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The Hengshan Low-angle Normal Fault Zone: Structural and Geochronological Constraints on the Late Mesozoic Crustal Extension in South China

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We document in this paper a significant low-angle normal fault, namely the Hengshan detachment fault, which extends more than 150 km long in NNE orientation and bounds an elongated Early Cretaceous basin in Hunan

Province, central South China. Detailed structural and geochronological analyses have been conducted along its southern segment, where a well exposed, ~3km thick, flat ductile shear zone develops along the western margin of

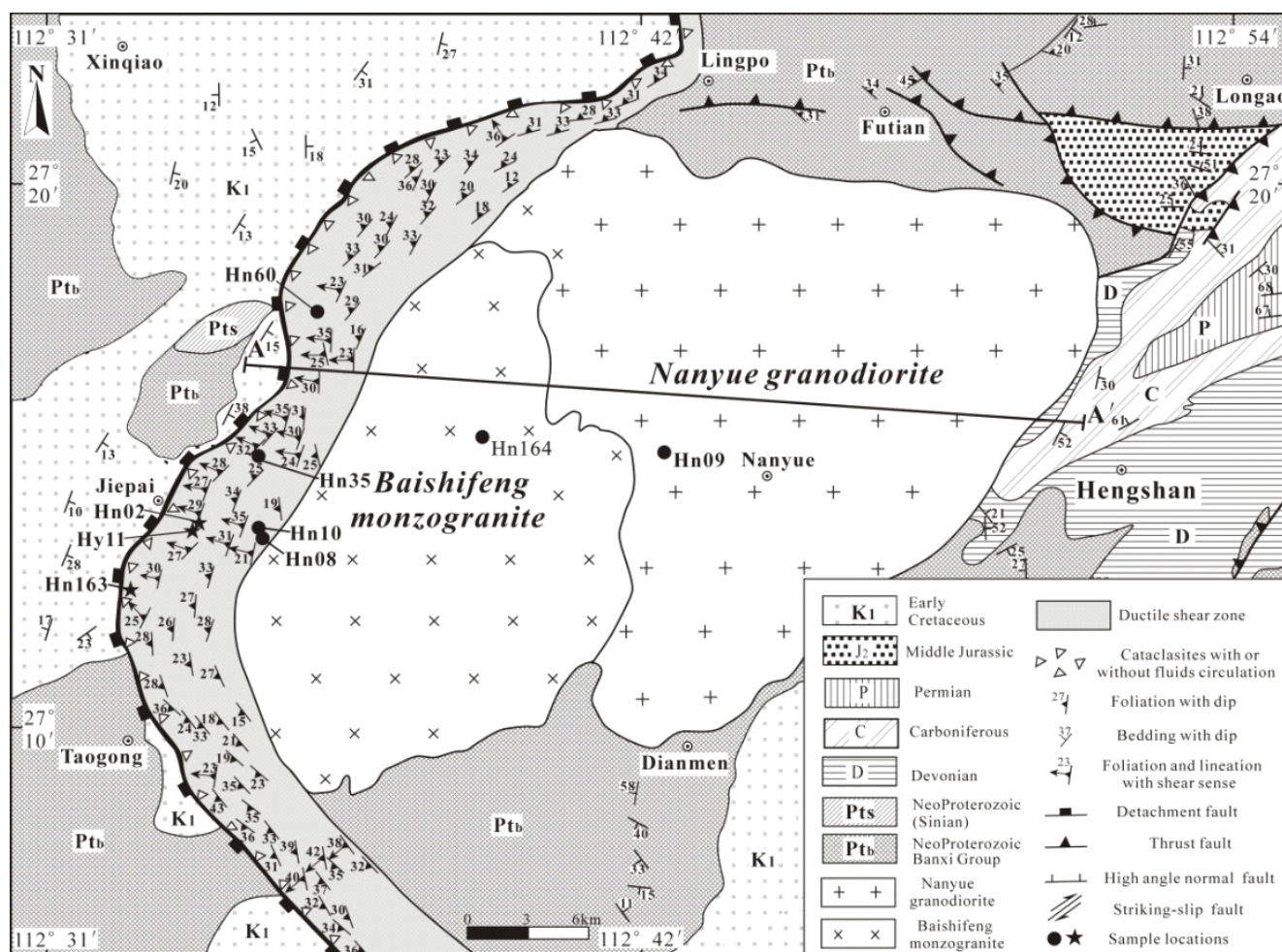


Fig.1 Detailed geological and sample location map of the Hengshan low-angle fault zone.

