Structural style and stratigraphy in northeast Bowser and Sustut basins, north-central British Columbia

C.A. Evenchick
Cordilleran and Pacific Geoscience Division, Vancouver

Evenchick, C.A., Structural style and stratigraphy in northeast Bowser and Sustut basins, north-central British Columbia; in Current Research, Part E, Geological Survey of Canada, Paper 88-1E, p. 91-95, 1988.

Abstract

The distribution of lithofacies, including anthracite coal, that developed in the mid-Jurassic to Cretaceous(?) Bowser Basin is controlled by: 1) the initial location of deposition within a sequence that grades upwards from marine at the bottom to nonmarine at the top; 2) tight folds and thrust faults, and 3) is offset by large-scale near vertical dip-slip faults.

Résumé

La distribution des lithofaciès, y compris du charbon anthracitique, qui se sont formés dans le bassin de Bowser du Jurassique moyen au Crétacé(?) a été régie par: 1) le site initial de sédimentation à l'intérieur d'une séquence qui passe de conditions marines à sa base à des conditions continentales à son sommet; 2) des plis étroits et failles chevauchantes; et 3) elle est décalée par des failles normales de grande échelle, presque verticales.

INTRODUCTION

In 1987, mapping at 1:50 000 scale in Spatsizi map area (Fig. 1) was extended to the northwest, southeast, and south of the area covered in 1985 and 1986 (Evenchick, 1986, 1987). Field work focused on establishing mappable units in the Bowser Lake Group, on the structural style in the Bowser Lake and Sustut groups, and the structural relationships between map units at the common boundary of the two groups.

Strata of the Bowser Basin consist of Middle Jurassic to lower (?) Cretaceous marine and nonmarine clastic sediments named the Bowser Lake Group. The Bowser Lake Group was deposited on a lower Jurassic basement of Cold Fish volcanics, and sediments of the Spatsizi Group (Thomson et al., 1986). Strata of the Sustut Basin consist of Cretaceous nonmarine clastic rocks named the Sustut Group (Eisbacher, 1974). It unconformably overlies the Bowser Lake and Spatsizi groups, and the Cold Fish volcanics. All rock units, with the exception of the upper part of the Sustut Group, have been deformed by northeast-verging folds and thrust faults that have accommodated major northeasterly contraction. Steep dip-slip faults offset all stratigraphic units and contractional structures. Data constraining the timing of deformation are outlined by Evenchick (1987).

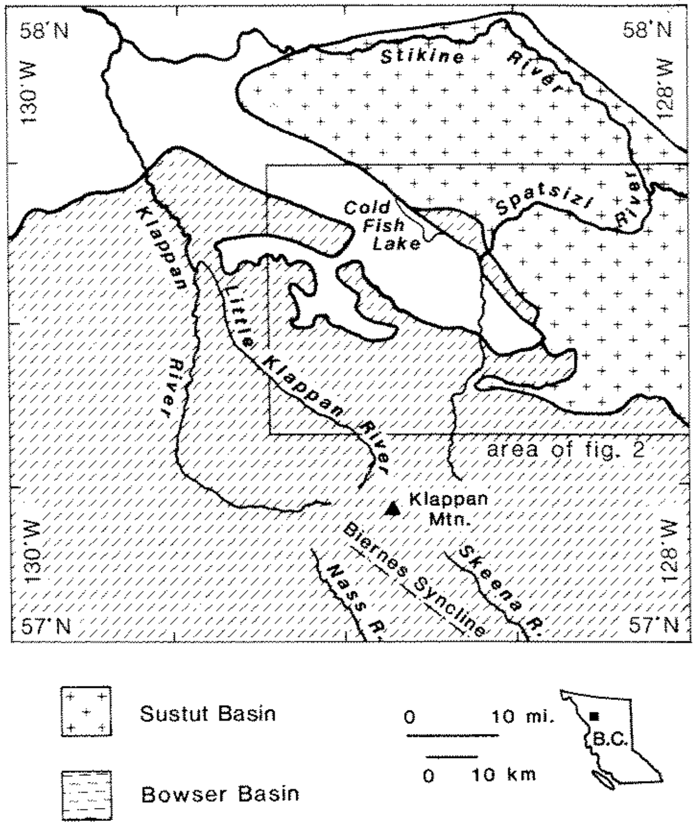

Figure 1. Regional geological and geographic features in Spatsizi map area, and the location of the study area.

