Journal of Volcanology and Geothermal Research 190 (2010) 123–135

Contents lists available at ScienceDirect

Journal of Volcanology and Geothermal Research

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

Volcanic and structural evolution of the Okataina Volcanic Centre; dominantly silicic volcanism associated with the Taupo Rift, New Zealand

J.W. Cole [a,*], K.D. Spinks [b], C.D. Deering [a], I.A. Nairn [c], G.S. Leonard [d]

[a] Dept. of Geological Sciences, Univ. of Canterbury, Private Bag 4800, Christchurch 8140, New Zealand
[b] Mighty River Power, P.O. Box 445, Hamilton, New Zealand
[c] 45 Summit Road, Lake Okareka, Rotorua, RD5, New Zealand
[d] GNS Science, P.O. Box 30368, Lower Hutt 5040, New Zealand

ARTICLE INFO

Article history:
Received 5 September 2008
Accepted 13 August 2009
Available online 24 August 2009

Keywords:
Okataina
caldera complex
Taupo Rift
ignimbrite
rhyolite

ABSTRACT

The Okataina Volcanic Centre (OVC) contains the northeasternmost caldera complex in onshore Taupo Volcanic Zone (TVZ), New Zealand, sited largely within the Taupo Rift. Pyroclastic fall deposits and ignimbrites deposited in the Bay of Plenty coast area between 420 and 625 ka were probably erupted from OVC, and these provide a maximum age for the centre. The earliest ignimbrite for which there is good evidence for eruption from OVC is the c.550 ka Quartz-biotite Ignimbrite, exposed to the west of Lake Okataina and to SE of OVC. This ignimbrite probably correlates with one of the early ignimbrites found in the Kawerau geothermal wells, and is large enough to have been accompanied by caldera collapse. It was followed by extensive rhyolitic explosive eruptions of the Murupara Subgroup, culminating with eruption of the Matahina Ignimbrite at c.325 ka. This c.160 km^3 (magma volume) eruption was accompanied by caldera collapse to form the southern part of the present day Okataina caldera complex. A long duration sequence of rhyolite lavas and pyroclastics was then erupted on the southern and western sides of OVC, before eruption of the >100 km^3 Rotoiti Pyroclastics at c.61 ka was accompanied by caldera collapse on the northern side of the centre. The Rotoiti episode was followed by an intensive period of intra-caldera volcanic activity which is still going on today. The Mangaone Subgroup pyroclastics were erupted between 40 and 31 ka, and include the c.33 ka Kawerau Ignimbrite (~20 km^3), large enough to have caused further minor caldera collapse. In the last 26 ka, nine rhyolite eruption episodes have built the Haroharo and Tarawera lava and pyroclastic massifs (>85 km^3 magma volume) within the caldera complex. The structural boundaries of the OVC calderas are buried by the products of later eruptions, but are probably controlled by regional tectonic features. Both the Matahina and Rotoiti calderas appear to have embayments which represent downsags where magma has migrated along regional structures associated with the Taupo Rift.

OVC is sited at a major offset within the young Taupo Rift and represents a structurally complex transfer zone. Some early rhyolite domes are aligned north–northwest suggesting control by structures in the subvolcanic basement, while more recent domes are aligned northeastwards, reflecting the orientation of the Taupo Rift. Southwestward propagation of the axial rift of the Whakatane segment and northeastward propagation of the Kapenga segment have created two linear vent zones through OVC (Haroharo and Tarawera). At Tarawera, fissures and near surface dikes formed during the 10 June 1886 basalt eruption are oblique to the vent lineation suggesting some near surface strike-slip component consistent with OVC being in a zone of transtension.

1. Introduction

The Okataina Volcanic Centre (OVC; includes the Okataina Caldera Complex of Cole et al., 2005; Cole and Spinks, 2009; and peripheral domes and dome complexes) is one of seven rhyolitic calderas and caldera complexes (Fig. 1) recognised in the young Taupo Volcanic Zone (TVZ; e.g. Rogan, 1982; Wilson et al., 1995; Nairn 2002; Spinks et al., 2005; Cole et al., 2005; Cole and Spinks, 2009), and one of two caldera complexes in the axial rift zone of TVZ that have erupted within the last 2000 years. OVC contains the northeasternmost known caldera or caldera complex in onshore TVZ and conspicuously forms the northern boundary to the area of voluminous silicic volcanism there. OVC has been the site of activity over at least 550 ka, based on recent preliminary Ar/Ar dating by Graham S. Leonard and Andrew T. Calvert (*pers comm.*, 2009), and remains highly productive with an eruptive output of c.0.28 $m^3\ s^{-1}$ over the last 340 ka (Wilson et al., 1995). The 325 ka Matahina and 61 ka Rotoiti Ignimbrite eruptions

* Corresponding author.
E-mail address: jim.cole@canterbury.ac.nz (J.W. Cole).

