

Application of radiolarian biostratigraphy in constraining the geology of the northern Canadian Cordillera, British Columbia and Yukon



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Abstract

Pelagic sedimentation of radiolarian tests in deep-water oceanic settings leads to accumulations of oozes that become lithified as chert. The biostratigraphy of radiolaria preserved in such cherts is an important tool for establishing the geological history of oceanic crustal fragments. Deep-water oceanic rocks in the northern Cordillera have historically been considered ophiolitic terranes. However, radiolarian biostratigraphy from nearly four decades of sampling in the Atlin, British Columbia-Teslin, Yukon Territory area, demonstrates that most pelagic strata comprise disrupted Middle Triassic to Early Jurassic overlap successions, predominantly the Kedahda Formation. Older, late Paleozoic chert is either interbedded with carbonate platform deposits such as the Horsefeed Formation or occurs as slivers in accretionary complexes such as the Lincoln complex.

Keywords: Radiolaria, fossil age, geochronology, ribbon chert, Atlin terrane, Cache Creek terrane, Sentinel complex, Lincoln complex, Kedahda Formation, Shonectaw Formation, Nakina suite, Jurassic, Triassic, Permian, ophiolite, tectonic accretion, Cordilleran geoscience

1. Introduction

Crustal fragments that comprise much of the Cordillera (Fig. 1) have historically been classified with a focus on the principal tectonic setting in which they were formed. Fragments that have been significantly displaced with respect to the North American continent to which they are now attached are called terranes, which are classified as peri-continental margin, back-arc basin, volcanic arc, or offshore 'oceanic' derivation. 'Oceanic' terranes are made of chert, limestone, within-plate volcanic rocks, siliciclastic rocks, and ocean crust sequences (ophiolites) on which the others were interpreted to have formed (e.g., Coney et al., 1980; Silberling et al., 1992).

In the few decades following the birth of the new plate tectonic hypothesis in the late 1960s, ophiolites were generally accepted to represent mid-oceanic or back-arc ridges. Grouping all apparently related 'oceanic' rocks of the Canadian Cordillera into a few terranes made sense in this historical context. As such, it was natural to assume that oceanic plateau-like sequences were built on top of older ophiolitic ocean floor. Biogenic chert deposition was expected on the ocean floor below and adjacent to the volcanic plateau (Monger et al., 1991), and chert deposition was expected above carbonate that capped plateaus as they thermally subsided.

Further work revealed two serious problems with this view of the general geological evolution of the former Cache Creek oceanic terrane. First, the widespread mafic sequences assumed

to be plateau substrate for carbonate bank successions were found to lack geochemical characteristics of ocean island basalts (OIB) but were instead mostly characterized by primitive island arc tholeiite geochemistry (IAT; English et al., 2002, 2010; English and Johnston, 2005; Zagorevski et al., 2021). Perhaps the more serious problem is that the isotopic age of this IAT ocean crust is now known to be mostly younger (ca. 264-245 Ma) than the carbonate banks (ca. 359-254 Ma) that were thought to be built atop the plateaus (Mihalynuk et al., 2003a, b; Zagorevski et al., 2021). Cherts were deposited throughout the lifetime of both the carbonate bank and IAT crust formation (though mostly coeval with the IATs) allowing the evaluation of the link between various environments and deformational events that juxtapose them. Evaluation of the relationship between the carbonate bank and ophiolites was made possible through the use of isotope and macrofossil geochronology, but, critically, depended on identification of widespread radiolaria, the primary component of biogenic chert.

In this paper, we explore the utility of radiolarian cherts and other radiolarian-bearing rocks found in oceanic sequences of the Cache Creek and ophiolitic Atlin terranes of northern British Columbia, near Atlin, and southern Yukon, near Teslin (Fig. 1; e.g., Aitken, 1959; Gabrielse, 1969, 1998; Monger, 1975; Cordey et al., 1991; Monger et al., 1991; Mihalynuk et al., 1999, 2003a, 2004a, b; Cordey, 2020; Zagorevski et al., 2021) in the traditional territories of the Taku River Tlingit First Nation,

