Petrogenesis of Mesozoic granitoids and volcanic rocks in South China: A response to tectonic evolution

This paper summarizes the new results on the petrogenesis of Mesozoic granitoids and volcanic rocks in South China. The authors propose that these rocks were formed in time and space as a response to regional tectonic regime change from the continent-continent collision of the Indosinian orogeny within the broad Tethyan orogenic domain in the Early Mesozoic (T1–T3) (Period I) to the largely extensional setting as a result of the Yanshanian orogeny genetically associated with the NW–WNW-ward subduction of the paleo-Pacific oceanic lithosphere in the Late Mesozoic (J2–K2) (Period II). Of the Period I Indosinian granitoids, the early (T1–T21) ones are syn-collisional, and formed in a compressional setting; the late (T22–T3) ones are late-collisional, and formed in a locally extensional environment. During the Period II Yanshanian magmatism, the Early Yanshanian (J2–J3) granitoid-volcanic rocks, which are distributed mainly in the Nanling Range and in the interior of the South China tectonic block (SCB), are characteristic of rift-type intraplate magmatism, whereas the Late Yanshanian K1 granitoid-volcanic rocks are interpreted as genetically representing active continental margin magmatism. The K2 tholeiitic basalts interlayered with red beds are interpreted as genetically associated with the development of back-arc extensional basins in the interior of the SCB. The Yanshanian granitoid-volcanic rocks are distributed widely in South China, reflecting extensional tectonics within much of the SCB. The extension-induced deep crustal melting and underplating of mantle-derived basaltic melts are suggested as the two principal driving mechanisms for the Yanshanian granitic magmatism in South China.

Introduction

The South China tectonic block (SCB) is bounded to the north by the Qinling-Dabie orogenic belt, and to the west and southwest by the Tibetan and Indochina blocks. The Mesozoic granitoids and volcanic rocks in the SCB are largely concentrated in the southeast region of the block; thus the authors use the acronym SE-SCB to emphasize their geographic and geological distributions. It has been known for many years (e.g., Department of Geology, Nanjing University, 1981: The Granitoid Research Group of the Nanling Project, Ministry of Geology and Mineral Research, 1989; Xie et al., 1996; Wang and Zhou, 2002) that Mesozoic granitoid-volcanic rocks are widespread in the SE-SCB (Figure 1), and economically significant W, Sn, U, Nb-Ta, REE, Sb and Hg mineralizations are genetically associated with these rocks, particularly the strongly peraluminous granites with A/CKN (molar Al2O3/[CaO + Na2O + K2O]) > 1.1. Two periods of tectono-magmatism are recognized, i.e., the Indosinian Period and the Yanshanian Period. The former includes the Early (251–234 Ma) and Late (234–205 Ma) Indosinian sub-periods, and the latter includes the Early (180–142 Ma) and Late (142–67 Ma) sub-periods. Noticeably, there are two stages of tectono-magmatism in South China during the Late Yanshanian sub-period: (1) K1 active continental margin magmatism, corresponding to low-angle fast subduction of the paleo-Pacific Plate, producing calc-alkaline granitoid-volcanic rocks (Zhou and Li, 2000), and (2) K2 intra-plate magmatism, when a new subduction zone started further to the east (geologically equivalent to the Japan-Taiwan zone), corresponding to high-angle subduction of the paleo-Pacific Plate (Uyeda, 1983), forming fault-bounded basins with red beds and intra-continental tholeiitic basalts. A compressional tectonic event may have taken place ~100 Ma inferred from the interpreted Late Cretaceous angular unconformity (Charvet et al., 1994). The nature of this unconformity is debatable, but it is interpreted to be represented by the undeformed upper volcanic series overlying the highly sheared volcanics and deformed older granites in the coastal areas of the SE-SCB. This unconformity has been further interpreted as indicating the collision between the K1 active margin of the SCB and the West Philippine block (Charvet et al., 1994; Lapierre et al., 1997; Maruyama et al., 1997). It is also known that the SE-SCB experienced a tectonic shift from being influenced by the eastern Tethyan tectonic regime in the early Mesozoic to being influenced by the paleo-Pacific tectonic regime in the late Mesozoic. The timing of such a tectonic shift remains debatable. Thus, the petrogenesis of granitoid-volcanic rocks and the tectonic evolution in the SE-SCB have attracted great attention (Tao et al., 1998; Chen et al., 2002). Current views on the Mesozoic petrogenesis in the SE-SCB include lithosphere extension and asthenosphere upwelling (Li, 2000; Li et al., 2001), rifting and large-scale lithosphere delamination/thinning in eastern Asia (Zhu et al., 1997; Cai et al., 2002), Mesozoic rifts in coastal areas of eastern China (Gilder et al., 1991), paleo-Pacific Plate subduction beneath East Asia (Jahn et al., 1976, 1990; Guo et al., 1980; Charvet et al., 1994; Lapierre et al., 1997; Zhou and Li, 2000; Niu, 2005), and Mesozoic mantle plume activities in South China (Xie et al., 1996; Xie et al., 2001).

