Magmatism in the Gejiu District, SW China

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South China consists of two major crustal blocks: the Yangtze Block to the northwest, and the Cathaysia Block to the southeast. The western Cathaysia Block, also known as the Youjiang Basin, includes western Guangxi, southwest Guizhou and southeast Yunnan provinces (Zhou and Qi, 1999). The Gejiu district is located on the west margin of western Cathaysia, adjacent to the Yangtze block to the north, and to the Three Rivers fold belt to the west.

The Gejiu district is the largest tin district in the world. Ore reserves include 300 Mt of ~1% Sn ore, 300 Mt of ~2% Cu ore , 400 Mt of ~3-10 % Pb+Zn ore, and >1000 Mt of Mn ore. This district is characterized by widespread igneous rocks, including gabbro, mafic microgranular enclaves (MMEs), alkaline rocks, mafic dykes, porphyritic granitoids, and equigranular granitoids. In the last few decades most research has focused on the porphyritic and equigranular granitoids that have a close spatial relationship to polymetallic tin mineralization (308 Geological Party, 1984; Wu et al., 1984, 1986; Li, 1985; Luo, 1995).

According to our most recent studies (Cheng and Mao, 2010; Cheng et al., 2012, 2013), SHRIMP/LA-ICP-MS zircon U-Pb analyses of representative samples from various phases of the Gejiu complex yielded Late Cretaceous ages of 78-85 Ma. Based on their mineralogical, geochemical and Sr-Nd-Hf isotope characteristics, these rocks are categorized into three groups: felsic rocks, alkaline rocks and mafic rocks. The felsic rock group includes the equigranular and porphyritic granites. Geochemical characteristics include high SiO_2 contents, enrichment in Rb, Th, U, Nb, Ta, Nd and Hf and depletion in Ba, K, Sr, P, Eu and Ti compared to primitive mantle. REE patterns feature slight LREE enrichment with pronounced negative Eu anomalies. Geochemical data and Sr-, Nd- and Hf-isotopic compositions indicate that the felsic rocks were probably generated by partial melting of crustal source rocks with a minor input from mantle materials. The mafic rocks (gabbro and mafic microgranular enclaves) have distinct geochemical and isotopic features consistent with derivation from an enriched mantle source, with variable degrees of mixing with crustal-derived magmas. Strontium- Nd- and Hf-isotopic compositions of the alkaline rocks are similar with those of the mafic rocks, suggesting they have a similar source. Nevertheless, petrological and geochemical characteristics of these rocks indicate they experienced extensive crystal fractionation and limited crustal contamination.

Petrological and geochemical data on the igneous rocks from Gejiu district preclude models in which their parental magmas are derived by partial melting of crust or by a single-stage melting of young mafic rocks. The hypothesis that best explains the geochemical and petrological variations at Gejiu Complex is intraplate basaltic magmas underplated the lithosphere under western Cathaysia block and

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caused the overly crust partial melting, experienced complicate interaction of these contemporaneous mantle- and crustal-melts during their emplacement and formed these various igneous rocks.

The gabbro-MMEs association has the similar parental magma. They are proposed to be derived from an enriched lithospheric mantle source with different degrees of assimilation of crustal materials, and both magma mixing and mingling contributed the formation of this association. The alkaline rocks also derived from enriched lithospheric mantle source but experienced different evolutionary process, which were dominant by crystal fractionation with limited crustal assimilation. Granites in the Gejiu district were derived from old crust with minor input from mantle materials, although crystal fractionation is the dominant factor controlled the compositional variability in these rocks (Cheng and Mao, 2010;

