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西昆仑塔什库尔干布伦阔勒群的岩石地球化学特征及变质*P-T*轨迹

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摘要：

西昆仑布伦阔勒群变质岩是西昆仑造山带的重要组成部分,但其成因一直存在争议。在塔什库尔干县的马尔洋地区,布伦阔勒群主要由石榴斜长角闪片麻岩和孔兹岩组成。根据地球化学特征,石榴斜长角闪片麻岩稀土元素配分曲线可以分为两种类型:一种稀土总量较高(ΣREE=190.2×10^{-6}～359.1×10^{-6}),从轻稀土到重稀土逐渐亏损($(La/Yb)_N$=4.28～5.79),与E-MORB类似;另一种稀土总量较低(ΣREE=89.28×10^{-6}～113.0×10^{-6}),轻稀土亏损($(La/Yb)_N$=0.59～0.84),重稀土曲线平坦($(Gd/Yb)_N$=0.99～1.07),与N-MORB类似。微量元素蛛网图中石榴斜长角闪片麻岩具有Ba正异常,Sm、Cr、Zr、Hf和Ti的负异常,轻微的Nb、Ta的负异常,显示为岛弧拉斑玄武岩的特征。孔兹岩的原岩判别图解显示其原岩可能为岛弧环境沉积的页岩和硬砂岩。因此,推测塔什库尔干布伦阔勒群的石榴斜长角闪片麻岩和孔兹岩的原岩形成于岛弧环境。根据岩相学观察、矿物化学分析和温压计算,石榴斜长角闪片麻岩经历了三个变质阶段:M1为高压变质阶段,矿物组合为Grt+Hbl1+Pl1+Qtz,变质温压条件为850～870℃/12.9～13.3kb;M2和M3为两期角闪岩相退变质阶段,矿物组合分别为Hbl2+Pl2+Qtz和Hbl3+Pl3+Kfs+Bt+Qtz,变质温压条件分别为730～770℃/7.3～7.8kb和680～740℃/4.7～5.7kb。孔兹岩也经历了三个变质阶段,推测其早期M1阶段变质温压条件可能与石榴斜长角闪片麻岩的峰期变质阶段相同(850～870℃/12.9～13.3kb);峰期M2和峰期后M3阶段变质矿物组合分别为Grt2+Pl2+Bt2+Sil+Qtz和Grt3+Pl3+Bt3+Sil+Mus+Qtz,温压计算结果分别为800～830℃/7.9～9.2kb和670～700℃/5.1～5.6kb。孔兹岩的M1、M2和M3变质阶段对应于石榴斜长角闪片麻岩的M1、M2和M3变质阶段。上述温压计算结果形成顺时针的*P-T*轨迹,表现为峰期高压变质作用后叠加了由高角闪岩相-中压麻粒岩相到低角闪岩相的退变质作用,反映了西昆仑与碰撞相关的大地构造背景,这可能与海西期古特提斯洋的闭合有关,之后叠加了印支期构造抬升过程中的剪切作用。

英文摘要：

The Bulunkuole Group is an important metamorphic terrain exposed in the Western Kunlun Orogen but is debatable about its genesis. It is mainly composed of Grt-Pl-Hbl gneiss and khondalite at Maryang in Taxkorgan, western Kunlun. According to the geochemical characteristics, the Grt-Pl-Hbl gneiss may be subdivided into two types: the first type has higher content of total REE (ΣREE=190.2×10^{-6}～359.1×10^{-6}) than that of the other type of Grt-Pl-Hbl gneiss (ΣREE=89.28×10^{-6}～113.1×10^{-6}), and gets poorer from LREE to HREE ($(La/Yb)_N$=4.28～5.79), with the feature of E-MORB; the second is poor in LREE ($(La/Yb)_N$=0.59～0.84) and horizontal HREE pattern ($(Gd/Yb)_N$=0.99～1.07) with the feature of N-MORB. However, both kinds of the Grt-Pl-Hbl gneiss exhibit positive Ba but negative Sm, Cr, Zr, Hf and Ti anomalies with slightly negative Nb and Ta anomalies, showing the feature of the island arc tholeiite. Discrimination diagrams indicate that the protoliths of the khondalites are shale and greywacke formed in an island arc. Thus, the protoliths of the Grt-Pl-Hbl gneisses and the khondalites were likely developed in the island arc setting. Further petrography and mineral chemical data, combined with *P-T* estimates, indicate three metamorphic stages in the Grt-Pl-Hbl gneiss: M1 is a high-pressure metamorphic stage, with a mineral assemblage of Grt+Hbl1+Pl1+Qtz and the *P-T* conditions of around 850～870℃ with 12.9～13.3kb; the retrograde stages M2 and M3 have mineral assemblages of Hbl2+Pl2+Qtz and Hbl3+Pl3+Kfs+Bt+Qtz respectively, and the *P-T* estimates are respectively 730～770℃/7.3～7.8kb and 680～740℃/4.7～5.7kb. Whereas the khondalite is considered to have undergone three metamorphic stages: the *P-T* condition of the early M1 stage is implied to be same with that of peak assemblage in the Grt-Pl-Hbl gneiss (850～870℃/12.9

～13.3kb); its peak M2 stage and post-peak M3 assemblages are respectively Grt2+Pl2+Bt2+Sil+Qtz and Grt3+Pl3+Bt3+Sil+Mus+Qtz, with the corresponding *P-T* estimates of 800～830℃/7.9～9.2kb and 670～700℃/5.1～5.6kb. The three metamorphic stages of the khondalite are interpreted to match with the M1, M2 and M3 of the Grt-Pl-Hbl gneiss. The calculated results suggest clockwise *P-T* paths with a peak high-pressure stage overprinted by an upper amphibolite- or mid-pressure granulite facies metamorphism followed by a lower amphibolite facies metamorphism, which are interpreted to form in the Hercynian collision-related tectonic setting. They are possibly associated with the closure of Paleo-Tethyan Ocean, followed by the intracontinental shearing during the Indosinian tectonic uplift.

关键词：石榴斜长角闪片麻岩 孔兹岩 *P-T*轨迹 布伦阔勒群 西昆仑

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