Report for the
Tillamook Bay National Estuary Project

Rocks of the Tillamook Bay Drainage Basin, the Coast Range of Oregon — Sources of Sediment Accumulation in the Bay

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The objective of this report is to review and summarize the nature of the geologic rock formations found within the Tillamook Bay drainage, which is part of the western flank of the Coast Range of Oregon. Our interest in these rocks is that their erosion releases sediments ranging in grain sizes from cobbles to sand, and fine-grained silts and clays. These eroded sediments are transported into the five major rivers that drain the watershed, and eventually are carried into Tillamook Bay. Of particular significance are the compositions of the sediments, as this determines the mineralogies as well as the grain sizes of the sediments delivered to the Bay.

GEOLOGIC FORMATIONS AND THEIR LITHOLOGIES

The **Siletz River Volcanics (Tsr)** are the oldest rocks present in the drainage basin (see the attached geologic map, where the rocks are identified by their symbols). They are early Eocene and have been dated to 50-62 Ma. They consist of aphanitic to porphyritic vessicular pillow flows, tuff breccias, massive lava flows and sills of thoeleiitic alkolic basalt. The upper sequence has numerous interbeds of basltic siltstone, sandstone, tuff, and conglomerate. Most of the series is marine in origin, and has been interpteted as seafloor crust and/or seamounts (Baldwin, 1964; Walker and MacLeod, 1991). Warren et al. (1945) origionally called outcrops east of Tillamook the **Tillamook Volcanics (Ttv)**, but they included both early and late Eocene flows. The older of Warren et al.'s Tillamook Volcanics were later reassigned to the Siletz River Volcanics, and the upper part of the series was assigned to the Goble Volcanics by Baldwin et al. (1955).

The **Yamhill formation (Ty)** is mid-Eocene in age, and consists of massive and thin bedded marine siltstone and thin interbedded arkosic and basaltic sandstone. Locally interbedded basaltic lava flows and lapilli tuff are found (Walker and Macleod, 1991). Few thin limestone concretion zones and sandstone lenses are interbedded with the finer grained clastic rocks. Thicker beds of limestone are present to the south and at the base of the formation (Baldwin, 1964).

Overlying the Yamhill fm is the **Cowlitz formation (Tsd?)**, which is upper Eocene in age. It is a bedded sandstone and siltstone deposit with minor volcanic flows, breccias, and tuffs located in the upper areas of the formation (Baldwin, 1964; Warren et al., 1945; Farr, 1989). These volcanics are refered to as the **Goble Volcanics (Ti)** (Wilkinson, Lowry, and Baldwin, 1946; Avolio, 1973). The upper Tillamook Volcanics were added to this series by Baldwin et al. (1955).

The **Nestucca formation (Tss)** was deposited in the mid to upper Eocene. It is an interbedded siltstone and calcareous sandstone. The sandstone is feldspathic and basaltic, while the siltstone is shaley and tuffaceous (Avolio, 1973; Baldwin, 1964). The northern extent of the formation is not exactly known in the area of Tillamook Bay. It is likely that it is not found within the drainage basin.

The **Keasey formation (Tss)** is a bedded tuffaceous siltstone that was laid down during in the upper Eocene and lower Oligocene. It is marked by occasional ash beds and calcareous concretions. The base of the formation is marked by a pebbley green-gray tuff resting on a dark silty shale. It is debated whether this dark shale is part of the upper Cowlitz formation (Warren Norbiruth, and Grivetti, 1945; Baldwin, 1964).

The **Pittsburgh Bluff formation (Tsd?)** is a massive quartzose sandstone with local minor coal beds. It is mid-Oligocene and has an unconformity with the Keasey fm (Walker and MacLeod, 1991; Baldwin 1964). Similar to the Pittsburgh Bluff fm, the **Scappoose formation (Tsd?)** is upper Oligocene and lower Miocere deposits. They are a tuffaceous and arkosic sandstone and siltstone, and are locally fossiliferous. Minor conglomerate layers are associated with the base of the formation (Walker and MacLeod, 1991; Warren and Norbisrath, 1946; Baldwin, 1964).

On top of the Scappoose fm is the **Astoria formation (Tms)**, which is mid-Miocene. It consists of massive sandstone, shale, and siltstone (Avolio, 1973). There is a marked unconformity in the upper regions of the formation, between the sandstone and shale (Dodds, 1963). The **Columbia River Basalts** interfinger with the upper part of the Astoria fm and are mid-Miocene in age. They are basaltic flows, submarine breccias and pillow lavas (Walker and MacLeod, 1991; Baldwin, 1964).

