San Juan Island National Historical Park

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for San Juan Island National Historical Park

sajh_geology.pdf

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# Geologic Resources Inventory Map Document for San Juan Island National Historical Park

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This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for San Juan Island National Historical Park, Washington (SAJH).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

This document contains the following information:

1) **About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2) **GRI Digital Maps and Source Map Citations** – A listing of all GRI digital geologic-GIS maps produced for this project along with sources used in their completion. In addition, a brief explanation of how each source map was used is provided.

3) **GRI Digital Geologic-GIS Map of San Juan Island National Historical Park and Vicinity**
   
   a.) **Map Unit List** – A listing of all geologic map units present on the above map, generally listed from youngest to oldest.

   b.) **Map Unit Descriptions** – Descriptions for all geologic map units present on the above map. If a unit is present on multiple source maps the unit is listed with its source geologic unit symbol, unit name and unit age followed by the unit's description for each source map.

   c.) **Geologic Cross Sections** – Geologic cross section graphics pertaining to the above map.

   d.) **Additional Supporting Information** – Additional information relevant to the above map.

   e.) **Ancillary Source Map Information** – Additional source map information relevant to the above map presented by source map.
4) GRI Digital Surficial Geologic-GIS Map of American Camp Area, San Juan Island National Historical Park

a.) **Map Unit List** — A listing of all geologic map units present on the above map, generally listed from youngest to oldest.

b.) **Map Unit Descriptions** — Descriptions for all geologic map units present on the above map.

c.) **Ancillary Source Map Information** — Additional source map information relevant to the above map presented by source map.

5) **GRI Digital Data Credits** — GRI digital geologic-GIS data and ancillary map information document production credits.

For information about using GRI digital geologic-GIS data contact:

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About the NPS Geologic Resources Inventory Program

Background

The Geologic Resources Inventory (GRI) provides geologic map data and pertinent geologic information to support resource management and science-informed decision making in more than 270 natural resource parks throughout the National Park System. Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The GRI is one of 12 inventories funded by the National Park Service (NPS) Inventory and Monitoring Program. The Geologic Resources Division of the NPS Natural Resource Stewardship and Science Directorate administers the GRI. The NPS Geologic Resources Division partners with the Colorado State University Department of Geosciences to produce GRI products. Many additional partners participate in the GRI process by contributing source maps or reviewing products.

The GRI team undertakes three tasks for each park in the Inventory and Monitoring program: (1) conduct a scoping meeting and provide a summary document, (2) provide digital geologic map data in a geographic information system (GIS) format, and (3) provide a GRI report. These products are designed and written for nongeoscientists.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: https://www.nps.gov/articles/gri-geodatabase-model.htm

Geologic Reports: GRI reports synthesize discussions from the original scoping meeting, follow up conference call(s), and subsequent research. Chapters of each report discuss the geologic setting of the park, distinctive geologic features and processes within the park, highlight geologic issues facing resource managers, and describe the geologic history leading to the present-day landscape. Each report also includes a poster illustrating these GRI digital geologic-GIS data.

For a complete listing of GRI products visit the GRI publications webpage: https://go.nps.gov/gripubs. GRI digital geologic-GIS data is also available online at the NPS Data Store: https://irma.nps.gov/DataStore/Search/Quick. To find GRI data for a specific park or parks select the appropriate park(s), enter “GRI” as a Search Text term, and then select the Search button.
For more information about the Geologic Resources Inventory Program visit the GRI webpage: https://www.nps.gov/subjects/geology/gri.htm. At the bottom of that webpage is a “Contact Us” link if you need additional information. You may also directly contact the program coordinator:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division. Learn more about I&M and the 12 baseline inventories at the I&M webpage: https://www.nps.gov/im/inventories.htm.
GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS maps for San Juan Island National Historical Park, Washington (SAJH):

**Digital Geologic-GIS Map of San Juan Island National Historical Park and Vicinity, Washington (GRI MapCode SAJH)**

The above GRI digital geologic-GIS map was produced from the following source maps listed below.


Only a partial extent of each source map was used. For the Washington Division of Geology and Earth Resources, 2005, source map, all geologic features present on the source map (within the extent used) were captured. For the Logan, 2002 source map, only faults, geologic attitude observation localities and cross section lines (within the extent used) were captured. From the Schasse, 2003 source map, only fault and fold symbology was captured (with in the extent used), and the source map was also used for some fault and fold data attribution in the above GRI digital geologic-GIS map.

The above GRI digital geologic-GIS map uses the Logan, 2003 and Schasse, 2003 source maps (listed above), as well as the following source maps listed below for unit descriptions.


Digital Surficial Geologic-GIS Map of American Camp Area, San Juan Island National Historical Park, Washington (GRI MapCode SJIS_surficial)

The above map was produced from the following source maps. The full extent of each source map was used, and all geologic features present on both source maps were captured. Unit descriptions were also taken from these source maps.

Dethier, D.P. et. al., 1996, Maps of Surficial Geology and Depth to Bedrock of the False Bay, Friday Harbor, Richardson, and Shaw Island 7.5-minute Quadrangles, San Juan County, Washington: WDGER, Open File Report 96-7, plate 1, scale 1:24,000 (False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 1)). (GRI Source Map ID 2118).

Dethier, D.P. et al., 1996, Maps of Surficial Geology and Depth to Bedrock of the False Bay, Friday Harbor, Richardson, and Shaw Island 7.5-minute Quadrangles, San Juan County, Washington, WDGER, Open File Report 96-7, plate 2, scale 1:24,000 (False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 2)). (GRI Source Map ID 7487).

Additional information pertaining to each source map is also presented in the GRI Source Map Information (SAJHMAP) table included with the GRI digital geologic-GIS data.
Index Map

The following index map displays the extents of the GRI digital geologic-GIS maps produced for San Juan Island National Historical Park (SAJH). The extent of the GRI Digital Geologic-GIS Map of San Juan Island National Historical Park and Vicinity is outlined in black (within the colored area), whereas the extent of the GRI Digital Surficial Geologic-GIS Map of American Camp Area, San Juan Island National Historical Park is outlined in purple. The boundaries (as of July, 2022) for the American Camp Unit and English Camp Unit of San Juan Island National Historical Park are outlined in green. The 7.5’ quadrangles that intersect the GRI digital geologic-GIS maps are also shown (in gray).