Therefore, it is timely and necessary to reassess these interpretations for the development of a unified model capable of explaining most geological observations on the petrogenesis of Mesozoic granitoid-volcanic rocks in the SE-SCB. This paper attempts to present such a model, which is largely based on our field observations and laboratory studies over the past 10 years. Emphases are placed on petrological and geochemical characteristics, and spatial and temporal distribution/variation of these rocks in the context of regional tectonic evolution, with particular reference to the tectonic regime shift from the influence of the Tethyan tectonics from the southwest to that of the Pacific tectonics.
Distribution and general characteristics of the Mesozoic magmatic rocks

The Mesozoic magmatic rocks in the SE-SCB are distributed mostly in Zhejiang, Fujian, Jiangxi, Guangdong and Hunan Provinces with a total outcrop area of nearly 218,090 km² (Table 1), which is 28.3% of the entire land surface area of those provinces. The percentages of outcrop in coastal Zhejiang and Fujian Provinces are 62% (~ 62,000 km²) and 55% (~ 66,000 km²), respectively. Figure 1 shows explicitly that the Mesozoic magmatic rocks are concentrated in the coastal region, with the density increasing towards the ocean.

Lithologically, over 90% of the Mesozoic magmatic rocks in the SE-SCB are granitoids and equivalent volcanic rocks with minor basalts. These were formed in two periods: the Early Mesozoic Indosinian Period (T₁–T₃, 251–205 Ma) and the Late Mesozoic Yanshanian Period (J₂–K₂, 180–67 Ma). The principal characteristics of these rocks are discussed below.

Indosinian granitoids (251–205 Ma)

Except for the southwestern part of the SE-SCB, the Indosinian magmatic rocks in the SE-SCB occur only as plutons. Their total outcrop area is nearly 14,300 km² (Table 1). About 60% of the Indosinian granitoids are strongly peraluminous with A/CNK > 1.1. They may be defined as S-type granites, and contain high aluminous minerals such as muscovite, garnet and tourmaline (Sun et al., 2005). These strongly peraluminous granites plus weakly peraluminous granites with A/CNK ≈ 1.0–1.1 make up about 91% of the total outcrop area of Indosinian granitoids. The rest are calc-alkaline I-type granites, with or without amphiboles, but always coexist spatially with the Yanshanian granitoids, forming a series of multi-age granitic complexes.

The Late Indosinian granitoids (T₂–T₃, 234–205 Ma) make up about 90% of all the Indosinian granitoids. They occur as dispersed small plutons characterized by medium grain size and massive appearance, features that are consistent with being emplaced at a relatively shallow depth range of 6.5–13 km (Buddington, 1959) and solidified in the circumstances of relatively "free" space made available by localized extensions, while the overall tectonic regime may be under compression (e.g., during late-collisional phase). The authors interpret these granitoids to be late collisional granites. No

Table 1 Outcrop area of Mesozoic granitoid-volcanic rocks in South China.

| Age               | Total area of granitoids (km²) | Outcrop area (km²) and A/CNK ratios of various granitoids | Outcrop area of volcanic rocks (km²) |
|-------------------|--------------------------------|----------------------------------------------------------|-------------------------------------|
|                   | Actual (km²) and relative (%)  | A/CNK <1.0 | 1.0–1.1 | >1.1 |                             |
| Indosinian        | 14300                          | 14300      | 1300    | 4400 | 8600 | 0 |
| EM, T₁–T₃        | 6.6%                           | 9.1%       | 30.8%   | 60.1%|                             |
| Early Yanshanian  | 63870                          | 62700      | 12500   | 29300| 20900| 1170 |
| LM₁, J₂–J₃       | 29.3%                          | 20.0%      | 46.7%   | 33.3%|                             |
| Late Yanshanian   | 139920                         | 50300      | 19300   | 21600| 9400  | 89620 |
| LM₂, K₁–K₂       | 61.7%                          | 38.4%      | 42.9%   | 18.7%|                             |
| (K₁ dominates)   | 140–66 Ma                      | 218090     | 135000  | 90790|                             |

Figure 1 Distribution of Mesozoic granite-volcanic rocks in South China. • Location of Luoding, Fenjianan and Xishanling plutons.
coeval volcanic rocks are found to be associated with the intrusives.