STRATIGRAPHY

Spatsizi Group

The Spatsizi Group consists of lower Pliensbachian to upper Bajocian sediments that are interpreted as basinal equivalents of the lower Jurassic Cold Fish volcanics (Smith et al., 1984; Thomson et al. 1986). The group was formally defined by Thomson et al. (1986) based on work on the flanks of the Joan Lake anticline (Fig. 2 and 3 east of Tsetia Creek).

Strata north of Tsetia Creek that are not present in the area mapped by Thomson et al. (1986) include a 15 m thick horizon of massive chert-pebble conglomerate with interbeds of siliceous siltstone. Radiolarian chert is the most common clast type, with lesser volcanic and siltstone clasts. The siltstone both within and above the conglomerate is similar to the Quock Formation of the Spatsizi Group. Ammonites collected from below and above the conglomerate will permit an assignment of age to the conglomerate. The presence of chert clasts in the Spatsizi Group is of regional significance when one considers possible sources. The Cache Creek terrane is the source of chert clasts in the Bowser Lake Group (Currie, 1984), and thus the chert clasts have been interpreted to be the first stratigraphic link between Stikinia, on which the Bowser Basin developed, and the Cache Creek terrane (Eisbacher, 1981). Chert clasts in the Spatsizi Group confirm the presence of a source of radiolarian chert prior to deposition of the Bowser Lake Group. Whether or not that source was the Cache Creek terrane is unknown, but there are no other large sources of radiolarian chert in the region.

Bowser Lake Group

Four lithological units in the Bowser Lake Group are identified in Figure 2. At the base, black marine siltstone contains lenses and relatively continuous beds of conglomerate, and rare chert sandstone. These strata are overlain by a unit of black siltstone interbedded with chert sandstone members about 10 m thick. Sandstone constitutes 30 to 80 per cent of the unit. The siltstone-sandstone unit is locally overlain by a unit comprising alternating siltstone and sandstone members 2 to 10 m thick, with rare conglomerate and coal. Uppermost is a rusty weathering, massive, chert-pebble conglomerate unit, locally with minor interbeds of siltstone and sandstone.

Not all units above the basal marine siltstone are present in every area. The units vary greatly in thickness and character between areas of outcrop, but the nature of the changes is obscure, and the continuity of units across structures is difficult to establish. The units are diachronous. For example, the rusty conglomerate west of the confluence of Spatsizi River and Buckinghorse Creek is about the same age (late Oxfordian, H.W. Tipper, pers. comm., 1987) as the sandstone-siltstone-conglomerate-coal sequence between the Little Klappan and Spatsizi rivers. The coal-bearing unit probably reflects a depositional environment similar to that of the strata with anthracite coal seams at Mt. Klappan (Fig. 1), but the two coal-bearing sequences may be a different age. Strata of the Bowser Lake Group in Figure 2 are mid-to late Jurassic, but include rocks as young as Albian farther south (Biernes syncline in Fig. 1; Moffat, 1985). The Bowser Lake Group represents a complex of lithofacies that may be repetitive both vertically and laterally. Correlation of apparently similar strata between widely separated areas may be misleading.

STRUCTURE

Structural style of the Bowser Lake and Sustut groups is dominated by northeasterly-verging tight to open folds, and by thrust faults which sole into the volcanic basement of the Bowser Basin (Evenchick, 1987). The lateral continuity of stratigraphic sequences, folds, and thrust faults is disrupted by dip-slip faults of large displacement.

In the area north of Eaglenest Creek large scale southwest-verging folds are prominent, in contrast to the northeasterly vergence of structures to the east and southeast. Whether these structures predate the northeast-verging structures, or are simply another expression of the same phase of northeast-southwest contraction is unknown.

New data have helped resolve a structural dilema near the confluence of Buckinghorse Creek and Spatsizi River. The highest structure in Figures 2 and 3 is a thrust fault that separates Bowser Lake Group in the hanging wall from Tango Creek Formation in the footwall. It can, with extrapolation across dip-slip faults, be traced from east of the head of Ross River to south of the confluence of Spatsizi River and Buckinghorse Creek (Fig. 2). It cannot be traced to the west across the Griffith Fault. Thus the highest structural level exposed is only 6 km south of the lowest structural level, marked by pre-Jurassic rocks. The proximity demands that stratigraphic and structural elements be missing. Rocks to the east of the confluence do not seem to be seriously displaced relative to those to the west, but are distinctly different from those to the north and south. Recognition of a dip-slip fault along Buckinghorse Creek (herein named the Buckinghorse Fault) has in part solved this enigmatic situation. The combination of down-to-the-southeast displacement on

