RECONNAISSANCE QUATERNARY GEOLOGICAL INVESTIGATIONS IN PEACE RIVER DISTRICT, BRITISH COLUMBIA (93P, 94A)

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KEYWORDS: Surficial geology, Quaternary, Pleistocene, Peace River, sedimentology, stratigraphy, Wisconsinan glaciation, diamicton, rhythmite, till, glaciolacustrine.

INTRODUCTION

Geologic investigations were undertaken in the area bordering the Peace River in northeastern British Columbia. Study was restricted to the region extending from the town of Hudson Hope to directly east of the city of Fort St. John, and from Highway 97 to the north end of Charlie Lake (Figure 4-7-1). This area includes the northern half of NTS Sheet 93P (Dawson Creek) and the southern half of NTS Sheet 94A (Charlie Lake). Existing surficial mapping coverage for the region is available at a scale of 1:1 000 000

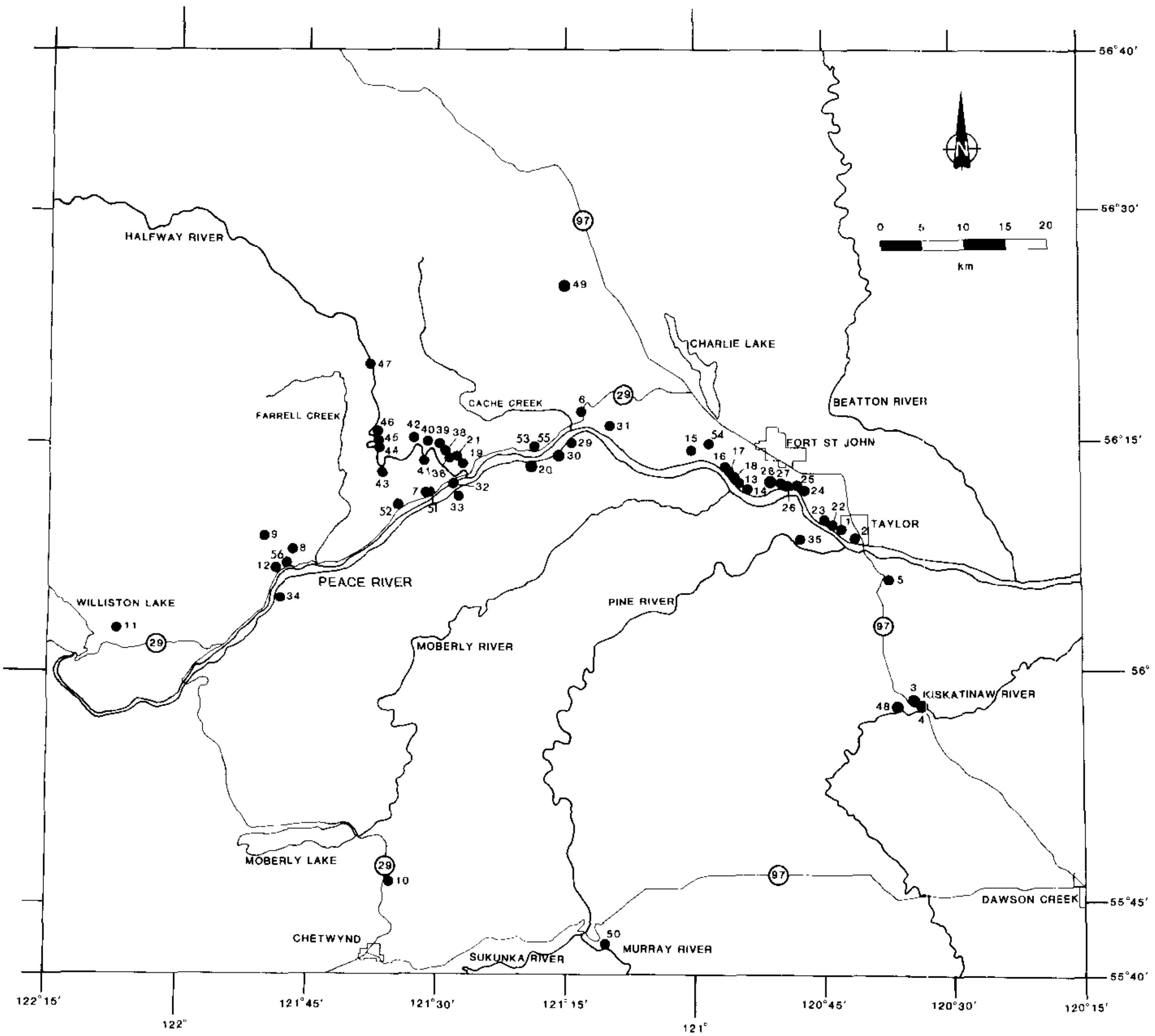


Figure 4-7-1. Location map of Quaternary sections in the Peace River study area. Coordinates for the sites given in Table 4-7-1.

Plate 4-7-1. Section PTB90-43 (Halfway River landslide). View to south of recent Attachie-like slope failure, which originally extended across the Halfway River and temporarily blocked drainage until breached several hours later. Note small channelling and leveeing along the surface formed during and after the failure. (GSB photo PTB90-13-15).

94 A/5 GROUND BIRCH	94 A/6 BEAR FLAT	94 A/7 NORTH PINE	94 A/8 ALCES RIVER
94 A/4 HUDSON HOPE	94 A/3 MOBERLY RIVER	94 A/2 FORT ST JOHN	94 A/1 SHEARER DALE
93 P/13 MOBERLY LAKE	93 P/14 FAVELS CREEK	93 P/15 SUNSET PRAIRIE	93 P/16 DAWSON CREEK
93 P/12 COMMOTION CREEK	93 P/11 EAST PINE	93 P/10 ARRAS	93 P/9 POUCE COUPE

Figure 4-7-2. Index map of 1:50 000-scale NTS map sheets comprising study area. Shaded sheets indicate regions mapped in 1990, and accompanying report by Catto (1991).

for NTS Sheet 94 (Beatton River; Mathews *et al.*, 1975) and at a scale of 1:250 000 for NTS Sheet 94A (Mathews, 1978a) and NTS Sheet 93P (Reimchen, 1980). Aggregate data for the area are poor, as are the data on peat deposits, both issues recommended as requiring attention (Hora, 1988; Maynard, 1988).

The objectives of this project are to provide detailed surficial geological maps (1:50 000 scale) of practical use to industry, as well as municipal, regional and provincial governments; determine the occurrence of, and assess the exploration potential for, aggregate and peat deposits in the same area; study mass-movement deposits along the Peace River Canyon, and if possible determine the timing of occurrence of these past events (Plate 4-7-1); to contribute to the provincial geoscience database by refining the Quaternary geologic history of the Peace District through stratigraphic investigation. Field activities during the 1990 season included surficial mapping of four map sheets (Figure 4-7-2), as well as extensive reconnaissance to locate exposures and sections suitable for further detailed study. This paper presents the results of the reconnaissance efforts and therefore addresses the latter two project objectives, whereas the surficial maps and their accompanying interpretation which are published separately will cover the first two project objectives (Catto, 1991).

The earliest published description of the Peace River Canyon appears in the journal of Sir Alexander Mackenzie during his trip through the region in 1793. Almost 100 years later, in 1872, Captain W.F. Butler provided a detailed and picturesque description of the Peace River valley, and in 1875, A.R.C. Selwyn provided the first geologic description of the area, concentrating on the bedrock geology; only passing reference was made to the unconsolidated sediments by Selwyn (Beach and Spivak, 1943). The most significant contributions to the Quaternary geology of the Peace Region occurred in the period 1950-1980 by W.H. Mathews, and 1967-1977 by N.W. Rutter (Mathews, 1954, 1962, 1972, 1973, 1978a, b, 1980; Rutter, 1968, 1969a, b, 1974, 1976, 1977, 1980, 1981, 1984). However, recent geologic interpretations in the adjacent Rocky Mountain Trench (Bobrowsky, 1984, 1987, 1988, 1989a, b; Bobrowsky and Rutter, 1989, 1990) and the Peace District of Alberta (Liverman, 1987, 1989a, b; Liverman *et al.*, 1989) may have significant effects on interpretations presently applied to the study area. These recent investigations, coupled with the need for an assessment of aggregate and peat exploitation potential, and the continued threat of frequent mass movements, provide a necessary stimulus for renewed geologic work along the Peace River.

