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VOLCANO HAZARDS FACT SHEET

U.S. DEPARTMENT OF THE INTERIOR
U.S. Geological Survey

EVOLUTION OF SEDIMENT YIELD FROM MOUNT ST. HELENS, WASHINGTON, 1980-93

The most enduring geological consequence of the eruption of Mount St. Helens, Washington, on May 18, 1980, and the most costly single element in the recovery effort, has been the persistent downstream sedimentation caused by erosion of the approximately 3 cubic kilometers (km^3) of sediment deposited on the landscape surrounding the volcano. Most of the sediment was associated with the emplacement of a 2.8 km^3 debris avalanche in the upper part of the watershed of the North Fork Toutle River, and debris flows in the channels of the South Fork Toutle River, Pine Creek, Swift Creek, and Muddy River. An additional 0.2 to 0.3 km^3 of volcanic material was emplaced by pyroclastic flows, blasts, and ash fall. Part of this vast quantity of volcaniclastic sediment has been subsequently eroded by runoff and streamflow. This brief report summarizes the changes in sediment yield at five locations around Mount St. Helens in the first 13 years following the May 18, 1980, eruption.

DATA-COLLECTION SITES

Shortly after the eruption on May 18, 1980, a network of stream-gaging stations was established on the major streams and rivers draining Mount St. Helens. Some stations were discontinued after a few years, but at five sites, continuous daily discharge and suspended-sediment measurements are still being made (fig. 1). Operation of the five gaging stations continues because they include sites that were affected by different kinds of volcanic activity and provide information on long-term response to different volcanic disruptions. At two stations on the Toutle River, water and sediment data are collected below the debris avalanche – at Kid Valley about 17 km downstream from the avalanche toe, and at Tower Road about 40 km downstream. Kid Valley data include suspended sediment from the Green River, and the Tower Road site includes data from the North and South Forks Toutle River. Green River is tributary to the North Fork Toutle River, and was disrupted in the upper two-thirds of its basin by tree blow-down and the deposition of blast deposits and 5-10 cm of tephra. Gages on the South Fork Toutle River and Muddy River, which drain the south and west sides of Mount St. Helens, monitor streams affected by pyroclastic flows in their headwaters and by large volcanic debris flows.

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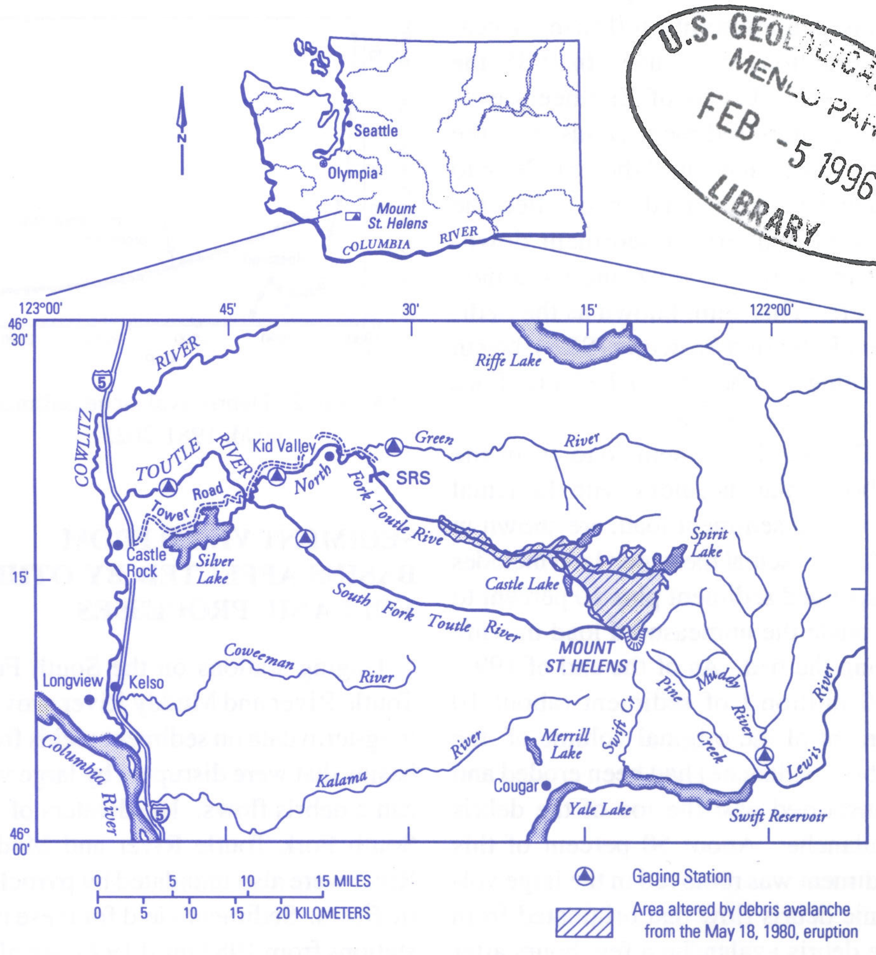

FIGURE 1. Map of the Mount St. Helens area.

