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Radiocarbon Dates from Volcanic Deposits
at Mount St. Helens, Washington

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Stratigraphic studies of the eruptive products of Mount St. Helens volcano, supported by radiocarbon dates, were begun in the late 1950's (Crandell and others, 1962; Mullineaux and Crandell, 1962). More detailed studies were begun by Jack H. Hyde in 1968 (Hyde, 1970, 1973, 1975) and were expanded by Crandell and Mullineaux between 1970 and the present. Age determinations in the radiocarbon laboratory of the U.S. Geological Survey in Reston, Va., on organic matter incorporated in the volcanic products, permitted the volcano's eruptive events to be arranged chronologically (table 1). These radiocarbon dates have contributed immeasurably to an understanding of the volcano's history and potential hazards (Crandell and Mullineaux, 1978), and through long-range tephrochronology have also aided in the solution of other geologic problems in the Pacific Northwest such as dating the last scabland flood in eastern Washington (Mullineaux and others, 1978).

Some of the 65 radiocarbon dates listed here have been published previously, but nowhere have they all been assembled in a single place. Because of widespread interest in the past history of the volcano as a result of the eruptions that began in 1980, and to make these dates readily available to future workers, we prepared this compilation of U.S. Geological Survey radiocarbon dates of the last decade, and selected earlier ones, that pertain to Mount St. Helens.

In order to cover uncertainties beyond counting errors, these dates were all initially reported with a plus and minus approximately three times greater than the one-sigma statistical counting error (one standard deviation) now in conventional use, and they were so cited in previous publications. In this compilation they are reported with the conventional one-sigma error. As a result, the radiocarbon ages of several samples conflict with their stratigraphic positions.

Many of the outcrops from which the samples were obtained were buried by products of the May 18, 1980, eruption of Mount St. Helens. These outcrops are located according to preeruption conditions and are identified by asterisks. Nearly all sample locations reported here can be found on the U.S. Geological Survey 1:100,000-scale topographic map of Mount St. Helens and vicinity, published in April 1980.

Radiocarbon dates that appear opposite the following sample numbers are based on the conventional half life of 5568 years and are reported in years before A.D. 1950. Dates of less than 3500 years are corrected in the accompanying text by means of the tree-ring calibration curve of Suess (1970), unless the calibration curve of Stuiver (1978) is specified. These calibrations show that organic materials of more than one calendar date can produce the same radiocarbon age, and these alternative calendar dates are given in this report. Sample activities have not been corrected by a ^{13}C measurement for possible isotope fractionation.

Table 1.--Summary of eruptive history of Mount St. Helens
[d, dacite; a, andesite; b, basalt]

Eruptive period	Approximate age, years before 1950 ¹	Tephra ² unit	Other eruptive products
Goat Rocks	150-100	{ T (d)	Dome (d) Lava flow (a)
Dormant interval of about 200 years ²			
Kalama	500-350	{ X (a) W (d)	Pyroclastic flows (d) Dome (d) Pyroclastic flows (a) Lava flows (a)
			Pyroclastic flows (d)
Dormant interval of about 650 years			
Sugar Bowl	1150	{	Dome (d), pyroclastic flows (d), deposits of lateral blast (d)
Dormant interval of about 550 years			
Castle Creek	2,200-1,700	{ Bu (b) Bi (d) Bo (a) Bh (a)	Lava flows (b)
			Pyroclastic flow (a), lava flow (a)
			Lava flow (b) Pyroclastic flow (d)
			Lava flow (a)
Dormant interval of about 300 years			
Pine Creek	3,000-2,500	P (d)	Pyroclastic flows (d)
Dormant interval of about 300 years			
Smith Creek	4,000-3,300	Y (d)	Pyroclastic flows (d)
Dormant interval of >4,000 years			
Swift Creek	13,000->8,000	{ J (d) S (d)	Pyroclastic flows (d)
			Pyroclastic flows (d)
Dormant interval of about 5,000 years			
Cougar	21,000-18,000	{ K (d) M (d)	Pyroclastic flows (d)
			Pyroclastic flows (d)
Dormant interval of about 15,000 years			
Ape Canyon	~40,000(?)~35,000	C (d)	Pyroclastic flows (d)

¹Ages of Goat Rocks and Kalama periods are in calendar years; ages of older periods are in radiocarbon years.

²Dormant intervals are intervals during which no unequivocal eruptive products from Mount St. Helens are presently recognized.

