Crystal size distributions as a guide for microanalysis: An example from Detroit Seamount

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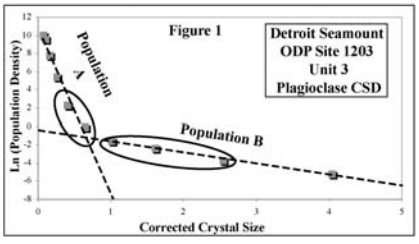
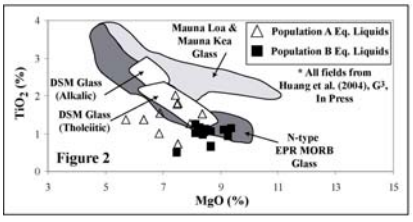
Microanalysis of minerals is informative when structured in a physical framework, where crystal populations or common zoning can be identified prior to costly analytical work. Crystal size distributions (CSDs) distinguish crystal populations with similar nucleation and growth conditions and kinetic processes during crystallization (e.g., magma mix-ing). A plagio-clase CSD from a single thin section of an OIB-generated ~ 76 Ma Detroit Seamount (DSM) pillow basalt (from ODP Site 1203) is shown in Fig. 1, formed when the Hawaiian hot-spot was near a MOR at 75-80 Ma. The CSD shows 2 populations, A (length = 104 – 226 μm) and B (length = 815 μm – 1.6 mm). The slope of the dashed line is related to growth rate and residence time. Is this CSD a result of magma mixing? EMP analyses focused on the 2 circled size ranges from each population. MELTS modelling of pillow rim glass suggests plagioclase should be An_{76-77} at shallow crustal pressures. Plagioclase crystals in Populations A & B have disitnct compositions: A = An_{59-66}; B = An_{77-88}. In Fig. 2, equilibrium liquids for Population A overlap DSM tholeiitic glasses and the young Hawaiian basalt glass field. Population B equilibrium liquids are more primitve and overlap the EPR N-MORB field.





Conclusions

These preliminary results are interpreted to be consistent with mixing of OIB and MORB magmas. Trace element data and Sr isotope data will provide better insight into this hypothesis.

A new calibration of H measurements by SIMS in glasses and nominally anhydrous minerals: Application to experimental determinations of H partitioning

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We present new SIMS calibrations of H concentrations in basalt (0.17 to 7.37 wt% H_2O, n = 13), rhyolite (0.3 to 6.2 wt% H_2O, n = 10), and quartz (4 wt% H_2O, n =1) glasses, and olivine (~0 to 243 ppm H_2O, n = 5), opx (~0 to 263 ppm H_2O, n = 5), cpx (~0 to 490 ppm H_2O, n = 6), pyrope garnet (~0 to 194 ppm H_2O, n = 8) minerals using the CAMECA 6f ion microprobe at ASU. Standards include experimental and natural samples characterized for H content by unpolarized (glasses and garnet) and polarized (on oriented olivines and pyroxenes) FTIR and nuclear reaction analysis (for olivine, Bell et al. JGR 2003).

Careful attention to vacuum quality, including epoxy-free sample mounting using aluminium disks filled with indium, yielded routine detection limits of 5–10 ppm H_2O, measured on H_2O-free synthetic olivine. Calibration curves for basaltic, rhyolitic and quartz glasses show negligible compositional effects when $^1H/^{30}Si$ measured by SIMS is compared to sample H_2O/SiO_2, indicating that matrix effects for H analyses of SIMS calibration may be minimal, though further assessment is required.

Experimental measurements of mineral/melt partition coefficients, including new experiments analyzed at ASU and our previous results (Aubaud et al., GRL 2004) are consistent with mineral/melt partition coefficients applicable to the mantle as follows: $D^{(ol/melt)} = 0.0017$, $D^{(opx/melt)} = 0.019$, and $D^{(cpx/melt)} = 0.023$ and $D^{(sol/liq)} = 0.009$. Mineral/melt *D*s do not show obvious dependences on pressure between 1–3 GPa or H_2O concentrations in glasses between 3.1 and 8.8 wt.% H_2O, though such effects may occur at higher pressure or lower H_2O.