

曹花花, 许文良, 裴福萍, 郭鹏远, 王枫. 2012. 华北板块北缘东段二叠纪的构造属性: 来自火山岩锆石U-Pb年代学与地球化学的制约. 岩石学报 28(9): 2733-2750

华北板块北缘东段二叠纪的构造属性: 来自火山岩锆石U-Pb年代学与地球化学的制约

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基金项目: 本文受国家自然科学基金项目(41172057); 中国地质调查局项目(1212321013019、1212011085480); 吉林大学科学前沿与交叉学科创新项目(200903032)和中国地质大学(武汉)地质过程与矿产资源国家重点实验室开放基金(GPMR2011^{*})联合资助

摘要:

本文对华北板块北缘东段大河深组、关门咀子组火山岩进行了锆石LA-ICP-MS U-Pb定年和岩石地球化学研究以便制约该区的区域构造演化。大河深组和关门咀子组火山岩中的锆石均呈自形-半自形晶,具有清晰的岩浆振荡生长环带和条痕状吸收(玄武安山岩)的特点,其Th/U值高达0.31~1.56,表明其岩浆成因。测年结果表明,桦甸大河深组流纹岩形成于早二叠世(279±3Ma~293±2Ma),珲春和图们关门咀子玄武安山岩和玄武岩分别形成于早二叠世(275±7Ma)和晚二叠世(250±5Ma)。大河深组火山岩SiO₂含量介于64.9%~75.4%,Mg[#]值为0.21~0.57,属于中钾-高钾钙碱性系列,明显富集轻稀土元素(LREEs)和大离子亲石元素(LILEs)、亏损高场强元素(HFSEs,如Nb、Ta、i)以及P元素,类似活动大陆边缘火山岩;其锆石的 $\epsilon_{\text{Hf}}(t)$ 值为+0.9~+10.37,Hf同位素二阶段模式年龄值为785~1240Ma,表明它们均起源于中-新元古代新增生玄武质下地壳的部分熔融。珲春早二叠世关门咀子组属于中钾钙碱性系列;贫硅(53.4%~53.7%)和HFSEs,富铝(16.4%~16.8%)和LILEs,具有较低的稀土元素总量,以及较平坦的稀土配分型式,显示出岛弧火山岩的地球化学属性;该组火山岩的原始岩浆起源于受俯冲板片脱水熔融交代的亏损地幔楔。图们晚二叠世关门咀子组玄武岩SiO₂含量为48.7%~49.6%,Mg[#]值高达0.64~0.72,相富集LREEs和LILEs,亏损HREEs和HFSEs,具有火山弧玄武岩的地球化学属性,同时其 $\epsilon_{\text{Nd}}(t)=+6.01$,暗示其原始岩浆起源于亏损的岩石圈地幔。综上所述,我们认为早二叠世至晚二叠世期间,华北板块北缘东段(吉林中部地区)和兴凯地块西南缘均处于古亚洲洋的俯冲作用下。

英文摘要:

LA-ICP-MS zircon U-Pb dating and geochemical data have been obtained for the volcanic rocks from the Dahesh and Guanmenzuizi formations in the middle-eastern parts of Jilin Province, with the aim of constraining the tectonic nature of the eastern section of the northern margin of the North China Plate in Late Paleozoic. Zircons from the volcanic rocks in the Daheshen and Guanmenzuizi formations are euhedral-subhedral in shape and display fine-scale oscillatory zoning and striped absorption (basaltic andesite) as well as high Th/U ratios (0.31~1.56), implying their magma origin. LA-ICP-MS zircon U-Pb age data indicate that the dacite and rhyolites from the Daheshen Formation in Huadi County formed in the Early Permian (279±3Ma~293±2Ma), whereas the basaltic andesite and basalt from the Guanmenzuizi Formation in the Hunchun and Tumen areas formed in the Early Permian (275±7Ma) and Late Permian (250±5Ma), respectively. The volcanic rocks from the Daheshen Formation have SiO₂=64.9%~75.4%, Mg[#]=0.21~0.57, belonging chemically to medium- to high-K calc-alkaline series, and display an enrichment in LREEs and LILEs and depletion in HFSEs (such as Nb, Ta, and Ti) and P, similar chemically to those from an active continental margin setting. The initial Hf isotopic ratios and Hf two-stage model ages range from +0.9 to +10.37 and from 785Ma to 1240Ma, respectively, suggesting that their primary magmas could be mainly derived from partial melting of the Meso-Neoproterozoic accreted lower crust. The Early Permian basaltic andesites from the Guanmenzuizi Formation in Hunchun area, belonging chemically to medium-K calc-alkaline series, are poor in SiO₂ (53.4%~53.7%) and HFSEs, rich in Al₂O₃ (16.4%~16.8%) and LILEs, and display low REE abundances and flat REE pattern, similar to those from an island arc setting. The primary magma of the basaltic andesites could be mainly derived from partial melting of the depleted mantle wedge metasomatized by the subducted slab-derived fluid. The Late Permian basalts from the Guanmenzuizi Formation in Tumen area have SiO₂=48.7%~49.6%, Mg[#]=0.64~0.72, and are enriched in LREEs and LILEs, and depleted in HREEs and HFSEs, similar chemically to those from a volcanic arc setting. Combined with its Nd isotopic ratios (+6.01), we consider that its primary magma could be derived from partial melting of a depleted lithospheric mantle. Taken together, we conclude that the subduction of the Paleo-Asian oceanic plate happened in both the eastern section of the northern margin of the North China Plate (in middle part of Jilin Province) and the southwestern margin of the Khanka Massif

om Early Permian to Late Permian.

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