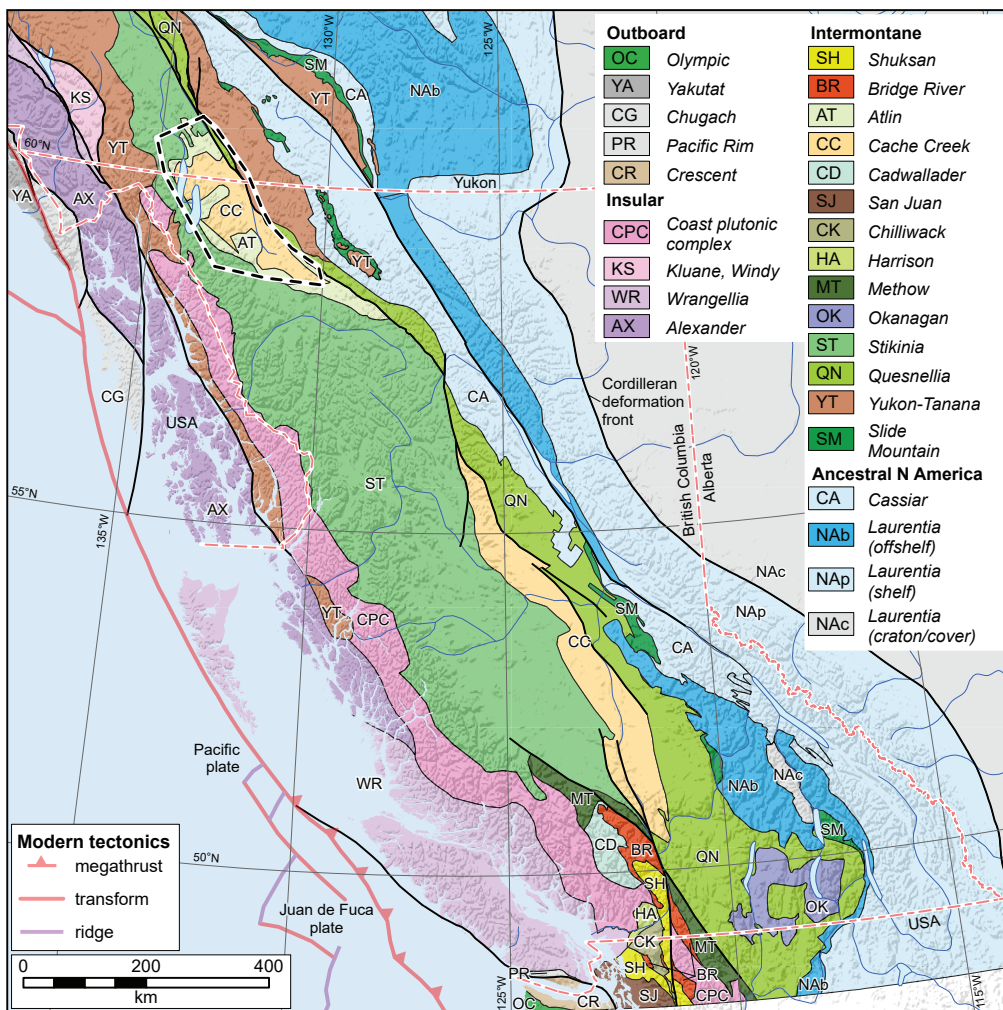


Fig. 1. Location of study area. Terranes after Colpron (2020) and Zagorevski et al. (2021).

Carcross-Tagish First Nation, Teslin Tlingit Council and Tahltan First Nation. We also present new biochronological age data from radiolarian chert samples collected in the 2024 field season (Table 1). In a companion publication (Zagorevski et al., 2026), we compile these biostratigraphic data together with other unpublished and published sources (Figs. 2, 3). We demonstrate that these data facilitate tectonic analysis by constraining the ages of ophiolites, mélanges, and other oceanic sequences, as well as widespread marine sedimentation that accompanied and postdated initial terrane amalgamation.

2. Methods

Radiolaria are unicellular marine protists, generally less than 1 mm in diameter, that first appeared in the Early Cambrian fossil record (Chang et al., 2018) and have rapidly evolved into a diverse array of forms since then. An even older origin in the Neoproterozoic is suggested by fossil-calibrated molecular clocks (760 Ma; Sandin et al., 2025). Approximately 15,000 species of radiolaria are known, with ~90% found only in the fossil record (Bánki et al., 2025, and

references therein). Intricate opaline silica skeletal remains of radiolaria were the principal contributor to biogenic silica production in ocean basins (pelagic ‘silica ooze’) in the Paleozoic and Mesozoic. Largely due to their adaptability and entirely planktonic lifestyle, they were carried by currents to every part of the marine environment. This ubiquity, together with their rapid and diverse morphological evolution, underpins their usefulness as a biochronometer. Radiolarians are still present in modern oceans but have been partly replaced by diatoms as primary pelagic silica producers since the Cenozoic (Westacott et al., 2021).

Chert biochronology is a relatively simple, inexpensive, and effective method for determining the age of pelagic strata that may otherwise be difficult to date, even when applying costly isotopic techniques. Radiolaria can commonly be seen with the unaided eye in chert bands (Fig. 4) but may require the use of a hand lens. The general rule is that unless radiolaria can be seen, collection and submission for the purpose of radiolarian dating is not done. However, sampling of key undated intervals of pelagic strata that lack visible radiolaria, especially where

Table 1. New radiolarian sample collection.

