Available online at www.sciencedirect.com
ScienceDirect
Lithos 94 (2007) 168–180
LITHOS
www.elsevier.com/locate/lithos

Zircon megacrysts from basalts of the Venetian Volcanic Province (NE Italy): U–Pb ages, oxygen isotopes and REE data

D. Visonà [a,d,*], V. Caironi [b], A. Carraro [a], L. Dallai [c], A.M. Fioretti [d], M. Fanning [e]

[a] Dipartimento di Mineralogia e Petrologia, Università di Padova, Corso Garibaldi 37, 35137 Padova, Italy
[b] Dipartimento di Scienze della Terra, Università di Milano, Via Botticelli 23, 20133 Milano, Italy
[c] CNR, Istituto di Geoscienze e Georisorse, Via Moruzzi 1, 56127 Pisa, Italy
[d] CNR, Istituto di Geoscienze e Georisorse, Corso Garibaldi 37, 35137 Padova, Italy
[e] Research School of Earth Sciences, Australian National University, Canberra, ACT 0200, Australia

Received 22 February 2005; accepted 2 June 2006
Available online 28 August 2006

Abstract

Mafic alkaline lavas from the Venetian Volcanic Province (NE Italy) contain orange–brown zircon megacrysts up to 15 mm long, subhedral to subrounded and showing equant morphology, with width-to-length ratios of 1:2–1:2.5. U–Pb ages of zircon (51.1±1.5 to 30.5±0.51 Ma) fit the stratigraphic age of the host lava (Middle Eocene and Oligocene) and their oxygen isotope composition ($\delta^{18}O$=5.31–5.51‰) is similar to that of zircon formed in the upper mantle. Cathodoluminescence images and crystal chemical features, e.g. depletion of incompatible elements such as REE, Y, U and Th at constant Hf content, indicate that centre-to-edge zircon zoning is not consistent with evolution of the melt by fractional crystallization. All the above features, together with the fact that zircon and host basalts are coeval, indicate that the studied Zr megacrysts crystallised from a primitive alkaline mafic magma, which later evolved to the less alkaline host magma.

Keywords: Zircon megacrysts; Basalts; SHRIMP U–Pb dating and REE; Oxygen isotopes; Mantle; Venetian Volcanic Province (NE Italy)

1. Introduction

Zircon is a refractory and resistant mineral, and has a generally low, geologically insignificant, diffusion rate for most cations and oxygen (Cherniak and Watson, 2003). For this reason, the oxygen isotope composition of magmatic zircon can be used as a fingerprint to characterise mantle vs. crustal derived melts. Valley (2003) showed that zircon megacrysts, clearly identified as mantle-derived, have typical $\delta^{18}O$ values of 5.3±0.3‰, on the average, slightly different from those of olivine from mantle xenoliths and oceanic basalts (e.g., $\delta^{18}O$=4.88‰ for San Carlos Olivine), but similar to those of worldwide mantle-derived garnet megacrysts (Schulze et al., 2001).

Mafic rocks with mantle affinity may contain large zircon crystals (i.e., megacrysts), the origin of which is highly controversial (Valley et al., 1998). This is due to the fact that normal mantle values ($\delta^{18}O$=5.3±0.3‰) may be ambiguous because "normal" mantle-derived zircon megacrysts could be formed by multiple processes (e.g., subducted ocean crust and primary mantle magmas). For

* Corresponding author. CNR, Istituto di Geoscienze e Georisorse, Corso Garibaldi 37, 35137 Padova, Italy. Tel.: +39 049 8272026; fax: +39 049 8272010.
E-mail address: dario.visona@unipd.it (D. Visonà).

0024-4937/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.lithos.2006.06.007

magmatic zircons, $\delta^{18}O$ values can be considered an averaged composition for the mantle source region (Kinny et al., 1989) and are expected to be homogeneous, within a district, due to large scale mixing within the magma (Valley et al., 1998).

The timing of zircon formation in these mafic rocks is still not fully understood. To the best of our knowledge, only experimental data on zircon crystallization from felsic melts are available (Hanchar and Watson, 2003). Zr is a highly incompatible element and therefore could reach high concentrations in small degree melt fractions. Later zircon crystallisation may also be made easier by the entry of greater amounts of mafic components, such as CaO and FeO (Watson, 1979) or by variations in P–T conditions. In this scenario, the onset of zircon crystallisation is still quite obscure.

