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Petrogenesis of the Zhongchuan zoned pluton: implication for incremental assembly of magma

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Understanding the emplacement mechanism of magma is essential to interpret the compositional variation in magma system and the way of the pluton and crust assembly. A growing body of data indicates that the pluton generates via incremental assembly of magma (Coleman et al., 2004, Geology), distinct from the way of diapirism and stoping (Pitcher, 1993, Springer Science & Business Media). The contribution exhibits the systematic study of mineralogy, petrology and geochemistry on normally zoned Zhongchuan pluton located in the western Qinling orogen, China, with the aim to reflect batch-wise assembling process of magma. Our data reveal that the Zhongchuan pluton was assembled by two pulses of magma, which experienced distinct magma evolution. The middle and central portion of the pluton experienced crystal fractionation of plagioclase and alkali-feldspar with concomitant accumulation of biotite, whereas, the outer portion is dominated by crystal fractionation of alkali-feldspar with attendant accumulation of biotite, which is identical to the petrographical observation. Although the variable-degree mixing between the mafic magma represented by mafic microgranular enclaves (MMEs) and the host rocks can explain the distinct isotopic signatures, the similar content of K2O among different portions of this pluton preclude this speculation due to the high K2O content of the MMEs. The sharp contact between the MMEs and the host rocks probably limits their isotope exchange. In fact, the simple mixing between the MMEs and their host rocks is difficult to lead to overall variations due to their smaller volumes (Clemens et al., 2017, EGU). As a consequence, the middle and central portions were originated from the same magma source and experienced assimilation and fractional crystallization subsequently, distinct from the outer portion which was derived from a slight depleted source. The distinct oxygen fugacity conditions also confirm their discrete magma source. Our results provide a compelling example for incremental assembly of the pluton.