行政院國家科學委員會專題研究計畫　成果報告

華南印支期之岩漿活動與大地構造演化研究（II）

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行政院國家科學委員會專題研究計畫進度報告
華南印支期之岩漿活動與大地構造演化研究（II）
計畫編號：NSC 92-2116-M-002-017
執行計畫期限：93 年 10 月 1 日至 94 年 10 月 31 日
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1. Abstract:

Darongshan granitic suites are the most important and extensive Indosinian intrusive rocks in the Cathaysia Block. Many previous works, including field and dating studies, show that these granites were formed at the Hercynian-Indosinian periods. In order to better constrain the exactly intrusive ages and discuss their possible magma source, zircons from Darongshan granitic suites are separated for U-Pb age dating using the LA-ICP-MS method. We report the zircon U-Pb ages of granites from four batholiths of Darongshan granitic suites (Taima, Jiuzhou, Nadong and Pubai). Ages obtained are 255.3±2.9, 257.0±3.8, 259.7±3.1, 255.5±5.8 and 256.2±7.2 Ma, respectively, with the last two from the same batholith of Pubai. The data indicate that these granites are Indosinian intrusives emplaced at a very short period of time (260~255 Ma). However, all these samples inevitably contain many inherited zircons with ages ranging from Mesoprotero- zoic to Early Paleozoic (mostly Caledonian). Combined with the geochemical results we reported last year, it can be concluded that Darongshan granites were generated from remelting of the thickened (meta)sedimentary crust typical of the S-type granites.

2. Geological background:

South China is composed of Yangtze Block in the northwest and Cathaysia Block in the southeast, separated by the Jiangshan-Shaoxing fault in Zhejiang and the Pingxiang-Yushan fault in Jiangxi (Chen and Jahn, 1998). The Cathaysia Block is characterized with the rocks of extensive granitic magmatism especially in the Mesozoic. Intrusions of Mesozoic granites correspond to three orogenies: Indosinian (mainly Triassic), Early Yanshanian (Jurassic) and Late Yanshanian (Cretaceous). Relative to the widespread Yanshanian igneous rocks, Indosinian intrusive rocks are exposed locally and limited in the inland areas of S China, mainly in Hunan and Guangxi provinces. Darongshan granitic suites are the most important and extensive Indosinian intrusive rocks in the Cathaysia Block. They exposed in the southeastern part of the Guangxi province extending northeasterly for 400 km in length and 20-75 km in width, and cropping out an area of 10,000 km^2, as a consequence of the opening of the Qinzhou Geosyncline to the southwest (Ren et al., 1990).

Darongshan granitic suites include Darongshan, Pubai, Taima, Jiuzhou, Nadong batholiths and Banba volcanics which are controlled by Bobai-Cenxi and Lingshan-Tangxian deep faults and their bifurcate faults (Fig. 1). Major rock types include the garnet-hypersthene granite, cordierite-biotite granite and hypersthene granitic porphyry (Deng, 2004). Existence of Al-rich minerals such as cordierite, hypersthene, almandine garnet, sillimanite and andalusite is the characteristic feature. From Late Paleozoic to Triassic, this area was strongly folded and intruded by the granites. Chen et al. (1995) suggest that the Darongshan granites are genetically produced by the anatexis of the migmatites during the NW-SE compression in Late Paleozoic and Triassic, which might be related to the continent-continent collision between the Indochina-South China Blocks in the southeast and Indochina-Yangtze Blocks in the northwest. According to the classification of Chappell and White (1974), they are considered to be the S-type granites. The zircons chosen for this study are separated from four large granitic batholiths (Pubai, Taima, Jiuzhou and Nadong batholiths) (Fig. 1).

