Elucidating the tectonic evolution of the Southern Canadian Cordillera: A comprehensive analysis of the enigmatic orogenic processes and structural architecture.

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Abstract

This thesis reconstructs the present-day orogenic architecture diagram of the Southern Canadian Cordillera, focusing on the complex interplay of orogenic processes from the Mid-Jurassic to the Cenozoic. Through detailed analysis of stratigraphic, structural and geochronological data this study identifies major tectonic units and their kinematic relationships, which will shed light on the enigmatic nature of this region and provide insights into the region's geological evolution. In this study the orogenic architecture diagram displays the schematic obduction of the Cache Creek-marine accretionary complex- onto Stikinia (a plutonic arc formation) and significant crustal thickening within the Omenica Belt. These events, alongside deformation, sedimentation and metamorphism in the region have been synthesized in the orogenic architecture diagram, which provides a comprehensive overview of the Cordillera's development. This in combination with the detachment in thre lower crust of the region played a crucial role in shaping the regions geological history.And by linking these tectonic events across the orogen progress can be made in deciphering the enigmatic nature of the Southern Canadian Cordillera.

Introduction

The paleogeographic and tectonic history of the Canadian Cordillera remains enigmatic. Citing the disappearance of large tracts of ocean floor beneath the western margin of North America (~13,000 km during the past 150 m.y.), Monger and Price (2002) pointed out the potential of plate convergence of this magnitude to leave behind cryptic and highly incomplete record of accretionary and arc complexes within the Canadian cordillera. These complexes have been named 'terranes' with an often poorly constrained or unspecified paleogeographic origin.These terranes are separated from adjacent terranesby faults that formed during of after accretion, and whose amounts of displacement is not always clear.

In this paper we wish to elucidate the ambiguous nature of terranes by constructing orogenic architecture diagrams. These will help the readers form thorough visual image of the stratigraphy an the structural evolution in the history of the Cordillera.

In south-central British Columbia, three terranes have been identified based primarily on paleogeographic reasoning (see Figs 1). They consist of the following: Kootenay, characterized as pericratonic-within the proximity of continental margin- according to Gabrielse et al. (1991); Quesnel, described as a far-traveled upper Paleozoic-lower Mesozoic intra-oceanic arc complex by Monger et al. (1991); and Slide Mountain, interpreted as the remains of an accretionary complex and oceanic crust, believed to have originated within an oceanic basin situated between the Quesnel and Kootenay terranes, as indicated by Murphy et al. (1995).

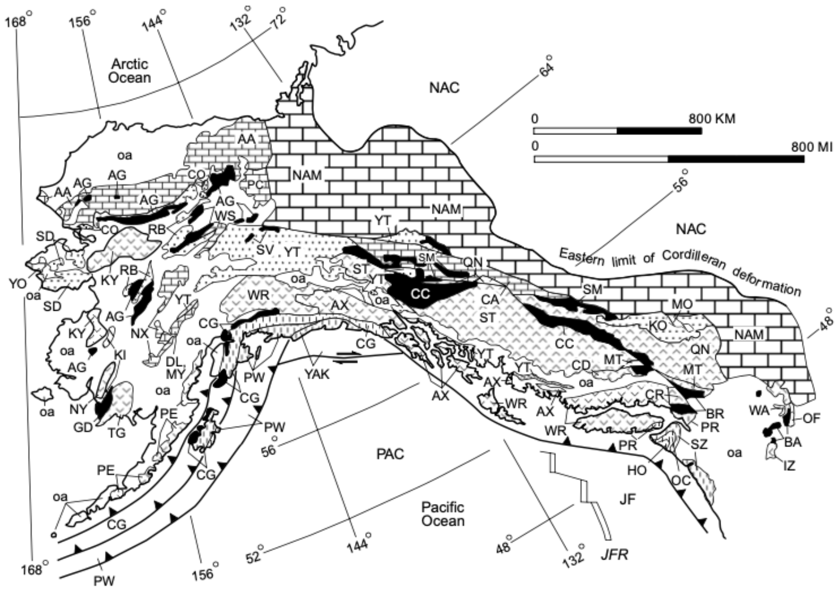

Fig 1: the Canadian Cordillera, and adjacent offshore areas, showing locations of major terranes, major oceanic plates, major offshore faults, and tectonic environment. Adapted from Nokleberg and others (1994a, 1997a, b) and Monger and Nokleberg (1996).

To properly understand the tectonic evolution of the Cordillera we must look the connection between the western Canada Sedimentary Basin and its connection to global plate tectonics. This evolution of the WCSB is indistinguishable from the origin and evolution of the Cordillera (Armstrong 1988) and thereby also linked to the plate convergence problem of the Cordillera.

The Canaedian Cordillera is often subdivided into five distinct morpho-geological belts, denominated as Foreland, Omineca, Intermontane, Coast, and Insular belts, progressing from east to west (Fig 2; Gabrielse et al., 1991). Each of these belts exhibits unique combinations of different topographical features, geological compositions, metamorphic gradation, and structural styles. The spatial arrangement of these belts is delineated in Figure 1, while Table figure provides a synthesis of their distinctive attributes and spatial relationships with major mountain ranges and plateaus. It is noteworthy that each belt embodies the cumulative processes that have molded the Cordilleran region since the late Neoproterozoic era (approximately 750 Ma) (ref).

Furthermore, the Canadian Cordillera, depicted in Figure 1, is composed of three main components: (1) primarily sedimentary deposits that developed on and near the continental edge of prehistoric North America, known as the craton margin; (2) terranes primarily composed of arc and oceanic rocks that separated early in their histories and later joined the Cordilleran "collage" (Coney et al., 1980; Gabrielse and Yorath, 1991); and (3) supracrustal rocks deposited in basins both during and after terrane accretion. Geological history and physiography are both reflected in the five morphogeological bands that make up the Canadian Cordillera (Gabrielse et al., 1991; Fig 1). The metamorphic-plutonic Omineca and Coast belts correspond with the main zones of terrane fusion and accretion (Monger et al., 1982).

The Foreland, Intermontane, and Insular belts, which are composed of sedimentary, volcanic, and plutonic rocks with little to no metamorphosis, border these. The accreted terranes are primarily coincident with the Intermontane and Insular belts, whereas the Foreland belt comprises of strata deposited on the old cratonic edge of North America (Simony and Carr 2011). Additionally, fold-and-thrust belts spanning the Cretaceous to early Cenozoic era were created by the deformation of syn- and post accretion successions. Terranes from the Intermontane belt accreted primarily to North America during the Early to Middle Jurassic (e.g., Gabrielse & Yorath, 1991). According to van der Heyden (1992) and McClelland et al. (1992), the accretion of Insular belt terranes to those farther inboard occurred either in the Jurassic or earlier.

The accretion of Insular belt terranes to those farther inboard occurred either in the Cretaceous (Monger et al., 1982) or earlier in the Jurassic (van der Heyden, 1992). Significant orogen- parallel displacement occurred on transcurrent faults inside or near the metamorphic-plutonic belts during and after amalgamation. From the mid-Cretaceous to the early Cenozoic, there were dextral faults in and around the Omineca and Coast belts (e.g., Gabrielse, 1991a; Gabrielse et al., 2006). Before then, for the Early Cretaceous rocks offshore of the Bowser basin, a sinistral displacement of unknown scale is inferred (Evenchick, 2001). These strike-slip displacements will be taken into account in our analysis of pre-Cenozoic orogenic history.

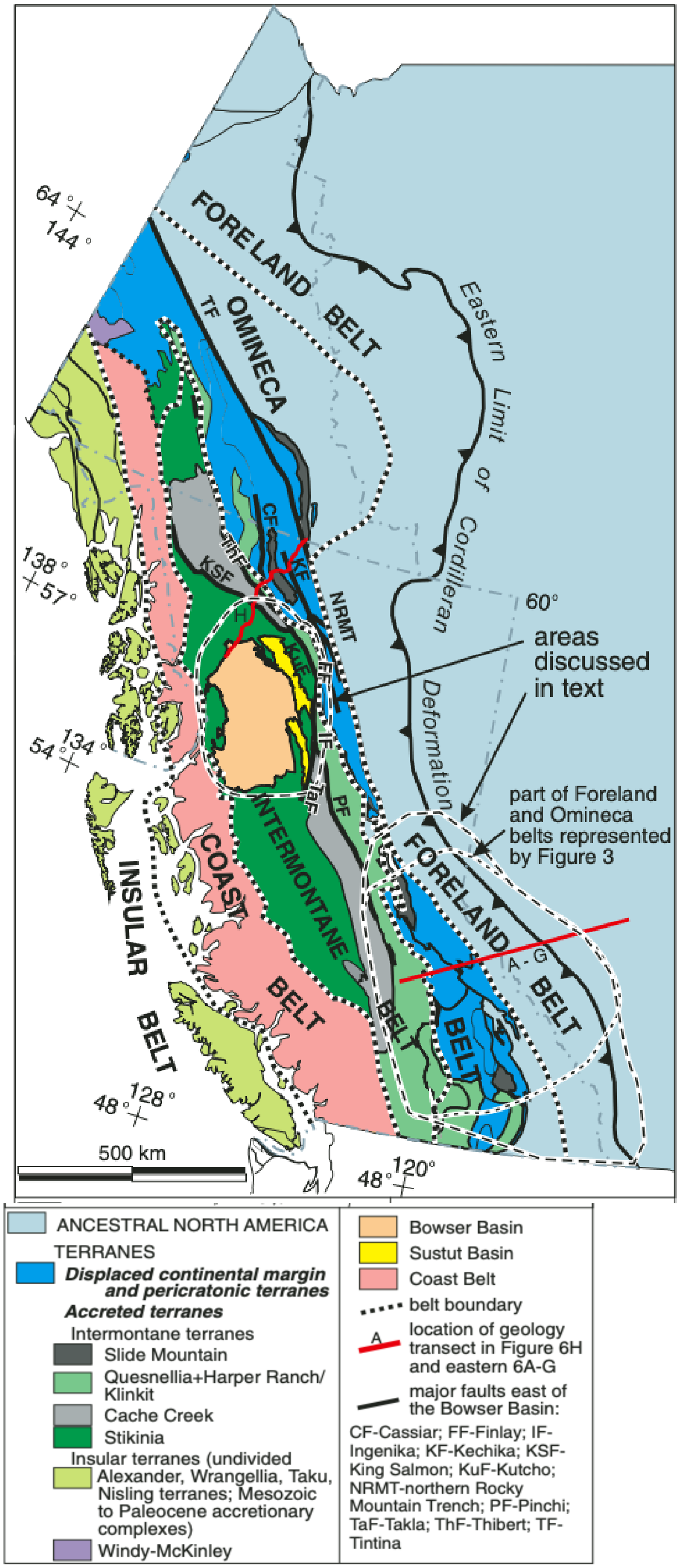

Fig 2: Morphogeological belts and major terranes of the Canadian Cordillera. Slide mountain, Cache Creek and Quesnellia ‘terranes are further discussed in text’ (Evenchick et al.,2007)

Plate tectonics and Cordilleran tectonic evolution

The contemporary plate tectonic regime provides an actualistic model for elucidating the role of plate tectonics in the orogenic progression of the Cordillera. Presently, the tectonically active western boundary of the North American Plate consists of three different segments (Figure 3). The southern segment depicts a subduction zone where sections of oceanic lithosphere from the Juan de Fuca Plate and its derivative, the Explorer plate, undergo northeastward subduction beneath the overriding continental lithosphere of southern British Columbia and Washington at a rate of 20-46km/Ma. These slabs descend into the asthenosphere beneath, the magmatic arc, depicted by the Cascade volcanoes, spanning from Mount Shasta in northern California to Mount Garibaldi in SW British Columbia (Figure 3).