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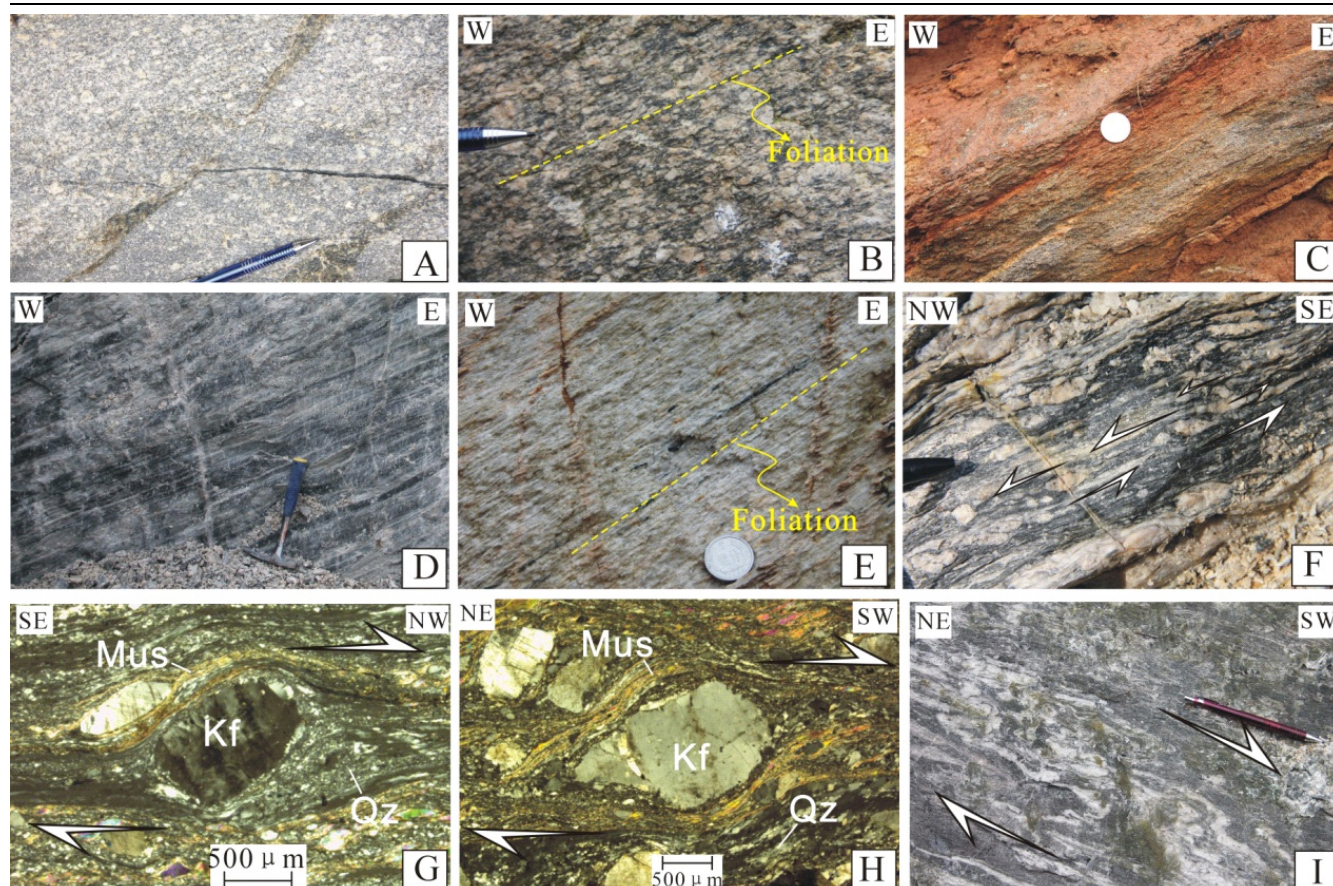


