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PRELIMINARY REPORT
on the
GEOLOGY OF SOUTHERN SNOHOMISH COUNTY

to
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by
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INTRODUCTION:

The map area includes eighty-five square miles in South Snohomish County southeast of Everett, bounded on the west by Interstate 5, on the south by Highway 405 and the Snohomish-King County boundary, on the east and north by the Snohomish River floodplain.

The purpose of the project is to provide a geologic map of the area at a scale which can be useful as a tool in urban planning. Since the project has been done in conjunction with the Snohomish County Planning Commission, hopefully, it will provide geologic data that will be useful to them in planning for future metropolitan and industrial growth. The geologic map will provide a basis for applying groundwater, seismic response, slope stability and engineering property studies to the area, all of which are important factors in today's urban and regional planning.

The field work for mapping was accomplished during the summer of 1973 over a 2 1/2 month period. Exposures in road-cuts, stream cuts and foundation excavations were observed and test pits were dug with post-hole diggers and bars below the weathered profile when possible. U.S. Geological Survey 7-1/2 minute quadrangles of the area were used as a base for mapping.

The area consists primarily of Tertiary sedimentary and volcanic rocks and Pleistocene glacial and interglacial unconsolidated sediments.

TERTIARY ROCKS:

Consolidated tertiary rocks outcrop in the southeast part of the study area between the towns of Monroe and Cathcart, covering an area of approximately 4 sq. miles.

Volcanic Rocks

Bald Hill, northwest of Monroe, consists primarily of andesite flows. These blue-green porphyritic rocks weather quite readily to a light grey material with a reddish hue which can easily be disintegrated by hand. At several localities on Bald Hill vertical dikes are exposed which contain andesite xenoliths in a fine grained matrix.

Sedimentary Rocks

Tertiary sandstone, conglomerate, coal and fossiliferous shale border the Snohomish River Valley on the west. The sandstone varies from tan to red depending on iron oxide content. The shale is yellow with red iron oxide deposits concentrated along bedding planes. Spheroidal weathering and fossils are common in the shale. Fossil studies by Capps place the shale in the Oligocene. The conglomerate is comprised of deeply weathered pebbles and cobbles jacketed with red iron oxide. Some coal beds are exposed interbedded with the sedimentary rocks. The sandstone appears arkosic in hand specimen. Composition will be more accurately determined by laboratory studies.

Weathering

The sedimentary rock exposures are deeply weathered to a red soil, rich in plant nutrients known as Cathcart Loam. The weathering products of the sandstones, conglomerates and shales are similar to some of the glacial deposits and may be confused with them when the units are found in close proximity to one another. The weathered sandstone looks very much like the Esperance sand. The weathered shale is very similar to the Whidbey clay and the conglomerate in some areas may be confused with the Vashon and Possession tills. In some cases laboratory studies provide the only means of distinguishing between Pleistocene and Tertiary units.

Stratigraphy

No exposures have been found showing a direct contact between the volcanic and sedimentary rocks. Until studies have been completed nothing definite can be said about their stratigraphic relationship.

Structure

Volcanic rocks on Bald Hill have been folded, faulted and intruded by dikes. Jointing is also common. The sedimentary rocks exhibit some local structures but extensive weathering makes effective regional structural studies difficult.

Future Studies of Tertiary Rocks

A more precise lithological investigation will be made on both the volcanic and sedimentary rocks, including x-ray diffraction studies, petrographic microscope studies, studies of engineering properties, and weathering characteristics. Time permitting, an investigation of the industrial value of the andesites and associated rocks will be included in the final report.

PLEISTOCENE SEDIMENTS

Whidbey Formation

The oldest Quaternary deposit in the map area is the Whidbey Formation. Its stratigraphic position is pre-Possession, (>40,000 years B.P.) and is probably equivalent to the Puyallup Interglaciation (Easterbrook, 1969). Newcomb (1952) called the formation Admiralty, but that term is no longer used in Pleistocene stratigraphic nomenclature. Further work will be done to correlate the unit with the type section on Whidbey Island.

The Whidbey Formation is characteristically compact, bedded, bluish to gray-brown silt and clay. Thin sand layers are present in places, but silt and clay dominate. Its vertical extent is from well below sea-level, as indicated by well records, to about 200 feet above sea-level. There may be sequences up to 100 feet of almost pure

clay. A good exposure of the thick clay unit is located in an active clay pit in Section 21, T.28N.,R.5E. 5 miles southeast of Everett. The exposure shows the bedded nature and blue color that is characteristic of the Whidbey Formation. There are other good exposures of the Whidbey clay located along the High Bridge Road west of Monroe. The known extent of the Whidbey Formation in the map area is about 5 square miles.

Because the Whidbey's physical characteristics are similar to younger clay units, the principal criterion used for mapping was its stratigraphic position. More detailed study will be conducted to confirm the age of each exposure.