SAMPLE	Lat	Long	Unit	Lithology and field notes	Lab observations/ Preservation	Radiolarian/conodont taxa or features	Age	Comments (biochronology)
24ZE1602A01	59.1041	-132.4983	Lincoln	Grey chert with ghostly rads	radiolarians/ poor	internal moulds of <i>Parafollicucullus</i> sp. or <i>Follicucullus</i> sp.	Permian	preservation insufficient to establish a more precise age
24ZE1613A01	59.1074	-132.4887	Lincoln	Bedded grey chert, well preserved radiolaria apparent in dark grey chert	abundant radiolarians including internal moulds/ moderate recrystallization	<i>Haploaxon</i> sp., <i>Latentifistula</i> sp., <i>Parafollicucullus scalpratus</i> ,	Early Permian, Cisuralian	age based on occurrence of <i>P. scalpratus</i> (Aitchison et al., 2017)
24ZE1619A01	59.1069	-132.5076	-	Basalt with interpillow limestone and blocks of dark grey chert	radiolarians, recrystallized matrix/ poor	<i>Latentifistula</i> sp., internal moulds of <i>Parafollicucullus</i> sp. or <i>Follicucullus</i> sp.	Permian	preservation insufficient to establish a more precise age within the Permian
24ZE1669A01	59.4242	-133.4299	-	White chert	recrystallized matrix, silica fragments	-	-	-
24ZE1669A02	59.4242	-133.4299	-	Large >20m pod of laminated grey to beige chert; very similar to Horsefeed Fm. in the Nakina	silica fragments, clays	-	-	-
24ZE1674A01	59.4284	-133.4315	-	Laminated grey green chert	silica fragments, clays	-	-	-
24ZE1690B01	59.4352	-133.4682	Sentinel	Finely to medium bedded cherty tuff, and locally graded turbidite beds overlain by light grey chert. Looks like a large block within basalt breccia. Immediately above gabbro sill, beautifully bedded and laminated light grey chert	radiolarians, silica fragments, clays/ poor	internal mould of <i>Parafollicucullus</i> sp. or <i>Follicucullus</i> sp., <i>Pseudotormentus</i> sp.	Permian	preservation insufficient to establish a more precise age within the Permian
24ZE1691A01	59.4358	-133.4689	-	Well bedded haematitic / dark gray chert with radiolaria	recrystallized matrix, silica fragments	-	-	-
24ZE1699A01	59.4359	-133.4823	Sentinel	Well bedded haematitic / dark gray chert with radiolaria	abundant radiolarians recrystallized matrix/ moderate	<i>Hegleria</i> sp., <i>Latentifistula</i> sp., <i>Follicucullus monacanthus</i>	Late Permian, Wordian-Capitanian	age based on occurrence of <i>F. monacanthus</i> (UA 9-12; Xiao et al., 2018)
24ZE1702B01	59.4371	-133.4897	-	Haematitic basalt overlain by red shale to cherty shale	abundant red clays, radiolaria, matrix fragments/ moderate	<i>Albaillella</i> sp., <i>Ishigaum</i> sp., <i>Latentifistula</i> sp., <i>Latentibifistula</i> sp., <i>Murcheyella triporosa</i> , <i>M.</i> sp. aff. <i>triporosa</i> (Murchey, 1990), <i>Parafollicucullus</i> sp. <i>G</i> (Ishiga, 1982)	Pennsylvanian, Moscovian-Gzhelian	correlation with assemblage 6 and part of assemblage 7 of Murchey (1990)
24ZE1707A01	59.4440	-133.4941	-	White weathering chert, black on fresh surfaces	siliceous matrix fragments, clays	-	-	-
24ZE1709A01	59.4455	-133.5010	Sentinel	Folded dark grey cherts	recrystallized matrix, abundant spheres	<i>Latentifistula</i> sp., <i>Parafollicucullus scalpratus</i>	Early Permian, Cisuralian	age based on occurrence of <i>P. scalpratus</i> (Aitchison et al., 2017)
24ZE1710A01	59.4461	-133.5012	-	Red, green, and dark gray chert	spheres and rods, but no clear morphologies	-	-	-
24ZE1720A01	59.4826	-133.4484	-	Black chert to black argillite, seems to be most of the cliff face	siliceous matrix fragments, clays	-	-	-
24ZEAV237A01	59.8311	-133.1313	-	Light gray chert	silica spheres, clays	-	-	-
MM124-06-04	59.8449	-133.0830	-	Dark gray chert	abundant silica spheres, unfortunately undiagnostic	-	-	too recrystallized
MM124-06-05	59.8445	-133.0831	-	Dark gray chert	silica spheres, clays, silica fragments	-	-	-

