

Complex ash leachate compositions of the 6 August 2012 Mt. Tongariro (Te Maari) eruption, New Zealand, and implications for volcanic health hazard evaluation

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After 115 years of quiescence, Mt. Tongariro erupted suddenly at 2350 hrs (NZ time) on 6 August 2012 from the upper Te Maari Crater. The eruption produced a fine ash of minor volume (0.004 km³) but wide distribution (>1,000 km³), extending over 200 km from source. The threat of further eruptions sparked an investigation of the possible health and agricultural impacts of any future eruptions from this volcano, particularly since the most recent large-scale ash falls in New Zealand, the 1995-1996 Mt. Ruapehu eruptions, had generated significant agricultural problems, including livestock deaths.

Te Maari ash was sampled between 5 and 200 km from the volcano within hours of settling and before rainfall. Analysis of this revealed several unusual features. Using a series of three repeated leaches of the same samples, strong variations in ash properties could be established. Typical single-leaching analyses, most commonly recommended for volcanic ash health impacts, showed highly variable results, in many cases considerably underestimating the potential chemical impact of these tephras. In this case, sample/leachant ratios of 1:20 appeared highly unsuitable for estimating total fluoride and sulphate concentrations and also had limitations for metal analysis. While also limited, leaching experiments using 1:100 ratios provided a more realistic estimate of soluble components.

In addition to method-related variability, total soluble concentrations and leaching behaviour during three sequential runs also varied for ash produced at different times of the eruption and with distance from source. Using the example of fluoride (F), a single leach of the earliest erupted/deposited ash extracted c. 75-90% of the total F removed in three sequential leaches from the same sample. Subsequently erupted ash, deposited only minutes later in an adjacent area due to shifting wind direction, had far less soluble forms of F, with single leaches yielding only c. 30-40% of the total amount extracted over three leaches. Distal ash, collected c. 200 km from source, showed the highest total F concentrations (112 ppm). Similar properties were observed for some cations with the early ash displaying strong correlations of F with aluminium and calcium, while later ash contained significantly lower quantities of aluminium and also released less calcium. The strongly variable leaching behaviour during the course of the eruption appears to reflect changes in soluble components/gas while variation with distance is most likely a function of grain size or an effect of residence time in the plume, i.e. ongoing ash-acid reaction.

The Te Maari data indicate that even if rapid results are required for health hazard assessment, a full understanding of time-dependent leaching behaviour is required before definitive recommendations can be made.