



### 1.9 磷灰石 LA-ICP-MS 微区原位 U-Pb 定年和微量元素分析

磷灰石 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。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  $\times\times\text{Hz}$ 。磷灰石 MAD (Thomson et al., 2012) 作为外标以进行 Pb/U 分馏和质量歧视校正，玻璃标准物质 NIST 612 作外标进行微量元素含量校正(Liu et al., 2008)。Sumé 作为未知样品进行分析。在本研究中，Sumé 的  $\times$  次分析中获得的  $^{206}\text{Pb}/^{238}\text{U}$  年龄值为  $***\text{Ma}$ ，与参考年龄  $568.0\pm 3.1\text{Ma}$  一致 (Lana et al. 2022)。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 Iolite 4.0(Paton et al. 2011)完成。磷灰石样品的 U-Pb 年龄 Tera-wasserburg 图解绘制和  $^{207}\text{Pb}$  法校正年龄加权平均计算采用 Isoplot/Ex\_ver3 (Ludwig, 2003) 完成。

### 1.9 In-situ U-Pb dating and trace element analysis of Apatite by LA-ICP-MS

U-Pb dating and trace element analysis of apatite were simultaneously conducted by LA-ICP-MS at the Wuhan SampleSolution Analytical Technology Co., Ltd., Wuhan, China. 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. Apatite MAD (Thomson et al., 2012) was used as an external standard to correct the Pb/U fractionation and instrumental mass discrimination, The trace element compositions of apatite were calibrated against NIST 612 glass as an external calibration (Liu et al., 2008). Apatite Sumé was analyzed as an unknown. The obtained weighted average  $^{206}\text{Pb}/^{238}\text{U}$  ages in  $\times$  analyses of Sumé are  $***\text{Ma}$  in this study, which are consistent with the reference age of  $568.0\pm 3.1\text{Ma}$  (Lana et al. 2022). Each analysis incorporated a background acquisition of approximately 20-30 s followed by 50 s of data acquisition from the sample. A software Iolite 4.0 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 (Paton et al. 2011). Tera-wasserburg diagrams of U-Pb ages and  $^{207}\text{Pb}$  corrected age weighted average calculations were made using Isoplot/Ex\_ver3 (Ludwig, 2003).

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