Fig.2 Outcrop photographs and microscopic views showing the structures and kinematic criteria in the Hengshan low-angle fault zone. (A) Non-mylonitic granodiorite of the Nanyue pluton. (B) Mylonitic Baishifeng monzogranite in a plane parallel to the lineation (XZ plane). (C) Strongly mylonitized and foliated Neoproterozoic metamorphic rocks in the shear zone. (D) The Neoproterozoic metamorphic rocks permeated by the fluid of albitite suffer from strong mylonitization. (E) Strongly mylonitized and foliated albitite dyke in a plane parallel to the lineation (XZ plane). (F) On the macroscopic view, strongly stretched albites with asymmetric tails indicating a top-to-the-NW sense of shear along the northern part of the shear zone. (G) On the microscopic view, sigma-type asymmetric K-feldspar phenocrystal on "XZ" plane in the mylonitic rocks indicating a top-to-the-NW sense of shear along the northern part of the shear zone. (H) Sigma-type asymmetric K-feldspar phenocrystal indicating a top-to-the-SW sense of shear along the southern part of the shear zone. (I) Asymmetric folds indicating a top-to-the-SW sense of shear along the southern part of the shear zone.

the Hengshan granitic massif. This zone is featured by NE-NW gently dipping foliations bearing NW-SW stretching lineations. Shear sense criteria indicate top-to-the-NW and top-to-the-SW motions along its northern and southern parts, respectively. Quartz c-axis orientations of mylonitic rocks from the shear zone exhibit asymmetric single or crossed girdle patterns, and the distributions of fabric point maxima suggest a simultaneous operation of basal $\langle a \rangle$ and prism $\langle a \rangle$ slips, indicating a deformation temperature ranging from 400°C to 550°C. One zircon U-Pb age of the sheared albitite and three muscovite $^{40}\text{Ar}/^{39}\text{Ar}$ ages of the mylonitic rocks indicate that the ductile shearing initiated at 136 Ma and lasted till 97Ma. The zircon U-Pb dating results of five granitic samples from the Hengshan granitic pluton yield two phases of crystallization ages of 232-228Ma and 150-151Ma respectively, indicating two preceding magmatic events

prior to the ductile shearing in the lower plate. Our structural and geochronological data allow defining the Hengshan massif as an extensional dome, rather than a metamorphic core complex as previously predicted, due to the lack of syn-tectonic plutonism. This study provides crucial evidence for understanding how the mid-upper crust deformed during the process of extension, which testifies to a coeval occurrence of non-coaxial deformation of the ductile flow in the middle crust and brittle faulting in the upper crust. It also sheds new insights into the timing of the regional crustal extension in South China, and permits to constrain its onset time to be ca. 136Ma.

Key words: Hengshan detachment fault; SHRIMP zircon U-Pb; $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology; Late Mesozoic; extensional structures; South China