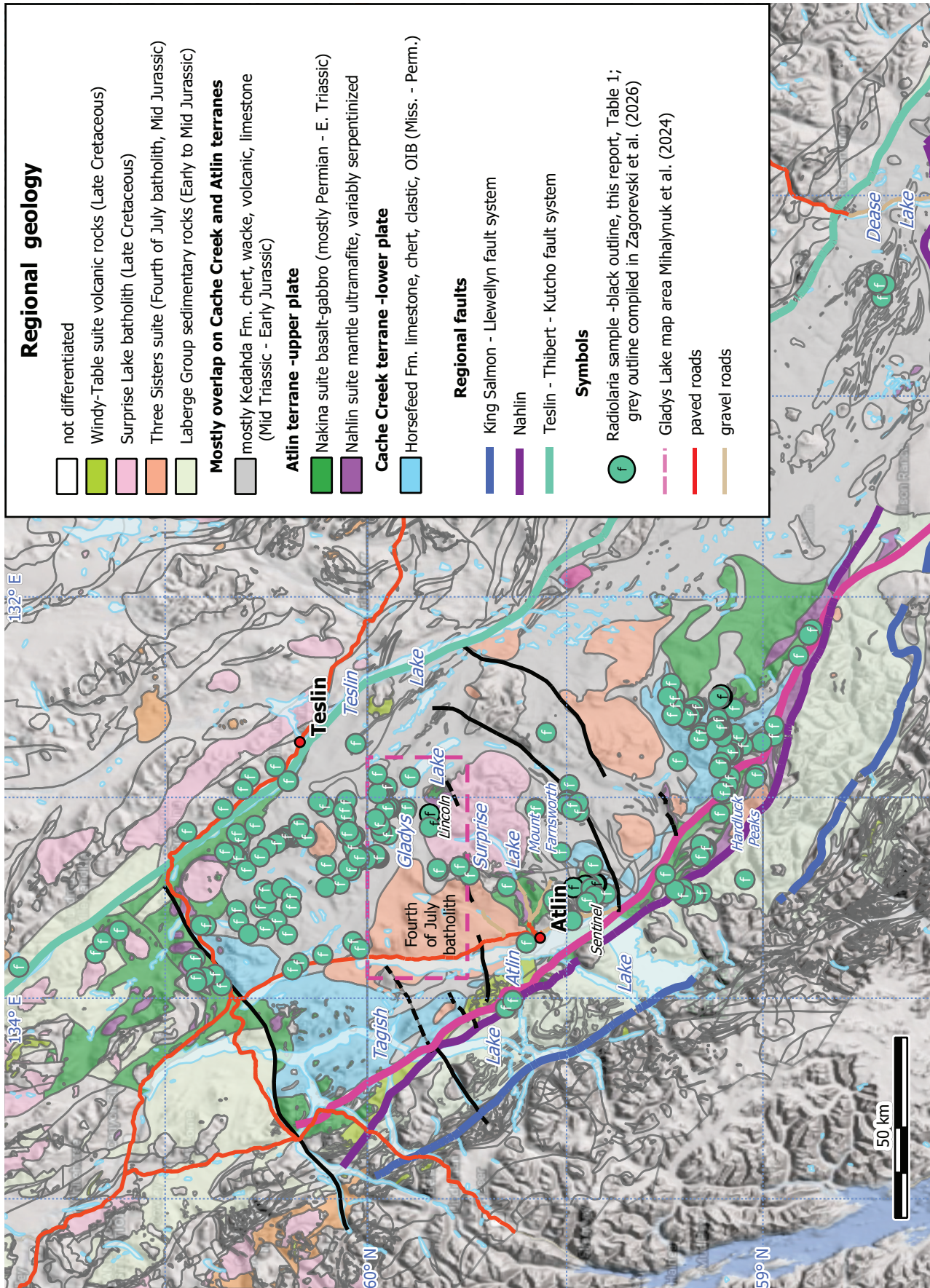


Fig. 2. Geological setting of radiolarian samples in the Atlin-Teslin area. Samples reported here for the first time (Table 1) are shown with a black outline, and those are compiled together with samples from previous studies (shown with grey outlines in Zagorevski et al., 2026). Bedrock geology in Yukon derived mostly from Yukon Geological Survey (2019).

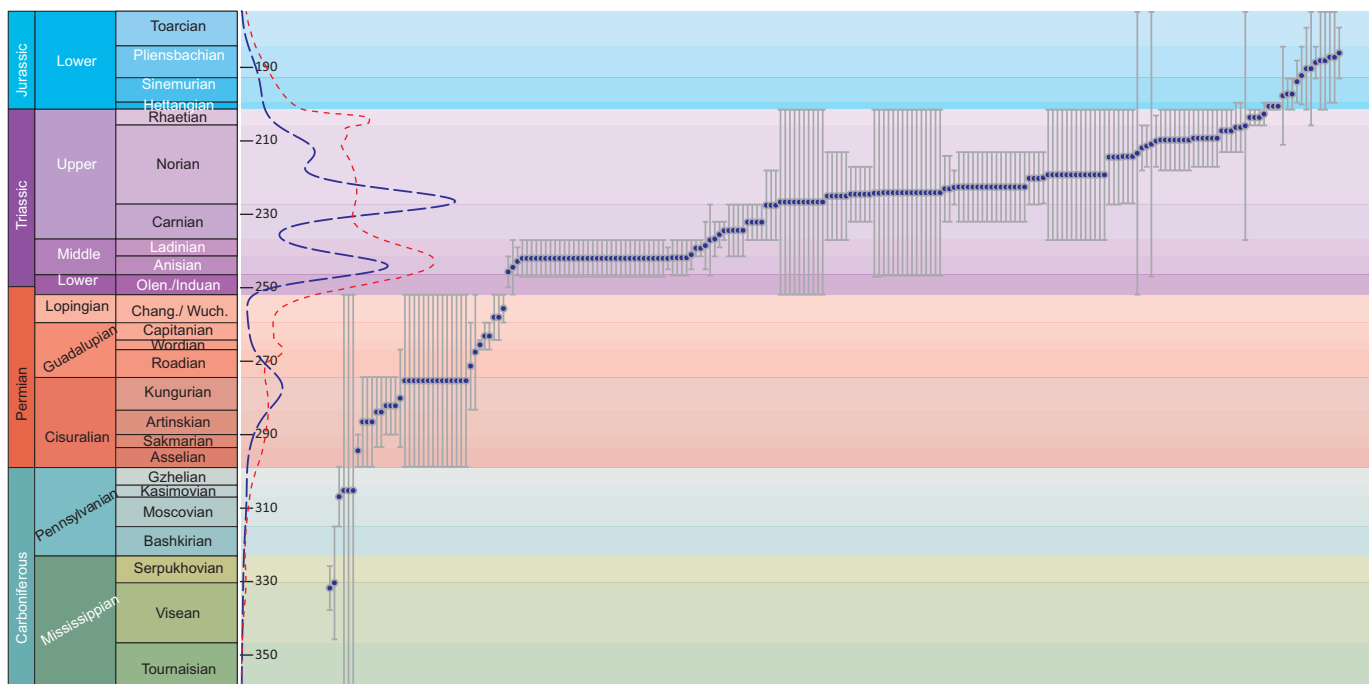


Fig. 3. Summary of biostratigraphic data from radiolaria-bearing samples in this study and in previous work (Zagorevski et al., 2026). Absolute age calibration of time period boundaries is from the International Chronostratigraphic Chart (Cohen et al., 2025). Red dashed line: Probability Density Plot derived from conversion of biostratigraphic data into numerical scale and treating the age range as a 2σ error (see methods in Zagorevski et al., 2026). Blue Dashed line: Kernel Density Plot from conversion of biostratigraphic data into numerical scale and using the median biostratigraphic age and kernel density of 4 (Vermeesch, 2018).



