

EFFECT OF THE MAY-JUNE MOUNT ST. HELENS ERUPTIONS ON PRECIPITATION CHEMISTRY IN CENTRAL COLORADO

WILLIAM M. LEWIS, Jr.
and

MICHAEL C. GRANT

Department of Environmental, Population and Organismic Biology, University of Colorado, Boulder, CO
80309, U.S.A.

(First received 13 November 1980 and in final form 9 February 1981)

Abstract—Bulk precipitation chemistry for the interval 17 May to 12 June 1980, when the Mount St. Helens volcano was intermittently erupting, was compared with similar data over the same interval in previous years at a site in central Colorado. Although phosphorus, chloride and particulate loading values were higher than in previous years, no significant differences exist for these or other variables, indicating that the volcanic effect on chemical loading from the atmosphere at this site was within the ordinary range of variability for bulk precipitation chemistry.

INTRODUCTION

Volcanoes may affect biogeochemical cycles, since the mixture of chemical species which they release may differ greatly from the background of substances normally transported through the atmosphere. The Mount St. Helens eruption provides an opportunity for documentation of effects of volcanism on biogeochemical cycles. Some results of chemical analyses from the site have already been published (Stoiber *et al.*, 1980), and others will undoubtedly be forthcoming. The extent and geographical scope of the biogeochemical effects of the volcano will be difficult to deduce fully from analyses near the site of the eruption, however. The rate of delivery of gaseous and particulate substances to terrestrial surfaces and the ratio of the volcanic contribution to the background of various chemical species are not obvious even if the magnitude of the volcanic release is known. A complementary approach is possible given the availability of relatively long-term records of bulk precipitation chemistry in years prior to the eruption. We have a detailed record of this type dating back to 1975 for the Como Creek Watershed, located in the central Rockies of Colorado (40° 2' N, 105° 32' W). Satellite photography of airborne volcanic materials (Fig. 1) and the presence of a light film of volcanic dust in north and central Colorado following the major eruptions in May 1980 established the movement of volcanic materials over the central Rockies. The Como Creek precipitation chemistry data should thus provide a quantitative indication of the regional effects of the volcano on loading rates for particulates and for various chemical species of biological interest.

METHODS AND STUDY SITE

Precipitation chemistry at the Como Creek Watershed, which is the oldest continuously operating

precipitation chemistry collection point in the western U.S., has been studied since June 1975. Two large collectors, mounted 4 m off the ground in forest clearings, are emptied and rinsed at weekly intervals throughout the year. The collectors are connected to borosilicate glass bottles with surgical rubber tubing incorporating a vapor barrier. Complete design details are given by Lewis and Grant (1978). Wet and dry fractions are also separated, but we focus our attention here on bulk precipitation chemistry, which includes the composite of wet and dry deposition on the collector surface. We have averaged the data for the two stations, which are 1 km apart, as they do not differ significantly for any component over the long term (Grant and Lewis, 1981).

Samples were analyzed within 24 h of collection. Particulate and soluble fractions were separated by filtration with Whatman GF/C glass fiber paper. Complete analytical methods are given in detail by Lewis and Grant (1980) and Lewis (1981), and will consequently be treated only briefly here. Standard high sensitivity wet chemical methods were used for soluble nitrate, nitrite, ammonia and phosphate. Barium precipitation turbidimetry was used for sulfate determinations and chloride was analyzed by a mercuric thiocyanate method. Dissolved organic carbon was approximated from absorbance in the near UV region, and dissolved organic nitrogen and phosphorus were determined by ultraviolet combustion of soluble organic matter followed by reanalysis for inorganic nitrogen and phosphorus species. Bicarbonate was determined by electrometric titration to pH 4.4. The hydrogen ion concentration was determined from measurements made on a fresh sample with a calibrated pH meter. The major cations were determined by atomic absorption spectrophotometry with appropriate addition of lanthanum for calcium. Insoluble phosphorus was determined by acid diges-

