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Short Communication

A Laser Based Fluorination (BrF_5) System for the Extraction of Oxygen (O_2) from Silicate Rocks of Himalaya and $\delta^{18}O$ Measurements: Method Establishment and Implications

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Abstract

Oxygen forms the majority of minerals constituting the terrestrial and planetary objects. Its chemical and isotopic compositions often bear signatures of the processes occurring within these objects on different time scales. Silicates are the common rocks in the Himalaya, the major feature on the Earth, which has witnessed different stages of metamorphism and got reworked during its evolution. Therefore, oxygen isotopes in silicate rocks can be used to reveal the processes pertaining to the Himalayan orogeny. These processes include petrogenesis, metamorphism, subduction and associated magmatic events, etc. Oxygen isotopic composition ($\delta^{18}O$) is needed to be measured in silicate rocks which require special arrangements. Towards this, a vacuum line of stainless steel coupled with a computer controlled CO_2 laser system was fabricated, for the first time in India, to extract oxygen (O_2) from rock forming mineral in the BrF_5 environment. The line is equipped with suitable valves and traps for the efficient recovery of oxygen from the silicate minerals and reliable handling of hazardous oxidants (i.e., BrF_5, etc.) that are used as fluorination agents to break Si=O bonds. This extraction system is interfaced with a continuous flow stable isotope ratio mass spectrometer and is being used successfully for the oxygen isotopic ($\delta^{18}O$) measurements in silicate and oxide minerals. Here we report the $\delta^{18}O$ results on a set of silicate rocks and standard reference materials including Norway olivine, Gee Whiz Garnet

standard from University of New Mexico, olivine from Norway Fan (Lab Standard), silicate rocks from North West Himalaya (India) and NBS-28 quartz a standard reference material from International Atomic Energy Agency, Vienna. The average $\delta^{18}O$ values (relative to Vienna standard mean ocean water) and 2SD are 6.4 ± 0.3 ‰ (N = 17) for Norway olivine, 12.7 ± 0.2 ‰ (N = 10) for Gee Whiz Garnet and 9.5 ± 0.3 ‰ (N = 12) for NBS-28 quartz. In addition, some of the quartz vein and quartzites from the Garhwal Himalaya were also measured to establish the measurement protocols and procedures. Silicate rocks from the Himalaya near the main central thrust zone were tried to fix the end-member composition for oxygen isotopes ($\delta^{18}O$). Such information is helpful to infer about the origin of quartzite and their relationship with possible protoliths in the region. Further, this technique finds applications in the analysis of biogenic silica (diatoms and phytoliths, etc.) for paleoclimatic reconstruction.

Keywords

Oxygen isotopes – BrF5 – Laser-fluorination – Silicates – Oxides