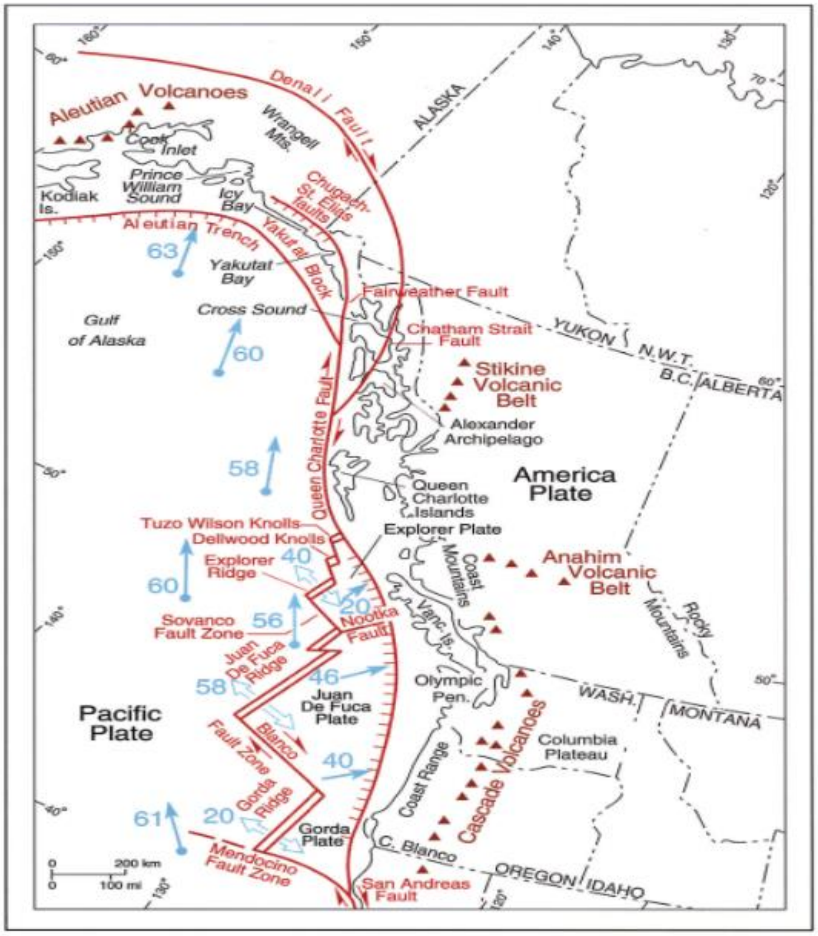

Fig 3: Present-day plate tectonic movement for the Canadian Cordillera and opposing Pacific Ocean basin. Blue arrows showing direction and rate of displacement relative to North America. (Riddihough and Hyndman 1991)

The central segment, extending northward into the Gulf of Alaska from south of the Queen Charlotte Islands, encompasses the Queen Charlotte and Fairweather right-lateral transform faults. Along these faults, the Pacific Plate and the Yakutat (Wrangel mountain-) block move in a northwestward direction relative to the NA plate at approximately 55km/Ma.

The northern segment encompasses the Aleutian Trench and he Chugach-St Elias faults. These geological features facilitate the sliding of the Pacific Plate and the Yakutat “block” beneath the magmatic arc aligning with the Aleutian volcanoes which extend westward from the Cook Inlet. The Yakutat "block" represents an allochthonous terrane, comprising of Cenozoic and Mesozoic clastic sediments transported into the Gulf of Alaska on the Pacific plate. These sediments are currently in the process of colliding with and becoming accreted to the NA plate.

This overarching pattern of oblique convergence, involving a combination of right hand strike-slip, subduction of oceanic lithosphere from the Pacific Ocean floor beneath the western NA, and the accretion of buoyant rock bodies embedded in the oceanic lithosphere, has dominated the evolution of the Canadian Cordillera since the mid-Cretaceous period.

Reconstructions of Late-Mesozoic- Tertiary Plate motions

Reconstructions of Late Mesozoic-Tertiary plate motions, based on the examination of sea-floor magnetic anomaly patterns and the trajectories of mantle hotspots as depicted by (Engebretson et al.,1985;Andjic et al 2023), reveal an extended history spanning more than 160Ma of convergence between NA and the oceanic lithosphere of the Pacific Oceanic basin. These reconstructions indicate a transition from a pre-Mid-Cretaceous configuration characterized by nearly orthogonal and left-lateral oblique convergence to a Late Cretaceous and Tertiary right lateral oblique convergence pattern.

Engebertson et al.,1988 estimates that a swath of oceanic lithosphere, approximately 11,500 km in width, has undergone subduction beneath the western boundary of the NA plate within 20 and 60° latitude north since the Jurassic period. Consequently, vast horizontal displacements involving the transport of relatively buoyant masses, such as oceanic volcanic arcs, oceanic plateaus and seamount chains nestled in the oceanic lithosphere along with the tectonic accretion of extensively migrated allochtonous terranes (Debiche et al.,1987), are expected along the convergent plate boundaries that separate NA and the eastern Pacific Ocean Ben-Avraham et al.,1981)

Geological setting

The Main and Front ranges of the Rocky Mountains, as well as the Foothills, are the External zone of the orogen, also known as the Foreland thrust and fold belt. It is made up of Mesozoic to Paleocene layers from the Foreland Basin and Paleozoic and Paleozoic strata from the North American platform and border (Figure 4). These strata were deformed over time by thin-skinned, east-verging, thrusting and folding events that occurred in successive pulses from the Cretaceous to the Eocene. The Purcell, Selkirk, and Cariboo mountain ranges, and the western Rocky Mountains, are home to the Eastern Internal zone of the fold and thrust belt. This consists primarily of clastic Proterozoic and Paleozoic rocks from North America. Locally interwoven sheets of basement from the Laurentian (Canadian Shield) were tectonically interlaced and interfolded with the cover (e.g. Malton Complex; Price,1994). The Western Internal zone, the metamorphic and plutonic core of the origin is situated in the southern Selkirk and western Purcell mountains and partly in the Cariboo, Selkrik and Monashee mountains, and to the west in the uplands of these ranges (Figure 4). The Western Internal zone comprises of clastic Proterozoic and Paleozoic North American strata along with the inboard part of the hinterland, namely the inner accreted terranes, including the Slide Mountain marginal basin and Quesnel volcanic arc terranes, which were accreted by eastward directed thrusting onto the North American strata during the Late Triassic- Middle Jurassic due to westward underthrusting of the craton (Simony and Carr 2011, Fig 1). In the Western internal zone the Canadian shield basement rocks are apparent in the Thor-Odin and Frenchman Cap domes. There are several prevailing igneous suits, in the Internal zones that provide important timing constraints on tectonic thermal events. These include Middle Jurassic calc-alkaline plutons derived above a subduction zone in a continental arc and Early Cretaceous and Paleocene leucogranites generated by crustal thickening and anatexis (Armstrong, 1988; Ghosh and Lambert 1995)