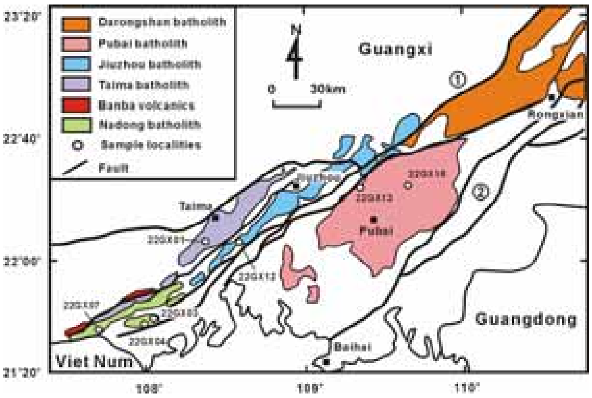


Fig 1. Simplified geological map and sampling sites of the Darongshan granitic suites.

3. Analytical method－Zircon U-Pb dating using Laser Ablation Inductively Coupled Plasma-Mass Spectrometer (LA-ICP-MS)

Zircon separates were mounted on the double-stick tape, cast in epoxy resin and polished using 1 μm diamond paste to expose surfaces suitable for analysis. U-Pb isotopic ratios and concentrations of zircons were determined on 40-60 μm diameter regions of single zircons by an excimer LA-ICP-MS at the Key Laboratory of Continental Dynamics, Northwest University (China), following analytical procedures described by Yuan et al. (2004). The ICP-MS used was an Elan 6100 DRC (Dynamic Reaction Cell) from Perkin Elmer/SCIEX (Canada) coupled to the GeoLas 200M laser-ablation system (MicroLas, Göttingen, Germany) equipped with a 193 nm ArF-excimer laser and a homogenizing, imaging optical system. Helium was used as carrier gas to enhance transport efficiency of the ablated material. The helium gas inside the ablation cell was mixed with argon as a makeup gas before entering the ICP-MS to maintain stable and optimum excitation conditions.

For LA-ICP-MS analysis, raw count rates for ^{29}Si, ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{232}Th and ^{238}U were measured for age determination. Common Pb corrections were made using measured ^{204}Pb. In the result of low ^{202}Hg contents (usually <10 counts per second) in the gas blank, the contribution of ^{204}Hg to ^{204}Pb is negligible and no correction was made. U, Th and Pb concentrations were calibrated by using ^{29}Si as an internal standard and NIST SRM 610 (Pearce et al.,

1997) as reference material. $^{207}Pb/^{206}Pb$, $^{206}Pb/^{238}U$ and $^{208}Pb/^{232}Th$ ratios were calculated using GLITTER 4.0 software (Macquarie University), which were then corrected using Harvard zircon 91500 (Wiedenbeck et al., 1995) as external standard. The reference zircon TEMORA 1 (Australian National University) yielded a weighted $^{206}Pb/^{238}U$ age of 415±4 Ma (Yuan et al., 2004), which is in good agreement with the recommended ID-TIMS age of 416.75±0.24 Ma (Black et al., 2003). As ^{204}Pb could not be measured due to low signals and interference from ^{204}Hg in the carrier gas, we have carried out common-lead corrections using the procedure of Andersen (2002). All the reported ages were calculated and the concordia diagrams were made by using the ISOPLOT program (rev.2.49) (Ludwig, 2001) (Fig. 2). Among them, the $^{206}Pb/^{238}U$ ages were considered to be the most reliable for concordant Phanerozoic zircons (Compston *et al*., 1992).

4. Results

22 zircon analytical results of 22GX01 from Taima batholith show 7 late Paleozoic ages (323~268 Ma), 3 early Paleozoic ages (512~406 Ma), and 1 Sinian age (684 Ma). Other 12 zircons have a concordia age and the $^{206}Pb/^{235}U$ average age is 255.3±2.9 Ma.

23 zircon analytical results of 22GX07 from Nadong batholith show 1 late Palezoic age (289 Ma), 4 early Paleozoic ages (543~530 Ma), 3 Sinian age (781~656 Ma) and 4 Neo-Proterozoic ages (1085-1062 Ma). Other 11 zircons have a concordia age and the $^{206}Pb/^{235}U$ average age is 257.0±3.8 Ma.

