Precambrian Research 279 (2016) 37–56

Contents lists available at ScienceDirect

Precambrian Research

journal homepage: www.elsevier.com/locate/precamres

Geochemistry and geochronology of mylonitic metasedimentary rocks associated with the Proterozoic Miaowan Ophiolite Complex, Yangtze craton, China: Implications for geodynamic events

Xingfu Jiang [a,b,c], Songbai Peng [a,c,d,*], Ali Polat [c,e,f], Timothy Kusky [c,d,f], Lu Wang [c,d,e], Tuoyu Wu [e], Musen Lin [a], Qingsen Han [a]

[a] School of Earth Sciences, China University of Geosciences, Wuhan 430074, China
[b] School of Earth Sciences, East China University of Technology, Nanchang 330013, China
[c] Center for Global Tectonics, China University of Geosciences, Wuhan 430074, China
[d] State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan 430074, China
[e] Department of Earth and Environmental Sciences, University of Windsor, Windsor, ON N9B 3P4, Canada
[f] Three Gorges Center for Geohazard, Ministry of Education, China University of Geosciences, Wuhan 430074, China

ARTICLE INFO

Article history:
Received 11 September 2015
Revised 23 March 2016
Accepted 2 April 2016
Available online 08 April 2016

Keywords:
Yangtze craton
Miaowan Ophiolite Complex
Rodinia
Amphibolite facies metamorphism
Grenvillian orogeny

ABSTRACT

Constraining the timing of tectonothermal events in the Proterozoic Miaowan Ophiolite Complex (MOC) and associated rocks in the southern Huangling dome, Yangtze craton, is critical for understanding late Mesoproterozoic and Neoproterozoic tectonic evolution (ca. 1.2–0.9 Ga) of South China and its relationship with the formation of the Rodinian supercontinent. The MOC consists of metamorphosed dunite and harzburgite, isotropic and layered gabbros, diabasic sheeted dike, basalt, plagiogranite, and calc-silicate-bearing siliceous and carbonaceous mylonitic rocks. In this study, we present new field, petrographic, geochemical, geochronological and isotopic data for these metasedimentary rocks and mylonitic metasandstone between the ophiolite and underlying flysch sequence, to unravel their origin and tectonic significance for the Yangtze craton. The MOC and associated sedimentary rocks underwent amphibolite facies metamorphism. Geochemical data and field relationships indicate that the mylonitic metasandstone was derived from both the autochthonous rocks of the underlying Yangtze craton and the allochthonous MOC during the accretion of the ophiolite to the craton. The calc-silicate-bearing siliceous and carbonaceous rocks are interpreted as tectonic slices of metasomatized and mylonitized chert and limestone, respectively, deposited on the basaltic crust in a Neoproterozoic ocean. Cores of igneous detrital zircons in the calc-silicate-bearing siliceous and carbonaceous mylonitic rocks have yielded two distinct age groups including a 967–1105 Ma (Mean = 1009 Ma) group and a 1011–1095 Ma (Mean = 1054 Ma) group. The majority of initial $\varepsilon_{Hf}(t)$ values (+9.2 to +14.1) in the zircon cores are similar to those of zircons from the gabbro, diabase and plagiogranite in the MOC, indicating that zircons in the mylonitic rocks were mainly derived from the MOC. Metamorphic overgrowth ages in zircon rims suggest that the latest tectonothermal event in the Precambrian basement rocks of the Yangtze craton took place between 942 and 935 Ma. These metamorphic ages are comparable to those of the Grenvillian-aged collisional events recorded in orogenic belts worldwide. Accordingly, we suggest that this youngest tectonothermal event represents the latest amalgamation time of the heterogeneous tectonic blocks of the Yangtze craton, which were associated with the assembly of the Rodinian supercontinent.

1. Introduction

Sedimentary rocks associated with ophiolites are mainly deposited on the oceanic crust during seafloor spreading, transport and in trenches and foredeeps during accretion-collision processes, and include many different types of lithologies, such as pelagic chert, carbonate (if the ridge is elevated above the carbonate compensation depth), hemipelagic shale, and sandstone (e.g., see review by Kusky et al., 2013). Geochemical compositions and geochronological investigation of these sedimentary rocks can provide significant new insights into the nature of depositional environment, provenance, and of the timing of tectonothermal

* Corresponding author at: School of Earth Sciences, China University of Geosciences, Wuhan 430074, China.
E-mail address: psongbai@aliyun.com (S. Peng).

http://dx.doi.org/10.1016/j.precamres.2016.04.004
0301-9268/© 2016 Elsevier B.V. All rights reserved.

events associated with the formation and accretion of their host ophiolites (Coleman, 1977; Bédard et al., 2008; Zhou, 2008).

The Yangtze craton is one of the largest Precambrian blocks in China (Fig. 1a; Wu et al., 2012; Zheng et al., 2013). It is composed of voluminous Mesoproterozoic to Neoproterozoic igneous intrusions containing minor mafic to ultramafic rock associations along the margins, while Paleoproterozoic to Archean rocks crop out mainly in the Huangling dome that is located about 200 km away from the northern margin of the craton (Li et al., 2008; Wang et al., 2013a; Zheng et al., 2013; Guo et al., 2014; Xu et al., 2014, and references therein). A study of the sedimentary rocks associated with the late Mesoproterozoic-early Neoproterozoic mafic to ultramafic rock associations can provide an excellent opportunity to resolve outstanding questions about Precambrian tectonothermal events that occurred during the evolution of the Yangtze craton (Jiang et al., 2002; Xiong et al., 2004), especially for the assembly and break-up of the Rodinia (Li et al., 2003; Zhou et al., 2007; Zhang et al., 2008; Peng et al., 2010; Zhang and Zheng, 2013) and the Columbia supercontinents (Zhang et al., 2006; Xiong et al., 2008; Wu et al., 2009; Peng et al., 2012c).