SEDIMENT YIELD FROM DEBRIS AVALANCHE

The catastrophic debris avalanche that was deposited in the upper North Fork Toutle River valley involved 2.8 km^3 of volcaniclastic sediment that subsequently became available to be eroded and transported downvalley. The debris avalanche covers 60 km^2 of the valley of the upper North Fork Toutle River to an average depth of 45 meters. Although the debris avalanche contains house-sized blocks of the original volcano, median particle size is coarse sand and fine gravel. Measured suspended-sediment downstream from the debris avalanche during the first several years following the main eruption was as high as 70,000 tonnes (t) per square kilometer. This is one of the largest sediment yields ever measured in the United States and among the largest in the world. Data on the percentage of new deposits that has been eroded during the period of landscape instability following volcanic eruptions are sparse. In 1985, the U.S. Army Corps of Engineers estimated future sediment yields from the debris avalanche until the year 2025 to aid in the design of a dam to collect the prevent delivery of sediment downstream to the Cowlitz and Columbia Rivers. This dam, known as the Sediment Retention Structure (SRS), began trapping sediment from the North Fork Toutle River in 1987.

Projected sediment load from the debris avalanche, along with the actual measured sediment load, are shown in figure 2. Actual measured load includes suspended sediment plus 10 percent to estimate the unmeasured load moving along the bed. As of the end of 1993, 410 million t of sediment (about 10 percent of the original volume of the debris avalanche) had been eroded and transported past the toe of the debris avalanche. About 50 percent of this sediment was removed in the large volcanic debris flow that originated from the debris avalanche a few hours after emplacement and flowed all the way to the Columbia River on May 18-19, 1980. A much greater percentage of the debris avalanche deposit has been reworked, but because the deposit accumulated in a wide, low-gradient glacial valley, much eroded sediment has yet to be transported past the toe and has been temporarily stored in closed depressions, valley flats, and alluvial fans. The lack of large, intense storms in the area since 1980 has further inhibited sediment yield.

In 1993, sediment eroded from the debris avalanche was only 3.2 million t, or 4,350 t/km^2, far less than the 22.3 million t projected in 1985. Nevertheless, 1993 sediment yield values are about ten times estimated pre-eruption values, and are similar to sediment yields from watersheds affected by other kinds of major disturbances, such as strip mining.

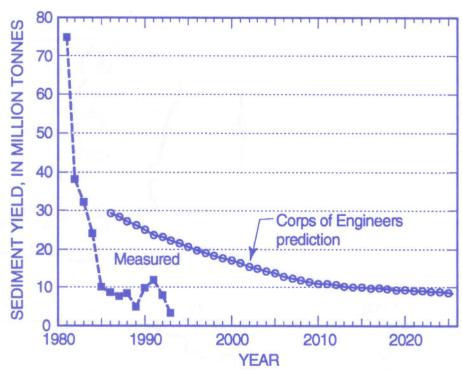

FIGURE 2. Debris avalanche sediment yield, 1981-2025.

SEDIMENT YIELD FROM BASINS AFFECTED BY OTHER VOLCANIC PROCESSES

Gaging stations on the South Fork Toutle River and Muddy River provide long-term data on sediment yields from basins that were disrupted by large volcanic debris flows. Headwaters of the South Fork Toutle River and Muddy River were also inundated by pyroclastic flows. Sediment yield for these two stations from 1982 until 1993, are plotted in figure 3. In 1993, sediment eroded from these stations was 1,640 and 930 t/km^2 respectively, substantially less than the sediment yield from the debris avalanche-affected North Fork Toutle River. The Green River was affected only by blast and airfall deposits on slopes and floodplains.

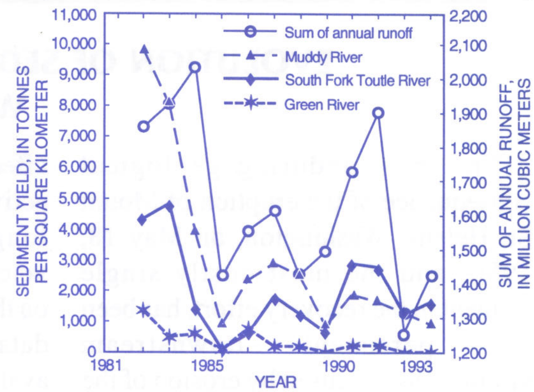

FIGURE 3. Sediment yield and sum of annual runoff for three volcanically disrupted watersheds.

Hillslopes in the basin ceased to be significant sources of sediment within three years of the eruption. Sediment yield in 1993 was only 19 t/km^2, a value typical of natural, undisturbed forested basins. Significant sediment sources remain for the debris-flow affected basins, including pre-1980 volcaniclastic sediment in headwaters and 1980 debris flow deposits on downstream valley floors. Suspended-sediment yields in all monitored streams have decreased since 1980, and fluctuate in response to annual runoff (fig. 3). Revegetation and natural armoring of channels and floodplains have reduced sediment yields at all sites so that present sediment yield ranges from 1 to 10 times natural background levels.

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