Notes on Glacial Geology of the City of Seattle

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- "The primary aim is to establish a groundwork for the assembling of detailed information needed by engineers on types of materials and the localities where they may be expected to occur at and blow the surface within the city [of Seattle]." (page 2)
- Field work was conducted between April 1949 and May 1950 (page 4)

Types of Pleistocene Sediments

Clay

- up to 1/256th mm
- Three main types of clay deposits.
    1. **Massive clays -** homogenous deposit; blue-gray; almost impermeable. Little variation in rate of deposition. Weathering proceeds slowly, mainly due to low permeability. Few visible bedding planes or laminations. (pages 7 -8).
    2. **Laminated clays** – thin layers of stratification. Adhesive in individual layers but not between layers, so breaks easily along bedding planes. Relatively impermeable, but water moves more through silty layers. Beaches and steep slopes are often developed in layers of laminated clay. (pages 8-9).
    3. **Varved clay** is made up of a series of similar pairs of laminations. Each varve = one thick and one thin layer. Thick = mostly silt, thin = mostly clay. The most permeable of the three types of clay. Water tends to drain out of the hill at the top of varves. Individual varves vary in thickness from < 1 inch to >1 foot. (pages 9-11)

Silt

- 1/256th – 1/16th mm
- Silt is very common in Seattle as a gradational deposit between clay and sand.
- In general permeability varies directly with variation in grain size
- Silt is gritty to the touch (vs. smooth clay).
- Beds of silt are less resistant to erosion than most other types of Pleistocene sediments in the city of Seattle.
- In steep banks & sea cliffs silt = the weakest member present. Most troublesome in terms of land sliding. (pages 11-12)

Sand

- 1/16th mm – 2 mm
- Fine = 1/16 m- 1/4 mm

Sand continued

- Medium = ¼ mm – ½ mm
- Coarse = ½ mm – 2 mm
- In this area much of the sand is glacial outwash material and the grains tend to be sub-angular (rather than rounded).
- Pebbles are common in bedding surfaces.
- Sand beds in general are weak and easily eroded.
- Movement of ground water out of sand layers just above more impermeable layers increases slumping and sliding, which are common in sand units throughout the city. (pages 11-15)

Gravel

- 2 mm+
- Gravel in Seattle is actually gravelly sand containing enough pebbles and cobbles that the coarse material appears dominant. Size ranges from the upper limit of sand to boulders a foot or more in diameter. (page 15)

Peat

- Most peat in this area is very hard, due mainly to compression. Peat layers are usually so hard and compact that they are impermeable. (page 16)

Glacial Till

- Unstratified and unsorted aggregate of clay, silt, sand and gravel resulting from direct deposition by ice.
- Although not bedded, and apparent stratification present is called sheeting.
- Kneading = structure present in till due to pressure of ice; gives massive, compact, somewhat swirled appearance.
- As the glacier advances, till is plastered all over the surface over which it rides, leaving a mantle on the pre-existing topography.
- The permeability of till varies with the properties of the constituent minerals. Clayey till is the least permeable; sandy till is the most permeable.
- Development of a soil cover on the surface makes the till more susceptible to erosion.
- Hardness, compactness, and lack of permeability make glacial till on of the strongest sediments in the Pleistocene series.
- Capping till covers most of the hills and acts as a strong, impervious protective layer over other sediments.

General Pleistocene Stratigraphy

- Seattle's soils are complex. They were deposited over three glacial episodes separated by long intervals of erosion. (page 20)
- The deposits from oldest to youngest deposits are:
    - **Beacon Till** – oldest Pleistocene deposit. Thick glacial till. South of Spokane street on west side of Beacon Hill. (pages 20-21)
    - **Duwamish Formation** (pages 21-22)
    - **Klinker Till** (pages 22-23)
    - **Lawton Formation** (pages 23-24)
    - **Vashon Advance Gravel** (pages 24-25) and
    - **Vashon Till** (page 25).
- **Vashon Advance Gravel** is gravel deposited in channels cut into the Lawton formation and earlier unit during the advance of Vashon ice. This type of deposit most typically is found in the same area in West Seattle that the Klinker till is. Vashon gravel I composed of rounded pebbles, cobbles and boulders with a considerable fraction of finer sand and silt. The gravel also contains some boulders, clay blocks and other fragment of the earlier Pleistocene sediments into which the channel was cut. (pages 24-25)
- **Vashon Till** is till that was deposited by the last continental glacier to occupy the Puget Lowland. "Willis (1898) gave the name Vashon to extensive capping till on Vashon Island and there is no doubt that the capping till on the island and the till that veneers the Seattle hills are the same." (page 25)

  The Vashon till varies in thickness in Seattle from a few feet up to 125 feet or more, and the base and top of the till sheet both vary from below sea level to above 500 feet. The till is composed of sand, clay, and an assemblage of coarser, rounded stones. The sandy mixture helps to distinguish it from the earlier tills which are much more clayey, and a darker gray. (page 25)

Stratigraphy of Districts

- All of the previously described stratigraphic units vary markedly in elevation above sea level. The authors describe these variations by districts.
- The authors define the following districts:
    - The West Seattle District (pages 26-31)
    - The Beacon Hill District (pages 31-34)
    - The Capitol Hill District (pages 34-36) and the
    - North District (pages 36-38)

  This summary focuses on the findings in the North District

Characteristics of the North Seattle District

- The North Seattle District is the area north of Lake Union and the ship canal from Puget Sound to Lake Washington. (page 36)
- The lowest stratigraphic unit seen in the North Seattle district is the **Lawton formation**, which is widely exposed from sea level to 350 feet in elevation. On the west side of the North District there is little variation from the type of section of the Lawton formation. This is described further. (pages 36-37)
- The next younger unit in the North Seattle District is **Vashon advance gravel**. These are described at the Sand Point Naval Air station, and between Sand Point and Webster point. It is not referred to as being in the west side of the North district. However current soil maps show a potential area of **glacial outwash gravel** in Ballard. [1]
- **"Vashon till** deposition followed immediately after deposition of the advance outwash gravel. The till in North Settle district varies from a few feet of nearly unrecognizable till to till as thick as 125 feet. **North Seattle is more completely mantled with thick till than any other part of the city, especially down the gradual southern slope in Ballard to the ship canal."** (page 38).

[1] I am not yet clear on the difference between Vashon advance gravel and gravel outwash.