



1.12 铌钽铁矿 LA-ICP-MS 微区原位 U-Pb 定年和微量元素分析

铌钽铁矿 U-Pb 同位素定年和微量元素含量在武汉上谱分析科技有限责任公司利用 LA-ICP-MS 同时分析完成。详细的仪器参数和分析流程见 (Lu et al. 2023)。GeolasPro 激光剥蚀系统由 COMPexPro 102 ArF 193 nm 准分子激光器和 MicroLas 光学系统组成, ICP-MS 型号为 Agilent 7900。激光剥蚀过程中, 采用氦气作载气, 氩气为补偿气以调节灵敏度。两者在进入 ICP 之前通过一个 T 型接头混合, 激光剥蚀系统配置有信号平滑装置(Hu et al., 2015)。本次分析的激光束斑和频率分别为 $\times\times\mu\text{m}$ 和 $\times\times\text{Hz}$ 。U-Pb 同位素定年和微量元素含量处理中采用铌钽铁矿标准 SN3 和玻璃标准物质 NIST610 作外标分别进行同位素和微量元素分馏校正。每个时间分辨分析数据包括大约 20-30 s 空白信号和 50 s 样品信号。对分析数据的离线处理 (包括对样品和空白信号的选择、仪器灵敏度漂移校正、元素含量及 U-Pb 同位素比值和年龄计算) 采用软件 ICPMSDataCal (Liu et al., 2008; Liu et al., 2010) 完成。铌钽铁矿样品的 U-Pb 年龄谱和图绘制和年龄加权平均计算采用 Isoplot/Ex_ver3 (Ludwig, 2003) 完成。

1.12 In-situ U-Pb dating and trace element analysis of Columbite by LA-ICP-MS

U-Pb dating and trace element analysis of columbite were simultaneously conducted by LA-ICP-MS at the Wuhan SampleSolution Analytical Technology Co., Ltd., Wuhan, China. Detailed operating conditions for the laser ablation system and the ICP-MS instrument and data reduction are the same as description by (Lu et al. 2023). Laser sampling was performed using a GeolasPro laser ablation system that consists of a COMPexPro 102 ArF excimer laser (wavelength of 193 nm and maximum energy of 200 mJ) and a MicroLas optical system. An Agilent 7900 ICP-MS instrument was used to acquire ion-signal intensities. Helium was applied as a carrier gas. Argon was used as the make-up gas and mixed with the carrier gas via a T-connector before entering the ICP. A “wire” signal smoothing device is included in this laser ablation system (Hu et al., 2015). The spot size and frequency of the laser were set to $\times\times\mu\text{m}$ and $\times\times\text{Hz}$, respectively, in this study. columbite SN3 and glass NIST610 were used as external standards for U-Pb dating and trace element calibration, respectively. Each analysis incorporated a background acquisition of approximately 20-30 s followed by 50 s of data acquisition from the sample. An Excel-based software ICPMSDataCal was used to perform off-line selection and integration of background and analyzed signals, time-drift correction and quantitative calibration for trace element analysis and U-Pb dating (Liu et al., 2008; Liu et al., 2010). Concordia diagrams and weighted mean calculations were made using Isoplot/Ex_ver3 (Ludwig, 2003).



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