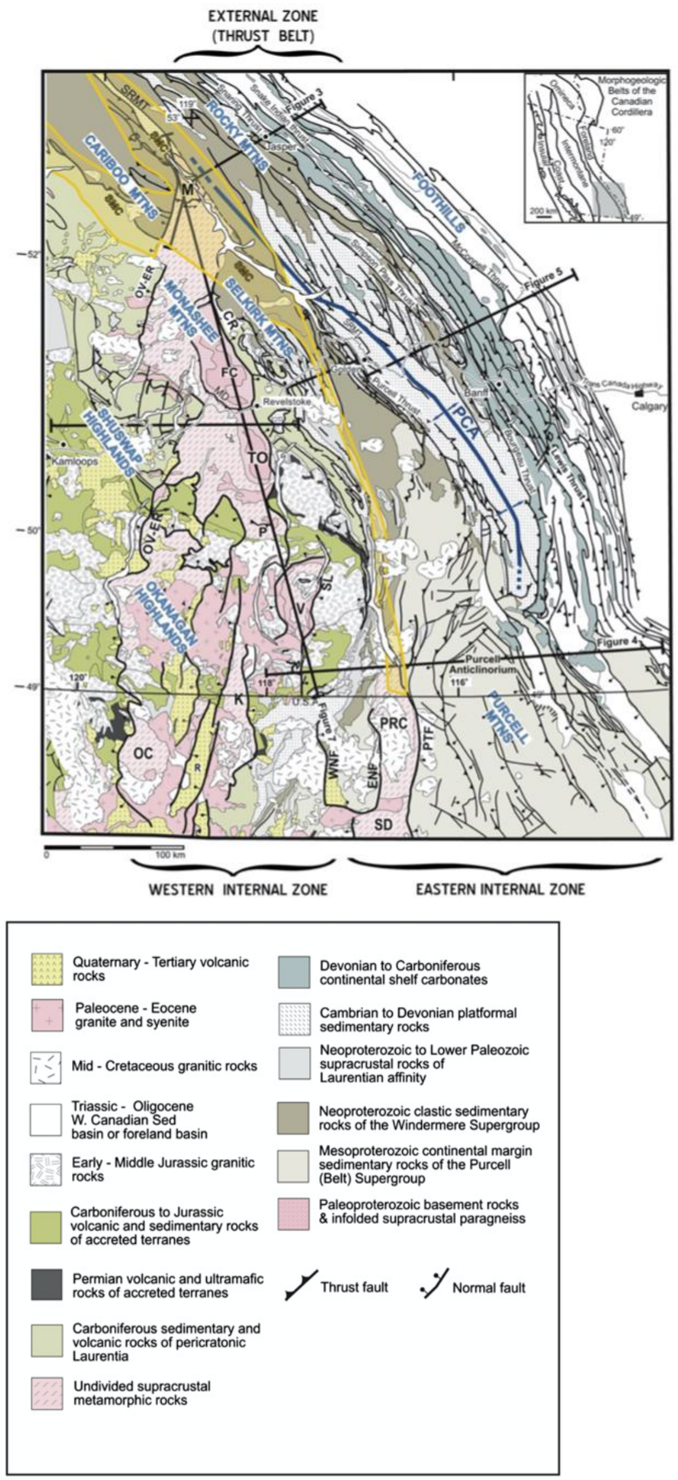

Figure 4: Geological map of the SE Canadian Cordillera depicting the External, Western internal and Eastern Internal zones. The shaded area shows the map within the morpheological belts of the Canadian Cordillera. (Simony and Carr 2011)

Cordilleran Terranes

The Cordilleran terranes can be distinguished in a large subset of allochthonous terranes (Figure 2). Each of which is characterized by a distinct geological history that sets it apart from the other (Davis et al.,1978). The larger terranes, namely Quesnellia, Stikinia, Wrangellia, and Alexander, comprise of cohesive entities encompassing laterally persistent tectonostratigraphic assemblages primarily composed of oceanic volcanic arc rocks. Adjacent to these are disrupted terranes, such as Slide Mountain, Cache Creek, Bridge River, Hozameen, Pacific Rim, and Chugach, characterized by a dominance of deep-ocean-basin sedimentary rocks, basaltic volcanic rocks, and ultramafic rock bodies (Monger and Price, 1979). These disrupted terranes are indicative of former ocean basins, marginal seas, or back-arc basins, primarily serving as oceanic accretionary prisms.

The Kootenay terane consists of Paleozoic pelite, feldspatic quartz wacke and grit and basic acidic volcanick rocks that are commonly deformed by Devonian granites, and are unconformably overlain by upper Paleozoic pelite, conglomerates, sandstones, limestones and basic volcanic rocks (Monger et al., 1982).

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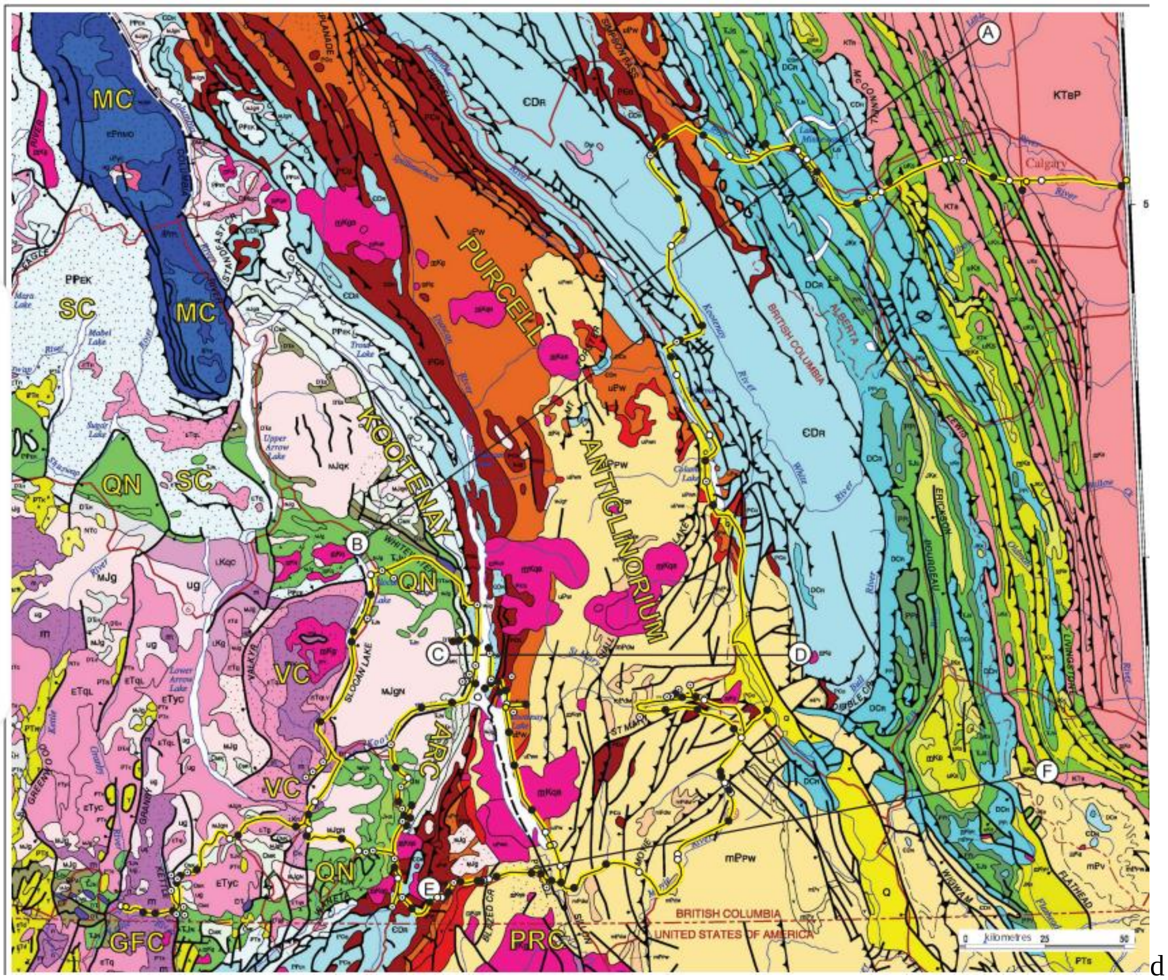

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Figure 5: Geological map of SE British Columbia (Journeay et al.,2000). GFC: Grand Forks complex. MC: Monashee complex. PRC: Priest River complex. QN: Quesnellia (Quesnel terrain). SC: Shuswap complex (of which the MC is its eastern, deeper part). VC: Valhalla complex. (Pattison et al.,2020)

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Foreland Belt

Geomorphological Units: Include Rocky, Mackenzie and Franklin mountains

1. **Geology:** Primarily consists of sedimentary rock: Mesoproterozoic (locally Paleoproterozoic) clastics, carbonates, and minor magmatic rocks, deposited within continental basins.
2. Neoproterozoic to earliest Cambrian shale, sandstone, conglomerate, minor carbonate, and localized mafic magmatic rock, sedimented during the rifting and initial fragmentation of the Rodinian supercontinent, which shaped the ancient continental margin of western North America.
3. Cambrian to Jurassic shelf and slope formations, consisting of carbonate and shale, deposited on and close to the ancient continental margin of North America.
4. Late Jurassic to early Cenozoic marine to non-marine clastics, eroded from the uplifting Omineca and Foreland belts, with subsequent folding and thrusting of rocks eastwards over the ancient continental margin during the Late Jurassic to early Tertiary period.

Omineca Belt

Geomorpholigical units include: Purcell, Selkirk, Monashee, Cariboo, Omineca, Cassiar and Selwyn mountains

Geological compositions are diverse, comprising sedimentary, volcanic, and granitic rock types, typically metamorphosed to high grades. These formations include:

1. Local Paleoproterozoic continental crust.
2. Neoproterozoic rift-related clastics and volcanics.
3. Paleozoic pericratonic formations, off-shelf clastic deposits, and volcanic rocks.
4. Locally accreted late Paleozoic to Early Jurassic volcanic and sedimentary strata, originating from island arcs and marginal basins.
5. Early Cenozoic continental volcanic and sedimentary formations.
6. Paleozoic to early Tertiary granitic rocks.

These rocks have undergone complex deformation, primarily through compression between the Middle Jurassic and early Tertiary periods, and, in southern regions, extension during the early Tertiary era.

Intermontane Belt

Geomorpholigical units include Interior Stikine, Yukon plateaus and Skeena Mountains

Geology: Volcanic, sedimentary, and granitic rocks:

Sedimentary and volcanic rocks from the Devonian to the Early Jurassic period originated in island arcs and chert-rich accretionary complexes. 2a. Volcanic rocks from the Middle Jurassic to the early Cenozoic period predominantly formed in continental arcs.2b. Marine and non-marine clastics were primarily eroded from the uplifting Omineca Belt during this period.

Granitic rocks spanning from the Devonian to the Cenozoic period were subjected to deformation primarily by compression during the Mesozoic era and extension-transtension in the early Cenozoic era.

Coast Belt

Geomorpholigical units include: Coast and Cascade mountains

Geology: Mainly granitic rocks (1) Spanning from the Jurassic to the Cenzoic era. (2) Remaining Paleozoic to Holocene volcanic and sedimentary rocks formed mainly in magmatic arcs and occasionaly in accretionaty complexes. They underwent metamorphism up to high grades in mid-Cretaceous through early Cenozoic time.

Insular Belt

Insular Mountains, Saint Elias Ranges, coastal depressions, continental shelf and slope

Geology: Volcanic, sedimentary, and granitic rocks are characterized as follows:

1) Latest Proterozoic to mid-Cretaceous volcanic and sedimentary rocks primarily formed in island arc settings, with less frequent occurrences in oceanic plateau environments.
2) Clastic formations from the mid-Cretaceous period onwards, eroded mainly from the Coast Belt.
3) Granitic intrusions spanning from the Paleozoic to the Tertiary period.
4) Clastic-rich accretionary complexes from the Late Jurassic to the Holocene period, predominantly deformed during the Late Cretaceous to Holocene times.