0377-0273/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.jvolgeores.2009.08.011

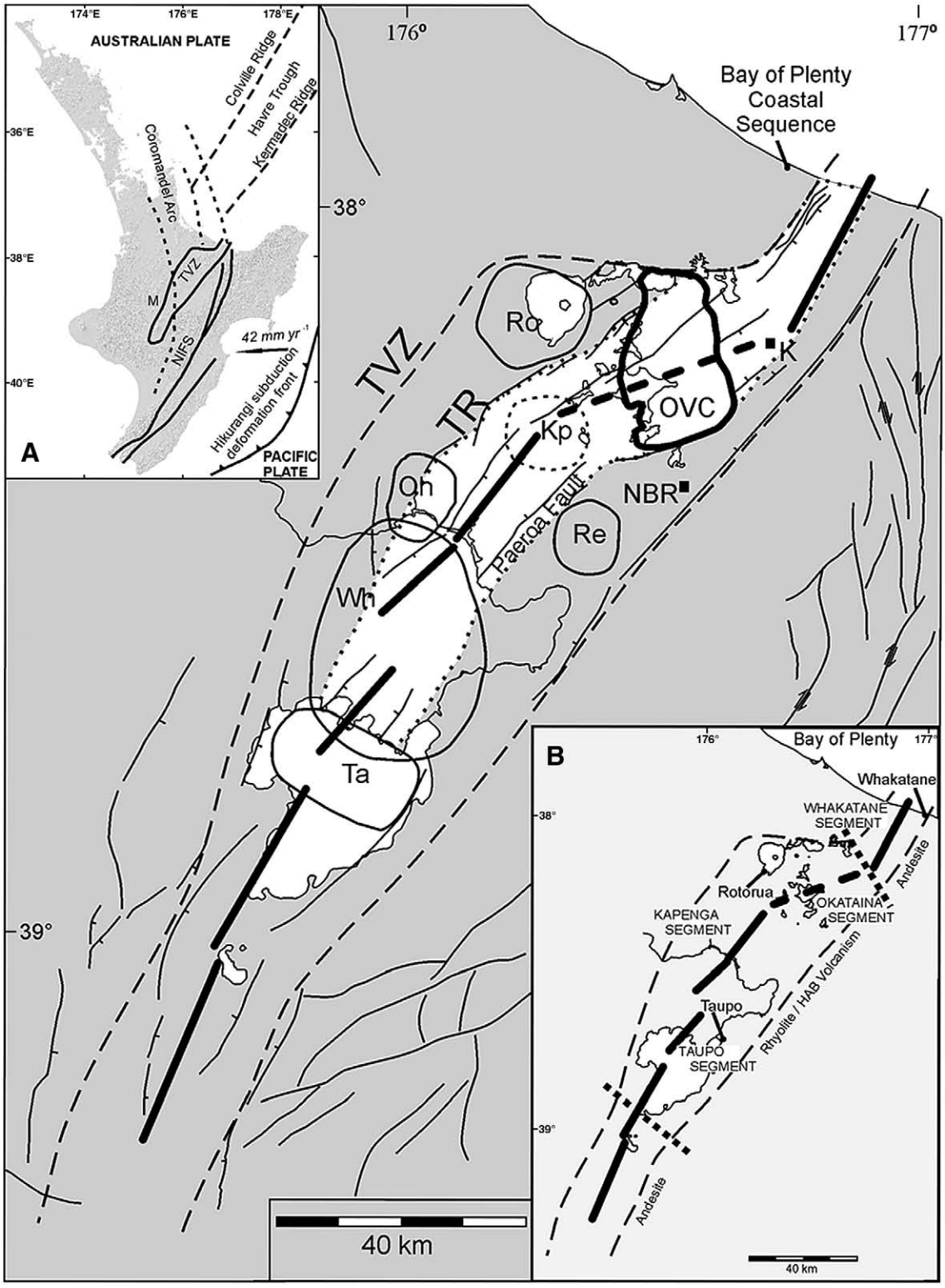

Fig. 1. Schematic outlines of caldera and caldera complexes of 'young' TVZ (modified from Hiess et al., 2007). OVC = Okataina; Ta = Taupo; Re = Reporoa; Ro = Rotorua; Oh = Ohakuri; Wh = Whakamaru; Kp = Kapenga (buried). K = location of Kawerau drillholes; NBR = location of the Northern Boundary Road drillholes. TVZ = Taupo Volcanic Zone; TR = Taupo Rift. Major rift segments are shown in heavy solid lines; the dashed heavy line shows the trend through OVC. Inset A shows the principal tectonic features of North Island, New Zealand; the arrows indicate the relative movement of the Pacific plate with respect to the Australian plate (rate from De Mets et al., 1990). M = location of earlier Mangakino Caldera. Inset B shows the locations of the Whakatane, Okataina, Kapenga and Taupo segments of Spinks et al. (2005).

(ages from Manning, 1996 and Wilson et al., 2007 respectively) have long been attributed to caldera-forming episodes at OVC (Healy, 1962, 1964; Healy et al., 1964; Ewart and Healy, 1965; Ewart, 1968; Nairn, 1981, 1989; Wilson et al., 1984; Bailey and Carr, 1994). The earlier Quartz-biotite Ignimbrite eruption was inferred to have resulted from a caldera-forming eruption at OVC (Nairn, 1981, 1989, 2002), while Beresford and Cole (2000a) indicated that the Kawerau Ignimbrite (c.33 ka; Spinks, 2005) was also erupted from OVC.

In this paper we recognise three well-substantiated caldera collapse events at OVC (from presence of lithic lag deposits) accompanying