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H_2S and SO_2 degassing from El Chichón (Chiapas, Mexico) and Víti (Iceland) volcanic lakes

Nathalie Hasselle (1), Dmitri Rouwet (2), Alessandro Aiuppa (1,3), Mariana Patricia Jácome Paz (4), Melissa Pfeffer (5), Robin Campion (4), Yuri Taran (4), and Marcello Bitetto (1)

(1) Università degli Studi di Palermo, Dipartimento di Scienze della Terra e del Mare (DiSTeM), Italy (nathaliehasselle@gmail.com), (2) Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Bologna, Italy, (3) Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Palermo, Italy, (4) Instituto de Geofísica, Universidad Nacional Autónoma de México, Mexico City, Mexico, (5) Icelandic Meteorological Office, Bustaðavegi 7-9, 150 Reykjavík, Iceland

Measurements of the composition of volcanic gas, especially S-species, have mainly been concentrated in fumaroles, plumes, bubbling/boiling waters and hyper-acidic lakes hosted by quiescent and active volcanoes. Here, we study for the first time the composition (CO_2, H_2S, H_2 and SO_2) of gases released by two steam-heated volcanic lakes, El Chichón volcano (Chiapas, Mexico) and Víti (Askja volcano, Iceland). Both lakes have similar pH (2-3) and SO_4^{2-} contents ($\sim$700 mg/l) but differ for their temperature (30.1$\pm$1 °C at El Chichón and 21.8$\pm$1 °C at Víti) and maximum depth ($\sim$11 m and $\sim$60 m at El Chichón and Víti, respectively). The aim of this study is to test if sulfur species (H_2S and SO_2) are actively released at these chemical and physical lake-water conditions. Our results evidence the presence of relatively high (1-100 ppmv) H2S concentrations in the El Chichón and Víti lake gas plumes, with CO_2/H_2S and H_2/H_2S ratios (31.5-5685 and 0.77-35.1, respectively) higher than in the feeding volcanic gas, i.e. the offshore fumarolic gas composition (12.7-28.6 and 0.08-0.49, respectively). H_2S degassing at the lake surface implies that only a fraction of the fumarolic gas entering the lake bottom is ultimately dissolved into the lakes. At El Chichón, by scaling our CO_2/H_2S ratios by the lake CO_2 output in 2016, we evaluate an H_2S flux from the crater lake into the atmosphere at 0.02-0.06 t/d. Surprisingly, SO_2, a highly soluble gas in water, is also detected (at trace levels, 0.003-0.3 ppmv) in the plume of both lakes. To explain SO_2 degassing from pH 2-3 volcanic lakes, we propose a formation mechanism via H2S oxidation reactions into lake waters, having dissolved sulphite as transient species. This explanation is favoured by higher SO_2 concentrations measured where higher dissolved sulphite were detected (i.e. in bubbling areas; Casas et al., 2016). The original H_2S is therefore partially oxidized in the lake water (mainly as SO_4^{2-}), and partially released as a gas phase, as H_2S or SO_2.

Reference

Casas, A. S., Armienta, M. A., & Ramos, S. (2016). Sulfur speciation with high performance liquid chromatography as a tool for El Chichón volcano, crater lake monitoring. Journal of South American Earth Sciences, 72, 241-249. https://doi.org/10.1016/j.jsames.2016.09.001