In contrast, the Early Indosinian granitoids (T1–T2, 251–234 Ma) show gneissic or mylonitized structures, which are interpreted as syn-collisional granites under compression. These rocks are well exposed along and in the vicinity of the Songma suture, where the Indochina Block collided with the SCB. The peak age of the collision is dated at 258 to 243 Ma (Carter et al., 2001). Luoding, Fenjian and Xishanling plutons in the southwest SCB are good examples, with 40Ar/39Ar muscovite ages of 249.7±2.6 Ma (n = 8), 255.3±3.0 Ma (n = 3) and 229.4±2.5 Ma (n = 5), respectively (Shao et al., 1995).

Early Yanshanian granitoid-volcanic rocks (180–142 Ma)

The Early Yanshanian granitoid-volcanic rocks were emplaced in the mid- and late-Jurassic (J2–3, 180–142 Ma), and are distributed in the interior of the SE-SCB, 250–800 km away from the southeast coastline. The total outcrop area is about 63,870 km². Most of the granitoids are distributed in zones parallel to the coastline, and extend discretely northeastward for about 1,000 km (Figures 1, 2). In the Nanling Range (110.0–116.5°E, 23.5–26.5°N), the granitoids strike E-W, and are distributed in three distinguishable belts with the between-belt intervals being about 1° in latitude (Table 2). These are the northern (Qitianling–Jiufeng), middle (Dadongshan–Guidong) and southern (Fugang–Xinfengjiang) granitoid belts. They represent three fault systems, in which some Indosinian granitoids are also emplaced. The compositions of the Early Yanshanian granites in various stages are similar, i.e. dominated by calc-alkaline I-type granites with A/CNK <1.1, and spatially coexisting with minor gabbro-diorites.

The Early Yanshanian volcanic rocks (180–170 Ma) are preserved mainly in the southern Jiangxi, southern Hunan and southwestern Fujian region, with a few in northern Guangdong. These rocks have unique compositions, with the following features (Chen et al., 2002):

1. A narrow age range of 180 to 170 Ma.
2. Multiple small-scale volcanoes occurring as E-W linear arrays extending >400 km.
3. A bimodal magmatic assemblage of basalts and rhyolites with similar thickness/abundance.
4. Spatial association with intrusions of calc-alkaline granites, A-type granites, aegirine-bearing alkaline granites and syenites, which were apparently emplaced later than basalts and rhyolites along the pre-existing rift systems.

The Early Yanshanian volcanic rocks are interpreted to be of rift origin (Barberi et al., 1982), which probably represents the initial magmatism of continental rifts. The rocks are perhaps genetically associated with partial melting of the crust and the lithospheric mantle induced by subduction of the paleo-Pacific oceanic plate (Zhou, 2003). This might mark the ending of an old tectonic regime (Tethyan) and the beginning of a new tectono-magmatic cycle (paleo-Pacific).

Late Yanshanian granitoid-volcanic rocks (142–67 Ma)

The Late Yanshanian granitoids and volcanic rocks occupy about 139,920 km² in the SCB. They are divided into two stages: early Late Yanshanian (K1) granitoid-volcanic rocks genetically associated with active continental margin magmatism and the late Late Yanshanian (K2) tholeiitic basalt volcanism recorded in red beds of back-arc basins. They differ from the Early Yanshanian and Indosinian rocks in spatial and temporal distribution, rock assemblage and geochemistry. Their characteristics are described as follows:

1. Granites and rhyolites commonly coexist, forming volcano-subvolcano-intrusion assemblages. In places, these assemblages are also associated with gabbros and basalts. However, the mafic rocks are volumetrically minor (<10%) to absent. The mafic/felsic rock ratios are much smaller than those of the Early Yanshanian bimodal magmatic assemblages in the southern Jiangxi-southwestern Fujian region.

