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Novel approaches to stable isotope instruments for in situ measurements of mineral samples

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Stable isotope measurements yield essential quantitative information: mineral formation temperatures; sources, sinks and fluxes in global geochemical cycles of the elements. Use for planetary applications has been hindered by absence of appropriate instrumentation. Detailed analyses of separated and characterised samples are needed but spatially resolved micro-analyses, of zones within a mineral grain or of different grains within the same rock achieve the same. Although there are well-developed instruments, they measure gases and most cannot analyse minerals except in some cases by sample pyrolysis. None performs in a spot analysis mode. We are developing two approaches to in-situ stable isotope instrumentation both with laser micro-sampling. Laboratory demonstrations of the concepts, have focused on sulphate minerals because of their relevance to Mars. We use a NewWave UP213 Nd-YAG laser and produce sulphur dioxide gas directly from sulphate minerals for isotopic analysis. In one of our approaches the gas is measured not by the most usual approach, mass spectrometry, but by very high resolution infra-red spectral absorption using a Tuneable Laser Spectrometer. In tests so far we have measured a sample of 24 micromoles to an internal precision of approximately 2 per mil. In the other approach, the gas is delivered to a Miniature Ion Trap Mass Spectrometer. With a sampling period of 3 to 5 minutes we have released 17 nanomoles of gas from a 100 micro-metre spot, which also was measured to an internal precision of approximately 2 per mil. However, it must be stressed that both these approaches are in the early stages of development and even in the time between the abstract deadline and the meeting, there may be further advances. However, even in their present state of development, both methods offer sufficient precision to give valuable scientific returns.