



## Spatial trends in S and Cl in ash leachates of the May 18th, 1980 eruption of Mt. St Helens

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It has long been known that surficial deposits of salts and acids on volcanic ash particles derive from interactions of ash with sulphur and halide species within the eruption plume and volcanic cloud. These compounds are mobilised as ash particles are wetted, and beneficial or detrimental environmental and health impacts may be induced where the most concentrated solutions are produced. However, limited mechanistic understanding of gas-ash interactions currently precludes prediction of the spatial distribution or variation in leachate chemistry and concentration following an eruption. Sampling and leachate analysis of freshly-fallen ash therefore offers the sole method by which such variations can be observed.

Previous ash leachate studies often involve a limited number of ash samples, and utilise a 'one-dimensional' analysis that considers variation in terms of absolute distance from the source volcano. Here, we demonstrate that extensive sampling and a 'two-dimensional' analysis can uncover more complex spatial trends. We compiled over 358 leachate compositions from the May 18<sup>th</sup> 1980 eruption of Mt. St. Helens. Of the water-extracted leachates, only 95 compositions from ash sampled at 45 localities between 35 and 1129 km from the volcano are sufficiently documented to be retrospectively comparable. To consider the effects of intra-deposit variability, we calculated average concentrations of leachate data within 11×22 km grid cells across the region, and defined a data quality parameter to reflect confidence in the derived values. To investigate any dependence of leachate composition on the grain size distribution, we generated an interpolated map of geometric specific surface area variation across the deposit, normalising ash leachate data to the calculated specific surface area at the corresponding sampling location.

The data treatment identifies S and Cl enrichments in proximal blast deposits; relatively constant Cl concentrations across the ashfall deposits; and a core region of depleted S concentrations in ashfall deposits between 240 and 400 km from the volcano, coinciding with the distal thickening of the deposit attributed to particle aggregation and enhanced fallout. Blast deposit enrichments can be attributed to pre-eruptive uptake of SO<sub>2</sub> and HCl gases within the cryptodome, while ashfall deposit trends could reflect differences in the rates of HCl and SO<sub>2</sub> uptake by ash, modified by in-plume aggregation processes. However, to validate and interpret such trends with greater confidence would have required a greater spatial density and temporal resolution of sampling, with comprehensive characterisation of the recovered ash and the surrounding deposit. In the future, rigorous study and sampling of equivalent extent to that in the aftermath of the historic Mt. St. Helens eruption is likely required to extend insight into processes affecting the spatial distribution of leachate chemistry.