Available online at www.sciencedirect.com
ScienceDirect
Lithos 96 (2007) 127 – 150
LITHOS
www.elsevier.com/locate/lithos

Contrasting zircon Hf and O isotopes in the two episodes of Neoproterozoic granitoids in South China: Implications for growth and reworking of continental crust

Yong-Fei Zheng [a,b,*], Shao-Bing Zhang [a], Zi-Fu Zhao [a], Yuan-Bao Wu [a,c], Xianhua Li [d], Zhengxiang Li [e], Fu-Yuan Wu [b]

[a] *CAS Key Laboratory of Crust–Mantle Materials and Environments, School of Earth and Space Sciences, University of Science and Technology of China, Hefei 230026, China*
[b] *State Key Laboratory of Lithosphere Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China*
[c] *Faculty of Earth Sciences, China University of Geosciences, Wuhan 430074, China*
[d] *CAS Kay Laboratory of Isotope Geochronology and Geochemistry, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China*
[e] *Tectonics Special Research Centre, School of Earth and Geographical Sciences, The University of Western Australia, Crawley, WA 6009, Australia*

Received 12 October 2005; received in revised form 18 September 2006; accepted 24 October 2006
Available online 29 December 2006

Abstract

The genetic links among rift magmatism, crustal growth and water–rock interaction are an important issue about mass and heat transfer between mantle and crust during supercontinent breakup. A combined study of Hf and O isotopes in zircons from Neoproterozoic granitoids in South China provides evidence for growth and reworking of juvenile and ancient crusts with different styles of water–rock interactions along rift tectonic zones. Two generations of the granitoids show contrasting features in both zircon Hf and O isotope compositions, indicating their distinct petrogenesis. The ~825 Ma granitoids exhibit negative $\varepsilon_{Hf}(t)$ values of −3.4±0.8 to −1.6±0.8 with old model Hf ages of 1.81±0.07 to 1.92±0.10 Ga, and high $\delta^{18}O$ values of 8.7 to 10.4‰. These indicate that the source material of granitoid magmas was derived from melting of Paleoproterozoic basement that has the Hf isotope signature similar to the enriched mantle but experienced chemical weathering process before anatexis. Reworking of ancient crust is demonstrated to occur at ~825 Ma in the orogenic collapse zone, with overprinting of subsolidus hydrothermal alteration during magma emplacement. In contrast, the 760–750 Ma bimodal intrusives are characterized by positive $\varepsilon_{Hf}(t)$ values of 3.5±0.8 to 9.9±0.8 with young model Hf ages of 0.94±0.06 to 1.18±0.06 Ga, and both low and high $\delta^{18}O$ values of 4.2 to 6.2‰ relative to 5.3±0.3‰ for the normal mantle zircon. Prompt reworking of juvenile crust is suggested to occur at ~750 Ma in the rifted tectonic zone, with occurrence of supersolidus hydrothermal alteration and local low-^{18}O magmatism during supercontinent breakup. Contributions of the depleted mantle to their magma sources are contrasting in the two episodes of magmatism in association with breakup of the supercontinent Rodinia. While the change in melt source from the crust to the mantle keeps pace with the advance from continental rifting to supercontinent breakup, significant transport of both heat and material from the depleted mantle to the continental crust only occurred along the active rifting zone. In either case, the growth and reworking of continental crust are episodically associated with rift magmatism.
© 2006 Elsevier B.V. All rights reserved.

Keywords: Zircon; Hf isotope; O isotope; Neoproterozoic magmatism; South China; Continental growth; Mantle upwelling; Supercontinent breakup

* Corresponding author.
E-mail address: yfzheng@ustc.edu.cn (Y.-F. Zheng).

