High Spatial Resolution Analysis of Noble Gases using UV lasers

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The use of UV lasers to analyse noble gases in laboratory experiments has provided new impetus to experimental work attempting to determine the fundamental solubility, diffusion and partition of noble gases. Bulk experiments provided some constraints on diffusion parameters but failed to recover real diffusion parameters where minerals broke down. However, attempts to determine solubility and partition coefficients were largely frustrated by surface adsorption, and effects of damage within powders used in the experiments.

UV lasers have been used to analyse, *in situ*, noble gases introduced during laboratory experiments using depth profile technique, by rastering the laser and collecting gas from thin layers of sample. Spatial resolution achieved by this technique improved from around 2 microns to 0.2 microns largely resulting from a move to shorter wavelength lasers. While this technique has provided reproducible results, is has also highlighted problems of different diffusion regimes and provoked discussion of the importance of noble gas diffusion through a mineral lattice compared with noble gas diffusion through defects.

The ability to control ablation using UV laser has also provided a technique to analyse, *in situ*, experimental charges where crystals have been grown from a melt. This work highlighted the importance of melt inclusions within such crystals and gas bubbles formed within the melt and occasionally trapped within the crystals. UV laser extraction of gas from crystals of the order of 100 microns in diameter, has provided reproducible partition coefficients for olivine and clinopyroxene in mantle melts.

The future of such work lies in yet higher spatial resolution depth profiling to study the interaction of the lattice and defect diffusion regimes, and experiments to study noble gases at very high pressures.