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Constraining magma storage and dynamics from complexly zoned crystal cargoes: Snake River Plain volcanic province, USA

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The Snake River Plain (SRP) volcanic province, located in the western United States, is a prime example of a continental hotspot. It records 12 million years of bimodal volcanism, with early rhyolite caldera complexes covered by extensive younger basaltic flows. The ICDP Snake River Scientific Drilling Project completed three drill holes in the SRP, which combined offer an overview of the entire volcanic sequence.

The Kimana drill core samples 1912 m of continuous basalts, which were erupted over a time span of 6 million years and represent lavas from 78 separate monogenetic volcanic centers, of which we focus on one. The basalts consist of mm-scale macrocrysts of plagioclase and olivine with zoning patterns too complex to have grown in situ, and are interpreted to be entrained mush fragments. The groundmass is crystalline and consists of plagioclase, olivine, pyroxene and oxides. Plagioclase macrocrysts often display different types of zoning in a single crystal, and are intergrown in large glomerocrysts. Plagioclase cores can be divided into three categories: (i) low-anorthite resorbed, (ii) patchy and (iii) sieved, and are the result of early mush disaggregation and decompression. They are overgrown by oscillatory mantles with repeated resorption surfaces and narrow late-stage low-anorthite crystal rims. Anorthite contents of crystal cores and oscillatory mantles overlap (~An_{50-70}), except for sieved cores which have slightly higher anorthite contents (~An_{55-75}). Oscillatory rims do not display clear increases in minor elements (Fe, Mg) along resorption surfaces, indicating resorption events are due to convection or to episodic influx of heat rather than direct interaction with recharge magma. Sieved crystal cores have narrow oscillatory mantles and are not fused with other crystals as part of glomerocrysts, and are interpreted to have been brought into the magmatic system as part of a mafic recharge event at a late stage before eruption.

The complex plagioclase textures show evidence of several stages of mush disaggregation and remobilization of mush crystals, due to episodic magmatic recharge and heat influx before eruption. They indicate a complex magmatic plumbing system under the Snake River Plain with different interconnected crystallization environments.