Method

Here we will elaborate on the tectonic evolution diagrams to shed light on the region's complexity and tectonic evolution. This diagram will depict and simplify the building blocks of the orogenesis which will comprise of the region's stratigraphy, the stages of metamorphism the structural positioning and the position and incorporation in the orogenesis. This will be a schematic representation of the orogenic architecture of the region which will make the history of the region more simple.

We will reconstruct the present-day pattern of major tectonic units of the Southern Canadian Cordillera, whereby we characterize the platforms and basins based on sedimentary facies, or on oceanic or continental basement. By identifying the major nappes and viewing their timing of emplacement we create the Table Figure based on structural, stratigraphic and geochronological constraints which will describe the architecture of the Southern Canadian Cordillera.

In the Table Figure we identify the major extensional and compressional windows and review the quantitative constraints on extensional, strike-slip displacement and shortening. The summary of this will be displayed in the orogenic architecture where we will link a schematic cross-section through the main orogenic belts with first-order kinematic relationship and timing of displacement.

Furthermore, we will review he orogenic architecture of the Southern Canadian Cordillera at first order, illustrated with maps and orogenic architecture charts that show the juxtapositions of the main tectonic units of the orogen and the timing of their emplacement.

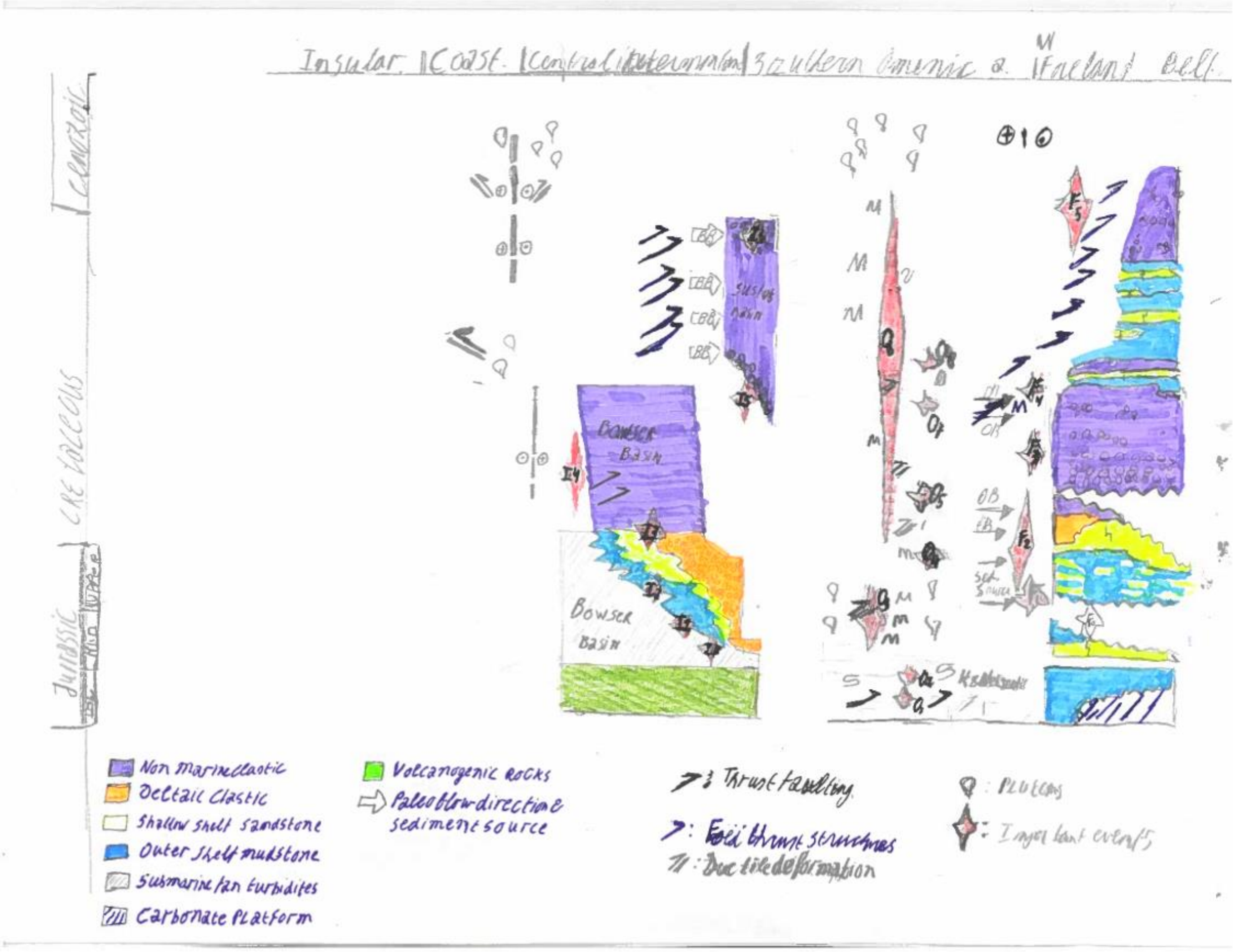


Table Figure architecture diagram: Depicting the most important moments in the development of the region's tectonic evolution.

Fig Code	Event	Timing	Reference
F5	There was rapid sedimentation of coarse clastic materials at a rate of 100 meters per million years (m/m.y.). The primary source of these sediments was the dominant Foreland belt. This period coincided with a significant phase of deformation, during which the deformation front migrated eastward across the Front Ranges and Foothills.	Late Campanian– Early Eocene (ca. 77–53 Ma)	Price and Mountjoy (1970); Price (1981); McMechan and Thompson (1993, and references therein); Ross et al. (2005)
F4	In the westernmost part of the Foreland belt near 53°N, there was northeast-directed thrust faulting. Around 110 million years ago, the Yellowjacket gneiss experienced cooling. Additionally, at approximately 100 million years ago, deformation resulted in thrust faults immediately to the east.	110-100Ma (Albian)	Mcdonny and Simony 1988
F3	Major period of pedimentation; development of low-angle unconformity with stratigraphic separation increasing eastward except in westernmost Foreland basin.	Hauterivian to Early Aptian (ca. 136–110 Ma)	Stott and Aitken (1993); Stott (1998); White and Leckie (1999)

F2	During the Upper Jurassic period, there was rapid sedimentation originating from the west Omineca highland, with deposition rates reaching up to 100 meters per million years (m/m.y.). This period was characterized by a shallowing- and coarsening-up sequence.	Kimmeridgian-Valanginian ca. 156–136 Ma)	Poulton (1989); Poulton et al. (1993, 1994b); Stott and Aitken (1993); Stott et al. (1993); Stott (1998)
F1	The initial phase involves regional subsidence accompanied by the deposition of thick sediments derived from the west (Omineca highland). These sediments overlay a thin basal transgressive sandstone derived from the craton.	Oxfordian (post–Early Oxfordian (ca. 158–156 Ma)	Poulton (1984, 1989); Poulton et al. (1993, 1994b); Stott (1998)
F0	The base of the Alberta foreland basin succession exhibits a time-transgressive erosive disconformity.	Callovian- Oxfordian (ca. 164–160 Ma)	Poulton (1984); Poulton et al. (1993, 1994b)

Table Omenica Belt

Fig Code	Event	Timing	Reference

O8	The Purcell thrust system is situated chronologically between the Bearfoot and related thrusts and the Horsethief Creek batholith.	Mid-Cretaceous pre–ca. 93 Ma	Archibald et al., 1983); P.S. Simony (2005, personal commun.)
O7	The emplacement of Malton gneiss basement-cored nappes occurred through the Bearfoot and related ductile thrusts. This event took place after the period between 140 and 126 million years ago, as evidenced by deflected isograds [O6]. It also predates or synchronizes with the cooling of Yellowjacket gneiss around 110 million years ago and the formation of deformation thrust faults in the Foreland belt approximately 100 million years ago, which occurred immediately to the east.	Late early Cretaceous	McDonough and Simony (1988, and references therein); Digel et al. (1998); Crowley et al. (2000, and references therein)
O6	Between 51.5 and 52.5 degrees latitude in the Cariboo, Monashee, and Selkirk mountains, there is evidence of penetrative polydeformation and metamorphism. Close to the line depicted in Table Figure.., there's a southeastward imbrication of basement slices at depth, accompanied by southwest-verging folds and faults at higher levels, such as observed in the Hobson Lake area. Additionally, fold fans like the Ozalenka fan are present in this region. South of 52 degrees latitude and at deeper structural levels, there is generally northeast-verging polydeformation and the presence of high-strain zones, as exemplified by findings in the Scammell area (Scammell, 1993).	throughout the Late Jurassic, Early Cretaceous, and Late Cretaceous	Parrish (1995); Currie (1988); Scammell (1993); Digel et al. (1998); Crowley et al. (2000); Reid (2003, and references therein); Gibson (2003)

O5	Penetrative polydeformation and metamorphism—Allan Creek area, Cariboo Mountains.	ca. 143–126 deformation; ca. 135 Ma metamorphism	Parrish (1995); Currie (1988)
O4	In the eastern Hobson Lake area of the Cariboo Mountains, there is evidence of southwest-verging penetrative deformation and metamorphism	Ca 147Ma syntectonic metamorphism	Reid 2003
O3	The onset and formation of significant architectural features, such as southwest-verging folds, fold fans, and belts of northeast-verging folds and faults, occurred during a period around the peak of metamorphism, approximately 165 to 160 million years ago. This period coincides with biotite-grade metamorphism observed in locations like Hobson Lake and the Scrip Nappe.	(3b) 174–162 Ma in Cariboo Mountains	Archibald et al. (1983); Gerasimoff (1988); Struik (1988); Brown et al. (1992b); Parrish (1995); Warren (1997); Colpron et al. (1998); Gibson (2003); Reid (2003)
O2	South west-verging thrusts and isoclinal recumbent folds south of 51°N.	Onset by 175 Ma	Parrish and Wheeler (1983); Klepacki (1985); Smith et al. (1992); Warren (1997); Colpron et al. (1996, 1998); Gibson (2003); Reid (2003)
O1	Obduction of Slide Mountain and Quesnellia terranes onto North America pericratonic terranes	ca. <187 Ma, 187–173 Ma	Tipper (1984); Parrish and Wheeler (1983); Murphy et al. (1995, and references therein); Beatty et al. (2006)

