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# Cl and $H_2O$ in mantle-derived magmas: Leveraging geochemical databases with element ratios and proxies

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Geochemical databases can be used to address questions of global fluxes from the mantle to the exosphere when there are data covering the entire earth. In many cases though, data from specific areas or sample types are lacking, because: 1) analyses have not been done; 2) samples are not available; 3) samples are not suitable; or, 4) the element or isotope in question has been contaminated or lost so that even good analyses are not trustworthy. In such cases, element ratios or proxies may be reliably used to estimate the element's output. It is critical to establish how variable the element ratio or proxy is regionally and with respect to composition or mantle source type.

In this study, we calculate the global output of Cl and $H_2O$ from mid-ocean ridge basalts (MORB) using PetDB and ocean island basalts (OIB) using GEOROC and compare the Cl/$H_2O$ ratio with seawater and the exosphere. In mantle processes, Cl behaves most like Ba [1], but there are many more data available for K2O, so we use the Cl/K ratio. The biggest problem with determining Cl output from the mantle is that assimilation of seawater-derived Cl is very common and severe in MORB and OIB, and obscures the mantle contribution [2]. Earlier limits (mantle Cl/K<0.07; [2]) are too high for most MORB. We propose that mantle Cl/K is $\approx$0.005 for NMORB and $\approx$0.035 for most E-MORB. These are based on the lowest ratios of MORB, especially from ultraslow ridges where assimilation is least [2]. NMORB values are consistent with depleted MORB melt inclusions [3]. Cl/K in EMORB is similar to OIB, which ranges from 0.02 for EM-type to 0.08 for HIMU basalts [4]. The well-established $H_2O$/Ce [5] ratio can be used to estimate $H_2O$ where there are no $H_2O$ data, or where degassing has occurred. $H_2O$/Ce varies regionally especially in the N. Atlantic, but slow spreading there makes it's contribution less important. If only major element data are available, the content of $H_2O$ can be estimated using the linear relationship in $H_2O$/K2O vs K2O/$TiO_2$. Magma production rates are also important. For MOR, crustal thickness is known or can be estimated using empirically-derived geochemical proxies [6] with the databases. Another issue is how to calculate averages for specific parts of the mid-ocean ridge or specific islands. It is most accurate to calculate a weighted average of an island group based on the volume and element concentrations, but these data are often lacking.

The fluxes of Cl and $H_2O$ into and out of the mantle at subduction zones are greater than from MORB + OIB, even though the magma volume is less. Element ratios and proxies are not as reliable because the mineralogy, source compositions and processes are more complex and numerous. Glass inclusions in olivine are most useful for estimating Cl and $H_2O$ concentrations in arc magmas before degassing, but must be filtered carefully. Magma volumes are also harder to measure in subduction settings.

[1] Schilling, et al. (1980) Ph.Tr.Roy.Soc.Lond.297, 147-178.. [2] Michael & Cornell (1998) JGR 103, 18325. [3] Saal et al. (2006) Nature 419, 451-455. [4] Stroncik & Haase (2004) Geology 32, 945-948. [5] Michael (1988) GCA 52, 555-566. [6] Humler, et al. (1999) EPSL 173, 7-23.