

QUATERNARY STRATIGRAPHY, FRASER LOWLAND

YEARS B.P. (X10 ³) (scale varies)	TIME-STRATIGRAPHIC UNITS	GEOLOGIC-CLIMATE UNITS	RADIOCARBON DATES (years B.P.)	LITHOSTRATIGRAPHIC UNITS Deposited by ice flowing from N and E ←, N and W →	COMMENTS
5	HOLOCENE	POSTGLACIAL	Salish and Fraser River Sediments: more than forty dates from 12 350±190 to 570±100	SALISH SEDIMENTS AND FRASER RIVER SEDIMENTS	See Note 2 of Table of Lithologic Units and Environments of Deposition
10			Capilano Sediments: nine dates ranging from 12 800±175 to 10 430±150		
11			Sumas Drift: six dates ranging from 11 700±150 to 11 300±100		Capilano Sediments: glaciomarine and marine sediments deposited when the sea was at least 15m above present sea level. In contrast to similar sediments that comprise a large part of Fort Langley Formation, Capilano Sediments were not overridden by Sumas ice
12			Fort Langley Formation: five dates ranging from 12 900±170 to 11 680±180		Sumas Drift: these glacial deposits are not overlain by glaciomarine or marine sediments
13					Fort Langley Formation: records at least three local advances and retreats of a valley glacier into the sea
15	LATE WISCONSIN	FRASER GLACIATION	Vashon glaciolacustrine sediments: two dates 16 000±150 and 17 800±150	VASHON DRIFT	Includes at least three tills. Fluvial dissection occurred between deposition of Quadra Sand and Vashon Drift
17					
18					
20			Quadra Sand and Coquitlam Drift: three dates from Quadra Sand (?) ranging from 18 700±170 to 16 300±170 from sediments overlying Coquitlam Drift. Five dates from Coquitlam Drift ranging from 22 700±320 to 21 600±200. Four dates from Quadra Sand ranging from 26 100±320 to 24 400±300		Quadra proglacial deposits were formed during local advances and retreats, such as the Coquitlam, and during the main Vashon ice advance
26					Coquitlam Drift: Coquitlam ice probably represents an advance and retreat that occurred in Coquitlam Valley before Vashon ice moved into the area
30	MIDDLE WISCONSIN	OLYMPIA NONGLACIAL INTERVAL	Fourteen dates ranging from 29 800±200 to 25 800±310. Five dates ranging from 36 200±500 to 31 000±520. Two dates 40 500±1700 and 40 200±430. Three dates > 39 000 to > 36 800	COWICHAN HEAD FORMATION	Olympia nonglacial interval sediments consist of subaerial deposits marked by unconformities. One such unconformity, recognized at the Mary Hill gravel pit, separates sediments from 26 000 to 30 000 years old from sediments 40 000 years old
35					
41					
50			One date at 58 800±2900 - 2100. Five dates ranging from > 37 000 to > 43 000	COWICHAN HEAD FORMATION?	Cowichan Head Formation? sediments are not seen in contact with sediments identified as Cowichan Head; however they appear to be part of the same lithostratigraphic unit
60					
>62	THE OLDEST UNITS PROBABLY ARE SEVERAL HUNDRED THOUSAND YEARS OLD	EARLY WISCONSIN AND PRE-WISCONSIN	SEMAHMOO GLACIATION	SEMAHMOO DRIFT	Believed to be Early Wisconsin. Includes at least two till units plus glaciofluvial and glaciomarine sediments. Semiahmoo Glaciation probably similar in complexity and duration to Fraser Glaciation
			HIGHBURY NONGLACIAL INTERVAL	HIGHBURY SEDIMENTS	May be equivalent of Sangamon interglacial
			WESTLYNN GLACIATION	WESTLYNN DRIFT	Very poorly exposed. Westlynn Glaciation probably similar in complexity and duration to Fraser Glaciation
				OLDER SEDIMENTS	

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LITHOLOGIC UNITS AND ENVIRONMENTS OF DEPOSITION

MAJOR LITHOLOGIC UNITS	LITHOLOGIC SUBUNITS CLASSIFIED ACCORDING TO ENVIRONMENT OF DEPOSITION																
