Towards a self-consistent thermodynamic magmatic model for conduit transport processes

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The geodynamical side of explosive volcanic eruption modelling on the one hand, as well as the petrological one on the other, have reached a high degree of sophistication and maturity independently from each other over the years. Unfortunately, adherents of one discipline often only utilize the other's tools in a simplified and makeshift way, obscuring the full potential of their synergies. Over the past decade efforts have been made to re-integrate both approaches to the issue into a more holistic view on the sub-surface processes leading to and concurrent with explosive volcanism.

One of the difficulties encountered in that effort are conceptual and technical incompatibilities between thermo- and fluid-dynamic modelling toolboxes. While the tools perform well individually, they are often not suitable to work in combination in highly complex numerical models, due to interface problems impeding performance.

For an ongoing numerical study on transport processes within a volcanic conduit, it has been deemed necessary to re-implement an established thermodynamic model based on Holland and Powell (2011, and follow-ups) in order to a) attain the required computing performance and b) to gain sufficient petrological insight (starting from a geophysical point of view) to be able to make apt use of the tool then at hand.

The path to the intermediate goal of deriving the thermodynamic and transport properties (e.g. density, viscosity, heat capacity and conductivity) in a self-consistent and stable manner suitable for further use in a numerical fluid-dynamics model is illustrated here. The focus is on problems encountered with the petrological modelling, and on the subsequent derivation of the above properties, that are not directly available from the former results. The methods presented are general and applicable to various settings regarding volcanic chemistry and transport processes, however, they will be demonstrated on low-viscosity open-conduit systems typical for strombolian activity.