# New paleontological investigations of Upper Triassic shallow-water reef carbonates (Lewes River Group) in the Whitehorse area, Yukon

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## ABSTRACT

The thickest and best-developed Upper Triassic reef complex in the entire North American Cordillera is at Lime Peak in the southern Yukon. The Lime Peak reef complex is a Dachstein-type, Tethyan reef that lies within Whitehorse Trough stratigraphy of Stikinia, an inboard island-arc terrane of unknown Mesozoic paleogeography. Initial studies of Lime Peak reef faunas revealed characteristics similar to other North American Triassic reefs. Our investigation attempts to better define these paleontological relationships and establish paleobiogeographical associations.

Paleontological samples from five carbonate localities within the Lewes River Group contain corals, sponges, brachiopods, bivalves, disjectoporids, and spongiomorphs. For this study, corals and giant bivalves are identified and compared with fauna from Triassic reef deposits found in the Chulitna (Alaska), Quesnel (southern BC), Wallowa and Western Great Basin (western US), and Antimonio (Mexico) terranes. Preliminary field observations in the Yukon confirm the presence of *Wallowaconchid* bivalves known previously only from the Wallowa and Antimonio, and systematic analysis of Lime Peak corals identified seven species common in the Quesnel, Wallowa, or Antimonio terranes. These findings demonstrate that reef fossils found in the Whitehorse Trough of southern Yukon constitute an important paleobiogeographical link between Stikinia and other exotic terranes of the Cordillera.

## RÉSUMÉ

Le complexe récifal du Trias supérieur le plus épais et le mieux formé de la Cordillère nord-américaine est situé à Lime Peak dans le sud du Yukon. Ce complexe est un récif téthysien de type Dachstein inclus dans la stratigraphie de la dépression de Whitehorse située dans le terrane d'arc insulaire intérieur de Stikinia dont la paléogéographie du Mésozoïque n'est pas connue. Les échantillons paléontologiques prélevés dans cinq zones à roches carbonatées du Groupe de Lewes River renferment des coraux, des éponges, des brachiopodes, des lamellibranches, des disjectoporoïdes et des spongiomorphes. Aux fins de la présente étude, les coraux et les lamellibranches géants sont identifiés, puis comparés avec la faune des dépôts récifaux du Trias se trouvant dans les terranes de Chulitna (Alaska), de Quesnel (sud de la Colombie-Britannique), de Wallowa, de la partie occidentale du Grand Bassin (ouest des États-Unis) et d'Antimonio (Mexique). Les premières observations de terrain effectuées au Yukon confirment la présence de lamellibranches de Wallowaconchide connues antérieurement dans les terranes de Wallowa et d'Antimonio. L'analyse systématique des coraux de Lime Peak a mis en évidence sept espèces communes aux terranes de Quesnel, de Wallowa et d'Antimonio. Ces résultats montrent que les fossiles récifaux trouvés dans la dépression de Whitehorse (sud du Yukon) constituent un lien paléobiogéographique important entre le terrane de Stikinia et les autres terranes allochtones de la Cordillère.

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## INTRODUCTION

The North American Cordillera contains numerous Triassic carbonate buildups that once rimmed islands in the paleo-Pacific Ocean, and are now accreted along the continental margin. Although studied less intensely, coral and other reef fauna found in these buildups show similarities to "Tethyan" fossil reefs in Eurasia (Stanley and Senowbari-Daryan, 1986; Reid and Tempelman-Kluit, 1987; Stanley, 1994). However, because of poor development, smaller size, and limited research, little is known about the evolution and paleogeography of North American Triassic reefs. Continued analysis and comparison of Cordilleran reefs will create the basis for a model, analogous to the classic "Tethyan" reef model, of Triassic reef evolution and paleogeography in North America.

Fieldwork was conducted in the Whitehorse area as part of a research project on North American Triassic reef deposits. The goal is to investigate Triassic carbonate deposits of the northern Stikine Terrane (a.k.a. Stikinia) to better understand their paleoecology and paleogeography. Lime Peak and four other carbonate localities, Pilot Mountain Subdivision, Emerald Lake, Grey Mountain, and upper Cap Creek, were examined and sampled for paleontological specimens.

This report presents primary observations and analysis of the paleontology of the Stikine Terrane and its relationship to Cordilleran paleogeography. Through paleontological associations, a paleobiogeographical link between Stikinia and other displaced terranes of North America is formed. This relationship is important in the reconstruction of a Triassic paleogeography for rocks in the Cordillera.