Index map by Stephanie O'Meara (Colorado State University).
GRI Digital Geologic-GIS Map of San Juan Island National Historical Park and Vicinity

Map Unit List

The geologic units present on the GRI Digital Geologic-GIS Map of San Juan Island National Historical Park and Vicinity map are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qa - Alluvium). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (SAJUUNIT) table included with the GRI digital geologic-GIS data.

Cenozoic Era

Quaternary Period

Qa - Alluvium
Qb - Beach deposits
Qd - Dune sand
QT - Artificial fill, including modified land
Qp - Peat deposits
Qgdm - Glaciomarine drift, may correlate with Everson Interstade
Qgdm(es) - Glaciomarine drift, Everson Interstade and Sumas Stades, Fraser-age
Qgdm(e) - Everson Glaciomarine Drift
Qgom(e) - Everson Glaciomarine Drift, marine outwash
Qgom - Continental glacial outwash, marine, Fraser-age
Qgd - Continental glacial drift, Fraser-age
Qgt - Continental glacial till, Fraser-age

Mesozoic Era

Cretaceous and Jurassic Periods

KJmm(c) - Constitution Formation, Decatur terrane, marine metasedimentary rocks
KJm(ll) - Lopez structural complex, Lummi Formation derivative

Jurassic and Triassic Periods

JTRmc(o) - Orcas Chert, Deadman Bay terrane

Triassic Period

TRn - Haro Formation

Mesozoic and Paleozoic Eras

Triassic and Permian Periods

TRPv - Volcanics of Deadman Bay

Paleozoic Era

Permian and Devonian Periods

PDmt - East Sound Group, metasedimentary and metavolcanic rocks

Pre-Permian Period

pPsh - Garrison Schist
Pre-Devonian Period
\[ \text{pDi} \quad - \text{Turtleback Complex, undivided intrusive rocks} \\
\text{pDit} \quad - \text{Turtleback Complex, tonalite} \\

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below.

Qa - Alluvium (Holocene)

Port Angeles Quadrangle
Qa Alluvium (Holocene) — Generally well-stratified and well-sorted rounded cobble and pebble gravel, sandy gravel, gravelly sand, silt, and clay; deposited in and along present streams; grain size varies both laterally and vertically due to stream migration. Description from source map: (Port Angeles 1:100,000 Quadrangle (portion of)).

Roche Harbor Quadrangle
Qa Alluvium (Holocene) — Sorted combinations of silt, sand, and gravel deposited in streambeds and alluvial fans; clasts are generally rounded and derived from local bedrock sources or reworked Puget Lowland glacial deposits. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

Qb - Beach deposits (Holocene)

Port Angeles Quadrangle
Qb Beach deposits (Holocene) — Generally well-sorted sand and cobbles within the influence of the surf zone; may include silt and pebbles; forms elongate spits; larger clasts in coarser deposits are generally well rounded and flat as a result of wave action. Description from source map: (Port Angeles 1:100,000 Quadrangle (portion of)).

Port Townsend Quadrangle
Qb Beach Deposits (Holocene) — Moderately to well sorted sand and gravel accumulations along shorelines; mapped only where present above high tide. Individual particles are typically well rounded and locally include wave-worn shell fragments. Reach deposits form spits along protected shorelines and are widespread throughout coastal parts of study area, especially on western Whidbey Island, southern San Juan Island, and on northern and eastern Marrowstone Island. Description from source map: Port Townsend 30' x 60' Quadrangle (Surficial).

Roche Harbor Quadrangle
Qb Beach deposits (Holocene) — Sand and (or) gravel with minor shell fragments deposited along shorelines; clasts are typically well rounded. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

Qd - Dune sand (Holocene)

Port Townsend Quadrangle
Qd Dune Deposits (Holocene) — Moderately to well sorted, medium to coarse, wind-deposited sand containing minor amounts of silt. Dunes commonly form near beach level and along tops of bluffs where barren slopes are exposed to strong onshore winds. Stratification may be absent or may form broad, planar crossbeds; tuned organic Layers representing former soil horizons are locally present. Exposed thickness ranges from 1 m to more than 5 m. Examples of mapped dune
deposits era present on San Juan Island near Cattle Point and on west shore of Whidbey Island north of Point Partridge and south of West Point. Description from source map: Port Townsend 30' x 60' Quadrangle (Surficial)

Qf - Artificial fill, including modified land (Holocene)

Port Angeles Quadrangle
Qf Artificial fill and modified land (Holocene) — Riprap, soil, sediment, rock, and solid waste material that has been added and reworked to modify topography; includes engineered and non-engineered fill. Description from source map: Port Angeles 1:100,000 Quadrangle (portion of).

Qp - Peat deposits (Holocene-Pleistocene)

Port Angeles Quadrangle
Qp Peat and marsh deposits (Holocene) — Peat, muck, and lacustrine silt and clay rich in organic matter; formed by the accumulation and decomposition of organic material in wet depressions and other areas of poor drainage. Description from source map: Port Angeles 1:100,000 Quadrangle (portion of).

Roche Harbor Quadrangle
Qp Peat deposits (Holocene) — Peat, muck, and lacustrine silt and clay rich in organic matter; deposited mostly in closed depressions. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

Qgdm - Glaciomarine drift, may correlate with Everson Interstade (Pleistocene)

Port Angeles Quadrangle
Qgdm Glaciomarine drift (Pleistocene) — Poorly sorted, weakly stratified to non-stratified, poorly compacted pebbly silt and clay with discontinuous layers of silty sand; weathers to a pseudo-columnar appearance on vertical sea-cliff faces; tan to gray, weathers to dark to pale yellowish brown; rare marine fossils. A shell from the unit collected northwest of Sequim yielded a 14C age of 12,600 ±200 yr B.P. (Dethier and others, 1995), indicating that unit Qgdm was deposited during the time interval established for the Everson Interstade of the Fraser Glaciation; however, it is not clear that the label ‘Everson’ should be applied to deposits this far west of the Puget Lowland. Description from source map: Port Angeles 1:100,000 Quadrangle (portion of).

