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SHRIMP U–Pb zircon geochronology and geochemistry of metavolcanic and metasedimentary rocks in Northwestern Fujian, Cathaysia block, China: Tectonic implications and the need to redefine lithostratigraphic units

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Abstract

Northwestern Fujian Province is one of the most important Pre-Palaeozoic areas in the Cathaysia Block of South China. Metavolcano-sedimentary and metasedimentary rocks of different types, ages and metamorphic grades (granulite to upper greenschist facies) are present, and previously were divided into several Formations and Groups. Tectonic contacts occur between some units, whereas (deformed) unconformities have been reported between others. New SHRIMP U–Pb zircon ages presented here indicate that the original lithostratigraphy and the old "Group" and "Formation" terminology should be abandoned. Thus the "Tianjingping Formation" was not formed in the Archaean or Palaeoproterozoic, as previously considered, but must be younger than its youngest detrital zircons (1790 Ma) but older than regional metamorphism (460 Ma). Besides magmatic zircon ages of 807 Ma obtained from metavolcano-sedimentary rocks of the "Nanshan Formation" and 751–728 Ma for the "Mamianshan Group", many inherited and detrital zircons with ages ranging from 1.0 to 0.8 Ga were also found in them. These ages indicate that the geological evolution of the study area may be related to the assembly and subsequent break-up of the Rodinia supercontinent. The new zircon results poorly constrain the age of the "Mayuan Group" as Neoproterozoic to early Palaeozoic (728–458 Ma), and not Palaeoproterozoic as previously thought. Many older inherited and detrital zircons with ages of 3.6, 2.8, 2.7, 2.6–2.5, 2.0–1.8 and 1.6 Ga were found in this study. A 3.6 Ga detrital grain is the oldest one so far identified in northwestern Fujian Province as well as throughout the Cathaysia Block. Nd isotope t_{DM} values of eight volcano-sedimentary and clastic sedimentary rock samples centre on 2.73–1.68 Ga, being much older than the formation ages of their protoliths and thus showing that the recycling of older crust played an important role in their formation. These rocks underwent high grade metamorphism in the early Palaeozoic (458–425 Ma) during an important tectono-thermal event in the Cathaysia Block.

Keywords: Proterozoic; Early Palaeozoic; Cathaysia Block; SHRIMP; Nd-isotopes; Rodinia; South China

1. Introduction

Grabau (1924) suggested that the metamorphic rock series distributed widely in southeastern China are Archaean to Proterozoic in age and are overlain unconformably by late Palaeozoic strata. He named all this suite of rocks "Cathaysia". Huang (1960) interpreted "Cathaysia" to be equivalent to the European Caledonides. Since then, the age and tectonic evolution of the metamorphic rock series in southeastern China have long been in dispute, and one of the foci of dispute is still whether to use "Cathaysia" or "Caledonides" (Ma et al., 1961; Ren, 1964; Shui et al., 1986, 1988; Shui, 1987; Tu, 1993; Ren et al., 1999; Jin and Sun, 1997; Zhuang et al., 2000). Nd isotopic studies of many granitic and sedimentary rocks indicate that the Palaeoproterozoic (2.2–1.7 Ga) was an important period of formation and accretion of continental crust in "Cathaysia" (hereinafter referred to as the "Cathaysia Block") (Chen and Jahn, 1998; Chen et al., 1999; Hong et al., 1999;

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Shen et al., 2000), thus ruling out the possibility that its main part originated in the Archaean. However, the specific rock formation ages are still uncertain. Although a wealth of zircon ages has been obtained (Gan et al., 1993, 1995; Jin and Sun, 1997; Li, 1997; Li et al., 2005b), most are multigrain isotope dilution and evaporation zircon ages, and only a few ages were recently obtained by the SHRIMP in situ microanalysis technique. In addition, the interpretation of the most zircon ages has not been verified by cathodoluminescence studies, with the exception of work by Li et al. (2005a). It is therefore evident that the main cause for the above dispute is the lack of reliable rock formation ages.

In order to help resolve the age and history of rocks in the Cathaysia Block, we have undertaken whole-rock geochemical analyses and SHRIMP U–Pb zircon geochronology on the metamorphosed and deformed strata in the northwestern Fujian area. The purpose was to determine the ages of the main metamorphic rock units and to elucidate the Pre-Palaeozoic crustal evolution in that area.

