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An Investigation of Helium Liberation During Olivine Serpentinization as a Potential Future Experimental Method for Research into Natural Subsurface Hydrogen Production

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This study investigates the experimental viability of measuring helium liberated from olivine crystal breakdown during a serpentinisation reaction and using it as a quantitative proxy for natural hydrogen production. If proven, such a methodology would significantly simplify future investigations into natural subsurface hydrogen production from this reaction.

Olivine samples were sourced from Aheim, Norway. Gas streams produced from dry olivine samples heated to 300°C, and wet olivine samples, which had been serpentinised at 300°C and 1,000 bar for six weeks were collected, cryogenically separated, and measured using mass spectrometry to quantify helium release. Account is taken of the natural diffusion of helium out of olivine crystals at elevated temperatures independent of any serpentinisation.

The control experiments in this study were the first to investigate helium diffusion in natural olivines and demonstrated a linear relationship between sample grain size and the diffusion rate coefficient of proportionality.

For an olivine sample with grain size of 20–30 µm in the presence of 4 molal NaCl, the results confirm that measuring helium liberation during serpentinisation is a viable proxy experimental method for future investigations of natural, subsurface hydrogen production.

Other samples tested did not produce reliable data. Further research is needed to definitively prove the viability of this method, to investigate its experimental limits and to test a range of pressure and temperature reaction conditions, including those simulating specific areas of the crust.

This study showed that measuring helium release from olivine can be successful as a method of investigating serpentinisation and ultimately for use in future research of natural subsurface hydrogen production.