WASHINGTON STATE DEPARTMENT OF
Natural Resources
Jennifer M. Belcher - Commissioner of Public Lands

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LAHAR INUNDATION OF THE LOWER SKAGIT RIVER VALLEY

WASHINGTON DIVISION OF GEOLOGY AND EARTH RESOURCES
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PLATE 3
OPEN FILE REPORT 2000-6
GEOLOGIC MAP OF THE ANACORTES SOUTH AND
LA CONNER 7.5-MINUTE QUADRANGLES,
WESTERN SKAGIT COUNTY, WASHINGTON

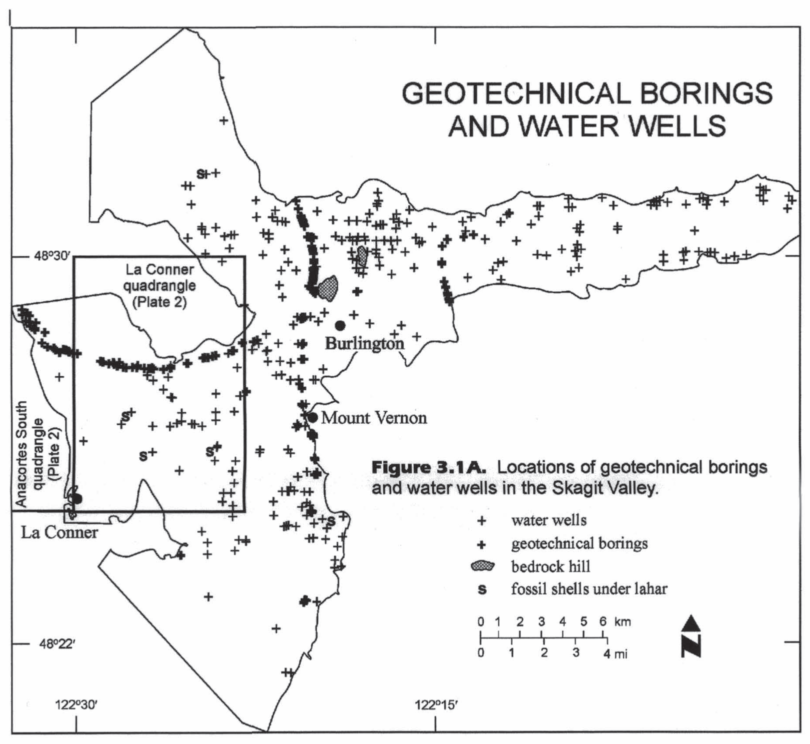


Figure 3.1A. Locations of geotechnical borings and water wells in the Skagit Valley.

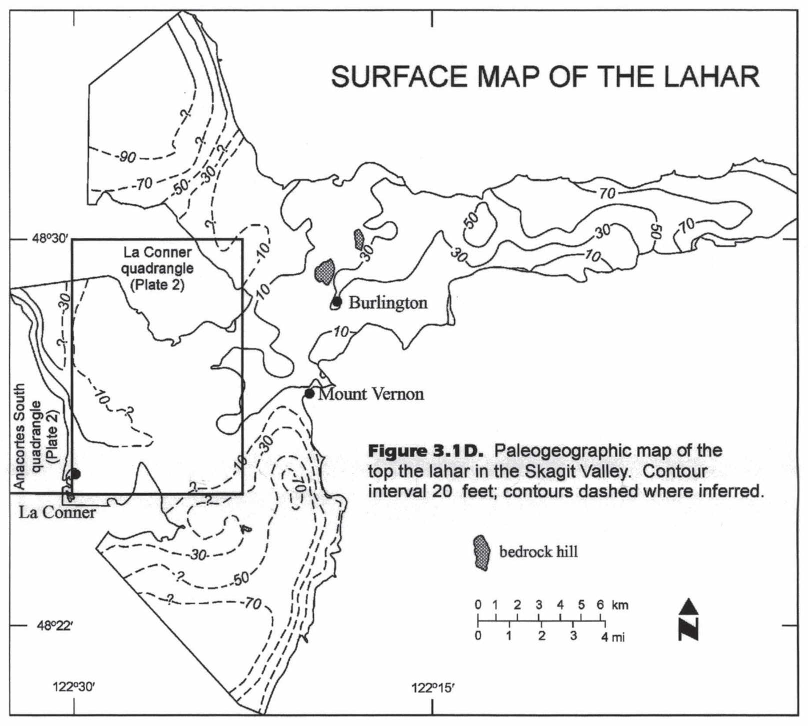


Figure 3.1D. Paleogeographic map of the top the lahar in the Skagit Valley. Contour interval 20 feet; contours dashed where inferred.