	GLACIAL (Sediments deposited by ice)	GLACIOFLUVIAL (Sediments deposited by meltwater streams flowing from wasting glacier ice)			GLACIOLACUSTRINE (Sediments deposited in glacial lakes)	GLACIOMARINE (Marine sediments that contain material dropped from floating ice)	MARINE		FLUVIAL		LACUSTRINE (Sediments deposited in lakes)	EOLIAN (Sediments transported by wind)	SLOPE (Colluvial sediments deposited by mass wasting processes)	ORGANIC (Includes bog, swamp, and shallow lake deposits)	LANDFILL		
		Channel and Floodplain	Deltaic	Ice Contact (Including kame deposits)			Offshore (Includes estuarine and lagoonal deposits)	Shore	Deltaic	Channel and Floodplain (Includes overbank deposits)							
* ①																	
SALISH SEDIMENTS (SA)								Beach gravel and sand. Varies from sand to boulders at back of beach (1-3m), (8m)		Gravel and sand deposited by mountain streams (10-15m), (20m)		Silt, silty clay, and fine sand deposited by lowland streams (3-7m), (10m). Gravel and sand deposited by mountain streams (3-7m), (10m)	Sand, silty sand, clayey silt, and silty clay. Includes sand spits, beaches, and lake bottom deposits. (5-15m), (20+m)	Fine sand (1-3m), (15m). The maximum thickness is found in dune deposits	Gravel, sand, silt, and talus (1-7m), (15+m). The maximum thickness is found in fan deposits	Peat muck, gyttja, and organic silt and clay (1-8m), (20m)	Sand, gravel, crushed stone, till, and waste products
②								(SAI.g) ③		(SAI) ④		(SAH,I,J,K)	(SAQ,r,s)	(SAI)	(SAM,n.o,p)	(SAb,c,d,e,i)	(SAa)
FRASER RIVER SEDIMENTS (F)								Fine sand to clay silt (10-150m), (10-185m)		Sand, silty clay, sandy silty and clayey loam, and loam, may be in a large part estuarine deposits (10-125m), (215m)		Sand, gravel, silt, silty clay, sandy silty and clayey loam, and loam, organic silt, and clay; gravel and sand predominate from east of Mission (10-15m), (40m)					
⑥								(Fe)		(Fd) ⑤		(F.a,b,c,d,f,g,h)					
CAPILANO SEDIMENTS (C)			The deltaic deposits mapped as fluvial may belong here			Stony silt, silty loam, and silty clay loam (2-8m), (15m)	Silt, clayey silt, and fine sand (3-10m), (15m)	Gravel and sand forming spits, bars, and beaches (1-5m), (8m). Wave washed gravel veneers, normally too thin to map as a separate unit		Gravel and sand, minor silt (5-15m), (20m)		Gravel and sand deposited by mountain streams (5-7m), (10m)					
⑦							(Cd,e)	(Cd,e)		(Cc) ⑧		(Cc)					
SUMAS DRIFT (S)	Sandy loam, lodgment and flow tills (1-3m), (6m)	Gravel and sand (10-20m), (30m)	Gravel, sand, minor silt (15-35m), (45m). Lenses of marine silt (5-15m), (30m)	Gravel and sand containing lenses of Sumas till and of Fort Langley glaciomarine sediments (5-10m), (30m)	Rhythmically bedded silt, clayey silt, silty clay, and sand (5-35m), (757 m)												
⑨	(SI.g) ⑨	(SA,I)	(Se,I)	⑩ (So,c,d,j)	(Sh)												
FORT LANGLEY FORMATION (FL)	Sandy loam, lodgment and flow tills (1-3m), (5m). More than one local ice advance is represented	Gravel and sand (5-10m), (20m)	Gravel, sand, and minor silt. Included here are kame deltas. These deltaic sediments occur in three or more places in the Fort Langley section (10-30m), (50m)	Gravel and sand containing lenses of sandy till and till-like material which characteristically contains clasts of glaciomarine sediments. The tills are mainly flow tills (5-15m), (45m)		Stony silt, silty clay, and clay loam, in places stratified and in places almost stone free. Contains till-like mixtures probably formed by grounded icebergs and tidewater glaciers (5-20m), (60m)	Fine sand, silt, and clayey silt, interbedded with glaciomarine deposits occur at base of Fort Langley section (5-10m), (30+m)										
⑩	(FLa) ⑩	(FLb)	(FLc)	(FLb)		(FLc) ⑩	(FLd)										