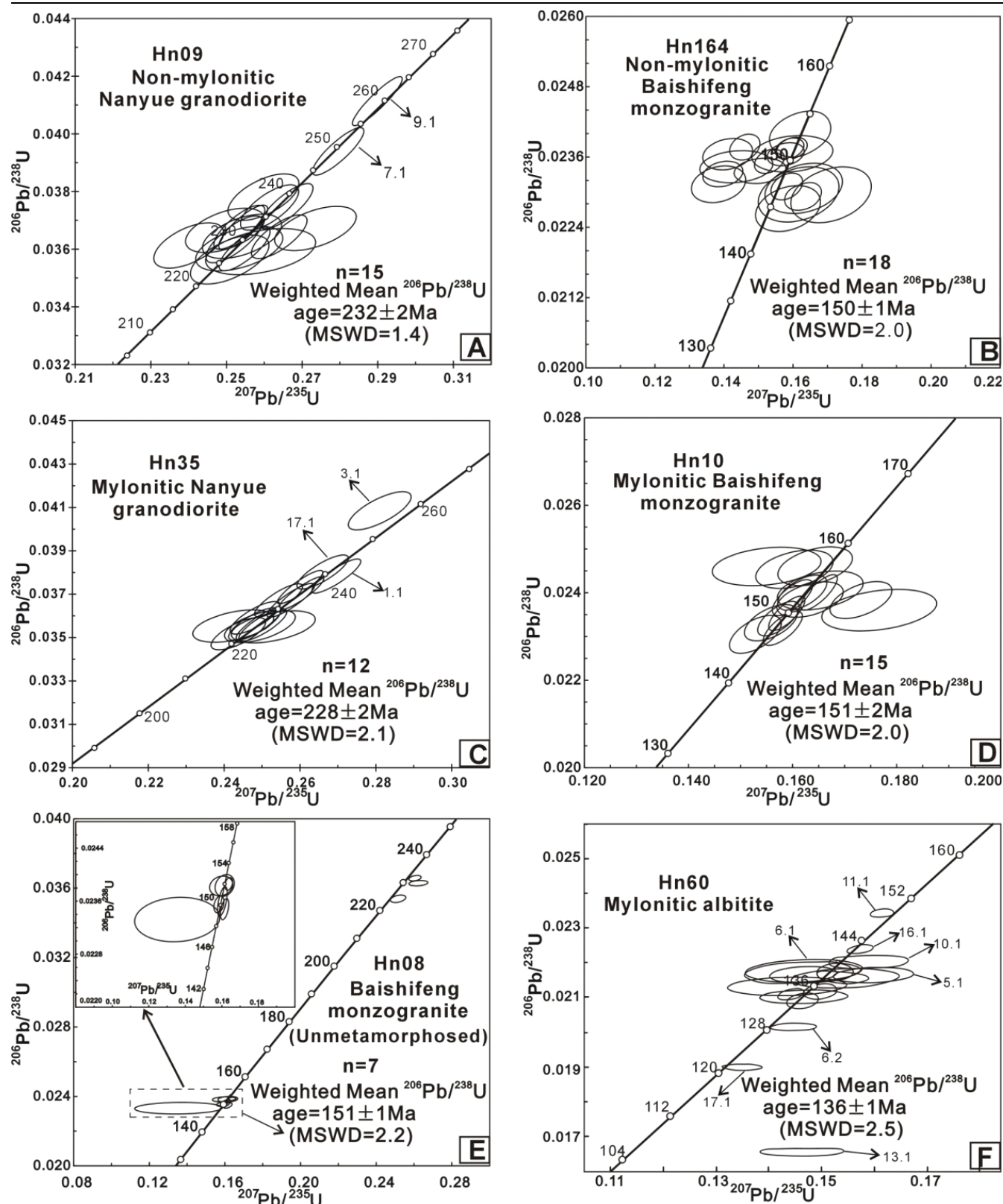


Fig.3 Cathodoluminescence (CL) images and SHRIMP U-Pb zircon dating results for rock samples from the Hengshan low-angle fault zone and granitic plutons. MSWD, mean square of weighted deviates.