21 zircon analytical results of 22GX12 from Jiuzhou batholith show 2 late Paleozoic ages (314 and 288 Ma), 2 early Paleozoic ages (455 and 433 Ma), 6 Neo-Proterozoic ages (1020~877 Ma) and 1 Paleo-Protrozoic age (1444 Ma). Other 10 zircons have a concordia age and the $^{206}Pb/^{235}U$ average age is 259.7±3.1 Ma.

22 zircon analytical results of 22GX13 from Pubai batholith show 4 late Paleozoic ages (287~270 Ma), 4 early Paleozoic ages (464~417 Ma), 2 Sinian ages (837~812 Ma), and 1 Neo-Proterozoic age (1063 Ma). Other 11 zircons have a concordia age and the $^{206}Pb/^{235}U$ average age is 255.5±5.8 Ma.

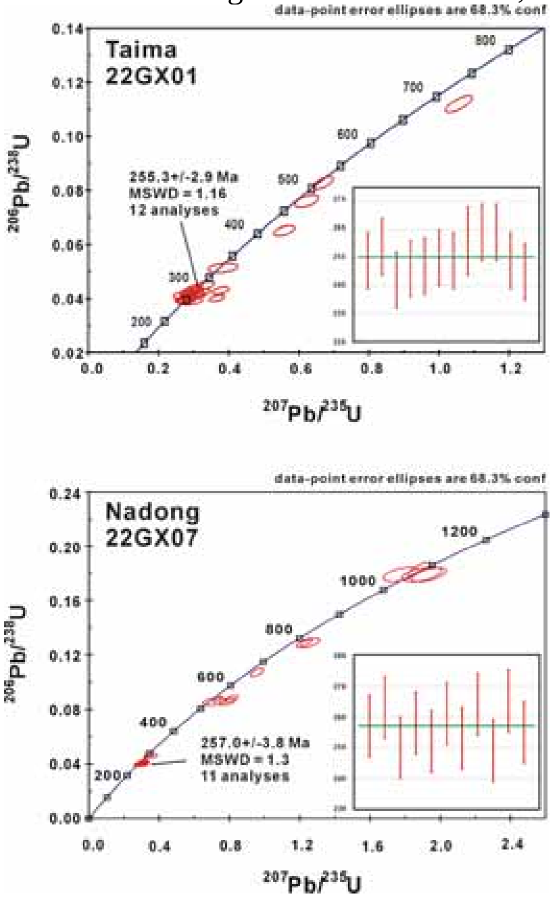
Another sample (22GX16) from Pubai batholith with 21 zircon analytical results has 6 late Paleozoic ages (343~272 Ma), 5 early Paleozoic ages (606~448 Ma), 1 Sinian age (758 Ma), and 2 Neo-Proterozoic ages (1156 and 982 Ma). Other 7 zircons have a concordia age and the $^{206}Pb/^{235}U$ average age is 256.2±7.2 Ma.

LA-ICP-MS zircon U-Pb dating results reveal that all the Taima, Jiuzhou, Nadong and Pubai batholiths from the Darongshan granitic suites belong to Indosinian stage and generate at the similar age (255-260 Ma). However, numerous zircons present with old ages are obviously relicts of previous thermal events.

5. Discussion and conclusion

Inheritance zircon ages (Mesoproterozoic to early Paloezoic) mainly concentrate in 5 time spans: 265~290 Ma, 400~475 Ma, 510~610 Ma, 750~900 Ma and 1000~1085 Ma (Fig. 3).

These intervals correspond with the major crustal thickening events in S China, e.g.



