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DEGLACIATION OF THE ALLISON-SAWMILL CREEKS AREA, SOUTH SHORE OF PORT VALDEZ, ALASKA

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INTRODUCTION

Signs of intense glaciation dominate a rugged landscape in the Port Valdez area. Jagged bedrock ridgecrests separate deep, U-shaped valleys that once served as conduits for fast-flowing ice streams born in alpine cirque basins under dynamic conditions of cool temperatures, heavy snowfall, and rapid ablation. Faceted ridge spurs, steep, ice-planed and fluted valley walls, and the deep fiord all attest to effective scouring and plucking of the layered bedrock by formerly thick ice tongues. The morainal arc at the mouth of Shoup Bay marks a brief, late 18th century invasion of Port Valdez by Shoup Glacier (Lethcoe, 1987, fig. 101) and during the early part of this century Valdez Glacier nosed around the corner of the valley at the head of its broad outwash fan, although it has since receded out of sight (Grant and Higgins, 1913; Tarr and Martin, 1914). Along the south shore of Port Valdez in the vicinity of Allison and Sawmill Creeks, fresh moraines and striations on ice-molded bedrock document a late resurgence of glaciers from tributary valleys after retreat of the large trunk glacier that formerly occupied Port Valdez (fig. 1; Williams and Coulter, 1981, p. B78).

The freshness of these ubiquitous signs invites the curious to ask, "How long ago was the ice here?" The purpose of this report is to present geologic evidence in the Allison-Sawmill Creeks area that will partially answer this question.

EVIDENCE IN THE ALLISON-SAWMILL CREEKS AREA

Intercalated and interlayered metagraywacke and phyllitic argillite are dominant bedrock lithologies and greenstone is a minor bedrock component in the Allison-Sawmill Creeks area (Updike and Ulery, 1987). These foliose to massive rocks generally strike slightly north of east and dip steeply northward. Scouring by debris carried in the thick trunk glacier flowing down Port Valdez roughly parallel to rock layering differentially abraded this metamorphic sequence, leaving more competent metagraywacke units standing as streamlined (whaleback) ridges separated by deeply grooved, less competent layers of phyllitic argillite.

Silty gravel till deposited by the trunk glacier discontinuously covered the Allison-Sawmill Creeks area prior to construction of the marine terminal for the Trans-Alaska Pipeline System (TAPS). Moraines of this age, if present, are inconspicuous.

In the vicinity of lower Allison Creek and lower Sawmille Creek, irregular, small moraines related to late advances out of these two tributary valleys cut across the fabric (ridges and grooves) of the last major glaciation of Port Valdez (fig. 1). Sets of at least two moraines are recognized in each of these drainages; the most extensive (earliest) moraines are clearly related to ice advances and are associated with numerous smaller, less extensive, and discontinuous recessional moraines. Major still-stands or significant

