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Rainwater Chemistry in an Active Volcanic Area – Mt. Etna, Italy

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In the recent past, relevant data have been acquired concerning the environmental impact of explosive volcanic activity on the chemistry of the Earth's atmosphere and on global climate (Symonds et al., 1988; Bluth et al., 1993). Minor efforts were made to assess the local environmental impact of relative quite volcanic activity. Mt. Etna, located in eastern Sicily, is about 3350 m a.s.l. high and covers an area of about 1200 km^2. It has been in a persistent activity state since the last 200 ka. Recent studies have shown that volatile species such as S, Cl, F, Br and trace metals, together with major compounds (H_2O and CO_2), are continuously released from the summit crater Etnean plume (Allard, 1997; Pennisi & Le Cloarec, 1998). Yearly calculated CO_2 and SO_2 fluxes from Mt. Etna plume (13 and 2 Mt/a respectively) correspond to about 10% of global volcanic emissions (Allard, 1997). This huge gas release derives from degassing of volatile-rich alkali basalts. As many chemical compounds emitted by the volcanic plume are water soluble, it may be suggested that wet deposition is a major scavenging process. Through rainwater, chemical substances released to the atmosphere are transported to the Earth's surface and finally enter the hydrological cycle. In order to study the scavenging of acid gases emitted by the plume of Mt. Etna rainwater samples were monthly collected, over a period of about three years, by a network of 11 bulk rain gauges located at various altitudes and different distances from the craters along the flanks of the volcano. Samples were analysed for F, Cl, Br, NO_3 and SO_4 content by HPLC methodologies. The results highlight the significant contribution of the volcanic plume to the chemistry of rainwater in the Etnean area. The clear dependence of fluoride, chloride and sulphate content on the distance from the summit craters points to a prevalent volcanic origin for these species. Seawater and human activities result to be of minor importance both for chloride and sulphate, despite the contribution from both sources increases in coastal and urban areas. By contrast nitrate is mainly of anthropogenic origin. By comparing sulphur and halogens rainwater inflows with the respective plume emission rates, we compute that wet deposition over the Etnean area is a minor scavenging process, corresponding to a small fraction (0.3-1.2%) of the atmospheric discharge of the volcano. This points to a high residence time, wide dispersal and regional environmental impact of Etna gaseous emissions. Data reported here also indicate that rainwater accounts for a significant fraction of total chloride (17.8%) and sulphate (10.2%) transported by groundwaters. This implies that precipitation acts as a carrier of magmatic-derived gases emitted by the plume to the Etnean aquifer. Rainwater chemistry has also shown remarkable variations during the investigated period, mainly in the rain gauges located close to the craters. High sulphur and halogens meteoric inflows in rainwater correlate with intense activity at the craters and increasing SO_2 release from the plume.

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