VASHON DRIFT (V)	Lodgment till with a sandy loam matrix. In places at least three layers of till separated by glaciolacustrine deposits. In much of the area only one till has been observed. Included with these tills are lenses of substratified silt, sand, and gravel (1-5m), (25m)	Gravel and sand; gravel normally poorly sorted and containing stones ranging in size from pebbles to boulders (3-8m), (15m)	Gravel and sand, normally poorly sorted and containing stones ranging in size from pebbles to boulders. Deltaic bedding characteristic (10-20m), (60m)	Gravel and sand, normally poorly sorted and containing stones ranging in size from pebbles to boulders. Slump structures common (5-10m), (15m)	Rhythmically bedded silt, fine sand, silty clay, minor gravel and boulders (10-50m), (80m)												
⑪	(Va) ⑪	(Vb) ⑫	(Vb)	(Vb) ⑬													
QUADRA SAND (PVa,b,c)	Sand, minor gravel, silt and clayey silt. In places organic-rich layers are associated with the tills (5-65m), (85m)	Gravel and sand (5-25m), (40m)	Gravel and sand (5-25m), (40m)				In places Quadra believed to have been deposited in the sea										
⑬	(PVa) ⑬	(PVb) ⑭	(PVb)	⑭			(PVc) ⑮										
COQUITLAM DRIFT (PVD)	Lodgment till with a sandy loam matrix. Lenses of glaciolacustrine silt and boulder layers are associated with the till (1-3m), (5m)	Sand and gravel (5-15m), (25m)		Sand and gravel (20-40m), (75m)	Massive, stony, clayey silt mixtures containing scattered fossil shells, both broken and whole (3-5m), (10m)												
⑮																	
COWICHAN HEAD FORMATION (PVe) (AND PROBABLE COWICHAN HEAD FM)							Silt, sand, and gravel containing casts of marine shells (5-10m), (20m). May be in part fluvial deposits					Silt, sand, and gravel containing interbeds of organic sediments (see organic sediments) (5-20m), (25m)		Stony organic colluvium, at least two layers differing by 13 000 years in age (1-5m), (5m)	Interbedded peat, gyttja, sapropel, and organic-rich silt and clay (2-15m), (15m)		
⑰										⑰							
SEMAHMOO DRIFT (PVF)	Lodgment till with sandy silt and clayey silt matrix, contains lenses of sand, gravel, and silt. In places two or three layers of till separated by glaciofluvial, glaciolacustrine, and glaciomarine deposits (2-10m), (15m)	Gravel and sand; probably includes some deltaic deposits. Occurs in at least two layers (3-10m), (15m)		Gravel and sand, containing lenses of till (10-20m), (25m)	Rhythmically bedded silt, silty clay, and clayey silt grading laterally into fine and medium sand, scattered dropstones (5-10m), (45m)	Massive, stony, clayey, and sandy silt, containing scattered fossil shells (2-5m), (10m)	Clayey silt, silt, and silty clay associated with glaciomarine sediments (10-25m), (25+m)										
⑲																	
HIGHBURY SEDIMENTS (PVg)																	
⑳																	
WESTLYNN DRIFT (PVh)	Lodgment till with a clayey silt matrix (2-5m), (12m)	Gravel and sand including a boulder-cobble gravel (5-25m), (25+m)			Rhythmically bedded clayey silt and silty clay (1507 m)	Massive, stony, sandy to clayey silt containing fossil shells (5-10m), (10+m)											
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OLDER SEDIMENTS		Tills and glaciofluvial gravel and sand (35m)			Probable glaciolacustrine silt, clayey silt, and silty clay (65m)	Probable glaciomarine sandy to clayey silt and silty clay with dropstones											
㉒																	

- NOTES
- The same names are used for the major lithologic and lithostratigraphic units (cf. Quaternary stratigraphy). In general the units are arranged with oldest at the bottom and youngest at the top. Some compromises are necessary as most units are time transgressive as illustrated in the table of Quaternary stratigraphy (e.g., Capilano Sediments are contemporaneous with Fort Langley Formation and Sumas Drift).