Qgdm(es) - Glaciomarine drift, Everson Interstade and Sumas Stades, Fraser-age (Pleistocene)

Port Angeles Quadrangle
Qgdm(es) Glaciomarine drift, subtidal deposits, Everson age (Pleistocene) — Moderately to well-sorted sand, silty sand, and silt containing local pods and lenses of gravel; laminated to thin bedded, locally massive or cross stratified; gray to bluish gray; generally overlies marine diamicton, till, and undifferentiated diamicton (units Qgdm, Qgt, and Qgd); preserved in topographic depressions below 200 ft elevation; locally fossiliferous; deposited in a glaciomarine or marine environment during the Everson Interstade. Radiocarbon ages from shells range from about 12.9 to 12.5 ka. (Description and ages compiled from Dethier and others, 1996.). Description from source map: Port Angeles 1:100,000 Quadrangle (portion of).
Roche Harbor Quadrangle

**Qgdm(es) Glaciomarine subtidal deposits, Everson Interstade (Pleistocene)** — Moderately well- to well-sorted sand, silty sand, and silt containing local pods and lenses of gravel; gray to bluish gray; laminated to thin-bedded, locally massive and cross stratified; deposited in a glaciomarine or marine environment during the Everson Interstade; preserved in topographic depressions below 200 ft elevation; generally overlies marine diamicton, till, and undifferentiated diamicton (units **Qgdm(e)**, **Qgt**, and **Qgd** respectively); locally fossiliferous; radiocarbon ages from shells range from about 12.9 to 12.5 ka (description and ages compiled from Dethier and others, 1996). Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

**Qgdm(e) - Everson Glaciomarine Drift (Pleistocene)**

Port Angeles Quadrangle

**Qgdm(e) Glaciomarine drift, marine diamicton, Everson age (Pleistocene)** — Poorly to moderately sorted pebbly silt and diamicton; contains lenses and discontinuous beds of silt, sand, and gravel; massive to poorly stratified; unweathered matrix is light olive-gray to gray, locally bluish gray; sparsely to highly fossiliferous; overlies Vashon till (unit **Qgt**); generally underlies marine subtidal deposits (unit **Qgdm(es)**); locally mantles the landscape below 200 ft elevation; deposited in a glaciomarine or marine environment during the Everson Interstade; radiocarbon ages from shells range from about 13.1 to 12.8 ka. (Description and ages compiled from Dethier and others, 1996.) Description from source map: Port Angeles 1:100,000 Quadrangle (portion of).

**Roche Harbor Quadrangle**

**Qgdm(e) Glaciomarine drift, Everson Interstade (Pleistocene)** — Generally poorly sorted to faintly stratified pebbly sandy silt and pebbly clay; locally capped by shallow-water clay or silt; consists of undifferentiated deposits of the Everson Interstade on Point Roberts. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

**Qgom(e) - Everson Glaciomarine Drift, marine outwash (Pleistocene)**

Bellingham Quadrangle

**Qgom(e) Marine outwash, Everson Interstade (Pleistocene)** — Loose, moderately to well-sorted, subangular to sub-rounded gravelly sand, sandy gravel, and sand with minor interbeds of silt and silty sand. Clasts are subangular to rounded and locally angular. Bedding is well developed on a scale of centimeters to meters and is rarely massive. Unit Qgome commonly forms high-amplitude foreset beds and trough cross-bedding, which are indicative of deltaic deposition. These beds are usually tens of meters high, dip 15 to 40 degrees, and overlain by 1 to 2 m thick subhorizontal topset beds. Distal marine outwash deposits are generally thinly plane-laminated and rarely rhythmically bedded. Clasts were derived from local and distant sources, and clasts and sand are locally phyllite and vein-quartz rich. Color is brown to gray, depending on oxidation state and lithologic content. Thickness is from less than 1 m to 70 m.

The age of unit Qgom(e) is between 12,900 and 12,500 yr B.P. in the western San Juan Island (Dethier and others, 1996) and possibly as young as 11,990 ±1 10 yr B.P., a 14C date from wood near the top of the unit in the Alger 7.5-minute quadrangle (Dragovich and others, 1998). This unit interfingers with unit Qgdm(e) and therefore may locally include it. Outcrops are common within the Bow, Alger, Sedro-Woolley North, and Lyman 7.5-minute quadrangles, especially flanking the Skagit River valley. All exposures occur below the lowering marine limit during Everson time. (See Easterbrook, 1979, 1992, and Dethier and others, 1995, for discussions on changing sea level during Everson time.) (Description compiled from Easterbrook, 1968; Dethier and others, 1995, 1996; Dragovich and Grisamer, 1998; and Dragovich and others, 1998, 1999.). Description from source map: Bellingham 1:100,000 Quadrangle.
Qgom - Continental glacial outwash, marine, Fraser-age (Pleistocene)

Port Townsend Quadrangle
On the Port Townsend surficial geologic source map, unit Qgom was mapped as units Qvrc and Qfu.

Qvrc Recessional Continental Deposits (Pleistocene) — Poorly to well-sorted, locally iron-stained sand, gravel, and silt deposited predominantly by meltwater from the receding Vashon-age ice sheet. Thickness commonly ranges from 2 to 10 m, but unusual thicknesses of 20-50 m are found as valley fills along major drainages. These deposits are associated with three principal depositional environments, each containing sediments with somewhat different characteristics.

Ice-contact deposits - Typically deposited in contact with masses of stagnant glacier ice; original stratification commonly dips 10 degrees or less; with local cut-and-fill structures; particle size and degree of sorting range widely; locally contains lenses and pods of glacially derived sediment flow deposits, for example, flow till. Topographic expression commonly is hummocky with closed depressions and irregular ridges caused by collapse of the original sediment surface after melting of buried glacier ice. Collapse structures such as steeply tilted, contorted, and faulted layers are common. Examples of ice-contact deposits are preserved near Point Partridge on central Whidbey island; in southwest corner of study area near Blyn; and in the vicinity of Lake Armstrong, north of Arlington.

Outwash deposits - Deposited downvalley horn the zone of stagnant glacier ice. Sediments are horizontally stratified to gently dipping (5 to 10 degrees) with channel crossbeds and cut-end-fill structures. Deposits are typically composed of medium to well-sorted, pebble-cobble gravel and coarse to medium sand with local lenses of fine sand and silt. Topographic expression of outwash deposits, where not modified by erosion, is typically a relatively smooth surface with a gentle (3-5 m/km) downvalley gradient. Smith Prairie southeast of Penn Cove on central Whidbey Island and the salole on which Arlington Heights is located are examples of a plain underlain by recessional outwash deposits.

Alluvial fan deposits - Poorly to moderately well-soiled, pebble-cobble gravel with boulders and lenses of finer materials deposited by swift-flowing streams coming from upland areas. Boulders, cobbles, and pebbles are angular to subrounded and are commonly derived from local sources. Some fans, built into laws or marine waters, have large-scale deltaic foreset beds. Fan surface, slope valleyward at angles less than 15-degrees but individual layers may dip as steeply as 30-degrees. Deposits range in thickness from 20 to 40 m and interfinger with and overlie the horizontally layered outwash deposits. A well-preserved example of a recessional alluvial fan deposit is found at the North mouth of Gilligan creek, south of the Skagit River, southeast of Sedro-Woolley. Description from source map: Port Townsend 30' x 60' Quadrangle (Surficial).

