

Note

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Notes

EARLY POSTGLACIAL SEDIMENTATION OF LOWER SEYMOUR VALLEY, SOUTHWESTERN BRITISH COLUMBIA

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ABSTRACT In lower Seymour Valley, much of the sediment derived from the erosion of valley-side drift (paraglacial sediments) remains in storage in the form of alluvial fans and aprons. Fluvial incision into these features has exposed sections for lithostratigraphic and chronological study. Radiocarbon dating of organic-rich beds within these deposits indicate that paraglacial sedimentation of lower Seymour Valley commenced before 11.4 ka, was periodic, and was essentially complete by about 9 ka; Seymour River had incised to its present vertical position by about 5 ka. Furthermore, our radiocarbon ages indicate that, although paraglacial sedimentation commenced shortly following deglaciation when the climate was cool and moist, a significant amount of sedimentation occurred during a transition from wet and moist climate to warm and dry (xerothermic) conditions (ca. 10 ka). Charcoal-rich beds indicate that some erosional events may have been a result of slope instability caused by fire.

INTRODUCTION

It has been recognized that in British Columbia the majority of sediment that is currently being transported by rivers is produced by fluvial erosion of valley-fill sediments deposited during the late Quaternary (Church and Slaymaker, 1989). In the Coast Mountains of southwestern British Columbia, valley-fill sediments generally consist of glacial and postglacial deposits. Although the glacial component has received considerable attention, little detailed work on the nature and timing of early postglacial erosion and deposition has been undertaken (that of Souch, 1989 and Brooks, 1994 provide exceptions).

It has been recognized that the majority of postglacial sedimentation occurs while drift deposited during glaciation remains easily accessible for fluvial erosion (Church and Ryder, 1972). The term "paraglacial period" is now commonly used to define the time over which such erosion occurs (Church and Ryder, 1972; Jackson *et al.*, 1982; Brooks, 1994). In British Columbia, however, the timing of paraglacial sedimentation associated with the last glaciation has been difficult

RÉSUMÉ La sédimentation dans la vallée inférieure de la Seymour River au début du Postglaciaire. La plus grande partie des sédiments de la vallée résultant de l'érosion latérale des dépôts « paraglaciaires » demeurent accumulés sous forme de cône alluvial ou de plaine alluviale. L'encaissement fluviale dans ces formes a mis au jour des coupes favorisant les études lithostratigraphiques et chronologiques. La datation au radiocarbone de lits riches en matière organique montre que la sédimentation « paraglaciaire » périodique a commencé avant 11,4 ka et s'est à toutes fins pratiques terminée vers 9 ka dans la vallée. L'encaissement de la Seymour River jusqu'à son niveau actuel était atteint vers 5 ka. De plus, les datations montrent que même si la sédimentation « paraglaciaire » a commencé peu après la déglaciation, alors que le climat était frais et humide, une bonne partie de la sédimentation s'est effectuée au cours d'une période de transition vers un climat chaud et sec (conditions xerothermiques) vers 10 ka. Les lits riches en charbon indiquent qu'une certaine partie de l'érosion est attribuable à l'instabilité des pentes occasionnée par les feux.

to discern because of a lack of datable material (see, for example, Ryder, 1971 and Souch, 1989).

The mountain valleys bordering the Fraser Lowland (Fig. 1) contain thick glacial valley fills (ca. 100 m thick) capped with paraglacial alluvial fan and apron deposits. These alluvial deposits are unusual in that many contain organic-rich beds that allow for the establishment of a radiocarbon chronology. In Seymour Valley, several of these beds were radiocarbon dated by Lian and Hickin (1993) in order to establish a limiting age on deglaciation. In the present note we present a detailed discussion of these fan and apron deposits, and introduce four new radiocarbon ages.

THE STUDY AREA

Located within the Pacific Ranges of the Coast Mountains, Seymour Valley (Figs. 1 and 2) is one of several major valleys that open into the Fraser Lowland. Seymour Valley is relatively narrow and deep, rising to the east and to the west to an elevation of more than 1400 m (Fig. 2). Bedrock in the study area is part of the Coast Plutonic Complex consisting mainly of quartz diorite, migmatite, granodiorite, and minor granite of Cretaceous age (Roddick, 1979). There are presently no glaciers in the valley or on adjacent mountains.

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In Seymour Valley, the top of the valley-fill forms a bench at about 200 m between Seymour Lake and Rice Lake (Fig. 2). Seymour River flows at an elevation of about 200 m below Seymour Falls Dam but has incised to about 100 m near Rice Lake through sediments deposited during the Vashon Stade (Hicock and Armstrong, 1985), the Port Moody interstade (Hicock and Armstrong, 1985; Hicock and Lian, 1995), and the Coquitlam stade (Ryder and Clague, 1989; Hicock and Lian, 1995) of the last (Fraser) glaciation, and finally into sediments formed during the Olympia nonglacial interval (Armstrong and Clague, 1977), $\delta^{18}O$ stage 3. These sediments have been divided into 11 lithostratigraphic units and are discussed in detail by Lian and Hickin (1993). A composite schematic cross-section of the valley fill near Rice Lake is shown in Figure 3.

The glacial component of the valley-fill is capped by paraglacial sediments. South of Hydraulic Creek (Fig. 2) they form a veneer usually no more than 1 m thick (Fig. 3) while north of Hydraulic Creek, where tributaries are more numerous, they can reach a thickness of 10 m. These deposits comprise units 12 and 13 of Lian and Hickin (1993) and form fans and aprons emanating from the valley sides (Figs. 2 and 3). Tributary streams have incised these features leaving sections in cutbanks and slumps where stratigraphy and sedimentology can be studied. The measured sections discussed here were chosen based on accessibility and the availability of organic material for radiocarbon dating. Except for section SVMS-35, they are a subset of those introduced in Lian (1991), which were mainly concerned with the glacial component of the valley fill. Sections SVMS-13, -21, and -25 were briefly discussed in Lian and Hickin (1993). Locations of measured sections discussed in this note, and the distribution of surficial sediments, are shown in Figure 2. Measured sections are shown in Figure 4, and a summary of the radiocarbon ages is given in Table I.