 - Salish Sediments include all postglacial terrestrial sediments and postglacial marine sediments that were deposited when the sea was within 15 m of present sea level (except for Fraser River Sediments).
 - Approximate thickness (m) of lithologic subunit. Figures in first bracket record normal variation in thickness; those in second bracket record maximum thickness observed in outcrop or obtained from reliable drillhole information. In most drillholes only tentative correlations are possible, and these indicate that maximum thicknesses of many units probably greatly exceed those listed. In much of Fraser Lowland one or more periods of erosion have resulted in reduced thicknesses or complete removal of Quadra and older units.
 - All Salish deltaic deposits were laid down in the sea except for those at the mouth of Chilliwack River where it debouched into Sumas Lake (drained in 1926).
 - The term loam refers to a mixture of sand(23-52%), silt (28-50%), and clay (7-27%) as defined by the U.S. Department of Agriculture Soil Survey; no organic material is implied by use of term. Grain size: sand (0.05-2.0 mm), silt (0.002-0.5 mm), and clay (less than 0.002 mm).
 - Fraser River Sediments are shown separately from other postglacial sediments for mapping purposes and because of their major importance.
 - Capilano Sediments are glaciomarine and marine deposits that are found west of the limit of Sumas Drift and that were deposited when sea level was 15 m or more above that of present.
 - These deltaic deposits derived sediments from glacial meltwater streams terminating in the sea, when sea level was above present mean sea level. These could be considered marine deltas, disregarding source of sediments.
 - Till-like stony silt loam and silty clay loam, which have been included in Fort Langley glaciomarine deposits, are probably tills formed by Sumas and Fort Langley ice moving across and reshaping glaciomarine sediments.
 - Thickness (m) of glaciomarine unit outcrop. Three or more glaciomarine units occur (in the Fort Langley Formation) at different levels in the section, and total thickness may be more than 140 m.
 - Thickness (m) of till layer outcrop.
 - In many places it is difficult to separate channel and floodplain deposits from deltaic; ice-contact deposits are characterized by collapse structures. Lithologically all three units are similar. At least three glaciofluvial units separated by tills have been observed in places. Thickness figures (m) refer to individual units.
 - Quadra Sand probably was deposited as outwash aprons in front of ice. Deltaic deposits are recognizable in places, mainly in the upper part of the formation but also may occur elsewhere in the section.
 - Fossil shell casts have been found in sediments lithologically similar, and possibly stratigraphically equivalent to known Quadra sections.
 - The possibility that this material is till formed by glaciers moving across Semiahmoo glaciomarine deposits cannot be excluded although the presence of whole shells would be difficult to explain.
 - Included are probable Cowichan Head sediments (see table of Quaternary stratigraphy).
 - Marine facies of proven Cowichan Head affinities has not been found in Fraser Lowland, however fossil-bearing sand overlain and underlain by tills is included.
 - Thickness (m) of each layer of till or glaciofluvial gravel and sand.
 - Maximum thickness (m) seen in sections, but drillhole information from east of 122°45' W indicates that pre-Fort Langley glaciomarine and marine sediments may be up to 150 m thick.
 - Only this unit and the organic unit of Highbury Sediments have been observed in outcrop. The other unit was intersected in Highbury tunnel (cross-section AX, Map 1486A). Many drillholes intersect sediments that are probably Highbury correlatives. Maximum thicknesses (m) are probably too low and are based on data from exposures rather than from drillholes.
 - Stratigraphically equivalent glaciolacustrine sediments up to 150 m thick are believed to be part of Westlynn Sediments.
 - Known only from drill records. Maximum thicknesses (m) are probably low.