Table Intermontane Belt

Figure Code	Event	Timing	References
I6	Initiation of coarse clastic sedimentation in Sustut basin and continued deformation in the Skeena fold belt	Late Campanian to Early Maastrichtian, (ca. 74–68 Ma)	Eisbacher (1974a); Evenchick and Thorkelson (2005); MicNicoll (2005, personal commun.); McNicoll et al. (2005)
I5	The initial deposition of easterly derived metamorphic clasts and clasts of cratonic North American lithologies, occurred in the Sustut Basin.	Early Cretaceous (Albian; ca. 112–110 Ma)	Eisbacher (1974a); Evenchick et al. (2001); Evenchick and Thorkelson (2005); V.J. MicNicholl (2005, personal commun.); McNicoll et al. (2005, 2006)
I4	Development of piggy back basin within Skeena fold belt and end of eastward sedimentation	Early Early to middle Early Cretaceous (ca. 145–135 Ma)	Evenchick et al. (2001); Evenchick and Thorkelson (2005); V.J. McNicoll (2006
I3	Transition to nonmarine conditions across central & southern Bowser Basin	Jurassic- Cretaceous boundary (ca. 145 Ma)	Evenchick et al. (2001); Evenchick and Thorkelson (2005); Smith and Mustard (2006); V.J. McNicoll (2005)

I2	Westward migration of facies belt in Bowser Basin	Late Jurassic (Oxfordian/ Kimmeridgian; ca. 157–151 Ma)	Evenchick et al. (2001); Evenchick and Thorkelson (2005)
I1	Deposition in the Bowser Basin (focussed in the NE trough)	Middle Jurassic (Bathonian to early Oxfordian; ca. 168–158 Ma)	Evenchick et al. (2001); Evenchick and Thorkelson (2005).
I0	The initial deposition of east-derived sediment from the Cache Creek terrane onto Stikinia marks the first occurrence of coarse clastic sediment in the Bowser Basin. This was accompanied by the rapid exhumation of the Cache Creek terrane.	187 Ma, 187–173 Ma	Tipper (1984); Parrish and Wheeler (1983); Murphy et al. (1995, and references therein); Beatty et al. (2006)

Discussion

Literary consensus on the Evolution of The Canadian Cordillera.

The contemporary map pattern of the geology, metamorphism of the Foreland and Omenica belts shown in Fig 5 is largely a consequence of processes associated with the development of the Canadian Cordillera (block diagram Fig 7). ......The main phase of the Cordilleran orogenesis is associated with episodic, (oblique) compression and transpression in the ~120-130Ma time interval during the late- early Jurassic ~ 180Ma and the early Cenozoic between ~60-50Ma (Monger & Price, 2019). This was followed by a period of regional extension that became fully developed by ~52Ma (Simony and Carr, 2011). In the interval ~60-50Ma, inner parts of the Omenica belt have begun a transition to extension at a similar time that compression was continuing in the outer parts of the orogen (in The Foothill belts). This orogen-parllel movement on transcurrent faults occurred during the compressional and extensional phases

(Simony & Carr, 2011). These events are preserved in the rock record by deformation, metamorphism, magmatism and syn-orogenic sedimentary basins containing the eroded remains of the mountain building.

The predominant view of the overall driving force for orogenisis is eastward-directed subduction- in a relative sense- of the Pacific plate and its forebears beneath the plate containing the North American craton (Laurentia), with the craton posing as a backstop and arc magmatism being able to develop above the eastward dipping subduction zone (Figure 6). Monger and Gibbson (2019) argued that in an absolute plate motion sense, Cordilleran orogenesis was driven by the westward movement of the tectonic plate containing the North American continent (Laurentia) in the direction of the Pacific plate and its ancestors as the Atlantic Ocean opened in the Triassic. The argument here is that the Cordilleran orogen developed between the strong craton and the strong eastward-subducting ancestral Pac ific Ocean floor in the minimal continental rocks of Laurentia that were weakened by the intervals of arc magmatism and back-arc development.

A more proximal driving force for the orogenesis considered to be the accretion of ocean- and arc-related domains to the continental margin was assumed for the past years within this broad framework (Monger et al.,1982). Recent findings presented by Monger & Gibson (2019) suggest that all terranes had been integrated along the craton margin by 174 million years ago, predating the majority of magmatism, deformation, and metamorphism linked with Cordilleran orogeny. They contended that the recorded episodes of magmatism, deformation, and metamorphism over the approximately 130 million years of generally compressional Cordilleran orogeny correspond to variations in the direction and speed of the North American plate in relation to the Pacific plate during this period.

An alternative hypothesis, proposed by Sigloch & Mihalynuk (2013), was inspired by low-velocity tomographic anomalies in the sub-North American lithosphere. They interpreted these anomalies as a "slab wall" resulting from west-dipping subduction from the Jurassic through the Cretaceous, approximately between the Insular and Intermontane superterranes. This hypothesis was challenged by Monger (2014) and Pavlis et al. (2019). Other alternative models include the west-dipping subduction of ancestral North America (Laurentia) beneath various types of "ribbon continents," whose eastern boundaries (representing the suture between the ribbon continent and the ancestral North America margin) are suggested to be located in the Rocky Mountains or Rocky Mountain Trench (Chamberlain & Lambert, 1985; Johnston, 2008). This model is yet to be completely acknowledged by other geologists (e.g. Mihalynuk, 2017; McMechan et al 2020).

A comprehensive description of the history of the Canadian Cordilleran orogen is beyond the scope of this literary thesis. We have used to reviewed provided by Price & Monger (2003), Evenchick et al., (2007), Simony & Carr (2011), Monger (2008) to portray and study the evolution of the region as portrayed below. Here a summary is given that attempts to integrate several linked components of the orogens evolution based of Monger (2008)

Figure below shows an orogen-scale interpretation of the relationship between the magmatic, deformational, metamorphic and sedimentary processes at play during the three major periods of the history in this schematic cross section by Evenchick et al.,(2007). The approximate line of this cross section is shown in figure 2. What is notable is the ~800km dextral offset in the line section interpreted by Gabrielse et al (2006) and Evenchick et al.,(2007) that movement on Cretaceous and Cenozoic strike-slip faults placed the Mesozoic Bowser basin opposite to the Foreland basin on either side of a highland area in the Omenica belt which has thought to have been risen during the Mesozoic Cordilleran thickening (Evenchick et al., 2007). The dextral movement can be ascribed to a ~430km Cenozoic strike-slip movement on the Tintina-Rocky Mountain Trench fault combined with its splays (Gabrielse et al.,2006; Evenchick et al.,2007).

The Early to Middle Jurrasic period (180~160Ma; block Figure g) was marked by the overthrusting of the Quesnel terane onto the continental margin strata of ancestral North America (Murphy et al.,1995). Geoseismic, geological and geochemical data by (Cook et al.,2012; Thompson et al.,2006) suggest that the current unit of Quesnel terrane that is now exposed to the surface- regarded as a thin “flap” (Evenchick et al.,2007)- has become separated from its base and was thrusted eastward over the Laurentian margin by as much as 190 km. Obduction of Quesnellia was followed by SW-directed thrusting and folding in the Kootenay arc and its advancement to the north, and considerable continental arc-related plutonic activity (e.g. Nelson plutonic suite). The aftermath of this was the development of a highland area at the site of the contemporary Omenica belt whose substantial erosion led to an influx of clastic sediments into flanking basins to the west (Bowser Basin) and, to a lesser extent to the east (lowest parts of the Foreland basin: Evenchick et al.,2007).

In the Early Cretaceous (~140-100Ma; panel B Figure 6), continued deformation magmatism and Metamorphsim led to the development of a more substantial and wider orogen. This period of substantial orogenesis and crustal thickening is revealed by ~140-130Ma regional metamorphism (Simony & Carr 2011). A considerable amount of sediment influx from the eroded highlands accumulated in the Foreland basin and basins to the west. Substantial plutonic activity occurred in the latter stages of this period (e.g., the mid-Cretaceous Bayonne intrusive suite in the Kootenay arc and the Purcell Anticlinorium, Figure 3). Development of deep detachment beneath the rocks of the previously accreted intermontane terrane is believed to be connected to the subducting plate margin to Omenica and Foreland belts (Pana and van der Pluijm, 2015). Major thrust faults in the Purcell anticlinorium and western Foreland belt were activated during this time (Simony & Carr 2011), with the fold-thrust belt migrating eastwards and incorporating early-formed Foreland basin strata. Through the late Cretaceous and Paleocene (~70-50Ma; Block fig h), the fold-thrust belt continued to migrate eastwards, leading to a transition in sediment source in the Foreland basin from the Omenica highlands to the mountain front (Simony and Carr 2011). In the Omenica belt, complementary ductile eastward directed deformation and metamorphism was occurring in the lower crust that tied with the thrusting in the Foreland basin.

