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Rapid source shifting of a deep magmatic system revealed by the Fagradalsfjall eruption, Iceland

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Recent Icelandic rifting events have illuminated the roles of centralized crustal magma reservoirs and lateral magma transport, important characteristics of mid-ocean ridge magmatism. A consequence of such shallow crustal processing of magmas is the overprinting of signatures that trace the origin, evolution and transport of melts in the uppermost mantle and lowermost crust. We present unique insights into processes occurring in this zone from integrated petrologic and geochemical studies of the 2021 Fagradalsfjall eruption on the Reykjanes Peninsula in Iceland. Geochemical analyses of basalts erupted during the first 50 days of the eruption combined with associated gas emissions, reveal direct sourcing from a near-Moho magma storage zone. Geochemical proxies which signify different mantle compositions and melting conditions (K_2O/TiO_2, La/Yb and radiogenic isotopes) changed at a rate unparalleled for individual basaltic eruptions globally. Initially, the erupted lava was dominated by melts sourced from the shallowest mantle but over the following three weeks become increasingly dominated by magmas generated at a greater depth. This shift in lava chemistry is greater in magnitude than the entire five-century output during the last eruptive episode on the Peninsula (circa 700 to circa 1240 AD). This exceptionally rapid trend in erupted compositions provides an unprecedented temporal record of magma mixing that filters the mantle signal, consistent with processing in near-Moho melt lenses containing 10^7–10^8 m^3 of basaltic magma. Exposing previously inaccessible parts of this key magma processing zone to near-real time investigations, provides new insights into the timescales and operational mode of basaltic magma systems.