SETTING

The study area lies along the western edge of the Alberta Plateau within the Interior Plains (Mathews, 1986). Low-relief topography characterizes the region and consists of broad rolling plateaus and cuestas at elevations near 900 metres. These upland areas are dissected by the Peace River and its major tributaries including the Halfway, Moberly, Pine, Beatton and Kiskatinaw rivers, as well as Lynx, Farrell and Cache creeks (Holland, 1976). The elevation of the Peace River is 520 metres at Hudson Hope and less than 450 metres at the mouth of the Kiskatinaw. The disorganized drainage in the uplands is imprinted upon unconsolidated glacial deposits which cover flat-lying or gently east-dipping sedimentary bedrock of Cretaceous age. Most of the sedimentary rocks in the area belong to the Fort St. John Group. The oldest rocks, which belong to the Gates Formation, are composed of marine shale, siltstone and sandstone

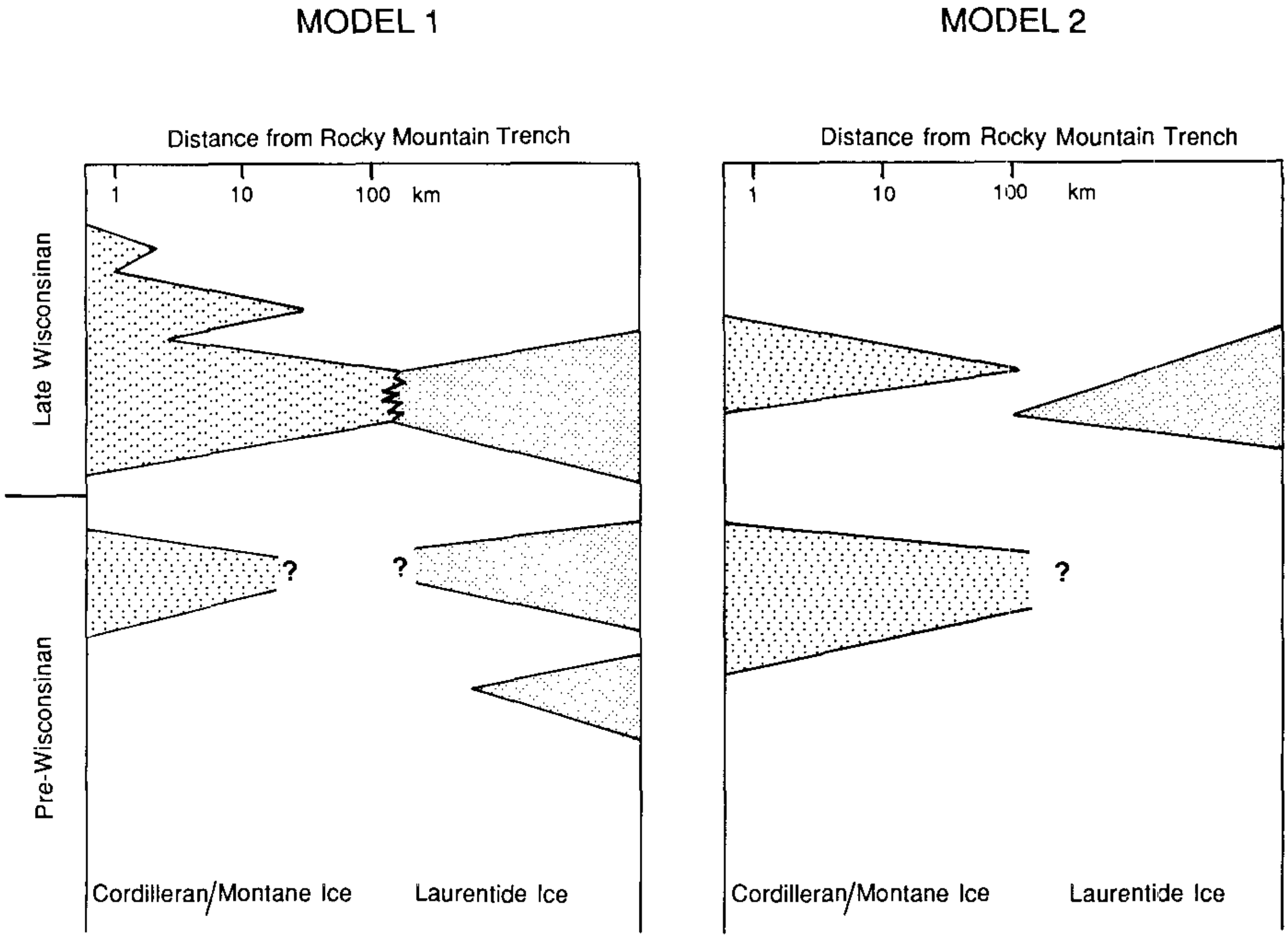
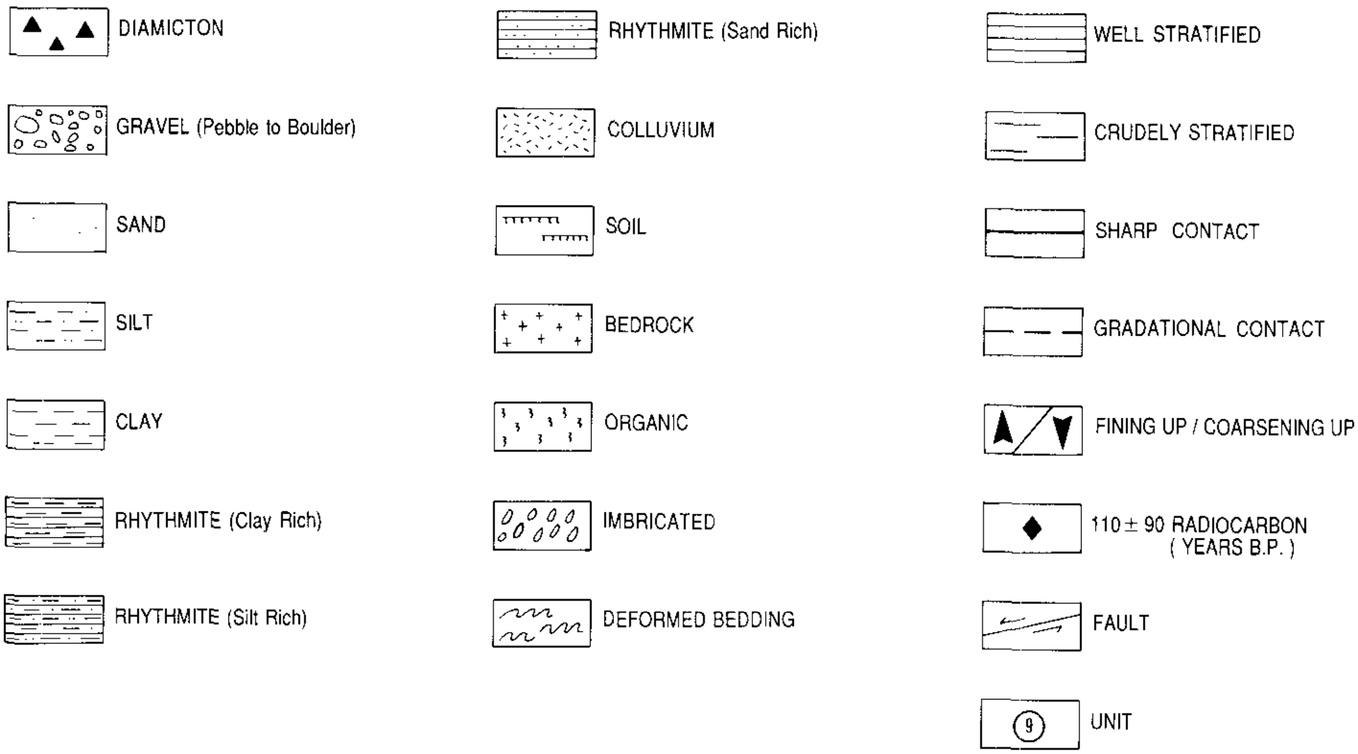


Figure 4-7-3. Time-distance diagram for Quaternary geologic history in the Peace River area. Model 1 based in part on Mathews (1978a, 1980) and Rutter (1976, 1977). Model 2 after Bobrowsky (1989a).

and outcrop in the west, near Hudson Hope. Marine siltstone, silty shale and shale belonging to the Shaftesbury Formation overlie the Gates Formation and outcrop in several places throughout the study area. These rocks, in turn, grade upward into more resistant siltstone and sandstone of the Dunvegan Formation (Mathews, 1978a).