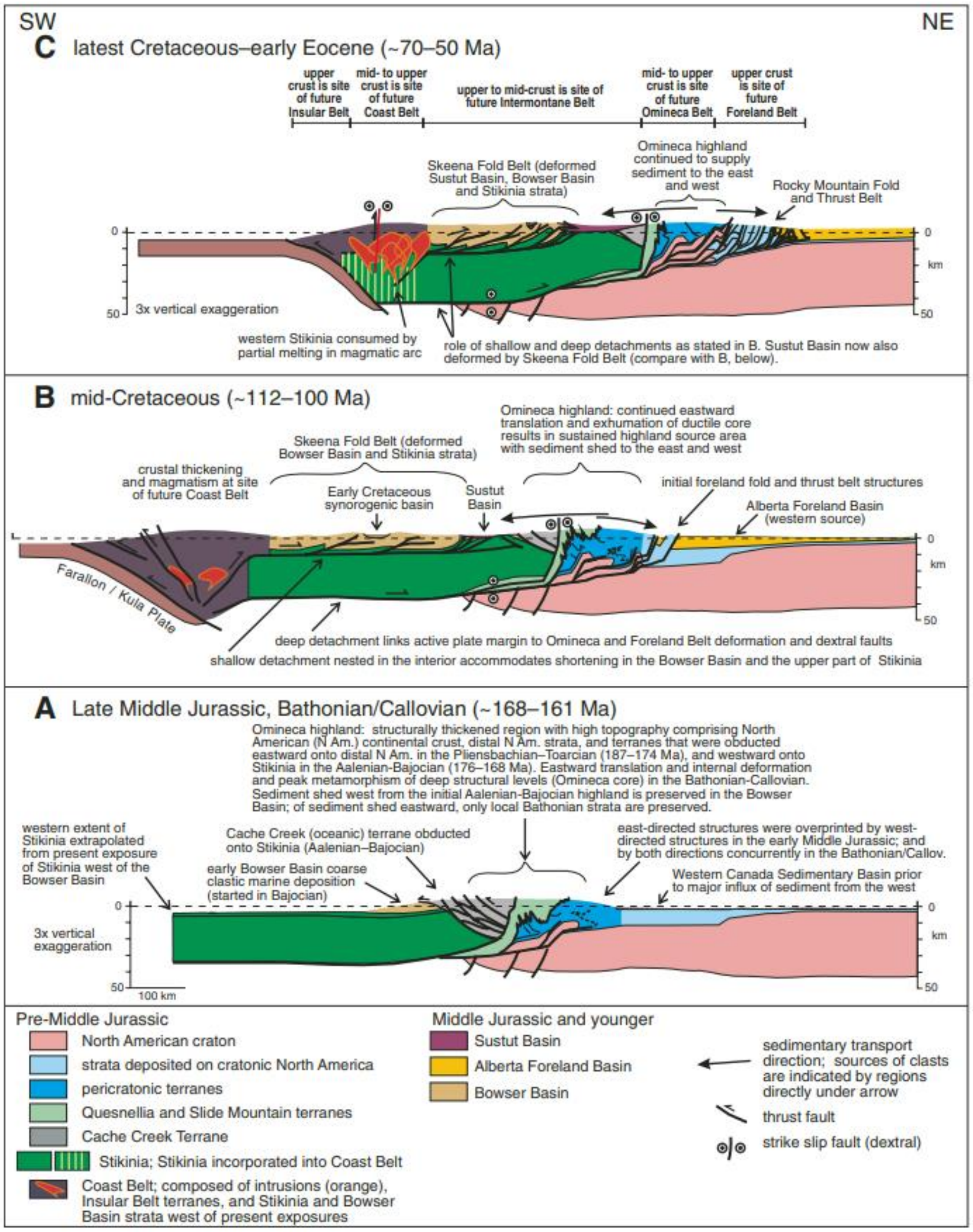
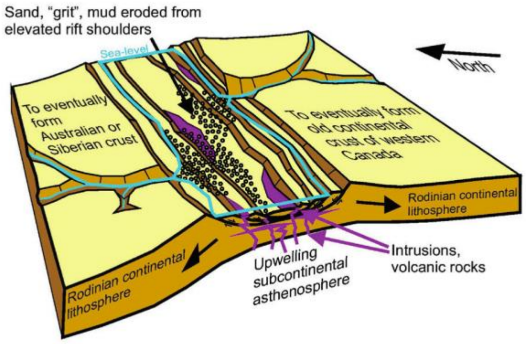
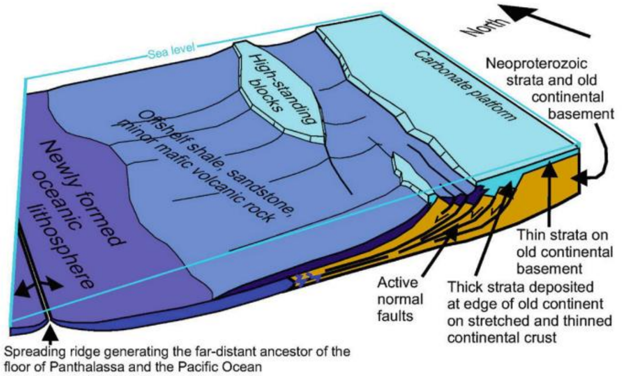


Figure 6: Simplified cross-section orogenic evolution diagram depicting key events during the Mesozoic to early Cenozoic evolution of the southern Canadian Cordillera. (Evenchick et al.,2007)

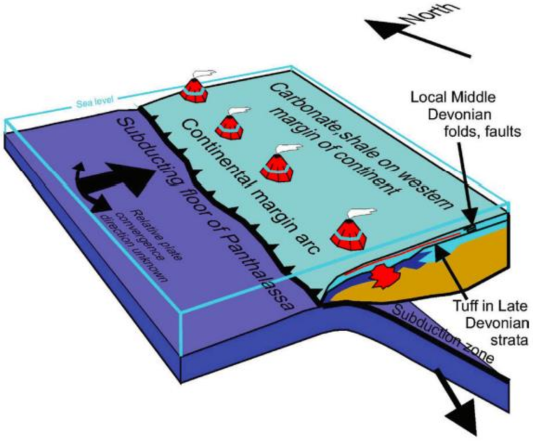
a. **Neoproterozoic and(?) Early Cambrian**



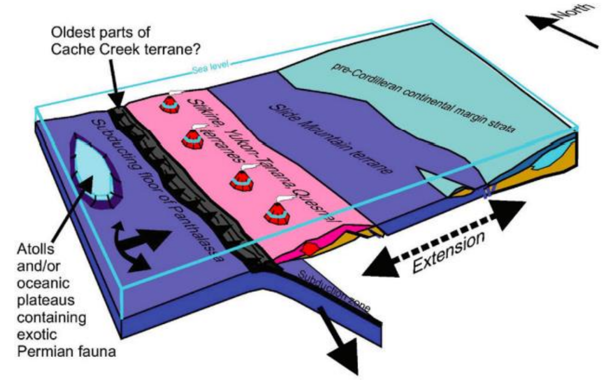
b. **Early Paleozoic**



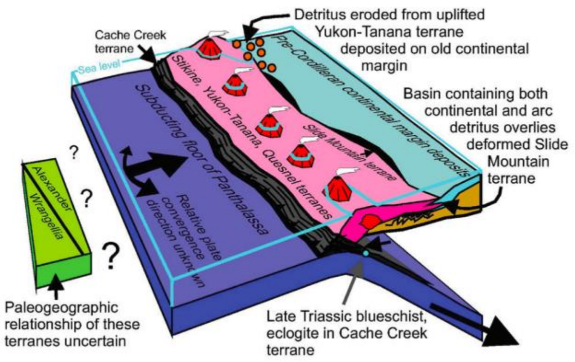
c. **Late and Middle Devonian**



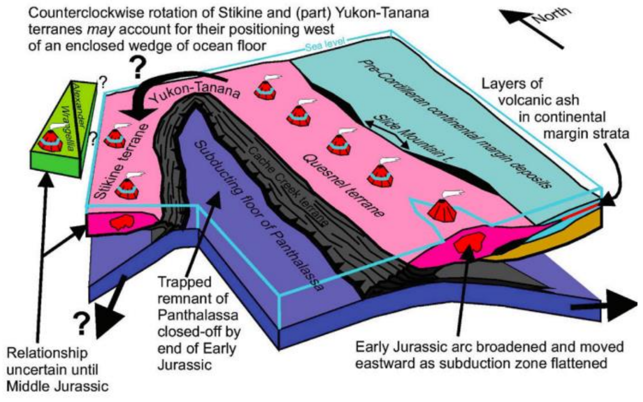
d. **Permian and Carboniferous**



e. **Triassic**



f. **Early Jurassic**



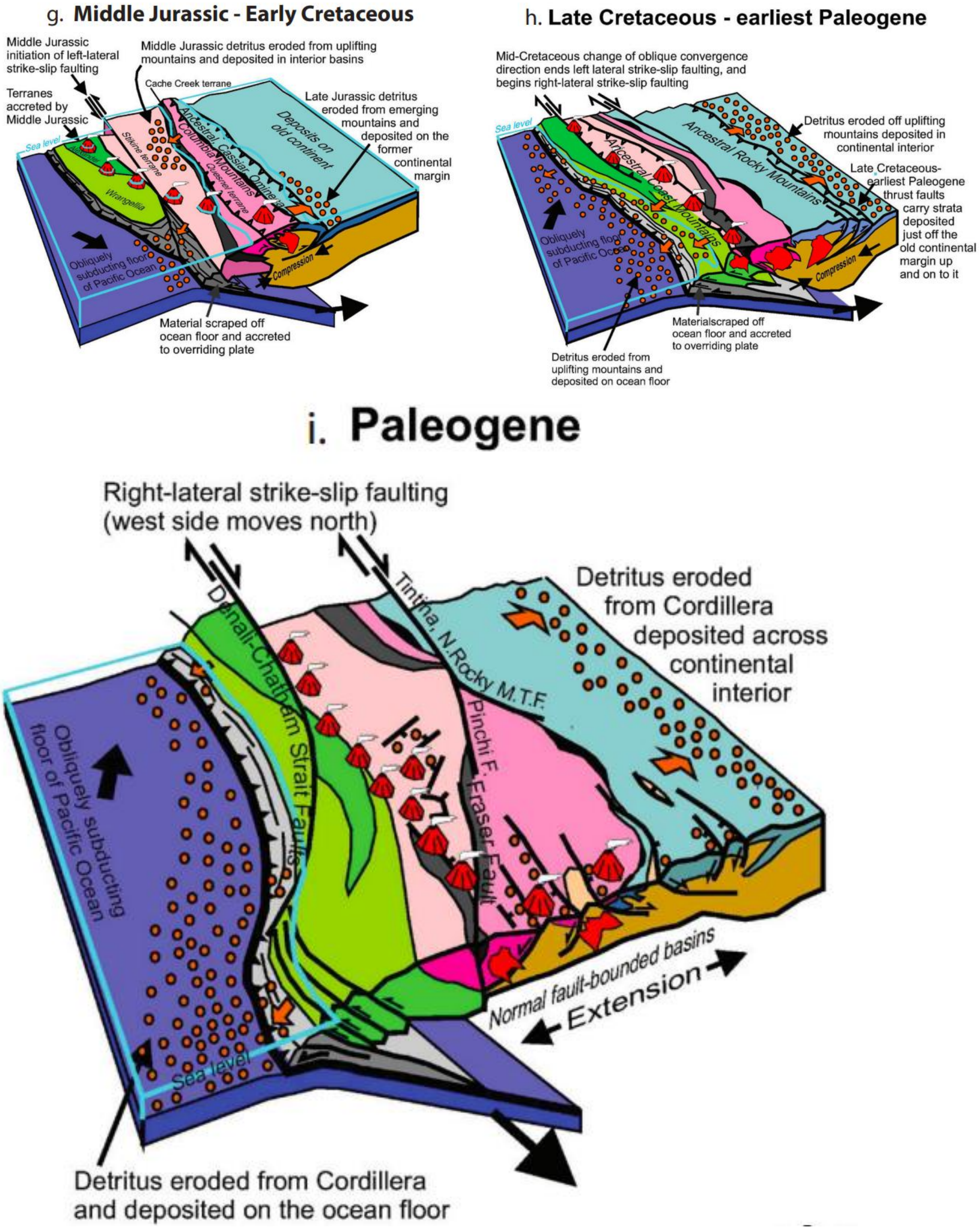


Fig 7: block diagram from Monger (2008) showing the stages of evolution of the western margin of Canada from the Neoproterozoic to the Neogene