Samples from deposits of the Kalama eruptive period and
of post-Kalama age

W-3993

Modern

Wood from a log within a lahar of dacitic rock debris derived from the pre-1980 summit dome of the volcano, exposed in a gravel pit on the north side of South Fork Toutle River valley about 10.7 km west-northwest of the pre-1980 summit of the volcano* (SE 1/4 NW 1/4 sec. 32, T. 8 N., R. 5 E.; lat 46°08' N.; long 122°13' W.). Lahar deposits at this location were thought to have been formed during emplacement of the summit dome more than 300 years ago, but the radiocarbon date indicates they may be younger.

W-3260

< 200

Wood from a log in a lahar about 3 m above water level in the west bank of Smith Creek about 10.3 km east-southeast of the pre-1980 summit of the volcano* (NW 1/4 NW 1/4 sec. 15, T. 8 N., R. 6 E., lat 46°10' N., long 122°05' W.). The lahar is part of a fan of dacitic rock debris derived chiefly from the summit dome of the volcano (see W-3150) and is believed to be more than 300 years old. The anomalously young date probably represents a sampling error.

W-3986

240±60

Charred wood fragments immediately beneath tephra set W exposed in a roadcut about 6 km northeast of the pre-1980 summit of the volcano (NW 1/4 sec. 26, T. 9 N., R. 5 E.; lat 46°14' N., long 122°09' W.). The corrected date (Stuiver, 1978) is about A.D. 1650. The sample should date the initial eruption of tephra set W. Tree-ring data, however, indicate that this tephra was erupted before about A.D. 1525 (Crandell, 1971, p. 12); thus, the radiocarbon age is anomalously young.

W-3991

275±60

Charcoal from the outermost part of a log in the deposit of a hot lahar(?) exposed in the south bank of the North Fork Toutle River near Spirit Lake Lodge, 7.3 km north of the pre-1980 summit of the volcano* (SE 1/4 NE 1/4 sec. 16, T. 9 N., R. 5 E.; lat 46°15' N., long 122°10' W.). The deposit postdates tephra layer Wn, and trees as much as 330 years old were growing on the deposit in the late 1950's (Mullineaux and Crandell, 1962). The corrected date determined from the calibration curve of Stuiver (1978) is either about A.D. 1640 or 1540. The lahar(?) probably was caused by a pyroclastic flow of scoriaceous pyroxene andesite that melted snow on the north flank of Mount St. Helens.

W-3995

290±70

Charcoal from a pumiceous pyroclastic-flow deposit exposed in a gravel pit in the Kalama River valley 12 km southwest of the pre-1980 summit of the volcano (NW 1/4 sec. 33, T. 8 N., R. 4 E.; lat 46°08' N., long 122°19' W.). The sample was collected from the outermost part of a charcoal log. The deposit contains abundant hypersthene-hornblende pumice similar to that in tephra set W, and overlies a pyroclastic-flow deposit in which pumice is less abundant (W-2403, 610±50). The corrected date from the calibration curve of Stuiver (1978) is about A.D. 1620 or 1540. The pyroclastic flow probably originated during explosive eruptions of tephra set W.

W-3150

350±60

Charcoal from a pumiceous pyroclastic-flow deposit exposed in a roadcut in the Castle Creek valley 6 km northwest of the pre-1980 summit of the volcano* (SW 1/4 NE 1/4 sec. 25, T. 9 N., R. 4 E.; lat 46°14' N., long 122°15' W.). The deposit overlies a lahar that contains dacitic rock debris from the pre-1980 summit dome of the volcano, and predates trees that started to grow before A.D. 1670. The corrected date from the calibration curve of Stuiver (1978) is about A.D. 1620 or 1600. The pyroclastic flow probably was caused by an explosive eruption of pumiceous hypersthene-hornblende-augite dacite.

W-2874

460±60

Charcoal from the deposit of a hot lahar(?) exposed in the south bank of North Fork Toutle River near Spirit Lake Lodge* (see W-3991, 275±60). The corrected date is about A.D. 1420. This date conflicts with that of W-3991 and is believed to be somewhat too old.

W-2989

510±50

Charcoal from a log in a lithic pyroclastic-flow deposit exposed upslope from a quarry 8 km southwest of the pre-1980 summit of the volcano (NW 1/4 NE 1/4 sec. 26, T. 8 N., R. 4 E.; lat 46°10' N., long 122°16' W.). The corrected date is about A.D. 1490. The deposit is thought to postdate tephra set W, and thus the date conflicts with W-3986, W-3991, and W-3995. The pyroclastic flow probably was caused by the collapse of part of a dome of hypersthene-hornblende dacite as it was being extruded high on the west flank of the volcano.