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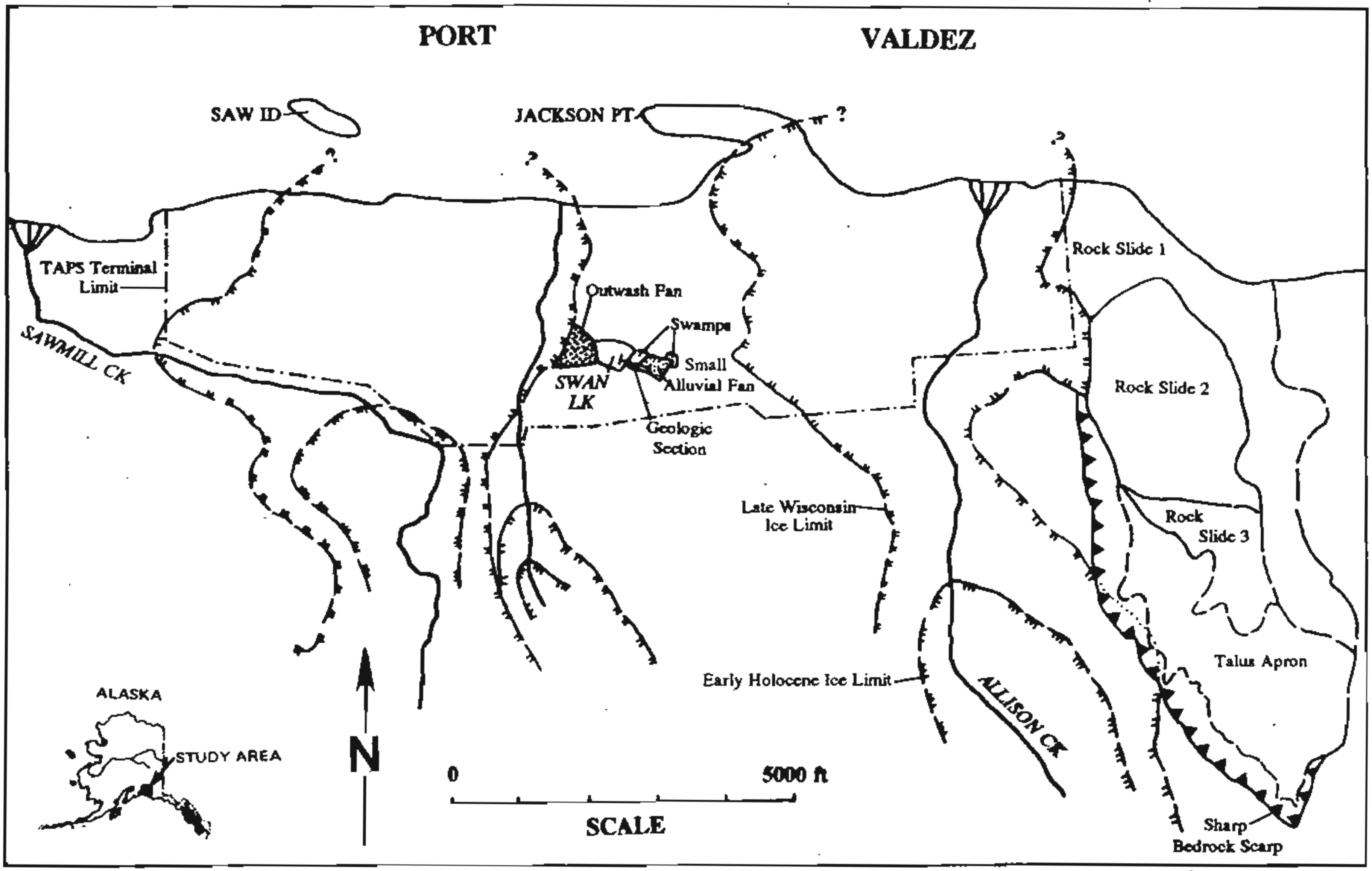

Figure 1. Location of Swan Lake section relative to nearby features in the Allison-Sawmill Creeks area. Landforms mapped on 1:15,840-scale aerial photographs EEV-19-171 through 174, taken for the U.S. Forest Service on June 13, 1959. Topographic features modified from U.S. Geological Survey Valdez A-7 (1960 with minor revisions 1970) Quadrangle and Valdez A-7SE (1983) Quadrangle maps, Alaska, to show conditions prior to extensive landscape alteration during construction of the Trans-Alaska Pipeline System (TAPS) marine terminal beginning in 1974.

readvances are probably represented by younger end moraines 910 to 1,880 m (3,000 to 6,200 ft) south of Port Valdez.

Paired lateral moraines identify a former ice advance down Allison Creek beyond the south shore of Port Valdez (fig. 1; Williams and Coulter, 1981). East of Allison Creek, the east lateral moraine abuts a massive rock slide, known locally as the Liscum or Fort Liscum slide (Williams and Johnson, 1980; Combellick, 1987), but in the lower canyon of Allison Creek, this moraine trends out into a gap left when a later stage of bedrock failure dropped part of the east valley wall from beneath the moraine (fig. 1). Surface morphology indicates that the Liscum slide resulted from at least three failures.