Fig. 4. Radiolarian chert in outcrop. Dark grey to almost black, spherical radiolaria (~0.2 mm) visible on a weathered surface of light grey and rusty chert outcrop north of Gladys Lake (site of sample RCA23-19-26). Samples collected nearby returned Late Triassic ages. Scale divisions are in mm.

unmetamorphosed, may be worthwhile, and lead to unexpected results. For example, sampling of the Stuhini Group, south of Atlin yielded radiolaria delicately replaced by pyrite, and identifiable to the species level (Fig. 5).

Extraction of radiolaria generally relies on collection of residues following serial dissolution of the samples in hydrofluoric acid (HF). Rinsed residues are dried and microfossils are separated with the aid of a binocular microscope. Radiolaria are mounted and examined with the use of a scanning electron microscope (SEM) as required.

2.1. Sampling of cherts

Many cherts containing diagnostic radiolaria are shades of grey (ranging from black to almost white). However, beige to tan, green and red chert varieties, as well as argillites, can

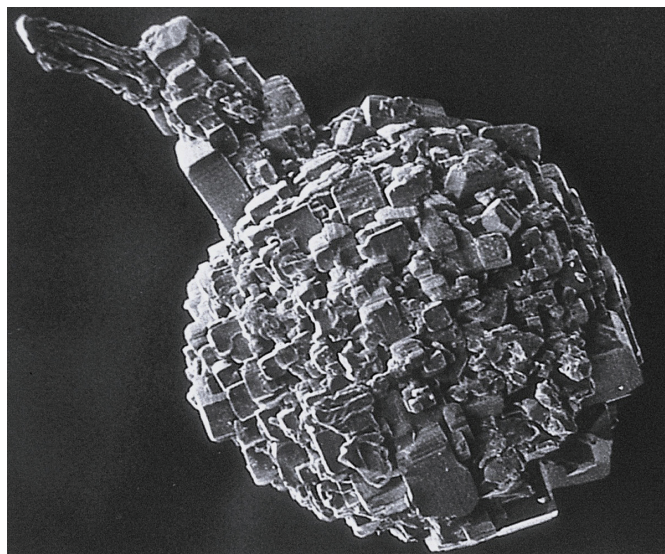


Fig. 5. SEM photomicrograph of a pyritized radiolarian test from the Stuhini Group south of Atlin (diameter of the sphere is 0.3 mm).

also yield diagnostic radiolaria. Depending on the sample, radiolarian tests may be best observed on fresh surfaces, weathered surfaces, and are commonly accentuated in glossless, weathered outcrop rinds. Radiolaria preservation can be limited to only specific beds within an outcrop, or even to certain parts of beds, or individual boudins. Chert and argillite samples collected for radiolarian analysis can typically be small, with ~20 cm³ being sufficient.

Recrystallization of chert leads to degradation of fossil

radiolaria and is a common problem. Collectors should attempt to screen samples in the field, rejecting sucrosic (granular) samples. Whitening and deformation of radiolarian tests into ovoids generally indicate extensive recrystallization. So too, is extensive veining and patchy discolouration of chert. At a finer scale, diffuse margins of radiolaria can be a sign of recrystallization; radiolaria with sharp margins are most likely to yield high quality determinations. Screening using thin sections may also be useful (Figs. 6, 7, 8).

Although proximity to intrusions generally correlates with recrystallization, it does not necessarily rule out preservation of radiolaria. For example, some samples in Zagorevski et al. (2026) were collected from enclaves in the mafic dike zone of an ophiolite, and others were from within the thermal-metamorphic halo of the Surprise Lake batholith. In both cases, the material sampled included radiolaria that were visible to the unaided eye.

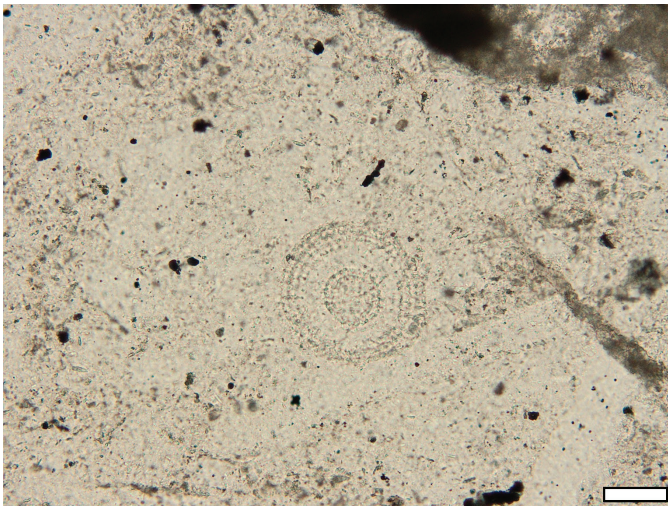


Fig. 6. Photomicrograph of a well-preserved test in a chert clast in a pebble conglomerate north of Sterlin Lake, southern Yukon. Internal structure of the radiolarian test is clearly visible, and the outer margin is sharp, both excellent indications of a sample that will yield identifiable microfossils. Nearby chert samples yielded a Late Triassic radiolarian age determination. Scale bar is 50 μ m.