Qfu Glacial and Nonglacial sedimentary Deposits of Fraser Glaciation, Undivided (Pleistocene) - Unit consists variously of any glacial, glacial marine, or marine sediments deposited during the Fraser glaciation in places where present-day steep slopes preclude more detailed delineation at map scale. Description from source map: Port Townsend 30' x 60' Quadrangle (Surficial).

Of note, the Geology of Washington State (digital 1:100,000 version 1) source map presents this unit as mainly of the Vashon stade in Western Washington.

Qgd - Continental glacial drift, Fraser-age (Pleistocene)

Bellingham Quadrangle
Qgd Glacial deposits, undifferentiated (Pleistocene) — May include any and all glacial deposits described below. Unit symbol Qgd is used where detailed field and map data are lacking and (or)
differing interpretations of Quaternary glacial deposits are irreconcilable. Description from source map: Bellingham 1:100,000 Quadrangle.

Port Angeles Quadrangle

**Qgd Vashon Drift, undivided (Pleistocene)** — Glacial deposits of Vashon age consisting of mixtures of sand and gravel, lodgment till, sandy ablation(?), till, and lacustrine(?) silts; commonly characterized by hummocky topography. Represents those materials not separately mappable as units Qgo, Qgl, Qgt, or Qga at the map scale; age range is that of the included units (~12–19 ka). On southern San Juan Island, consists of poorly sorted, generally non-stratified till covered by 1.5 to 10 ft of marine diamicton (unit Qgdm(e)); mapped below 200 ft elevation where till (unit Qgt) and marine diamicton (unit Qgdm(e)) cannot be differentiated at map scale; generally unfossiliferous. Description from source map: Bellingham 1:100,000 Quadrangle (portion of).

**Roche Harbor Quadrangle**

**Qgd Drift, Vashon Stade (Pleistocene)** — Undifferentiated till, sand, gravel, silt, and clay; mostly Vashon till and outwash not separately mappable at the map scale. Consists of part of the Vashon Drift and part of the Everson Glaciomarine Drift. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

Of note, the Geology of Washington State (digital 1:100,000 version 1) source map presents this unit as mainly of the Vashon stade in Western Washington.

**Qgt - Continental glacial till, Fraser-age (Pleistocene)**

Port Angeles Quadrangle

**Qgt Vashon till (Pleistocene)** — Most commonly lodgment till consisting of an unstratified, highly compacted mixture of poorly sorted clay, silt, sand, gravel, and boulders deposited directly by glacier; gray where fresh and yellowish gray to light gray and tan where oxidized; locally includes ablation till of varied thickness and characterized by irregular hummocky topography. Lies stratigraphically between overlying recessional outwash (unit Qgo) and underlying advance outwash (unit Qga); age is bracketed by 14C ages from Vashon advance outwash near Sequim of about 17.5 to 18.5 ka (Blunt and others, 1987) and a 14C date of about 14.5 ka from a bog on Vashon Drift near the western margin of the Strait of Juan de Fuca (Heusser, 1973). On southern San Juan Island, consists of a poorly sorted, compact mixture of silt, sand, and clay containing pebble to boulder gravel; generally non-stratified, but locally contains subhorizontal layering, partings, and deformation structures; locally contains lenses, pods, and thin discontinuous beds predominantly of sorted gravel; olive-gray and gray where unoxidized and olive to buff where oxidized; generally rests on striated bedrock and underlies marine diamicton (unit Qgdm(e)). Age is older than 13.2 ka. Description and ages for unit on San Juan Island compiled from Dethier and others, 1996.). Description from source map: Port Angeles 1:100,000 Quadrangle (portion of).

Port Townsend Quadrangle

**Qvt Till (Pleistocene)** — Poorly sorted mixture of rock fragments deposited directly by the Vashon-age ice sheet. Finer components include silt, sand, and clay. In variable proportions, constituting a coherent to friable. moderately to highly compact matrix in which the coarser components (pebbles, cobbles, and boulders) are firmly embedded. The deposit is typically non-stratified, but subhorizontal layering and fissile structure are locally well developed; may contain lenses and pods of stratified sand, silt, and gravel. Thickness varies considerably, but typically ranges from a few meters to as , much as 40 m and probably averages between 3 and 15 m. In fresh exposures at depths greater than 1.2 m. the fill matrix is light olive gray (5Y6/2) to gray (2.5Y6); clay-rich fill tends to have bluish-gray aspect and weathering of the uppermost few meters typically has produced a matrix color of olive (5Y 5/3) to buff (2.5Y 6/4). Till stones are commonly subangular to subrounded. In addition to rock types derived from local bedrock such as greenstone, phyllite, schist and gneiss, stone lithologies also commonly include granitic rock types derived from southern British Columbia,
indicating glacier transport from considerably north of study area. Examples of the (Vashon) till are exposed along Interstate Highway 5 immediately north of the Stillaguamish River and north of the Pilchuck Creek crossing. Other good exposures of the (Vashon) till are located along sea cliffs; lot example, on Whidbey, and Camano islands, southwest of Lake Hancock and on the east side of Elger Bay; at Kinney Point on Marrowstone island; and near Point Wilson, north of Pint Townsend.

Description from source map: Port Townsend 30' x 60' Quadrangle (Surficial).

**Roche Harbor Quadrangle**

-Qgt Till, Vashon Stade (Pleistocene) — Unsorted, unstratified, highly compacted mixture of clay, silt, sand, gravel, and boulders deposited by glacial ice; may contain interbedded stratified sand, silt, and gravel. Includes part of the Vashon Drift. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

Of note, the Geology of Washington State (digital 1:100,000 version 1) source map presents this unit as mainly of the Vashon stade in Western Washington.

