THE GEOLOGICAL HISTORY OF MT. TABOR PARK

MT. TABOR VOLCANO

Basaltic cinder from Mt. Tabor Volcano- We have a collection of rocks at the Visitor Center where visitors can see differences in form, composition, and texture of the samples.

Around 200,000 years ago, It was Mt. Tabor's turn. Only this time the magma didn't initially reach the surface. Rather, the upwelling magma pooled underneath the Troutdale Formation uplifting an enormous section of earth into the air! Viola! Mt. Tabor is formed. The magma also pooled to the north of Mt. Tabor forming a bench-like uplift that extends to the north of Belmont and Thorburn Streets. However, at Mt. Tabor, the magma eventually breached the surface on the west side of the mountain (where the amphitheater is located), probably exploiting local fractures, and erupted cinders, lava, and ash. This material collected around the vent forming a small cinder cone, the remnants of which can be seen on the west wall of the amphitheater. WPA workers excavated and removed the eastern part of the cinder cone in the 1930's for roads, paths, and walls around the park. The west wall reveals the complex intermixed layers resulting from the eruptions.

Because the volcanic activity pushed up a portion of the Portland basin, Troutdale Formation sediment now makes up most of the surface of Mt. Tabor. Subsequent erosion exposed the river cobblestones that can be seen to this day in many places on Mt. Tabor. Some of the cobblestones are quite beautiful, with several color variations of white, black, red, and buff. Visitors will see that the cobblestones are embedded in the soil of the hill like berries in a mold of gelatin. These cobblestones were transported by the ancestral Columbia River from their original emplacements as far away as Idaho and Montana to then be deposited in the Portland Basin as the Troutdale Formation.

During the volcanic eruptions at Mt. Tabor, basaltic magma was pushed to the surface and, depending on the amount of water and gas in the molten mix, contact with the atmosphere created moderately large "blobs" of partially molten rock or small ashy particles that then fell and became part of the cinder cone. The blobs retained a fair amount of heat when they landed and therefore fused with other blobs forming an agglutinate of black, basaltic material. Basaltic cinder therefore contains lots of air bubbles, making it rough in texture and friable (easily broken apart).

The presence of water during some basaltic eruptions caused the formation of different-colored cinders. Reddish-colored cinders, called **scoria**, which are commonly used as landscape rock, come from oxidation of iron-bearing minerals during eruption. Yellowish-colored cinders, from even greater oxidation of iron, are called **palagonite**. Martian dust has a spectral quality similar to palagonite and this signature is often cited as evidence of water on Mars. Some of these colored cinder layers are visible in the west wall of the cinder cone at Mt. Tabor (see front photograph).

MISSOULA FLOODS

Mt Tabor's geology was also affected by events in the Pleistocene era, a bizarre age of oversized glaciers and oversized fauna. Near its end (about 18,000-15,000 years ago), oversized floods helped sculpt a large swath of the Pacific Northwest, including the Portland area (Bishop, 2003). A prominent example was In Northwest Montana, where a glacier dammed a 2500 ft. deep river canyon creating a huge lake behind it, estimated to be the size of present-day Lake Ontario and Lake Erie combined.

Inevitably, the ice dam broke, releasing catastrophic amounts of water and unleashing some of the largest recognized floods in the world. Water rushed across eastern Washington, carving what is now known as the "channeled scablands" before eventually funneling into the Columbia River. Geologists estimate that the entire Columbia Gorge was filled to over flowing including rushing over the top of Crown Point. The top of Mt. Tabor probably rose slightly above the highest flood event. The floodwaters transformed the Willamette Valley into a temporary lake 60 miles across and 100 miles long. As the water emptied into the Pacific Ocean, ice-rafted rocks of granite and metamorphic rock originally picked up in Canada were deposited throughout the Valley (and perhaps even at Mt. Tabor), exotic foreigners to the native basaltic rock (Bishop, 2003). This type of catastrophic event is thought to have occurred about 90 times between ~18,000 and 15,000 years ago, though perhaps only 40 or so floods reached the Portland area.

Further reading; Bishop, E.M., 2003, "In Search of Ancient Oregon", Timber Press, Portland Oregon.

Thank you to our neighbors at Mt. Tabor Realty and Friends of Mt. Tabor Park for underwriting the printing of this brochure.

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GEOLOGY OF MT. TABOR

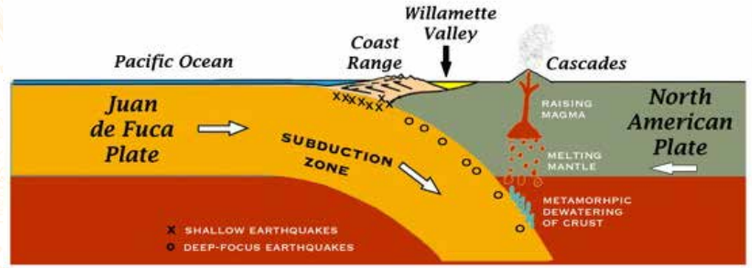
TECTONIC SETTING

Earth's mantle, the molten rock below Earth's crust, is just a few dozen kilometers beneath your feet, and it's extremely hot (700 to 1,200 °C or 1,300 to 2,200 °F). The high temperature causes rock to melt and the resulting liquid, or semi-liquid, called **magma**, collects in chambers beneath Earth's surface. More buoyant than the surrounding rock, magma tends to make its way up through weaknesses in the rock until it reaches the surface where it can be released as an eruption (i.e., a volcano).