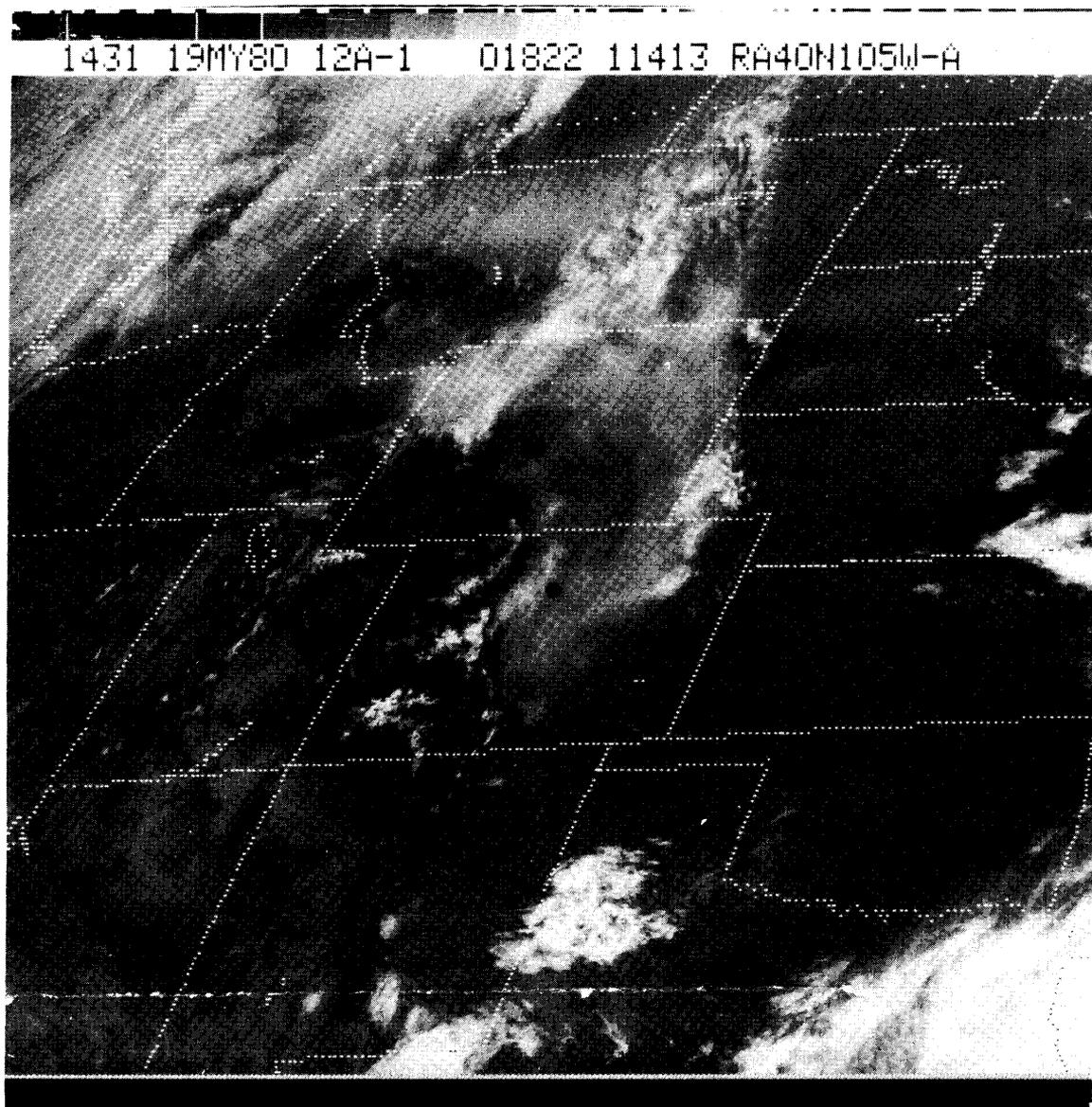


Fig. 1. Satellite photograph 22 h 52 min after the 18 May 1980 eruption showing visible volcanic ash passing over the Como Creek site (black dot). Photograph courtesy NOAA/NESS, Washington, D.C.

tion of particulates followed by analysis for soluble inorganic phosphorus.