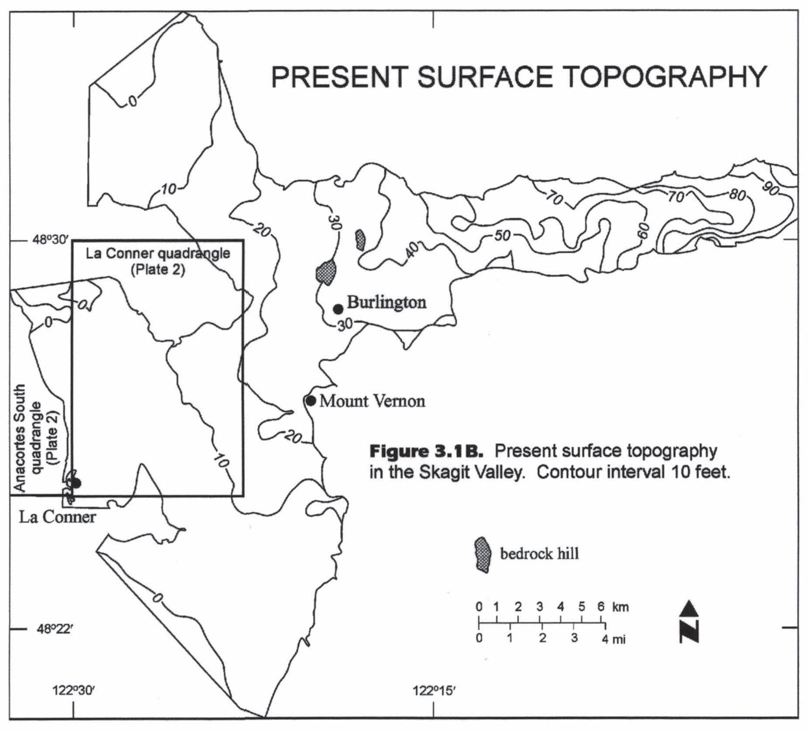


Figure 3.1B. Present surface topography in the Skagit Valley. Contour interval 10 feet.

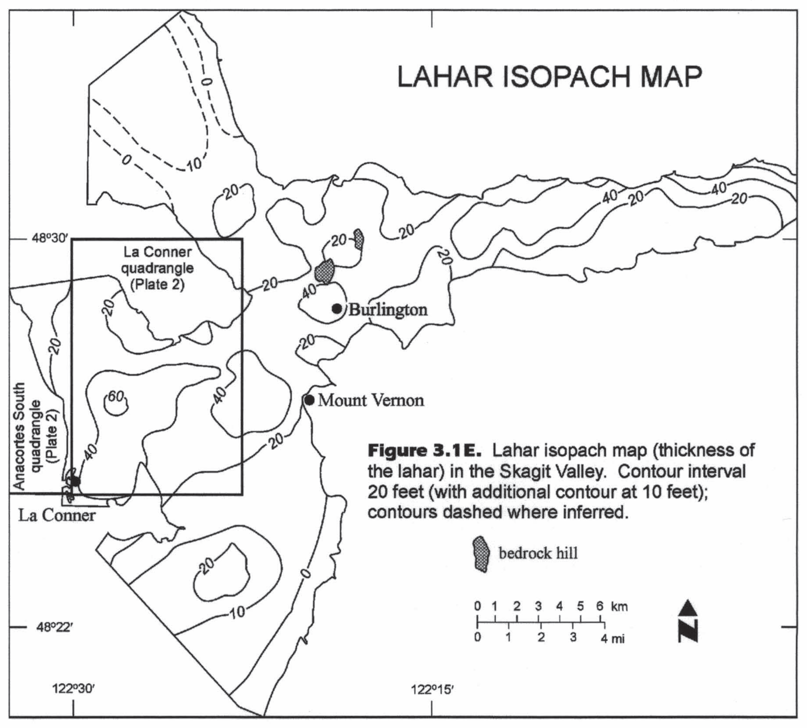


Figure 3.1E. Lahar isopach map (thickness of the lahar) in the Skagit Valley. Contour interval 20 feet (with additional contour at 10 feet); contours dashed where inferred.