The Peace River, which rises farther west at the Rocky Mountain Trench, is part of the Mackenzie River system, and is a preglacial feature which cuts across the Rocky Mountains perpendicular to the regional bedrock trend. It is likely that the course of the Peace River was established in the early Tertiary, and it is thus antecedent to the Rocky Mountain uplift which formed, in this area, during the late Tertiary (Holland, 1976). The preglacial Peace River occupied a much broader channel than the present river. Notable changes in its course include: a preglacial channel between Bull and Portage mountains (now occupied by the Portage Mountain moraine); paleoriver-flow 1 to 2 kilometres south of the present channel between Hudson Hope and Halfway River; and, paleoriver-flow 4 to 5 kilometres south of the present channel between Bear Flat and Fort St. John (Beach and Spivak, 1963; Mathews, 1978a, 1980; Rutter, 1977; Seyers and Buchanan, 1990).

Historically the northwest part of British Columbia has long been favored as a primary centre for Pleistocene ice build-up (*cf.* Bobrowsky, 1989a for a detailed review). Modifications to this theme are minor and include recognition of other glacial ice accumulation centres such as the Cassiar, Cariboo and northern Rocky Mountains. The style, extent, intensity and timing of glaciations, however, attract a greater diversity of opinions and interpretations. The most contentious issue of the Pleistocene history in the study area centres on two aspects: the influence of Laurentide glacial ice in the province of British Columbia; and the number of glacial events. In the Peace District, two primary models and their variants have been put forward to describe the Pleistocene glacial history of the region (Figure 4-7-3). Model I recognizes two to three Laurentide and three to four Cordilleran glacial events, whereas Model II recognizes one Laurentide and two Cordilleran events. More importantly, Model I recognizes a coalescence of Cordilleran and Laurentide ice sheets, not recognized in Model II.



LEGEND FOR FIGURES 4-7-4 through 4-7-12.

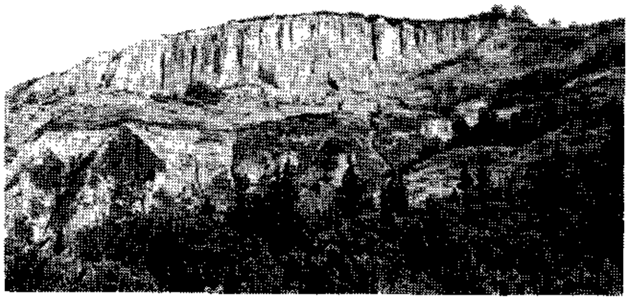


Plate 4-7-2. Section PTB90-26. View to north illustrates bluff exposure consisting of late Quaternary glacial sediments. Majority of exposed sediment at this site is late Wisconsinan diamicton deposited by Laurentide ice sheet. (GSB photo PTB90-11-34).

RESULTS AND INTERPRETATIONS

Field reconnaissance in the study area during 1990 resulted in the identification of 56 sites (Figure 4-7-1), providing some form of subsurface exposure of the unconsolidated sediments (Plate 4-7-2). Table 4-7-1 lists the coordinates and elevations of these sites. Preliminary sedimentologic and stratigraphic work at a few of these locations supports the contention of a complex glacial history for the area, involving ice interaction from three independent sources (Laurentide, Cordilleran and Montane). Descriptions and genetic interpretations for several localities are discussed below.

DIAMICTON DEPOSITS

Section PTB90-06

Section PTB90-06 is located 17.1 kilometres west of Fort St. John, along Highway 29 (Figure 4-7-1). The 15.7 metres of sediment exposed at this locality comprises four units (Figure 4-7-4). Overlying the shaly bedrock along a brecciated regolith-like contact is a coarse, matrix-supported diamicton, 2.3 metres thick, containing planar silt lenses which are approximately 2 centimetres thick and 20 to 30 centimetres in length (Unit 1). Clasts in the unit are all angular and of local lithology. Unit 2 which is 8 metres thick, consists of 672, stone-free, normally graded silty sand and sandy silt rhythmite couplets, which are 1 to 5 centimetres thick. Both upper and lower contacts are sharp and erosional. The rhythmites are overlain by a stratified, matrix-supported diamicton, 4.3 metres thick, containing many planar and biconvex, fine silt lenses, which are 1 to 2 centimetres thick and up to 20 centimetres in length (Unit 3; Plate 4-7-3). The diamicton grades upward into approximately 1 metre of silt and clayey silt rhythmites which show postdepositional disturbance and pedogenesis (Unit 4). Large clasts, up to boulder size, are present in the upper rhythmites.

The lower diamicton, overlying bedrock, is interpreted to be local colluvium or debris-flow deposits. The remaining

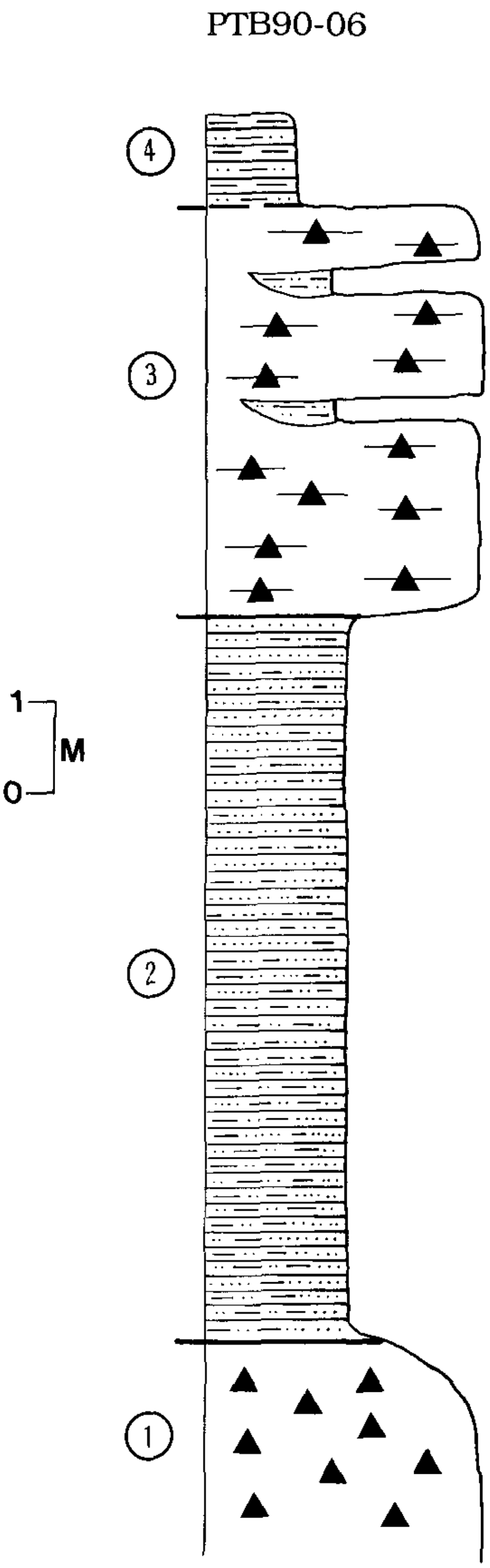


Figure 4-7-4. Composite stratigraphic column for Section PTB90-06.