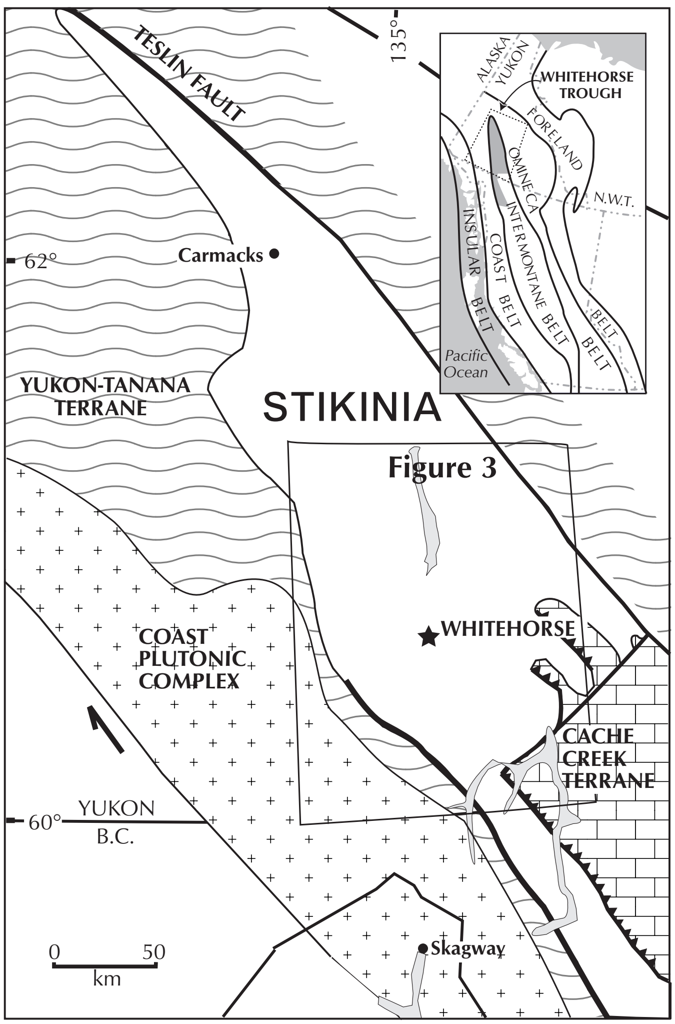


***Figure 1.*** *Regioinal tectonic setting of the study area in Stikinia of southern Yukon. Inset map shows location of Whitehorse Trough with respect to the Cordilleran physiographic belts. Much of Stikine Terrane is underlain by the Intermontane Belt.*

## REGIONAL GEOLOGY

Much of the Canadian Cordillera is composed of disparate crustal fragments called terranes, whose origins, prior to their accretion to the western margin of North America, are suspect. Among the largest of these suspect terranes is Stikine Terrane. In the Yukon, Stikine Terrane is composed of a Paleozoic poly-metamorphosed basement assemblage (Stikine Assemblage), upon which a Mesozoic arc, fore-arc and marginal basin assemblage was built and deposited. Middle Triassic tholeiites and Late Triassic calc-alkaline basalts of the Joe Mountain and Povoas Formations respectively, comprise the dominantly volcanic portions of the arc (Hart, 1997). Whitehorse Trough (Fig. 1), the arc marginal basin, was the depocentre for approximately seven kilometres of largely arc-derived clastic rocks that accumulated during Upper Triassic to Middle Jurassic time (Wheeler, 1961). This sedimentary package, the Whitehorse Trough Supergroup, is divisible into Triassic (Aksala Formation-Lewes River Group) and Jurassic

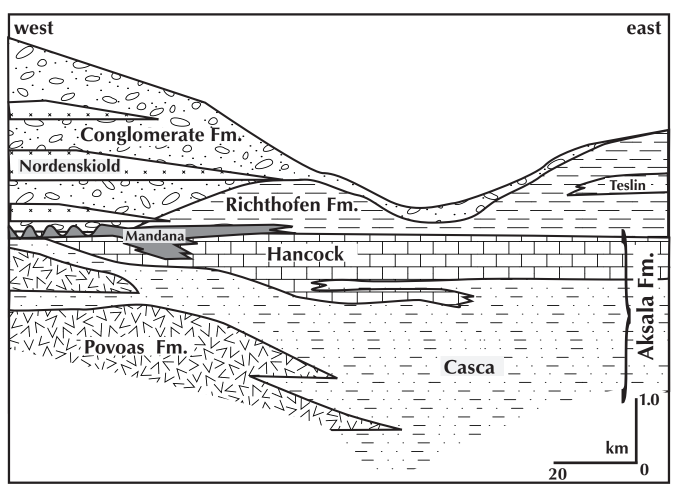


***Figure 2.*** *Generalized stratigraphic section of Whitehorse Trough. Fossils are hosted in the Upper Triassic Hancock Member limestone.*

