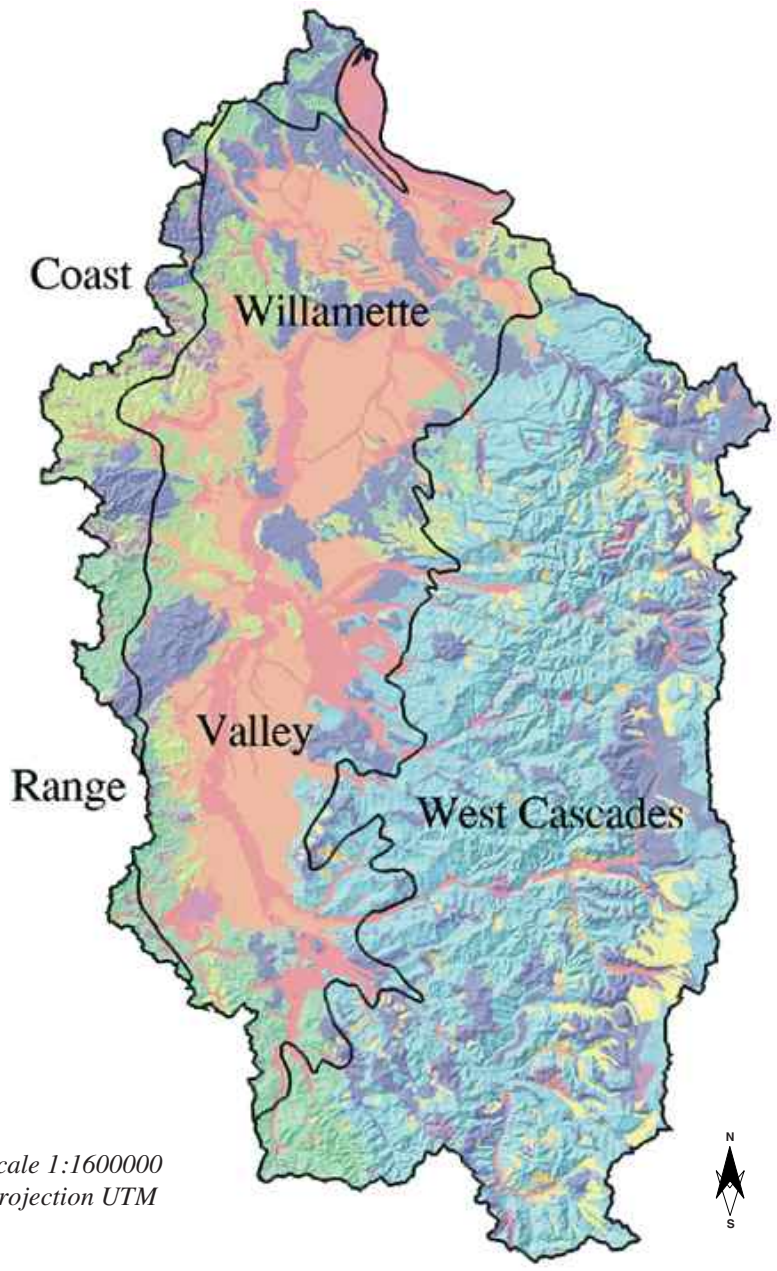

Figure 7. *Physiographic provinces and major lithological types of the WRB.*

Figure 8. *Geologic formations contained in each lithological group.*[27] *Map 1 on the facing page depicts geological formations identified by map symbols, more fully described in the Appendix. At left these formations are reclassified by major lithological groups. The legend below identifies the formations contained in each lithological group.*

- Outwash: OW
- Calc-Alkaline intrusive rocks: KJg
- Alkalic bodies: Tia
- Mafic pyroclastics: QTmv, QTp, Tp, QTib, Tba, Tc, Ttv, Tps, Ttvm, Qyb, Tcg, Tcw, Tfeb, QTa, QTb, QTba, Tob, Trb, Tsr
- Mixed eugeosynclinal rocks: Tfee
- Siltstone: Ty, Tmst, Tfe, Tcss, Tco, Ts, Tsd
- Shale and mudstone: QTs, Tss
- Lake sediments: Qs
- Mafic intrusive rocks: Thi, Ti, Tib, Tmv, Tvi, Tim
- Mafic volcanic flows: Tub
- Calc-Alkaline volcanic rocks: Tu, Tus, Tut
- Felsic volcanic flows: Qrd, Qba, Tbaa, Tfc, Qa, Tsv
- Sandstone: Tsm, Tt
- Glacial drift: Qg
- Landslide: Qls
- Alluvium: QTg, Qt, Qal, Qgf, Qgs