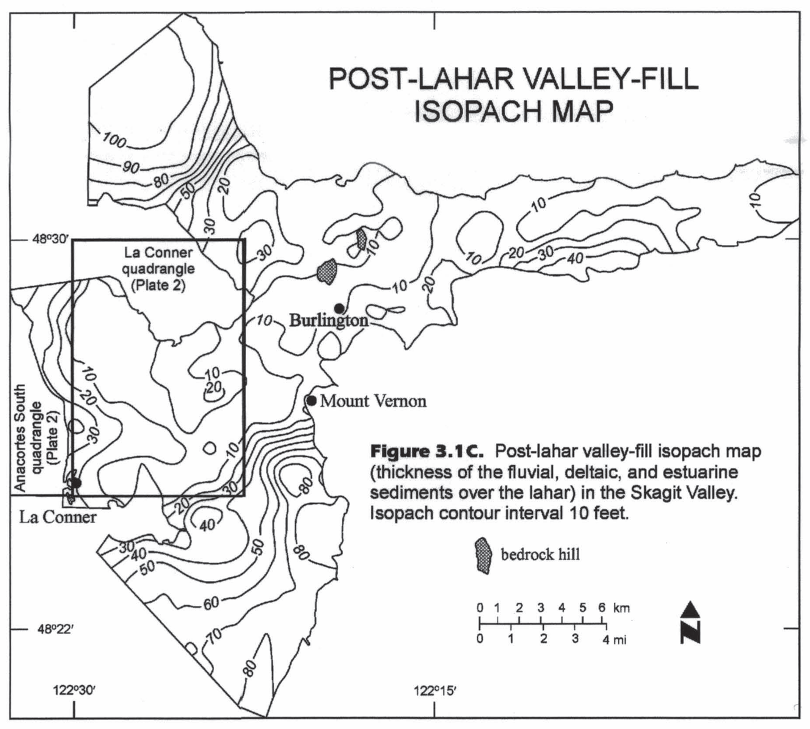


Figure 3.1C. Post-lahar valley-fill isopach map (thickness of the fluvial, deltaic, and estuarine sediments over the lahar) in the Skagit Valley. Isopach contour interval 10 feet.