W-2403

610±50

Charcoal from a lithic pyroclastic-flow deposit exposed in a gravel pit in the Kalama River valley (same location as W-3995, 290±70 years). The deposit contains a minor amount of hypersthene-hornblende pumice that resembles pumice of tephra set W and is overlain by a pyroclastic-flow deposit in which similar pumice is abundant (W-3995). The corrected date is about A.D. 1320, but the deposit is believed to be no older than tephra set W and probably is the same age as the overlying pyroclastic-flow deposit (W-3991, 275±60).

W-3263

700±60

Wood from a lahar exposed in the north bank of the South Fork Toutle River about 18.3 km west-northwest of the pre-1980 summit of the volcano* (SW 1/4 SW 1/4 sec. 27, T. 9 N., R. 3 E.; lat 46°14' N., long 122° 25' W.). The lahar contains no evidence that it was caused by volcanic activity, and no other evidence of volcanism about 700 years ago has been recognized at Mount St. Helens.

Samples from deposits of the Sugar Bowl eruptive period

W-2993 1150±60
Charred wood within explosion rubble ("basal coarse bed of set W" of Mullineaux, Hyde, and Rubin, 1975) beneath tephra set W exposed in a roadcut about 6 km northeast of the pre-1980 summit of the volcano (lat 46°14' N., long 122°09' W.) (same location as sample W-3986, 240±60). The corrected date is between about A.D. 870 and 700 (also see sample W-3138, 1410±70). The sample dates an explosive lateral blast associated with the extrusion of the Sugar Bowl dacite dome on the north flank of the volcano.

W-3138 1410±70
Wood from immediately below explosion rubble beneath tephra set W exposed in a roadcut about 4.2 km northeast of the pre-1980 summit of the volcano (SE 1/4 SE 1/4 sec. 27, T. 9 N., R. 5 E.; lat 46°14' N., long 122°09' W.) The corrected date is about A.D. 600 (also see sample W-2993, 1150±60). The sample provides an older limit for the age of the explosion rubble.

Samples from deposits of the Castle Creek eruptive period

W-2990 1620±50
Charred wood immediately above tephra layer Bu exposed in a roadcut about 7 km north of the pre-1980 summit of the volcano* (SW 1/4 NE 1/4 sec. 16, T. 9 N., R. 5 E.; lat 46°16' N., long 122°11' W.). The corrected date is between about A.D. 400 and 430 and provides a younger limit for the age of layer Bu (see W-2527, below).

W-2527 1740±70
Charcoal from between tephra layers Bo and Bu exposed in a roadcut about 6 km southeast of the pre-1980 summit of the volcano (NE 1/4 sec. 26, T. 8 N., R. 6 E.; lat 46°08' N., long 122°09' W.). The deposit overlies a pyroclastic-flow deposit (see W-2529, 2580±60) and underlies tephra set W. The corrected date is about A.D. 270. Tephra layer Bo resulted from mildly explosive eruptions of scoriaceous olivine-pyroxene andesite, and layer Bu from similar eruptions of olivine basalt. This sample provides an older limiting age for layer Bu and a younger limiting age for layer Bo.

W-2924 1780±60
Peat from directly above tephra layer I in a peat bog about 20 km east of the pre-1980 summit of the volcano (SE 1/4 sec. 33, T. 9 N., R. 7 E.; lat 46°13' N., long 121°56' W.). The corrected date is between about A.D. 150 and 250. This date and that for sample W-2925 (see below) bracket the age of the tephra layer between A.D. 100 and 250.

W-2925 1850±60
Peat from directly below tephra layer I in a peat bog (same location as sample W-2924). The corrected date is about A.D. 100.

W-2277 1860±70
Charcoal from tree roots beneath the Cave Basalt lava flow within the Lake Cave lava tube (Greeley and Hyde, 1972, p. 2399) (sec. 17, T. 7 N., R. 5 E.; lat 46°06' N., long 122°13' W.). The corrected date is about A.D. 100.

W-2977

2060±50

Charcoal from a pumiceous pyroclastic-flow deposit exposed near the top of the canyon wall of the South Fork Toutle River about 4 km northwest of the pre-1980 summit of the volcano (NW 1/4 SW 1/4 sec. 31, T. 9 N., R. 5 E.; lat 46°13' N., long 122°15' W.). The deposit underlies a lava flow of pyroxene andesite and overlies much older laharcic and pyroclastic-flow deposits. The corrected date is either about A.D. 50 or 70 B.C. The deposit probably resulted from a small-volume explosive eruption of hypersthene dacite.

