

# U–Pb dating of zircons from tuff layer, sandstone and tillite samples in the uppermost Liantuo Formation and the lowermost Nantuo Formation in Three Gorges area, South China



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## ABSTRACT

Uranium-lead (U–Pb) dating was conducted on zircons in tuff layers and sandstone samples from the uppermost Liantuo Formation and in a tillite sample from the lowermost Nantuo Formation in Three Gorges area, South China, using SHRIMP and LA-ICP-MS techniques. Zircons from these samples yielded age spectrum (within 1000 Ma) of ~890, ~830, ~780, ~730, and 646 Ma. Zircons from the Liantuo tuffs have a weighted mean  $^{206}\text{Pb}/^{238}\text{U}$  age of  $734.1 \pm 8.1$  Ma ( $2\sigma$ ,  $n=7$ , MSWD=0.48), which was regarded as the best estimation of the upper boundary age of the Liantuo Formation. Combining with previous geochronologic data, the Liantuo Formation was proposed to be a pre-Chang'an glaciation unit, and it is comparable to the middle-upper Banxi/Danzhou Group in South China.

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## 1. Introduction

During the last decades, great efforts have been made on the Neoproterozoic history of South China, and a stratigraphic framework of this time interval was proposed as following: The Neoproterozoic strata of South China included the Qingbaikouan, Nanhua, and Sinian Systems in ascending order, and the Nanhua System was comprised of three glacial intervals, i.e., Chang'an Formation, Gucheng Member and Nantuo Formation in ascending order, and two inter-glacial intervals, i.e., Liangjiahe Member and Datangpo Formation in ascending order (see Fig. 1 in Zhu et al., 2007). In Three Gorges area, the Nantuo tillite directly covers the Liantuo Formation sandstone. This leads to two controversial speculations: the Liantuo Formation is an interglacial unit between Nantuo and Gucheng or Chang'an glaciation (Xue et al., 2001; Peng et al., 2004), or the Liantuo Formation is a unit before Chang'an glaciation (Wang and Li, 2003; Zhang and Chu, 2006; Zhang et al., 2008a).

This controversy is partly caused by the lack of precise age of the Liantuo Formation. Up to now, only few ages are obtained for the upper boundary age of Liantuo Formation (Compston, 1982; Ma et al., 1984; Zheng 2003; Gao and Zhang, 2009; Du et al., 2013; Lan et al., 2015). Gao and Zhang (2009) firstly set the upper boundary age of Liantuo Formation at  $724 \pm 12$  Ma according to two zircon U–Pb dating data (Suppl. Table 1), and then Du et al. (2013) suggested the upper boundary age of Liantuo Formation was  $736 \pm 5.8$  Ma based on an zircon U–Pb dating age group (722–747 Ma). Recently, Lan et al. (2015) constrained the upper boundary age of Liantuo Formation at  $714 \pm 8$  Ma. The variation casts great uncertainty on the upper boundary age of the Liantuo Formation.

In this study, we conducted U–Pb dating of zircons from the uppermost tuff beds to constrain the upper boundary age of the Liantuo Formation. In order to confirming our results, we also dated detrital zircons from sandstone and tillite collected from the Liantuo/Nantuo Formation boundary.

## 2. Geological setting and sampling

The Liantuo Formation was once considered as the lower boundary of the former Sinian System (consisting of Liantuo, Nantuo, Doushantuo and Dengying Formations in ascending order, Liu et al.,