**KJmm(c) - Constitution Formation, Decatur terrane, marine metasedimentary rocks (Cretaceous and Jurassic)**

**Bellingham Quadrangle**

-KJm(c) Constitution Formation of Vance (1975) (Cretaceous to Jurassic) — Poorly to moderately sorted volcaniclastic sandstone, cherty sandstone, mudstone, and conglomerate with lesser ribbon chert, green tuff, and pillow lava and rare limestone. Clastic lithologies are commonly massive and locally graded at a scale of a few millimeters to a few centimeters; local cataclastic deformation is especially apparent toward the base of the section where many underlying lithologies are tectonically interleaved within the Constitution Formation. Sandstone is commonly turbiditic and largely contains volcanic detritus with lesser chert, non-volcanic quartz, and epidote grains; mudstone is commonly massive and consists mainly of clay- and silt-sized grains with minor sand-sized grains and local olistolithic limestone and metavolcanic boulders 1 to 2 m in diameter. Conglomerate contains rounded to angular volcanic, chert, metaconglomeratic, and schistose clasts in siltstone matrix. Clasts are thought to be derived from underlying units (Orcas Chert, Turtleback Complex, and Garrison Schist; Vance, 1975, 1977). Clasts average 5 cm in diameter. Ribbon chert, rhythmically bedded every 3 to 4 cm, is interbedded with clastic rocks throughout the entire section but is more abundant near the base. Green tuff occurs near the base of the section and is commonly fine grained and indurated; intercalated mudstone and chert in tuff give it a layered appearance. Pillow lava ranges in composition from ocean-floor basalt to possibly arc-derived dacite (Brandon and others, 1988) and is interlayered with clastic rocks. Whether the pillow lava is olistoliths blocks, in place, or both is unclear. Limestone occurs near the base of the unit as isolated pods. Metamorphic minerals in clastic rocks include albite + quartz + chlorite + calcite/ aragonite + white mica lawsonite prehnite. (See Brandon, 1980, and Brandon and others, 1988, for more details.) Clastic rock is generally tan to gray on weathered surfaces and gray to dark gray on fresh surfaces, pillow lavas range from light to dark green and locally red-green, tuff is light green, chert is grayish green to pale black, and limestone is light gray. Unit KJm(c) may locally include units pDit, Orcas Chert of Vance (1975), and the pre-Permian Vedder Complex of Armstrong and others, 1983.

The age of unit KJm(c), is poorly constrained, but radiolarians from chert give Late Jurassic or Early Cretaceous ages (Brandon and others, 1988). Outcrops occur on Orcas, Shaw, and San Juan Islands. The type locality is Mount Constitution on Orcas Island. (Description compiled from Shelley, 1971; Vance, 1975, 1977; Brandon, 1980; Brandon and others, 1988; and this study.) Description from source map: Bellingham 1:100,000 Quadrangle.

**Port Angeles Quadrangle**

-KJmm(c) Constitution Formation (Cretaceous–Jurassic) — Poorly to moderately sorted volcaniclastic sandstone, cherty sandstone, mudstone, and conglomerate with less-abundant
ribbon chert, green tuff, and basalt and dacite pillows; includes rare limestone. Clastic rock types are commonly massive and locally graded; sandstone is commonly turbiditic; mudstone is commonly massive. Conglomerates contains rounded to angular volcanic, chert, metaclast, and schistose clasts in a siltstone matrix; rhythmically bedded ribbon chert is commonly interbedded with clastic rocks throughout the unit but more abundant near the base. Green tuff occurs near base of section and is commonly fine grained and indurated; pillow lava is interlayered with clastic rocks; limestone occurs near base of unit as isolated pods. Metamorphic minerals in clastic rocks include albite, quartz, chlorite, calcite/aragonite, and white mica ± lawsonite and (or) prehnite (Brandon, 1980; Brandon and others, 1988). Structurally overlies unit JTRmco. Age is poorly constrained, but radiolarians from chert give Early Cretaceous or Late Jurassic ages (Brandon and others, 1988). Description from source map: (Port Angeles 1:100,000 Quadrangle (portion of)).

Roche Harbor Quadrangle
KJmm Marine metasedimentary rocks (Cretaceous–Jurassic) — Metamorphosed sandstone, argillite, mudstone, and conglomerate; commonly dark gray-brown and highly penetrated by veinlets of secondary minerals. Consists of the Constitution Formation. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

KJm(ll) - Lopez structural complex, Lummi Formation derivative (Cretaceous and Jurassic)
Port Townsend Quadrangle
Kls Sandstone and argillite (Late Cretaceous) — Foliated graywacke-argillite flysch with minor chert, greenstone, and conglomerate. Mapped as Lopez Terrane of Whetten and others, 1978. A mélangé, Kls is highly deformed and locally tektontically mixed with unit greenstone. Early Cretaceous (Valanginian) Buchia, Jurassic radiolarians, and a Late Jurassic or Early Cretaceous belemnite have been found. Description from source map: Port Townsend 30' x 60' Quadrangle (Surficial).

JTRmc(o) - Orcas Chert, Deadman Bay terrane (Jurassic and Triassic)
Port Angeles Quadrangle
JTRmc(o) Orcas Formation (Jurassic–Triassic) — Ribbon chert with less-abundant pillow basalt, mafic tuff, limestone, and mudstone; intraformational chert breccia and coarse chert-lithic sandstone occur locally; bedding commonly contorted where preserved; ribbon chert is well bedded with shaly interbeds; pillow basalt and mafic tuff are interbedded with chert; limestone is recrystallized into aragonite marble (Vance, 1968) and occurs as interbeds in chert and as olistolith blocks; interbedded mudstone and mafic tuff are locally abundant. Early Jurassic to Triassic ages were determined from radiolarians in chert, and limestone associated with chert yields Late Triassic conodonts (Brandon and others, 1988). Consists of part of the Deadman Bay terrane of Brandon and others (1988). Description from source map: (Port Angeles 1:100,000 Quadrangle (portion of)).
Roche Harbor Quadrangle
JTRmc Metachert (Jurassic–Triassic) — Metamorphosed gray or white ribbon chert with minor marble; locally contains quartzite, metamorphosed argillite and pillow basalt, basaltic tuff, greenstone, and phylilitic slate; commonly highly folded and locally chaotically disrupted; radiolarians from chert are early Jurassic to Triassic (Vance 1975); late Triassic conodonts found near Roche Harbor (Vance, 1975). Consists of the Orcas Formation. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).
TRn - Haro Formation (Triassic)
Roche Harbor Quadrangle
TRn Nearshore sedimentary rocks (Triassic) — Andesitic and dacitic siltstone, sandstone, tuff, conglomerate, breccia, and limestone at Davidson Head on the north end of San Juan Island; metamorphosed to the zeolite facies (Johnson, 1978). Consists of the Haro Formation. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

