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Geological maps and cross sections of the northern Canadian Cordillera from southwest of Fort Nelson, British Columbia to Gravina Island, Southeastern Alaska

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ABSTRACT

The cross-sections show the generalized stratigraphic sequence and structural style in the five major tectonic belts of the northern Canadian Cordillera. A restored section from the Interior Platform across the Rocky Mountain Thrust and Fold Belt to the Northern Rocky Mountain Trench suggests a minimum shortening of supracrustal rocks of about 55 Km with major structures verging to the east. Basement rocks may be involved in the deformation in the region underlain by late Proterozoic Windermere strata.

The Northern Rocky Mountain Trench, a locus of apparently great dextral transcurrent movement separates regions of markedly contrasting stratigraphy and structural style. In the Omineca Belt the earliest and generally dominant structures verge westerly. Crystalline basement is postulated to be at relatively shallow depths under domal anticlinoria.

In the Intermontane Belt competent and massive Mesozoic volcanic rocks are block faulted but commonly only gently folded. Sharply dissimilar structural style between the volcanics and highly deformed overlying sedimentary rocks with easterly verging structures indicates a zone of decollement at least locally separates the two assemblages. The depth and character of basement in the Intermontane Belt are unknown.

Late Mesozoic westerly directed structures are evident in the Insular Belt and western part of the Coast Plutonic Complex. Elsewhere multiple phases of deformation and plutonism have produced a complicated structural style.

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STRUCTURAL STYLES

Rocky Mountain Thrust and Fold Belt. Northeasterly directed thrust faults and related folds dominate the structural style of the northern Rocky Mountains (Gabrielse et al, 1977; Taylor and Stott, 1968 and 1973; Thompson, 1979, 1980). In a broad area underlain by thick Helikian Proterozoic rocks and overlying thin platformal Paleozoic strata beds are commonly flat lying to gently dipping except near significant faults. Relatively uniform doubly plunging anticlines and synclines of the Foothills die out easterly into essentially flat lying beds of the Interior Plains. West of the exposed Helikian rocks strata are tightly folded and crumpled and locally are involved in arrays of imbricate thrust slices.

Most of the structures reflect one major deformation but it is not clear which are related to early Cretaceous or older compression seen in the western part and which are late Cretaceous or early Tertiary compression suggested for eastern parts. In addition, Helikian strata were folded, block faulted and intruded by swarms of diabase dykes presumably as a result of an extensional episode of deformation prior to deposition of Hadrynian and younger rocks.

Near the Northern Rocky Mountain Trench the structural style is exceedingly complex probably because of major dextral transcurrent movements along the Trench. Tertiary movements in and along the Trench included listric faults particularly on the eastern side downdropping early Tertiary sediments in half grabens.

Omineca Belt. In a general way the structural style in the Omineca Belt is much more complex than that in the Rocky Mountain Thrust and Fold Belt (Gabrielse, 1979; 1962a, 1962b, 1963; Gabrielse et al. 1977a, 1977b; Mansy, 1980). Deformation has been multiphase, the earliest producing the dominant westerly verging folds and related thrust faults. These structures were involved in easterly directed thrust faults and related folds before mid-Cretaceous time. Possibly related to these structures is an easterly transported allochthonous sheet of late Paleozoic oceanic rocks that overlies platformal lower Paleozoic strata. Doming produced major anticlinoria during mid Cretaceous and possibly early Tertiary times. Finally, zones of intense cataclasis accompanied by folds ranging from crinkles to amplitudes of hundreds of metres formed in response to movements on regional dextral transcurrent faults. These are presumed to have moved at intervals from mid-Cretaceous to early Tertiary time.

Intermontane Belt. The eastern boundary of the Intermontane belt is a zone of cataclasis across which the stratigraphy and structural style change markedly (Gabrielse et al, 1977; Gabrielse 1979). The oldest observed rocks are commonly intensely folded but are exposed in such small areas that no comprehensive view of their structural style is available (Thorstad, 1980). In contrast, overlying volcanic rocks generally show few folds except broad flexures. They are strongly block faulted along northwest and northeast trends. Sedimentary strata in the northeastern part of Sustut basin are gently dipping to flat lying but farther west, and continuing throughout Bowser Basin they are tightly folded (Eisbacher, 1974; Richards and Gilchrist, 1979; Hanson, 1935). Mid Triassic and early Tertiary appear to have been times of major deformation.