3. Stratigraphic overview of northern Cache Creek and Atlin terranes

Radiolarian biostratigraphic age control has provided critical constraints on the definition of key stratigraphic units in the Atlin BC-Teslin YT area. The stratigraphic nomenclature summarized herein follows Zagorevski et al. (2021) who suggested revisions consistent with modern tectonic environments, with updates from Mihalynuk et al. (2024). Due to radiolaria age data, we now know that the most widespread chert unit in the Atlin-Teslin area, the Kedahda Formation, is Mesozoic and largely an overlap on older conjoined terranes (together with the more restricted Shonektaw Formation) and have been since deformed. Paleozoic chert, in part comprising

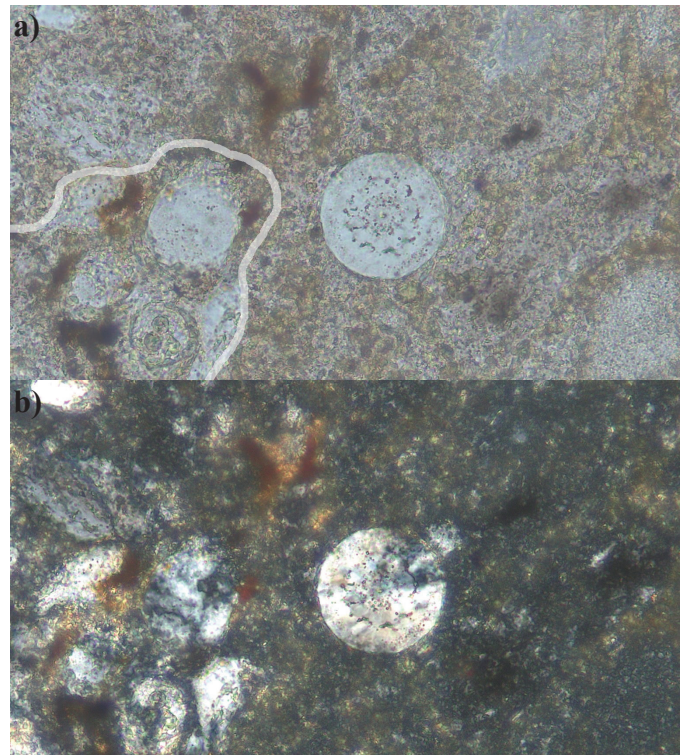


Fig. 7. Photomicrographs of radiolaria in siltstone-argillite beds of probable Carnian age, southern Atlin Lake area. **a)** Partly recrystallized radiolaria with a quartz overgrowth in a fine-grained wacke grain (translucent white outline), versus a sharply defined and larger specimen at right displaying relict interior structure (field of view is \sim 2 mm). **b)** Same view as a) but in cross-polarized light, which reveals feathery quartz in recrystallized and overgrown radiolarian test versus incipient recrystallization of the sharply defined test at right.

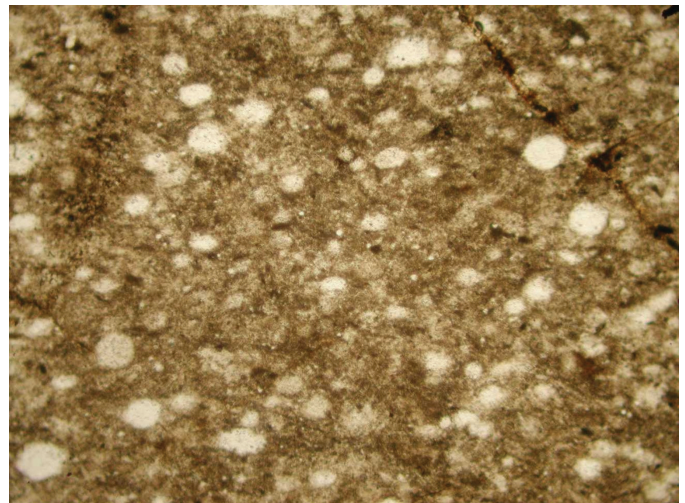


Fig. 8. Photomicrograph of an argillaceous chert sample from near Hardluck Peaks, \sim 75 km south of Atlin, that contains abundant radiolaria tests (field of view \sim 4 mm), but with diffuse margins indicating that they are too recrystallized to be reliably identified which, together with deformation of the rock, makes it difficult to distinguish radiolarian tests from mineral grains (from Mihalynuk et al., 2004b).

accretionary complexes and/or *mélange* (Lincoln complex and Sentinel complex) but also deposited on ocean crust and mantle of the Nakina suite, are a relatively minor component of the northern Cache Creek and Atlin terranes. However, the term ‘*mélange*’ has historically been widely applied to the northern Cache Creek terrane as well as a variety of structurally or stratigraphically complex regions of other ‘oceanic’ terranes in the Cordillera where it has become a prominent defining feature. Yet in many cases the use of ‘*mélange*’ as a genetic descriptor inferring subduction zone processes is unwarranted. For example, competent chert beds in otherwise incompetent chert-argillite sequences are commonly pervasively boudinaged and dismembered in a scaly, ductile argillite matrix, resulting in a sedimentary ‘*mélange*’. Similarly, deformation and serpentinitization of peridotite intruded by gabbro results in gabbro knockers in a fault zone of scaly serpentinite ‘*mélange*’. Sedimentary and fault zone *mélanges* are characterized by local rock types, they lack exotic clasts, and they are better described as ‘broken formation’ (Raymond, 1984) and igneous equivalents.