(Laberge Group) stratigraphic packages (Fig. 2) that are separated by an erosional disconformity along the western margin of the Trough (Hart, 1997).

The upper portion of the Aksala Formation is characterized by thick units of massive carbonate that distinguish the Hancock Member. The age range of this member, as constrained by conodonts and macrofossils, is limited to the upper Norian (Hart, 1997). However the occurrence of Mysidioptera sp. in limestone-rich sections (Formation "C" of Tozer, 1958; Wheeler, 1961, p. 33) indicates that some carbonate buildups are possibly Late Carnian in age. The thick carbonate sequences are within the dominantly clastic Aksala Formation and represent quiescent depositional episodes.

Thick accumulations of carbonate are characterized by massive, resistant weathering, but rounded topography and occurrences are plentiful in the southern Yukon. In the Whitehorse area, the Upper Triassic limestone forms Grey Mountain and is responsible for hosting copper-gold-silver skarn mineralization adjacent to the mid-Cretaceous Whitehorse Pluton.

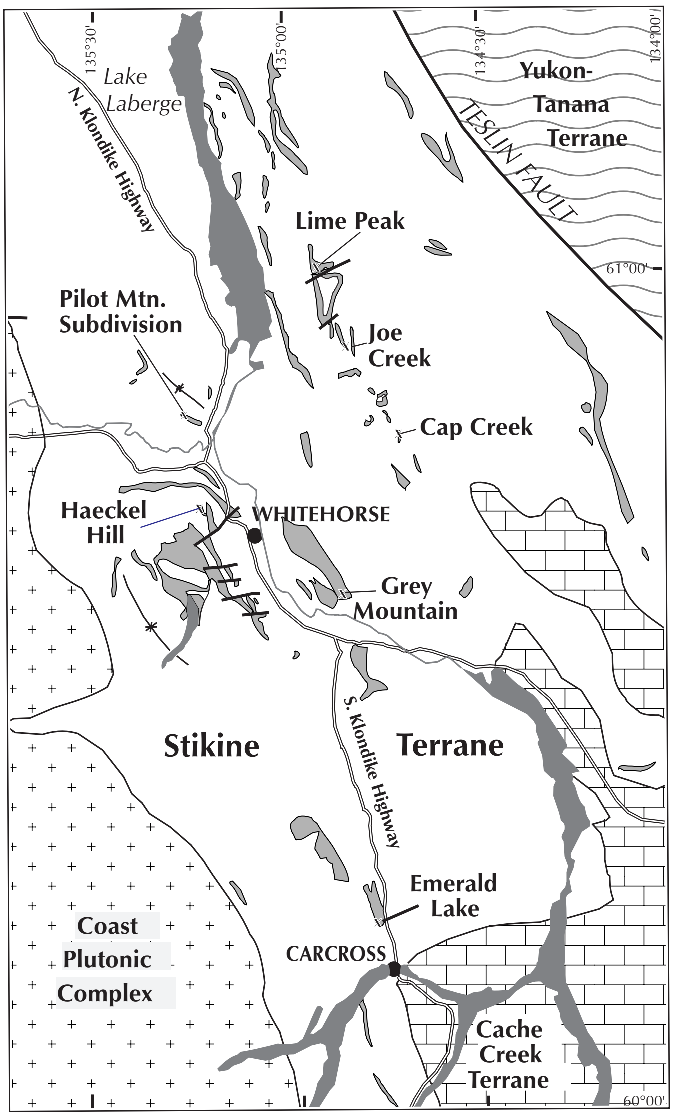


***Figure 3.*** *Upper Triassic carbonate (Hancock Member) (shaded) in the southern Yukon, and fossil localities mentioned in this report.*

# PALEONTOLOGY

Carbonate units outcrop throughout the Whitehorse Trough in the southern Yukon (Fig. 3) but occurrences with well-preserved macrofossils are less common. We document five localities in the southern Yukon with diverse faunas and fair to good preservation — Lime Peak, Pilot Mountain Subdivision, Emerald Lake, Grey Mountain, and upper Cap Creek. Each locality was selected for its abundance of carbonate rock outcrop and the presence of fairly well preserved fossils. Paleontological samples were collected from each location, and the condition of the rock was observed. The age of each locality is determined as Upper Triassic, based on fossil assemblages and adjacent stratigraphy.