TABLE 4-7-1
LOCATION OF STUDY SITES IN PEACE RIVER AREA

LOCALITY	LATITUDE	LONGITUDE	UTM	ELEVATION	NTS NO.
90-01	56°09.2′	120°43.0′	FT 419252	472	94 A/2
90-02	56°08.7′	120°41.5′	FT 435243	472	94 A/2
90-03	55°57.9′	120°34.1′	FT 518048	640	93 P/15
90-04	55°57.6′	120°33.9′	FT 521041	579	93 P/15
90-05	56°06.3′	120°38.2′	FT 475201	579	94 A/2
90-06	56°17.2′	121°13.4′	FT 100391	594	94 A/6
90-07	56°11.6′	121°30.8′	ET 923285	488	94 A/4
90-08	56°07.5′	121°46.5′	ET 762205	610	94 A/4
90-09	56°07.8′	121°49.2′	ET 735209	655	94 A/4
90-10	55°47.7′	121°35.4′	ES 882839	792	93 P/13
90-11	56°02.7′	122°07.8′	ET 542113	1097	94 B/1
90-12	56°06.8′	121°47.9′	ET 747192	472	94 A/4
90-13	56°12.4′	120°55.0′	FT 292309	564	94 A/2
90-14	56°11.9′	120°49.5′	FT 296300	457	94 A/2
90-15	56°14.7′	121°00.5′	FT 234348	701	94 A/3
90-16	56°13.5′	120°56.5′	FT 275329	579	94 A/3
90-17	56°12.8′	120°55.5′	FT 287317	594	94 A/3
90-18	56°12.6′	120°55.2′	FT 289312	594	94 A/3
90-19	56°13.5′	121°27.3′	ET 958322	472	94 A/3
90-20	56°13.6′	121°18.9′	FT 045325	610	94 A/3
90-21	56°13.7′	121°27.9′	ET 952324	625	94 A/3
90-22	56°09.5′	120°43.6′	FT 412256	488	94 A/2
90-23	56°09.8′	120°44.1′	FT 407263	503	94 A/2
90-24	56°11.5′	120°47.1′	FT 375295	533	94 A/2
90-25	56°11.9′	120°47.4′	FT 371301	594	94 A/2
90-26	56°12.2′	120°47.9′	FT 365307	625	94 A/2
90-27	56°12.3′	120°48.7′	FT 357309	625	94 A/2
90-28	56°12.5′	120°50.2′	FT 341312	610	94 A/2
90-29	56°15.6′	121°13.2′	FT 102362	625	94 A/6
90-30	56°14.4′	121°15.8′	FT 077339	472	94 A/3
90-31	56°15.8′	120°09.8′	FT 138368	579	94 A/6
90-32	56°12.5′	121°27.5′	ET 956302	434	94 A/3
90-33	56°12.0′	121°27.2′	ET 961292	610	94 A/3
90-34	56°04.8′	121°49.8′	ET 738155	472	94 A/4
90-35	56°08.8′	120°48.1′	FT 366244	549	94 A/2
90-36	56°13.8′	121°29.2′	ET 939326	533	94 A/3
90-37	56°14.0′	121°29.0′	ET 941328	594	94 A/3
90-38	56°14.6′	121°29.5′	ET 945340	610	94 A/3
90-39	56°14.8′	121°29.8′	ET 932344	579	94 A/3
90-40	56°15.0′	121°30.5′	ET 924347	610	94 A/4
90-41	56°14.2′	121°31.2′	ET 916332	472	94 A/4
90-42	56°15.2′	121°31.6′	ET 913349	610	94 A/5
90-43	56°13.4′	121°36.1′	ET 867319	488	94 A/4
90-44	56°14.9′	121°36.6′	ET 862344	625	94 A/4
90-45	56°15.1′	121°37.0′	ET 857347	610	94 A/5
90-46	56°15.7′	121°36.8′	ET 858358	625	94 A/5
90-47	56°19.4′	121°37.8′	ET 847427	518	94 A/5
90-48	55°57.5′	120°36.5′	FT 494038	625	93 P/15
90-49	56°26.7′	121°15.6′	FT 073568	686	94 A/6
90-50	55°42.3′	121°10.7′	FS 146755	610	93 P/11
90-51	56°12.4′	121°29.6′	ET 936298	518	94 A/3
90-52	56°11.0′	121°33.6′	ET 894273	503	94 A/4
90-53	56°14.5′	121°18.4′	FT 049001	457	94 A/3
90-54	56°14.7′	120°57.8′	FT 262352	732	94 A/2
90-55	56°15.5′	121°16.7′	FT 067358	475	94 A/6
90-56	56°06.9′	121°47.5′	ET 753194	533	94 A/4

units all represent facies formed in a glacial-lake environment. Unit 2 rhythmites probably represent sediment deposited during the early stages of glacial-lake formation as drainage to the east was blocked by Laurentide ice. The diamicton overlying these rhythmites is either a subaqueous sediment gravity-flow accumulation deposited in the impounded lake, or a deformation till of unknown provenance. The topmost rhythmites with drop-stones reflect the

Plate 4-7-3. Section PTB90-06 (Bear Flat section). Stratified glacial diamicton near top of section, approximately 5 metres thick, is interpreted to be either a subaqueous debris-flow deposit or deformation till related to the late Wisconsinan glaciation. (GSB photo PTB90-08-20).

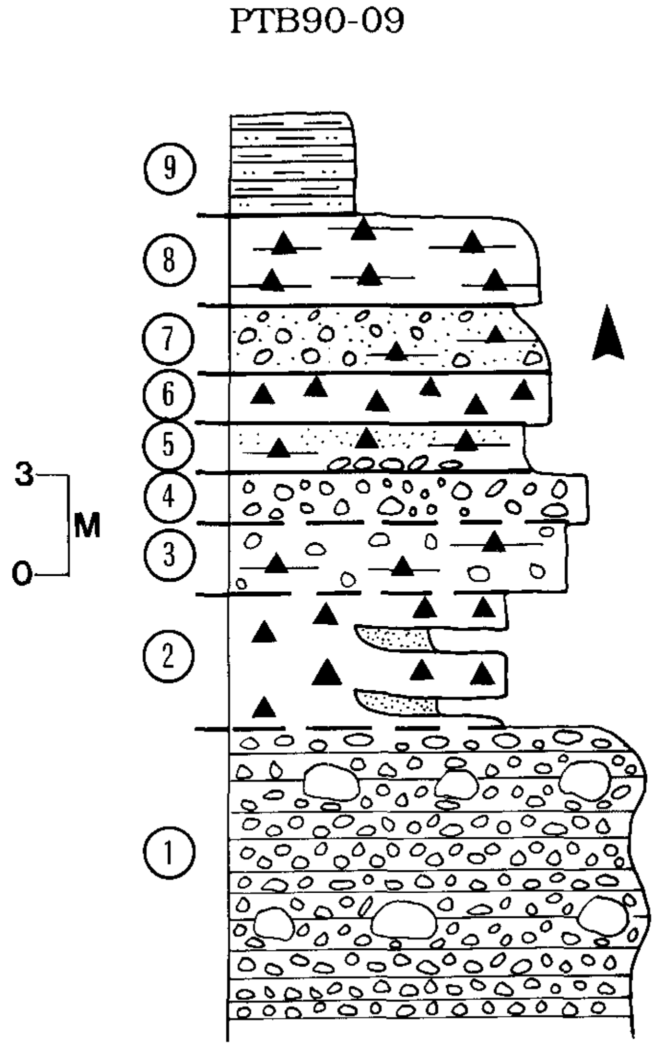


Figure 4-7-5. Composite stratigraphic column for Section PTB90-09.

retreating stages of the glacial event and thus the later stages of the lake history.

Section PTB90-09

This section is located 13 kilometres northeast of Hudson Hope, 2.5 kilometres north of Highway 29 in a small unnamed ravine (Figure 4-7-1). Nine units are represented in the 27.2 metres of sediment exposed in the section (Figure 4-7-5). At the base, 11 metres of horizontally stratified pebble-gravel, with some boulders (Unit 1), is gradationally overlain by 3.4 metres of massive matrix-supported diamicton containing silty sand lenses (Unit 2). The Unit 2 diamicton grades upward into 2 metres of pebble-rich, slightly stratified, clast-supported diamicton (Unit 3), which in turn, grades up into 0.7 metre of poorly stratified, open-work pebble-gravel (Unit 4). Unit 5 comprises 1.1 metres of massive to slightly stratified matrix-supported diamicton which rests upon a sharp lower contact marked by a well-cemented, pebble lag bed. The upper contact shows sheared horizontal bedding with slickenside structures. Unit 6 consists of 1.8 metres of massive, matrix-supported diamicton with vertical jointing. Sharply overlying the diamicton is a 1.9-metre fining-upward sequence of horizontally stratified sand and imbricated gravel beds (Unit 7). Discontinuous and thin silty diamicton lenses are intercalated within the sand and gravel. A 2.3-metre matrix-supported diamicton, with some crude stratification and sharp upper and lower contacts overlies the sand and gravel (Unit 8). The top of the section consists of approximately 3 metres of sandy silt and clayey silt rhythmite couplets.

