

Fate and agricultural consequences of leachable elements added to the environment from the 2011 Cordón Caulle Volcanic Complex tephra fall.

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The June 2011 eruption of Cordón Caulle Volcanic Complex, Chile, dispersed tephra over ~350,000 km², including productive agricultural land. This resulted in the death of nearly one million livestock. Two distinct environments were affected: a proximal temperate Andean setting, and the semi-arid Argentine steppe farther from the volcano. The purpose of this study was to better understand the fate and agricultural consequences of leachable elements added to the environment by this large silicic tephra fall. Tephra, soil and surface water samples across the depositional area were collected both immediately after the eruption (tephra and water) and nine months afterwards (tephra, soil and water). Tephra samples were analysed following a new hazard assessment protocol developed by the International Volcanic Health Hazard Network (IVHHN). Water-extractable element concentrations in freshly-collected tephra were very low to low compared to other eruptions. Surface water analyses suggested short-term changes to water composition due to the release of elements from tephra. No effect on the fertility of soils underlying tephra was apparent after nine months. Water-extractable fluorine (F) in freshly-collected tephra ranged from 12-167 mg/kg, with a median value of 67 mg/kg. Based on parallels with the 11-12 October 1995 eruption of Ruapehu volcano, New Zealand, we suggest that the role of F toxicity cannot be ruled out as a contributing factor to large-scale livestock deaths and also to reported cases of chronic fluorosis in wild deer and livestock populations in the CC-VC tephra fall depositional area. Finally, we recommend that effective response to widespread tephra fall over agricultural areas should include: rapid, statistically representative field sampling of tephra, soils, surface water supplies and forage crops; analysis using appropriate and reliable laboratory methods; timely dissemination of results to agricultural agencies; provision for longitudinal sampling; and provision for reliable diagnoses of fluorosis cases through autopsies and chemical analysis.