H$_2$S and SO$_2$ degassing from El Chichón (Chiapas, Mexico) and Víti (Iceland) volcanic lakes

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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$_2$S, 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$_2^-$ contents (~700 mg/l) but differ for their temperature (30.1 ± 1 °C at El Chichón and 21.8 ± 1 °C at Víti) and maximum depth (~11 m and ~60 m at El Chichón and Víti, respectively). The aim of this study is to test if sulfur species (H$_2$S 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) H$_2$S concentrations in the El Chichón and Víti lake gas plumes, with CO$_2$/H$_2$S and H$_2$/H$_2$S 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$_2$S 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$_2$S ratios by the lake CO$_2$ output in 2016, we evaluate an H$_2$S 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 H$_2$S 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$_2$S is therefore partially oxidized in the lake water (mainly as SO$_4^{2-}$), and partially released as a gas phase, as H$_2$S or SO$_2$.

Reference