## Lime Peak

Located approximately 40 km northeast of Whitehorse, on the north side of Thomas Lake, Lime Peak (Fig. 4) (61°03.5'N, 134°54'W; NTS 105E/2) is the thickest and most fossiliferous accumulation in the Whitehorse Trough. The facies and evolution of Lime Peak are well documented by Reid (1985) who recognized the exposure as representing a series of shallow-water reefs and intervening bedded lagoonal or interreef environments. The diverse assemblage of chambered and nonchambered thalamid sponges also is studied (Senowbari-Daryan and Reid, 1986; Reid and Tempelman-Kluit, 1987). They noted that most of the "reef limestone" consists of several smaller bodies or patch reefs. In many respects the Lime Peak complex is somewhat similar to the Dachstein Reef Limestone

***Figure 4.*** *Aerial view, looking north, towards the Lime Peak Reef complex. Thomas Lake is in the foreground.*

of the Northern Calcareous Alps of Austria and southern Germany (Zankl, 1968).

Our investigation focused on the massive, light brown and unbedded limestone facies where most of the fair-to-well preserved reefal fauna are located. The fossil biotas sampled and observed at Lime Peak include sponges, spongiomorphs, tabulozoans, disjectoporids, scleractinian corals, algae, brachiopods, and molluscs. Recent, unconfirmed coral identifications show the presence of *Gablonzeria* sp., *Chondrocoenia* sp., *Distichomeandra* sp., *Crassistella* sp., *Procyclolites* sp., *Astraeomorpha* sp., and *Retiophyllia* sp. at Lime Peak.

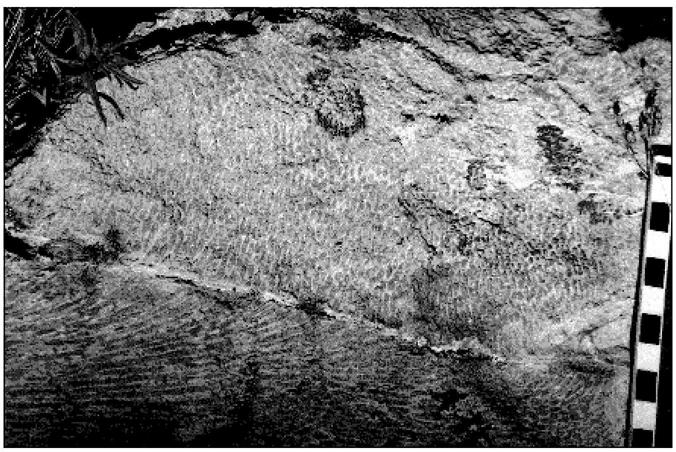

***Figure 5.*** *Retiophyllia oppeli colony in outcrop at Pilot Mountain Subdivision. Scale is in centimetres.*

## PILOT MOUNTAIN SUBDIVISION

This locality (60°52'00"N, 135°13'11"W; NTS 105 D/14), occurs as a linear, 10 m wide exposure that outcrops at its intersection with the hydro line service road, north of the Pilot Mountain subdivision off of the Takhini Hotsprings road. The exposure is less impressive than Lime Peak, but just as important. The limestone is massive and appears slightly silicified. The fossils collected include corals, sponges, tabulozoans, and brachiopods. Initial identification of a coral from this locality (Fig. 5) indicates the presence of *Retiophyllia oppeli* (Reuss).

## EMERALD LAKE

Located approximately 48 km south-southeast of Whitehorse (60°15'44"N, 134°45'28"W; NTS 105 D/7), this locality is exposed along the western side of the south end of Emerald Lake. Access is a short hike from a pull-off along the South Klondike Highway. Outcrop is a steeply east-dipping limestone face that forms the eastern limb of a north-striking anticline. The limestone is massive and quite fossiliferous; however, the nature of the outcrop makes sampling difficult. Samples representing a diverse fauna were collected, such as brachiopods, spongiomorphs, crinoids, thick-shelled oysters, corals, gastropods, inozoan sponges, and the "winged" bivalve known as *Wallowaconchid*. Due to recrystallization, preservation of corals and sponges is poor, however, two brachiopods were identified as *Spondylospira lewesensis* (Lees) and *Terebratulid* sp. and the oyster is *Lopha*. These three species are also found at Lime Peak.

