# Improving capability to model volcanic gas-water-rock reactions and interpret geochemical anomalies

Volcanic gas science is experiencing a renaissance as newly developed multi-GAS (multiple Gas Analyzer System) instruments proliferate and enable the collection of gas-composition data with unprecedented time resolution and fidelity. The USGS has developed and deployed multi-GAS instruments to numerous volcanoes in the United States (e.g. Kīlauea, Mauna Loa, Mount St. Helens, Mount Lassen, Yellowstone, Augustine) and to countries in Latin America, Southeast Asia, and Africa through VDAP. These efforts have greatly improved the ability of the USGS and its foreign partners to monitor volcanic gases, assess hazards, and in some cases forecast eruptions.

However, the ability to interpret such data is limited because the USGS-VSC and VDAP lack the capability to numerically model the interaction of magmatic gases with waters and rocks prior to emission at the surface (ie, “scrubbing”; Symonds et al., 2001); such reactions can drastically alter the compositions of volcanic gas emissions and make the interpretation of monitoring signals difficult. Fortunately, geochemical modeling software (SOLVEQ, CHIM-XPT) developed by academic partners at the University of Oregon can solve complex gas-solid-aqueous phase chemical equilibria problems in hydrothermal systems, and there is much to gain by deepening the collaboration between our institutions to better model problems in volcano-gas geochemistry.

The scientific and societal benefits of such work stand to be far-ranging and will support the interpretation of geochemical data being collected in the US and around the world by VDAP partners. Furthermore, this pursuit aligns with VDAP’s goal of developing a user-friendly application to model volcanic gas scrubbing (USAID/OFDA Department of the Interior USGS Volcano Disaster Assistance Program 5-year Participating Agency Program Agreement for FY2023-2027, submitted) and the VHP’s complementary goals to “take advantage of advances in real-time gas sensors”, “strengthen existing partnerships…in the next five years as USGS VHP seeks to implement the NVEWS”, and to address staffing needs with “increased hires in cooperative agreement awards to observatory partners” (Mandeville et al., in prep.).

For this work to proceed VDAP is exploring options for funding a) one full-time PhD-level researcher for up to 12 months and b) partially funding a Research Associate at University of Oregon for high-temperature thermochemical database development support.

Specifically, the following tasks may be included in the scope of work for a possible contract or cooperative agreement:

* Become fluent in the SOLVEQ and CHIM-XPT softwares (and supporting modules) developed by Mark Reed’s group at University of Oregon
* Adapt SOLVEQ and CHIM-XPT to address the magmatic gas scrubbing problem
* Evaluate and update the high-temperature thermochemical databases that SOLVEQ and CHIM-XPT utilize for their calculations
* Reproduce the calculations detailed in Symonds et al., 2001
* Create and document a scrubbing example problem for inclusion in the SOLVEQ and CHIM-XPT training materials
* Create a manual and/or ‘cheat sheet’ document that explains how to use the software modules to make scrubbing calculations. The expectation is that a geochemist researcher could operate the software and perform their own basic scrubbing model computations independently by following the guide.
* Use the software to model a system of interest (TBD) that is relevant to a VDAP partner or the USGS VHP (e.g. Turrialba, Ijen, Makushin, Redoubt, etc.) with the goal of producing a publication suitable for publication in a journal
* Participate in weekly VDAP and/or VEP videoconference meetings

REFERENCES

Mandeville, C., Cervelli, P., Avery, V., Wilkins, A., in prep. The Volcano Hazards Program:

Strategic Science Plan for 2021-2025, Report Series 2021-XXXX

Symonds, R. B., Gerlach, T. M., & Reed, M. H. (2001). Magmatic gas scrubbing: implications for volcano monitoring. *Journal of Volcanology and Geothermal Research*, *108*, 303–341. www.elsevier.com/locate/jvolgeores