TRPv - Volcanics of Deadman Bay (Triassic and Permian)
Roche Harbor Quadrangle
TRPmv Metavolcanic rocks (Triassic–Permian) — Metamorphosed pillow basalt, breccia, tuff breccia, mafic tuff, and chert; contains metamorphic aragonite; contains minor fusulinid limestone (Brandon and others, 1988). Consists of the Deadman Bay Volcanics. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

PDmt - East Sound Group, metasedimentary and metavolcanic rocks (Permian and Devonian)
Roche Harbor Quadrangle
PDmt Metasedimentary and metavolcanic rocks, undivided (Permian–Devonian) — Metamorphosed, well-bedded argillite and volcanic sandstone with basalt to rhyolite breccia, tuffs, and flows, as well as silicic hypabyssal rocks; also contains local pebble conglomerate, non-Tethyan fusulinid limestone, gabbro, and rare chert. Consists of the East Sound Group. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

pPsh - Garrison Schist (Pre-Permian)
Roche Harbor Quadrangle
pPsh Schist (pre-Permian) — Well-foliated amphibolite, greenschist, blueschist, micaceous quartzite (metachert), mica-quartz (± garnet) schist, and rare marble. Consists of the Garrison Schist. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

pDi - Turtleback Complex, undivided intrusive rocks (Pre-Devonian)
Roche Harbor Quadrangle
pDi Intrusive rocks (pre-Devonian) — Metamorphosed gabbro, quartz diorite, tonalite, trondhjemite, diabase, and rare pyroxenite; local orthogneiss and metamorphosed basaltic to silicic dikes; veins of calcite, aragonite, and prehnite; metamorphosed to greenschist and amphibolite facies; a leucotonalite at Steep Point on Orcas Island yielded a Pb/U date of 405 ±15 Ma. Consists of the Turtleback Complex. Description from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

pDit(t) - Turtleback Complex, tonalite (Pre-Devonian)
Port Townsend Quadrangle
Klm Metaplutonic rocks; Tonalite(Late Cretaceous) — Unit mapped as part of the Lopez Terrane of Whetten and Others (1978) as described by Brandon (1980), this unit is cataclastic, contains the metamorphic minerals aragonite, lawsonite, pumpeylite, and epidote, and is cut by
metabasaltic dikes. Includes exotic blocks of metamorphosed quartz diorite dated by R. E. Zartman (in Whitten and others, 1978) as Devonian. Description from source map: Port Townsend 30' x 60' Quadrangle (Surficial).

Of note, the Geology of Washington State (digital 1:100,000 version 1) source map lists the unit as pre-Devonian in age, whereas the Port Townsend 30' x 60' Quadrangle (Bedrock) source map has this unit's age as Late Cretaceous. The more recent source, Geology of Washington State (digital 1:100,000 version 1), was used for the unit's age.

Geologic Cross Sections

The geologic cross sections present on the GRI Digital Geologic-GIS Map of San Juan Island National Historical Park and Vicinity are presented below. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A'

Graphic from source map: Roche Harbor 1:100,000 Quadrangle (portion of).

Cross Section B-B'

Graphic from source map: Roche Harbor 1:100,000 Quadrangle (portion of).
Additional Supporting Information

The following information was produced for the GRI Digital Geologic-GIS Map of San Juan Island National Historical Park and Vicinity.

San Juan Island Location Map

Location map showing San Juan Island National Historic Park and Washington State.

![San Juan Island Location Map](image)

English Camp

American Camp

San Juan Island National Historic Park

Graphic produced by Greg Mack (NPS Pacific West Region).
1:100,000 Quadrangle Index

Washington State index of 1:100,000-scale quadrangles are presented below. Quadrangles outlined in yellow were used for the GRI Digital Geologic-GIS Map of San Juan Island National Historical Park and Vicinity map.

Ancillary Source Map Information

The following section present ancillary source map information associated with source maps used for the GRI Digital Geologic-GIS Map of San Juan Island National Historical Park and Vicinity, Washington map.

Bellingham 1:100,000 Quadrangle

The formal citation for this source.

References


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References from source map: Bellingham 1:100,000 Quadrangle
Geology of Washington State (digital 1:100,000 version 1)

The formal citation for this source.


No additional information is presented in this document from the source map.

Port Angeles 1:100,000 Quadrangle (portion of)

The formal citation for this source.


References


Dethier, D. P.; White, D. P.; Brookfield, C. M., 1996, Maps of the surficial geology and depth to bedrock of False Bay, Friday Harbor, Richardson, and Shaw Island 7.5-minute quadrangles, San Juan County, Washington: Washington Division of Geology and Earth Resources Open File Report 96-7, 7 p., 2 plates.


References from source map: Port Angeles 1:100,000 Quadrangle (portion of).
Port Townsend 30' x 60' Quadrangle (Bedrock)

The formal citation for this source.


References


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References from source map: Port Townsend 30' x 60' Quadrangle (Bedrock)
Port Townsend 30' x 60' Quadrangle (Surficial)

The formal citation for this source.


Prominent graphic and references associated with this source:

Late Pleistocene stratigraphic sequences

The late Pleistocene stratigraphic sequences in the Puget Sound region from the Port Townsend 30' x 60' Quadrangle (Surficial) source map is available as an embedded document. Double-click the following link to open this document, [Glacial_Strat_PT_Townsend.pdf](#).

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--------1979, Coastal zone atlas of Washington, v.4 and 5, Island and Snohomish Counties scale 1:24,000.


References from source map: Port Townsend 30’ x 60’ Quadrangle (Surficial)
Roche Harbor 1:100,000 Quadrangle (portion of)

The formal citation for this source.


References


Dethier, D. P.; White, D. P.; Brookfield, C. M., 1996, Maps of the surficial geology and depth to bedrock of False Bay, Friday Harbor, Richardson, and Shaw Island 7.5-minute quadrangles, San Juan County, Washington:Washington Division of Geology and Earth Resources Open File Report 967, 7 p., 2 plates.


References from source map: Roche Harbor 1:100,000 Quadrangle (portion of).
GRI Digital Surficial Geologic-GIS Map of American Camp Area, San Juan Island National Historical Park

Map Unit List

The geologic units present on the GRI Digital Surficial Geologic-GIS Map of American Camp Area, San Juan Island National Historical Park map are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qf- Fill). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the Geologic Unit Information (SJISUNIT_surficial) table included with the GRI digital geologic-GIS data.