3.1. Cache Creek terrane

In the northern Canadian Cordillera, the Cache Creek terrane is typified by thick accumulations of late Paleozoic carbonate rocks named the Horsefeed Formation by Monger (1975). Relatively thin mafic volcanic layers interbedded with these carbonate rocks generally have geochemical signatures consistent with OIB (Zagorevski et al., 2021) or enriched mid-ocean ridge basalt (enriched MORB; English et al., 2010; Mihalyuk et al., 2018). In contrast, large tracts of basalt in adjacent areas (Nakina Formation of Monger, 1975) are IAT (Zagorevski et al., 2021), and these are juxtaposed with the Horsefeed Formation across crustal-scale faults interpreted as reworked subduction zone structures. Thus, an upper plate (Nakina arc)-lower plate (Horsefeed ocean island/plateau) relationship is preserved. At the interface is accretionary complex represented by true *mélange* as preserved, for example, in the Lincoln and Sentinel complexes, derived mostly from the subducting plate, and are therefore included with the Cache Creek terrane.

3.1.1. Lincoln complex

Recent mapping near Lincoln Lake (Gladys Lake area of northern British Columbia), demonstrated a tectonic *mélange* origin for structurally interleaved peridotite, serpentinite, gabbro, basalt, argillite and other siliciclastic rocks, limestone/marble, and chert, and comprises the type locality of the Lincoln complex (Mihalyuk et al., 2024). This is one of several areas that demonstrably contain interleaving of a variety of crustal and mantle rock types, indicating a tectonic *mélange* origin (e.g., Mihalyuk et al., 2003a, 2024; Zagorevski et al., 2021). Targeted sampling of chert in the Lincoln complex yielded Paleozoic radiolaria (Table 1).

3.1.2. Sentinel complex

The Sentinel Range south of Atlin exposes a section of Paleozoic basalt, limestone, chert, and diabase (e.g., Monger, 1975; Bloodgood et al., 1990). These rocks are in fault contact with Paleozoic limestones of the Horsefeed Formation (Cache Creek terrane) and Middle Permian to Middle Triassic Atlin terrane ophiolitic rocks and are unconformably overlain by the Late Triassic rocks of the Kedahda Formation. Mafic rocks display a variety of geochemical signatures including MORB, OIB, and back-arc tholeiite. Chert and lesser limestone occur between clasts and basalt flows and also appear to stratigraphically overlie the basalts. These cherts are also intruded by mafic sills with contact zones locally displaying perperite-like and fluidal textures suggesting wet sediment-magma interaction, and range in age from Carboniferous to Permian (Table 1), although field relationships suggest that most of the chert accumulated in the Permian. Several distinct chert-bearing imbricated thrust panels are inferred. Some of these thrust panels may correlate with less coherent slices within the Lincoln complex. Similar rocks may occur elsewhere in northern British Columbia and Yukon, such as on the western shores of Teslin Lake and in the Nakina Lake area.

3.2. Atlin terrane

The Nakina Formation was originally defined by Monger (1975) and its rank was changed to Nakina suite (Zagorevski et al., 2021; Mihalyuk et al., 2024) to be more consistent with the traditionally included rock types and the stratigraphic code (North American Commission on Stratigraphic Nomenclature, 2021). The Nakina suite, as originally defined, is generally a massive and structureless, or laminated to “flow banded”, commonly rubbly-weathering IAT basalt. Detailed investigations indicate that many localities of the Nakina suite include a significant proportion of deformed and mylonitized hypabyssal rocks (basaltic, diabase, micro-gabbro dikes or sills). In some places (e.g., Hardluck Peaks south of Atlin, or King Mountain east of Dease Lake), the Nakina suite forms the upper crustal portion of the Atlin terrane ophiolites. However, the general paucity of middle to lower crustal rocks at most localities suggests that spreading was tectonically accommodated, similar to modern ocean core complexes (Zagorevski et al., 2021; Bogatu et al., 2023; Mihalyuk et al., 2024). Permian chert is locally present as screens within hypabyssal rocks or is intruded by sparse mafic sills within these core complexes, demonstrating that these old chert units form part of the Atlin terrane ophiolites. Broad tracts of the Atlin terrane are primitive IAT, including the ophiolite basalt as well as poorly developed volcanic edifices constructed atop them that are dated by U-Pb isotopic techniques and radiolaria as ranging from Late Permian to early Middle Triassic (Zagorevski, 2021 and sources therein).

3.3. Shonektaw Formation

The Upper Triassic Shonektaw Formation is exposed on the

east side of Teslin Lake (e.g., Gordey and Stevens, 1994a, b). This unit comprises fine-grained siliciclastic rocks, augite and/or hornblende porphyritic volcanic and volcanoclastic rocks, chert, and minor limestone. Gordey and Stevens (1994b) identified several bodies of harzburgite, pyroxenite, dunite, and gabbro within the Shonektaw Formation. Contained volcanoclastic units locally include altered ultramafic clasts and are characterized by anomalously high Cr concentrations (Zagorevski et al., 2018). This suggests that the Shonektaw Formation unconformably overlies and is partly derived from the mafic-ultramafic plutonic rocks and mantle rocks (Nakina suite, see above) and incorporated clasts derived through either volcanic or sedimentary processes (Zagorevski et al., 2018).

