Precambrian Research 180 (2010) 285–298

Contents lists available at ScienceDirect

Precambrian Research

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

Thermochronology of central Ribeira Fold Belt, SE Brazil: Petrological and geochronological evidence for long-term high temperature maintenance during Western Gondwana amalgamation

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ARTICLE INFO

Article history:
Received 24 April 2009
Received in revised form 25 February 2010
Accepted 5 May 2010

Keywords:
Ribeira Fold Belt
Thermochronology
Cooling rate
Granulite
Western Gondwana

ABSTRACT

The studied sector of the central Ribeira Fold Belt (SE Brazil) comprises metatexites, diatexites, charnockites and blastomylonites. This study integrates petrological and thermochronological data in order to constrain the thermotectonic and geodynamic evolution of this Neoproterozoic–Ordovician mobile belt during Western Gondwana amalgamation.

New data indicate that after an earlier collision stage at ∼610 Ma (zircon, U–Pb age), peak metamorphism and lower crust partial melting, coeval with the main regional high grade D_1 thrust deformation, occurred at 572–562 Ma (zircon, U–Pb ages). The overall average cooling rate was low (<5 °C/Ma) from 750 to 250 °C (at ∼455 Ma; biotite–WR Rb–Sr age), but disparate cooling paths indicate differential uplift between distinct lithotypes: (a) metatexites and blastomylonites show a overall stable 3–5 °C/Ma cooling rate; (b) charnockites and associated rocks remained at $T > 650$ °C during sub-horizontal D_2 shearing until ∼510–470 Ma (garnet–WR Sm–Nd ages) (1–2 °C/Ma), being then rapidly exhumed/cooled (8–30 °C/Ma) during post-orogenic D_3 deformation with late granite emplacement at ∼490 Ma (zircon, U–Pb age). Cooling rates based on garnet–biotite Fe–Mg diffusion are broadly consistent with the geochronological cooling rates: (a) metatexites were cooled faster at high temperatures (6 °C/Ma) and slowly at low temperatures (0.1 °C/Ma), decreasing cooling rates with time; (b) charnockites show low cooling rates (2 °C/Ma) near metamorphic peak conditions and high cooling rates (120 °C/Ma) at lower temperatures, increasing cooling rates during retrogression.

The charnockite thermal evolution and the extensive production of granitoid melts in the area imply that high geothermal gradients were sustained for a long period of time (50–90 Ma). This thermal anomaly most likely reflects upwelling of asthenospheric mantle and magma underplating coupled with long-term generation of high HPE (heat producing elements) granitoids. These factors must have sustained elevated crustal geotherms for ∼100 Ma, promoting widespread charnockite generation at middle to lower crustal levels.

1. Introduction

Experimental petrology and thermal modelling data have shown that different isotopic systems have different isotopic closure temperatures (e.g. Dodson, 1973; Mezger et al., 1992). Therefore, for the same rock, different isotopic systems will provide distinct geochronological results that can be used to obtain a *T–t* evolution (thermochronology) and, ultimately, the cooling rates of that rock.

Several authors have tried to determine thermochronological evolutions and cooling rates, mainly based on low temperature fission track (e.g. Lim and Lee, 2005; Lee et al., 2006) and Ar–Ar thermochronology (e.g. Glassmacher et al., 1999; Gray et al., 2006). However, the thermochronological data, cooling rates and the thermal evolution record of granulite belts from high temperatures (∼800 °C) to low temperatures (∼250 °C) is still very incomplete, worldwide. This has severely hampered the ability to constrain the processes involved in exhuming granulites from the middle/lower crust and the geodynamic evolution of the studied granulite belts themselves.

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doi:10.1016/j.precamres.2010.05.002