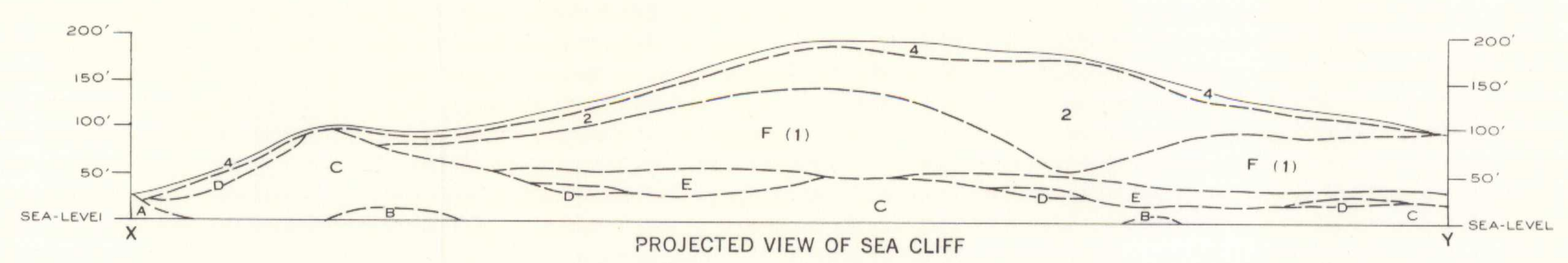
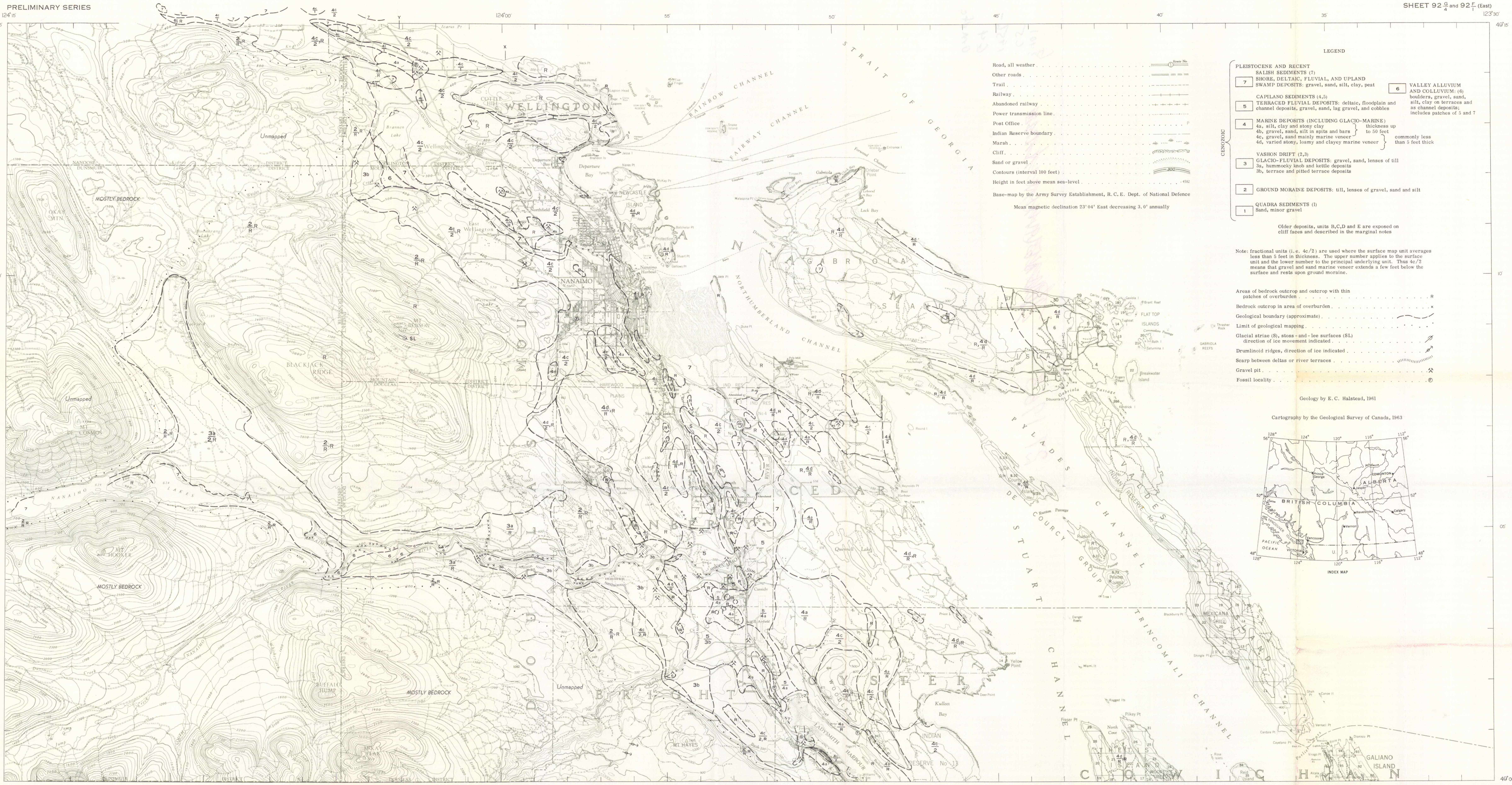
GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS