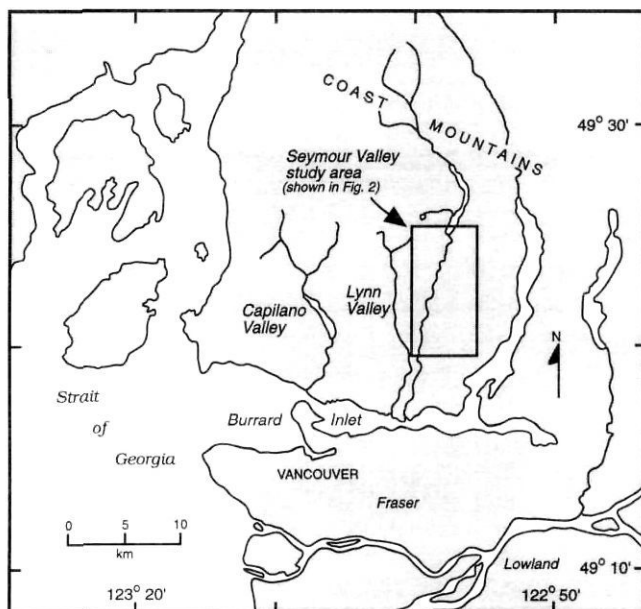


FIGURE 1. Location of the study area.
Localisation de la région à l'étude.

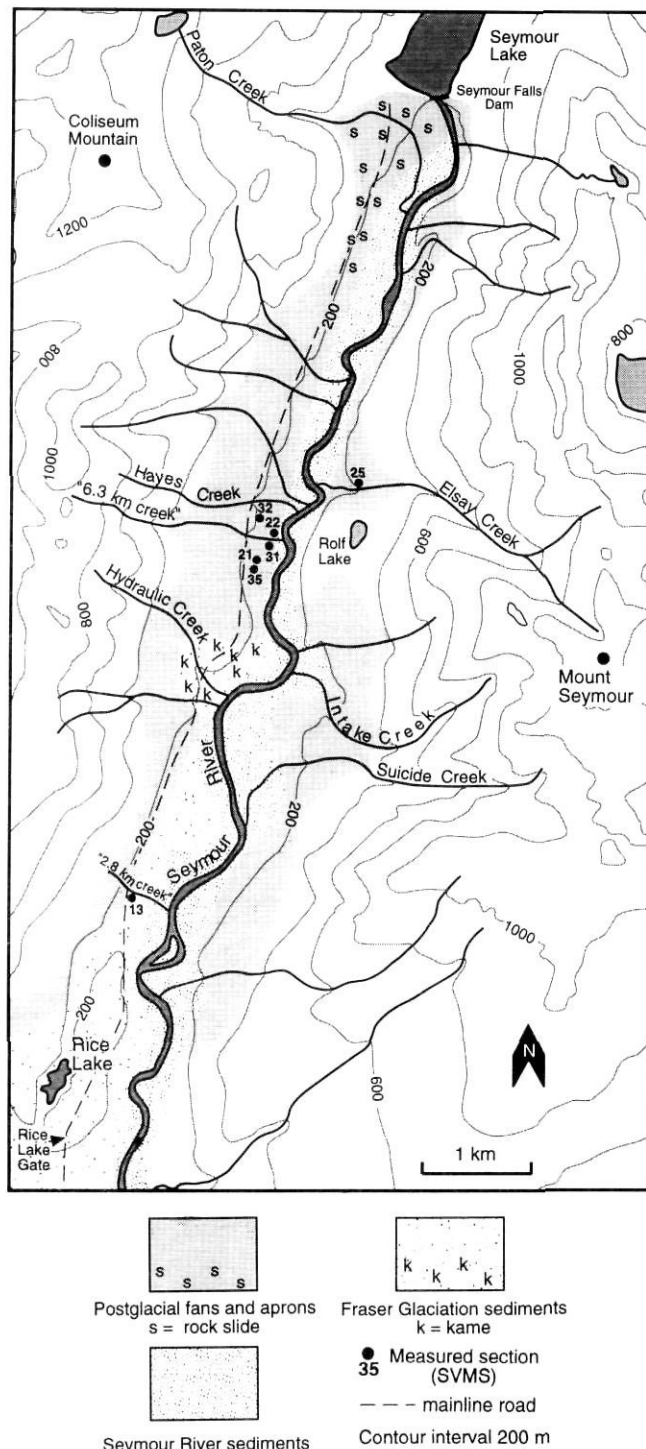
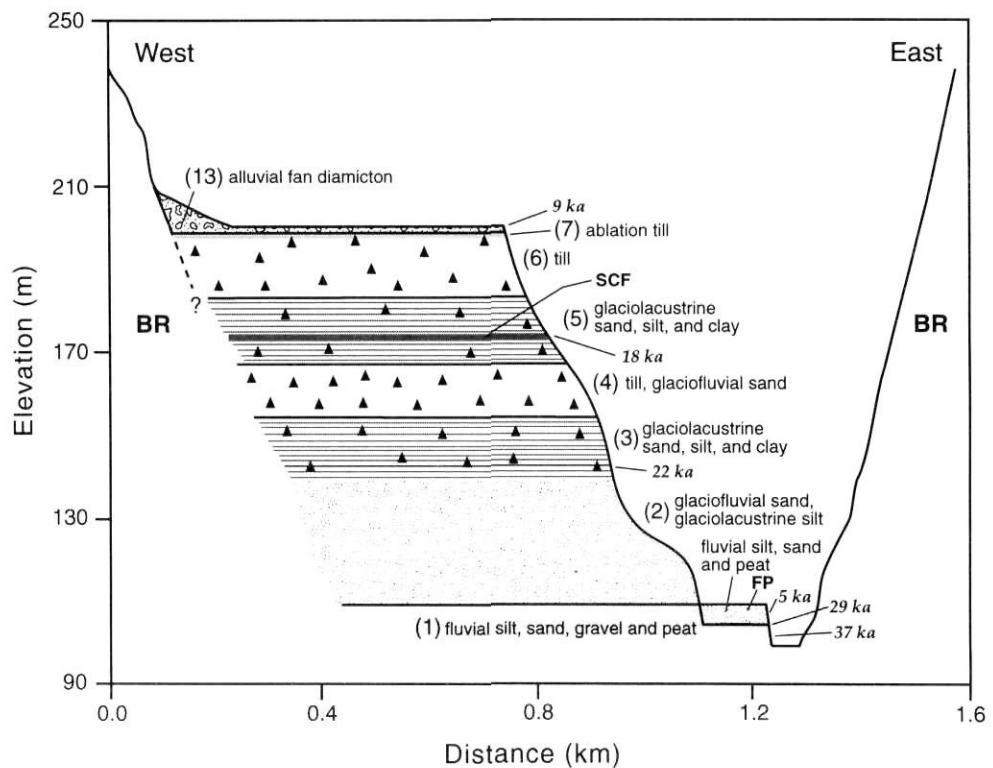


