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Rates and processes of crystallization in on-axis and off-axis MOR basaltic melts

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We obtained FE-EPMA elemental maps and LA-ICPMS-derived Sr profiles of over 60 plagioclase crystals from MOR basalts erupted from ultra-slow to fast spreading ridges (Gakkel, JdF, Gorda, EPR). Besides on-axis lava flow samples, the sample set includes two samples from the JdF Axial Seamount, one from a young off-axis seamount of the JdF Southern Cleft segment, and two from EPR off-axis flows. We derive equilibration times for the relatively rapidly diffusing Sr of the order of months to a few years. Most crystals preserve diffusive disequilibria of strontium. Crystal residence times at MORB magmatic temperatures are thus significantly shorter, of the order of days to a few months at most, precluding prolonged crystal storage in axial magma chambers and instead pointing to rapid crystal growth and cooling (up to about 1 deg. C per hour) shortly prior to eruption of these samples. Crystal growth is therefore inferred to occur mostly during dike injection. However, there are clear differences between different samples: At the fast spreading EPR, on-axis samples yield residence times of mostly < 5 weeks, while off axis samples cluster between 5 and 10 weeks, similar to on axis samples at intermediate spreading rates. One slightly more evolved JdF axial MOR lava yields residence times of mostly > 10 weeks, while for the JdF off-axis seamount, ages > 6 months dominate. In conjunction with the crystal morphological observations, these results provide insights into differences in the tectonomagmatic environments in which these rocks were generated.

Keywords: geospeedometry, MORB, seamount, dyke, magma chamber, residence time