W-2978

2100±50

Charcoal from a pumiceous pyroclastic-flow deposit exposed on the west side of the Studebaker Creek valley 3.5 km northwest of the pre-1980 summit of the volcano* (SE 1/4 NE 1/4 sec. 31, T. 9 N., R. 5 E.; lat 46°13' N., long 122°14' W.). The deposit is stratigraphically older than a basalt lava flow that crops out a few hundred meters upvalley, and the deposit underlies tephra of set W. The corrected date is about 140 B.C. The pyroclastic-flow deposit probably is correlative with deposits from which samples W-2977 and W-2923 (see below) came, and all these deposits probably resulted from one or more small-volume eruptions of hypersthene dacite pumice.

W-2923

2200±60

Charcoal from a pumiceous pyroclastic-flow deposit exposed in a roadcut through a low terrace adjacent to Castle Creek about 8 km northwest of the pre-1980 summit of the volcano* (NW 1/4 sec. 24, T. 9 N., R. 4 E.; lat 46°15' N., long 122°15' W.). The deposit is underlain by hypersthene-augite andesite scoria of layer Bh and a pyroxene andesite lava flow; it is overlain by lahars. The corrected date is either about 240, 300, or 420 B.C. The deposit probably resulted from a small-volume explosive eruption of hypersthene dacite pumice, and probably is nearly contemporaneous with the pyroclastic-flow deposit represented by samples W-2977 and W-2978.

W-2872

2220±50

Same sample as W-2923.

W-2436

2200±60

Charcoal from a lenticular bed of fluvially transported pumice gravel exposed in a roadcut on the north side of the Kalama River valley about 36 km west-southwest of the pre-1980 summit of the volcano (sec. 31, T. 7 N., R. 2 E.; lat 46°06' N., long 122°36' W.). A lahar that overlies the pumice gravel forms a terrace which is about 20 m above the Kalama River. Deposits beneath the gravel include three lahars interbedded with fluvial deposits; these are believed to be correlative with the post-Y part of the Pine Creek assemblage of Crandell and Mullineaux (1973). The corrected date is either about 190, 250, or 370 B.C. The deposit probably originated during explosive eruptions of hypersthene-hornblende dacite pumice at Mount St. Helens.

W-4004

2660±80

Wood from a bed of sand that is about 10 m below the top of the north valley wall of the South Fork Toutle River about 4 km west-northwest of the pre-1980 summit of the volcano* (SE 1/4 SE 1/4 sec. 36, T. 9 N., R. 4 E.; lat 46°13' N., long 122°15' W.). Lahars above and below the sand contain pyroxene andesite rock debris; they underlie tephra of set B and a pumiceous pyroclastic-flow deposit which was dated at a nearby outcrop (sample W-2977, 2060±50). The age of sample W-4004 implies a correlation with the younger part of the Pine Creek assemblage of Crandell and Mullineaux (1973), but the lithology of the lahars indicates a post-Pine Creek age and suggests that the radiocarbon date is 100-200 years too old.

Samples from deposits of the Pine Creek eruptive period

W-3266

2450±90

Charcoal from a lithic pyroclastic-flow deposit exposed at the top of a bluff between two branches of Pine Creek about 14.3 km southeast of the pre-1980 summit of the volcano (NE 1/4 SE 1/4 sec. 9, T. 7 N., R. 6 E.; lat 46°06' N., long 122°04' W.). The deposit is stratigraphically the youngest unit in the post-Y part of the Pine Creek assemblage in this area. The corrected date is either about 530, 640, or 780 B.C. The pyroclastic flow probably was caused by the collapse of part of a dome of hypersthene-hornblende dacite being extruded at the volcanic center.

W-2529

2580±60

Charcoal from a lithic pyroclastic-flow deposit exposed in a roadcut about 6 km southeast of the pre-1980 summit of the volcano (NE 1/4 sec. 26, T. 8 N., R. 6 E.; lat 46°08' N., long 122°09' W.). The deposit is part of the post-Y unit of the Pine Creek assemblage of Crandell and Mullineaux (1973). The corrected date is about 850 B.C. The pyroclastic flow probably was caused by the collapse of part of a dome of hypersthene-hornblende dacite being extruded at the Mount St. Helens eruptive center.

W-2541

2670±70

Charcoal from a pumiceous pyroclastic-flow deposit exposed in a cut along an abandoned logging road on the west valley wall of Pine Creek 13 km southeast of the pre-1980 summit of the volcano (SE 1/4 sec. 9, T. 7 N., R. 6 E.; lat 46°06' N., long 122°04' W.). The deposit is interbedded with tephra of set P. The corrected date is about 870 B.C. The pyroclastic flow was caused by an explosive eruption of pumiceous hypersthene-hornblende dacite.