FIGURE 2. Seymour Valley study area showing locations of measured sections and the distribution of surficial sediments (boundaries are approximate).

Partie de la vallée de la Seymour à l'étude montrant les sites de mesure des coupes et la répartition des sédiments de surface (limites approximatives).

FIGURE 3. Composite schematic cross-section of the valley fill near Rice Lake showing radiocarbon ages (ka). Unit numbers are in parentheses. Only units 1 to 7, 13 and 14 occur in this part of the valley. Unit 1 formed during the Olympia nonglacial interval. Units 2 to 4, and possibly part of unit 5, formed during the Coquitlam stade, whereas units 5 to 7 were deposited during Vashon Stade of the Fraser Glaciation. Unit 13 is paraglacial alluvial fan diamicton. **SCF**: Sisters Creek Formation - organic-rich sediments representing the Port Moody interstade; **BR**: bedrock; **FP**: 5 ka floodplain sediments (unit 14 of Lian, 1991). Vertical exaggeration is 7.6 X. Based on Fig. 4(a) of Lian and Hickin (1993).

*Coupe composite schématique dans les matériaux de remblayage de la vallée près du Rice Lake montrant les sites de datations au radiocarbone (ka). L'unité n° 1 s'est formée au cours de l'intervalle non glaciaire d'Olympia. Les unités n°s 2 à 4, et peut-être une partie de l'unité n° 5, se sont formées pendant le stade de Coquitlam, tandis que les unités n°s 5 à 7 ont été mises en place pendant le stade de Vashon au cours de la Glaciation de Fraser. L'unité n° 13 est un cône de déjection de diamicton « paraglaciaire ». **SCF** : Formation de Sisters Creek - sédiments riches en matière organique représentant l'interstade de Port Moody ; **BR** : substratum ; **FP** : sédiments de la plaine d'inondation (unité n° 14 de Lian, 1991). Exagération verticale de x 7,6. Coupe fondée sur la figure 4 (a) de Lian et Hickin (1993).*



LITHOSTRATIGRAPHY AND SEDIMENTOLOGY

EAST SIDE OF VALLEY

On the east side of Seymour River fans emanate from small, steep tributary valleys (Figs. 2 and 5b). These fans were incised by tributary streams initially graded to Seymour River or to local bedrock outcrops; the upper reaches of most of these streams presently are graded to culverts. The fans consist of weakly-bedded clast-supported diamicton (unit 13); in places the diamicton is matrix-supported. Clasts are generally subrounded with an average diameter of about 30 cm. In roadcuts, away from incised streams, fan diamicton is observed to sharply overlie laminated clayey silt with minor sand containing dropstones. The fan surfaces are generally forested and stable.

At Elsay Creek (section SVMS-25; Figs. 2 and 6) ~4 m of fan diamicton is exposed in a cutbank (Fig. 6a). Here an ~30 cm thick discontinuous bed of sand and minor pebble gravel occurs about 2 m below the surface of the fan (Fig. 6b). The bed contains disseminated organic material and lenses of charcoal fragments (Fig. 6c). A bulk sample of charcoal (collected from a single lens over a distance of ~1 m) yielded a radiocarbon age of 11 420 ± 110 BP (Beta-40687). Other major fans (e.g. those exposed at Suicide and Intake creeks; Fig. 2) show similar sedimentology but no evidence of an (the?) organic-rich bed.

WEST SIDE OF VALLEY

On the west side of Seymour River where tributary streams are more numerous, fans have combined to form an apron (Figs. 2 and 5a). Tributary streams have incised through apron deposits and into an underlying unit composed of laminated clayey silt with rare dropstones. This is unit 8 of Lian and Hickin (1993) and is likely correlative with a similar unit that directly underlies fan diamicton on the east side of Seymour River (described above).

At section SVMS-21 (Fig. 7a) unit 13 is composed of up to 4 m of weakly-bedded sand and gravel. Here unit 13 overlies about 4 m of horizontally laminated organic-rich sand and silt containing logs, sticks (Fig. 7b), and near the base, charred wood and beds rich with charcoal (Fig. 7c); this is unit 12 of Lian and Hickin (1993). Here it overlies a thin (~20 cm thick) bed of pebble and cobble gravel that in turn rests on unit 8 (Fig. 7a); the contacts between the units are sharp. Two wood samples collected from near the base of unit 12 yielded radiocarbon ages of 10 350 ± 60 BP (Beta-38912) and 10 120 ± 60 BP (Beta-38911), while a third wood sample collected 2 m higher in the unit gave a radiocarbon age of 10 150 ± 70 BP (Beta-52822).

