1.3 铀矿 LA-ICP-MS 微区原位 U-Pb 定年

铀矿 U-Pb 同位素定年在武汉上谱分析科技有限责任公司利用 LA-ICP-MS 分析完成。有关详细的实验流程、数据处理和校正策略见 Zong et al. (2015)。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)。在本次分析中，激光束斑和频率分别为××μm 和××Hz。U-Pb 同位素定年处理中采用铀矿标准物质 GBW04420 作外标进行同位素分馏校正。每个时间分辨分析数据包括大约 20-30 秒空白信号和 50 秒样品信号。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以及 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。对铀矿样品的 U-Pb 年龄谐和图绘制和年龄加权平均计算采用 Isoplot/Ex_ver3 (Ludwig, 2003) 完成。

1.3 In-situ U-Pb dating of uraninite by LA-ICP-MS

U-Pb dating of uraninite was conducted by LA-ICP-MS at the Wuhan SampleSolution Analytical Technology Co., Ltd., Wuhan, China. Detailed operating processes and data reduction are consistent with those described by Zong et al. (2015). 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, while argon, serving as the make-up gas, was mixed with the carrier gas through 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 ××μm and ××Hz, respectively. Uraninite standard GBW04420 was used as an external standard for U-Pb isotope calibration. Each analysis incorporated a background acquisition of approximately 20-30 seconds, followed by 50 seconds 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 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).

References

Zong, K.Q., Chen, J.Y., Hu, Z.C., Liu, Y.S., Li, M., Fan, H.H., Meng, Y.N., 2015. In-situ U-Pb dating of uraninite by fs-LA-ICP-MS. Science China Earth Sciences, 58, 1731–1740.

Hu, Z.C., Zhang, W., Liu, Y.S., Gao, S., Li, M., Zong, K.Q., Chen, H.H., Hu, S.H., 2015. “Wave” signal-smoothing and mercury-removing device for laser ablation quadrupole and multiple collector ICPMS analysis: application to lead isotope analysis. Analytical Chemistry, 87(2), 1152–1157.

Liu, Y.S., Hu, Z.C., Gao, S., Günther, D., Xu, J., Gao, C.G. and Chen, H.H., 2008. In situ analysis of major and trace elements of anhydrous minerals by LA-ICP-MS without applying an internal standard. Chemical Geology, 257(1-2): 34-43.

Liu, Y.S., Gao, S., Hu, Z.C., Gao, C.G., Zong, K.Q. and Wang, D.B., 2010. Continental and oceanic crust recycling-induced melt-peridotite interactions in the Trans-North China Orogen: U-Pb dating, Hf isotopes and trace elements in zircons of mantle xenoliths. Journal of Petrology, 51(1–2): 537–571.

Ludwig, K.R., 2003. ISOPLOT 3.00: A Geochronological Toolkit for Microsoft Excel. Berkeley Geochronology Center, California, Berkeley, 39 pp.