W-3265

2810±70

Wood fragments in sand beneath a sequence of lahars exposed in a gravel pit at Gilmore Corners, Wash. (SW 1/4 NE 1/4 sec. 30, T. 10 N., R. 1 E.; lat 46°20' N., long 122°45' W.). Alluvium and a lahar beneath the sand contain pumice derived from tephra set Y. The oldest lahar above the sand contained a wood fragment that was dated as 2030±240 years old ((W-811) Mullineaux and Crandell, 1962), but this date is believed to be at least 400 years too young. The corrected age of sample W-3265 is either 1000 or 1060 B.C. This sample provides a lower limiting date on the aggradation of the Toutle River valley by lahars and alluvium during post-Y time.

W-2873

2840±100

Charcoal from a lithic pyroclastic-flow deposit exposed in a borrow pit on the west side of the Castle Creek valley about 6.5 km northwest of the pre-1980 summit of the volcano* (SE 1/4 NW 1/4 sec. 24, T. 9 N., R. 4 E.; lat 46°15' N., long 122°15' W.). The deposit is correlative with the post-Y unit of the Pine Creek assemblage of Crandell and Mullineaux (1973). The corrected date is about 1100 B.C. The pyroclastic flow may have been caused by the collapse of part of a dome of hypersthene-hornblende dacite being extruded at the Mount St. Helens eruptive center.

W-2542

2850±60

Charcoal from a pumiceous pyroclastic-flow deposit exposed in the east valley wall of Pine Creek 14.5 km southeast of the pre-1980 summit of the volcano (SE 1/4 sec. 9, T. 7 N., R. 6 E.; lat 46°06' N., long 122°04' W.). The deposit is the lowest unit in a sequence of at least 10 pyroclastic-flow deposits that represent the post-Y part of the Pine Creek assemblage of Crandell and Mullineaux (1973). The corrected date is about 1100 B.C. The pyroclastic flow was caused by an explosive eruption of pumiceous hypersthene-hornblende dacite.

W-2875

2900±70

Carbonized wood from a buried soil between lahars exposed in a gravel pit on the south side of the North Fork Toutle River near the mouth of Alder Creek, about 32 km northwest of the pre-1980 summit of the volcano (SW 1/4 sec. 15, T. 10 N., R. 2 E.; lat 46°21' N., long 122°33' W.). The soil is developed in sand that overlies a lahar; above the soil is a lahar which is correlated with the post-Y part of the Pine Creek assemblage of Crandell and Mullineaux (1973). The corrected date is either about 1130 or 1210 B.C. The sand probably is correlative with the sand that underlies three lahars near Gilmore Corners (see sample W-3265, 2810±70).

W-2980

2910±70

Charcoal from a log in a pumiceous pyroclastic-flow deposit exposed in a roadcut in the Coldspring Creek valley 5 km west-southwest of the pre-1980 summit of the volcano (SW 1/4 SE 1/4 sec. 12, T. 8 N., R. 4 E.; lat 46°12' N., long 122°15' W.). The deposit is part of the post-Y unit of the Pine Creek assemblage of Crandell and Mullineaux (1973). The corrected date is either about 1130 or 1210 B.C. The pyroclastic flow resulted from an explosive eruption of pumiceous hypersthene-hornblende dacite.

W-2829

2930±60

Charred wood from immediately under tephra set P exposed in a roadcut in the Smith Creek valley about 1.3 km south of the mouth of Ape Canyon Creek and about 9 km east of the pre-1980 summit of the volcano (NW 1/4 NW 1/4 sec. 9, T. 8 N., R. 6 E.; lat 46°12' N., long 122°05' W.). The sample provides an older limiting date for the deposition of tephra set P. The corrected date is about 1220 B.C.

W-2675

2960±50

Sample from same location and horizon as W-2829. The sample provides an older limiting date for the deposition of tephra set P. The corrected date is either about 1240 or 1320 B.C.

Samples from deposits of the Smith Creek eruptive period

W-3262 3280±90
Wood from the deposit of a hot lahar exposed in a roadcut in the Smith Creek valley 8 km northeast of the pre-1980 summit of the volcano* (SE 1/4 NE 1/4 sec. 30, T. 9 N., R. 6 E.; lat 46°14' N., long 122°05' W.). The lahar is interbedded with layers of tephra set Y. The corrected date is about 1630 B.C. The lahar contains abundant fragments of pumiceous cummingtonite-hornblende dacite and may have been caused by an explosive eruption.

