

A new laser-based, field-deployable analyzer for laboratory-class stable isotope measurements in water

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Details are presented of a new isotopic water analyzer that incorporates an evaporator system, allowing isotopes in liquid water samples as well as in water vapor from ambient air to be measured by the same instrument with precision rivaling or exceeding that of conventional IRMS. The measurements require no sample preparation and the same analyzer can measure both $\delta^{18}\text{O}$ and δD in water simultaneously. Importantly, vapor measurements are made in-situ, in real time, obviating the need for flask sampling. The results of field trials and laboratory measurements show that this analyzer is ideal for precise, accurate measurements with extremely low drift, in widely varying environmental conditions. In the laboratory as well as in field settings, the analyzer can achieve precisions better than of 0.3‰ for δD and 0.05‰ for $\delta^{18}\text{O}$, previously reserved for dedicated, laboratory-based IRMS systems. These results demonstrate that this laser based isotope analyzer, employing wavelength scanned cavity ring down spectroscopy (WS-CRDS) is among the most remarkably simple and reliable tools available to scientists for water isotope studies. It enables real-time, continuous measurements of water vapor in ambient air as well as measurement of waters from precipitation, ice cores and many surface waters, facilitating our greater understand of hydrology, metrology and more recently, global climate change.

B isotope composition of Gorgona komatiites: Do melt inclusions support a subduction-related origin?

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A fundamental question in komatiite genesis is whether komatiites originate due to partial melting of dry and hot (i.e., 400-500°C hotter than the present) mantle or they could be produced by hydrous melting of mantle peridotite at temperatures which are probably only modestly higher than those known today. Gorgona Island, Colombia, is a unique place where Phanerozoic (ca. 90 Ma) komatiites are found and whose origin remains controversial, mostly because of concerns about the nature of volatile components which they appear to contain. In addition, a possible role of subduction impact or later shallow depths magma contamination also remains unclear.

We have analysed major, trace and volatile element concentrations and B isotopic compositions of olivine-hosted melt inclusions from primitive Gorgona picrites and komatiites, using the JEOL JXA8200 electron and Cameca IMS 3f and 1280 ion microprobes at MPI for Chemistry, Germany, and at WHOI, USA. A distinctive feature of all melt inclusions is that they are characterized by relatively high contents of volatile components and boron (0.3–1.0 wt% H_2O , 0.03–0.08 wt% S, 0.02–0.07 wt% Cl, 0.8–2.0 ppm B). These components display positive anomalies in the overall depleted, primitive mantle (PM) normalized trace and REE spectra of melt inclusions ($[\text{La}/\text{Sm}]_n = 0.16\text{--}0.38$; $[\text{H}_2\text{O}/\text{Nb}]_n = 8\text{--}50$; $[\text{Cl}/\text{Nb}]_n = 25\text{--}130$; $[\text{B}/\text{Nb}]_n = 8\text{--}30$, assuming 300 ppm H_2O , 8 ppm Cl and 0.1 ppm B in the PM). Two distinct groups of melt inclusions can be distinguished based on their $^{11}\text{B}/^{10}\text{B}$ ratios (given at average $\pm 1\sigma$ SE of 2.5‰) but having the same range of B concentrations. The $\delta^{11}\text{B}$ values show within the groups subtle correlations with K, Sr, Hf and some REEs. The first group is characterized by relatively low $\delta^{11}\text{B}$ values ranging from -5 to -10 ‰ relative to NBS951 standard and is interpreted as representing melts formed by partial melting of a mantle plume probably containing a component of recycled crust with depleted ^{11}B isotope signature. The second group has $\delta^{11}\text{B} = 0$ to $+16$ ‰ and may well reflect either an injection of a component from a nearby subduction zone carrying fluid-mobile elements and ^{11}B or later contamination by seawater or hydrothermally altered oceanic crust.