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# Radiolarian ages from chert pebbles of the Tantalus Formation, Carmacks area, Yukon Territory

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## Abstract

Eighteen chert pebbles from three levels of the Late Jurassic-Cretaceous Tantalus Formation conglomerate near Carmacks contain radiolaria of Triassic (Ladinian-Carnian, Late Carnian-Middle Norian, Middle Norian, Late Norian) age. The known ages of chert pebbles from the Tantalus Formation near Whitehorse and Carmacks, which range from the Early Permian to the latest Triassic, differ from the age of Paleozoic chert-bearing units located to the northeast of the Tintina Fault. They more closely resemble the age of ribbon cherts of the northeastern part of the Northern Cache Creek Terrane (Teslin Plateau) in southern Yukon.

## Résumé

Près de Carmacks, dix-huit cailloux de chert provenant de trois niveaux conglomératiques de la Formation de Tantalus du Jurassique tardif-Crétacé contiennent des radiolaires triasiques (Ladinien-Carnien, Carnien tardif-Norien moyen, Norien moyen, Norien tardif). L'âge connu des cailloux de chert de la Formation de Tantalus près de Whitehorse et de Carmacks, qui varie du Permien précoce au Trias terminal, diffère de celui des unités du Paléozoïque observées au nord-est de la faille de Tintina. Il correspond plus à celui des cherts rubanés de la partie nord-est du terrane de Cache Creek (plateau Teslin), dans le Yukon méridional.

## INTRODUCTION

The Tantalus Formation (Fig. 1A) is a scattered chert pebble conglomerate unit of the south-central Yukon Territory, an overlap assemblage lying unconformably on the Lower and Middle Jurassic Laberge Group, the upper part of the pre-Cretaceous succession of the Whitehorse Trough (Fig. 1A). First described by Cairnes (1912, "Tantalus Conglomerates"), it has also been mapped near Carmacks by Bostock (1936) and Tempelman-Kluit (1974, 1984). The Tantalus Formation also outcrops to the south in Whitehorse area (Fig. 1A), where Wheeler (1961) was the first to recognize radiolaria in chert clasts. Recent work on the Tantalus includes sedimentological studies by Lowey and Hills (1988), and mapping by Hart and Radloff (1990).