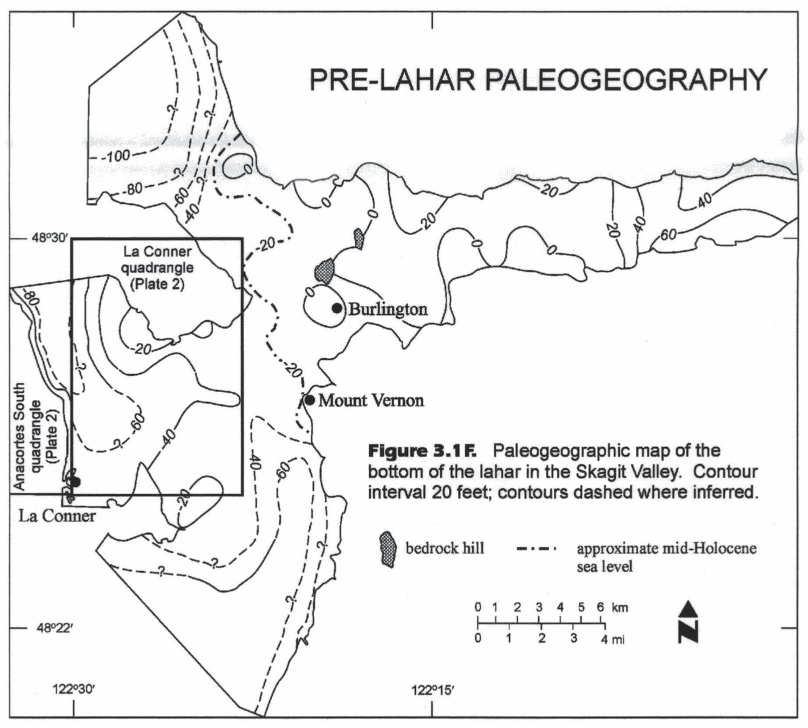
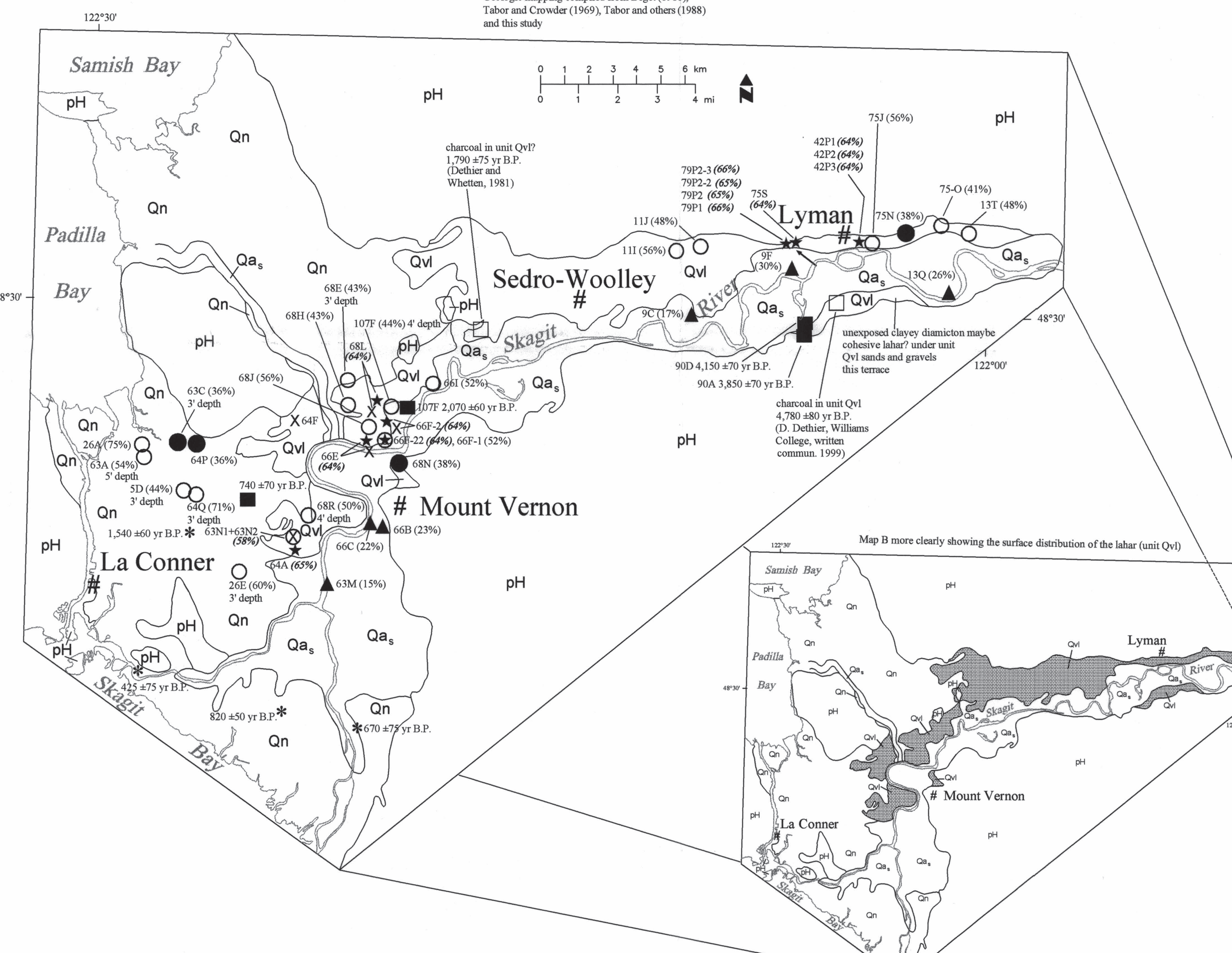
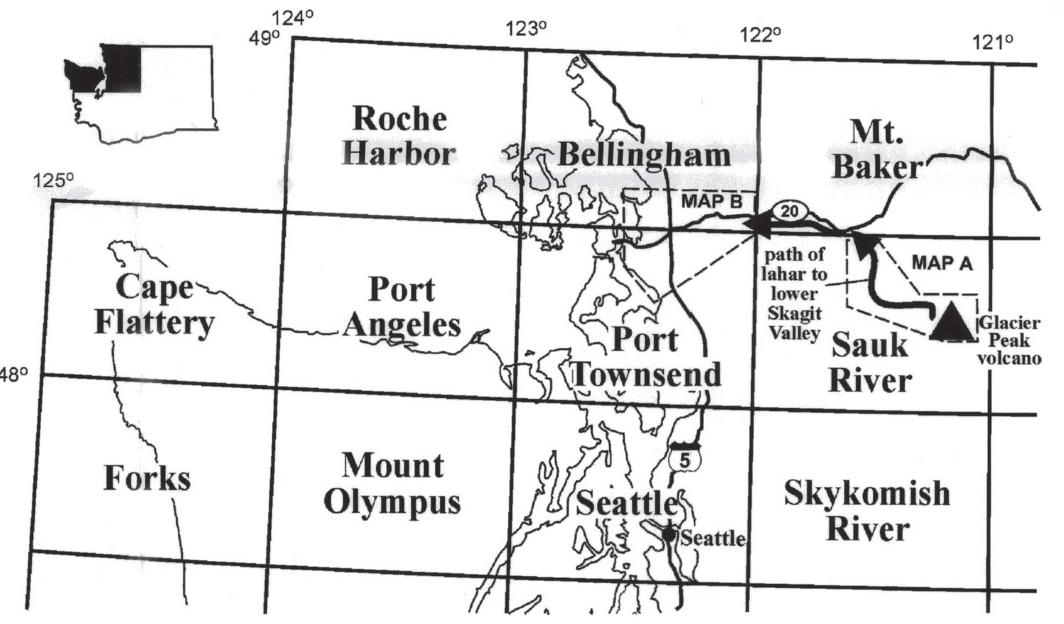


Figure 3.1F. Paleogeographic map of the bottom of the lahar in the Skagit Valley. Contour interval 20 feet; contours dashed where inferred.