The Foreland Belt

The Foreland belt comprises Proterozoic to early Mesozoic continental-margin deposits from the Western Canada sedimentary basin and Mesozoic synorogenic deposits from the Alberta foreland basin, a segment of the Western Canada sedimentary basin fed by the uplifting Cordillera (e.g., Stott and Aitken, 1993). Sediments originating from the west, South of 58°N, first emerge in the Oxfordian (F1 in Table .Figure.), except in the basin's southwestern extremity where a western origin is evident in the Bajocian (Stronach, 1984). A significant hiatus in the foreland basin sedimentation spans the Hauterivian to early Aptian, marked by the development of low-angle unconformity with increasing stratigraphic seperation in the east (F3 in table Figure; White and Leckie, 1999). In the foreland basin of western Alberta, sediment buildup and basin subsidence occur from the Kimmeridgian to the Valanginian (up to 4 km thick; indicated by F2, table figure), and span a wider region from the Campanian to the Paleocene (over 5 km thick; F5 in Fig. 3; Table figure..).

The Foreland belts contractional thin-skinned structures are basically continuous with those of the Poly deformed and metamorphosed Omineca belt south of 53°N, and they are connected to them kinematically (McDonough and Simony, 1988). Up to 200 km of horizontal shortening was accommodated by the foreland fold-and-thrust belt's deformation, which typically moves from west to east (Bally et al., 1966; Price and Mountjoy, 1970). Structures close to the Foreland belt's western edge emerge before 108 million years ago in the vicinity of 50°N (Larson et al., 2004) and between 100 and 112 million years ago in the vicinity of 53°N (F4 in table figure, McDonough and Simony, 1988). The earliest surviving strata (upper Paleocene around 53°N; Demchuk, 1990) are deformed by faults in the east, and contractional deformation persists throughout the Eocene (Alkreuth and McMechan, 1996).

Most of the shortening of the southern Foreland belt occurred after the Turonian (< 89Ma), and thus simultaneous with the strike-slip faulting on the Rocky Mountain-Tintina fault system (Fig 2; Gabrielse et al.,2006)

Omineca Belt

The Omineca Belt's evolution began in the Early to Middle Jurassic between 187 and 174 million years ago, marked by significant deformation and metamorphism associated with the accretion of terranes to the

western margin of North America. This period saw the development of the Quesnel and Slide Mountain terranes along with the tectonic thickening of the continental crust (Archibald et al. 1983).
The Middle Jurassic to Early Cretaceous was a crucial period for the Omineca Belt, as it experienced further crustal thickening and the development of the Omineca highland. This highland acted as a major source of sediment for adjacent basins, such as the Bowser Basin, influencing their sedimentation patterns. The highland's uplift was driven by continued convergence and deformation (Murphy et a.,1995).

By the mid-Cretaceous, the Omineca Belt was dynamically linked to the broader orogenic system through a lower-crustal detachment. This detachment system connected the Coast Belt and the eastern fold-and-thrust belts, facilitating coordinated deformation across the Cordillera. The presence of this detachment indicates a kinematic linkage among various structural elements of the orogen, leading to synchronized tectonic events across different regions (Simony and Carr 2011).

During the Late Cretaceous, the Omineca highland continued to evolve, contributing detritus to the Sustut Basin. The Sustut Basin, located between the Omineca highland and the Skeena fold belt, contains nonmarine clastic sedimentation derived from the erosion of the Omineca highland. Additionally, The Omineca Belt is characterized by complex structural geometries and metamorphic facies resulting from its prolonged tectonic history. Structural studies (Simony and Carr 2011; Monger & Gibson 2019) reveal a progression of deformation styles and metamorphic conditions, reflecting the changing tectonic regime over time. The belt's rocks exhibit a range of metamorphic grades, from greenschist to amphibolite facies, indicative of significant tectonic thermal events (Williams and Jiang 2005).

The following are examples of the protoliths which depict the geology of the region: (1) Paleoproterozoic basement exposed in the Monashee Complex's structural culminations and overlapping thrust slices of the Monashee complex; (2) Mesoproterozoic to Paleozoic supracrustal rocks deposited on North America's western cratonic~~al~~ margin; and (3) Lower Paleozoic sedimentary, volcanic, and igneous rocks of the near-cratonic and acc~~r~~reted Kootenay terrane formed adjacent to the North American margin; (4) Permian volcanic and ultramafic rocks of the oceanic Slide Mountain terrane; (5) Triassic to Lower Jurassic volcanic and sedimentary arc-related rocks of Quesnellia; (6) approximately 175–159 million years old calc-alkaline plutons of the Kuskanax and Nelson Suites; (7) approximately 110–90 million years old granites of the Bayonne Suite. Paleocene–Eocene peraluminous leucogranites are discovered in high-grade rocks that have been excavated from the mid-crust south of 51°N (Reid 2003; Parrish 1995; Crowley et al.,2000; Gibbson 2003)

Central Intermontane Belt

Stikinia (Fig. 1) is a terrane with volcano-plutonic arc formations extending from the Devonian to Permian, Late Triassic, and Early Jurassic to early Middle Jurassic periods (e.g., Monger and Nokleberg, 1996), makes up the majority of the central Intermontane belt. These strata exhibit a range of metamorphic grades and deformation styles, from subgreenschist to greenschist facies. The Cache Creek terrane, which is part of the eastern Intermontane belt (Fig. 1), is an accretionary complex that originated in marine conditions and contains some volcanic arc strata. According to Struik et al. (2001), rocks of marine origin found in this terrane date from the Mississippian to Early Jurassic (Toarcian) era and include Permian Tethyan fauna, indicating a remote origin from the North American craton boundary. The Cache Creek terrane's structural composition is typified by southwest-vergent fold-and-thrust fault systems, which are often distinguished by northeast-verging fold systems (e.g., Struik et al., 2001; Mihalynuk et al., 2004). These fault systems sometimes cover chaotically damaged structures. Along the southwest-directed King Salmon fault (KSF, Fig. 1; e.g., Gabrielse, 1991b), the Cache Creek terrane is

situated structurally above Stikinia and, in certain sections, strata of the Bowser basin in the northern portion (Fig. 1). The western accretionary border between Stikinia and the Cache Creek terrane is less visible in the southern portion (Fig. 1). Dextral strike-slip faults, such as the Thibert and Pinchi faults in the north and south, respectively, constitute the eastern limits of the Cache Creek terrane with Quesnellia throughout both segments (Fig.1; Gabrielse, 1985; Struik et al., 2001).
According to Struik et al. (2001), the latter is thought to have had an impact on the Triassic–Jurassic Pinchi suture. While Quesnellia and Stikinia are comparable in terms of age and lithology generally, their pre-Triassic stratigraphy is very different (e.g., Monger and Nokleberg, 1996). Quesnellia and Cache Creek are interpreted as forming thin sheets (~2.5 km and ~7.5 km thick, respectively) on a seismic-reflection profile that spans most of the terranes in northern British Columbia, while Stikinia is interpreted as relatively thick (~35 km), encompassing the entire crust above the Moho (Cook et al., 2004).

Coast Belt & Insular Belts

The geological evolution of the Coast Belt began in the Jurassic period. During this time, significant accretion of terranes to the western margin of the North American plate occurred, accompanied by substantial magmatic activity. This magmatism, primarily arc-related, was instrumental in forming the Coast Plutonic Complex. The accretion and magmatism laid the foundational framework for the Coast Belt’s subsequent geological development (Gabrielse et al.,1991).

Subsequently, in the Early to Middle Cretaceous, the Coast Belt experienced intense deformation and high-grade metamorphism. This phase was characterized by the collision and accretion of additional terranes, leading to significant crustal thickening. During this period, major structural features such as thrust faults and fold systems developed (e.g. Subduction of the Farallon and Kula plates) shaping the Coast Belt's structural architecture (Crawford et al 2005).By the mid-Cretaceous, the Coast Belt had become part of a larger orogenic system through a lower-crustal detachment. This detachment system connected the Coast Belt with the eastern fold-and-thrust belts, enabling coordinated deformation across the orogen. The presence of this detachment indicates a kinematic linkage among various structural elements of the Cordillera, resulting in synchronized tectonic events across different regions (Simony and Carr 20111).

Farther west, the Insular belt is composed of the Late Proterozoic to early Mesozoic volcanic arc terranes of Wrangellia and Alexander that are stratigraphically distinct from the more inboard terranes (Monger and Nokleberg 1996). Additional components of the Insular belt are late Mesozoic and Cenozoic accretionary complexes and Proterozoic to Paleozoic metamorphosed continental margin domains (Gabrielse et al.,1991; Geherls aand Boghossian 2000).

During the Middle Jurassic to Early Cretaceous, the Insular Belt experienced significant deformation and magmatism. The subduction of oceanic plates beneath the North American margin led to volcanic arc magmatism, contributing to the growth of the Insular Belt. Concurrently, compressional tectonics caused folding and faulting, shaping the structural framework of the region (Evenchick et al., 2007).
The timing of almagation of the Intermontane terrane and Insular belt remains enigmatic. The western boundaries of Stikinia and the Bowser basin are within the Coast belt, but their relationship with the Insular belt terranes are obscured by the shear volume of medium- to high-grade intrusive rocks and high-strain zones (van der Heyden 1992) .