The complex sequence exposed at this section may reflect one or two glacial/nonglacial events. The interpretation that follows is tentative. The basal gravel represents fluvial deposition in a braided stream system, probably advance outwash (Unit 1). Over-riding ice may then have deposited the massive diamicton which is interpreted to be a till (Unit 2). As ice retreated, local deposition of resedimented diamicton within gravel occurred, as interpreted from the sediments in Unit 3. A second depositional cycle in a braided stream system is then inferred for the Unit 4 deposit. A period of erosion (= boulder lag) clearly pre-

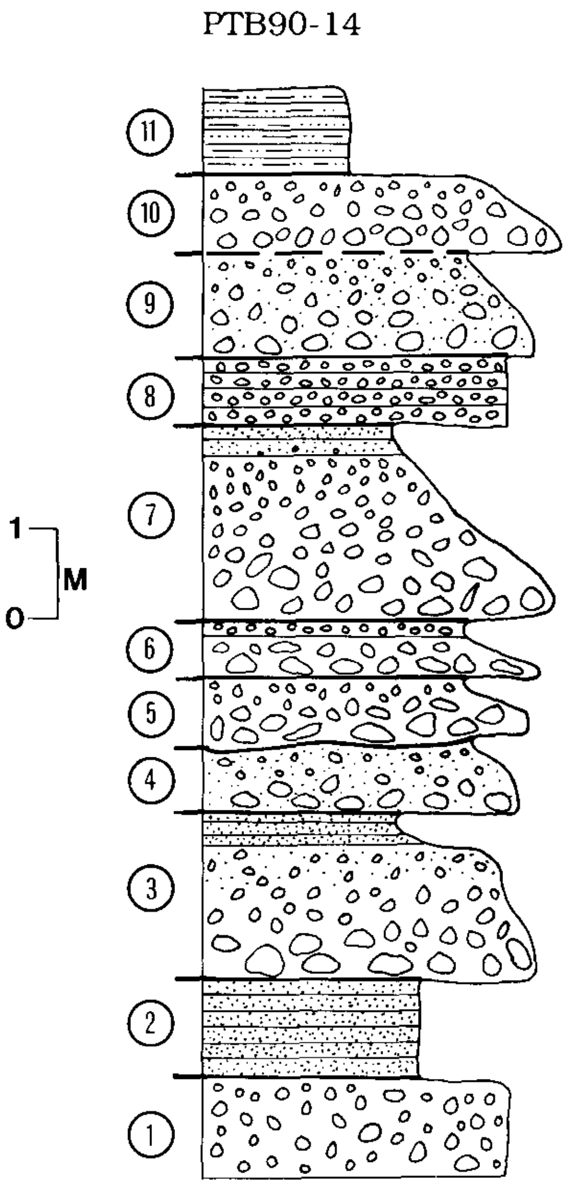


Figure 4-7-6. Composite stratigraphic column for Section PTB90-14.

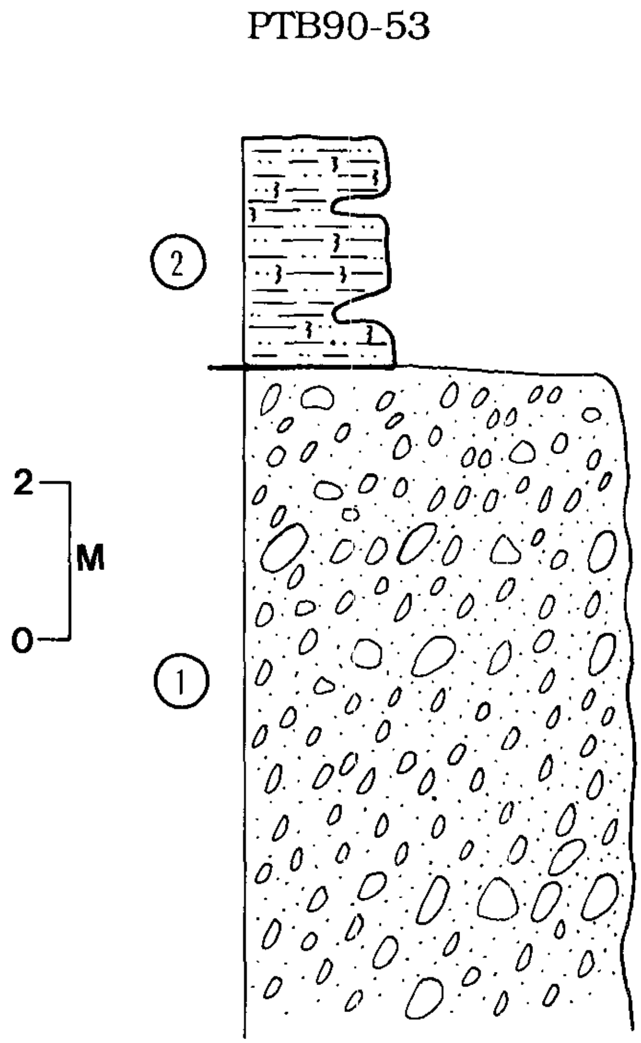


Figure 4-7-7. Composite stratigraphic column for Section PTB90-53.

ceded accumulation of the resedimented diamicton beds in gravel (Unit 5) and till (Unit 6) as ice once again advanced over the area. This was followed by additional resedimentation in ice-contact gravel deposits during ice retreat (Unit 7). Continued ice retreat blocked the regional drainage, resulting in a proglacial lake environment into which a subaqueous sediment gravity-flow would have deposited the stratified diamicton (Unit 8) and subsequently glaciolacustrine rhythmites (Unit 9).

COARSE-GRAINED DEPOSITS

Section PTB90-14

Section PTB90-14 is located 41.5 kilometres southwest of Fort St. John, along the north bank of Peace River (Figure 4-7-1). With the exception of the upper 1 metre of sandy and clayey silt rhythmites, the remaining 14 metres of sediment exposed at this location is predominantly composed of sand and gravel interbeds (Units 1 to 10) (Figure 4-7-6). Several fining-upward cycles are evident in the deposit. Much of the sediment ranges from massive, open-work cobble-gravel to stratified and imbricated pebble-gravel with a sandy matrix. Horizontally laminated, well-sorted, medium sand is found near the base of the section (Unit 2).

This sequence is interpreted to represent fluvial deposition in a relatively high-energy channel of a braided or wandering stream system. The multiple fining-upward cycles of gravel, and sporadic interbeds of sand, reflect the shifting of channels and fluctuating energy levels which are characteristic of the braided stream environment.

Section PTB90-53

This section, located 27.2 kilometres west of Fort St. John, along the north side of Highway 29, is a currently

PTB90-55

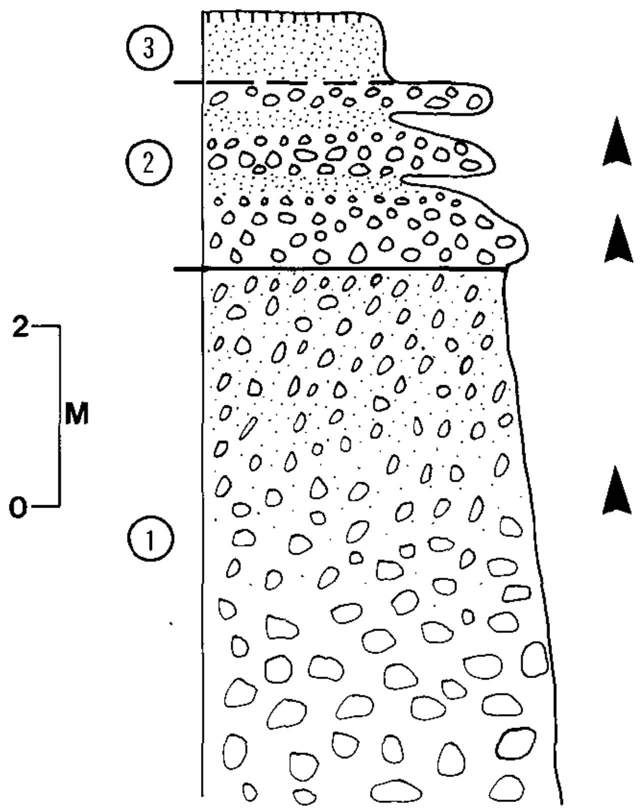


Figure 4-7-8. Composite stratigraphic column for Section PTB90-55.