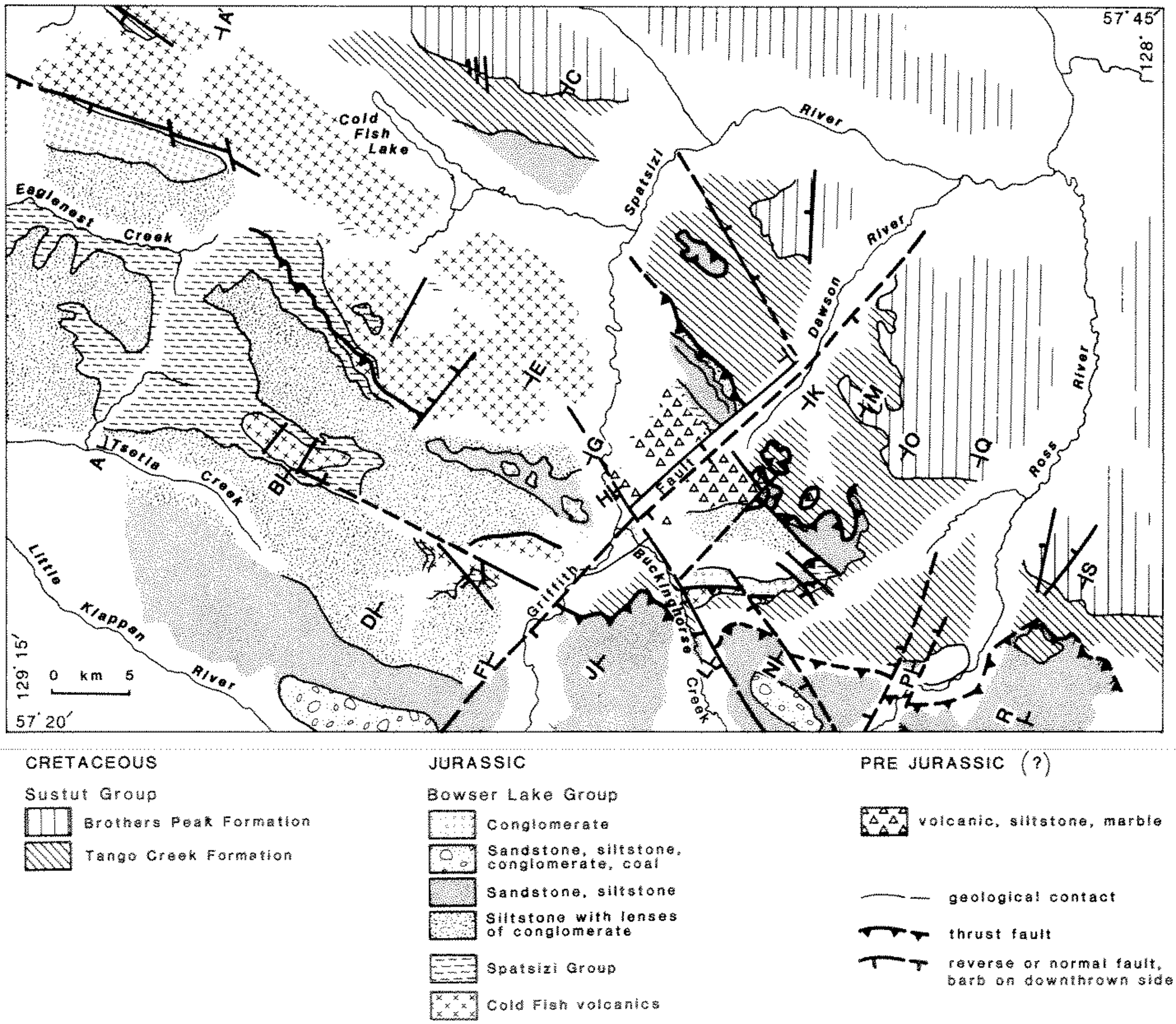

Figure 2. Geological map of the study area.

Griffith Fault with down-to-the-southwest displacement on Buckinghorse Fault results in net downward displacement of the south block relative to the north block that is equal to the sum of the vertical displacement on both the Griffith and Buckinghorse faults. If the magnitudes of displacment on Buckinghorse and Griffith faults are about equivalent, the areas east and west of the confluence would not be largely offset relative to one another; their exposed structural elements would be higher than those to the north and lower than those to the south. These relationships are independent of timing of fault displacements. Both faults offset the Tango Creek Formation, indicating that displacements were no older than Albian.