2. On the MORB-normalized incompatible trace element plot, the early Late Yanshanian basalts (Figure 3, LM2-CAB, n = 21, K1) show large ion lithophile element (LILE) enrichments with obvious Nb-Ta depletion, which is consistent with their origin being associated with subduction-related wet mantle wedge melting (McCulloch & Gamble, 1991). On the other hand, basalts (Figure 3, LM1-
In terms of granite rock types, the I-type granitoids are scattered throughout the SE-SCB (Zhu et al., 1996 and Li et al., 2002), and continental margin arc basalts (LM2–CAB) (Wang et al., 1994; Xie et al., 2003; and Zhou et al., 1994). The Late Yanshanian granitoids are formed by the mixing of crust-mantle interactions: 1) mixing of felsic and mafic melts within granites, 2) composite lava flows of rhyolites and basalts, 3) protoliths at mid-lower crustal depths (Zhou & Li, 2000), and the heat causing the crustal melt-generation resulted from the underplating of basaltic magmas along the interpreted active continental margin arc. The Late Yanshanian magmatism is genetically associated with the NW–WNW-ward subduction of the paleo-Pacific plate. Therefore, the NE-trending Late Yanshanian magmatism is volumetrically the most important part of the late Mesozoic magmatic zone in the SE-SCB. Importantly, the Late Yanshanian granitoid-volcanic rocks in the SE-SCB, the synchronous granitoid-volcanic rocks on both sides of the Songliao Basin in Northeast China, in the Yanshan-Taishan Mountains of North China and in the Dabie Mountain in Central China, taken altogether, are compelling evidence that the Yanshanian period represents the most important tectono-magmatic period in eastern China.

Table 3 Characteristics of Mesozoic basins and synchronous granitoid-volcanic rocks in the SE-SCB.

| Type of basin | Age (Ma) | Area (km²) | Lithology | Main distribution areas | Synchronous granitoids |
|---------------|----------|------------|-----------|------------------------|-----------------------|
| Para-foreland basin | T₁ (major) | 15120 | 10.6 | Lower: variegated coarse fragment mafic rocks, Upper: bimodal volcanic rocks with felsic composition | Southern part of the SE-SCB, Late Indosinian granitoids |
| Rift basin | J₂ (minor) | 4640 | 3.2 | Bimodal volcanic rocks with basaltic and rhyolitic components | Southern Jiangxi and southwestern Fujian Province, Inland of the SE-SCB |
| Faulted basin | K₁ | 85490 | 59.7 | K₁ is the peak period. Mostly rhyolite with minor basaltic components | Coast of the SE-SCB, Late Yanshanian granitoids |
| Back-arc basin | K₂-E | 37850 | 26.5 | Mostly red bedded sedimentary rocks with evaporites such as gypsum and rock salt, reflecting dry-hot environment | Much of the vast area west of Wuyishan (including Guangdong Province) |

Table 3: Characteristics of Mesozoic basins and synchronous granitoid-volcanic rocks in the SE-SCB.

The large-scale red-bed basins mainly formed in K₂. Some of them contain tholeiitic basalts, as in the Qzhou-Guangfeng basin, the Jian-Taihe basin, the Nanxiang basin, etc. (Shu et al., 2004), but no granitoids. We interpret these basins to have been formed in extensional settings in response to the opening of backarc basins, perhaps in a scenario similar to the opening of the Japan Sea in the Cenozoic.

Para-foreland basins are not typical foreland basins (Dewey et al., 1987), because they are small in scale and have limited sediment accumulation. Such basins are characterized by sediments of low maturity and coarse fragments, and by the E-W trending stratigraphy perpendicular to the mapping direction. Their associated granitoids are of strongly peraluminous S-type formed during the Late Indosinian
ian Period. Of course, the origin of this type of basin is related to folding-napping and thickening of crust during the Indosinian collision (Liu, 2002), followed by local extension.