2. Geological background

The North and South China Cratons are the two largest Precambrian domains in eastern China. The South China Craton

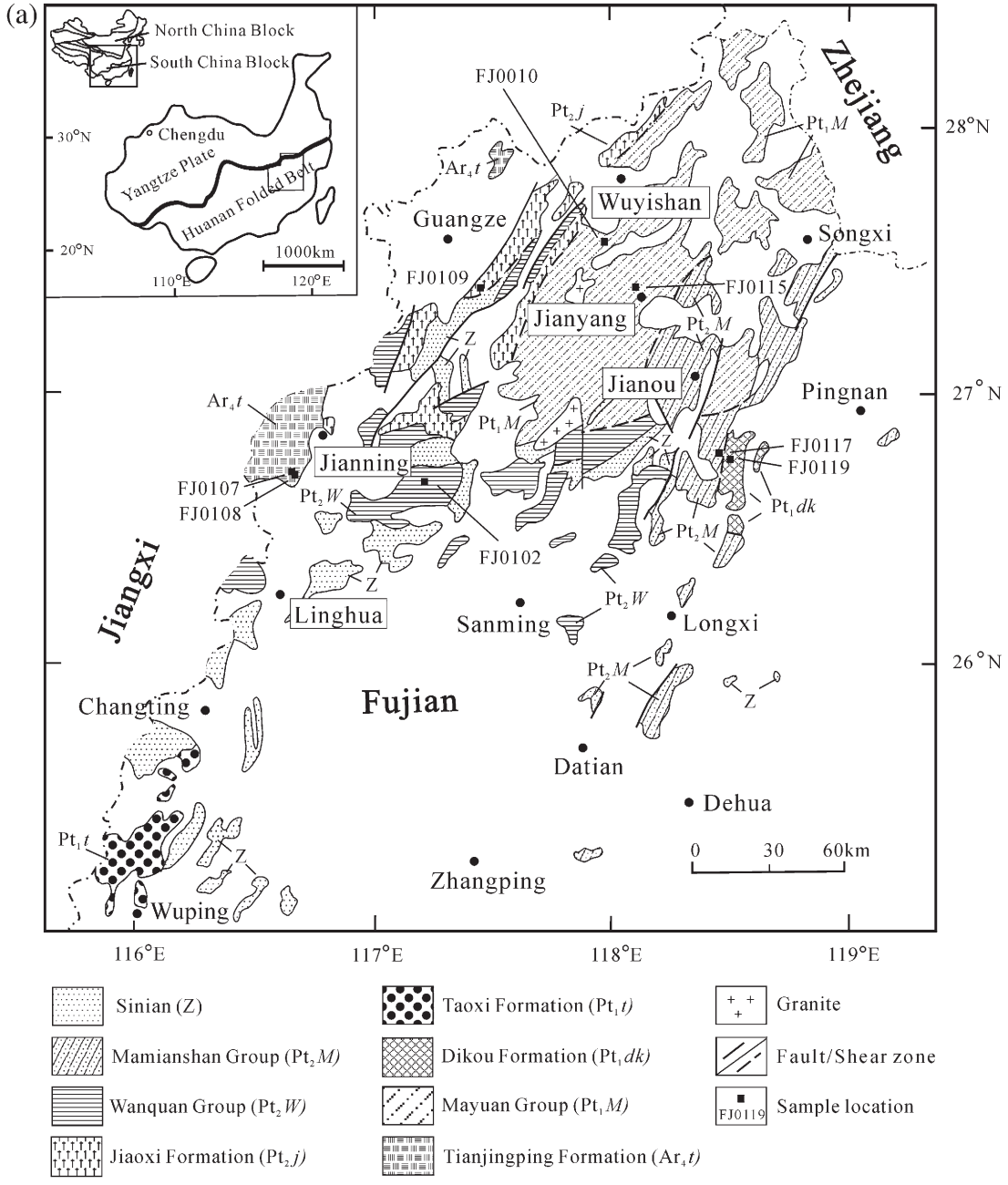

Fig. 1. (a) Sketch geological map of the northwestern Fujian Province showing distribution and classification of Pre-Palaeozoic metamorphic rocks (after Zhuang et al., 2000). Also shown are locations of samples analyzed in this study. (b) Reappraisal of age and distribution of Pre-Palaeozoic metamorphic rocks using the zircon results in this study.