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湘南宝山铅锌多金属矿区花岗闪长斑岩及其暗色包体成因：锆石U-Pb年代学、岩石地球化学和Sr-Nd-Hf同位素制约

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摘要：

本文对湘南宝山铅锌多金属矿区花岗闪长斑岩及其暗色包体进行了系统的锆石U-Pb年代学、岩石地球化学和Sr-Nd-Hf同位素研究，探其岩石成因和构造意义。LA-ICP-MS锆石U-Pb定年表明，宝山花岗闪长斑岩成岩年龄为156~158Ma，暗色包体的形成年龄为155.2±1Ma，与寄主岩的成岩年龄一致。宝山花岗闪长斑岩为准铝质花岗岩，富集K、Rb、U等大离子亲石元素，亏损Nb、Ti、P等元素，Nb/Ta均比值为11.3，（$^{87}Sr/^{86}Sr$）$_i$值为0.7095~0.7115，$\varepsilon_{Nd}(t)$值为-7.3~-5.0，t_{2DM}（Nd）值为1.35~1.54Ga，锆石$\varepsilon_{Hf}(t)$值14.0~-9.0。暗色包体呈细粒结构，具浑圆的外形，与寄主花岗闪长斑岩接触界线清晰，具暗色的冷凝边，常见针状磷灰石。暗色包体具低的SiO_2含量（55.46%~57.30%），较高的K_2O含量（5.86%~6.90%），富集Rb、Ba、Th、U等大离子亲石元素，亏损Nb、Ta等元素，Nb/Ta平均比值为15.3，（$^{87}Sr/^{86}Sr$）$_i$值为0.7062~0.7063，$\varepsilon_{Nd}(t)$值为-2.1~-1.9，锆石$\varepsilon_{Hf}(t)$值为-12.1~-4.7。寄主花岗闪长斑岩相比，暗色包体含有较高的Fe、Mg、V、Cr等相容元素。主微量元素和同位素特征表明，宝山花岗闪长斑岩是由来自经冲沉积物熔体交代过的富集岩石圈地幔且富水富钾的底侵基性岩浆与由其引起的下地壳部分熔融形成的长英质岩浆发生混合形成，暗色包体是来自该底侵基性岩浆与少量长英质岩浆发生混合形成。Sr-Nd同位素模拟表明，宝山花岗闪长质岩浆由大约20%~30%的富集地幔物质70%~80%的地壳物质组成。892±20Ma继承锆石核的$\varepsilon_{Hf}(t)$值为+6.0，t_{DM}（Hf）年龄为1.21Ga，与江南造山带东段新元古代岛岩浆的Hf同位素特征一致，推断在花岗闪长斑岩的源岩部分熔融过程中有新元古代岛弧岩浆岩物质的加入，新元古代岛弧岩浆带及扬子与华夏陆块弧陆碰撞带从萍乡向南延伸部分可能与郴州-临武断裂相接。在燕山早期（190~150Ma），受古太平洋板块俯冲作用影响，南岭地处于岩石圈伸展-减薄的构造环境，由于地幔玄武质岩浆底侵至古老地壳源区，诱发地壳发生部分熔融作用，伴随着壳幔岩浆混合作用，形了该区众多花岗质岩石。

英文摘要：

Zircon U-Pb chronology, Hf isotope, whole rock geochemistry and Sr-Nd isotopes are reported for the granodiori porphyry and the mafic microgranular enclave (MME) from the Baoshan Pb-Zn polymetallic deposit, southern Hunan ovince. LA-ICP-MS zircon U-Pb dating yields crystallization ages of 156~158Ma and 155.2±1.4Ma for the granodiori porphyry and MME, respectively, indicating they are coeval. The Baoshan granodiorite porphyry is metaluminous. Th porphyry is enriched in LILEs such as K, Rb and U, depleted in Nb, Ti and P, and has an average Nb/Ta ratio of 11.3 has initial $^{87}Sr/^{86}Sr$ ratios of 0.7095~0.7115, $\varepsilon_{Nd}(t)$ values of -7.3 to -5.0, t_{2DM}(Nd) ages of 1.35Ga to 1.54Ga, and con $\varepsilon_{Hf}(t)$ values of -14.0 to -9.0. The MME is characterized by microgranular texture, oval-like shape, sharp contact th the host rock and darkly chilled margin, and contains needle-like apatite. It has low SiO_2 (55.46%~57.30%) but h K_2O (5.86%~6.90%). This MME is enriched in LILEs such as Rb, Ba, Th and U, depleted in Nb, Ta and Ti, and has i al $^{87}Sr/^{86}Sr$ ratios of 0.7062~0.7063, $\varepsilon_{Nd}(t)$ values of -2.1~-1.9, zircon $\varepsilon_{Hf}(t)$ values of -12.1~-4.7, and relative high b/Ta ratio (average of 15.3). The MME has higher compatible elements, such as Fe, Mg, V and Cr, than the granodio e. The elemental and isotopic geochemistry suggests that the Baoshan granodiorite porphyry might have been forr d by mixing of mafic and felsic member magmas. The mafic member is hydrous and K-rich mafic magma which might derived from enriched lithospheric mantle source that had been metasomatized by subducting-sediment-derived me s. The felsic member was generated by partial melting of lower crust induced by the underplating of the hydrous an K-rich mafic magma. The MME might be derived from the mafic magma with minor addition of the felsic magma. The r

deling using Sr-Nd isotopes shows that the mixture of 20%~30% mafic magma and 70%~80% felsic magma can ge
erate the Baoshan granodiorite porphyry. Inherited zircon with age of 892±20Ma has the $\varepsilon_{Hf}(t)$ and t_{DM}(Hf) values
+6.0 and 1.21Ga, respectively, which is compatible with those of the Neoproterozoic arc magmatic rocks in the east
n Jiangnan Orogenic Belt. Therefore, the Neoproterozoic arc magma might have been involved in the formation of th
Baoshan granodiorite porphyry, and the Neoproterozoic arc magma belt and continent-arc collision belt between th
Yangtze Block and Cathaysia Block might extend southward from Pingxiang to Chenzhou-Linwu faults. In Early Yans
anian (190~150Ma), the Nanling Range has undergone lithosphere extensional and thinning due to the subduction
the Paleo-Pacific Plate. The mantle-derived mafic magma underplating into the old lower crust resulted in partial me
ng of the crust. With the mixing of crust-derived and mantle-derived magmas, extensive granites were generated.

关键词：花岗闪长斑岩 暗色包体 地球化学 岩浆混合作用 湘南宝山铅锌多金属矿