W-2549 3350±50
Charcoal from an ash-cloud deposit exposed in a roadcut in the Smith Creek valley about 8.7 km northeast of the pre-1980 summit of the volcano (SE cor. sec. 19, T. 9 N., R. 6 E.; lat 46°14' N., long 122°06' W.). The deposit is interbedded with tephra of set Y and is above layer Yn. The ash-cloud deposit may be correlative with a nearby lithic pyroclastic-flow deposit from which sample W-3144 (see below) was obtained. The corrected date is about 1670 B.C.

W-3144 3380±60
Charcoal from a lithic pyroclastic-flow deposit exposed in a roadcut in the Smith Creek valley 8 km northeast of the pre-1980 summit of the volcano* (SE 1/4 NE 1/4 sec. 30, T. 9 N., R. 6 E.; lat 46°14' N., long 122°05' W.). The deposit is interbedded with layers of tephra set Y and overlies the deposit of a hot lahar from which sample W-3262 was obtained. The corrected date is about 1690 B.C. The pyroclastic-flow deposit may be correlative with a nearby ash-cloud deposit in the same stratigraphic position from which sample W-2549 (3350±50) was obtained. The pyroclastic flow may have been caused by the collapse of part of a dome of hornblende-cummingtonite dacite being extruded at the Mount St. Helens volcanic center.

W-1752 3510±80
Charcoal from immediately below tephra layer Yn exposed in a roadcut 8 km northeast of the pre-1980 summit of the volcano (NW 1/4 sec. 24, T. 9 N., R. 5 E.; lat 46°14.5' N., long 122°09' W.). The sample provides an older limit on the age of tephra layer Yn.

W-3911 3850±70
Charcoal from immediately below tephra set Y exposed in a roadcut about 20.5 km north-northeast of the pre-1980 summit of the volcano (SE 1/4 sec. 9, T. 10 N., R. 6 E.; lat 46°22' N., long 122°03.5' W.). The sample is from under the oldest part of the tephra set that was deposited northeast of the volcano.

W-2677 3900±50
Charcoal from immediately below tephra set Y, at the top of a soil developed in tephra set J, exposed in a roadcut in the Smith Creek valley about 1.3 km south of the mouth of Ape Canyon Creek and about 9 km east of the pre-1980 summit of the volcano (NW 1/4 NW 1/4 sec. 9, T. 8 N., R. 6 E.; lat 46°12' N., long 122°05' W.). The sample provides an older limiting date for tephra set Y.

Sample from deposit of post-Swift Creek, pre-Smith Creek age

W-1751 4680±80
Charcoal from a soil zone beneath tephra set Y exposed in a roadcut about 6 km northeast of the pre-1980 summit of the volcano (SE 1/4 NW 1/4 sec. 26, T. 9 N., R. 5 E.; lat 46°14.5' N., long 122°09' W.). The sample provides an older limit on the age of tephra set Y (also see sample W-2677, which provides a younger lower limit).

Samples from deposits of the Swift Creek eruptive period

W-2867¹ 5860±80
Charcoal in tephra set J exposed in a roadcut about 6.5 km west-southwest of the pre-1980 summit of the volcano (SE 1/4 sec. 14, T. 8 N., R. 4 E.; lat 46°11' N., long 122°16' W.). The tephra is stratigraphically beneath the Mazama ash, which is about 7000 years old; thus, the age of sample W-2687 cannot be an accurate date for tephra set J.

W-2587¹ 8300±90
Charcoal from the upper middle part of tephra set J exposed in a roadcut in the Smith Creek valley about 6.5 km northeast of the pre-1980 summit of the volcano* (N 1/2 sec. 25, T. 9 N., R. 5 E.; lat 46°14' N., long 122°07' W.). The sample was obtained from a horizon stratigraphically above sample W-2702 (see below).

W-2702¹ 8430±100
Charcoal from the lower part of tephra set J at the same locality as sample W-2587.

W-2991¹ 8900±70
Charred wood from the upper layer of tephra set J exposed in a roadcut about 10 km east-southeast of the pre-1980 summit of the volcano (SE 1/4 sec. 21, T. 8 N., R. 6 E.; lat 46°09.5' N., long 122°04' W.).

¹These samples are all from pumice lapilli layers of set J; all have given dates that are locally inconsistent and younger than expected from stratigraphic relations. These samples are suspected of having become contaminated after deposition with fine-grained organic material that moved downward through the coarse pumice during the several thousand years that set J pumice was exposed at the surface.

