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SHRIMP dating of volcanic rock in the Zhangwu-Heishan area, West Liaoning province, China: Its relationship with coal-bearing strata

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ABSTRACT

The Zhangwu-Heishan area is located to the east of the Fuxin-Yixian Basin and is mostly covered with volcanic rock. At various periods, different geologists had varying opinions about their age and periods of volcanic eruptions, especially on sequences between volcanic rock and main coal-bearing strata, which affect the direction of searching for coal, as well as prospecting the entire research area. During our study, we carried out detailed field investigations in this research area; observed and recorded the main representative outcrops of volcanic rock. We collected over 20 volcanic rock samples and tested the Sensitive High Resolution Ion Microprobe II (SHRIMP II) U-Pb isotope age of 11 samples. The age of our volcanic rock samples ranged between 56.0 ± 2.9 and 132.3 ± 2.3 Ma. After taking earlier investigations into consideration, we concluded that, except for a suite of paleogene olivine basalt, the volcanic rock in the Zhangwu-Heishan area is younger than the coal-bearing Shahai Formation. It is therefore most unlikely to find coal seams equivalent to those of the early Cretaceous Shahai Formation in Fuxin Basin below volcanic rock.

1. Introduction

The Zhangwu-Heishan area is located to the east of the Fuxin-Yixian Basin. Besides the quaternary soil, our research area is mostly covered with volcanic rock, which is mainly composed of intermediate-basic andesite, trachyandesite and basaltic andesite and small amounts of dacite and rhyolite (Fig. 1). At various periods, a number of research units or individuals had different opinions about their age and volcanic eruption periods, especially about the sequence between volcanic rock and main coal-bearing strata which affect the direction of searching for coal and prospecting of the entire research area [1–12]. Investigations about the age and sequence of volcanic rock, volcanic eruption periods and source regions are important for the discovery of fossil beds, structural evolution of basins and accumulation of fossil fuels. Therefore, these key problems should be solved immediately. Our field investigation started at a high degree of intensity with the Yixian Basin and gradually advanced to the north and northeast of the basin, where major representative volcanic outcrops were observed and recorded. Volcanic outcrops and rock cores in different horizons were sampled for SHRIMP U-Pb isotopic dating. Based on previous research findings, the age and main eruption periods of these volcanic rocks were basically determined; the sequence between volcanic rock and main coal-bearing strata were identified and the directions of precious fossil discoveries and the search for coal defined.

2. Geology background

West Liaoning province is located in the eastern section of the Yanshan Platform Fold Belt to the north of the Sino Korean Paraplatform and belongs to the eastern extension of the Yanshan Orogenic Belt (see Fig. 1). The Yanshan Orogenic Belt, inside the North China Platform, experienced intense tectonic deformation, magmatic and volcanic activities and syn-orogenic sedimentation during the period of the Jurassic-Cretaceous Yanshan Movement. In the end, it became a typical intraplate orogenic belt far away from any contemporary plate boundaries [13]. The subduction of the Pacific Plate resulted in a NE-trending thrust nappe structure of the late Jurassic Epoch and an extension structure of the early Cretaceous Epoch. Prior to the Mesozoic Period, the research area was a large tectonic uplift area. The fault-folding at the early stages of the Yanshan Movement formed the lower–middle Jurassic Series in a NNE-trending depression area, including the coal-bearing Beipiao Formation. At the middle stages of the Yanshan Movement, large-scaled fractures occurred and were accompanied by magmatic eruption, which essentially formed the Mesozoic tectonic framework. In the middle and late Jurassic Period, due to a southward movement of the Siberian Plate and westward subduction of the Pacific Plate, the West Liaoning province was extruded in a

