Available online at www.sciencedirect.com
ScienceDirect
Gondwana Research 14 (2008) 675–685
www.elsevier.com/locate/gr

EPMA and PIXE dating of monazite in granulites from Stary Gierałtów, NE Bohemian Massif, Poland

Monika A. Kusiak [a,b,*], Kazuhiro Suzuki [b], Daniel J. Dunkley [c], Janusz Lekki [d], Nonna Bakun-Czubarow [e], Mariusz Paszkowski [a], Bartosz Budzyń [f]

[a] Institute of Geological Sciences, Polish Academy of Sciences, Kraków Research Centre, Senacka 1, 31-002 Kraków, Poland
[b] Center for Chronological Research, Nagoya University, Nagoya 464-8602, Japan
[c] National Institute of Polar Research, 1-9-10 Kaga, Itabashi-ku, 173-8515 Tokyo, Japan
[d] Henryk Niewodniczański Institute of Nuclear Physics, Polish Academy of Sciences, Radzikowskiego 152, 31-342 Kraków, Poland
[e] Institute of Geological Sciences, Polish Academy of Sciences, Twarda 51/55, 00-818 Warszawa, Poland
[f] Institute of Geological Sciences, Jagiellonian University, Oleandry 2a, 30-063 Kraków, Poland

Received 11 January 2007; accepted 18 February 2008
Available online 4 March 2008

Abstract

Chemical Th–U–total Pb (CHIME) dating of monazite by electron probe microanalyzer (EPMA) and proton microprobe (PIXE) was carried out on felsic granulites from Stary Gierałtów, Poland, which represent part of the Orlica-Śnieżnik Dome in the NE Bohemian Massif. Analyzed monazite is characterized by mosaic zoning rather than simple core-to-rim growth, and strontium contents of up to 750ppm. An isochron age of 347 ± 13Ma represents timing of amphibolite-facies metamorphism, in agreement with previously published estimates.

Keywords: Monazite dating; CHIME; PIXE; Orlica-Śnieżnik Dome; Bohemian Massif

1. Introduction

The structural and metamorphic evolution of the Orlica-Śnieżnik Dome (OSD), of the NE Bohemian Massif (BM), Western Sudetes, Poland, is a matter of some controversy. Discrepancies between tectonic interpretations are due to a lack of precisely-determined ages for crustal protoliths, magmatic activity and metamorphism. Monazite is an excellent candidate for obtaining such ages. It typically has relatively high contents of U, Th and radiogenic Pb, and the lack of Pb diffusivity at all but extreme granulite-facies temperatures on a geological timescale (Cherniak et al., 2004) makes monazite an ideal mineral for geochronology (e.g. Santosh et al., 2006a,b, 2007; Souza et al., 2006; Suzuki et al., 2006a; Skridalaite et al., 2008-this issue). In addition, single grains are capable of preserving elemental zoning patterns that reflect multiple thermal events (e.g. Townsend et al., 2000) and/or changes in chemical equilibrium during progressive metamorphic events (e.g. Pyle et al., 2001). The chemical Th–U–total Pb isochron method (CHIME) of dating by electron microprobe is an established and widely used technique for monazite geochronology (e.g. Suzuki and Adachi, 1991; Montel et al., 1996; Cocherie and Albarede, 2001; Jercinovic and Williams, 2005; Pyle et al., 2005; Williams et al., 2006, 2007). Of similar potential, but little utilized, the proton microprobe (PIXE) is capable of producing reliable age determinations, with potentially higher spatial resolution and greater peak-to-background sensitivity than CHIME. For a detailed description of the PIXE chemical dating method, see Kusiak and Lekki (2008-this issue). In this study, we present the first monazite CHIME chronological data for the felsic granulites from Stary Gierałtów in the OSD, obtained using the EPMA and PIXE.

* Corresponding author. Institute of Geological Sciences, Polish Academy of Sciences, Kraków Research Centre, Senacka 1, 31-002 Kraków, Poland. Tel.: +48 12 422 1910; fax: +48 12 422 1609.
E-mail address: ndkusiak@cyf-kr.edu.pl (M.A. Kusiak).

1342-937X/$ - see front matter
doi:10.1016/j.gr.2008.02.005

2. Geological setting

2.1. Bohemian Massif

The BM represents one of the largest and most complex tectonic units of the central European Variscides, a collage of Gondwana-derived terranes. These terranes migrated northward from the Gondwana margin and collided with northern continental blocks in the early Paleozoic (Tait et al., 1997; see also Vaughan and Pankhurst, 2008 for a recent review of Gondwana margin). The BM contains a number of well-defined, geologically distinct regions of dissimilar origin, including the Saxothuringian and Moldanubian Tectonic Zones (Škvor and Zeman, 1969) (Fig. 1). The Sudetes consist of a collage of Neoproterozoic to Early Carboniferous terranes located along the northeastern margin of the BM (e.g. Kryza et al., 2004). Commonly interpreted as a part of the European Variscan Belt, the Sudetes include the southeastern-most extent of the Saxothuringian Zone (Franke and Żelaźniewicz, 2002). The Moldanubian Zone is also represented by the OSD (Don et al., 1990; Matte et al., 1990) and its northern continuation, the Strzelin Hills Complex.