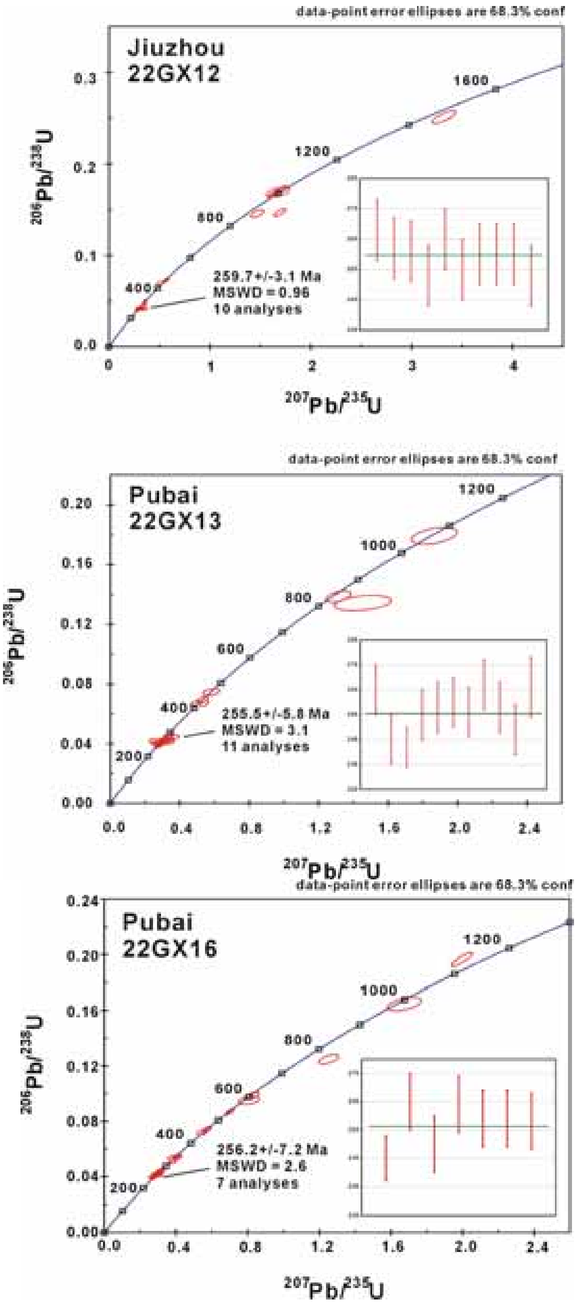


Fig 2. Concordia diagrams and $^{206}Pb/^{238}U$ average age for zircons from Darongshan granitic suites.

Indosinian, Hercynian, Caledonian, Sinian and Neoproterozoic orogenies. The fact that the Darongshan granites contain abundant detrital zircons is an evidence to support a source of sedimentary origin. This conclusion is in concord with geochemical and mineralo- gical characters of the Darongshan granites as we reported last year.

It is noted that the LA-ICP-MS ages are older than the SHRIMP ages on zircons from the studied areas (230±4 Ma, Deng et al., 2004). To find out the exact time of magma emplacement, the EMP monazite age dating is undertaking.

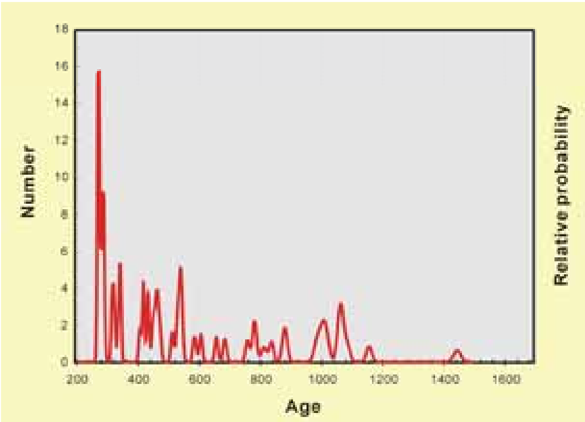


Fig 3. Relative probability diagram of Darongshan granitic suites zircon $^{206}Pb/^{238}U$ age.

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