Eruptions are commonly fed by a vertical conduit, a pipe-like structure that allows the magma to move upward. The intense energy resulting from concentrated magma in such confined spaces often results in explosive effects at the surface. With each eruption—and there were thousands—layer upon layer of lava, ash, and other eruptive products accumulated around the conduit, eventually creating huge cone-shaped mountains (**cinder cones**). These are called **stratovolcanoes**. Most of our familiar volcanoes of the Cascade Range, such as Mt. Hood, Mt. Adams, Mt. Jefferson, and Mt. St. Helens, are stratovolcanoes.

The volcano at Mt. Tabor Park, however, is not a stratovolcano; it lacks the vertical conduit. Instead, magma reached the surface in a more diffuse manner, through cracks and fractures in Earth's crust. Earth's thin outer crust is broken into very large pieces (thousands of square miles; e.g., the North American plate) called **tectonic plates**. The plates fit together like a puzzle, but they're not stationary—they shift significantly over time. They can be thought of as floating on Earth's mantle. Where they meet, plates collide with one another with such force that their edges can buckle, creating mountain ranges. For example, the highest mountain range above sea level, the Himalayas, was formed 55 million years ago when the Eurasian and Indo-Australian continental plates collided.

The plates can also move on top of each other, a process called **subduction**. The subducted plate is pushed downward (~75-200 kilometers) into the mantle where it melts and becomes magma.



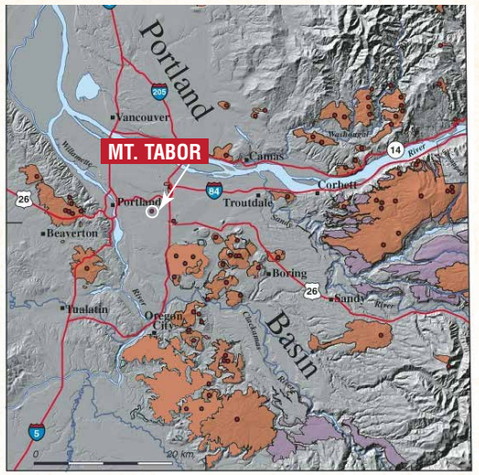
In the Pacific Northwest, the oceanic Juan de Fuca tectonic plate sinks beneath the overriding North American plate. Melt pockets created from the subduction of the Juan de Fuca plate were initially small but eventually coalesced into larger magma chambers. This allowed the magma to rise from great depths, and if it broke the surface, viscous lava erupted (the term **lava** is used for the solidified rock formed by the cooling of the magma). Thus the subduction of the Juan de Fuca plate is a significant source of magma in the Pacific Northwest.

Portland Basin and the Troutdale Formation

About 16 millions years ago, extensive volcanic activity east of Portland produced vast and fiery eruptions of basalt that moved down the ancestral Columbia River Valley to the Portland area and to the sea. Basalt is the most common volcanic rock on Earth (basically solidified lava) and because of its low silica content, basalt lava forms thin flows that can travel long distances. Remnants of these ancient basaltic lava flows, which can sometimes appear as columnar rock formations, can be observed as one drives through the Columbia River Gorge. These eruptions essentially filled the Columbia River Valley, but the river quickly reestablished itself and eroded a new valley. The river had sufficient power to carry gravel and cobblestones downstream and deposit them in a widening basin where Portland is now located. These sediments are called the Troutdale Formation and they generally consist of sand and basalt cobblestones. The Troutdale Formation underlies much of the Portland basin, extending south into the Tualatin Valley and north into Clark County, Washington. The Portland Hills on the west side of the basin caused Columbia River sediments to accumulate in the basin (in some cases to a depth of 1800 feet near Vancouver, WA).

Boring Lava Field

A restless magma mantle lay below the Troutdale sediments and because sediment layers were heavily fractured, lava erupted in multiple places. The underlying magma was therefore not as concentrated in one place as it was with the stratovolcanoes, but was instead dispersed over numerous eruptive centers, or volcanic vents, with less potential to build up significant pressure. As a result, the volcanoes were smaller and less productive than their larger stratovolcano cousins in the "High Cascades". In the Portland area these smaller volcanoes are referred to as the Boring Lava Field because there are numerous volcanic vents around the town of Boring, Oregon.



The Portland Basin showing the Boring Lava Field (Boring volcanic products shaded in orange and blue, vents are red circles, and Cascade-arc volcanic products in purple).

Gases, molten rock, lava, and rocks erupted from these vents and, over time, the accumulated rock and lava formed hills and small mountains. In the area around Boring Oregon there are at least 80 vents, suggesting that at one time, numerous fractures in Earth's crust existed there. This collection of vents created the familiar peaks of Mt. Scott, Mt. Sylvania, Larch Mountain, Rocky Butte, Kelly Butte, Mt. Tabor, and many others. The individual vents are considered extinct, although a new volcano could potentially erupt again some day.

The earliest eruptions within the Boring Volcanic Field occurred in the southern part of the Portland Basin, south of present day Oregon City, around 2.5 million years ago. The eruptions then progressed north, and by 1 million years ago, volcanic activity had spread to all of the areas where we see Boring volcanoes today. Beacon Rock, which erupted 57,000 years ago, is the youngest volcano in the Boring Volcanic Field. All that's left is the central core of the cinder cone, as the cinders that once surrounded it were stripped away by the Missoula Floods about 15,000 years ago.