Megacrystic, High-Pressure Pyroxenes From Lavas Co-eruptive with the Columbia River Basalt Group of Northeast OR, USA: Evidence of Deep Magmatic Storage

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The Basalts of Magpie Table (BMT) of northeastern Oregon, USA, make up small volume lavas (<5 km^3), which are surrounded by the Columbia River Basalt Group (CRBG) and lay on top of andesite and rhyolite lavas of the Strawberry Volcanics (SV). Field relations constrain the BMT to younger ages than the most proximal dated SV lavas of 15.6 Ma, coeruptive with the waning phase of the CRBG. The BMT lavas are primitive, high-alumium olivine tholeiites with ~8.0 to 8.8 wt% MgO and ~47.0 to 48.5 wt% SiO_2. They contain large (>4 cm) megacrysts of clinopyroxene (cpx) with spinel inclusions. All analyzed megacrystic cpx cores have ~8–10 wt% Al_2O_3 with <1 wt% TiO_2 and Mg#'s of 79–83. Rims of the cpx are chemically akin to groundmass cpx with moderate Al_2O_3 (~3-5 wt%) and Mg# of 74. Laser ablation ICP-MS analyses of the megacrystic cpx indicate that there is minor variblity in trace elements (e.g. La: 3.8 to 1.4, Nd; 12.0 to 7.5, and Ce: 12.0 to 6.3 ppm) negatively correlated with Al_2O_3. The most Al-rich cpx cores are less enriched in trace elements and REEs than the lower Al-rich cpx rims (~3-5 wt%). Both cores and rims of the cpx are in equilibrium with the liquid ($K_D(Fe\text{-}Mg)^{cpx\text{-}liq}$ = 0.27 ± 0.03) within uncertainty. Cpx thermobarometry indicates that the cores were originally grown in a magma between 11-14 kbars (~35-45 km depth) at ~1210-1240°C, then moved to a second storage location between 3-6 kbars (11-20 km depth) at ~1110-1140°C before erupting to the surface. MELTS modeling, using the bulk rock composition, confirms that cpx core compositions are first on the liquidus at the recorded higher pressures, but olivine began to crystallize at the lower pressures and temperatures recorded in the cpx rims (~5 kbars and ~1100°C). Olivine cores have a composition of ~Fo 88 and rims of ~Fo 62. Preliminary olivine diffusion modeling suggests ascent rates of ~62 m/hr for vertical transport through the crust.