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Large Igneous Province magma plumbing system processes: insights from mineral chemistry and diffusion chronometry from the Shatsky Rise Oceanic Plateau, Northwest Pacific

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Oceanic Large Igneous Provinces (LIPs) usually have abnormally thickened oceanic crusts and complex magma plumbing systems. Investigating the magma plumbing systems of LIPs is crucial for understanding the dynamic evolution of our Earth. The submarine Shatsky Rise oceanic plateau is the third largest oceanic plateau on Earth and reaches a maximum crustal thickness of 30 km at Tamu Massif. Here, we present major-trace elements of clinopyroxene and plagioclase from Site 1213 of Ocean Drilling Program Leg 198 at Tamu Massif. Based on the mineral chemistry and P–T calculations, we identified two types of Cpx and two groups of Pl. Type 1 Cpxs have higher Al2O3 (~3 wt.%), CaO (17~19 wt.%) and Na2O (0.3~0.4 wt.%), and crystallized at greater depth and prior to the onset of plagioclase crystallization, whereas Type 2 Cpxs have relatively lower Al2O3 (~1.5 wt.%), CaO (14~16 wt.%) and Na2O (0.2~0.3 wt.%), and crystallized at shallower depth. The Pls can also be divided into two groups: Group 1 are the core of phenocrysts with high crystallization pressure (727 to 733 MPa) and An values (~ 85), whereas Group 2 are the rim of phenocrysts and groundmass with low crystallization pressure (<204 MPa) and An values (<75). Based on our new results, we propose a two-stage petrologic model to reveal the magmatic evolution at Tamu Massif. Stage 1 occurs at the Environment A, located within the lower crust (~25 km depth) with high crystal crystallization temperature (>1220 ℃) and Stage 2 occurs at the Environment B, located within the shallow crust (~7 km depth) with low crystal crystallization temperature (~1140 ℃). Our MELTS modeling suggests the crystallization sequence is Ol-Cpx-Pl at Tamu Massif and Pl gradually replaced Cpx as the dominant fractionating phase at Environment B. The final transport time from Environment B to eruption on the seafloor is usually within a few days (6.27–93.9 h), which is indistinguishable from the ascent rates of fast spreading ridge systems, but slower than those of volatile-rich magmas in explosive arc volcanoes and kimberlites. This study improves our understanding of the formation and evolution of oceanic plateaus around the world.