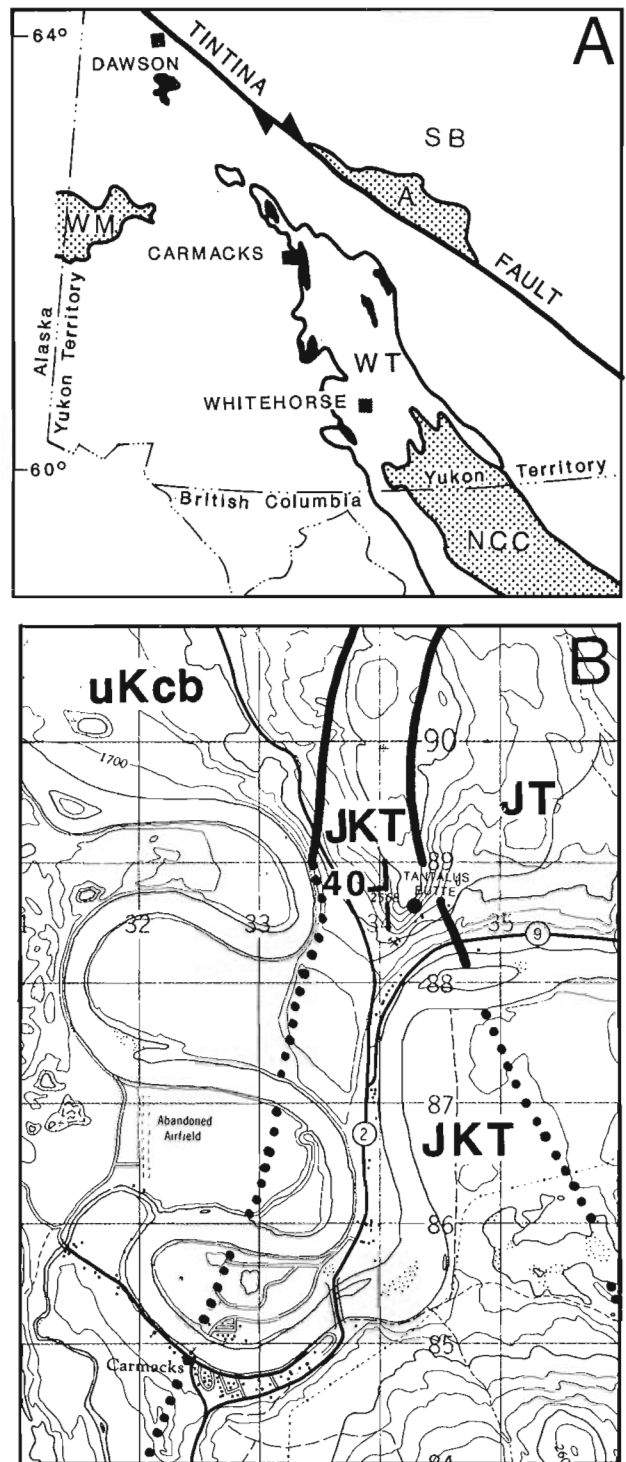
The Tantalus Formation consists mainly of massive beds of conglomerate, along with sandstone, shale, and coal seams. As first indicated by Cairnes (1912), these conglomerates are distinctive from others in the Yukon region, as the clasts consist almost entirely of chert, quartz, or slate. The age of the Tantalus Formation is Upper Jurassic to Early Cretaceous, possibly Late Cretaceous (Hart and Radloff, 1990, and references therein) based on palynomorphs.

Two previous ages are known from pebbles of the Tantalus conglomerate: a black chert pebble collected in Indian River area near Dawson (Fig. 1A) released pyritized radiolarians identified as Late Triassic in age by B. Murchey (U.S. Geological Survey) (Orchard, 1986; Lowey and Hills, 1988). A grey chert pebble collected near Whitehorse (C. Hart, pers. comm., 1989) has released Permian radiolarians identified by the writer (unpub. data).

Near the town of Carmacks, the Tantalus Formation outcrops along a north-trending belt crossed by the Lewes River (Fig. 1B). Good exposures occur on the south-facing slopes of Tantalus Butte where the formation dips 40° to the west. There, a conglomeratic sequence approximately 150 m thick contains abundant chert clasts of relatively uniform size, varying from 0.5 to 5 cm with an average diameter of 2 to 3 cm. The chert is a variety of colours, including green, grey, brown, black, and pink.

