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Contamination of Surface Waters caused by Volcanic Ash Fall

T. K. Flaathen (1), S. R. Gislason (2)

(1) Nordic Volcanological Center, Institute of Earth Sciences, University of Iceland, Sturlugata 7, 101 Reykjavik (therese@hi.is / Phone: +354-5255484), (2) Institute of Earth Sciences, University of Iceland, Sturlugata 7, 101 Reykjavik (sigrg@raunvis.hi.is / Phone: +354-5254800)

The 1991 and 2000 Hekla eruptions (Iceland) provided a unique opportunity to study the local environmental effect of high latitude eruptions in the middle of winter. This study measures the effect of these Hekla eruptions on the chemistry of surface waters on land and in the ocean.

The snow in the vicinity of the Hekla volcano was polluted following the eruptions. The enrichment factor in polluted Hekla 2000 snow relative to average winter precipitation for the main volcanic gas components F, Cl, S, C was 197 000, 296, 44 and 1, respectively. Dissolved K, Mg, Cl, F, Al, Fe, Mn, As, Ba, Cd, Pb, Zn, and U in the polluted snow-melt from the 2000 eruption exceed the limits for elements intended for human consumption. There is a drastic change in pH, dissolved concentration and saturation state of glasses and minerals between the polluted meltwaters and the polluted river waters. The river waters are over-saturated with respect to several secondary minerals, resulting in precipitation of amorphous Al- and Fe hydroxides and the ensuing consumption of dissolved Fe and Al and further, scavenging of some trace elements on the Al-, Fe- surfaces. Dissolved Al and F in River Ytri-Rangá, in the vicinity of the Hekla volcano, are the main pollutants in the river water following the Hekla 2000 eruption. Previous studies have shown the combined Al–F toxicity to be directly related to the predominance of specific Al–F species in solution. Model calculations for mixing of Hekla type volcanic cloud with 4 surface water's end-members show Al-F species to be most important in rain and dilute river waters. This makes Al and F phyto-available but might hinder direct toxicity of the Al_3^+ species, the most toxic Al-species. Mixing Hekla type volcanic cloud material with high alkalinity river wa-

ters or seawater at reasonable dilution ($>$800) results in the domination of non toxic $Al(OH)_4^-$ species, hindering Al toxicity and bio-availability.

This study indicates that H_2SO_4 pollution from volcanic eruptions is time and place dependent. Volcanic eruptions that take place during winter at high latitude result in relatively high global sulphur pollution and relatively low local sulphur pollution due to low oxidation rate of SO_2 into H_2SO_4 because of low solar radiation.