

王中亮,赵荣新,张庆,鲁辉武,李京濂,程蔚. 2014. 胶西北高Ba-Sr郭家岭型花岗岩岩浆混合成因: 岩石地球化学与Sr-Nd同位素约束. 岩石学报, 30(9): 2595-2608

胶西北高Ba-Sr郭家岭型花岗岩岩浆混合成因: 岩石地球化学与Sr-Nd同位素约束

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基金项目: 本文受国家自然科学基金项目(41230311、40872068、40672064)、国家科技支撑计划课题(2011BAB04B09)、高等学校学科创新引智计划(B07011)和地质过程与矿产资源国家重点实验室开放课题(GPMR201307)联合资助。

摘要:

胶东是我国最重要的金矿集区, 拥有全国近四分之一的金资源储量, 其95%以上赋存在玲珑型和郭家岭型花岗质岩体内。然而, 关于花岗岩类的成因, 尤其是早白垩世郭家岭型花岗质岩体成因仍存有争议。郭家岭型花岗质岩体自西向东包括三山岛岩体、新城岩体、上庄岩体、北截岩体、丛家岩体和郭家岭岩体等。其中, 新城岩体是迄今为止在胶东矿集区内发现的唯一赋存超大型金矿床的郭家岭型花岗质岩体, 呈北东向岩株状侵入到玲珑型花岗岩体中, 主要由石英二长岩和二长花岗岩组成, 二者之间呈渐变过渡关系, 为同期岩浆活动作用的产物。为了厘定新城岩体的岩石成因, 揭示胶西北早白垩世高Ba-Sr郭家岭型花岗岩形成的地球动力学背景, 论文对新城岩体进行了详实的野外地质调查, 系统采集了二长花岗岩样品, 分析了其矿物化学、元素地球化学和Sr-Nd同位素组成。新城二长花岗岩的SiO₂含量变化于70.89%~73.35%, 相对于传统的I、S、M和A型花岗岩具有高的全碱(K₂O+Na₂O=7.03%~8.68%)、Sr(>640×10⁻⁶)、Ba(>853×10⁻⁶)和轻稀土(LREE)含量(>65.43×10⁻⁶), 低的Al₂O₃(14.41%~15.54%)、MgO(0.21%~0.62%)、Rb(<103×10⁻⁶)、Th(<10.3×10⁻⁶)、U(<5.87×10⁻⁶)、Nb(<6.14×10⁻⁶)、Ta(<0.599×10⁻⁶)、Y(<10.3×10⁻⁶)和重稀土(HREE)含量(<5.3×10⁻⁶), LREE富集、HREE相对亏损(LREE/HREE=15.03~42.05), 轻、重稀土元素分馏明显[(La/Yb)_N=20.32~198.79], 无明显的铕异常, 明显亏损Nb、Ta、P、Ti等高场强元素, 显示出典型的高Ba-Sr花岗岩所具有的地球化学特征, 属高Ba-Sr花岗岩。二长花岗岩中的斜长石和钾长石斑晶均呈典型的反环带结构, 其中斜长石属于更长石, An值介于12.87~22.91, 钾长石属于正长石, Or值为81.24~93.69。Sr-Nd同位素分析表明二长花岗岩的初始⁸⁷Sr/⁸⁶Sr(*I*₀)和ε_{Nd}(*t*)分别为0.71071~0.71172和-21.3~-17.1, 二阶段亏损地幔模式年龄(*t*_{DM2})为2310~2648Ma。上述元素地球化学、矿物化学和Sr-Nd同位素数据分析表明, 高Ba-Sr新城二长花岗岩是胶北地体基底岩石胶东群变质岩部分熔融形成的酸性岩浆与早先幔源岩浆底侵作用形成的新生镁铁质地壳部分熔融形成的中性岩浆混合作用的结果, 古太平洋板块向华北板块俯冲及其伴生的软流圈物质上涌可能是胶西北高Ba-Sr郭家岭型花岗岩形成的机制。

英文摘要:

The majority of gold resources (>95%) in the Jiaodong Peninsula, the largest gold producer in China, are hosted in the Late Jurassic Linglong-type and Early Cretaceous Guojialing-type granitoids. However, the petrogenesis and sources of the granitic rocks, especially the Early Cretaceous granitoids, remain controversial. The Guojialing-type granitoid, intruding the Linglong-type granitoid, includes six plutonic bodies from west to east through the Jiaodong Peninsula: Sanshandao, Xincheng, Shangzhuang, Beijie, Congjia and Guojialing, of which the Xincheng pluton is the only Guojialing-type granitoid that hosts the super-large gold deposit in Jiaodong. The Xincheng pluton, intruding the Linglong biotite-granite, mainly consists of quartz monzonite and monzogranite. The boundary between the quartz monzonite and monzogranite is unclear, suggesting that they are coeval intrusions. In order to discuss the petrogenesis of the Xincheng Early Cretaceous granitoids, and reveal the geodynamics background for the high Ba-Sr Guojialing-type granite, this paper systematically investigated the Xincheng pluton to sample the monzogranite, and conducted the elemental, mineralogical and Sr-Nd isotopic analyse. The Xincheng monzogranites, typical high Ba-Sr granites, possess high SiO₂ (70.89%~73.35%), K₂O (7.03%~8.68%), total alkalis (K₂O+Na₂O=7.03%~8.68%), Sr (>640×10⁻⁶), Ba (>853×10⁻⁶) and LREE (>65.43×10⁻⁶), with low HREE and HFSE contents and insignificant Eu anomalies. The rocks display markedly high Sr/Y (>115) and (La/Yb)_N (20.32~198.8) ratios. They have low Al₂O₃ (14.41%~15.54%), MgO (0.21%~0.62%), Rb (<103×10⁻⁶), Th (<10.3×10⁻⁶), U (<5.87×10⁻⁶), Nb (<6.14×10⁻⁶), Ta (<0.599×10⁻⁶), Y (<10.3×10⁻⁶) and HREE (<5.3×10⁻⁶). The plagioclases and K-feldspars in the monzogranites both show the reverse zoning texture, of which the plagioclases belong to oligoclase with An contents of 12.87~22.91, and the K-feldspars belong to orthoclase.

ase with Or contents of 81.24~93.69. The monzogranites have $^{87}\text{Sr}/^{86}\text{Sr}$ (I_{Sr}) and $\epsilon_{\text{Nd}}(t)$ values of 0.71071~0.71172 and -21.3~-17.1, respectively, with the two-stage Nd model ages (t_{DM2}) of 2310~2648Ma. Detailed elemental, mineralogical and Sr-Nd isotopic data suggest that the Xincheng monzogranites were most likely generated by partial melting of the basement rocks of the Jiaobei terrane with minor addition of intermediate magma which were partial melting of juvenile mafic lower crust formed by the earlier underplating of mantle magma. Their genesis is linked to asthenosphere upwelling, triggered by the subduction of the paleo-Pacific slab beneath the North China Craton.

关键词: [高Ba-Sr花岗岩](#) [岩浆混合](#) [Sr-Nd同位素](#) [胶西北](#)

投稿时间: 2014-02-02 最后修改时间: 2014-05-10

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黔ICP备07002071号-2

主办单位: 中国矿物岩石地球化学学会

印刷版(Print): ISSN 1000-0569 网络版(Online): ISSN 2095-8927

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