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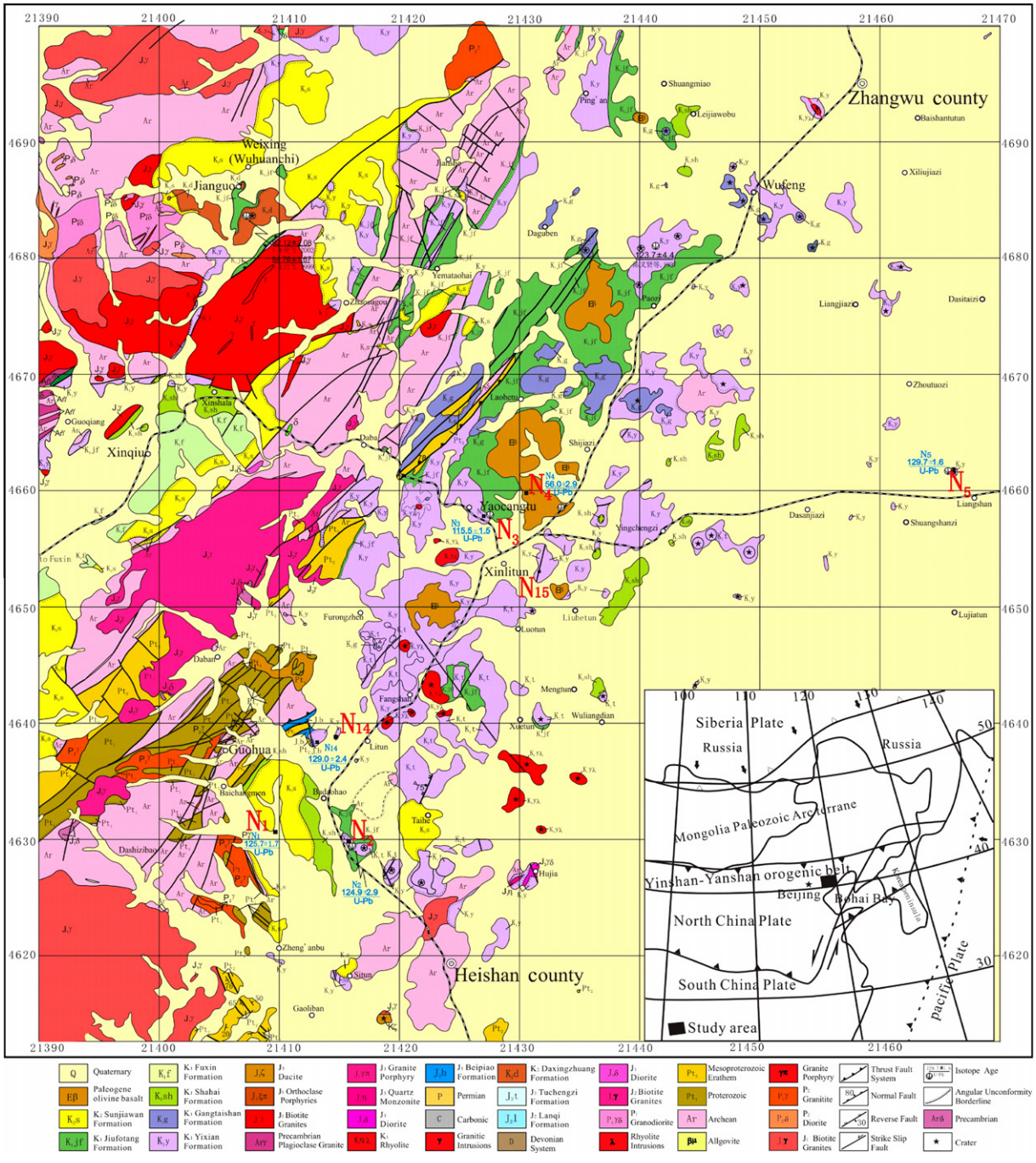

Fig. 1. Geological map of the Zhangwu-Heishan area and sampling location.

NW-SE direction and mainly features NE- and NNE-trending structures [14]. West Liaoning province is bordered by the Chifeng-Kaiyuan Fracture to the north, is adjacent to the Inner Mongolia-Xing'an Orogenic Belt and the Songliao Basin. It is also connected to the EW-trending Yanshan Orogenic Belt to the west and separated from the Liaodong Uplift Zone by the Yilan-Yitong Fracture Zone to the east. Its tectonic position belongs to the transition zone of the North China Block, the Liaodong Uplift Zone and the Inner Mongolia-Xing'an Orogenic Belt [15].

3. History of studies on volcanic rock in the research area

Isotopic dating of volcanic rock in the study area started early and many results have been published [16–34]. We conducted SHRIMP U-Pb isotope analyses on 11 volcanic rock samples. Although the research on the sequence of volcanic rock in the study area started early and many units and individuals participated in the research, little systematic and canonical work was performed. The history of research can be classified into three stages:

(1) Before 1970: Sun placed the Gangtai volcanic rock in the category of Badaohao Coal Measures after investigating a Badaohao Mine. In the 1950s, Wang et al. dug trenches near Gangtai Village to validate their sequence and further identified the sequence of Gangtai volcanic rock, which greatly affected later geological work. The Japanese geologist Shijingdu performed research in Fuxin city, which affected later geological work. He compared the volcanic rock below the