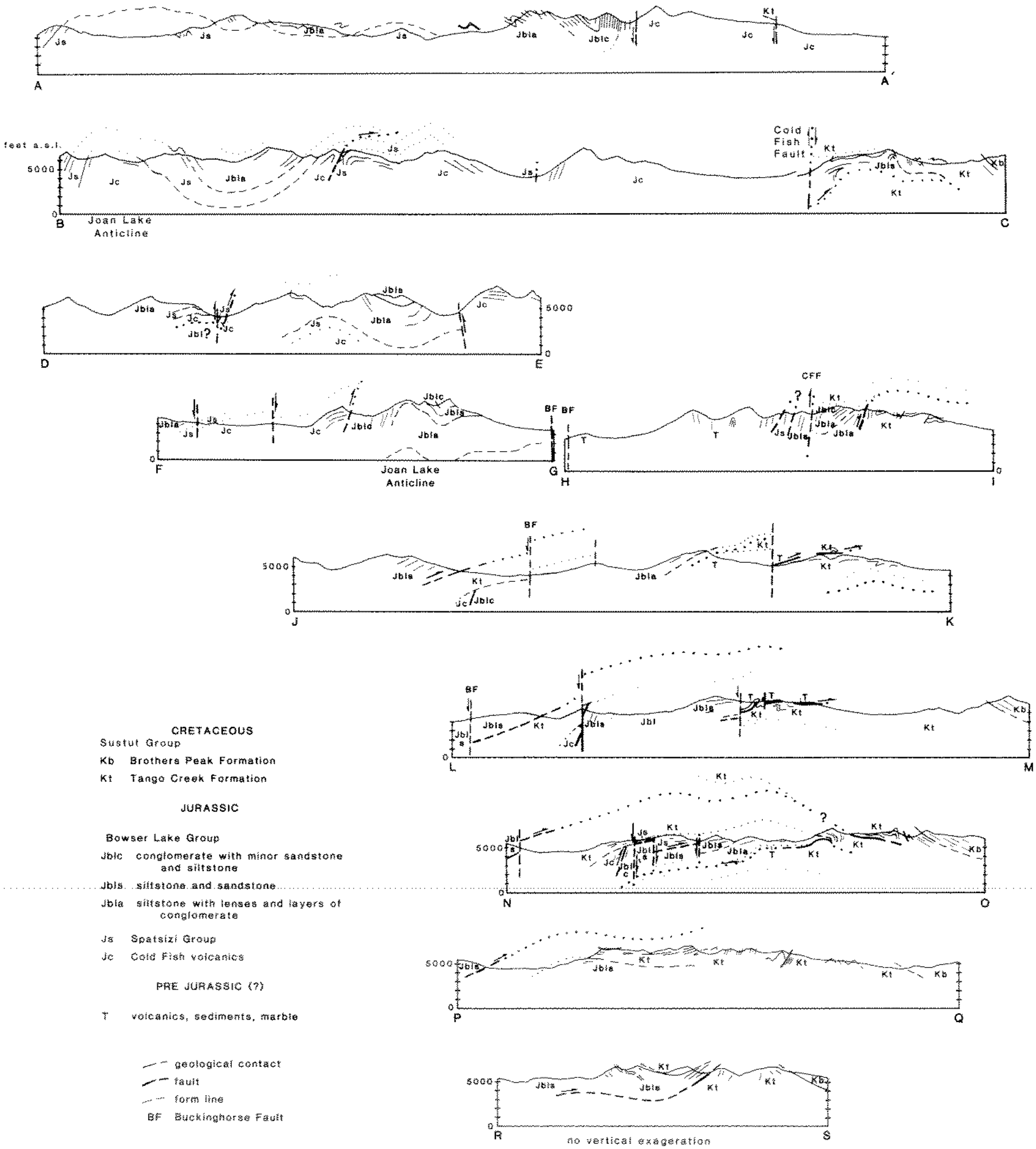

Figure 3. Schematic cross-sections of the study area. The location of the sections is shown in Figure 2.

The next lowest marker in the sections (Fig. 3) is the unconformity between the Tango Creek Formation and older rocks (sections JK to PQ). Immediately east of Buckinghorse Creek the Tango Creek Formation is in unconformable contact with volcanics, and overlaps a fault that separates volcanics from the Bowser Lake Group. The absence of volcanics along the Buckinghorse River is inferred to be a result of down-to-the-southwest displacement of the unconformity by the Buckinghorse Fault (sections JK, LM). The unconformity can be traced to the east and northeast around an open, southeast-plunging anticline to where a thrust fault cuts up section through the Bowser-Tango unconformity into the Tango Creek Formation (section NO). This thrust fault is interpreted to be the next lowest structural element. It places Bowser Lake Group and volcanic rocks in the hanging wall over Tango Creek Formation in the footwall (section LM).

