Emplacement of magma batches and incremental growth of igneous bodies: a case study of the Fangshan pluton, North China Craton

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The Fangshan intrusive suite is a composite pluton in the North China Craton, which has been attributed as an incremental assembly of small magma batches. In this contribution, the history of crystallization has been studied in detail through zircon LA-ICP-MS U-Pb dating, which records prolonged crystallisation of each intrusive unit between 132.2-127.9 Ma. The magmas were episodically extracted from the deep storage area and ascended to the final intrusion level at 10-16 km palaeo-depth. Zircon trace element and Hf isotopic compositions, Ti-in-zircon temperatures from the four intrusions and mafic enclaves show significant difference and suggest their crystallization occurred in isotopically and chemically diverse magma batches. These magma batches formed in the lower crust from mingling and mixing at various proportions of residual melts (derived from fractional crystallization of mafic magmas with crustal partial melts). Four type zircons were observed in mafic enclaves based on CL images, including antecrysts (type 1), xenocrysts (type 2 and type 3), recrystallized zircon (type 4), recording the whole evolution history of mafic magmas. Type 1 zircons were not formed at the emplacement level and were “antecrystic” formed at the deeper level of hot zone and entrained into the ascending melts. The most of type 2 zircons were captured from coarse-grained monzonite. The type 3 zircons display core-rim texture, illustrating that xenocrysts may successively grow in mafic melts. The type 4 zircons display patchy zoning that is a disequilibrium texture, manifested by the replacement of U–Th–REE-rich zircon by U–Th–REE-poor zircon, which was in response to the magma mixing between mafic melts and felsic melts. This study shows that zircon chemistry coupled with detailed textural analysis can provide a powerful tool to elucidate the complex evolution of a magma system.

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