In this work, zircon megacrysts that appear to be similar to mantle-derived ones (Visonà et al., 2001) are studied. They are hosted, together with peridotitic mantle xenoliths, in mafic rocks of the Venetian Volcanic Province (VVP) (Andreatta, 1938; Morten, 1987; Siena and Coltorti, 1989). In this region, lava was emitted in several brief pulses over an interval of about 40 Ma (Barbieri et al., 1991; De Vecchi and Sedea, 1995). The aims of this paper are to verify whether the examined zircon megacrysts are really of mantle origin or represent crustal xenocrysts, and whether they are all coeval, i.e., forming during a single episode, or whether their ages span the entire Venetian volcanic cycle, thus indicating distinct magmatic pulses. The latter hypothesis, together with the evidence that differentiated melts lack megacrysts, would prove that zircon formed directly from mantle magmas during each magmatic event.

2. Geological background

In the Venetian Region (NE Italy; Fig. 1) extensive volcanic activity took place during the Tertiary, due to

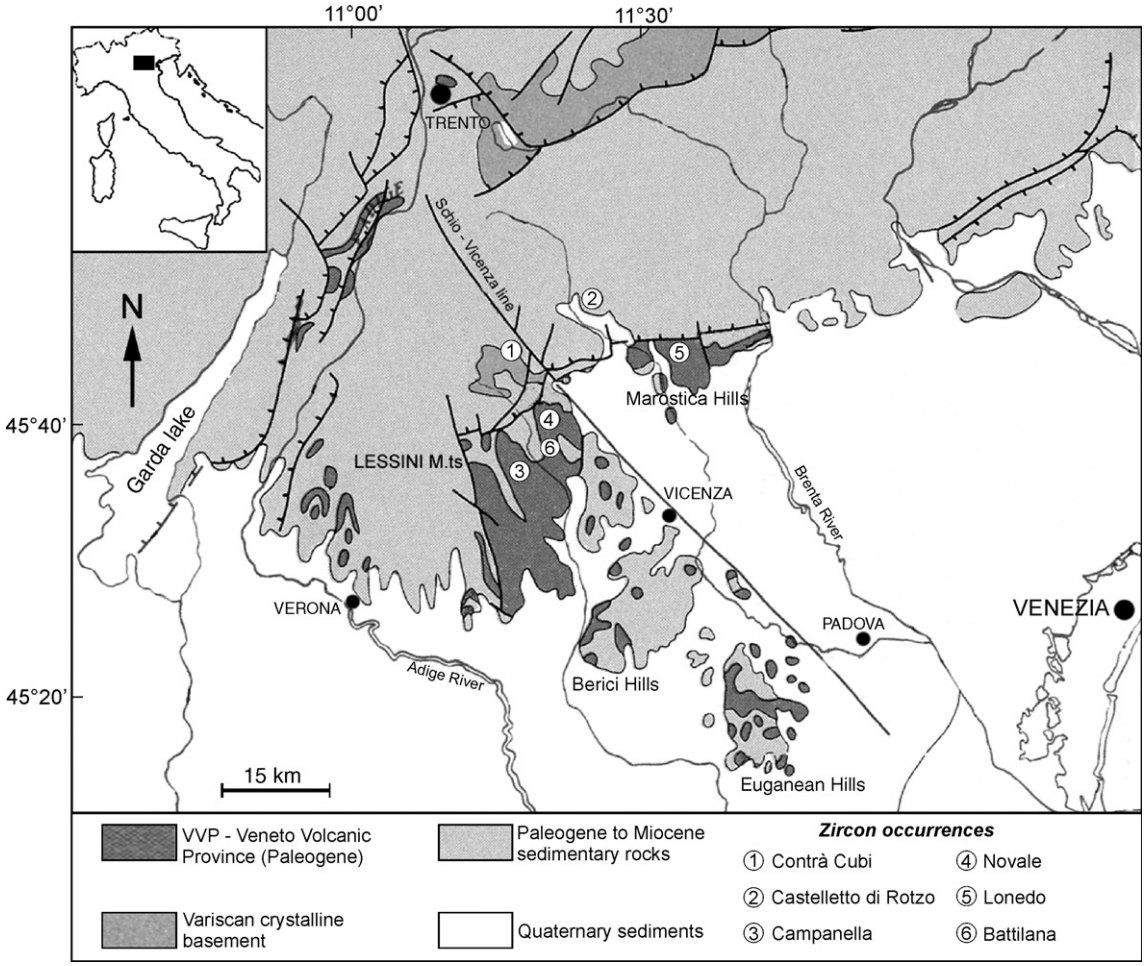

Fig. 1. Geological sketch of Venetian Volcanic Province. Numbers indicate zircon megacryst occurrences from both rocks and soil (see text).