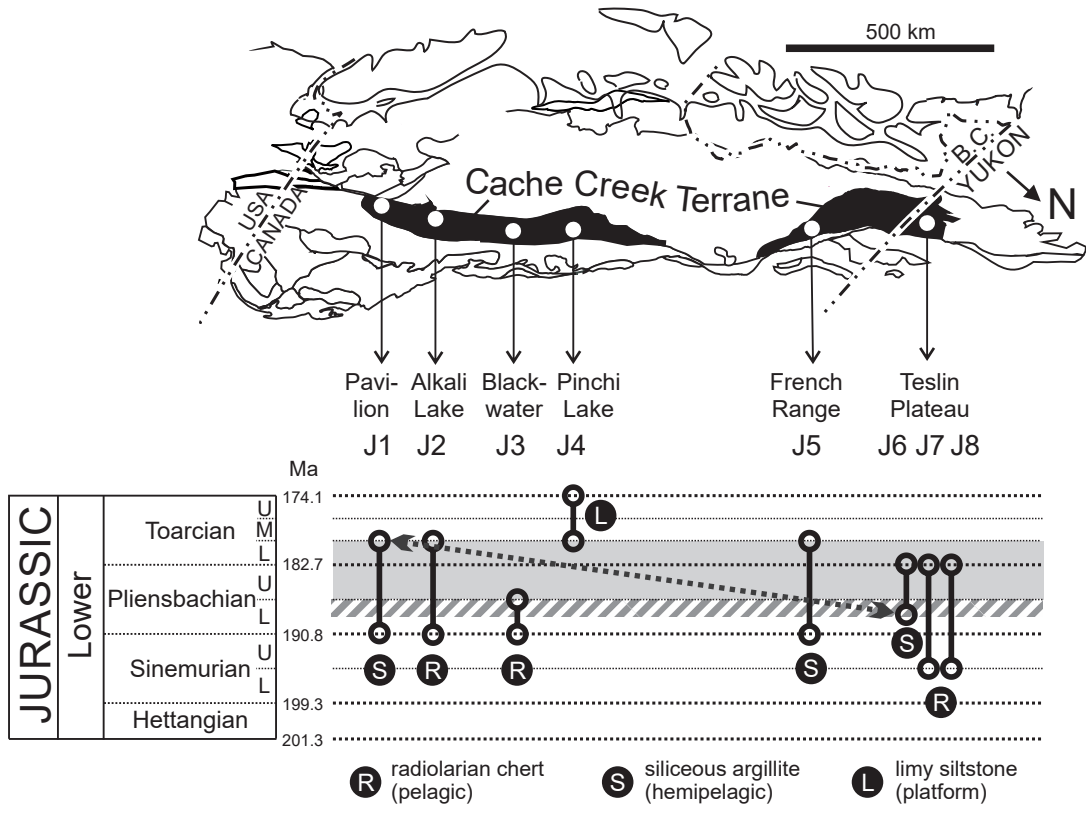


Figure 8