Cenozoic Era

Quaternary Period
Qf - Fill
Qd - Dune deposits
QB - Beach deposits
Qff - Tidal-flat deposits
Ql - Landslide deposits
Qm - Marsh, bog, or swamp

Deposits of the Vashon Stade of Fraser Glaciation
Qvrm - Fraser Glaciation, Vashon Stade, recessional-marine deposits
  Qvrm - Fraser Glaciation, Vashon Stade, recessional-marine deposits, emergence deposits
  Qvrms - Fraser Glaciation, Vashon Stade, recessional-marine deposits, marine subtidal deposits
  Qvrmd - Fraser Glaciation, Vashon Stade, recessional-marine deposits, marine diamiction
  Qvrmo - Fraser Glaciation, Vashon Stade, recessional-marine deposits, marine outwash
Qvt - Fraser Glaciation; Vashon Stade; till
Qvd - Fraser Glaciation; Vashon Stade; diamiction, undifferentiated

Pre-Tertiary Period
pTbr - Bedrock

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. All units descriptions were taken from the False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 1) source map.

Qf - Fill (Holocene)

Mixtures of earth materials, demolition debris, garbage, and other debris disposed of as solid waste; thickness generally more than 6 ft; overlies till, diamicton, or recessional deposits. Small areas of fill near roads are not shown.

Qd - Dune deposits (Holocene)

Generally well-sorted medium to coarse sand containing layers of silt and fine sand; massive to planar cross-stratified; locally include one or more buried soil intervals; thickness generally 7-16 ft; occur adjacent to beaches exposed to strong onshore winds; overlies glaciomarine deposits in most areas; active and sparsely vegetated dunes most extensive near South Beach, San Juan Island.
**Qb - Beach deposits (Holocene)**
Moderately well to well-sorted gravel and coarse sand along shorelines above high tide; planar and channel cross-stratified; locally massive; thickness more than 7 ft; overlies bedrock in most areas; forms elongate spits near Lopez and Flat Point on Lopez Island, and at Low Point and North Bay, San Juan Island. Numerous pocket beaches too small to show at this scale occur in shorelines mapped as bedrock, particularly along the southwest and northeast sides of San Juan Island, on Shaw Island, and along the south side of Lopez Island.

**Qtf - Tidal-flat deposits (Holocene)**
Fine sand, sand, silt, and minor clay, generally water-saturated, adjacent to active beach spits; massive; locally horizontally stratified; contain numerous burrows and remains of roots, particularly of eel grass; thickness and contact relations unknown; extends from high tide level to mean lower-low sea level. These deposits are most extensive near sheltered coves such as False Bay, San Juan Island, Fisherman Bay and west of Richardson, Lopez Island, and Squaw Bay, Indian Cove, and Blind Bay, Shaw Island.

**Ql - Landslide deposits (Holocene)**
Heterogeneous mixtures of silt, sand, and diamicton transported downslope by sliding, slumping, or flowing and exposed in coastal bluffs; stratification discontinuous, reflecting original layers in the bluff or layers formed during sliding; thickness 7-20 ft; overlie fine Pleistocene sediments; deposit surfaces commonly hummocky and include closed depressions and irregular low ridges; common along the west side of Lopez Island. Landslides too small to show at map scale are indicated by symbol.

**Qm - Marsh, bog, or swamp (Holocene and Pleistocene)**
Fine sand and silt mixed with decomposing vegetation; includes peat deposits and locally contains interlayered tephra; deposited in fresh or brackish water, stratification generally horizontal; thickness 7-27 ft; overlies Pleistocene deposits such as till and marine silt, or bedrock. Upland bogs and marshes fill local depressions on glacial deposits and bedrock, such as those near Sportsmans Lake, San Juan Island; salt marshes and swamps occur adjacent to lagoons, sand spits, and tidal flat deposits at Fisherman Bay, Lopez Island; small wetlands formed by dams and other impoundments are not shown.

**Qvrm - Fraser Glaciation; Vashon Stade; recessional-marine deposits (Pleistocene)**
Interbedded pebbly silt, sand and gravel, silt and sand containing lenses of diverse sediment types and sparse to locally abundant marine fossils; deposited in a glaciomarine or marine environment.

**Qvrme - Fraser Glaciation, Vashon Stade, recessional-marine deposits, emergence deposits (Pleistocene)**
Moderately well sorted to well-sorted gravel and sand containing sparse boulders; fine to medium sand in a few places; beds massive to locally channel cross-stratified; thickness ranging from a boulder lag less than 1 ft thick to about 27 ft thick; common at elevations below about 200 ft; unconformably overlies other marine deposits or till; locally fills channels cut into underlying deposits; lies beneath or grades up into sandy eolian deposits rich in organic matter, buried soil profiles 0.7-2 ft thick in some gravelly deposits. Two deposits south of Friday Harbor have the morphology of beach deposits. This unit contains local concentrations of shell fragments, many highly leached, and molds (in sand) of Protothaca staminae, Saxidomus giganteus, Chlamys sp. and other species (see table). Age between about 12.8 and 12.3 ka.
**Qvrms - Fraser Glaciation, Vashon Stade, recessional-marine deposits, marine subtidal deposits (Pleistocene)**

Moderately well to well-sorted sand, silty sand, and silt containing local pods and lenses of gravel; laminated to thin-bedded, locally massive and cross-stratified; thickness generally 10-50 ft; generally lies above marine diamicton, till, and undifferentiated diamicton and can be distinguished from these units by the lack of clasts; lies beneath organic-rich soils or peat deposits; gray to bluish gray; preserved in topographic depressions below an elevation of 200 ft; most extensive near False Bay, San Juan and Beaverton valleys, San Juan Island, north of Lopez and northwest of Richardson on Lopez Island. Locally fossiliferous (see table). Age between about 12.9 and 12.5 ka.

**Qvrmd - Fraser Glaciation, Vashon Stade, recessional-marine deposits, marine diamicction (Pleistocene)**

Poorly to moderately well sorted pebbly silt and diamicton; contains lenses and discontinuous beds of silt, sand, and gravel; massive to poorly stratified; normally graded bedding common locally; unweathered matrix light olive gray to gray, locally bluish gray; olive to buff colors common in the upper 3 ft of oxidized diamicton; thickness generally 10-27 ft, but as great as 50 ft near Cattle Point and American Camp, San Juan Island; overlies marine outwash or Vashon till; generally lies beneath gravelly emergence deposits or marine subtidal deposits; locally mantles the landscape below elevations of about 200 ft, particularly in topographic depressions, where some marine diamicton is included with Vashon diamicton (unit Qvd); sparsely to highly fossiliferous (see table); fossils commonly in growth position; at other localities sedimentary structures and mixtures of fossils of different depths demonstrate the polygenetic origin of this unit. Age between about 13.1 and 12.8 ka.