MAP B

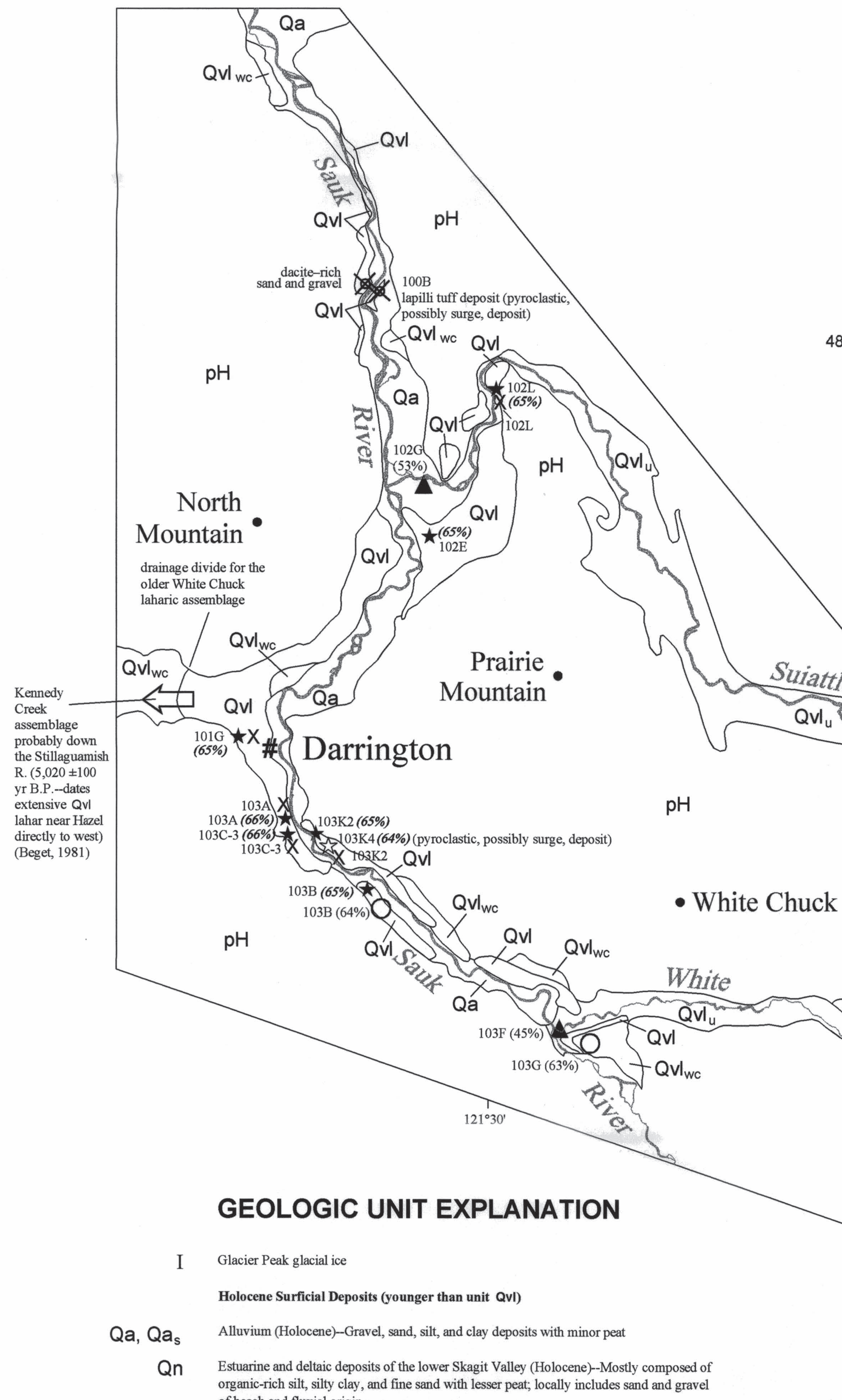
Geologic mapping compiled from Beget (1981), Tabor and Crowder (1969), Tabor and others (1988) and this study