## GREY MOUNTAIN

The Grey Mountain locality lies east of Whitehorse (60°39'25"N, 134°53'20"W; NTS 105 D/10) and is shown on many maps as

***Figure 6.*** *Large, "whole" Wallowaconchid bivalve at Grey Mountain. View is looking down at its top, at an oblique angle. Scale is in centimetres.*

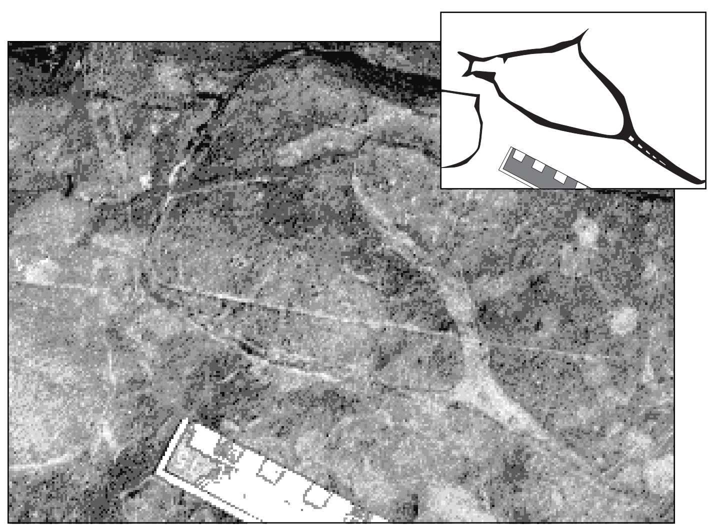

***Figure 7.*** *Cross-sectional view of a Wallowaconchid bivalve at Grey Mountain. Note characteristic "wings" and their segmentations. Scale is in centimetres.*

Canyon Mountain. Access is by a rough gravel road used to access communications towers at the south end. The limestone is massive, and light grey weathering but appears blackish and recrystallized on fresh surfaces. Exposure is generally continuous with intermittent covered intervals. A limited but significant fauna is observed, including abundant *Wallowaconchid*s and thickets of large and small sized *Retiophyllia* coral (Figs. 6 and 7). The *Wallowaconchid* "wings" measure 28 and 30 cm in length, and the *Retiophyllia* are dendroid and without connecting processes. The appearance of the *Retiophyllia* suggest a low energy, possibly lagoonal, depositional environment for this limestone.

### CAP CREEK

Accessible only by helicopter, the Cap Creek locality (60°51'19"N, 134°41'45"W; NTS 105 D/15) is near the upper reaches on the east side of Cap Creek. Limestone outcrops form dark grey, massive beds with covered intervals underlain by shales and mudstones. Fossils observed and sampled include bivalves, sponges, spongiomorphs, Distichophyllid corals, and gastropods. East of the limestone outcrop, a thinly laminated mudstone, indicative of deeper water depositional environment, contained a bed of *Monotis* sp. bivalves. Preliminary identification of the sponges finds probable *Nevadathalamia* sp. and *Cinnabaria* sp. similar to those found at Lime Peak. This locality produced a conodont assemblage defined as Late Norian (site T-20 of Hart, 1997).

## DISCUSSION

The Whitehorse area is unique in having well-developed Upper Triassic (Norian) carbonates which also contain thick reef complexes. Similar reef complexes of equivalent age are known from far-flung sites in the Cordilleran terrane collage including in northwestern Oregon, the Wallowa Terrane (Stanley and Senowbari-Daryan, 1986) and from central British Columbia, Quesnel Terrane, the Eaglenest reef (Stanley and Nelson, 1996).

The five localities investigated for this project are stratigraphically and paleontologically related and together reveal important information. Paleontological examination of fossil corals and giant alloform bivalves from the Stikine Terrane of the southern Yukon indicate the presence of species that show a possible link with other exotic terranes of the North American Cordillera. Six coral species, initially identified from Lime Peak and nearby carbonate deposits, are also known from the Quesnel, Wallowa, Western Great Basin, and Antimonio terranes (Table 1). However, coral and other fossils from the same deposits also show Tethyan, or European affinities (Reid and Tempelman-Kluit, 1987). A seventh coral sampled from Lime Peak and identified as *Procyclolites triadicus* Frech, is classified as Tethyan and is commonly found in fossil reef deposits in the Alps.