Unit 13 is also exposed above the south bank of "6.3 km creek"¹ between the culvert at the mainline road and its con-

1. Creek names in quotes are unofficial names (e.g. "6.3 km creek" is located ~6.3 km from Rice Lake gate, along the mainline road).

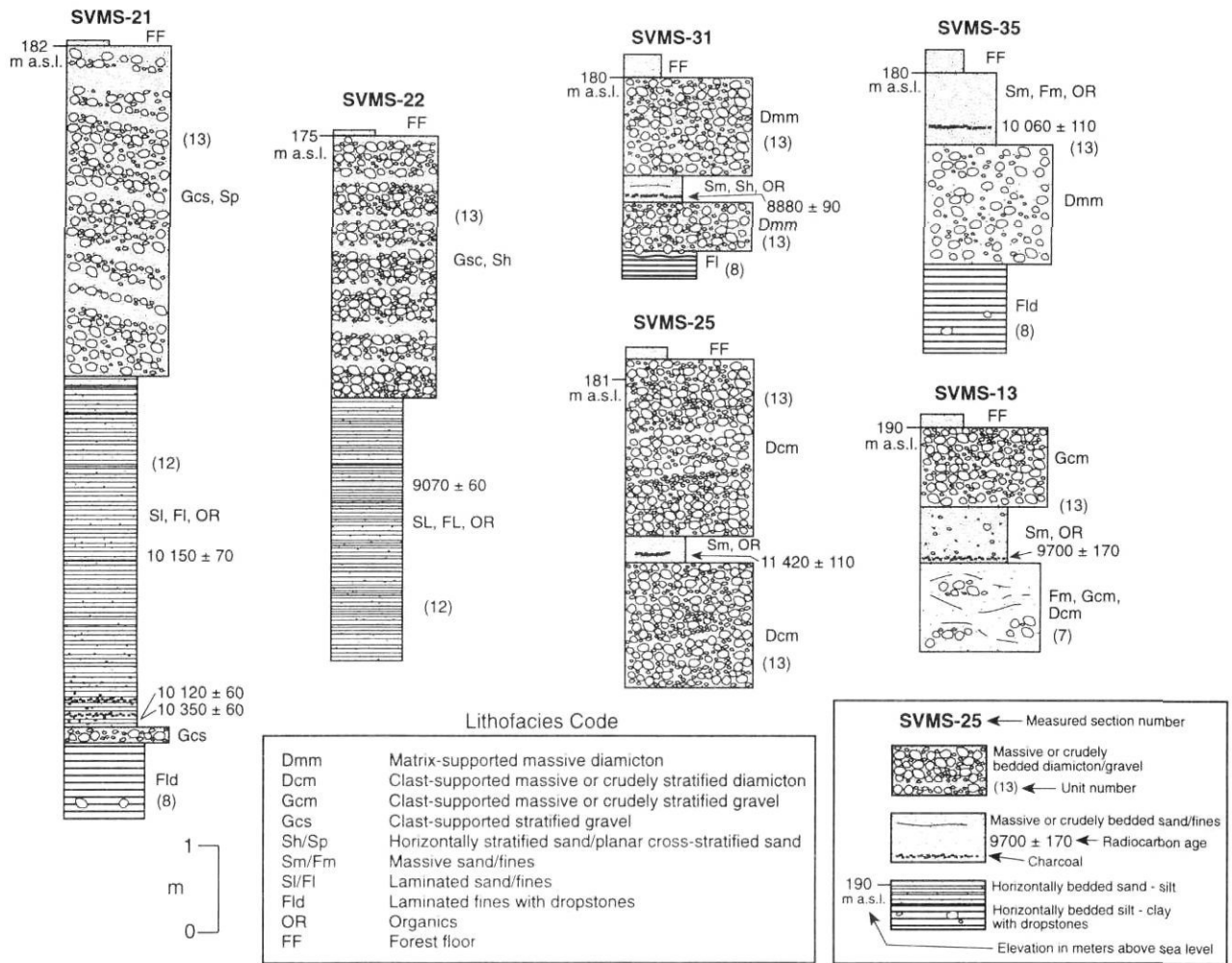


FIGURE 4. Lithostratigraphic sections. See figure 2 for locations. *Colonnes lithostratigraphiques (localisation à la fig. 2).*

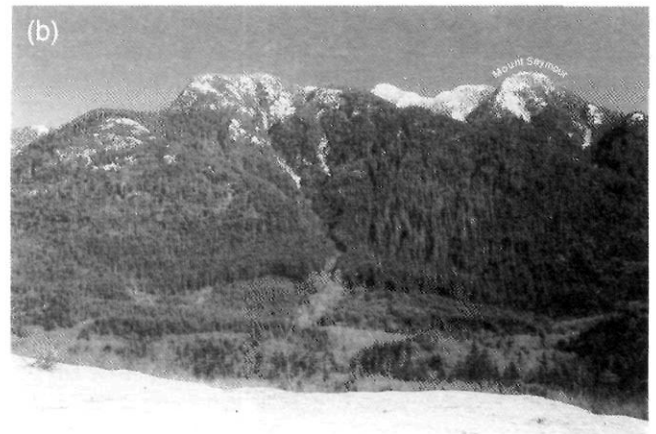
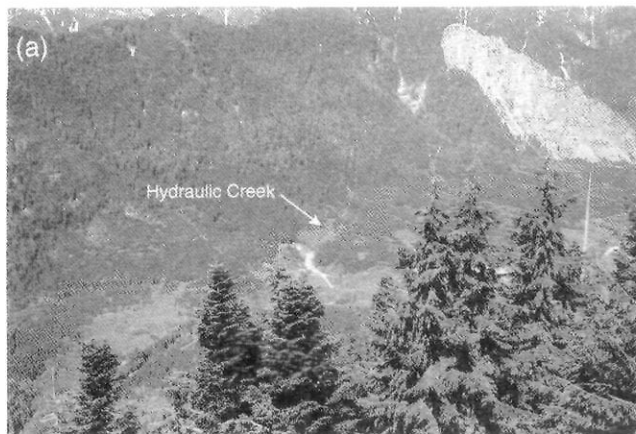


FIGURE 5. (a) View from Mount Seymour of the forested (second growth) alluvial apron on the west side of Seymour Valley. The lower border of the logging scar (top right) shows the approximate upper extent of the alluvial deposits. Hydraulic Creek, delineated by a lighter shade of vegetation, has incised these deposits. (b) Alluvial fan, viewed from the area near Hydraulic Creek, emanating from a steep tributary valley on the east side of Seymour Valley.