PROJECTED VIEW OF SEA CLIFF

PRELIMINARY SERIES

SHEET 92 G/4 and 92 F/1 (East)



LEGEND

Road, all weather . . . . . Route No.
Other roads
Trail
Railway
Abandoned railway
Power transmission line
Post Office . . . . . P
Indian Reserve boundary
Marsh
Cliff
Sand or gravel
Contours (interval 100 feet) 300
Height in feet above mean sea-level 4582

Base-map by the Army Survey Establishment, R. C. E. Dept. of National Defence

Mean magnetic declination 23° 04' East decreasing 3. 0' annually

CENOZOIC

PLEISTOCENE AND RECENT

SALISH SEDIMENTS (7)

7 — SHORE, DELTAIC, FLUVIAL, AND UPLAND SWAMP DEPOSITS: gravel, sand, silt, clay, peat

6 — VALLEY ALLUVIUM AND COLLUVIUM: (6) boulders, gravel, sand, silt, clay on terraces and as channel deposits; includes patches of 5 and 7

CAPILANO SEDIMENTS (4,5)

5 — TERRACED FLUVIAL DEPOSITS: deltaic, floodplain and channel deposits, gravel, sand, lag gravel, and cobbles

4 — MARINE DEPOSITS (INCLUDING GLACIO-MARINE)
4a, silt, clay and stony clay } thickness up to 50 feet
4b, gravel, sand, silt in spits and bars }
4c, gravel, sand mainly marine veneer } commonly less than 5 feet thick
4d, varied stony, loamy and clayey marine veneer }

VASHON DRIFT (2,3)

3 — GLACIO-FLUVIAL DEPOSITS: gravel, sand, lenses of till
3a, hummocky knob and kettle deposits
3b, terrace and pitted terrace deposits

2 — GROUND MORAINE DEPOSITS: till, lenses of gravel, sand and silt

QUADRA SEDIMENTS (1)

1 — Sand, minor gravel

Older deposits, units B,C,D and E are exposed on cliff faces and described in the marginal notes

Note: fractional units (i. e. 4c/2) are used where the surface map unit averages less than 5 feet in thickness. The upper number applies to the surface unit and the lower number to the principal underlying unit. Thus 4c/2 means that gravel and sand marine veneer extends a few feet below the surface and rests upon ground moraine.

Areas of bedrock outcrop and outcrop with thin patches of overburden . . . . . R
Bedrock outcrop in area of overburden x
Geological boundary (approximate)
Limit of geological mapping
Glacial striae (S), stoss - and - lee surfaces (SL) direction of ice movement indicated
Drumlinoid ridges, direction of ice indicated
Scarp between deltas or river terraces
Gravel pit
Fossil locality

Geology by E. C. Halstead, 1961

Cartography by the Geological Survey of Canada, 1963

DESCRIPTIVE NOTES

The west half of the map-area is mountainous, with elevations rising to more than 4,400 feet above sea-level. The east half is part of the east coast lowland of Vancouver Island, which extends diagonally across the map-area with a maximum width of about 8 miles. Except for volcanic rocks exposed at Cottle Hill and Woodley Range, bedrock that underlies the lowland consists of shale, sandstone, and conglomerate, whose weaker units have been eroded to form longitudinal valleys; the more resistant units provide cuesta-like ridges. Quennel, Holden, Beck, and Long Lakes, and other smaller lakes, occupy the deepened parts of these longitudinal valleys. The largest of these valleys is drowned at its northern and southern ends to form Nanaimo and Ladysmith Harbours, respectively. Midway in its course, it is entered from the west by the largest of the transverse valleys; through the latter, Nanaimo River flows eastward from the upland. Upon entering the longitudinal valley it flows north to Nanaimo Harbour, in which it is building a large delta.

In most places the glaciers that overrode the area contributed little more than a rounding and polishing of the rock surfaces and deepening of the longitudinal valleys. However, much of the lowland north of Nanaimo is mantled with drift, which in places is more than 250 feet thick. South of Nanaimo, and on the islands adjacent to the lowland, bedrock lies at the surface or is covered by a few feet of marine veneer, chiefly clay.