**Qvrmo - Fraser Glaciation, Vashon Stade, recessional-marine deposits, marine outwash (Pleistocene)**

Moderately well to well-sorted gravel and sand, matrix-supported gravel and sand-rich diamicton, and lenses and beds of pebbly silt; generally well stratified in beds 1-7 ft thick; some beds massive to poorly stratified. Beds dip 50-300 southeast, south, southwest, and west; planar crossbeds commonly extend 33-165 ft down dip; channels locally cut planar crossbeds. Pebbly marine silt most common in channels near the top and along margins of the deposit. Thickness ranges from 16 ft to more than 200 ft near Cattle Point, where deposits form an extensive moraine, and near Pear Point, San Juan Island, an area of extensive gravel mining. Marine outwash deposits overlie till, undifferentiated diamicton, or bedrock and lie beneath marine diamicton or marine emergence facies. The unit is locally collapsed or cut by thrust faults. Gravel units and beds of pebbly silt are locally fossiliferous (see table). Age about 13.2 ka.

**Qvt - Fraser Glaciation; Vashon Stade; till (Pleistocene)**

Poorly sorted, compact mixture of silt, sand, and clay containing 5-30 percent (by volume) pebble to boulder gravel; generally nonstratified, but subhorizontal layering, parting, and deformation structures present locally; contains lenses, pods, and thin discontinuous beds of sorted material, generally gravel, in some exposures; thickness variable, but generally ranging between 13 and 33 ft; matrix colors similar to those of the marine diamicton unit, mainly olive gray and gray where unoxidized and olive to buff in the upper 3-7 ft; clasts subangular to subrounded; rock types mainly local greenstones and graywackes, but granitic rocks derived from the Coast Range of British Columbia make up more than 10 percent of the larger clasts; generally rests on striated bedrock or on advance outwash and lies beneath marine diamicton or underlies the soil layer in most areas. Older than 13.2 ka.
Qvd - Fraser Glaciation; Vashon Stade; diamiction, undifferentiated (Pleistocene)
Poorly sorted, generally nonstratified till covered by 1.5-10 ft of marine diamicton; used as a map unit below an elevation of about 200 ft where till and marine diamicton cannot be differentiated at map scale; includes areas of marine diamicton; generally unfossiliferous.

pTbr - Bedrock (Pre-Tertiary)
Abundant bedrock exposures mantled with thin (less than 10 ft) surficial deposits.

Ancillary Source Map Information
The following section present ancillary source map information associated with source maps used for the GRI Digital Surficial Geologic-GIS Map of American Camp Area, San Juan Island National Historical Park, Washington map.

False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 1)
The formal citation for this source.

Dethier, D.P. et, al., 1996, Maps of Surficial Geology and Depth to Bedrock of the False Bay, Friday Harbor, Richardson, and Shaw Island 7.5-minute Quadrangles, San Juan County, Washington: WDGER, Open File Report 96-7, plate 1, scale 1:24,000 (GRI Source Map ID 2118).

Prominent graphics and text associated with this source:

Correlation of Map Units

Graphic from source map: False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 1).
Explanation of Map Symbols

EXPLANATION

x  Landslide deposit, too small to show at map scale
F  Fossil locality (see table)
C  Location of radiocarbon-dated sample
+  Measured section
SJ-5  Well-log location
   Striation or trough and direction of ice motion
   Drumlin, indicating orientation of long axis
   Uplifted beach deposit

Graphic from source map: False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 1).

Measured Sections
Locations for the measured sections present in the GRI digital geologic-GIS data.

Contacts and Symbols for Graphic Logs

Conformable (surface exposures);
or unknown (well log)
Erosional
Dropstone

Diamicton, deformed (Qvt, Qvd, Qvrmd)
Diamicton (Qvt, Qvd, Qvrmd)
Gravel (Qva, Qvrmo, Qvrme)
Fine gravel: coarse sand (Qva, Qvrmo, Qb)
Fine to medium sand (Qva, Qvrms)
Silty sand (Qva, Qvrms, Qrm, Qtf)
Silt and clayey silt (Qva, Qpfn)

Graphic from source map: False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 1).
Section DW-14

Graphic from source map: False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 1)).

Section DW-21
Graphic from source map: False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 1).

Section DW-83

Graphic from source map: False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 1).
False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 2)

The formal citation for this source.

Dethier, D.P. et al., 1996, Maps of Surficial Geology and Depth to Bedrock of the False Bay, Friday Harbor, Richardson, and Shaw Island 7.5-minute Quadrangles, San Juan County, Washington, WDGER, Open File Report 96-7, plate 2, scale 1:24,000 (GRI Source Map ID 74870).

Prominent graphics and text associated with this source:

Depth to Bedrock, Explanation of Map Symbols

EXPLANATION

- **25** - Well finished in bedrock; thickness of Quaternary sediment, in feet, indicated at selected wells.

- **≥250** - Well finished in Quaternary sediment; minimum thickness of Quaternary sediment, in feet, indicated at selected well sites.

- **≥20** - Line connecting points of equal depth to bedrock, in feet; contour interval 20 ft; locally not shown or generalized where gradient is steep and values are uncertain near American Camp.

Graphic from source map: False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 2).

Report

The report for Dethier and others (1996), plates 1 and 2, is available as an embedded document. Double-click the following link to open the document: Open File Report 96-7

The report includes a listing of late Pleistocene fossil genera and radiocarbon ages from the San Juan Islands.
References

The references from Dethier and others (1996), plates 1 and 2, are listed below.


References from source maps: False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 1). and False Bay, Friday Harbor, Richardson and Shaw Island Quadrangles (Surficial Plate 2).
GRI Digital Data Credits

This document was developed and completed by Stephanie O'Meara (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program. Quality control of this document by Ron Karpilo (Colorado State University). Earlier versions of this document, for each GRI digital geologic-GIS map, were produced by Greg Mack (NPS Pacific West Region) and Stephanie O'Meara.

The information in this document was compiled from GRI source maps, and is intended to accompany the digital geologic-GIS maps and other digital data for San Juan Island National Historical Park, Washington (SAJH) developed by Greg Mack and Stephanie O'Meara (see the GRI Digital Maps and Source Map Citations section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS maps).

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