Mesozoic and Paleozoic rocks in the hanging-wall of the King Salmon Fault are intensely cleaved, particularly near the sole of the thrust (Monger and Thorstad, 1978). Southwesterly directed structures are dominant in the highly deformed terrane between King Salmon and Kutcho faults (Monger and Thorstad, 1978; Leaming, 1980) and the bordering rocks to the southwest (Tipper, 1978). Along the western margin of the Intermontane Belt near Portland Canal a northerly trending zone of intense cataclasis as much as 1.5 Km wide involves volcaniclastic and plutonic rocks of late Triassic and early Jurassic page but does not affect overlying Middle Jurassic rocks (Grove, 1971; Smith, 1977).

Coast Plutonic Complex. Across the Coast Plutonic Complex the older plutons are strongly foliated and associated screens of metasedimentary and volcanic rocks are highly foliated and deformed (Berg et al, 1978;

Grove, 1971; Smith, 1977). Foliations form several broad anticlinoria and synclinoria but continuity is difficult to establish.

Insular Belt. Strata in the Insular Belt are involved in westerly verging folds and associated thrust faults. Complex folding is common and slaty cleavage is locally well developed.

Cross-section east of the Northern Rocky Mountain Trench. Structures shown at depth in the eastern part of the section are not uniquely constrained but are consistent with the general rules for balanced sections taking into account the following concepts and data:

1. Strata underlying the Great Plains have not been deformed and are considered to be 'pinned' to basement. The strata as intersected in the Canadian Superior Sun a-69-J borehole are used as the datum to establish the regional elevation of the formations prior to deformation.
2. The Precambrian crystalline basement is assumed not to be involved in the deformation eastward of the eastern limit of exposed Hadrynian strata. The position and gentle westward dip of the passive crystalline basement is established from published basement contours under the Plains and from an assumed parallelism with the overlying Helikian strata. The amount of dip is calculated from the rate of cut out of Helikian strata across the Tuchodi Anticline beneath Cambrian strata. In order to match dip of basement, with depth to basement it has been necessary to postulate the existence of approximately 3000 metres of Helikian strata that are not

known from outcrop. The position and dip of basement, and existence of the postulated strata are all consistent with the meagre amount of available reflection seismic data.

3) Thompson (1979, 1980) has convincingly demonstrated the existence of 'blind thrusts' within the foreland fold belt some 150 km south of this line of section. Similar structures have been mapped by Taylor in the Trutch map-area intermediate between these areas. The Pan Am Sheep c-86-D borehole only 2 km north of this line of section encountered Devonian carbonates more than 1000 metres above regional in an area where no surface thrusts are known. If crystalline basement is not involved in the structure, a blind thrust must be present. Such faults have been incorporated into the cross-section in order to account for the vertical position of the Mesozoic strata within the Foothills at elevations above regional.

4. Folds within the Foothills Province are primarily cylindrical except in zones of axial transfer or bifurcation where they assume conical geometry. The amplitude and wavelengths of the folds require multiple detachments surfaces separating stratigraphic assemblages. The most significant of these occurs in the Upper Devonian shales decoupling the entire overlying section from the Devonian carbonates and older rocks.

This particular line of section does not display the normally well developed triangle zone marking the eastern limit of deformation. The apparent lack probably is the result of the line of section being selected to run through an area where motion is being transferred from one blind thrust to another, resulting in a more evenly distributed shortening beneath the Foothills. Such a geometry would also account for the lack of any major structural culmination within the Foothills at this latitude.

Tuchodi Anticline, easternmost of the Rocky Mountain structures, has an elevated broad core of Helikian strata at elevations of 3000 metres above sea level that has been raised from projected depths of 6000 metres below sea level. Nowhere is a major frontal thrust exposed. To account for this structure requires a blind thrust with a horizontal translation of 22 kms over a ramp in the footwall beneath the western limb. An equivalent amount of shortening at the level of the Mesozoic rocks within the Foothills cannot be reconstructed within the constraints imposed by the surface mapping. Fitzgerald and Braun (1965) have demonstrated, however, that there is locally 50 per cent excess bed length of the post Middle Devonian sequence over the northern plunge of the Tuchodi Anticline and in effect the Foothills-Tuchodi Anticline structures can be balanced taking both elements into account. This implies a total decoupling of the Late Paleozoic and Mesozoic cover, at the level of the Upper Devonian shales, from the underlying carbonate beam, and the literal insertion of that mass of rock by a mechanism of blind thrusting.