The large, "winged" bivalve, *Wallowaconcha raylenea* is unequivocally known at two of the five reported Yukon locations (Grey Mountain and Emerald Lake), as well as two unreported locations (Haeckel Hill, 60°45'25"N, 135°12'25"W; Joe Creek, 60°59'10"N, 134°52'30"W; sites T-7 and T-9 respectively of Hart, 1997). The same species of *Wallowaconcha* also is reported from the Wallowa Terrane in northeastern Oregon), and a smaller, and yet indeterminate species, recently has been discovered from the Chulitna Terrane of Alaska (Stanley and Yarnell, in prep.). The Alaskan species appears also to occur in the Antimonio Terrane, Sonora, Mexico. These giant wallowaconchid bivalves constitute a unique tropical element, known only from the Norian stage of the Upper Triassic and endemic only to a few Cordilleran terranes. Reaching up to a meter in breadth, these bivalves lived in fine-grained muds. They are termed "alatoform" because unlike most bivalves, they lie flat on the substrate with their commissures oriented vertically. They were especially adapted to reef environments and appear to have inhabited lagoons. Wing-like extensions from the main body chamber surround the shell with series of tubes, appearing in cross section, like chambers. These chambers are interpreted as housing symbiotic algae. Like reef corals and molluscs today, these symbiots most likely benefitted the metabolism of the host and the growth of the large shells.

These tropical, specialized wallowaconchids constitute a new family, entirely unknown from any of the numerous Upper Triassic (Norian) reef localities in the former Tethys region. They

***Table 1.*** *Geographic distribution of Upper Triassic fossils in the North American Cordillera.*

| Taxa | Chulitna | Stikine | Quesnel | Wallowa | Western Great Basin Terrane | Antimonio |
|---|---|---|---|---|---|---|
| **CORAL** | | | | | | |
| *Astraeomorpha* sp. | | X | | | X | X |
| *Chondrocoenia* sp. | | X | X | | X | X |
| *Crassistella* sp. | | X | | X | X | |
| *Distichomeandra* sp. | | X | | | X | X |
| *Gablonzeria* sp. | | X | | X | X | X |
| *Retiophyllia* sp. | X | X | | X | X | X |
| **BIVALVE** | | | | | | |
| *Wallowaconcha* sp. | X | X | | X | | X |

are also unknown from the North American craton. Because of their restricted, endemic nature, most likely reflecting a limited ability to disperse, these bivalves appear important for reconstructing the Upper Triassic paleogeography of Tethys.

## CONCLUSION

Sedimentology and stratigraphic documentation of the spectacular Upper Triassic reef at Lime Peak by Reid (1985) was followed-up with a detailed taxonomic study of sponges found there (Senowbari-Daryan and Reid, 1987). Corals and other elements of the fauna are in need of study and appear useful in paleogeographic analysis. Although somewhat smaller and less well exposed than at Lime Peak, Upper Triassic reef carbonates are fairly common throughout the Whitehorse Trough.

Our investigations of Upper Triassic Stikine Terrane (Whitehorse Trough) carbonates indicate paleontological similarities with other terranes in Alaska, British Columbia, and the United States and suggest paleogeographical proximity during their deposition as coral and reef-fringed volcanic islands in the ancient Pacific Ocean). Since their accretion to North America, most terranes have been dislocated from their original paleolatitudes. Some were rotated and most were moved far from the tropics by extensive transcurrent or strike-slip faults which further modified the rock assemblages along the western edge of the North American Cordillera. These tectonic complexites complicates correlation and matching of terranes, and the reconstruction of their pre-accretion paleogeography.

Paleogeographic models based on fossils of the Permian and Jurassic show Stikinia in the northern hemisphere in the tropical eastern Pacific, some distance from North America. The presence of abundant Tethyan fossil taxa among the carbonates of the Whitehorse Trough also indicates a paleogeographical link between Stikinia and the Tethys. These associations so far from the western reaches of the Pacific seem problematic. Such distributions may indicate the dispersal abilities of some invertebrates in conjunction with changing patterns of terrane geography through time (Westermann et al., 1990). Continued research and study of the taxonomy of Triassic reef fossils in Yukon and throughout the Western Cordillera will improve an understanding of Triassic reef paleogeography and paleoecology.

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