SHRIMP U-Pb zircon age of the Jinbaoshan ultramafic intrusion, Yunnan Province, SW China

TAO Yan1†, MA YanSheng1,2, MIAO LaiCheng3 & ZHU FeiLin1,2
1 State Key Laboratory of Ore Deposit Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang 550002, China; 2 Graduate University of the Chinese Academy of Sciences, Beijing 100049, China; 3 Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China

SHRIMP U-Pb zircon dating gives ages of 260.6 ± 3.5 Ma and 260.7 ± 5.6 Ma for serpentinised wehrlite and plag-hornblendite in the Jinbaoshan ultramafic intrusion, respectively. The results indicate that the Jinbaoshan intrusion was emplaced at ca.260 Ma and contemporaneous with the Emeishan continental flood basalts (ECFB), similar to other mafic-ultramafic intrusions of the Emeishan large igneous province (LIP). The new ages provide a geochronological constraint on the origin of the Jinbaoshan ultramafic intrusion. It confirms that the Jinbaoshan ultramafic intrusion belongs to the Emeishan LIP that formed at ca. 260 Ma.

zircon, SHRIMP, U-Pb age, ultramafic intrusion, Emeishan LIP, Ni-Cu-PGE deposit

The Jinbaoshan ultramafic intrusion is located in Midu County, Yunnan Province. It occurs in the western margin of the Yangtze Block (Figure 1). The Jinbaoshan intrusion hosts the largest magmatic PGE deposit (sulfide-poor PGE deposit) in China at present. The intrusion is a sheet-like body composed mainly of wehrlite with minor gabbros, hornblendeites and pyroxenites. It intruded Devonian dolomites. The intrusion is ~5 km long, ~1 km wide and 25−170 m in vertical thickness (Figure 1).

The Jinbaoshan intrusion is considered to be an important ore-bearing intrusion in the Emeishan LIP[1]. Previous studies have suggested that it is related to the magmatism of the Emeishan continental flood basalts[2,3]. In the Jinbaoshan area, some of the associated gabbroic dykes intruded lower Permian limestone which locally occurred, and unconformably overlain by the Late Triassic shales. The stratigraphic correlation suggests that the intrusion was emplaced before the Late Triassic but after Early Permian. The field relations have been widely used as evidences for coeval relationship between the intrusive rocks and ECFB, but an accurate age is lacking. An accurate determination of the age and the associated geotectonic background for the Jinbaoshan intrusion is important for better understanding of the magmatism and associated metallogeny in the Emeishan LIP. In this paper, we report precise SHRIMP U-Pb zircon ages for the Jinbaoshan intrusion.

The zircons were separated from 2 samples. One is a serpentinised wehrlite (1309-3) from the entrance of adit 1309 and the other is a plag-hornblendite (L03) from the base of the intrusion in exploration section 1#. Sample 1309-3 represents a typical wehrlite immediately below the 1# ore seam in the intrusion. It is composed of serpentinised olivine and pyroxene with minor magnetite and other accessory minerals. Clinopyroxene commonly occurs as large poikilitic crystals enclosing olivine. The plag-hornblendite (L03) contains >60 vol% hornblende, ~20 vol% plagioclase and minor biotite and magnetite.
Hornblende occurs as euhedral crystals of 3–8 mm in diameter. The plag-hornblendite is considered to be an evolved phase of the intrusion[2]. Zircons in the samples were separated by heavy-liquid and magnetic methods, followed by hand-picking under a binocular microscope. About 120 zircon grains from 10 kg of the wehrlite sample and about 200 zircon grains from 10 kg of the plag-hornblendite were found. The sizes of the zircons are 50–100 μm in diameter. The grain sizes of zircons from plag-hornblendite sample are generally larger than those from the wehrlite sample.

The zircon grains from each sample were mounted randomly in target, respectively. U-Pb analyses were performed using a SHRIMP II machine in the Beijing SHRIMP Center, Chinese Academy of Geological Sciences. Inter-element fractionation of ion emission from zircon was corrected using the standard zircon TEMORA (417 Ma)[4]. The abundances of U, Th and Pb were measured based on the standard zircon SL13 (572 Ma, U = 238 ppm). Common Pb was corrected using the measured 204Pb. The analytical results were processed using the ISOPLOT program of Ludwig[5]. The decay constants given by IUGS were used in age calculations. The results are listed in Table 1.

A total of 19 spot analyses were made on 19 zircon grains from the wehrlite sample (1309-3). Three of them have 206Pb/238U ages of 2632 ± 73 Ma, 1842 ± 40 Ma and 545.2 ± 12 Ma. These ages are much older than that inferred from the field relations described above and these three grains are therefore considered to be inherited xenocrysts from the footwall strata that the magma of the Jinbaoshan intrusion passed through. These zircon xenocrysts show clear oscillatory zoning in CL images as shown in Figure 2(a), and are characterized by low Th, U contents and low Th/U ratios. Three other zircon grains from the wehrlite sample have 206Pb/238U age of 242.1 ± 5.8 Ma, 240.9 ± 5.8 Ma and 242.3 ± 5.7 Ma, significantly younger than crystallization age of the sample (see below). We call them abnormal age zircons. The zircon grains with abnormal ages have some unique features in CL images such as embayment structure and thin light-grey rim as shown in Figure 2(b). They are characterized by high U and Th contents and Th/U ratios between 1.61 and 4.41. Their younger ages than the crystallization age of the intrusion may have resulted from post-crystallization Pb-loss due to post-magmatic hydrothermal alteration. The remaining 13 analyses yield a weighted mean 206Pb/238U age of 260.6 ± 3.5 Ma (MSWD = 1.17). The concordant ages of these zircon grains are illustrated in Figure 3(a). These zircon grains have subhedral morphology and weak oscillatory zoning or unzoned texture in the CL images as shown in Figure 2(c). They have high Th/U ratios ranging from 0.47 to 7.8. These zircons are considered to be crystallized from basaltic magma and the mean age of these zircon grains is interpreted to be the crystallization age of the sample.

A total of 9 spots were analyzed on 9 zircon grains from the plag-hornblendite sample (L03). Two analyses have young 206Pb/238U ages of 244.7 ± 5.9 Ma and 245.9 ± 5.9 Ma. Their CL images show a thin light-grey rim, similar to the zircon grains with abnormal ages from wehrlite sample (1309-3). The contents of U, Th of the two spots are high. Their Th/U ratios are 1.25 and 3.68, respectively. One analysis gives a discordance U-Pb age with the 206Pb/238U age of 266.8 ± 6.6 Ma. The remaining 6 analyses yield a weighted mean 206Pb/238U age of 260.7 ± 5.2 Ma (MSWD = 0.89), which is interpreted to be the crystallization age of the sample. These zircon grains, similar to the basaltic magmatic zircons from