## TECHNIQUE

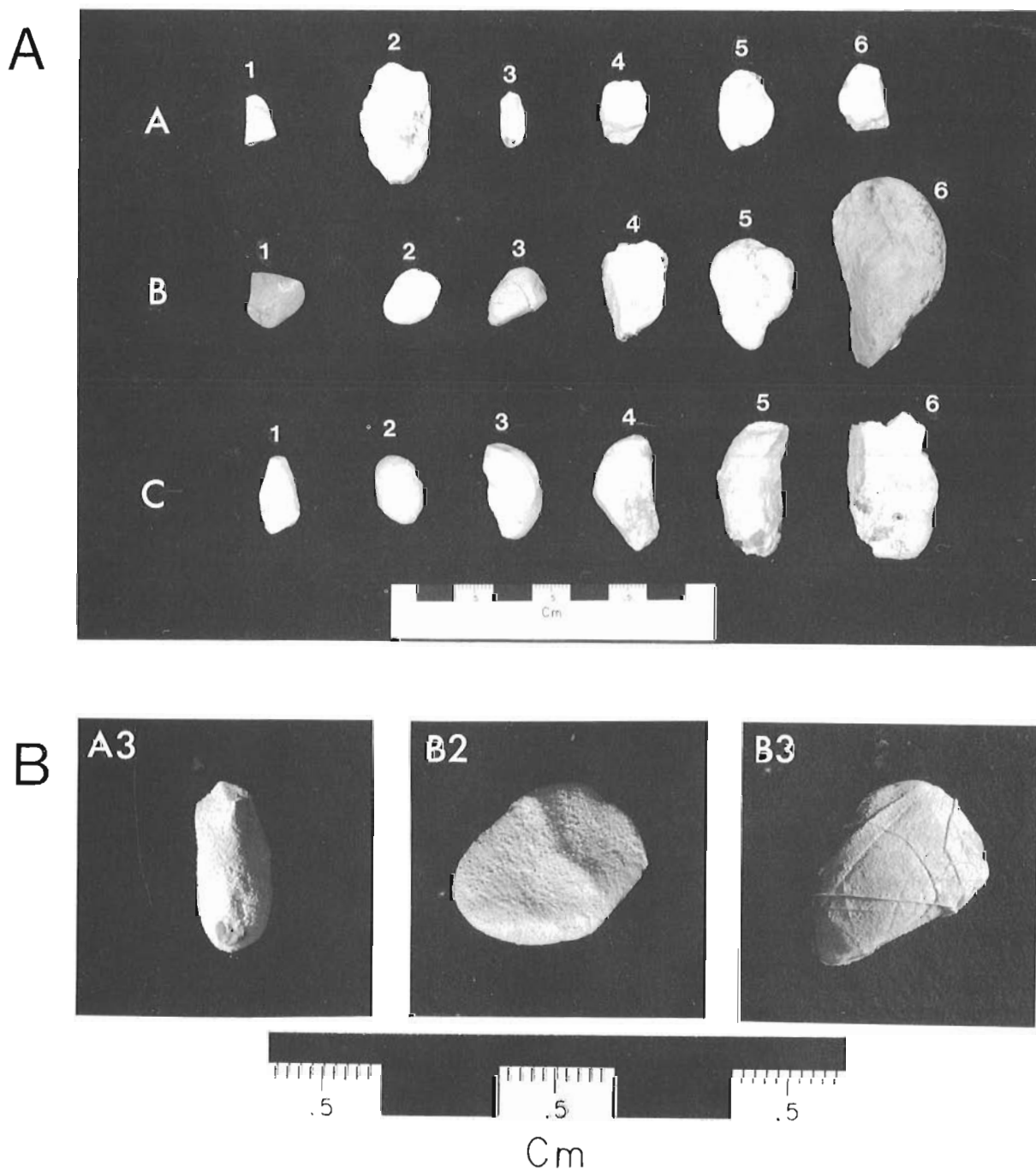
The search for radiolarian-bearing chert pebbles was done at three different stratigraphic levels of the Tantalus Butte slope (GSC locality C-177599, Fig. 1B). Six pebbles were selected at each level (Fig. 1B, 2A; pebbles A1 to A6: elevation 640 m (2100 ft.); B1 to B6: 670 m (2200 ft.); C1 to C6: 700 m (2300 ft.)). These eighteen pebbles range in diameter from 0.6 cm to 5 cm with an average of 1.8 cm, and are either slightly angular or well-rounded (Fig. 2A). Colour of the chert is mostly green or grey-green, but some of the pebbles are pink, brown-black, and black (Tables 1-3). Processing (Cordey, 1986) included mechanically removing residual matrix surrounding parts of a pebble, and further chemical cleaning with highly concentrated (50%) hydrofluoric acid (HF). Each pebble was then separately etched several times in a low-concentration (5%) HF solution, each etching ranging from 4 to 24 hours.