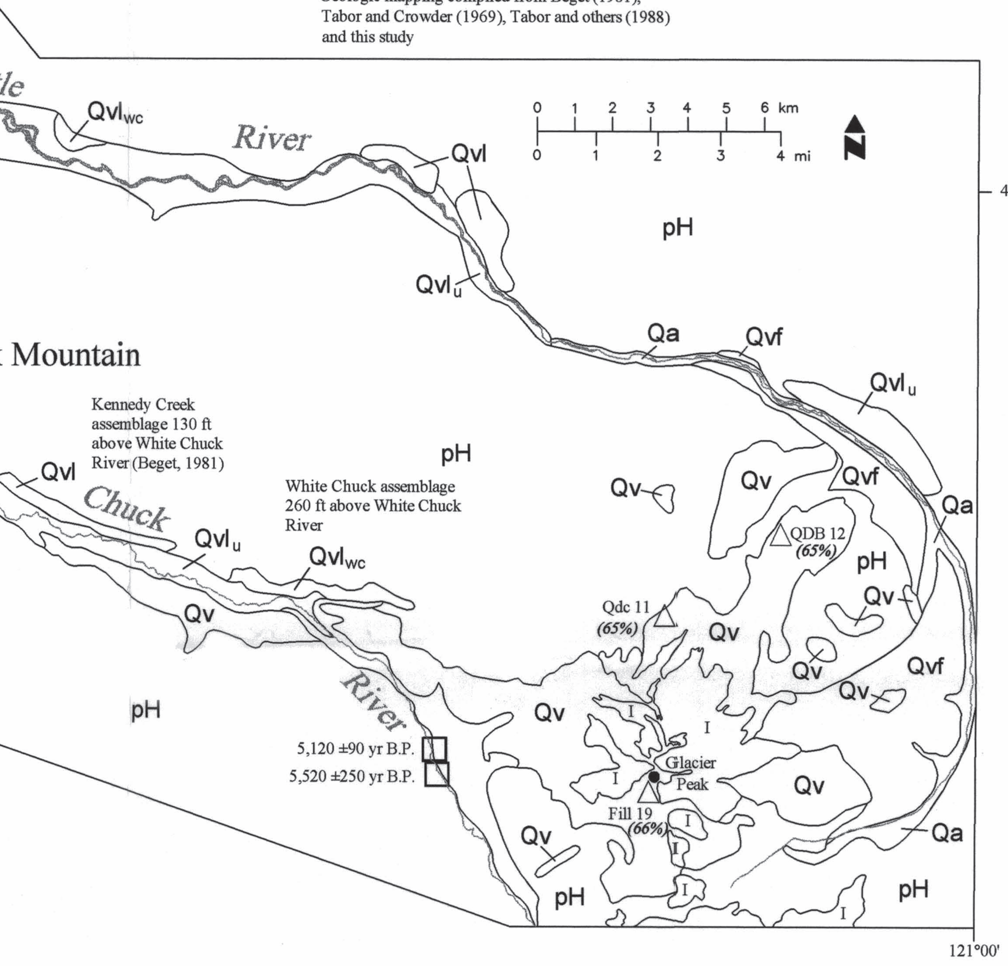




MAP A

Geologic mapping compiled from Beget (1981), Tabor and Crowder (1969), Tabor and others (1988) and this study





OVERVIEW

Deposits originating from a Glacier Peak eruptive event(s) are preserved in the lower Skagit River valley as 3- to 15-m- high terraces adjacent to the Skagit River flood plain. The cities of Lyman, Sedro-Woolley, and Burlington rest on terraces composed of dacite-rich sand and sandy gravel that we interpret as noncohesive lahar runout. New outcrops, ^{14}C ages*, stratigraphic relations, dacite-clast petrographic and geochemical data*, and laharic sand composition* suggest that the voluminous Kennedy Creek [volcanic] assemblage (KCA) of Beget (1981) reached Puget Sound. The KCA is mainly a lahar/pyroclastic surge deposit(s) that originated from Glacier Peak volcano. Near La Conner and Puget Sound, 135 km downvalley from Glacier Peak, the distal lahar can be traced as a 3- to 18-m-thick semi-continuous stratum on the basis of well and boring logs and isolated outcrops. This distal lahar is overlain by estuarine or deltaic sediments.

The Skagit Valley segment of the lahar appears to have originated from a single eruptive episode on the basis of an upward-fining sequence within the lahar, from crystal-dacite lithic sandy gravel (50-80% dacite clasts) to sand (41-75 % dacite clasts). Hypersthene-hornblende-phyric, vesicular dacite-clast samples collected at 21 lahar sites (from near Glacier Peak to La Conner) have nearly identical rare earth, trace, and major element geochemistry, suggesting of a single eruptive event. Charcoal in laharic sand near Lyman yielded an age of 4,780 ±80 yr B.P., similar to the 5,100–5, 500 yr B.P. age of the KCA and thus may be part of the KCA. Along the flanks of Glacier Peak, Beget (1982) estimated a total original volume of 2-3 km^3 for the KCA. Dusty Creek and Baekos Creek assemblages of Beget (1982) (The >3,400 and <6,700 yr B.P. have an estimated total original volume of >10 km^3 and could correlate with the KCA. Maximum-) minimum volume lahar estimates in the lower Skagit River basin suggest an additional 2 to 3 km^3 for the KCA. Thus, if our correlations are correct, the preserved KCA may have a volume exceeding 15 km^3.

Beget (1982) indicated that the KCA consists of noncohesive and cohesive lahar deposits, several pyroclastic flow deposits, with lesser lacustrine deposits, and alluvium. The assemblage contains abundant clasts of gray hypersthene-hornblende dacite. Banded dacites, consisting of alternating layers of frothy light gray to white and darker nonvesicular dacite, are present in some of the lahar and pyroclastic flow deposits. The KCA contains hornblende with lesser hypersthene and rare olivine similar to the dacitic sands and vesicular dacite clasts of lahar-runout deposits in the lower Skagit Valley. Beget (1982) noted that olivine is a minor mineral in the KCA and is not present in many of the dacite clasts of the assemblage. We observed rare olivine in the dacite clasts from samples of the lahar deposit(s) in this study. The KCA forms terraces in the White Chuck, Sauk, and Skagit River valleys. The deposits are tens to hundreds of meters thick near Glacier Peak and thin downvalley. The less well dated Baekos Creek and Dusty Creek assemblages of Beget (1982) may also have formed as a result of the 5,100 to 5,500 yr B.P. eruptive event that formed the KCA. If these other assemblages were part of the same eruptive event as the KCA, then eruptive products inundated most of the major drainages emanating from Glacier Peak. Correlation of the KCA with the lahar runouts of the lower Skagit River valley is strengthened by Beget's (1982) correlation of the KCA with a dacite-rich lahar at Minkler Lake (Map B, near Lyman): "a terrace east of [Minkler] Lake is composed almost entirely of dacitic-rich [laharic and alluvial deposits] and contains clasts as much as 20 cm in diameter that are mineralogically similar to rock fragments in the KCA." Beget's observations are of the lower, coarser part of the hyperconcentrated flood deposits. (His site is indicated by the arrow symbol near the bottom of the terrace directly south of sites 79P and 75S on Map B.) We herein extend the KCA to near the present Puget Sound.