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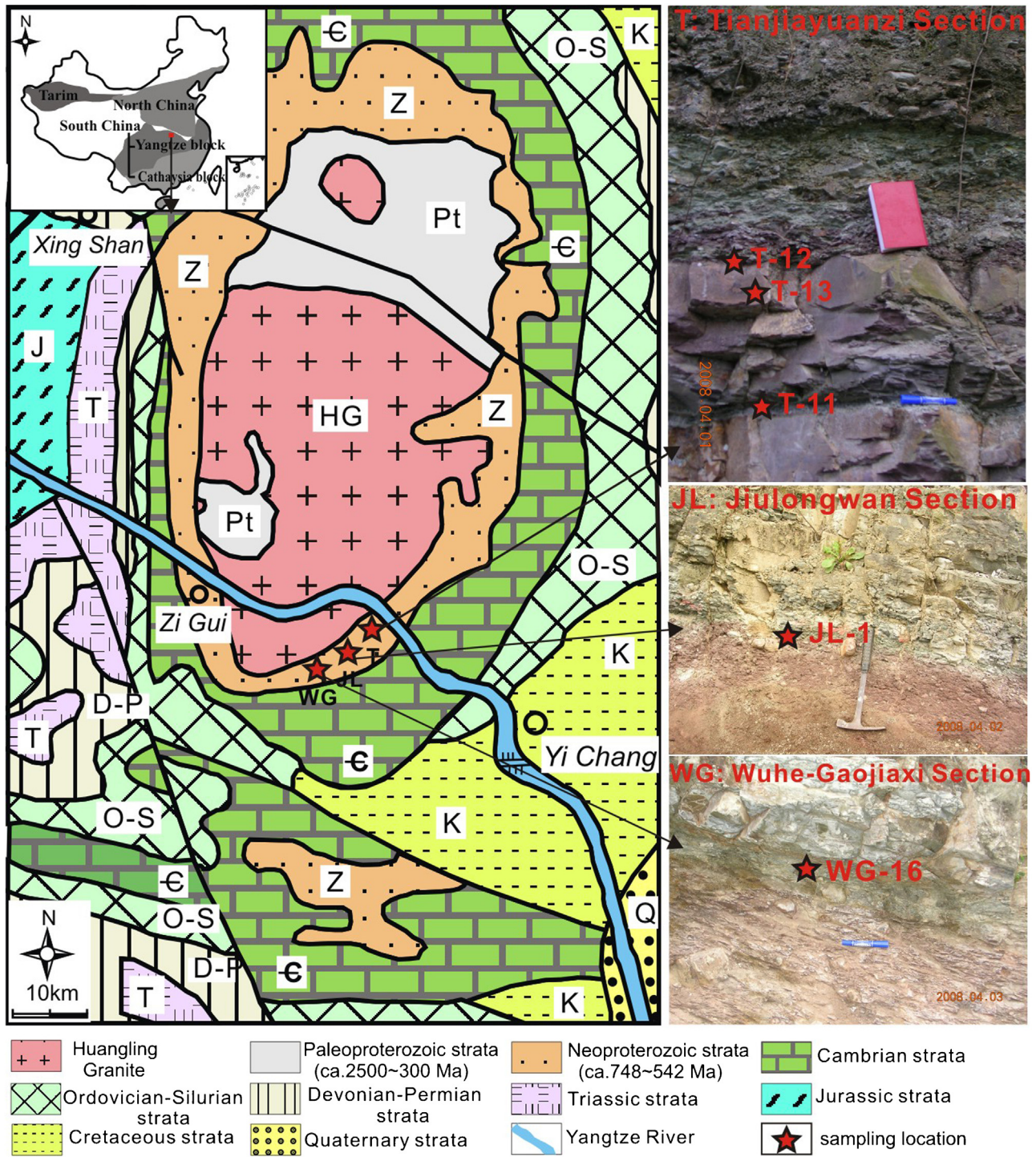


Fig. 1. Geological setting and sampling locations in Three Gorges area, South China (revised from Zhu et al., 2007).

1991), but at present it is moved out from the modified Sinian System (consisting of Doushantuo and Dengying Formations only). The Liantuo Formation is widely exposed in Three Gorges area, Hubei Province, and occurs with varying thickness, between 50–260 m, covering on the Huangling granite (locally referred to the Jinning orogeny) and underlying unconformably the Nantuo Formation tillite (Liu et al., 1991). The Liantuo Formation is mainly composed of aubergine-coloured medium/coarse-grained sandstones, demonstrating a variation from “coarse at the bottom to fine at the top” (Liu et al., 1991). The lower part is mainly composed of aubergine-coloured quartz sandstone and quartzose arkose, and

the upper part is mainly composed of laminated tuff and tuffaceous sandstones.

Tuff samples in this study were taken from the Tianjiayuanzi section, near Sandouping Town, Yiling district, Yichang (T-11 and T-12; N 30°50′05.3″, E 111°07′01.6″), and the Wuhe-Gaojiaxi section (WG-16; N 30°46′59.3″, E 111°02′00.6″) in the uppermost Liantuo Formation (Fig. 1). They are green in color, thin in thickness (<1 cm), and loose in texture, containing major clays and minor sands and/or gravels (their photomicrograph petrography can be referred to Fig. 5 of Lan et al., 2015). One sample each was also collected from the sandstone in the uppermost Liantuo Forma-

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