Possession Drift

The Possession Drift was deposited during the Salmon Springs Glaciation. It is stratigraphically above the Whidbey and on Whidbey Island is radio-carbon dated at 34,980 and 47,600 years B.P.(Easterbrook, 1969). Its physical characteristics are quite similar to those of the Vashon till. Both consist of gray, very compact ground moraine. The two units are nearly identical in the field, and as with the Whidbey Formation the main criterion for mapping was stratigraphic position. Where till was found in direct contact above a clay unit with outwash deposits above the till, the unit was mapped as Possession. With further studies of the age of the clay units confirmation of the age of the till units may be made.

VASHON DRIFT

Esperance Sand Member

The blue clays and Tertiary sediments in south western Snohomish County are blanketed with unconsolidated sands and gravels. These deposits represent sediments carried by meltwater streams from the advancing Vashon glacial lobe. The basal section of the deposit grades from clay to fine sands that are well sorted and often massive. The clays are interpreted as lacustrine deposits that are overridden by deltaic sands. The clays and massive sands are not ubiquitous and thus it is difficult to establish a correlation with the Lawton clay member which is well documented south of Snohomish County (Mullineaux, 1965).

As the ice advanced southward, coarse sands and gravels were deposited over the finer material and a variety of depositional structures including cross bedding, scouring, and channeling were found within these deposits. These sands and gravels range from angular to subrounded with rounding roughly increasing with increasing grain size. The gravels are primarily rock fragments of igneous intrusive origin, mostly dioritic in composition.

The Esperance sands are locally up to 300 feet thick but often pinch out along valley slopes. The thickest deposits are in the western region because there is a topographic high in the Tertiary rock to the east. The outwash material was overridden by the ice which

cut deep channels into the sands and deposited a concrete-like layer of till over the outwash material. Load structures, plastic dikes of clay, and minor shearing within the outwash deposits were formed by the overriding weight and movement of the glacier.

Vashon Till

Following deposition of the Esperance sand, Vashon till was layed down. According to Easterbrook (1969) the age of the Vashon till is about 15,000 years B.P. It consists of ground moraine which is locally known as "hardpan" because of its concrete-like nature. Vashon till covers most of the map area. Only in post-glacial outwash channels has the till been cut through to expose the underlying formations.

Vashon till consists of ablation till and lodgement till quite similar physically to the older Possession till. Vashon till is found stratigraphically above the Esperance in many exposures. The lodgement till was deposited as ice advanced over the area from the north.

The till is blue-gray, gray, brown to buff, unsorted, unstratified, very dense and very hard. Particle size ranges from clay and silt matrix to gravel, cobble and boulder. The coarser material is mostly gravel, but boulders and cobbles are scattered throughout. Most of the pebbles are rounded to subrounded, and the boulders are dominantly granitic to dioritic.

Weathering of the till is confined to the upper 10 feet in areas

mantled by ablation till. The weathering on lodgement till is very shallow in most places. Stratification in the till is normally absent, although local lenses of sand or gravel can be present. These are generally local and of very little extent. No fossils were found in the till.

The till normally forms a fairly thin mantle over the underlying Esperance sand. The till's thickness in the area ranges from several feet to 150 feet. It has normally been preserved on the upland surfaces, but can extend down the valley sides to the valley bottom. Quite frequently, along the lower portions of the valley, the till has been cut through to expose the underlying Esperance sand or covered by post-glacial outwash deposits, thus confusing its stratigraphic position.

The ablation till is also very poorly sorted, being deposited as the ice wasted away in the area. The ablation till is generally located on the upland surfaces. It is quite similar to the weathered lodgement till, very poorly sorted, loose to fairly compact although the weathered zone in the ablation till is generally deeper than it is in the lodgement till. The ablation till grades into the lodgement till and mapping them as separate units would be very difficult.

Recessional Outwash Gravels

Within the region studied, recessional outwash gravels are thin lenses which are often indistinguishable from weathered till or other

loosely consolidated sediment. There are only a few localities where these sediments are mapable as distinct units. More often they form a veneer of gravels and sands overlying till or blend ambiguously into the Esperance sands. The deposits are usually only a few feet thick and are very porous. Because of the porosity and permeability of the recessional outwash material, farms often rely on these sediments as a source of ground-water.

We have attempted to map these deposits as accurately as possible; however, it should be kept in mind that there is some question about the exact limits of these sediments. The Washon till may cover up to 60% of the area mapped, and its surface is generally mantled with 2 to 3 feet of loosely consolidated silt, sand and gravel. This is usually interpreted as the weathered product of till, but may very well be recessional deposits also.

Status of work in progress

The geologic map, which is provided within this preliminary report, is not to be used as a reference for a final publication. The map represents our present interpretation of geologic units, however we do expect upon submission of the final draft, a more accurate map based on in depth theses studies and secondary reconnaissance in areas not presently unquestionably defined.