3.4. Kedahda Formation, disrupted overlap

The widespread Kedahda Formation (Watson and Mathews, 1944; Gabrielse, 1969; Monger, 1975) is generally characterized by variably, but generally highly folded chert, argillite, wacke, and minor limestone. Locally, siliciclastic rocks and epiclastic rocks containing fresh hornblende, feldspar, clinopyroxene, quartz, epidote, and biotite are abundant (Aitken, 1959; Gabrielse, 1969; Monger, 1975). Numerous collections of Kedahda Formation chert and limestone have yielded Middle to Late Triassic, as well as some Early Jurassic, radiolaria and conodonts (Cordey et al., 1991, 2024, 2025; Golding et al., 2016; Mihalynuk et al., 2002, 2003a). Zagorevski et al. (2021) suggested that the Kedahda Formation should be restricted to Middle Triassic to Early Jurassic chert, argillite, wacke, and minor limestone. This restriction does not change the current distribution of the Kedahda Formation, except in Yukon, where Middle Triassic to Early Jurassic rocks have been previously excluded from the Kedahda Formation (Cordey et al., 1991; Yukon Geological Survey, 2019). Monger et al. (1991) inferred that parts of the Kedahda Formation may be correlative with the Laberge Group (Early Jurassic, Sinemurian). This is consistent with the Early Jurassic radiolaria in cherts and siltstones that are interbedded with siliciclastic rocks (e.g., Cordey, 2020) and presence of Mesozoic radiolarian chert clasts in the Laberge Group (e.g., Mihalynuk et al., 2004a).

Previous inferences that the Kedahda Formation either underlies or is interbedded/interfingering with the Paleozoic limestone have created significant confusion for deciphering regional stratigraphic relationships. Although Paleozoic radiolaria have been recovered from some chert in northern British Columbia and southern Yukon, notably from interbeds in Paleozoic carbonate successions, almost all of the Kedahda Formation is Mesozoic. Hence, Paleozoic stratigraphic relationships are largely incorrect. The base of the Kedahda Formation is poorly exposed but an angular unconformity has been inferred at several localities (e.g., Monger, 1975; Zagorevski et al., 2021; Mihalynuk et al., 2024). At least some of the Paleozoic chert localities appear to occur along or below this unconformity. These unconformable relationships, as well as detrital evidence of derivation from

underlying and adjacent terranes, suggest that the Kedahda Formation is a regional marine overlap assemblage that, at least in part, postdates terrane amalgamation (e.g., Zagorevski et al., 2021; Mihalynuk et al., 2024; Milidragovic et al., 2024). Constraining the paleogeographic evolution, including the amount of syn- and post-depositional deformation, will require much more work.

3.4.1. Farnsworth wacke, volcanic sandstone, and volcanoclastic units

The Farnsworth volcanic-sourced clastic beds are considered a subunit of the Kedahda Formation. Mapping near Gladys Lake (Mihalynuk et al., 2024) and, to the south, in the Mount Farnsworth area, identified these clastic units with interbedded chert and chert reworked as sharpstone conglomerate pebbles and coarse sand grains. Volcanic grains and clasts are locally predominant; they are typically plagioclase porphyry \pm hornblende/pyroxene/biotite/titanite. Occurrence of detrital grains of secondary minerals such as epidote and pumpellyite indicates erosion of hydrothermally altered volcanic rocks or those subjected to regional low-grade metamorphism. Coarse-grained strata are interbedded with silty and argillaceous beds in turbiditic successions, locally affected by soft-sediment deformation and incised by coarse mass flow deposits. In rare instances, they can be observed resting on mantle peridotite. They contain radiolaria and detrital zircon populations as young as Early Jurassic (Zagorevski et al., 2025).

4. Summary of data and implications

Radiolarian chert and pelagic argillite are a very common but underused components of oceanic terranes in the northern Canadian Cordillera. Out of 342 radiolaria-bearing chert, siltstone, or limestone localities (Fig. 2) compiled by Zagorevski et al. (2026), 220 yielded radiolarian and/or conodont fossils that are diagnostic enough to make an age determination (Fig. 3). Of these, 182 yielded Triassic to Early Jurassic fauna and form part of a disrupted overlap assemblage, comprising the Kedahda Formation and its equivalents. An additional 38 localities yielded Paleozoic radiolaria. Although the tectono-stratigraphic position of some Paleozoic samples is unknown, Lincoln complex and Sentinel complex yielded exclusively Paleozoic ages. These Paleozoic cherts may be diagnostic of the oceanic basement of the Atlin terrane. Eleven localities yielded very imprecise determinations, but they are still useful for separating overlap from oceanic basement terranes.

Consideration of global events is important when interpreting radiolarian biochronology. The scarcity of latest Permian and Early Triassic radiolaria (Fig. 3; Zagorevski et al., 2026) demonstrates changes in radiolaria productivity across the Permo-Triassic boundary, with a massive increase of productive chert samples in the Mesozoic. Although effects of sampling bias on this age distribution cannot be ruled out, the difference in radiolarian productivity is likely a result of the

Permo-Triassic mass extinction and related ocean conditions, and to tectonic factors influencing radiolarian abundance globally. Such inferences can be tested through complementary siliciclastic provenance or sedimentary geochemistry studies.

Use of chert and radiolaria in mapping and tectonic reconstructions is currently limited by several factors, including availability of comparative data, skill of the collector, calibration of the radiolarian (and conodont) time scales and, most critically, availability of paleontological expertise. This paper, in conjunction with the companion compilation of Zagorevski et al. (2026) addresses some aspects of data availability, albeit for only a small part of the Canadian Cordillera. We highlight the importance of radiolaria as an affordable chronostratigraphic tool in regional mapping, especially in regions where U-Pb zircon and other isotopic dating cannot be applied. In terranes containing pelagic strata, radiolarian biochronology can be applied by any informed individual with a hand lens and access to a willing paleontologist with expertise in radiolaria identification.

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