The vertical sequence of thrust fault-unconformity-thrust fault is difficult to trace northwest across a large northeast-trending fault (between sections LM and JK). The steeply-dipping fault separates a block in which Triassic(?) rocks are unconformably overlain by Bowser Lake Group, from the block which has the thrust fault that places volcanic rocks (Triassic (?)) above Tango Creek Formation.The amount of shortening illustrated by the overlap of thrust faults in Figure 3 is only a fraction of the total shortening across the region. Tight folds and local intense cleavage have also accommodated shortening.

SUMMARY

Four lithological units, based on the proportion of siltstone, sandstone, and conglomerate, were recognized in central Spatsizi map area. The distinction between these units is not always clear, particularly in areas of complicated structure. The usefulness of the breakdown regionally is questionable because facies changes cannot be recognized without tight fossil control. For example, in one area the upper conglomerate is known to be Oxfordian, but in the area of the Biernes syncline (Fig. 1), the upper conglomerate is Albian (Moffat, 1985). Athough lithologically the conglomerates have some similarities, it is doubtful that they were ever physically continuous.

An understanding of the interaction of dip-slip faults is important in explaining the distribution of map units and in the correlation of units in the Bowser Lake Group. Only by carefully piecing together the geology across faults does a better picture of the geometry and lateral continuity of the contractional structures emerge (Gabrielse and Tipper, 1984). As previously reported by Evenchick (1987) markers cannot be easily traced across the Griffith Fault. The fault continues to the southwest towards the west side of the anthracite coal-bearing strata at Mt. Klappan (Fig. 1), but it is obscure there because of the lack distinctive lithological units.

The location of coal-bearing strata in the Bowser Lake Group is controlled by: the primary site of deposition within a sequence that grades generally from marine at the base to nonmarine at the top; northwest-trending tight folds and thrust faults which may repeat coal seams; and offset by large-scale northeast- and northwest-trending, steeply dipping, dip-slip faults.

ACKNOWLEDGMENTS

The co-operation and hospitality of staff at Gulf Canada, and the professional service of Northern Mountain Helicopter pilots is appreciated. Jill Pardoe assisted in the field, and Christine Davis drafted the final diagrams.

REFERENCES

Currie, L.
1984: The provenance of chert clasts in the Ashman conglomerates of the northeastern Bowser Basin; B.Sc. thesis, Queen's University at Kingston, Ontario 59 p.

Eisbacher, G.H.
1974: Sedimentary and tectonic evolution of the Sustut and Sifton basins, north-central British Columbia; Geological Survey of Canada, Paper 73-31, 57 p.
1981: Late Mesozoic-Paleogene Bowser Basin molasse and Cordilleran tectonics, western Canada; *in* Sedimentation and Tectonics in Alluvial Basins; ed. Miall, A.D. Geological Association of Canada, Special Paper 23, p. 125-151.

Evenchick, C.A.
1986: Structural style of the northeast margin of the Bowser Basin, Spatsizi map area, north-central British Columbia; *in* Current Research, Part B, Geological Survey of Canada, Paper 86-1B, p. 733-739.
1987: Stratigraphy and structure of the northeast margin of the Bowser Basin, Spatsizi map area, north-central British Columbia; *in* Current Research, Part A, Geological Survey of Canada, Paper 87-1A, p. 719-726.

Gabrielse, H. and Tipper, H.W.
1984: Bedrock geology of Spatsizi map area (104H); Geological Survey of Canada, Open File 1005.

Moffat, I.W.
1985: The nature and timing of deformational events and organic and inorganic metamorphism in the northern Groundhog coalfield: implications for the tectonic history of the Bowser Basin; Ph.D. thesis, University of British Columbia, 205 p.

Smith, P.L., Thomson, R.C., and Tipper, H.W.
1984: Lower and Middle Jurassic sediments and volcanics of the Spatsizi map area, British Columbia; *in* Current Research, Part A, Geological Survey of Canada, Paper 84-1A, p. 117-120.

Thomson, R.C., Smith, P.L., and Tipper, H.W.
1986: Lower to Middle Jurassic (Pliensbachian to Bajocian) stratigraphy of the northern Spatsizi area, north-central British Columbia; Canadian Journal of Earth Sciences, v. 23, p. 1963-1973.