0024-4937/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.lithos.2006.10.003

1. Introduction

Growth and reworking of the continental crust in the history of the Earth are of substantial importance in understanding its chemical characteristics and underlying crust–mantle differentiation (Brown and Rushmer, 2005). While subduction-related arc magmatism has contributed juvenile crust to continental accretion (e.g., Rudnick, 1995; Condie and Chomiak, 1996), arc–continent collision and postcollisional collapse are two critical processes to cause intracrustal differentiation and thus to shape the major chemical feature of continental crust (e.g., Wu et al., 2006a). On the other hand, plume-related magmatism can also result in continental growth via either horizontal accretion of oceanic plateau and island basalts or vertical addition of continental flood basalts (e.g., Albarede, 1998; Condie, 2000), regardless of their origin from the core–mantle boundary, or the transition zone or the top of the asthenospheric mantle (Courtillot et al., 2003), and so can melting of subducted oceanic slabs in association with island arc magmatism (e.g., Defant and Drummond, 1990; Yogodzinski et al., 2001). Nevertheless, arc-like patterns of trace element partition in most igneous rocks on the continental crust clearly make reworking of arc-derived rocks the dominant mechanism. With respect to extraction of juvenile crust from the asthenospheric mantle, on the other hand, volcanic rifted margins are also a favorite site for continental growth (Zheng et al., 2006).

Rift magmatism has been found in close association with supercontinent breakup and mantle superwelling (or superplume event as defined by Larson, 1991a,b). Although generation of Proterozoic and Phanerozoic continental crust is predominated by orogenic magmatism in arc–continent collision belts (Rudnick, 1995; Condie and Chomiak, 1996; Wu et al., 2006a), rift magmatism is also an additional way for continental growth along broken up continental margins (Zheng et al., 2006). Heat from a zone of upwelling asthenosphere beneath the continental crust may cause extensive melting of both the subcontinental lithospheric mantle and the mafic lower crust to produce the bimodal igneous rocks of mafic and felsic compositions, respectively (Campbell and Hill, 1988). In association with extensional collapse of collision-thickened orogens (Dewey, 1988), thermal reworking by mantle upwelling may have played a significant role in the formation of intracontinental magmatic provinces (Thompson and Connolly, 1995). Therefore, it is important to know how matter and energy transfer from the mantle to the crust proceeds during rift magmatism with respect to growth and reworking of juvenile and ancient crust.

Zircon is a refractory mineral that forms a highly robust phase in most geological environments and thus is ideal for radiometric dating and geochemical tracing (Hanchar and Hoskin, 2003, and references therein). Zircon U–Pb ages register magmatic episodes related to crustal reworking, whereas zircon model Hf ages can provide a first approximation to timing of crustal extraction from the mantle in the extreme case where its initial Hf isotope composition approaches that of the contemporaneous depleted mantle (Zheng et al., 2006). A combined study of zircon U–Pb age and Hf isotope has the potential to date melt extraction, hence growth of juvenile crust and reworking of ancient crust by melting. If growth occurs shortly before reworking, as may occur at sites of continental and back-arc rifting, then it happened so close in time to the crustal reworking that it is not detectable from the Lu–Hf isotopic systematics. In contrast, if crustal growth occurs significantly before crustal reworking, as may occur at sites of arc–continent and continent–continent collision events, then post-collisional magmatism in these regions should result in its product with considerably older model Hf ages than the U–Pb ages.

Furthermore, bimodal magmatism and high-T water–rock interaction may be developed along rift tectonic zones, with potential incorporation of surface water into magmas via remelting of hydrothermally altered rocks. Therefore, it is necessary to identify these components in coeval igneous rocks that developed along supercontinental margins and thus to constrain the genetic relationship among rift magmatism, juvenile crust growth and surface fluid activity. In addition to its advantage for U–Pb dating, zircon provides high-quality records of Hf and O isotope compositions that can be simultaneously used both in protolith studies and as petrogenetic indicators (Hawkesworth and Kemp, 2006; Kemp et al., 2006; Zhang et al., 2006). This paper presents a combined study of Hf and O isotopes in zircons from Neoproterozoic intrusives along the margins of the Yangtze Craton in South China. The results provide geochemical evidence for growth and reworking of continental crust during arc–continent collision and rift magmatism in association with assembly and breakup of the supercontinent Rodinia.

2. Geological settings and samples

Neoproterozoic igneous rocks of felsic and mafic compositions are widespread around the Yangtze Craton in the South China Block (Fig. 1). Their distribution coincides in general with the distribution of Cryogenian continental rift systems (Wang and Li, 2003). The bimodal igneous rocks can be subdivided into two major

Download English Version:

https://daneshyari.com/en/article/4717751

Download Persian Version:

https://daneshyari.com/article/4717751

Daneshyari.com