(a) *Vue à partir du Mount Seymour de la plaine d'épandage sous forêt de deuxième venue, sur la rive ouest de la vallée de la Seymour. La limite inférieure de la zone d'exploitation (partie supérieure droite) correspond approximativement à la limite de la mise en place des dépôts alluviaux. L'Hydraulic Creek s'est encaissé dans les dépôts.* (b) *Cône de déjection, vu des environs du Hydraulic Creek, issu d'une vallée tributaire escarpée sur le côté est de la vallée de la Seymour.*

TABLE I

Summary of radiocarbon ages discussed in this paper

Lab. No. ^a	Age ^b	Material	Section	Elevation ^d
Beta-40687 ^c	11 420 ± 100	Charcoal fragments	SVMS-25	179
Beta-38912 ^c	10 350 ± 60	Log	SVMS-21	175
Beta-52822	10 150 ± 70	Stick	SVMS-21	177
Beta-38911 ^c	10 120 ± 60	Log	SVMS-21	175
Beta-72821	10 060 ± 110	Charcoal fragments	SVMS-35	175
Beta-40690 ^c	9700 ± 170	Charcoal fragments	SVMS-13	189 ^e
Beta-38913	9070 ± 60	Log	SVMS-22	173
Beta-72820	8880 ± 90	Charcoal fragments	SVMS-31	179

^a Beta: Beta Analytic Inc.; errors ± 1 σ .

^b All ages in radiocarbon years BP.

^c Originally published in Lian and Hickin (1993)

^d Elevations (metres above sea level) were measured with an altimeter; an uncertainty of ± 5 m should be associated with each measurement.

^e Incorrectly reported as 166 m in Lian and Hickin (1993).

fluence with Seymour River. Near the culvert unit 13 attains a thickness of about 7 m but thins to about 2 m near the confluence (section SVMS-31). It consists of massive matrix-supported diamicton including an ~30 cm-thick bed of light-brown organic-rich silty sand. This sand bed is weakly stratified but appears to show two upward fining sequences. Charcoal fragments are found throughout the sand bed but are concentrated near the base where a bulk sample produced a radiocarbon age of 8880 ± 90 BP (Beta-72820). Along this section of the creek unit 13 diamicton sharply overlies unit 8. However, in places, unit 13 clasts have been incorporated into and (or) deformed unit 8 sediments near their contact.

Above the north bank of "6.3 km creek", near the confluence with Seymour River (section SVMS-22), horizontally bedded fine to coarse sand (unit 12) sharply underlies 3 m of weakly stratified cobble gravel and sand (unit 13). Within the sand unit are organic-rich beds containing wood. A log from one of these beds, 1 m below the contact with unit 13 yielded a radiocarbon age of 9070 ± 60 BP (Beta-38913).

About 100 m south of section SVMS-21, at section SVMS-35, sediments that resemble the organic-rich sand bed found within unit 13 at "6.3 km creek" are found directly below the present forest floor. A bulk sample of charcoal collected from this bed yielded a radiocarbon age of 10 060 ± 110 BP (Beta-72821). This bed sharply overlies up to 1.3 m of matrix-supported diamicton (unit 13) which in turn sharply overlies laminated clayey silt and fine sand containing rare dropstones (unit 8).

Sediments of a similar character are also exposed ~3.5 km south at "2.8 km creek" (section SVMS-13) where ~50 cm of organic-rich pebbly medium and coarse sand underlie about 1 m of matrix-supported diamicton which in turn overlies a bed composed of weakly-structured clayey sand and silt contain-

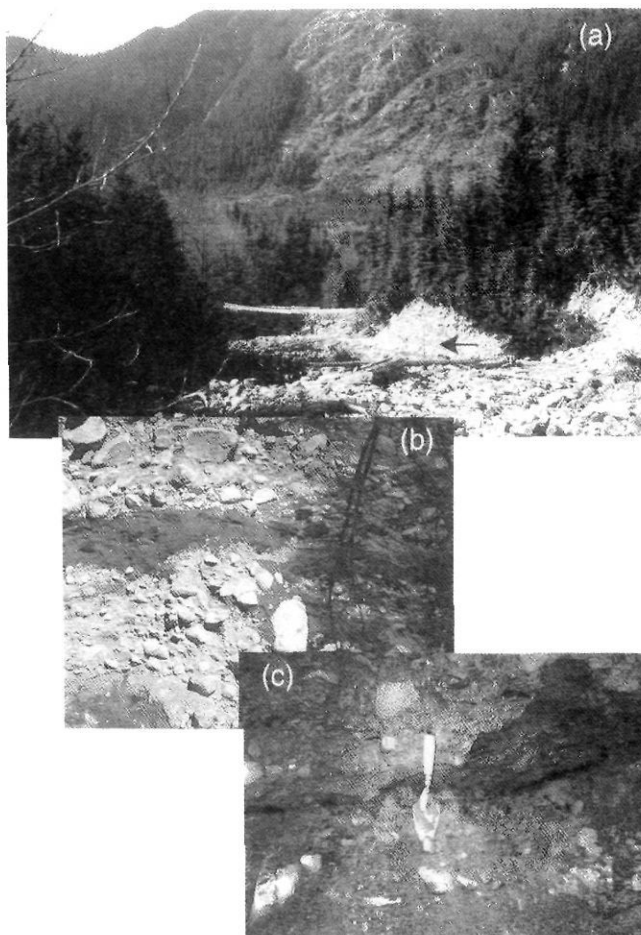


FIGURE 6. (a) View from Elsay Creek looking west. Approximately 4 m of fan diamicton is exposed at the north bank (section SVMS-25). Note that the fan surface is forested and stable. (b) Organic-rich mudflow bed ~30 cm thick; location arrowed in (a). (c) Close-up of the mudflow bed in (b) showing a lens rich with charcoal. A bulk sample of this charcoal yielded a radiocarbon age of 11 420 ± 100 BP (Beta-40687). The trowel is 25 cm long.