PTB90-52

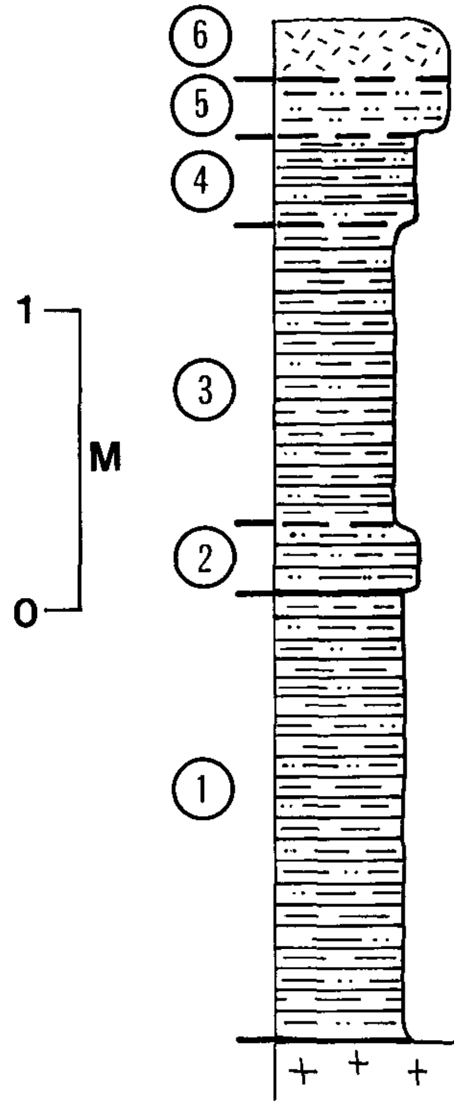


Figure 4-7-9. Composite stratigraphic column for Section PTB90-52.

inactive borrow pit (Figure 4-7-1). Exposed sediment totals 10.8 metres in thickness (Figure 4-7-7). At the base, Unit 1, is dominated by coarse, imbricated pebble-gravel, and shadow structures indicating consistent flow toward 105°. This unit is at least 8 metres thick. An abrupt, erosional upper contact separates the gravel from an interbedded sequence of clayey silt, silty clay and fibrous organic detrital beds totalling 2.8 metres in thickness (Unit 2). All beds within Unit 2 are internally structureless.

The sequence exposed in this section is interpreted to be a fluvial succession. The basal gravel unit is interpreted to represent thalweg deposition in a moderate to high-velocity stream, similar to the modern Peace River. The overlying unit represents overbank deposition in a similar environment. The sharp contact between the two units is either erosional and produced under conditions of a continuous single fluvial system, or represents a discontinuity in time.

Section PTB90-55

Section PTB90-55, located 2.8 kilometres northwest of Highway 29, along Road 167, is in a borrow pit exposing 8.7 metres of sediment (Figure 4-7-1). Three units are present at this site (Figure 4-7-8). Unit 1 is more than 6 metres thick and fines upward from open-worked cobble-gravel to matrix-filled coarse pebble-gravel. Imbricated bedding indicates depositional flow to the east and east-southeast. The mineralogy indicates derivation from western sources. The upper contact is erosional. Unit 1 is overlain by a pebble-gravel, 2 metres thick, with coarse and medium sand, consisting of several graded cycles (Unit 2). The uppermost Unit 3 gradationally overlies the pebble-gravel and consists of structureless fine to medium sand which has been pedogenically altered in the upper part.

This sequence is interpreted to represent fluvial deposition in a relatively high-energy channel of a braided or wandering stream system. The absence of clasts from the Canadian Shield indicates that the exposure may lie beyond the limits of influence of Laurentide ice or the deposit predates Laurentide glaciation.

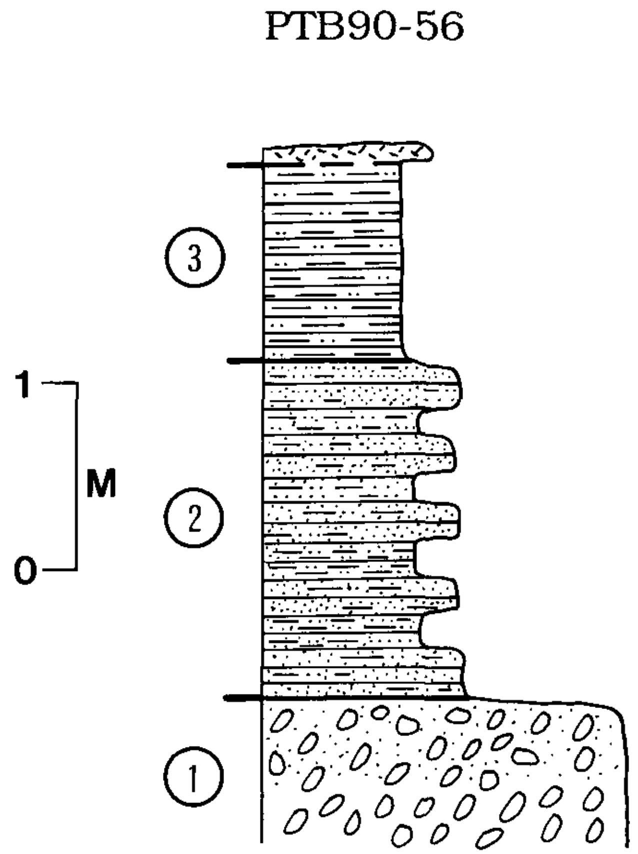


Figure 4-7-10. Composite stratigraphic column for Section PTB90-56.

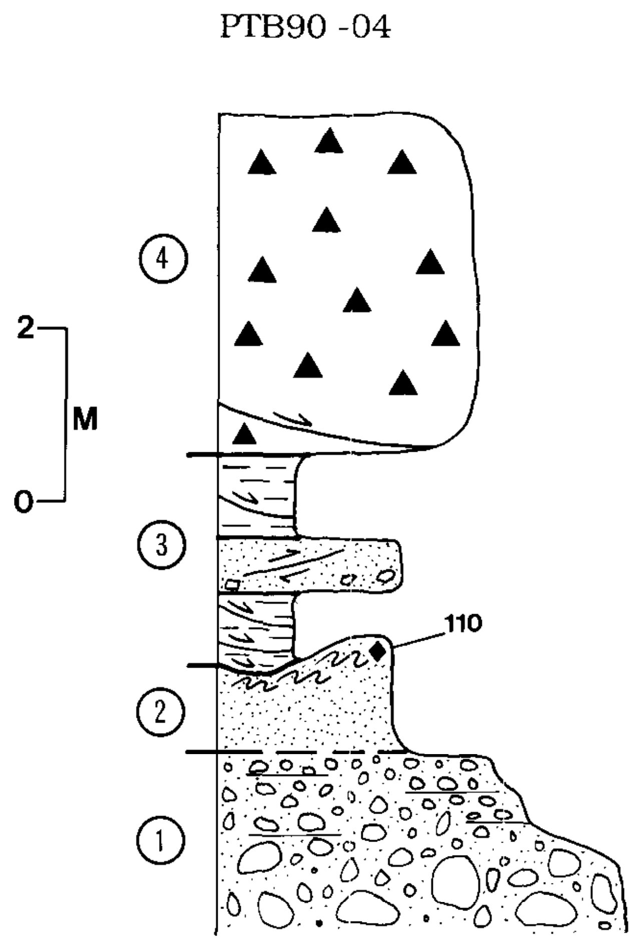


Figure 4-7-11. Composite stratigraphic column for Section PTB90-04.

FINE-GRAINED DEPOSITS

SECTION PTB90-51

This section is located 40.8 kilometres east of Hudson Hope, along the north side of Highway 29 (Figure 4-7-1). It consists of 18.6 metres of laminated silt and silty clay couplets, varying in thickness from 1 to 5 centimetres. Generally, the couplets at the base of the sequence are thicker than those in the upper 10 metres. Minor, structureless sand beds, 2 to 8 centimetres thick, are present in the basal 2 metres of the sequence. A total of 576 couplets were identified.

This sequence is interpreted as the product of low-density turbidity currents in a deep glaciolacustrine environment. In the basal part of the exposure, draped silt lenses, erosional structures and lateral textural gradation in some silt members suggest that flow during deposition was toward the northeast or east. Glaciolacustrine depositional environments were common during the Pleistocene in the Peace District and most often resulted from drainage impoundment to the east by the Laurentide ice sheet (Mathews, 1980). The gradual upward decrease in couplet thickness reflects either deepening of the lake waters or expansion of the lake to the west. The absence of a regressive sequence is probably due to subsequent erosion.

