

Interactive comment on “Ash iron mobilization in volcanic eruption plumes” by G. Hoshyaripour et al.

Anonymous Referee #1

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This manuscript investigates by 1-D modelling the in-plume and in-cloud processes implied in the ash iron solubilisation in volcanic eruption plumes. A first part of the paper is dedicated to present the model and the results corresponding to sensitivity tests on gas composition and ash composition. A second part is a discussion on the comparison of model results with experimental data.

The presented results are, in my opinion, limited in terms of new findings and correspond rather to a methodological paper on the development of 1-D model. In session 3 and 4, there is a lack of comparisons between results and references to support the reliability of the study. The text needs to be clarified and corrected to improve the original aspects of the paper for publication. Even if the purpose of this study is the estimation of atmospheric volcanic iron fluxes to the Ocean, it is an upstream work focusing

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on volcanic physico-chemical processes, which will be rather adapted to a journal on Earth problematic (as the majority of cited journal in the references)?

The title is very general and needs to be changed, e.g. “Investigation on the physicochemical processes implied on ash iron mobilization in volcanic eruption plumes (by 1-D modelling)”.

32537 L5: It is mentioned that “iron near the volcanic vent is mostly insoluble”, that means? Several studies on the solubility of fresh volcanic ash (< 1 or 2 hours) show that Fe ash has a very low solubility but is as soluble as dust Fe and that solubility seems to decrease with the age of volcanic ash, so probably with the distance to the source (e.g. Olgun et al., 2011). Mostly insoluble vs low solubility: what is the order of magnitude? Is it really this difference of solubility which can explained the fertilizing role of volcanic ash? Or simply the large deposition of volcanic particles (as developed in your paragraph p32553 L3). Please develop these points to support the rationale of the study.

32539 L9: It is known for other mineral particles, in particular dust, that cloud processing, acidification, mineralogical composition... are major parameters playing on iron solubility (e.g. Desboeufs et al., 2001; Hand et al., 2004; Schroth et al., 2009). I think that this literature should be mentioned in the background session then discussed in comparison of your results.

32544: Size distribution of the ash: The paper focuses on the processes improving iron mobilization in the volcanic plumes to estimate its biogeochemical impact on phytoplankton, i.e. particles which can be advected and deposited from volcanic plumes to the Ocean. The size distribution of transported volcanic particles in plume (even close to the volcano) seems to be limited to 100 μm with a main fraction inferior to 20 μm (e.g. Martin et al., 2008 or Mather et al., 2004). Why do you consider particle sizes < 1mm, i.e. fine ash rather than really volcanic aerosols?

32548 L9: It is interesting to know the iron dissolution from fine ash, but in a bio-

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geochemical context, could you provide the amount of generate soluble iron salts dependent on this dissolution, since it is this amount which will be critical to estimate the soluble iron from volcanic aerosols? Globally, it is a pity that the fraction of soluble salts is not estimated in the paper since it is really the paramount information to estimate the impact of iron ash after deposition to the ocean!

32549 L1: The pH between 0.3 and 0.5 (Table 4) found by modeling. In order to support the reliability of your chemical results, please specify if it is an usual pH of cloud droplets in volcanic plumes?

32549 L11: Results show an impact of HCl scavenging on pH which itself control iron dissolution. Please mention that pH effect on iron dissolution from oxide is already known (e.g. Schwertmann,1991), in particular with HCl (Sidhu et al., 1981) 32549 L25: "Since iron content of fayalite...is much higher than that of the glass, we can safely neglect the release from the glass.". I'm not agree with that: Even if iron content in glass is low, if its solubility is very superior to the iron solubility in magnetite, the glass could be the major provider of released iron. See paper of Journet et al., (2008) which showed that illite (Fe = 2wt%) is an higher provider of soluble iron than goethite (Fe=62wt%).

32552 L24: the results presented in the table 5 show a large range of calculated RFe. This range is important to compare with the experimental data! So, please discuss on the parameters explaining this range (is it exclusively due to the range of Di?) in order to validate the comparison with the experimental data.

Table 4: please precise in the legend: CP, DP, H and the cases A, B,C and D.

Table 5: please precise the legend: CFe, Di, RFe

References:

Desboeufs et al. (2001) : Factors influencing aerosol solubility during cloud processes. Atmos. Environ. 35(20): 3529-3537.

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Martin et al. (2008): Composition-resolved size distributions of volcanic aerosols in the Mt. Etna plumes, J. Geophys. Res., 113, D17211, doi:10.1029/2007JD009648.

Mather et al., (2004): Tropospheric Volcanic Aerosol, in Volcanism and the Earth's Atmosphere (eds A. Robock and C. Oppenheimer), AGU, Washington, D. C., doi: 10.1029/139GM12.

Schwertmann (1991): Solubility and dissolution of iron oxides." Plant and Soil 130(1-2): 1-25. Schroth et al. (2009): Iron solubility driven by speciation in dust sources to the ocean. Nature Geosciences, 2(5): 337-340.

Sidhu et al., (1981): Dissolution of iron oxides and oxyhydroxides in hydrochloric and perchloric acids, Clay and Clay Minerals, 29 (4), 269-276.

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