A major reconstructed feature illustrated by the cross-section is herein named the Roosevelt Graben. Several major sedimentary facies of Early and Middle Cambrian age are apparently related to synchronous normal faulting. Locally parts of the original bounding faults are preserved, elsewhere the same fault became the locus of the later deformation commonly with the sense of displacement reversed. The graben appears to be the easternmost, and youngest of similar structures representing the late Precambrian rifting of the continental margin and the associated thick Hadrynian clastic continental terrace wedge. Thick Middle Cambrian carbonate banks built on the western lip of Roosevelt Graben. Similar thick isolated Middle Cambrian carbonates enveloped in younger shaly rocks form discontinuous linear features in northwestern Ware (94F) map-area and there may also delineate the margin of an early buried graben. Block faulting of the basement and attenuation of the crust are postulated to have been important in the continued basinal environment that persisted during the early Paleozoic west of the carbonate platform.

Northern Rocky Mountain Trench. Along the line of the cross-section the Northern Rocky Mountain Trench separates regions of markedly contrasting stratigraphy and structural style. This discontinuity is believed to be the result of several hundreds of kilometres of dextral transcurrent displacement along a fault zone within the Trench. Within and near the fault zone strata are so highly contorted that the structures cannot be shown on the scale of the cross-section. Overprinting of earlier folds by later ones has resulted in steep and irregular plunges of fold axes and, in many places, zones of intense mashing.

Omineca Belt. The relatively high level shown for the crystalline basement surface is in accord with the premise, not yet well documented, that basement is exposed in the cores of several major anticlinoria. If this is so the total thickness of Hadrynian sedimentary rocks cannot be much thicker than depicted and Helikian strata are either absent or very thin. Several steeply dipping faults between the Northern Rocky Mountain Trench and the Thudaka fault zone separate areas in which some stratigraphic units have significantly different thickness or lithology. They may be the loci of dextral transcurrent faults.

The characteristic southwesterly verging folds and related thrust faults of the Omineca Belt are commonly accompanied by interstratal faults between units of different competencies. Stratigraphic throw on the faults may be negligable but displacements parallel with bedding could be large.

Thudaka fault zone is marked by strong catcalasis across a width of more than one km in which granitic rocks have been strongly foliated and mylonitized. The boundary between the Omineca Belt and Intermontane Belt is marked by a zone of clataclastic rocks across which there is no similarity in stratigraphy or structural style. The nature of displacements along the zone have not been resolved.

Intermontane Belt. Volcanic rocks in the eastern part of the Intermontane Belt are block faulted but generally little folded. Similarly the eastern areas of the Sustut Basin are only gently folded. Farther west, and possibly where the Mesozoic volcanic rocks change facies to dominantly volcaniclastic and sedimentary rocks, strata are highly folded across all of Bowser Basin. In the eastern part of Bowser Basin shortening in the sedimentary rocks may be transferred to thrust faults in the underlying more competent volcanic rocks as shown diagrammatically in the cross section. If the volcanics are not involved in thrusting a décollement must separate them from overlying rocks. Meagre regional information suggests that the Mesozoic volcanic rocks change facies to dominantly sedimentary strata in the western part of Bowser Basin and the depth to basement cannot be determined on available data.

Neither the lithology nor structural style of rocks basement to the Intermontane Belt are known. Permian rocks north of the line of section in Bowser Basin (Monger, 1977) occur in a southwards overturned anticline which also involves Upper Triassic rocks. Mississippian to Permian strata along the northern margin of Bowser Basin and northeast of Sustut Basin are also strongly folded. Pre-late Triassic, early Jurassic and pre middle Jurassic deformations are indicated. Consequent structures are diagrammatically shown on the cross-section.

<u>Coast Plutonic Complex and Insular Belt.</u> The lack of stratigraphic markers in the metamorphic terranes and complexities resulting from multiple deformation and multiple phases of granitic plutonism precludes extrapolation of surface data to depth. The form lines shown for folds in the metamorphic rocks are extended to reflect a relationship to the general attitudes of widespread foliation.

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