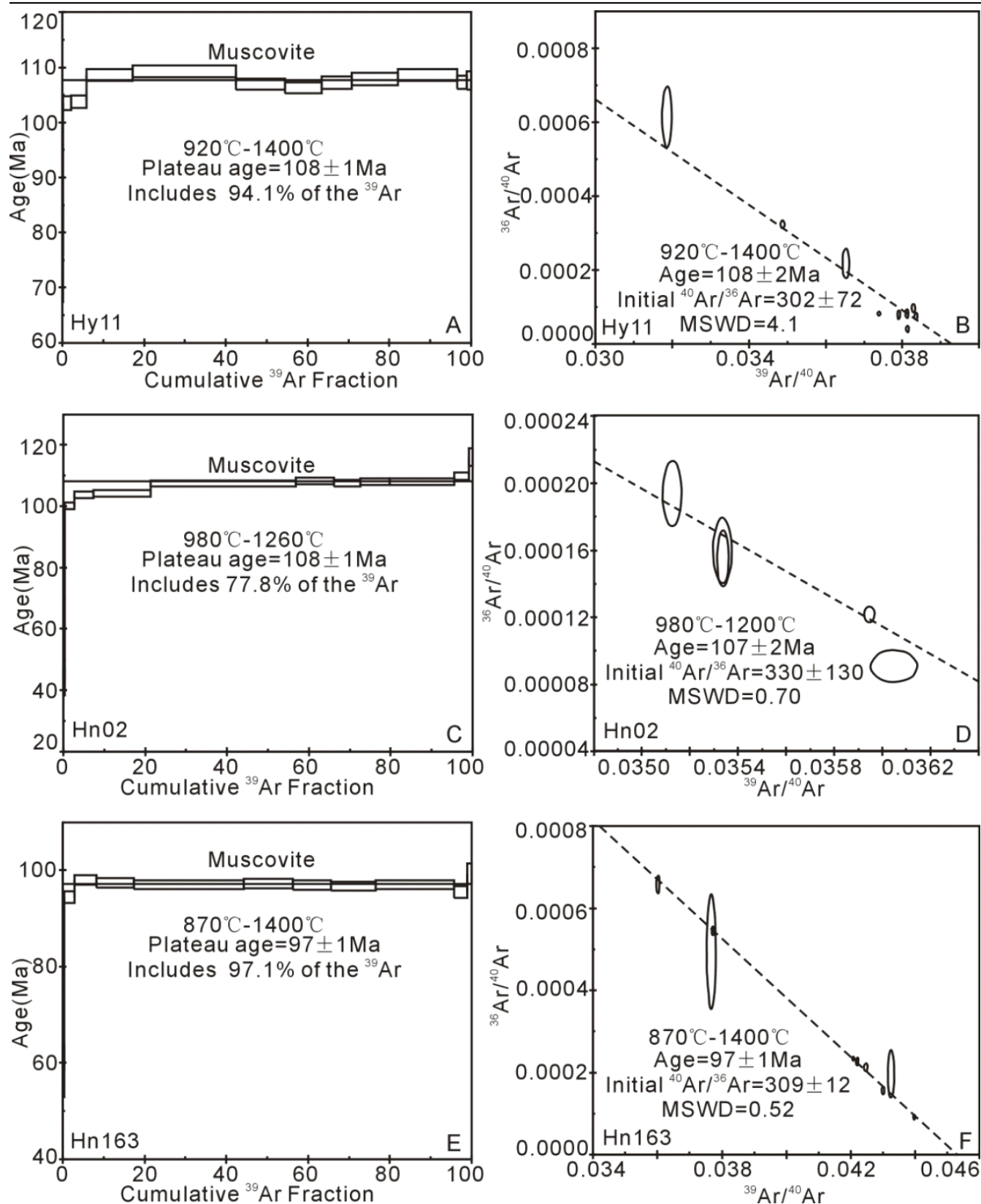


Fig.4 $^{40}\text{Ar}/^{39}\text{Ar}$ apparent age spectra and corresponding inverse isochron plots of syn-kinematic muscovites separated from the mylonitic rocks in the ductile shear zone. (A) and (B) Hy11, east of Jiepai township; (C) and (D) Hn02, east of Jiepai township; (E) and (F) Hn163, south of Jiepai township. See Fig. 1 for their locations. MSWD, mean square of weighted deviates.