Dacite clasts in the lahar are composed of quartz phenocrysts (subrounded and resorbed volcanic grains), plagioclase phenocrysts (blocky rectangular grains with distinct concentric zoning), and plagioclase microlites in a glassy matrix. Hypersthene phenocrysts occur as isolated single blocky crystals and less commonly as glomerocrysts with plagioclase and are very light green inplane-polarized light. The matrix is glassy and clear in plane-polarized light and includesmicrolites of plagioclase with lesser hornblende and hypersthene. Glassy magmatic flow features are conspicuous. Spherical, elliptical, and tear-drop shaped vesicles contribute to the magmatic flow appearance of these vesicular dacites.

Lahar-runout sands are distinctly dacite volcanic lithic rich*. Microlitic volcanic fragments (dacite), as well as the plagioclase, hypersthene, and some hornblende in the lahar runout sand grains are petrographically similar to the gravel-size dacite clasts in the lahar. The mineralogical similarity of the dacite lithics and relict volcanic phenocrysts in both the Skagit River alluvium and lahar-runout deposits and the abundance of these clasts in the Skagit River alluvium reflect active reworking of the laharic-volcanogenic sediment by the Skagit River.

Post-lahar Skagit River channel migration and lateral erosion formed erosional terraces composed of lahar deposits. The mid-to late-Holocene Skagit River has reworked the volcaniclastic sediment of the terraces resulting in a modern Skagit alluvium that has a distinct Glacier Peak volcanogenic provenance.

We examined all the available water well and geotechnical boring logs for the lower Skagit River valley. The above isopach and paleogeographic topographic maps, produced using Surfer software, combine this subsurface information (433 wells and geotechnical borings; Fig. 3.1A) with our surface mapping and sample analyses. Clast geochemistry, sand point-count data*, and the common occurrence of upward-fining trends from sandy gravels to sands (as indicated in the field and the water well data) suggest a single massive laharic event. Thus, we assume one catastrophic input of sediment into the lower Skagit River valley as the result of a Glacier Peak eruption at about 5,000 yr B.P.. (See Glacier Peak Kennedy Creek eruptive assemblage of Beget, 1982.) Another possible volcanic sediment inundation scenario is that the lahar deposit is a composite of the KCA and unnamed 1,750 yr B.P events. Perhaps the younger vesicular-dacite-rich deposit locally veneers the apparently concordant terrace surface of the older event along the lower Skagit River valley. It seems likely that the 1,750 yr B.P. event bypassed the high Lyman quadrangle lahar terraces and may be recorded only by subtle inset terraces farther down the Skagit Valley near Burlington. (See Dragovich and others, 2000.) However, available information (for example, dacite-clast geochemical homogeneity) suggests that most or all of the volcanic sediment composing the terraces in the lower Skagit Valley is correlative with the KCA (~5 ka).

Figures 3.1B-E show the paleogeography of the top and bottom of the lahar runout, as well as the thickness of the lahar and post-lahar sediments. The certainty of our correlation of the lahar diminishes away from lahar sample sites. For example, we were able to directly observe or probe to the top of the lahar north of La Conner and obtain sand samples for point-counting (Map B). Thus, we have high confidence in the subsurface correlation in the La Conner area. Confidence is also relatively high along Interstate-5 (where the lahar is exposed or at shallow depth) as a result of the tight spacing of geotechnical borings and analytical data that support a laterally continuous lahar stratum. However, the our confidence in the correlation of sand and gravel bodies below the present Skagit River alluvial system (Figs. 3.1C- E) with the lahar runout is only moderate to low. Confidence is significantly diminished toward Padilla Bay, as well as the present Skagit delta, where the lahar is apparently at depth or nonexistent (Figs. 3.1C-E) and subsurface data are sparse. Some subsurface data suggest the lahar is locally preserved below the modern Skagit channel fill; thus, the lahar may have been incompletely excavated by post-lahar channel migration and incision.