In addition to the ancient marine and volcanic rocks, the Tillamook Bay drainage basin contains a variety of Quaternary sediments. This includes alluvial deposits of sand, silt, and gravel filling channels and forming the flood plains of present-day streams. They are locally abundant in organic matter, with thin peat beds. There also are similar deposits found above the present flood plains, consisting of unconsolidated deposits of gravel, cobbles and boulders, locally interbedded with clay, silt, and sand. Finally, unstratified mixtures of fragments are derived from adjacent bedrock, including slope wash and colluvium accumulations.

ROCK FORMATIONS AND RIVER DRAINAGES

Important is the distribution of rock types found within the drainages of the principal rivers that flow into Tillamook Bay. It is only through such source differences that the several rivers might transport distinctive sediments, and their relative contributions thereby be identifiable within the sediments accumulating in the Bay. Descriptions are given here of the Tertiary rocks and Quaternary sediments in the river watersheds, based on an inspection of the geological map prepared by Walker and MacLeod (1991).

Miami River

Ti: Oligocene maffic intrusions; sheets, sills, and dikes of massive granophyric ferrogabbro, pegmatic gabbro, ferrogranophyre, and granophyre. This has been dated to 30 Ma.

Tss: Upper/Middle Eocene Tuffaceous siltstone and shale. Marine tuffaceous mudstone and siltstone with local deposits of fine to coarse grained sandstone. Locally carbonaceous, and Micaceous. Consists of the Nestucca fm and Keasey fm.

Ttv: Upper/middle Eocene, Tillamook volcanics; subaerial basaltic flows and breccia and submarine basaltic breccia, pillow lavas, lapilli and augite rich tuff. Interbedded basaltic sandstone, siltstone and conglomerate. Some andesite and dacite. This has been dated to 40-46 Ma.

Kilchis River

Tsd: Upper Eocene/Oligocene sedimentary rocks; Marine shale, siltstone, sandstone, and conglomerate. Local tuffaceous and basaltic debris. Interbedded arkosic and quartzose sandstone.

Ttv: Upper/middle Eocene, Tillamook volcanics; subaerial basaltic flows and breccia and submarine basaltic breccia, pillow lavas, lapilli and augite rich tuff. Interbedded basaltic sandstone, siltstone and conglomerate. Some andesite and dacite. This has been dated to 40-46 Ma.

Ttvm: Maritime facies; Basaltic clastic rocks and pillow lavas.

Tillamook River

Tms: Lower/middle Miocene marine sedimentary rocks; fine to coarse grained marine siltstone and sandstone that commonly contains tuff beds. Contains the Astoria fm, Gnat Creek fm.

Tsd: Oligocene/upper Eocene sedimentary rocks; Marine shale, siltstone, sandstone, and conglomerate. Local tuffaceous and basaltic debris. Interbedded arkosic and quartzose sandstone.

Ttv: Upper/middle Eocene, Tillamook volcanics; subaerial basaltic flows and breccia and submarine basaltic breccia, pillow lavas, lapilli and augite rich tuff. Interbedded basaltic sandstone, siltstone and conglomerate. Some andesite and dacite. This has been dated to 40-46 Ma.

Wilson River

Ti: Oligocene maffic intrusions; sheets, sills, and dikes of massive granophyric ferrogabbro, pegmatitic gabbro, ferrogranophyre, and granophyre. This has been dated to 30 Ma.

Ttv: Upper/middle Eocene, Tillamook volcanics; subaerial basaltic flows and breccia and submarine basaltic breccia, pillow lavas, lapilli and augite rich tuff. Interbedded basaltic sandstone, siltstone and conglomerate. Some andesite and dacite. This has been dated to 40-46 Ma.

Ttvm: Maritime facies; Basaltic clastic rocks and pillow lavas.

Ty: Upper/middle Eocene, Yamhill formation; massive and thin bedded marine siltstone and thin interbeded arkosic and basaltic sandstone. Locally interbedded basaltic lava flows and lapilli tuff.

Tsr: Middle/lower Eocene to Paleocene, Siletz River Volcanics; Aphanitic to porphyritic, vessicular pillow flow, tuff breccias, massive lava flows and sills of tholeiitic and alkalic basalt. Upper sequence has numerous interbeds of basaltic siltstone, sandstone, tuff and conglomerate. Most are marine and have been interpreted as seafloor crust and/or seamounts. This has been dated to 50-62 Ma.

Trask River

Tmst: Middle Miocene/upper Eocene marine sedimentary and tuffaceous rocks. Tuffaceous and arkosic sandstone, locally fossiliferous, tuffaceous siltstone, tuff, glauconitic sandstone, minor conglomerate layers and several thin coal beds. Contains the Scappoose fm.