**Figure 1A.** Geographic extent of the Tantalus Formation, Yukon Territory (shown in black). WT = Whitehorse Trough (Lewes River and Laberge groups) (grey pattern). Main chert-bearing terranes of the region (dots pattern): NCC = Northern Cache Creek Terrane; WM = Windy-McKinley Terrane; A = Anvil; SB = Selwyn Basin). Modified from Lowey and Hills (1988). **B.** Location map of the Tantalus Butte near Carmacks (from Carmacks map area 115 I/1), and locality GSC C-177599 (black dot; X = 136°16'33", Y = 62°07'29"). Transposed geology from Tempelman-Kluit (1984). JKT = Tantalus Formation; JT = Laberge Group; uKcb = Carmacks Group (stratigraphic contacts).

The duration of etching required to release well-preserved radiolaria is a function of (1) radiolarian/matrix silica composition differences, and (2) the decrease in HF concentration during etching process. This duration varies from one pebble to another. Recovery frequency of

radiolarian-bearing residues must be high because of the small size of samples (Fig. 2A, B). Under these conditions, a clast as small as pea-size has the potential to release an identifiable faunal association.



**Figure 2A.** Chert pebbles from levels A, B and C after 24 hours of 5% hydrofluoric acid (HF) processing. **B.** Pebbles A3, B2, and B3. Occurrence of radiolarians skeletons partly removed from the matrix on the pebble surface is outlined by tangential lighting. Thin silica joints visible on B3 are commonly observed in Cordilleran ribbon cherts.

**Table 1.** Radiolarian determinations and age assignments, pebbles A1 to A6 (Fig. 2A)

PEBBLE N° LITHOLOGY	RADIOLARIAN ASSOCIATION	AGE
91FC-TAN-A1 grey-green chert	<i>Capnodoce</i> sp. <i>Latium</i> sp. <i>Squinabolella</i> sp.	Late Triassic, Late Carnian-Middle Norian
91FC-TAN-A2 grey chert	<i>Sarla</i> sp.	Late Triassic
91FC-TAN-A3 green chert	<i>Palaeosaturnalis</i> sp. <i>Sarla</i> sp.	Late Triassic
91FC-TAN-A4 brown-green chert	<i>Betraccium</i> sp. <i>Canoptum</i> sp. <i>Canesium lentum</i> Blome 1984 <i>Corum</i> sp.	Late Triassic, Middle Norian
91FC-TAN-A5 green chert	<i>Plafkerium</i> sp. cf. <i>cochleatum</i> (Nakaseko and Nishimura) 1979 <i>Pseudostylosphaera compacta</i> (Nakaseko and Nishimura) 1979 <i>Triassocampe</i> sp.	Triassic, Ladinian-Carnian
91FC-TAN-A6 brown-black chert	<i>Pseudostylosphaera</i> sp. <i>Triassocampe</i> sp.	Triassic, Ladinian-Carnian

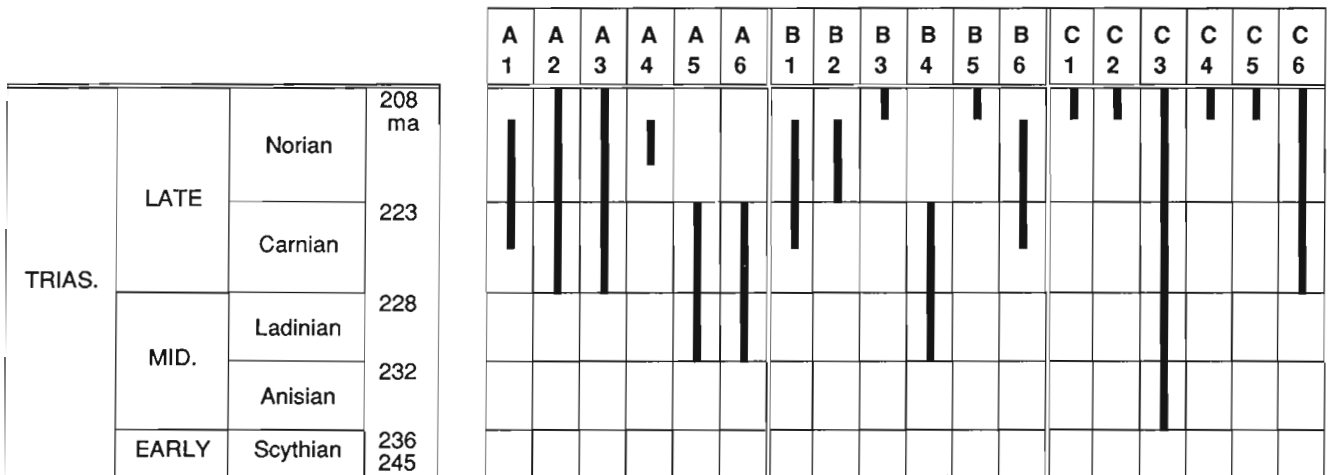
**Table 2.** Radiolarian determinations and age assignments, pebbles B1 to B6 (Fig. 2A)