(a) Vue du Elsay Creek vers l'ouest. Environ 4 m du cône de déjection composé de diamicton a été mis au jour sur la rive nord (coupe SVMS-25). Noter que la surface recouverte d'arbres est stable. (b) Lit de coulée boueuse riche en matière organique ~30 cm d'épaisseur; flèche en (a). (c) Gros plan du lit de coulée boueuse en (b) montrant une lentille riche en charbon. Un échantillon de ce charbon a donné un âge de 11 420 ± 100 BP (Beta-40687). La truelle mesure 25 cm de long.

ing clasts of diamicton and lenses of cobble gravel. This latter unit is unit 7 of Lian and Hickin (1993) and has been interpreted as ablation till. Charcoal fragments from the organic-rich sand bed gave a radiocarbon age of 9700 ± 170 BP (Beta-40690).

DISCUSSION

In lower Seymour Valley, deposition of paraglacial fans and aprons commenced before 11.4 ka and had essentially ended by about 9 ka. The presence of charcoal, sticks and logs in these deposits indicate that the area was vegetated throughout this period.

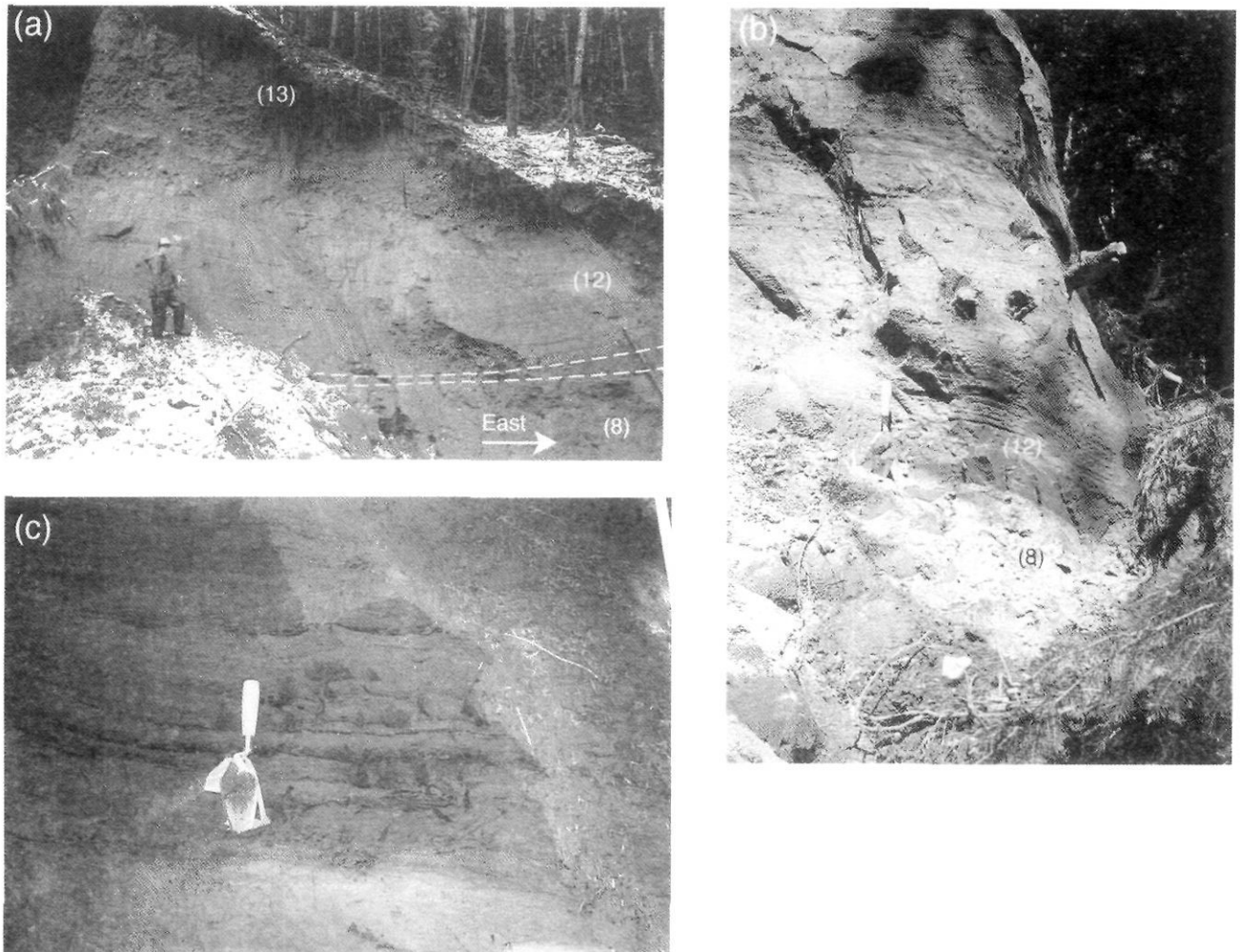


FIGURE 7. Section SVMS-21. Unit numbers are in parentheses. (a) Weakly-bedded unit 13 gravel overlying horizontally-bedded organic-rich sand and silt (unit 12), which in turn overlies unit 8 glaciolacustrine sediments. A gravel bed, delineated by dashed lines, separates units 8 and 12. See Figure 4 for the location of radiocarbon samples. (b) Exposure adjacent to section SVMS-21 showing organic-rich unit 12 sharply overlying unit 8 glaciolacustrine sediments (the trowel, 25 cm long, is at the contact). The gravel bed that separates these units in (a) is not present here. Note the logs protruding from unit 12. (c) Close-up of unit 12 near its contact with unit 8 showing horizontally-bedded sand and silt rich with charcoal fragments and charred wood; age ~10 ka. The trowel is 25 cm long.