**Tectonic evolution of the SE-SCB in the Mesozoic**

**Tectonic change from the Tethyan regime to the Pacific regime**

Magmatism is a tectonic response. This is true on a global scale, and also true on regional scales. The type and scale of the magmatism thus reflect the nature and scale of the orogenesis. The isotopic ages of Mesozoic granitoid-volcanic rocks from 344 samples of the SE-SCB (Figure 4) show that there was a ~25 Myr magmatically inactive period during the Early Jurassic (J1, 205–180 Ma). This tectonic quiescence in fact corresponds to the tectonic regime change from the influence of the Indosinian orogeny as part of the large-scale Tethyan tectonics to the influence of the Yanshanian orogeny genetically associated with the western Pacific tectonics. The outcrop area of the granitoids produced during the Indosinian orogeny (T1–T3) is significantly less than that produced during the Yanshanian (J2–K2), with a ratio of ~1:14.3. The outcrop area proportion of Early Yanshanian (J2–J3) to Late Yanshanian (K1–K2) rocks is 1:2.2, the latter distributed mostly in the coastal region of the SE-SCB. We stress that the Late Mesozoic granitoid-volcanic rocks were the products of the NW–WNW-ward subduction of the paleo-Pacific plate beneath the eastern Asian continent (Figure 5). The Late Mesozoic magmatic belt in eastern China extends for ~3,500 km from Northeast China down to Hainan Island. In other words, the SE-SCB was tectonically influenced by the Tethyan tectonic domain before J1, but has been controlled by the Pacific tectonics since J2. Thus, the SE-SCB changed from being influenced by the Tethyan tectonics to being influenced by the Pacific tectonics during J1.

**Tectonic background and stress disposition of granitoid-volcanic rocks during J2–K2**

A schematic diagram for extensional tectonism in the Late Mesozoic of South China is shown in Figure 6. As mentioned above, there are J2 bimodal volcanic rocks in the interior of the SE-SCB, with similar amounts of basalts and rhyolites scattered in the eastern Nanling Range along E-W fault zones. In the coastal region of the SE-SCB, limited bimodal volcanic rocks were emplaced during K1, with basalts being less than 10% of the total volcanic output. Geochemically, the K1 basalts are of the continent margin arc type. In addition, spatially in coexistence with the K1 bimodal volcanic rocks are synchronous mafic and felsic dike swarms, extrusive-hypabyssal porphyroclastic lava flows, 17 large volcano-tectonic depressions containing sedimentary layers, A-type alkaline and miarolitic granites, shoshonite zones, and a metamorphic core complex. All these rocks constitute an igneous rock assemblage characteristic of continental margin magmatic arc systems, indicating an extensional setting during J2–K1. After that, Late Cretaceous back-arc basins containing minor basalts developed inland throughout the SE-SCB without large-scale magmatism. The sediments of these K1–E basins include red sandstones and mudstones with inter-layered gypsum, indicating a dry and semi-desert paleogeographical environment.

All these observations suggest that the SE-SCB was largely under extension in the Late Mesozoic. This may explain why the Late Mesozoic granitoids mostly appear as massive structures.

As part of the Eurasia Plate, the SE-SCB may have suffered the subduction of the Izanagi ocean plate since J2 (Maruyama & Seno, 1986; Maruyama, 1997). The lithospheric stress distribution beneath the SE-SCB may be compressional at great depths, but extensional at shallow levels, just like cauliflower type divergence (Figure 5). Indeed, the integrated geophysical section of the SE-SCB (Zhou and Li, 2002) reveals that the base of the lithospheric mantle in the coastal region of the SE-SCB was 30–40 km shallower than that of the adjacent area due to the extension-induced asthenosphere uplift. Under this extensional condition, two-period granitoid-volcanic rocks were formed in the SE-SCB. In the Early Yanshanian, there was no magmatism in this active continental margin in the SE-SCB, probably because the Pacific lithosphere had not subducted to ~110 km in depth (Tatsumi et al., 1995). However, the stress may have been quickly propagated to the inland areas via the rigid SCB, where decompression melting might be triggered by localized extension and faulting. As a consequence, the intraplate granites and rift-type

**Figure 4** Isotopic age histogram of Mesozoic granites-volcanic rocks in South China. EM—Early Mesozoic Indosinian; LM1—Late Mesozoic Early Yanshanian; LM2—Late Mesozoic Late Yanshanian.