PEBBLE N° LITHOLOGY	RADIOLARIAN ASSOCIATION	AGE
91FC-TAN-B1 brown-black chert	<i>Capnodoce</i> sp. aff. <i>anapetes</i> DeWever (in Blome 1984) <i>Palaeosaturnalis</i> sp.	Late Triassic, Late Carnian-Middle Norian
91FC-TAN-B2 grey chert	<i>Capnodoce</i> sp. cf. <i>antiqua</i> Blome <i>Pseudosaturniiforma</i> sp. <i>Xipha striata</i> Blome	Late Triassic, Lower-Middle Norian
91FC-TAN-B3 pink chert	<i>Canoptum</i> sp. <i>Ferresium</i> sp.	Late Triassic, Late Norian
91FC-TAN-B4 green chert	<i>Pseudostylosphaera</i> sp. <i>Triassocampe</i> sp.	Triassic, Ladinian-Carnian
91FC-TAN-B5 grey chert	? <i>Ferresium</i> sp.	Triassic, possibly Late Norian
91FC-TAN-B6 black chert	<i>Capnodoce</i> sp. cf. <i>traversi</i> Pessagno 1979	Late Triassic, Late Carnian-Middle Norian

**Table 3.** Radiolarian determinations and age assignments, pebbles C1 to C6 (Fig. 2A)

PEBBLE N° LITHOLOGY	RADIOLARIAN ASSOCIATION	AGE
91FC-TAN-C1 green chert	<i>Ferresium</i> sp. <i>Livarella</i> sp. Gen sp. indet. C Carter 1990	Late Triassic, Late Norian
91FC-TAN-C2 dark grey chert	<i>Canoptum</i> sp. <i>Ferresium</i> sp. Gen sp. indet. C Carter 1990	Late Triassic, Late Norian
91FC-TAN-C3 grey-green ch.	torsaded spines	Middle or Late Triassic
91FC-TAN-C4 grey chert	? <i>Betraccium</i> sp. <i>Canoptum</i> sp. <i>Ferresium</i> sp.	Late Triassic, Late Norian
91FC-TAN-C5 grey-green ch.	<i>Betraccium</i> sp. <i>Ferresium</i> sp.	Late Triassic, Late Norian
91FC-TAN-C6 grey-green ch.	<i>Pseudoheliodiscus</i> sp.	Late Triassic

**Table 4.** Pebble ages grouped by levels (A, B, and C). Each vertical bar shows the age assignment for each pebble (Tables 1-3). Isotopic ages for stage boundaries based on DNAG time scale (Palmer, 1983)



**Table 5.** Pebble ages displayed in order of age. Chert colours: gy = grey; gg = grey-green; gr = green; bg = brown-green; bb = brown-black; b = black; p = pink