The unconsolidated deposits throughout much of the area are related to the regimen and wasting of the last major ice-sheet that occupied Vancouver Island, the British Columbia mainland, and the Strait of Georgia. The drift left from this glaciation is recognized in the area as the classical Wisconsin.

Older glacial deposits identified in the sea cliffs at Icarus Point indicate at least two earlier periods of ice accumulation and wasting. At this locality the oldest glacial deposits (unit B on section X-Y) are believed to rest on bedrock (unit A) and consist of grey stony clayey till. The oldest till (unit B, on section X-Y) is exposed at two places. It extends beneath the rubble and boulders of the present beach deposits and is assumed to continue beneath present sea-level. Laminated silts and clays with minor sand (unit C) overlie the oldest till and are exposed continuously along the base of the cliff. The maximum exposed thickness of these clays is about 120 feet, and they continue beneath recent beach deposits and extend beneath present sea-level. Unit C has also been identified in logs of the deeper drilled wells and has been exposed in an excavation at Nanaimo. The uneven, dissected surface of this unit represents an erosion surface upon which a second ice-sheet advanced and deposited a grey stony clay (unit D), much of which has been removed by subsequent erosion leaving remnants as shown. Resting on the second till (unit D), or on unit C where the till has been removed, is unit E, consisting of oxidized sand, silt, and clay, with peat layers. The peat is continuous throughout the cliff face. Its thickness is commonly less than 1 inch, but in places is as much as 10 inches. Crossbedded buff sands (unit F on section X-Y and unit 1 on map), in places as much as 90 feet thick, overlie unit E and are correlated with Quadra sediments mapped in Courtenay and Oyster River map-areas, north of Nanaimo[1].

The last major ice-sheet, which attained a thickness of more than 7,000 feet, overrode the Quadra sediments and upon retreat left a blanket of till (unit 2). During retreat and wastage of this ice, sea-level was considerably higher than present. Heavily loaded streams issuing from valley glaciers in Nanaimo River and Haslam Creek valleys, deposited sand and gravel as deltas (3b) into a sea that was about 500 feet higher than present sea-level. That sea-level reached these higher elevations is evidenced not only by the elevation of the top beds of the deltas but by erosion features such as wave-eroded caves on sandstone and conglomerate cliffs at elevations 380 to 420 feet near Extension, and also by gravel deposits that occur at a common elevation of about 500 feet along the west side of the lowland. Marine and glacio-marine deposits (4) were laid down in the seas that overlapped the lowland and left a marine veneer of gravel, sand, or silty clay with fossils. The age of shells collected from silty sand overlying the top till was determined by radiocarbon methods as 12,420 150 years BP (GSC-80)[2]. During the period of lowering of sea-level to the present, streams deposited gravel and sand and cut terraces in older deposits (5), and clays and silts were continually being deposited in the deeper waters.

Present sea-level has been maintained for a considerable time, during which Nanaimo River has built a sizeable delta in Nanaimo Harbour, and silt and clays have accumulated in Ladysmith Harbour. In the upland areas, swamp deposits are filling the depressions.

The deltaic deposits in the Nanaimo River valley are the source of aggregate material for the sand and gravel industry. During 1961, production from pits in this area was valued at more than $197,000[3]. The sand and gravel over much of this same area provide an extensive aquifer, which is recharged partly by rainfall and partly by the Nanaimo River. It supplies about 23 million gallons daily to meet the requirements for process and service water at the bleached sulphate pulp mill, Harmac, near Nanaimo.

[1] Fyles, J. G.: Surficial Geology, Oyster River, British Columbia; Geol. Surv., Canada, Map 49-1959: Surficial Geology, Courtenay, British Columbia; Geol. Surv., Canada, Map 32-1960

[2] Dyck, W., and Fyles, J. G.: Geological Survey of Canada, Radiocarbon Dates II; Radiocarbon, Vol. 5, 1963

[3] Annual Report, British Columbia Minister of Mines and Petroleum Resources, 1961

PUBLISHED, 1963
COPIES OF THIS MAP MAY BE OBTAINED FROM THE DIRECTOR, GEOLOGICAL SURVEY OF CANADA, OTTAWA

MAP 27-1963
SURFICIAL GEOLOGY
NANAIMO
BRITISH COLUMBIA

Scale: One Inch to One Mile = $\frac{1}{63,360}$

Miles
1 1/2 0 1 2 3

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MAP 27-1963
NANAIMO
BRITISH COLUMBIA
SHEET 92 G/4 and 92 F/1 East