**Figure 5** Formation mechanism for Indosinian continent-continent collision, Yanshanian paleo-Pacific Plate subduction, origin of Nanling Range, and three E-W granite belts.
magmatic assemblage were produced in the interior of the SE-SCB during this time period. In the Late Yanshanian subducting slab had reached the depth of 110 km beneath the SE-SCB of the east side of the Ganjiang fault (115°E), and slab-dehydration melting started (Hathtenton & Dickinson, 1969; Tatsumi et al., 1995). The mantle wedge wet melting produced a large amount of basaltic magmas. The basaltic magmas ascended, and underplated at the base of the lower crust. The basaltic magmas acted as a heat source that induced large-scale crustal melting and granitic magma formation. Such processes of granitic magma genesis readily explain the familiar geochemical characteristics of continental margin granitoids. Compositionally, such granitoids have high-K calc-alkaline rock assemblages (Zhou and Yu, 2001; Zhou and Li, 2002; Mao et al., 2002; Gu, 2003). In the same stress regime, a series of sedimentary basins seemed to have developed in the SE-SCB (Shu et al., 2004). Corresponding to this geological process in the SE-SCB, contemporaneous basalt magma underplating and crust-mantle interaction were also taking place (i.e., 180–80 Ma) in North China (Wilde et al., 1998; Li et al., 1999; Zhou et al., 1994; Zhou, 2003). On the basis of our field observations, up-to-date geochemical analyses, age data, and regional-scale stress analysis of the Mesozoic granitoids of the SE-SCB, the first-order characteristics, spatial and temporal distribution and evolution trend of Mesozoic granitoid-volcanic rocks have become clear. Some data and isotopic ages for individual rock suites used in this paper may be refined in the future, but these will unlikely alter the first-order interpretations discussed above. Therefore, it is timely and necessary to present an updated model capable of explaining major observations concerning the Mesozoic granitoid-volcanic rocks in the SE-SCB.

A new petrogenesis model

Chinese geologists have been studying the petrogenesis and tectonic background of the Mesozoic granitoid-volcanic rocks for nearly 60 years (Hsu and Ting, 1942; Huang, 1945; Jahn et al., 1976; Chen and Jahn, 1998; Zhou and Li, 2000; Zhou, 2003). On the basis of our field observations, up-to-date geochemical analyses, age data, and regional-scale stress analysis of the Mesozoic granitoids of the SE-SCB, the first-order characteristics, spatial and temporal distribution and evolution trend of Mesozoic granitoid-volcanic rocks have become clear. Some data and isotopic ages for individual rock suites used in this paper may be refined in the future, but these will unlikely alter the first-order interpretations discussed above. Therefore, it is timely and necessary to present an updated model capable of explaining major observations concerning the Mesozoic granitoid-volcanic rocks in the SE-SCB.

The new model considers two independent periods of magmatism spatially and temporally associated with different tectonic regimes. The continent-continent collisional orogeny produced the Early Mesozoic Indosinian granitoids and para-f oreland molasse basins, and was followed by the ocean-continent subduction that caused the Late Mesozoic Yanshanian granitoid-volcanic magmatism. In the Early Mesozoic, the continent-continent collision, which took place on the Indochina peninsula, formed syn-collisional granitoids under regional compression at the earlier Indosinian stage (T1–T2), and late-collisional granitoids which are rich in muscovite (Eskola, 1932; Marmo, 1971) under a local extensional setting at the Late Indosinian stage (T3–T4, about 20 Ma later than the time of the syn-collisional granitoid formation; Sun et al., 2005). Since T2, the paleo-Pacific oceanic plate subducted NW–WNW–ward beneath the eastern Asian continent. The Late Mesozoic magmatism in the SE-
SCB underwent three stages: (1) intraplate magmatism including initial rift-type magmatism at the Early Yanshanian stage (J4-J3), (2) continental margin arc magmatism at the early Late Yanshanian stage (K1), and (3) tholeiitic basalt volcanism recorded in red beds of back-arc basins at the Late Yanshanian stage (K2).

The extension-induced deep crustal melting and the underplating of basaltic magmas were the two main driving forces for the Yanshanian granitic magmatism. Progressively broader and stronger underplating of basaltic magmas in the lower crust in the SE-SCB were the most important factors in vertical crust growth. The above-mentioned Early Mesozoic Indosinian event was controlled by Tethyan tectonics, whereas the Late Mesozoic Yanshanian tectonic-magma event was caused by the paleo-Pacific plate subduction beneath the eastern Asian margin. The timing of the tectonic regime change seems to be associated with a magmatically inactive period of 205–180 Ma (J1) (Figure 4). The Nanling Range marks the zone of transition between the two tectonic regimes. The authors recognize that the spatial coexistence of plutons and volcanic rocks of the same origin is tectonically incompatible. The exposure of plutons would suggest some significant tectonic uplift and erosion, probably >10 km, yet the preservation of volcanic rocks indicates no significant uplift or erosion since their emplacement. These straightforward observations point to some highly localized uplift and erosion events since the Mesozoic. It is considered that these phenomena resulted from some recent tectonic reactivation of the existing rift/fault systems. A detailed account will be given separately.

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