Origins and Development of the Basin

We can begin the geologic story of the Willamette River Basin (WRB) in the Oligocene epoch roughly 35 million years ago (mya). During this time a line of sea floor subduction, which had run in a northeast direction from west of the Klamath Mountains to the Blue Mountains, moved to its current position several hundred miles to the west on its northern end. This change left a slab of what had been subducting sea floor attached to the continental margin and also moved the line of volcanic activity associated with remelting oceanic crust. Part of this orphaned slab, still covered by shallow seas, ultimately became the floor of the WRB. Although volcanic eruptions had started building the southern Cascade Mountains millions of years earlier in the Eocene, the northern Cascades lie on top of the slab and arose as volcanoes erupted through the slab in a line determined by the new orientation of the subduction zone. The eastern edge of the present-day valley near Eugene contains volcanic rocks from the Eocene eruptions, indicating that the old western Cascades were located near there. Farther to the north, volcanic rocks in the western Cascades date from two principal periods of volcanic activity, one occurring 20 to 30 mya, and another in the Miocene 10 to 15 mya, both of which included the entire length of the Cascades.

The Coast Range arose as continental sediments carried eastward by the subducting oceanic plate were forced under the western edge of the slab pushing it upward. The rise proceeded from south to north, the northern Coast Range not appearing until roughly 15 mya. During this process the area of the future Willamette Valley also rose, becoming dry land and draining its embayment by about 20 mya. Although the direction of sea floor spreading is south-eastward toward the Oregon coast, the entire Pacific plate, including the spreading and subduction zones, is moving northward. The net affect for the Oregon Coast Range appears to be a slow movement north, evidence for which may be seen in the roughly 50 mile northward offset of the Columbia River at Portland and the sharply curved Olympic Mountains in western Washington state, where movement of the Coast Range encountered the more deeply rooted Vancouver Island. This northward tearing of the Coast Range may also have contributed to the formation of the Willamette Valley, the floor of which is now composed of multiple fault blocks. In contrast to its south end, the valley is spreading more in the north possibly due to the thinner crust and reduced linkage with the subducting seafloor present there. Eugene marks the probable northern extent of the now buried Klamath Mountains, providing an older and deeper crust there than in the north and altering geomorphic response to tectonic processes affecting the Coast Range. The southern end of the WRB is defined by a northwest trending fault, south of which the Coast Range and the foothills of the Cascade Mountains are joined.[28]

Recent Geologic Events

Defining the northern limit of the WRB, the Columbia River has reestablished its course through multiple dammings by slides, basalt flows, and ice. Reaching their maximum 13 mya, basalt floods from the enormous Grande Ronde volcano in northeast Oregon flowed down the Columbia channel all the way to the river's mouth and into the Willamette Valley. In the Pliocene (3 to 11 mya), western Oregon was a desert and gravels produced during that time eroded into and covered the spreading valley floor. Work performed by J. Harlan Bretz[29] in the 1920s revealed that between 15,500 and 13,000 years ago ice periodically dammed the Clark Fork in Idaho east of Spokane, Washington, forming a lake in the present-day Missoula Valley of Montana covering some 3100 square miles (8000 km^2) and containing 500 cubic miles (2000 km^3) of water. In a typical release occurring over less than two weeks, a quantity of water equal to half the present volume of Lake Michigan, more than the modern annual volume of all the world's rivers, poured down the Columbia channel.[30] Backwater from these floods carried ice-rafted "erratic" rocks from Montana repeatedly into the Willamette Valley, filling it to about 400 ft (122 m) above current sea level.[31] The sediments left by these floods form much of the present valley floor.

Map 1. Geological Formations [27]