## Before Mount St. Helens: The Eocene to Miocene Cascade Volcanic Arc in Southern Washington

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The late Pleistocene and Holocene edifice of Mount St. Helens was constructed on a deeply eroded terrane of mildly deformed subaerial volcanic and shallow-level plutonic rocks that form the core of the Tertiary Cascade volcanic arc. Arc volcanism in southern Washington began about 40 Ma and continued vigorously until about 17 Ma. Most of the regionally extensive epizonal granitic plutons were emplaced at 18-22 Ma. Measurements of several well-dated stratigraphic sections along the arc axis indicate that volcanic strata accumulated at average rates of 250-350 m/my during the main period of late Eocene to early Miocene magmatism. Volcanic activity declined markedly after about 17 Ma and remained at a low level until about 5 Ma. Warping of the older strata into broad low-amplitude, northwest-trending folds may have occurred predominantly during this lull in volcanism.

Geologic and geophysical studies show that the southern Washington arc segment was built on a complex basement: the lowermost rocks of the volcanic arc interfinger with Eocene continental arkoses west of Mount Rainier, but unconformably overlie Jurassic plutonic and marine sedimentary rocks southeast of Mount Rainier, and rest conformably on low-potassium olivine tholeiites with E-MORB geochemistry southwest of Mount St. Helens. Deeper crustal levels may consist of trapped or tectonically underplated oceanic crust and accreted Mesozoic metasedimentary terranes.

Compositionally diverse tholeiitic and calc-alkaline magmas were generated throughout arc history in southern Washington. The average $SiO_2$ content of eruptive products increased during arc evolution, perhaps reflecting an increasing crustal contribution to Cascade magmas with time.

## How Do "Fire" and Ice Interact on a Volcano?

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The term "fire" is used in this paper to indicate active volcanism consisting of localized areas of high heat-flux associated with passive and/or violent eruptions that can affect glaciers and snowfields on a volcano. The effect of volcanism on glaciers is well documented at Mount St. Helens from 1979 to 1985. A distinctive englacial debris layer and thin ash layers were deposited by explosive eruptions that occurred during the mid-1800s; these units are described. Results are compared to depositional products derived during and after 1980. Contour maps of Shoestring Glacier and vicinity prior to May 18, 1980, are compared to later maps. Map, photo and field survey data on erosion and melt rates were obtained at regular intervals between 1979 and 1984 by the author at Shoestring and Swift glaciers; aerial photograph data are used after 1985. Heat-conduction models are used to evaluate the effects of volcanic heat-flux (from hot volcanic flows and intrusions, hot ash fall, hydrothermal fluids); comparisons are made to models of snow and ice loss attributable to mechanical erosion and explosions. As shown in this paper, "fire" dramatically affects the flow behaviour and water budget of glaciers on the volcano. Alternatively, ice affects the character of the volcanic "fire" produced by increasing the subsurface water content, by contributing water to the eruptive clouds and flows, by altering the fluidity of pyroclastic flows and lahars, and by minimizing the basal temperatures and friction of volcanic flows.

## Current Perspectives on the 18 May 1980 Lateral-blast Deposit at Mount St. Helens, Washington

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Two schools of thought have developed regarding the genesis of the deposit produced by the 18 May 1980 lateral blast at Mount St. Helens. One school interprets the deposit as the product of a single extended explosion, and invokes flow dynamics to explain the characteristics of the various strata. The other school invokes multiple explosions as well as flow dynamics.

Both views are compatible with stratigraphic data, but other independent data sets provide permissive evidence in support of multiple explosions. The paroxysmal eruption began with an earthquake (M=5.1) at 08:32.2 PDT (t=0s); an explosion began about t=30s. Photographs taken from the south show that the explosion cloud near the summit began to expand rapidly at t=90-100s. At about t=120s, a second earthquake occurred with magnitude similar to the first. From t=138-156s, satellite-born sensors recorded a rapid acceleration of the blast front. The blast cloud reached its maximum extent from about t=230-290s. People engulfed by the northern margin of the blast reported two distinct pulses separated by at least one minute.

The part of the blast deposit thought to be the product of the initial explosion contains a greater proportion of low-density juvenile dacite, and a lesser proportion of hydrothermally altered non-juvenile clasts than the part of the deposit thought to be the product of the later explosion. Apparently the initial eruption was magmatically driven, while the later explosion had an appreciable hydrothermal contribution.

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