A pair of small but obvious lateral moraines delineates a resurgence that advanced down Sawmill Creek beyond the present south shore of Port Valdez but probably did not override Saw Island or Jackson Point (fig. 1). This advance produced a small proglacial fan of sandy gravels up to 20 ft (6 m) thick, which dammed the west side of a local drainage and produced Swan Lake. During May 1975, when the east tank farm was being constructed, Swan Lake was drained by cutting through the sediment dam and basin sediments were subsequently removed preparatory to emplacement of a foundation for the large oil-storage tanks. Before its removal, I was given the opportunity to document a geologic section through the eastern margin of the Swan Lake basin and to collect several organic samples for dating the section. These dates and the associated paludal, alluvial, lacustrine, and glacial deposits provide evidence for the timing of late-glacial events in the area (fig. 2).

The Swan Lake section was 300 ft (90 m) long and 11 to 42 ft (3.3 to 12.7 m) deep (fig. 2). The eastern 40 percent of the section was cut through the distal part of a small, local alluvial fan (figs. 1 and 2). The western 20 percent exposed sediments of the former lake, and the remaining 40 percent was cut through deposits beneath a lake-margin swamp.

A gently irregular, ice-scoured, phyllitic metagraywacke surface formed the base of the section and between 4 and 18 ft (1.2 and 5.5 m) of medium-gray, compact silty gravel till continuously covered the bedrock. At the top of the till was a discontinuous lag of subangular to subrounded cobbles and boulders. In the former lake basin, up to 1 ft (0.3 m) of sandy fluvial gravel, which overlay the cobble-boulder lag, was capped by as much as 10 ft (3 m) of laminated (varved) lacustrine silt and clay. Up to 2.5 ft (0.8 m) of silty organic lacustrine sand overlay the varved sediments and was overlain by 8 to 12 ft (2.4 to 6.7 m) of alluvial-fan gravel, organic sand, peat, and fill material. Sandy alluvial-fan gravels, heavily stained by iron-oxides, had a maximum thickness of 6 ft (1.8 m) along the eastern edge of the section and thinned westward to 0.6 ft (0.2 m). This granular deposit buried lenses and tongues of paludal fine- to medium-grained organic sand and fibrous peat and was in turn covered by them (fig. 2). The upper peat had a maximum thickness of 6 ft (1.8 m) and was covered by up to 16 ft (4.8 m) of temporary fill.

Seven organic samples were collected from significant parts of the section and their radiocarbon ages were determined (fig. 2, table 1). Radiocarbon dates of 11,820$\pm$560 yr B.P. (GX-10,789) and 7,800$\pm$230 yr B.P. (GX-10,788) from the bottom and top of the lake section, respectively, indicate that varved sediments accumulated in the basin from 12,000 to 8,000 yr ago. Five concordant dates document local paludal deposition between 9,700 and 6,100 yr ago and demonstrate that significant alluvial-fan aggradation began at the site about 6,100 yr ago.