Ti: Oligocene maffic intrusions; sheets, sills, and dikes of massive granophyric ferrogabbro, pegmatitic gabbro, ferrogranophyre, and granophyre. This has been dated to 30 Ma.

Tss: Upper/Middle Eocene Tuffaceous siltstone and shale. Marine tuffaceous mudstone and siltstone with local deposits of fine to coarse grained sandstone. Locally carbonaceous, and Micaceous. Consists of the Nestucca fm, and Keasey fm.

Tsd: Upper Eocene/Oligocene sedimentary rocks; Marine shale, siltstone, sandstone, and conglomerate. Local tuffaceous and basaltic debris. Interbedded arkosic and quartzose sandstone.

Ttv: Upper/middle Eocene, Tillamook volcanics; subaerial basaltic flows and breccia and submarine basaltic breccia, pillow lavas, lapilli and augite rich tuff. Interbedded basaltic sandstone, siltstone and conglomerate. Some andesite and dacite. This has been dated to 40-46 Ma.

Ttvm: Maritime facies; Basaltic clastic rocks and pillow lavas.

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Tsr: Middle/lower Eocene to Paleocene, Siletz River Volcanics; Aphanitic to porphyritic, vessicular pillow flow, tuff breccias, massive lava flows and sills of tholeiitic and alkalic basalt. Upper sequence has numerous interbeds of basaltic siltstone, sandstone, tuff and conglomerate. Most are marine and have been interpreted as seafloor crust and/or seamounts. Basalts have labradorite, augite, and titaniferous magnetite as major constituents (Avolio 1973). This has been dated to 50-62 Ma.

RIVER SEDIMENTS

Sediments of the rivers reflect the nature of the rock sources within their drainage basins. Kulm et al. (1968) reported on analyses of the heavy-mineral contents of the sand fractions contained within Oregon coast rivers; their results for the five rivers that enter Tillamook Bay are given in Table 1. The non-opaque heavy minerals are limited almost exclusviely to augite and diopside (which are grouped together in heavy-mineral counts). These two minerals account for 92 to 98% of the non-opaque heavy minerals, with titanaugite making up most of the balance at 0 to 6%, with the Trask River containing the most according to the counts of Kulm et al. Several other heavy minerals were noted, Table 1, but only in trace amounts (denoted by T). According to the results of Kulm et al., there are essentially no differences in the heavy-mineral contents of the sand delivered to Tillamook Bay by the five rivers, except for the slightly greater titanaugite content in the Trask River. Their investigation did not analyze the opaque minerals within the river sands, so it is possible that there are differences between the rivers in that mineral component.

TABLE 1: Percentages of non-opaque heavy minerals in rivers draining into Tillamook Bay. The symbol "T" denotes trace amounts of the mineral, less than 1%. [*data from* Kulm et al. (1968)]

MINERAL	RIVER				
	Miami	Kilchis	Wilson	Trask	Tillamook
Hornblende	T		T	T	1
Garnet			T		T
Olivine	T	2	T	1	1
Hypersthene	T				T
Augite/Diopside	97	98	95	92	95
Titanaugite			2	6	1
Zircon			T		

The only subsequent mineralogical analyses of sands transported by the rivers entering Tillamook Bay are those of Glen (1978), undertaken as part of a study of sediments that have accumulated in the Bay. The results are much the same as found by Kulm et al. (1968) in terms of contents of non-opaque heavy minerals. There are distinct differences in the quantities of titanaugite, in that Glenn found the highest content in the Wilson River (17%), a smaller amount in the Kilchis River (6%), and none in the other rivers. Glen included "rock fragments" in the heavy-mineral counts, grains that consist of augite/diopside or an opaque heavy mineral, together with some feldspar. The percentages of rock fragments were highest in the Miami River (up to 34%), and generally decreased in the series of rivers from north to south, reaching a low of 9 to 12% in the Trask River and 15 to 16% in the Tillamook River.

The mineralogy of the river sediments is what one would expect to be derived from erosion of rocks found in these watersheds. Snavely, Wagner and MacLeod (1965) noted that titaninferous augite is common in the basalt flows and breccias of the Oregon Coast Range, and Kulm et al. (1968) concluded that basic igneous rocks (principally basalt) and marine sedimentary rocks, derived from the weathering and erosion of basic igneous rocks, appear to be the source of the augite/diopside minerals found in the rivers. While there is general agreement between the rock types found in the Tillamook Bay drainages and the mineralogies of the river sediments, there has not been sufficient study to establish whether differences exist between the five major rivers and their drainages, differences that permit the tracing of sediments contributed by the individual rivers.

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