By the mid-Cretaceous, the Insular Belt was characterized by widespread metamorphism and plutonism. High-pressure metamorphic rocks indicate significant crustal thickening and deep burial during this period. Additionally, the emplacement of large plutonic bodies occurred, further modifying the crustal structure of the Insular Belt (Journeay and Friedman, 1993). In the Late Cretaceous we believe that extensional tectonics became more prominent, leading to the formation of sedimentary basins and the deposition of clastic sediments derived from the erosion of uplifted regions. This phase marks a transition from compressional to extensional tectonic regimes, reflecting changes in the regional stress field (Hinsbergen and Schouten 2021; Table Figure). The Cenozoic era witnessed further extensional tectonics and erosion in the Insular belt which led to the exhumation of metamorphic rocks and the development of new sedimentary basin

Summary and Conclusion

In this literary thesis we reconstruct the present-day pattern of major tectonic units of the Southern Canadian Cordillera region, whereby we characterize the different platforms and basins based on sedimentary facies and we identify the different metamorphic features which have shaped the region as of the Mid-Jurassic. This data was subsequently integrated in an orogenic architecture diagram which kinematically linked the various terranes across the region and provide a schematic overview of the enigmatic nature of Southern Canadian Cordillera.

During the Middle Jurassic, the obduction of the Quesnellia and Slide Mountain terranes onto the continental terranes surrounding North America was succeeded by the southwestward obduction of the Cache Creek terrane onto Stikinia. This tectonic activity resulted in flexural subsidence within the Bowser Basin and the subsequent deposition of coarse Cache Creek detrital sediments within the basin (see Table O1 & Figure O2).During the Late Jurassic to Paleocene, ongoing deformation, crustal thickening and exhumation in the Omenica belt was ongoing while sediment was shed from the Omenica highland eastward into the Alberta foreland basin and westward into the Bowser and Sustut basins as can be seen from I2-I6, O3-O8 and F1-F5 in Table figure.

The Mid-Cretaceous saw the initiation of thin-skinned shortening in the Foreland belt, crustal thickening in the Coast belt, thin skinned shortening in the Skeena fold belt, initiation of the Sustut basin, and an ongoing eastward translation of the exhuming core of the Omenica belt above a basal detachment system depicted by I5, I6, O7, O8 and F4 in the Table Figure (Crawford et al.,1987). This was followed by concurrent pulses of synorogenic coarse clastics deposited in the Sustut and Alberta foreland basins during the Late Campanian to Early Maastrichtian, a period characterized by significant structural thickening and erosion (see Table Figure I6 and F5). This, in conjunction with horizontal shortening across the entirety of the Cordillera, persisted into the Cretaceous to early Cenozoic (I6, F5).

The synthesis of the Jurassic and Cretaceous depositional and tectonic processes of the Central Intermontane Belt, Southern Omineca Belt, and Foreland Belt, when considered in a paleogeographic context, reveals sedimentation and structural connections across the entire orogen. This synthesis highlights the tectonic interplay among crustal thickening, basin formation, and topographic evolution. From the orogenic architecture diagram and the literature, we can conclude that a kinematic linkage across the entire orogen is necessary in order to connect tectonically compatible events that are in close proximity of one another. We believe that a detachment in the lower crust which extended from the active plate boundary and Coast belt towards the east up to the Intermontane belt must have risen into the middle crust into the Omenica belt, and ultimately connected to the upper crust in the Rocky Mountain fold and thrust belt. This was also associated with the dextral strike-slip faults, facilitating regional transpression distributed across the orogen in response to oblique plate convergence. In the Intermontane Belt, this lower crust detachment transported Stikinia along with the Skeena Fold Belt, an upper crust and craton verging fold and thrust belt, within the interior of the orogen. The basal detachment of the Skeena fold

Belt was anchored in ductile structures on the eastern side of the Coast Belt. This development of this enigmatic fold belt was partly a result of the mechanical stratigraphy of Stikinia and the overlying basins. Further consideration and incorporation of actual in situ, geological data will lead to the improvement of tectonic models of the paleogeographic Cordilleran evolution.

Appendix:

Below, we first note the nature of the various Canadian cordilleran terranes.

AX represents the Alexander Terrane and comprises various geological formations ranging from Proterozoic to Triassic periods. These formations include mafic to felsic volcanic rocks, terrigenous clastic and carbonate rocks, and early Paleozoic granitic rock. Pre-Devonian rocks are associated with volcanic arcs. Additionally, Paleozoic paleomagnetic data exhibit discrepancies when compared to those of North America.

BR = Bridge River Terrane: Variably metamorphosed, Missippian to Late Jurassic chert, argillite, sandstone, basalt, ultramafics, and minor carbonates; contains Triassic blueschist; early to late Meszoic accretionary complex CA = CAS

CA represents the Cassiar Terrane, characterized by Neoproterozoic to Devonian platformal carbonate rocks, sandstone, and graptolitic shale. This terrane is interpreted as a sliced-off fragment of ancient continental margin deposits, transported northwards at least 500 km along Tintina and Northern Rocky Mountain Trench strike-slip faults.

CC denotes the Cache Creek Terrane, characterized by disrupted Mississippian to Early Jurassic formations including chert, argillite, basalt, carbonate, and ultramafic rocks. It also contains local occurrences of Triassic blueschist.

CD designates the Cadwallader Terrane, characterized by Permian basalt, gabbro, and ultramafic rock formations. These are overlain by Triassic arc-related basalt, carbonate, and clastic rocks, which in turn are overlain by Upper Triassic to mid-Cretaceous clastic rocks.

CG denotes the Chugach Terrane, which has variable characteristics depending on its location. Inboard, it features metachert, basalt, and localized carbonate formations alongside Early Jurassic blueschist. On the outboard side, there are Cretaceous greywacke and argillite formations. The terrane also contains a melange composed of Upper Jurassic to Lower Cretaceous cherty argillite matrix and blocks of various rocks including mafic volcanics, chert, limestone, and ultramafics. This indicates the presence of a long-lived Mesozoic accretionary complex.

CK represents the Chilliwack Terrane, which encompasses Devonian to Permian formations consisting of clastics, carbonate, and arc-related volcanics. These are overlain by early Mesozoic volcanogenic clastics, followed by Jurassic arc-related volcanic formations and Jurassic to mid-Cretaceous clastics. Faunas from the Permian period in this terrane resemble those found in Quesnellia and Stikinia, as well as in the southwestern United States.

KO signifies the Kootenay Terrane, characterized by variably metamorphosed Neoproterozoic and Paleozoic strata. These formations consist of continent-derived clastic rocks, rift-related volcanic rocks, and Devonian arc-related volcanic and granitic rocks. It is likely that these rocks underwent deformation before the deposition of late Paleozoic pelite, conglomerate, sandstone, limestone, and basic volcanic rocks occurred. The Kootenay Terrane is overlapped and/or overthrust by Slide Mountain and Quesnellian strata.

MT = METHOW TERRANE: Permian basalt, gabbro and ultramafics representing oceanic lithosphere; Lower Jurassic to Cretaceous marine clastic sedimentary strata containing local Middle Jurassic arc volcanic rocks; may = Cadwallader terrane but lacks the Triassic arc rocks.

PR = PACIFIC RIM TERRANE: Disrupted, mainly Upper Jurassic and Lower Cretaceous greywacke, argillite, chert, and basalt.

OL = OLYMPIC TERRANE: early Tertiary basalt, Tertiary greywacke, shale, melange and broken formation.

QN represents the Quesnel Terrane, also known as Quesnellia. This terrane comprises Upper Devonian to Permian formations consisting of clastics, arc-related volcanics, and carbonate. It also contains Ordovician to Permian ultramafics, basalt, chert, pelite, and minor carbonate ocean floor rocks from the Slide Mountain terrane. Additionally, there are overlapping early Mesozoic arc-related volcanic and intrusive rocks, argillite, sandstone, and localized carbonate deposits. Faunas from the Permian, Triassic, and Early Jurassic periods within this terrane differ from coeval faunas found at the same latitude on the craton. They are comparable to those found in the Stikine and Chilliwack terranes, as well as in western USA and northwest Mexico. Furthermore, mid-Cretaceous continental arc volcanics on the southwestern edge of this terrane are displaced approximately 10° northward with respect to the craton

SM = SLIDE MOUNTAIN TERRANE : Upper Paleozoic mafic volcanics, ultramafic and local mafic intrusions, chert, clastics and local carbonate; Pennsylvanian and Permian paleomagetic record suggests northward displacements of 20° w.r.to craton; overlapped by Upper Triassic fine clastics

ST represents the Stikinia Terrane. This terrane comprises formations ranging from the Devonian to the Jurassic periods, characterized by mafic to felsic, arc-related volcanic rocks, clastic rocks, and upper Paleozoic carbonate deposits. Faunas from the Permian, Triassic, and Jurassic periods within this terrane differ from those found at the same present latitude on the craton, but they are similar to those found in the Chilliwack and Quesnel terranes, as well as in the western United States. However, paleomagnetic studies on Permian, Late Triassic, and Early Jurassic rocks suggest little displacement with respect to the craton.

WR represents the Wrangel Terrane, also known as Wrangellia. This terrane encompasses Middle Paleozoic to Jurassic formations consisting of mafic to felsic volcanic rocks and magmatic intrusions, alongside limestone and pelite deposits. Notably, there are conspicuous Middle and Upper Triassic plume-related tholeiitic basalt formations overlain by carbonate rocks. Paleomagnetic data from Triassic strata on Vancouver Island suggest little or no displacement, while data from southern Alaska indicate approximately 20° northward displacement. This is interpreted as a late separation between the northern and southern regions.

YA signifies the Yakutat Terrane, which comprises Upper Mesozoic formations including pelite, greywacke, and melange, as well as Cenozoic deposits of marine and continental clastic rocks.

YT = YUKON-TANANA TERRANE (A and P): Heterogenous metamorphic terrane comprising sedimentary and magmatic rocks of Late Proterozoic, Paleozoic, and Mesozoic protolith ages. Similar to Kootenay Terrane in many aspects but may include rocks related to Slide Mountain Terrane.

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