SECTION PTB90-52

Section PTB90-52 is located 35.4 kilometres east of Hudson Hope, along the north side of Highway 29 (Figure 4-7-1). This exposure consists of 3.36 metres of silty clay and clayey silt units overlying bedrock at road level, with a gradational upper contact to colluvium near the surface (Figure 4-7-9). A total of 193 couplets were counted. The basal 1.85 metres consists of silt and silty clay couplets, with a modal thickness of 2 centimetres (Unit 1). Contacts between the couplets are all sharp, but not necessarily erosional. These couplets are overlain, along a planar upper contact, by 15 centimetres of laminated clayey silt (Unit 2), which grades upward into couplets of silty clay and clay totalling 96 centimetres (Unit 3). Couplets in this sequence are generally thinner and finer in texture than those of Unit 2. The Unit 3 couplets are overlain by the 29-centimetre-thick Unit 4, along a gradational contact, by couplets similar to those of Unit 1. A gradational upper contact separates Unit 4 from 11 centimetres of structureless silt (Unit 5), which completes the exposed section.

The units exposed at this locality are interpreted as the products of low-density glaciolacustrine turbidity currents, originating from the west. The fluctuations in couplet thickness and texture probably indicate changes in the energy regimes of the turbidity currents, induced either by fluctuations in shoreline position or by changes in the axis of deposition of the current.

Section PTB90-56

Section PTB90-56 is located 16.4 km east of Hudson Hope, along the north side of Highway 29 (Figure 4-7-1). The exposure consists of three units and is 3.73 metres thick (Figure 4-7-10). Unit 1 is more than 67 centimetres thick, and is composed of an imbricated pebble-gravel indicating flow to the east. Clasts indicate a western provenance. Overlying Unit 1 along an erosional contact are 187 centimetres of complexly interbedded, mottled sandy silt, silt and silty sand beds (Unit 2). The upper part of this unit is truncated along an erosional contact. The uppermost 119 centimetres (Unit 3) consists of silt to clay couplets, with gradational contacts between silt and clayey silt members, and erosional contacts between clay and silt members. A total of 44 couplets were counted in the unit, with a modal average of 3 centimetres in thickness.

Unit 1 is interpreted to be the product of a moderate-energy fluvial system. The overlying sediments may represent low-energy fluvial deposition, either as overbank deposits or in minor channels of a wandering stream. The high modal thickness of the uppermost rhythmites suggests that they represent periodic overbank sedimentation or paludal deposition in a fluvial system, rather than deposition in a lacustrine environment.

SLUMP DEPOSITS

Section PTB90-04

Section PTB90-04 is located 41.5 kilometres southeast of Fort St. John, along the north bank of the Kiskatinaw River

Plate 4-7-4. Section PTB90-15 (Target section). View of Unit 1, stratified glacial diamicton, containing prominent sand interbeds, numerous flat-lying boulders, and gradationally overlying Unit 2 rhythmites. Pebble fabric in diamicton approximately east-west. Pick for scale. Diamicton interpreted to be basal meltout-till. (GSB photo PTB90-11-08).

TABLE 4-7-2
SUMMARY STATISTICS FOR THREE-DIMENSIONAL PEBBLE-FABRIC ANALYSES

FABRIC	TREND	PLUNGE	S1	S2	S3	N
90-10A	029.0°	12.0°	0.8275	0.1618	0.0106	26
90-10B	163.3°	23.2°	0.7024	0.2374	0.0601	22
90-10C	143.4°	13.9°	0.8073	0.1390	0.0538	25
90-10D	154.4°	59.7°	0.5523	0.2592	0.1885	25
90-12	074.7°	06.9°	0.9783	0.0191	0.0026	26
90-06	265.9°	12.7°	0.8798	0.1082	0.0119	25
90-54	187.9°	13.1°	0.6596	0.2761	0.0643	25
90-15A	302.9°	04.1°	0.8143	0.1606	0.0252	25
90-15B	148.4°	30.0°	0.6765	0.2214	0.1021	25
90-08	210.9°	04.8°	0.6878	0.2802	0.0320	14

Note: Fabric number corresponds to section numbers listed elsewhere. S1 to S3 are normalized eigenvalues, and N is sample size.

TABLE 4-7-3
SUMMARY STATISTICS FOR TWO-DIMENSIONAL PEBBLE-FABRIC ANALYSES

FABRIC	VECTOR	R	S.E.	N	RAYLEIGH
90-03A	071.65°	0.9916	3.3140	6	0.0027
90-03B	136.55°	0.9715	2.8262	25	0.0000
90-03C	080.76°	0.9410	5.397	14	0.0000
90-12	107.22°	0.9940	2.7026	9	0.0001
90-10E	028.33°	0.9890	2.3463	12	0.0000

Note: Fabric number corresponds to section numbers listed in Table 4-7-1.

near the Highway 97 bridge (Figure 4-7-1). River erosion has resulted in a transverse section through the distal part of a slump. Approximately 9.5 metres of sediment is exposed (Figure 4-7-11). Horizontally bedded and well-imbricated boulder-gravel grading up into pebble-gravel (Unit 1) is conformably overlain by 1.5 metres of ripple-laminated sand (Unit 2). Climbing ripple sets, 2 to 15 centimetres thick, show convolution in the upper 0.5 metre of the unit. Wood and other organic debris, which is abundant in the upper 1 metre of Unit 2, has been dated to 110±90 years B.P. (AECV-1213C). A sharp, subhorizontal erosional contact separates Unit 2 from the overlying 2 metres of sand and clay interbeds of Unit 3. Approximately 4 metres of clay-rich, matrix-supported diamicton occurs at the top of the section. Numerous subhorizontal slickensided surfaces, brecciated beds and faults are evident in Unit 3 and the lower part of Unit 4.

Units 1 and 2 in this section are interpreted to represent a fining-upward channel-gravel sequence and fine overbank sedimentation, respectively, of a moderate to high-energy wandering braided-stream system. Unit 3 represents the lower cohesive sediment or contact zone of the slump which shears during sediment remobilization. In this unit, sorted beds are still preserved but overprinted with numerous shear planes formed during slumping. The overlying diamicton is interpreted to be the product of an upper zone of viscous resedimentation which also resulted from the same event.

DISCUSSION

Sediment Type

Based on a preliminary examination of several sections, Quaternary deposits in the study area can be grouped into