The area in a 20–30 km radius around the station is sparsely populated and mainly forested. The precipitation chemistry may be affected to some extent by the urban corridor including Denver and other cities to the east at lower elevation. The surroundings and precipitation chemistry are documented in more detail elsewhere (Lewis and Grant, 1979a, 1979b, 1980; Grant and Lewis, 1981).

RESULTS AND DISCUSSION

Minor volcanic activity began on 27 March at Mount St. Helens (Stoiber *et al.*, 1980), but major

releases of material occurred on 18 May, 25 May and 12 June. Following the May eruptions, volcanic dust was evident in Boulder County, where the samplers are located. We selected as our observation window the interval 17 May–21 June 1980. Using the same span of dates in the previous four years during which there was no volcanic activity, we could, by contrast, estimate the effect of the volcano on bulk precipitation chemistry. Other possible nonvolcanic effects that might contribute to differences between 1980 and previous years were controlled by comparison of a second window consisting of the five weeks immediately prior to the first window. This control window gave no indication of a statistically significant difference between 1980 and pooled previous years. Thus observed effects in the

volcano test window should be attributable to the volcano.

Table 1 summarizes the results for the volcano test window in 1980 and in the four previous years. It is clear from the table that none of the loading rates for the chemical substances reported in the table are different in a really major way from the background levels as determined from the years 1975–1979. Use of *a priori* statistical contrasts between 1980 and the average of four previous years provided no instances of statistically significant differences ($P > 0.05$ for all variables). The data are suggestive of increased phosphorus and chloride loading, but the probability levels are well above 0.05. Total particulates also appear to be somewhat higher than normal, and in the peak week this component reached the highest level we have recorded for the observation window over a five-year span, which is almost certainly due to ash. Even so, there is no significant difference between the particulate loading over the whole window and the aggregate particulate loading over the same window in previous years. For major cations and sulfate the loading rates are slightly lower than normal. This is probably explained by the slightly lower precipitation over the observation window in 1980, as these major ions are significantly associated with wet precipitation. Correction to an average amount of wet precipitation can be accomplished by use of the relationship between loading rate and amount of wet precipitation in a given week. For some variables, this relation is nonexistent;

for others it is significant, as shown by regression analysis of loading rate against amount of wet precipitation. When the relationship is significant, correction to an average precipitation can be accomplished with the formula for the regression line. When loading rates are corrected to the average background precipitation the picture conveyed by Table 1 is not changed substantially. Higher amounts of hydrogen ion and lower bicarbonate are suggestive but not significant statistically.

The results of Table 1 do not preclude some volcanic influence on the biogeochemical cycles in the central Rockies during the period of active releases by Mount St. Helens, but the table does suggest that the chemical deposition effects of the volcanic releases, however obvious from photography and from air chemistry near the site, were easily within the normal background of variation between weeks and between years by the time the materials had been dispersed as far as the central Rockies.

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Table 1. Summary of weekly loading for the weeks in 1980 coinciding with large releases of material from Mount St. Helens and for the same weeks of the year in previous years

	Background (17 May–21 June for 1975–1979)	Volcano year (17 May–21 June 1980)
Amount of precipitation (mm/wk)	17.	11.
Loading of solubles (mg/m ² /wk)		
Ca ²⁺	9.7	5.8
Mg ²⁺	1.2	0.5
Na ⁺	5.5	3.4
K ⁺	3.0	3.5
H ⁺	0.25	0.31
HCO ₃ ⁻	26.	12.
SO ₄ ²⁻	18.	16.
Cl ⁻	1.0	2.7
PO ₄ -P	0.17	0.24
NO ₃ -N	5.6	5.5
NO ₂ -N	0.09	0.04
NH ₄ -N	4.5	3.4
Dissolv. organic C	25.	17.
Dissolv. organic N	2.6	1.8
Dissolv. organic P	0.07	0.18
Loading of insolubles (mg/m ² /wk)		
Total insolubles	330.	396.
Insoluble P	0.43	0.63
Other pH	4.99	4.49

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