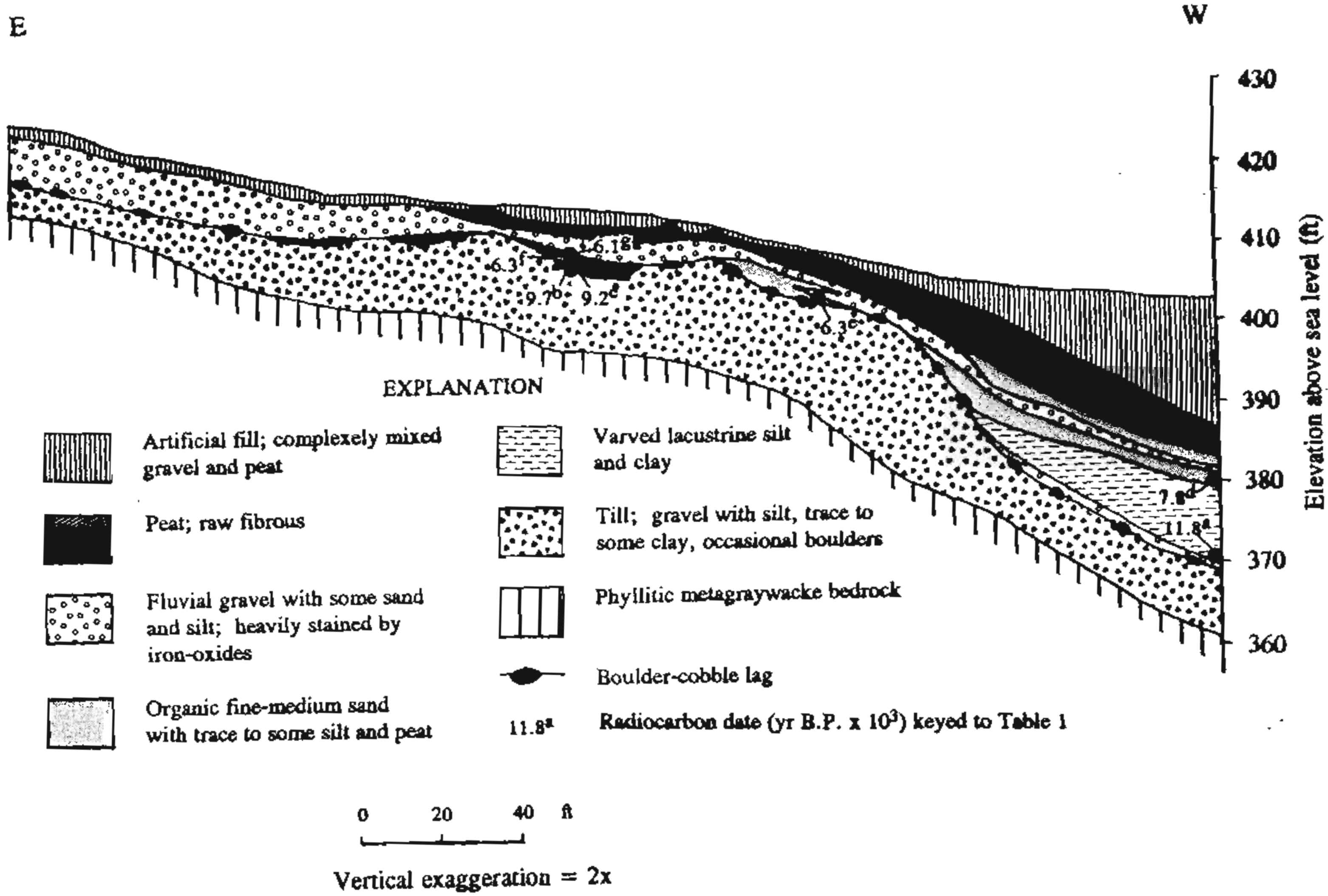

Figure 2. Geologic cross-section through eastern margin of former Swan Lake, Trans-Alaska Pipeline System (TAPS) Valdez marine terminal, exposed 5-17-75 in an artificial cut after lake drainage.

Sample	Material Dated	Radiocarbon Age (yr B.P.)	Laboratory Sample Number
a	Twigs, moss, and organic silt	11,820±560	GX-10,789
b	Peat and organic silt	9,660±290	GX-10,787
c	Wood	9,240±275	GX-11,329
d	Wood	7,800±230	GX-10,788
e	Organic silt	6,340±270	GX-11,332
f	Woody peat and organic silt	6,285±245	GX-11,330
g	Wood	6,065±130	GX-11,331

Table 1. Summary of radiocarbon dates for a geologic cross-section exposed 5-17-75 in an artificial cut through the eastern margin of former Swan Lake, TAPS Valdez marine terminal, keyed to Figure 2.