Coupe SVMS-21. (a) Gravier faiblement stratifié de l'unité n° 13 surmontant le sable et le silt à stratifications horizontales riche en matière organique de l'unité n° 12, qui à son tour surmonte les sédiments glaciolacustres de l'unité n° 8. Un lit de gravier (tirets) sépare les unités n° 8 et 12. La figure 4 donne la localisation des échantillons datés. (b) Affleurement près de la coupe SVMS-21 montrant l'unité n° 12 riche en matière organique surmontant de façon nette les sédiments glaciolacustres de l'unité n° 8 (la truelle de 25 cm de long identifie le contact). Le lit de gravier, qui sépare ces unités en (a), n'apparaît pas ici. Remarquer les bûches en saillie dans l'unité n° 12. (c) Gros plan de l'unité n° 12 près du contact avec l'unité n° 8 de sable et de silt à stratifications horizontales riches en fragments de charbon et de bois calciné (~10 ka). La truelle mesure 25 cm de long.

The presence of bedding, although weak in places, at sections SVMS-21, -22, and -25 (and at other unmeasured sections at Intake and Suicide creeks) suggest that unit 13 sediments were deposited as prograding fans, while its massive character at sections SVMS-31, -35, and -13, suggest deposition of this unit also occurred by rapid debris flow. The organic-rich pebbly sand beds found in contact with, or within, unit 13 at several exposures were probably deposited as a mud flow. At most sections unit 13 lies sharply on unit 8².

2. Units 9 and 10 are massive glaciomarine(?) stony clay and deltaic beach sand and gravel, respectively. They only occur south of Rice Lake (Lian and Hickin, 1993).

Unit 8 is interpreted as glaciolacustrine, or possibly glaciomarine (Lian and Hickin 1993), but because unit 8 has not been found south of Hydraulic Creek the former interpretation is favoured. The conformable(?) contact between units 13 and 8 at section SVMS-31 suggests, perhaps, that deposition of unit 13 commenced while a late-glacial lake, likely impounded by stagnant ice and (or) sediment near Hydraulic Creek, occupied this part of the valley. This, together with an age of 8.9 ka obtained from near the middle of unit 13 at this section (Fig. 3), implies that a later debris flow event had overridden and reworked some of the original unit 13 sediments at this locality. Further south, where unit 8 has not been

identified, unit 13 overlies ablation till (last glacial Vashon Drift: unit 7; section SVMS-13).

Unit 12 was observed in two sections (sections SVMS-21 and -22), but only at section SVMS-21 was it observed in contact with underlying unit 8. At section SVMS-21, unit 12 and unit 8 are, in places, separated sharply by a thin bed of pebble and cobble gravel that is interpreted as channel lag. This suggests that at section SVMS-21, unit 12 is channel fill, and similar radiocarbon ages from the base and the middle of the unit suggest that infilling was rapid. The origin of unit 12 at section SVMS-22 is thought to be similar.

Unit 12 and the organic-rich sand (mud flow) beds associated with unit 13, are likely composed of material that was derived from soil and vegetation that had become established higher on the valley sides. This suggests that there were periods of relatively little erosion and deposition between the onset (at ~12 ka) and cessation (at ~9 ka) of fan and apron development. It appears however that these mud flows were capable of reworking any paleosols that may have developed on the lower apron surfaces during periods of relative slope stability.

Since the nature and rate of erosion may be influenced by climate it is useful to relate paraglacial sedimentation in Seymour Valley to climatic intervals that have been established for the southern coast of British Columbia. Paleoeological studies indicate that the climate was cool and moist following deglaciation until about 10 ka when warm and dry conditions prevailed during the Holocene xerothermic interval which continued until about 7 ka (Mathewes and Heusser, 1981; Mathewes, 1985, 1993). It may therefore be expected that the vast majority of paraglacial sedimentation would occur immediately following deglaciation when the valley sides were essentially bare of vegetation and precipitation was relatively high. In lower Seymour Valley, however, it appears that a significant amount of paraglacial sedimentation occurred during the transition to xerothermic conditions. This suggests that the valley sides were quickly vegetated and stabilised following deglaciation. Indeed, our 11.4 ka age from Elsay Creek indicates that vegetation had returned to the valley within several hundred years of deglaciation. Thus it appears that the remaining valley-side drift was eroded during periods of slope instability during the early part of the Holocene xerothermic interval. During this time, vegetation change as a result of climatic change may have had a bearing on slope stability, but further work is needed to substantiate this.

Abundant charcoal and charred wood in unit 12 and 13 deposits suggest, perhaps, that the valley slopes were periodically destabilised by fire. Indeed, the presence of charcoal of middle Holocene age has been found to be associated with higher sedimentation rates elsewhere in southwestern British Columbia (Souch, 1989), and it has been suggested that the early to middle Holocene was a time when "fires were likely an important source of forest instability" and that during this period "the combined influence of higher summer temperature, lower precipitation, and perhaps also higher lightning frequency would be expected to result in greater fire frequency..." (Mathewes, 1985: 412).

