



## **Emplacement mechanism of Mishuling Pluton: Implications for the Late Indosinian Tectonic Evolution of Qinling Orogen**

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Late Indosinian granitic plutons (mostly 225-205 Ma) are extensively developed in Qinling orogen, Central China, which is generally considered as lithospheric-scale magmatic response to the Indosinian amalgamation of the North China Block and the South China Block. A wealth of geochemical studies about these granites focusing on their origin and magmatic settings has been conducted in the past decades. However, the timing of emplacement of the granites related to the collisional or postcollisional phases is intensively disputing recently.

A pilot multidisciplinary study primarily from the structural viewpoint including field observations, geochronology, microstructure, AMS, and gravity survey about one of the biggest granitic pluton, Mishuling pluton in West Qinling, had been performed recently to exemplify the emplacement mechanism of the late Indosinian plutons, then to clarify the controversy and further discuss its tectonic significance for Qinling.

Geometric and kinematic studies in the field about the brittle-ductile shear zone bordering Mishuling pluton on south display synmagmatic dextral transpression. New zircon dating by LA-ICP-MS method verified the accurate age of the pluton ( $212\pm 2$  Ma), which is in the range of the late Indosinian magmatism and accordant with the age dating on mylonitic granitic dykes in the southern bordering shear zone ( $215\pm 3$  Ma). Field and microstructural studies had recognized three types of deformation about magmatic rheological states in the pluton, magmatic flow, high temperature solid-state flow and low temperature solid-state flow, in which the former two predominate the fabrics that AMS recorded at pluton scale, the last one appears in the southern margin is the result of a later brittle deformation.

Thermomagnetic analysis and microstructures demonstrate that the AMS fabric is carried primarily by biotite with magnetite. Results of the fabric patterns in the pluton are contrasting between the western part and eastern part. The steep foliations dip inwardly in the western part with gently or moderately plunging lineation, which forms an anticlockwise eddy-like arrangement in planar, while in the eastern part, moderately W-plunging lineations are well developed within E-W-trending inward dipping foliations. The overall fabric patterns at pluton scale are continuous from west to east, eastern fabric wrapping around the western one to form a drip appearance fabric trajectory. Gravity survey allows determination of the 3D shape of the pluton, the western part of the pluton is thicker in the forward gravity modelling profiles than the eastern one which is interpreted as the feeder zone.

On the basis of all the evidences collected, we infer a spiral shape upwelling of magma in the west and then spread eastward during emplacement, which is coincided with and dominated by the regional wrench tectonics. Multidisciplinary study of the Mishuling pluton exemplify that the late Indosinian plutons in Qinling orogen is likely to considered as synorogenic magmatic event, but in the late stage of collision when the tectonic regime is transferring from collision to extension due to orogenic collapse, wrench tectonic resulted from collision-related lateral escape is prevalent during this period. The new structural results can also be used to explain the indiscernable geochemical characteristics.