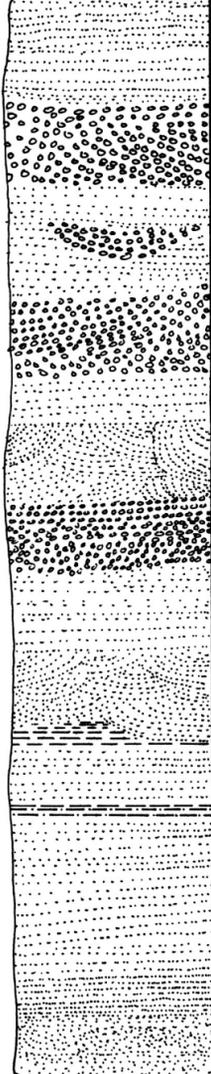
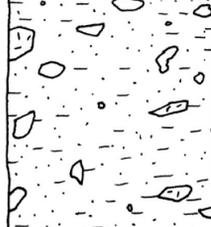
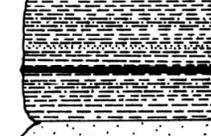
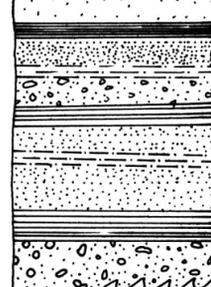
Beyond the general refinement of geologic information provided in the preliminary report, we intend to provide information which will assist the Snohomish County Planning Department in the utilization of this geologic data. The county planners have expressed a desire for information related to slope stability, seismic response and hydrology. We believe that a graphic display and written explanation related to these field will best satisfy their interests.

Following our report to the state, will be thesis work done on both tertiary volcanic and sedimentary rocks within this study area and a thesis investigation of Pleistocene clay deposit in western Snohomish County.

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SNOHOMISH COUNTY COLUMNAR SECTION

AGE	GLACIAL AND INTERGLACIAL UNITS	LITHOLOGY	DESCRIPTION	
RECENT			Post glacial fluvial sediments. Floodplain valley sediments of clay, silt and sand with lenses of peat. These sediments are primarily within the Snohomish River Valley.	
PLEISTOCENE	FRASER GLACIATION VASHON DRIFT	RECESSIONAL SANDS		Unconsolidated sands and gravels with no recognized depositional structures. Gravels range to cobble size and are poorly sorted. These gravels are distributed as a thin veneer overlying glacial till and is frequently very oxidized. These deposits amount to nothing more than a few feet at maximum.
		TILL		Poorly sorted blue grey densely compacted hardpan. The till is nearly impermeable and resembles concrete. There are occasional thin bands of gravels and clay within the till, but these are localized deposits. Average thickness is approximately 60 feet.
		ESPERANCE SAND MEMBER		The Esperance member is composed of well sorted sands and gravels with cross-bedding and channeling. Sands are subrounded to angular with alternating bands of gravel and sand. These coarser sediments overlie a more massive sequence of fine sands with thin lamina of clay. Where depositional structures do exist within this lower unit, there are no high-angle cross-bedding planes. The lamina are nearly horizontal. The estimated thickness is approximately 300 feet and there is a gradual thinning to the East.
		PILCHUCK CLAY(?)		Pilchuck clay occurs as thin discontinuous lenses of brown and green clay.
		SALMON SPRINGS GLACIATION POSSESSION DRIFT		Isolated undifferentiated till is here labeled as possibly Possession till, but there is no identifiable lithologic property to distinguish it from Vashon till.
		PUYALLUP INTER-GLACIATION WHIDBEY FORMATION		Blue clay with lenses of silt and sand. Only one exposure of peat was found, and it is five feet thick. This unit strongly resembles the Whidbey Formation. The clay is impure and often has pebbles or cobbles. Thickness may be as much as 600 feet.
OLIGOCENE			Alternating beds of fossiliferous arkosic sandstone and blue siltstone, with well sorted gravel conglomerate beds and thick beds of pencil shales. Intercalated within these sedimentary deposits may be volcanic sediments. A minimum thickness for the Tertiary sequence is 6,500 feet.	
	NO EVIDENCE OF CONTACT		Andesitic volcanic rocks which vary from massive to agglomeritic.	

PRELIMINARY GEOLOGICAL MAP OF
SOUTHERN SNOHOMISH COUNTY

BY
GERALD CAPPS, JOHN D. SIMMONS
AND FRANK D. VIDEGAR
1973

EXPLANATION

Recent	Qp	Peat
	Qal	Recent alluvium
Pleistocene	Qvr	Vashon recessional outwash
	Qvt	Vashon till
	Qve	Esperance sand
	Qpd	Possession drift
	Qw	Whidbey clay
Oligocene	Ts	Tertiary sedimentary rocks
	Tv	Tertiary volcanic rocks