Peng et al. (2010) showed that the mafic to ultramafic rock association, formerly called the Miaowan Formation, in the southern Huangling dome in the Yangtze craton represents a Proterozoic ophiolite, named the Miaowan Ophiolite Complex (MOC) (Fig. 1b). Subsequent studies (Deng et al., 2012; Jiang et al., 2012; Peng et al., 2012a) suggested that the MOC formed in a forearc tectonic setting at an intra-oceanic supra-subduction zone at ca. 1.0 Ga. If this interpretation is correct, a Neoproterozoic subduction–accretion–collision event should have taken place within the Yangtze craton, which has profound significance for understanding the tectonic evolution of the craton. However, the time of this tectonothermal event in the MOC has not been well constrained.

During our recent field studies, we have recognized strongly deformed, compositionally heterogeneous, up to several tens of meters thick and several hundreds of meters long, slices of calc-silicate-bearing siliceous and carbonaceous rocks in the MOC. Given their heterogeneous compositional characteristics and strong deformation, these rocks are collectively called "calc-silicate-bearing siliceous and carbonaceous mylonitic rocks". Their spatial association with the ophiolite suggests that these rocks likely have formed in the process when the ophiolite migrated from intra-oceanic trench to the continental margin, representing fragments of Neoproterozoic ocean plate stratigraphy (cf., Kusky et al., 2013). Hence, they may share a close genetic relationship with the ophiolite and record the tectonic processes associated with the emplacement of the ophiolite. Therefore, in order to understand their origin and assess their significance for tectonothermal events in the Yangtze craton, we have conducted integrated field, petrographic, geochemical, zircon U–Pb geochronological, and Lu–Hf isotopic studies on these rocks. In addition, we report new Lu–Hf isotope data for the diabase, plagiogranite, and gabbros in the MOC and for the metasandstones, to gain new insights into the formation of sedimentary rocks spatially associated with the ophiolite complex.

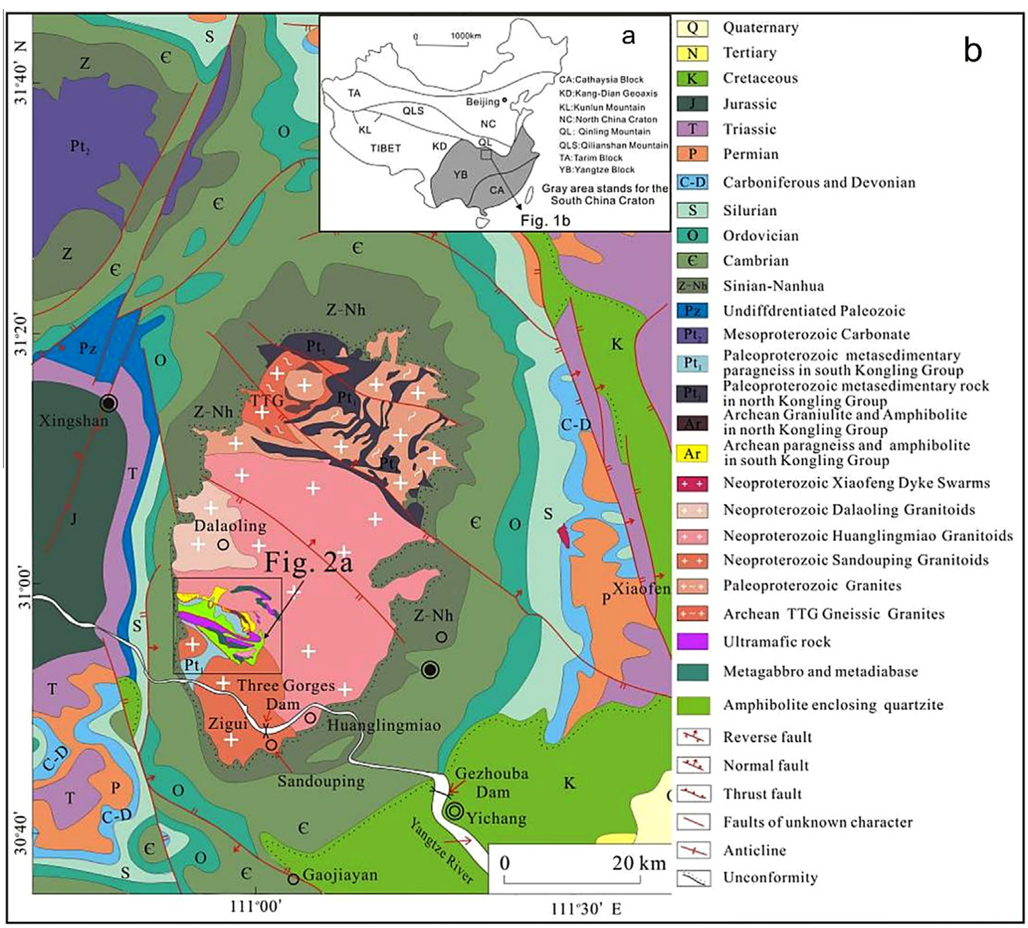

Fig. 1. (a) A simplified tectonic map of China (Qiu et al., 2011). (b) Geological map of the Huangling dome in the Yangtze craton. Modified after BGMRHP (1991), Peng et al. (2012b).