IMPLICATIONS

DEGLACIATION OF ALLISON-SAWMILL CREEKS AREA

The oldest radiocarbon date in the Swan Lake section (table 1) provides evidence that the Allison-Sawmill Creek area was free of glacial ice before 12,000 yr ago. The cobble-boulder lag at the top of the till and beneath the lacustrine section indicates that a significant period of exposure and subaerial erosion affected the till blanket after retreat of the trunk glacier and before formation of Swan Lake. Thus, the major period of deglaciation probably occurred several centuries or millenia before 12,000 yr ago.

Physiographic and stratigraphic relations indicate that outwash derived from the glacier that advanced out of the valley of upper Sawmill Creek blocked the mouth of a shallow, westward-sloping trough between the steep bedrock slope south of the TAPS terminal and a prominent ice-scoured bedrock ridge to form the Swan Lake basin (fig. 1). The date of 11,820$\pm$560 yr B.P. (GX-10,789) for twigs, moss, and organic silt in basal lake deposits demonstrates that this blockage and the glacial advance that produced it happened close to 12,000 yr ago (table 1).

Brief inspections of weathering profiles developed on oldest lateral moraines of local derivation in the Allison-Sawmill Creeks area indicates that they bear well-developed spodzolic soils with elluvial (E) layers 2.6 to 4.7 in. (7 to 12 cm) thick and that maximum depths to the base of weathered till range from 11.5 to 20 inches (4.5 to 7.9 cm). Degree of soil development is equal for moraines in both drainages, indicating that advances were simultaneous.

Although Lethcoe (1987, p. 124) assigned the oldest east lateral moraine and associated recessional moraines in the Allison Creek drainage to a neoglacial advance, they clearly predate the Holocene. This late Wisconsin advance was coeval with an expansion of Finger Glacier in the eastern Lituya district shortly after 12,400 yr ago (Mann, 1986). Comparison with the late Quaternary chronology for the upper Cook Inlet region suggests that moraines in the Allison-Sawmill Creeks area roughly correlate with the Elmendorf moraine in the Anchorage area. The Elmendorf moraine is dated younger than 13,690$\pm$400 yr B.P. (W-2151) and older than 11,690$\pm$300 yr B.P. (W-2375)(Schmoll and others, 1972) and represents the Tanya (last) stade of the Naptowne glaciation (Schmoll and Yehle, 1983, 1986; Schmoll and others, 1984). Therefore, the oldest moraines of local derivation in the Allison-Sawmill Creeks area represent the end of late Wisconsin glaciation in the Port Valdez area, and upvalley moraines recording the next younger advance or significant still-stand in these valleys are almost certainly early Holocene in age (fig. 1).

RELATION BETWEEN LOCAL GLACIATION AND LISCUM SLIDE

Spatial relations between Liscum slide and the east lateral moraine of the Allison Creek drainage suggest a temporal relationship between local glacial events and that massive rock failure. The main body of the slide (rock slides 1 and 2 in Figure 1) apparently was emplaced prior to the 12,000-yr-old readvance out of Allison Creek canyon because the undisturbed east lateral moraine fills a large indentation in the slide at the southeastern corner of the TAPS terminal. Undoubtedly, the first two stages of rock sliding occurred due to loss of support after retreat of the trunk glacier that undercut but also buttressed the steep rock wall south of Port Valdez. These failures were facilitated by the well-developed, planar foliation, which dips steeply northward (Updike and Ulery, 1987).

A third, smaller failure of the steep western rock wall at the head of the slide probably occurred after the 12,000-yr advance because the east lateral moraine in the canyon of Allison Creek trends into space occupied by the rock wall before it dropped onto the upper part of rock slide 2 (fig. 1). The jagged rocky ridgecrest in this area indicates that glacial ice did not flow through the gap. However, available evidence does not rule out collapse of the rock wall from beneath the glacier at a time when glacier thickness and activity did not permit significant ice flow into the gap.