Sea level during the mid-Holocene (~5,100 yr B.P.) was about 5 to 25 ft lower than at present, and the mid-Holocene Puget Sound extended several miles to the east of the present shoreline. We suggest that the mid-Holocene shoreline was approximately near the -20 ft contour on the pre-lahar paleogeographic map. (See the stylized -20 ft contour line on Fig. 3.1F.) We drew this line on the basis of marine shells reported in boring logs from stratum directly under the lahar west of Interstate-5 (Fig. 3.1A) and not reported from any borings east of the -20 ft contour line.

See Plate 4 for references cited.

* Data in Washington Department of Natural Resources files for future publication.

GEOLOGIC UNIT EXPLANATION

I — Glacier Peak glacial ice

Holocene Surficial Deposits (younger than unit Qvl)

Qa, Qa_s — Alluvium (Holocene)--Gravel, sand, silt, and clay deposits with minor peat

Qn — Estuarine and deltaic deposits of the lower Skagit Valley (Holocene)--Mostly composed of organic-rich silt, silty clay, and fine sand with lesser peat; locally includes sand and gravel of beach and fluvial origin

Holocene to Pleistocene Sedimentary and Volcanic Deposits

Qvl — Kennedy Creek assemblage of Beget (1981) (mid-Holocene) and probably correlative Baekos Creek and Dusty Creek assemblages of Beget (1981)--Distal, noncohesive, gravelly sand and sand lahar and lahar-runout deposits with proximal, typically thickly bedded pyroclastic flow, dome collapse, lahar, and tephra deposits; proximal deposits locally contain interbedded lacustrine deposits. (We correlate this assemblage with the lahar-runout deposits of the lower Skagit Valley.)

Qvf — Volcaniclastic and volcanic fill of the White Chuck and Suiattle River valleys (Holocene and latest Pleistocene?)--Suiattle fill consists of a thickly bedded assemblage of lahars, pyroclastic flows, air-fall ash, alluvium, and rare lava flows that grades downvalley into lahars; White Chuck fill consists of a thickly bedded assemblage of lahars, pyroclastic flows, alluvium, and reworked ash and silt that partly grades downvalley into Kennedy Creek and White Chuck assemblage lahars (Tabor and others, 1988); Beget (1982) correlated much of the debris in these volcanic aprons with the mid-Holocene eruptive episode of unit Qvl

Qv — Undivided volcanic rocks and deposits of Glacier Peak (Holocene to Pleistocene)--Includes valley-bottom, valley-side, ridge-capping, and undivided flows and flow breccias of Tabor and Crowder (1969) and Tabor and others (1988); locally includes pyroclastic deposits (for example, White Chuck valley vitric tuff); available geochemical analyses suggest that some of the dacite flows on Glacier Peak are associated with the mid-Holocene unit Qvl pyroclastic and laharic event(s)

Qvl_{wc} — White Chuck assemblage of Beget (1982) (late Pleistocene)--Intermittent tephra eruptions and large-volume pyroclastic flows, lahars, dome collapse eruptions

Qvl_u — Undivided lahars from Glacier Peak (Holocene to Pleistocene)--Boulder diamicton to well-sorted sand and gravel; includes poorly mapped lahars correlative with units Qvl_{wc} and Qvl as well as other volcanic assemblages of Beget (1981); contacts from Tabor and others (1988)

Pre-Holocene Glacial Deposits and Bedrock

pH — Glacial deposits and bedrock (pre-Holocene)

SYMBOL EXPLANATION FOR SAMPLE SITES*

Symbols may be combined

- ○ Mounted thin section of lahar sand for point-counting (percent microlitic volcanics in parentheses)
- ● Mounted thin section of late-stage (transitional) lahar sand for point-counting (percent microlitic volcanics in parentheses) (composition and field setting suggest late-stage lahar runout or reworked lahar)
- ▲ Mounted thin section of sand from modern alluvium for point-counting (percent microlitic volcanics in parentheses)
- ★ Geochemical sample of lahar dacite clast *(italicized and bold percent SiO_2 in parentheses)*
- ☆ Geochemical sample of angular dacite clast in lapilli lithic tuff (pyroclastic surge deposit?) *(italicized percent SiO_2 in parentheses)* (See Map A; southeast of Darrington)
- △ Comparative geochemical samples of dacite flow and breadcrust bomb of Tabor and Crowder (1969) near Glacier Peak *(italicized percent SiO_2 in parentheses)*
- X Petrographic analysis of lahar dacite-clast sample (some point counted)
- ■ Post-lahar radiocarbon dating sample site (minimum lahar ages from overlying peats or paleosols) (this study)
- * Post-lahar radiocarbon dating sample site (minimum lahar ages from overlying peats or paleosols); dates were obtained from human settlements probably near the Skagit River delta front (Thompson 1978)
- □ Lahar radiocarbon dating sample (charcoal or logs)
- Miscellaneous notes
- ← Location of the most distal laharic (unit Qvl) Skagit Valley stratigraphic section that is correlated by Beget (1981, 1982) with the Kennedy Creek assemblage (Map B near the city of Lyman)