			C	A	A	B	A	A	C	A	B	B	B	A	B	B	C	C	C	C	
			3	5	6	4	2	3	6	1	1	6	2	4	3	5	1	2	4	5	
TRIAS.	LATE	Norian	208 ma																		
		Carnian	223																		
	MID.	Ladinian	228																		
		Anisian	232																		
	EARLY	Scythian	236 245																		

## DISCUSSION

### Age of pebbles

All pebbles released identifiable Triassic radiolarians (Tables 1-3). Occurrence of radiolarians of Middle Triassic age in pebbles A5, A6, B4, and C3 is uncertain as the association may be Ladinian or Carnian (Table 1-3). Remaining pebbles are Late Triassic in age, with five or six pebbles being of Late Norian age. Pebbles of level A (Table 1) range in age from Middle-Late Triassic (Ladinian-Carnian) to Late Triassic (Middle Norian; *Latium paucum* - *Pantanellium silberlingi* Subzones of Blome, 1984). Pebbles of level B (Table 2), are younger on average and include Late Norian fauna (*Betraccium deweveri* Subzone of Blome, 1984) in B3 and possibly in B5. Radiolarian ages in C (Table 3) are predominantly Late Norian (*Betraccium deweveri* Subzone; pebbles C1, C2, C4, C5).

Although the age data hint that the erosion that yielded the pebbles affected progressively younger chert strata (Tables 4, 5), the confirmation of this hypothesis requires further detailed sampling. Occurrence of pebbles exclusively of Triassic age over a stratigraphic interval of 60 m at the Tantalus Butte suggests that clastics were derived from a large volume of Triassic chert. At a maximum "sedimentation rate" of 5 m/Ma (on average 1 or 2 m/Ma, circum-Pacific regions; Matsuda and Isozaki, 1991), a continuous Triassic chert sequence would represent a thickness of only 200 m. Erosion must therefore have affected tectonically disrupted, structurally thickened Triassic radiolarian chert sequences. Such structure is commonly observed in the main accreted oceanic terranes, for instance the Northern Cache Creek Terrane in southern Yukon where exposures of exclusively Triassic radiolarian chert cover wide areas (Cordey et al., 1991; Gordey, 1992).

### Potential source terranes

This study shows that Paleozoic chert-bearing units of south-central and eastern Yukon such as the Anvil Range Group (Fig. 1A) or the Road River Group of the Selwyn Basin (Lowe and Hills, 1988) represent unlikely potential source rocks for the Tantalus chert pebbles, at least in Carnacks area. The Paleozoic-Mesozoic Windy McKinley Terrane (Fig. 1A) possesses chert strata which are poorly exposed in Canada, but which are predominantly Pennsylvanian and Permian in age in Alaska (Jones et al., 1981). Referring to radiolarian occurrences, Wheeler (1961) suggested that chert clasts may be derived from the Cache Creek Group (called "Taku Group"). Wheeler illustrated (p. 28) a radiolarian chert thin section that possibly includes specimens of *Capnodoce* sp., *Capnuhosphaera* sp. (Late Triassic; Late Carnian-Middle Norian), or *Livarella* sp. (Late Triassic; Late Norian). More recently, Hart and Radloff (1990) have correlated the chert clasts of the Tantalus Formation with the western belt of the Northern Cache Creek Terrane (Kedahda Formation; Monger, 1975). This study shows that the strongest age similarity lies with the northeast belt of the Northern Cache Creek Terrane (Teslin Plateau) which contains chert of Permian (from blocks in melange, unpub. data by the writer), Middle Triassic, and Late Triassic age (Cordey et al., 1991) including Late Norian chert which is rare in the Canadian Cordillera. Chert colours occurring in the Tantalus pebbles are observable in place in Teslin Plateau exposures. Early Jurassic sediments (chert and siliceous argillite/greywacke) occur in a few localities in the Teslin Plateau (Cordey et al., 1991). If, as suggested by this study, the northeast belt of the Cache Creek Terrane is a source area, Jurassic chert pebbles may yet be found in Tantalus conglomerate, possibly at higher stratigraphic levels.

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