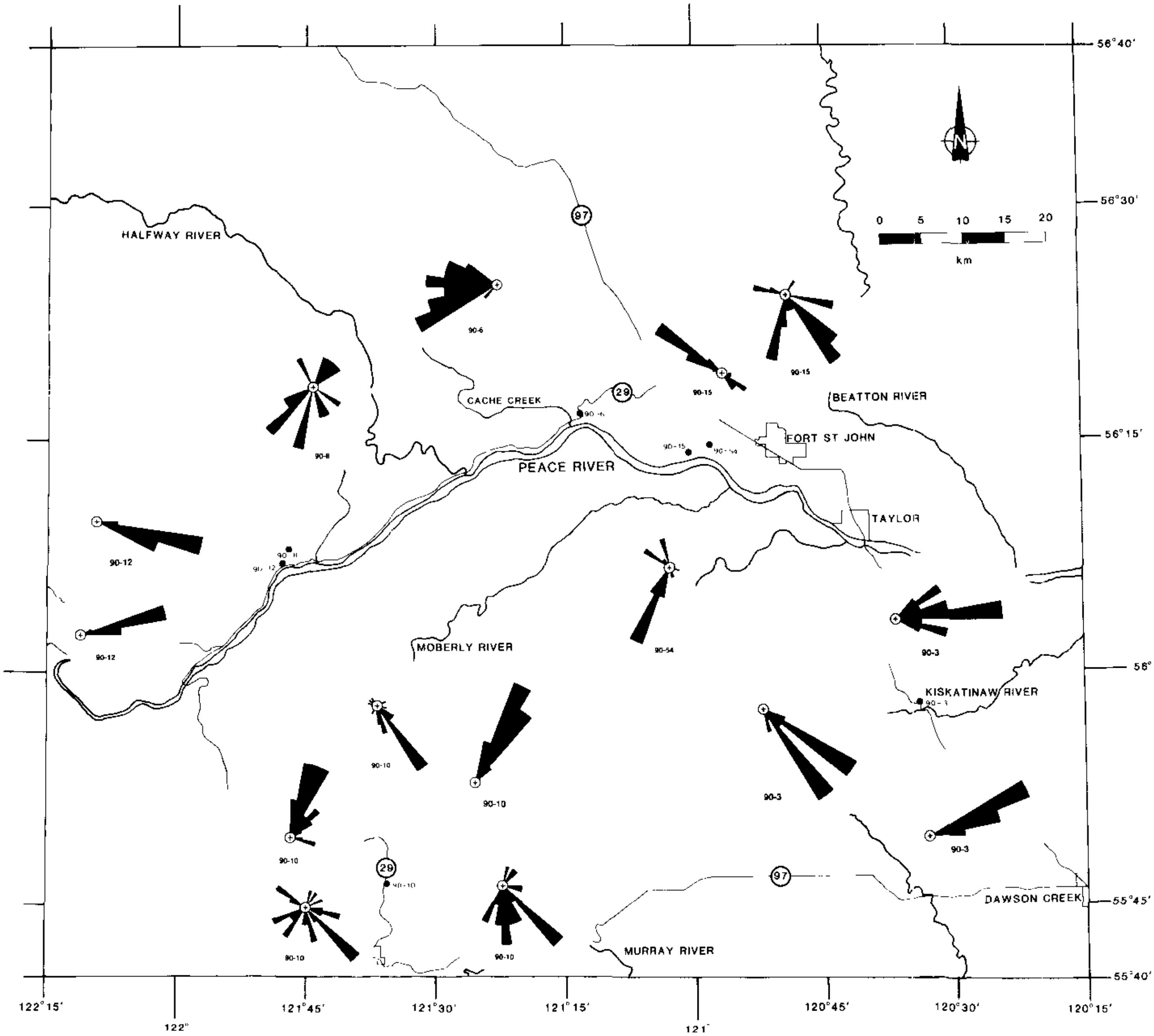


Figure 4-7-12. Pebble-fabric histograms for diamictons from seven locations. *See* Tables 4-7-2 and 4-7-3 for details of pebble-fabric data.

four broad textural groups including diamicton, gravel, sand and fines (silt and clay). Although additional work is required to identify and discuss all of the facies variations which may be present in these groups, a cursory review of some of the observations can be presented in this report.

Diamictons observed thus far include those that are structureless, stratified or massive with some interbeds (Plate 4-7-4). Their genesis is variable. For instance, the two diamictons (Units 2 and 6) observed at Section PTB90-09 are both interpreted to be basal till deposits, whereas the diamicton at the top of Section PTB90-04 is a debris-flow accumulation formed during slumping. The Unit 3 diamicton at Section PTB90-06 is interpreted to have been deposited by a subaqueous sediment gravity-flow. Detailed work is still pending to fully quantify the sediment characteristics of the diamictons. As a start, pebble-fabric was measured in diamicton beds at seven locations. The results illustrate variation in fabric orientation and strength (eigenvalues) which can be expected in sediments of differing genesis, or sediments deposited under different flow directions (Figure 4-7-12; Tables 4-7-2 and 4-7-3).

Gravel and sand deposits are ubiquitous but deep below surface, thus precluding easy extraction for aggregate use. All gravel accumulations are either massive or stratified, and quite often normally graded; both open-work and matrix-filled deposits were observed (Plate 4-7-5). All size fractions of sand are present, as are sediments which are either massive and stratified (horizontal, planar and trough-

Plate 4-7-5. Section PTB90-14 (Rib section). View of Unit 7 illustrating the massive to crudely stratified, oxidized gravel with sand interbeds. Minor manganese staining. (GSB photo PTB90-10-28).

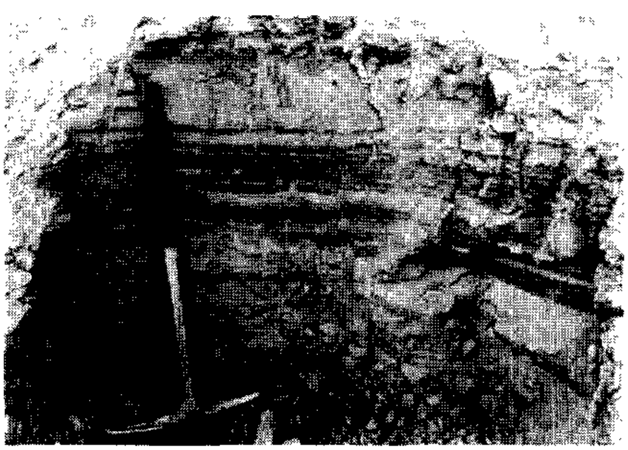


Plate 4-7-6. Section PTB90-12 (Red Paleosol section). View near base of section showing rhythmite variation in couplet thickness, and random interbeds of sand and granular diamicton. Couplets range from silty clay and clayey silt to sandy silt and silt textures. Charcoal wood fragments taken at top of paleosol (Sample PTB90-12-02) and below upper diamicton, radiocarbon dated to 3400±90 years B.P. (AECV-1204C). (GSB photo PTB90-10-04).

Plate 4-7-7. Section PTB90-02. (Ostero Gravel Pit). View of *Bison* tibia (Sample PTB90-02-01) recovered 5.5 metres above base of gravel pit and 12.8 metres below upper ground surface. Proximal end of tibia broken during recovery; trowel for scale. Sample radiocarbon dated to 10 240±160 years B.P. (AECV-1206C). (GSB photo PTB90-07-36).

cross-stratified). Sand deposits occur either independently of the gravel or quite often interbedded with gravel as discrete beds or lenses. Most gravel deposits examined reflect deposition by moderate to high-energy braided-stream systems including cyclic fining-upward sequences characteristic of shifting channels (*e.g.* Section PTB90-14). Most sand deposits represent waning-flow conditions in braided channels (*e.g.* Section PTB90-14) or overbank sedimentation in general fluvial environments (*e.g.* Unit 2 at Section PTB90-53).

A significant portion of the unconsolidated sediment blanketing the study area consists of texturally fine rhythmites. Rhythmites observed in section exposures display considerable variability in bed thickness and integrity, with couplets ranging in texture from coarse sand to clay (Plate 4-7-6). Most of the couplet beds are normally graded and support scattered out-sized clasts. Load structures, rip-up clasts, graded beds and directional flow structures, as well as stratigraphic association with other sediment types indicate that the rhythmites represent episodic deposits resulting from sedimentation of turbid density-driven underflows into proglacial lake environments with intervening quiet-water sedimentation.

Stratigraphy

The preliminary nature of the 1990 fieldwork restricts stratigraphic interpretations which would support either of the stratigraphic models presented earlier. Sections with multiple diamictons examined to date contain no more than two till units, but other sections with multiple diamictons (till?) have been recorded and have yet to be examined. Only a few radiocarbon dates were obtained during this season. Two mass movements were dated, indicating both recent [110±90 years B.P. (AECV-1213C) at Section

PTB90-04] and Mid-Holocene [3400±90 years B.P. (AECV-1204C) at Section PTB90-12] slope-failure events.

One *Bison sp.* bone was recovered from stratified pebble-gravel at Section PTB90-02 and resulted in a radiocarbon date of 10 240±160 years B.P. (AECV-1206C; Plate 4-7-7). *Bison sp.* and other large mammals were common in the area as early as 10 000 years ago (Driver, 1988), so the bone discovery is not unusual. In fact, large game occupied the Rocky Mountain Trench before 9000 years ago (Rutter *et al.*, 1972). However, a previous date of 27 400±580 years B.P. (GSC-2034) on mammoth bone from this section led Mathews (1978a) to correlate the gravel with other gravel of mid-Wisconsinan age. In light of the new date, a reworked faunal assemblage in postglacial gravel seems warranted as a more plausible interpretation for the deposit. Spurious dates from elsewhere in the Peace District have resulted in considerable misinformation regarding late Pleistocene glaciation (*e.g.* White *et al.*, 1979, 1985).

SUMMARY AND IMPLICATIONS

Quaternary geologic investigations in the Peace River region of northeastern British Columbia provide an opportunity to address concerns of importance and interest to the general populace in the area and to Quaternary geoscientists. During the summer of 1990, 56 sites were located for further study to address the following issues:

- Given the high frequency of slope failures in the Peace area, dating of historic and prehistoric failures can shed light on the mitigation of future slope-instability issues;
- Detailed sedimentologic and stratigraphic study of these sites will improve understanding of the glacial and nonglacial history for the region.

Surficial mapping, not discussed here, but presented elsewhere, addresses the following two questions:

- What is the location and integrity of aggregate deposits in the Peace District?
- Do economically viable and potentially commercial peat deposits occur in the region?

Field activities are planned for the summers of 1991 and 1992 to meet the above objectives.

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