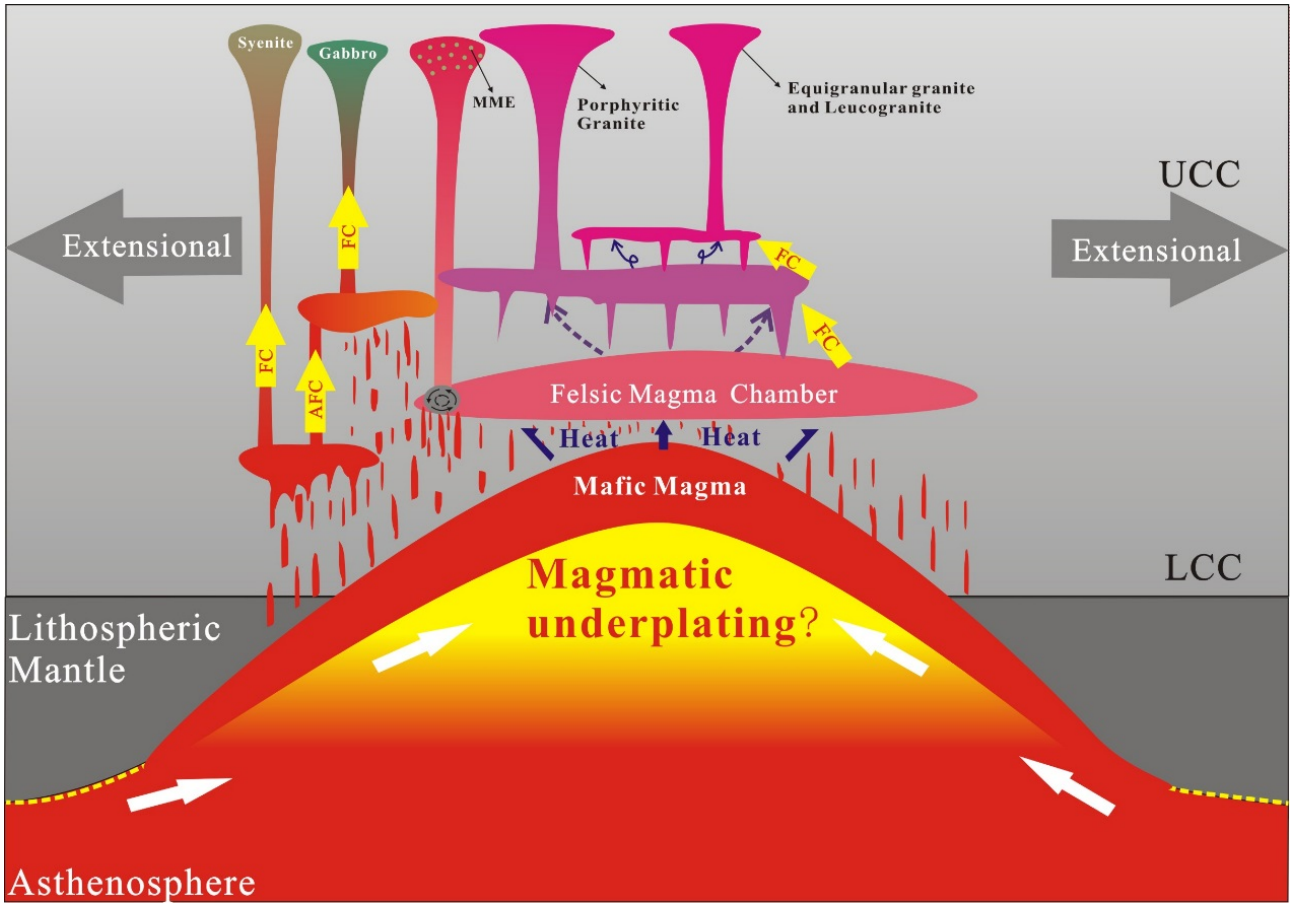

Fig. 1 Cartoon illustrates the magma origin of the Mesozoic igneous rocks in the Gejiu district, western Cathaysia block, south China. Accompanied with regional lithospheric extension and thinning, the intraplate mafic magma underplated the lower crust of western Cathaysia block, caused the overlying lower crust partial melting and formed felsic magma chamber. The coeval generated mafic and felsic magmas ascended along regional fault belt (e.g. the Red River Fault) and intruded shallow level of the crust. The MMEs were formed by the mafic and felsic magmas mixing and mingling, while the gabbro also been contaminated by the crustal magma and thus cannot represent the original primary mantle-derived magma. Mafic dykes directly derived from the mafic magma chamber and experienced crustal assimilation coupled with fractional crystallization (AFC) process. The evolution process of the alkaline rocks was dominated by fractional crystallization with limited crustal melt contamination. Granitic rocks mainly derived from crustal melt but contain limited amount of mantle materials, and these granitoids experienced various fractional crystallization stages before their emplacement and the equigranular granitic magma is supposed to be more evolved than the porphyritic granitic magma.

Cheng et al., 2012, 2013).

Integrating data on the igneous rocks from the Gejiu Complex with other regional geological data provides strong evidence to support an episode of lithospheric extension in the western Cathaysia block during the Late Cretaceous. The regional lithospheric extension may have been the driving force for generation and emplacement of the mafic/crust derived magmas, which induced partial melting of the overlying crustal materials to produce felsic magmas. These magmas then mixed with the mafic magma to varying degrees, and /or underwent crystal fractionation to form the gabbro-enclaves-syenite-granites association in Gejiu district, western Cathaysia block (Fig. 1).

References