DEGLACIATION OF PORT VALDEZ

Based on the results of a sparker survey of the sediment fill in Port Valdez and assuming an estimated yearly sediment influx between 34 x 10^9 and 65 x 10^9 metric tons (30.9 x 10^9 and 59.2 x 10^9 short tons), von Huene and others (1967) concluded that Port Valdez was deglaciated between 3,900 and 9,800 yr ago with a mean of 7,000 yr ago. Williams and Coulter (1981) reported a radiocarbon date of 9,520$\pm$350 yr B.P. (W-1654) for a freshwater peat sample recovered from a depth interval of 15.9 to 16.2 m (52.5 to 53.5 ft) below sea level in a borehole through the eastern margin of Mineral Creek fan on the north shore of Port Valdez. In the borehole, this peat occurred above a 13.8-m-thick (45.5-ft-thick) interval of interbedded till and marine silt and gravel deposited during the late Wisconsin glaciation. Therefore, their 9,520-yr date represents a minimum age for deglaciation of Port Valdez.

Clearly, the trunk glacier formerly occupying Port Valdez was gone before 12,000 yr ago. In fact, many areas that were glaciated in late Wisconsinan time in southcentral Alaska were free of ice well before 12,000 yr ago (table 2). Comparison with the Cook Inlet basin, where more evidence is preserved, suggests that the major deglaciation of Port Valdez occurred at the end of the Skilak stade of the Naptowne glaciation (Karlstrom, 1964). Unpublished work by my colleagues and I demonstrates that the Skilak stade ended close to 16,000 yr ago. Thus, Port Valdez was probably initially cleared of glacial ice about 16,000 yr ago.

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I thank Michael C. Metz, formerly of the Geotechnical Department of Alyeska Pipeline Service Company, who graciously granted permission to collect radiocarbon samples from the Swan Lake section and who encouraged publication of the results over the intervening years. The true significance of the cobble-boulder lag in the Swan Lake section crystallized in my mind during a recent, long, solo drive north to Fairbanks from Valdez. Thanks to Bud Burke and Steve Wilber for many thought-provoking discussions at the exposures and in the pits during our recent search for evidence of the glacial history of Port Valdez. Radiocarbon analyses were conducted at DGGS expense by Geochron Laboratories Division of Krueger Enterprises, Inc.

AREA	MATERIAL DATED	RADIOCARBON AGE (yr B.P.)	LABORATORY SAMPLE NUMBER	SOURCE	COMMENT
Turnagain Arm, Upper Cook Inlet	Mollusk shells	13,900±400	W-2919	Schmoll and Yehle (1983, 1986) Bartsch-Winkler and Schmoll (1984)	Shells incorporated into till of Elmendorf-age readvance
Point Woronzof, Upper Cook Inlet	Mollusk shells	14,900±350	W-2367	Schmoll and others (1972)	Shells from upper macrofossil-rich zone of Bootlegger Cove Formation
Lower Beluga River, West Shore Upper Cook Inlet	Shells	14,350±200	W-4292	Schmoll and Yehle (1983, 1986)	Shells from silt—clay zone of Bootlegger Cove Formation
Hidden Lake, Western Kenai Mountains	Organic Sediment	13,730±110	W-4827	Rymer and Sims (1982) Ager and Sims (1982) Ager (1983)	Sample from depth of 2.5-2.6 m in 3.3-m bottom-sediment core
Upper Matanuska Valley, Northern Chugach Mountains	Peaty Silt	13,100±60	USGS-2175	Williams (1986)	Basal 2 cm of 3-m-thick pond deposit overlying till
Tiekel Bog, Central Chugach Mountains	Silty Peat	13,900±400	I-3796	Sirkin and Tuthill (1987)	Sample from depth of 6.45 to 6.5 m in 6.65-m core
Katalla Vallley, Southern Chugach Mountains	Marine Clay	14,430±890	I-3082	Sirkin and Tuthill (1972)	Sample from depth of 4.25 to 4.5 m in 4.75-m core

Table 2. Summary of minimum radiocarbon dates associated with late-Wisconsin deglaciation in southcentral Alaska.

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