W-3257 9170±100
Carbonized wood fragments from a sand (ash?) layer above tephra set J exposed on the north wall of the South Fork Toutle River valley about 4.2 km west-northwest of the pre-1980 summit of the volcano* (SE 1/4 sec. 36, T. 9 N., R. 4 E.; lat 46°13' N., long 122°15' W.). The sample was supplemented with material from a correlative horizon that was exposed in a gully on the west flank of the volcano about 3 km from the summit (NE 1/4 sec. 7, T. 9 N., R. 5 E.; lat 46°12' N., long 122°14' W.). The date provides a younger limit for the age of the part of tephra set J that lies west of the volcano. Sample W-3548 (see below) provides an older limit of about 10,700 years.

W-2678 9600±80
Charcoal from within and just below tephra set S exposed in a roadcut about 32 km northeast of the pre-1980 summit of the volcano (SE 1/4 sec. 22, T. 10 N., R. 6 E.; lat 46°20' N., long 121°47' W.). The date is inconsistent with the age of tephra set S as known from other samples and from its stratigraphic relations to other deposits of known age.

W-3548 10,710±150
Carbonized wood fragments from beneath tephra set J exposed in a roadcut about 12 km west of the pre-1980 summit of the volcano (sec. 5, T. 8 N., R. 4 E.; lat 46°12.5' N., long 122°20' W.). The date provides an older limit for the age of the part of tephra set J that lies west of the volcano. Sample W-3257 provides an upper limit of about 9170 years.

W-2868 12,110±110

W-2870 11,550±230

W-2866 11,900±190
Charcoal obtained from beneath and within a sequence of three lithic pyroclastic-flow deposits exposed in a roadcut on the north side of Ape Canyon 7.7 km east of the pre-1980 summit of the volcano (NW 1/4 NE 1/4 sec. 5, T. 8 N., R. 6 E.; lat 46°12' N., long 122°05' W.). Rock fragments in the lowest, middle, and uppermost deposits are of hornblende-hypersthene dacite, hypersthene-hornblende dacite, and hornblende dacite, respectively. The deposits are underlain by tephra set S and overlain by tephra set J; thus, the dates provide approximate younger and older age limits, respectively, for these tephra. Sample W-2866 is from a soil beneath the lowest deposit, W-2870 is from within the lowest deposit, and W-2868 is from the uppermost pyroclastic-flow deposit (its date is inconsistent with the other two). The pyroclastic flows may have been caused by the collapse of parts of domes being extruded at the volcanic center.

W-2832 11,700±90
Charcoal from immediately below tephra set J exposed in a roadcut about 12 km east-southeast of the summit of the volcano (sec. 21, T. 8 N., R. 6 E.; lat 46°10' N., long 122°04' W.). The sample provides a lower limiting date for the deposition of the part of the tephra set that lies east of the volcano.

W-2655 11,800±90
Wood from a log in a lahar exposed near the top of the west valley wall of Muddy River about 18.5 km southeast of the pre-1980 summit of the volcano (center sec. 13, T. 7 N., R. 6 E.; lat 46°05' N., long 122°00' W.). The deposit underlies tephra of set J (Crandell and Mullineaux, 1973, fig. 4) and is one of the youngest units in a voluminous sequence of lahars that was deposited between about 11,700 and 13,000 years ago.

W-2441 11,880±110
Charcoal immediately below tephra set J exposed in a roadcut in the Smith Creek valley about 9 km northeast of the pre-1980 summit of the volcano* (SE 1/4 SE 1/4 sec. 19, T. 9 N., R. 6 E.; lat 46°14' N., long 122°05' W.). The sample provides an older limiting date for tephra set J.

W-3133 12,120±100
Peat from above tephra set S near the outlet of a small lake about 37 km northeast of the pre-1980 summit of the volcano (NE 1/4 sec. 33, T. 11 N., R. 8 E.; lat 46°24' N., long 121°48' W.). This sample and W-3136 bracket the age of tephra set S between about 13,650 and 12,120 years before the present (see sample W-3141, below).

W-3145 12,270±90
Charcoal from sand interbedded with lahars exposed in a small gravel pit in the South Fork Toutle River valley about 10.6 km west of the pre-1980 summit of the volcano* (SW 1/4 NW 1/4 sec. 4, T. 8 N., R. 4 E.; lat 46°13' N., long 122°20' W.). Ash and lapilli near the top of the sand are mineralogically similar to pumice in tephra set J. The sample probably provides an older limiting date on tephra set J.

