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胶东晚三叠世碱性岩浆作用的岩石成因——来自锆石U-Pb年龄、Hf-O同位素的证据

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摘要:

碰撞后岩浆活动记录了板块俯冲-碰撞过程中壳幔物质相互作用的重要信息,对于理解岩浆的源区性质、地球动力学背景乃至造山带构造演化、壳幔相互作用都是一个绝佳的切入点。苏鲁超高压变质带北部胶东威海地区的晚三叠世碱性岩浆作用以其接近大别-苏鲁造山带240~225Ma的碰撞造山时间而备受关注。这一期碱性岩浆岩包括邢家碱性辉长岩、甲子山正长岩体、中-基性岩墙和槎山正长花岗岩体。总体上,这套晚三叠世碱性岩石富K、LREE和LILE,亏损高场强元素,基性岩石普遍富含MgO。全岩Sr-Nd同位素组成比较均一,初始Sr同位素比值($^{87}\text{Sr}/^{86}\text{Sr}$)_i(212Ma)为0.7059~0.7074, $\epsilon_{\text{Nd}}(212\text{Ma})$ 为-14.5~-16.5,地球化学特征初步指示其起源于富集地幔源区。本文所测定的两个中性岩墙、正长岩脉和槎山正长花岗岩的锆石U-Pb年龄与前人发表的甲子山正长岩体的锆石U-Pb年龄非常接近,反映这套碱性岩石几乎是同期形成的。除了三叠纪侵位年龄外,1个中性岩墙和正长岩脉中都有1组新元古代的年龄信息(多分布在600~750Ma之间)。该中性岩墙的三叠纪年龄锆石Hf同位素变化很大, $\epsilon_{\text{Hf}}(t)=-8.2\sim-21.2$;其他样品的三叠纪年龄锆石Hf同位素则相对均一, $\epsilon_{\text{Hf}}(t)=-16.8\sim-22.2$ 。中性岩墙和正长岩脉的三叠纪锆石原位氧同位素组成不均一, $\delta^{18}\text{O}$ 值分别为4.76‰~6.46‰,1.12‰~6.74‰,且有低于地幔锆石(5.3‰±0.3‰)的分析点。另两个没有新元古代年龄的样品的锆石氧同位素特征则比较均一, $\delta^{18}\text{O}$ 平均值分别为6.88±0.18‰和5.86±0.36‰,没有亏损 ^{18}O 的特点。根据正长岩脉和中性岩墙的锆石得到的一些新元古代的年龄信息以及亏损 ^{18}O 的特点,可以认为这一期岩浆事件的源区有深俯冲扬子地壳组分的参与。综合其他资料我们认为胶东晚三叠世碱性岩浆岩的岩石成因是三叠纪华南板块向北板块深俯冲导致软流圈地幔上涌带来热源使得俯冲的扬子岩石圈富集地幔源区以及部分扬子陆壳共同发生部分熔融从而形成原始岩浆且随后发生一系列的结晶分异。

英文摘要:

Post-collisional magmatism contains important information and is a way to understand the nature of sources, background of the Earth's deep dynamics, tectonic evolution of orogens and mantle-crust interaction during the subduction/collision process. The Late Triassic alkaline magmatism in Weihai, East Shandong (Jiaodong), northern part of the Su-Lu UHP belt, is remarkable because its forming time was close to closure time of the Dabie-Sulu Orogen (240~225 Ma). The episode of alkaline igneous rocks includes Xingjia alkaline gabbros, Jiazishan syenites, intermediate-mafic dikes and Chashan syeno-granites. Overall, the Late Triassic alkaline rocks are enriched in potassium, LILE and LREE, depleted in HFSE, mafic rocks are mostly enriched in MgO concentrations. Whole-rock Sr-Nd isotope compositions are relatively homogeneous, ($^{87}\text{Sr}/^{86}\text{Sr}$)_i(212Ma)=0.7059~0.7074, $\epsilon_{\text{Nd}}(212\text{Ma})=-14.5\sim-16.5$. These chemical and isotopic characteristics indicate that the rocks were originated from an enriched mantle source. Zircon U-Pb dating results of two intermediate dikes, a syenitic dike and a syeno-granite are obtained, ranging from 210~216Ma and consistent with previous age data. This indicates that these alkaline rocks formed within a short period. Besides these Triassic ages, there are a group of Neoproterozoic ages (750~600Ma) in one of the intermediate dikes and a syenitic dike. Hf isotopic compositions of Triassic zircons from one of the intermediate dikes show large variations, ($\epsilon_{\text{Hf}}(t)=-8.2\sim-21.2$); whereas those from other samples exhibit relative similar values ($\epsilon_{\text{Hf}}(t)=-16.8\sim-22.2$). In-situ oxygen isotopes of zircons from samples with Neoproterozoic ages show inhomogeneous characteristics, $\delta^{18}\text{O}$ values of zircons vary from 4.76‰~6.46‰ and 1.12‰~6.74‰, respectively, including spots lower than mantle values. Other two samples without Neoproterozoic ages exhibit different oxygen isotopes, which are uniform and have no ^{18}O depletion, with the two weighted mean $\delta^{18}\text{O}$ values at 6.88±0.18‰ and 5.86±0.36‰ for an intermediate dike and a syenitic dike, respectively. Based on the information of Neoproterozoic ages and ^{18}O depletion of zircons from one of the intermediate dikes and one syenitic dike, We suggest that the subducted Yangtze crust could have been contributed to the Late Triassic magmatism, and the Late Triassic alkaline rocks in this area were derived from partial melting of the subducted Yangtze lithospheric mantle and crust, coupled with subsequent fractionation. This magmatism would have driven by heat brought from asthenosphere upwelling due to the subduction of the South China Block beneath the North China Block during Triassic.

关键词: [锆石氧同位素](#) [新元古代](#) [晚三叠世](#) [碱性岩](#) [胶东](#) [扬子地壳](#)

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