On the basis of our radiocarbon ages and stratigraphy, it appears that the formation of paraglacial fans and aprons had essentially ended by about 9 ka as the supply of easily-erodible valley-side drift decreased to a point where it could be moved through the fluvial system. Incision of tributary streams into units 13 and 12 probably started shortly after 9 ka in response to a dwindling sediment supply as base level (relative sea level) continued to fall in response to isostatic rebound; streams eventually incised into underlying glacial sediments. It is not known precisely when Seymour River reached its present vertical position, but radiocarbon ages from floodplain sediments near Rice Lake (Fig. 3) indicate that downstream incision through the glacial valley-fill was complete shortly before 5 ka (Lian and Hickin, 1993).

Although Seymour River presently is graded to bedrock that crops out ~2 km south of Rice Lake, erosion of the glacial and paraglacial valley-fill continues as a result of slumping and lateral movement of Seymour River and its tributaries. Indeed, many of the sections (several metres high) studied in 1990 had been substantially reworked and were almost unrecognizable in 1994. Despite this, many fans and aprons appear largely intact indicating that a significant amount of paraglacial sediment remains in storage. Paraglacial sedimentation as a result of erosion of the glacial valley fill, presently is restricted to the mouth of Seymour River and Burrard Inlet.

CONCLUSIONS

Paraglacial fans and aprons in lower Seymour Valley are rare in that many contain organic-rich beds and lenses which yield relatively good radiocarbon dating control. Furthermore, the presence of organic-rich beds and lenses of different radiocarbon age suggest that their development was punctuated by periods of relative slope stability. The abundance of charcoal and charred wood in these sediments suggest that periodic rapid erosion of drift on the upper slopes of Seymour Valley may have been enabled, in some cases, by fire.

Radiocarbon dating and stratigraphy indicate that a significant amount of fan and apron development occurred during the transition to xerothermic conditions. Radiocarbon dating and stratigraphy have also shown that paraglacial sedimentation in lower Seymour Valley probably ended by ~9 ka, and that incision through paraglacial fans and aprons into underlying glacial sediments occurred shortly after 5 ka when Seymour River reached its present vertical position.

Although erosion of paraglacial features in Seymour Valley has persisted to the present, a significant amount of these sediments remain in storage.

This study gives insight to the nature and timing of paraglacial sedimentation of a mountain valley bordering the Fraser Lowland. Similar organic-rich deposits have been noted in Lynn and Capilano valleys (Fig. 1), and are probably common to other adjacent valleys. Further lithostratigraphic and geomorphic study, on a more regional scale, in conjunction with radiocarbon dating, and paleoecological research, would increase our understanding of this important period of erosion and deposition.

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REFERENCES

- Armstrong, J.E. and Clague, J.J., 1977. Two major Wisconsin lithostratigraphic units in southwest British Columbia. *Canadian Journal of Earth Sciences*, 14: 1471-1480.
- Brooks, G.R., 1994. The fluvial reworking of late Pleistocene drift, Squamish River drainage basin, southwestern British Columbia. *Géographie physique et Quaternaire*, 48: 51-68.
- Church, M. and Ryder, J.M., 1972. Paraglacial sedimentation: A consideration of fluvial processes conditioned by glaciation. *Geological Society of America Bulletin*, 83: 3059-3072.
- Church, M. and Slaymaker, O., 1989. Disequilibrium of Holocene sediment yield in glaciated British Columbia. *Nature*, 337: 452-454.
- Hicock, S.R. and Armstrong, J.E., 1985. Vashon Drift: Definition of the formation in the Georgia Depression, southwest British Columbia. *Canadian Journal of Earth Sciences*, 22: 748-757.
- Hicock, S.R. and Lian, O.B., 1995. The Sisters Creek Formation: Pleistocene sediments representing a nonglacial interval in southwestern British Columbia at about 18 ka. *Canadian Journal of Earth Sciences*, 32: 758-767.
- Jackson, L.E., Jr., MacDonald, G.M. and Wilson, M.C., 1982. Paraglacial origin for terraced river sediments in Bow Valley, Alberta. *Canadian Journal of Earth Sciences*, 19: 2219-2231.
- Lian, O.B., 1991. Late Quaternary surficial geology and geomorphology of lower Seymour Valley, North Vancouver, British Columbia. M.Sc. Thesis, Simon Fraser University, Burnaby, 126 p.
- Lian, O.B. and Hickin, E.J., 1993. The late Pleistocene stratigraphy and chronology of lower Seymour Valley, southwestern British Columbia. *Canadian Journal of Earth Sciences*, 30: 841-850.
- Mathewes, R.W., 1985. Paleobotanical evidence for climatic change in southern British Columbia during late-glacial and Holocene time, p. 397-422. *In* C.R. Harington, ed., *Climate change in Canada. 5: Critical periods in the Quaternary climatic history of northern North America*. *Syllogeus* no. 55.
- 1993. Evidence for Younger Dryas-age cooling on the north Pacific coast of America. *Quaternary Science Reviews*, 12: 321-331.
- Mathewes, R.W. and Heusser, L.E., 1981. A 12 000 year palynological record of temperature and precipitation trends in southwestern British Columbia. *Canadian Journal of Botany*, 59: 707-710.
- Roddick, J.A., 1979. Vancouver North, Coquitlam, and Pitt Lake map-areas, British Columbia. Geological Survey of Canada, Memoir 335.
- Ryder, J.M., 1971. The stratigraphy and morphology of para-glacial alluvial fans in south-central British Columbia. *Canadian Journal of Earth Sciences*, 8: 1252-1264.
- Ryder, J.M. and Clague, J.J., 1989. British Columbia (Quaternary stratigraphy and history, Cordilleran Ice Sheet), p. 48-58. *In* R.J. Fulton, ed., *Quaternary Geology of Canada and Greenland*. Geological Survey of Canada, Geology of Canada No. 1 (also Geological Society of America, *The Geology of North America*, Vol. K-1).
- Souch, C., 1989. Holocene sedimentary environments of the Goat Meadows watershed, southern Coast Mountains, British Columbia. *Géographie physique et Quaternaire*, 43: 77-85.