W-3141 12,910±160
Charcoal from a pumiceous pyroclastic-flow deposit exposed in a roadcut near the east end of a highway bridge across Swift Creek, about 12.2 km south of the pre-1980 summit of the volcano (SW 1/4 sec. 16, T. 7 N., R. 5 E.; lat 46°05' N., long 122°12' W.). The deposit underlies airfall tephra of set S, and resulted from an explosive eruption of cummingtonite-hornblende dacitic pumice at the volcanic center. The sample provides an older limit for the age of this part of tephra set S.

W-3136 13,650±120
Peat from beneath tephra set S at the same location as sample W-3133.

Samples from deposits of the Cougar eruptive period

W-2413 18,560±180
Charcoal from a pumiceous pyroclastic-flow deposit exposed in a borrow pit on the south side of the Lewis River valley about 1 km west-southwest of Swift Dam (SE 1/4 sec. 29, T. 7 N., R. 5 E.; lat 46°03' N., long 122°12' W.). The deposit overlies tephra of set M (Mullineaux and others, 1978), which overlies another pyroclastic-flow deposit (see W-2540, below). Both pyroclastic-flow deposits evidently resulted from voluminous explosive eruptions of pumiceous hypersthene-hornblende dacite (Hyde, 1975).

W-4531 19,160±250
Charcoal from a 2-m-thick pyroclastic-flow deposit of hypersthene-hornblende dacite exposed in a roadcut on west bank of unnamed creek 14.5 km southeast of the pre-1980 summit of Mount St. Helens (SE 1/4 SW 1/4 sec. 9, T. 7 N., R. 6 E.; lat 46°06'N., long 122°04' W.) Sample is from horizon 5 cm above base of deposit, beneath which is a weak soil developed in thin tephra of cummingtonite-hornblende dacite of set K. Sample provides a date for the pyroclastic flow and is a younger limiting date for this part of tephra set K.

W-2540 20,350±350
Charcoal from a pumiceous pyroclastic-flow deposit at the same location as sample W-2413. The deposit underlies tephra of set M and another pyroclastic-flow deposit (see sample W-2413). The deposit evidently resulted from a voluminous explosive eruption of pumiceous hypersthene-hornblende dacite (Hyde, 1975).

Samples from deposits of the Ape Canyon eruptive period

W-2551 17,270±300
Organic matter within the basal part of tephra set C exposed in a roadcut 0.4 km east of a highway bridge over Swift Creek and about 12.3 km south of the pre-1980 summit of the volcano (SW 1/4 sec. 16, T. 7 N., R. 5 E.; lat 46°05' N., long 122°12' W.). This sample is believed to have been contaminated and does not represent the true age of tephra set C. Sample W-3545 from the same horizon was dated as >29,000.

W-3545 >29,000
Sample from the same horizon and the same location as W-2551.

W-2421 >35,000
Wood from same deposit and same location as W-2653 (see below).

W-2653 36,000±2100
Wood from a log in a lahar exposed in the bed and north bank of the Lewis River 2.5 km downstream from Swift Dam (SE 1/4 sec. 30, T. 7 N., R. 5 E.; lat 46°04' N., long 122°14' W.). The lahar includes fragments of pumice that contain biotite, cummingtonite, and hornblende (Hyde, 1975, p. B10-B11).

W-2976 36,000±2500

W-2661 37,600±1300
Charcoal taken from two horizons within tephra set C exposed in the slope above a rock quarry in the Muddy River valley about 11 km east of the pre-1980 summit of the volcano (sec. 15, T. 8 N., R. 6 E.; lat 46°11' N., long 122°03' W.). Sample W-2661 is from beneath a weak soil zone in the lowest part of the tephra set, and sample W-2976 is from the basal part of a layer higher in the set (Mullineaux and others, 1978, p. 173. In this reference, sample W-2976 is mislabeled W-2653). Tephra set C was deposited during some of the earliest known eruptions of Mount St. Helens.

W-3259

>42,000

Charcoal from a pumiceous pyroclastic-flow deposit exposed in a roadcut about 200 m south of the mouth of Ape Canyon Creek, in the Smith Creek valley about 8 km east of the pre-1980 summit of the volcano* (SE 1/4 NE 1/4 sec. 5, T. 8 N., R. 6 E.; lat 46°12' N., long 122°05' W.). Pumice in the deposit contains biotite, cummingtonite, and hornblende, a heavy-mineral suite that is characteristic of the earliest eruptive products of Mount St. Helens.

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