2.2. The Orlica-Śnieżnik Dome, West Sudetes (Lugicum)

The OSD forms the eastern-most part of the West Sudetes (Fig. 1). It is bound to the east by the Staré Město Shear Zone, part of the Moldanubian wrench–thrust system that defines the western boundary of the Moravo-Silesian domain of the Variscan Belt (Aleksandrowski et al., 1997). The OSD is bound by the granodioritic Kłodzko-Złoty Stok Granitoid Massif to the north, the Sudetes Marginal Fault to the northeast, and the Ramzovian Thrust to the southeast. The Nysa graben divides the OSD into the Śnieżnik region (Lądek-Śnieżnik metamorphic complex) to the east, and the Orlica and Bystrzyca Mountains to the west (Don et al., 1990). In terms of terrane

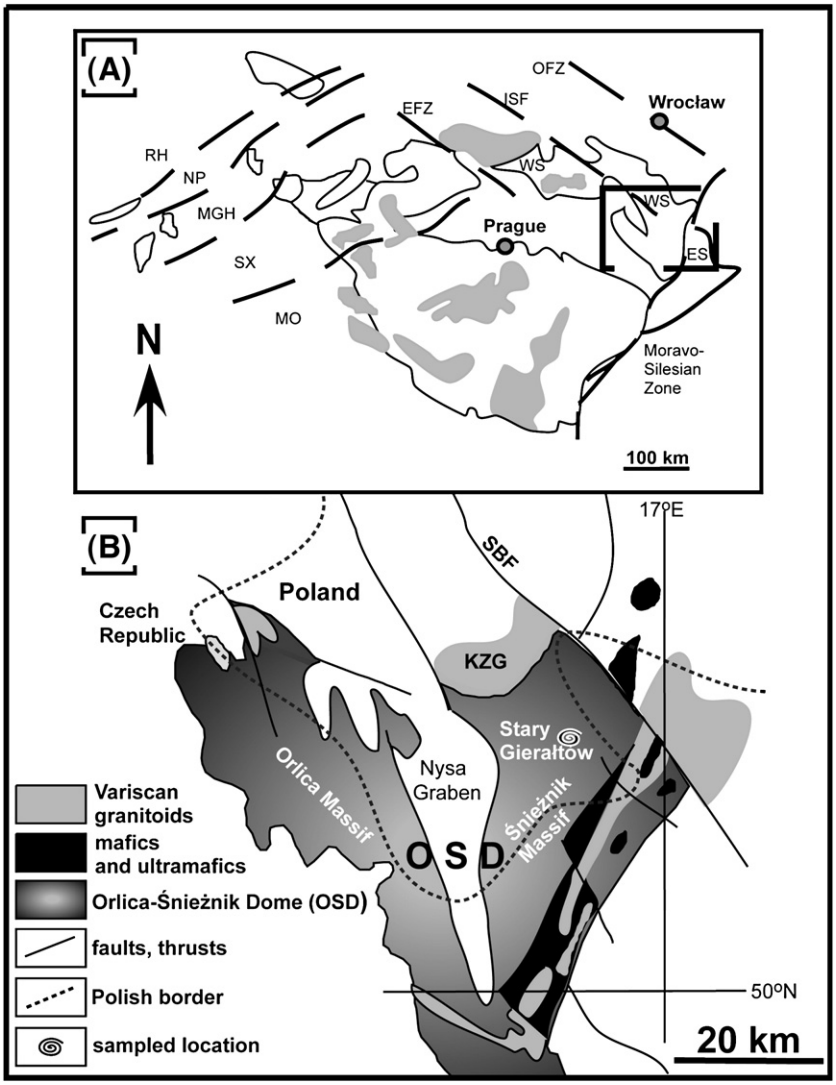

Fig. 1. A. Geological sketch of the Bohemian Massif (simplified after Turniak et al., 2000). EFZ — Elbe Fault Zone, ISF — Intra-Sudetic Fault Zone, KZG — Kłodzko-Złoty Stok Granitoid Massif, MGH — Mid-German Crystalline High, MO — Moldanubian Zone, NP — Northern Phyllite Zone, OFZ — Odra-Fault Zone, RH — Rhenohercynian Zone, SBF — Sudetic Boundary Fault, SX — Saxothuringian Zone. B. Sketch of the Orlica-Śnieżnik Dome and the location of the study area (simplified after Kryza et al., 1996); SMB — Staré Město Belt.