308 Geological Party, 1984. Geology of tin deposit in Gejiu area. Metallurgical Industry Publishing House, Beijing, pp. 50 – 90.

Cheng, Y.B., Mao, J.W., 2010. Age and Geochemistry of Granites in Gejiu area, Yunnan province, SW China: Constraints on their petrogenesis and corresponding tectonic setting. Lithos 120, 258 – 276.

Cheng, Y.B., Spandler, C., Mao, J.W., Rusk, B., 2012. Mafic Microgranular Enclaves in Gejiu Area, Yunnan Province, China: a case of interaction of crust- and mantle-derived magmas. Contribution to Mineralogy and Petrology 164: 659–676.

Cheng, Y.B., Mao, J.W., Spandler, C., 2013. Petrogenesis and geodynamic implications of the Gejiu igneous complex in the western Cathaysia block, South China. Lithos, DOI: 10.1016/j.lithos.2013.04.002.

Li, J.H., 1985. Characteristic and original study on granites in Gejiu area. Geology of Yunnan 4, 327 – 352 (in Chinese with English abstract).

Luo, J.L., 1995. The model of Sn, W, Zn, Pb, and Ag deposits in southeast Yunnan Province. Yunnan Geology 14, 319 – 332 (in Chinese with English abstract).

Mao, J.W., Xie, G.Q., Guo, C.L., Yuan, S.D., Cheng, Y.B., Chen, Y.C., 2008. Spatial-temporal distribution of Mesozoic ore deposits in South China and their metallogenic settings. Geological Journal of China Universities 14, 510 – 526.

Wang, Q., Li, J.W., Jian, P., Zhao, Z.H., Xiong, X.L., Bao, Z.W., Xu, J.F., Li, C.F., Ma, J.L., 2005. Alkaline syenites in eastern Cathaysia (south China): link to Permian–Triassic transtension. Earth and Planetary Science Letters 230, 339 – 354

Wu, Q.S., Liu, Q.L., 1986. Genesis evolution and mineralization of a complex formed from Sn-bearing granites in Gejiu,Yunnan. Journal of Metallurgy Geological College of Guilin 6, 229 – 238 (in Chinese with English abstract).

Wu, Q.S., Xu, J.Z., Yang, Z., 1984. Study on Sr isotope character and prospecting criteria of tin-bearing granite of Gejiu area. Geochemica 4, 293 – 302 (in Chinese with English abstract).

Zhou, H.W., Qi, X.L., 1999. Extremely low grade metamorphism: a case study of the Mesozoic metamorphic belt in Youjiang basin. Geological Publishing House, 1 – 66