Mesozoic to Cenozoic magmatism, Lorne Basin, NSW

Ian Graham
Geoscience, The Australian Museum
6 College St, Sydney, NSW 2010
iang@austmus.gov.au

Lin Sutherland
Geoscience, The Australian Museum
6 College St, Sydney, NSW 2010
lins@austmus.gov.au

Horst Zwingmann
CSIRO Petroleum
PO Box 1130, Bentley WA 6102
horst.zwingmann@csiro.au

SUMMARY

The Lorne Basin on the mid north coast region of New South Wales is a small circular-shaped basin within the southern margin of the New England Fold Belt. It comprises an Early Triassic terrestrial sedimentary sequence (the Camden Haven Group) overlain by rhyolitic volcanics which appear to be co-genetic with the Late Triassic granitoids (the Brothers) which intrude the Lorne Basin sedimentary sequence.

Over the last few years, we have conducted fieldwork in the Lorne Basin, mainly investigating the magmatic rocks, as part of a larger project on the volcanic sequences of eastern Australia. Initial work resulted in the identification of a number of rhyolitic dykes intruding the Brothers granitoids, previously unrecorded. As a result of this, we then undertook detailed geochronological and geochemical investigations of the magmatic sequences throughout the basin to determine their relationship to each other, and other peripheral sequences, outside of the basin.

Our results show that the Lorne Basin had a more complex and protracted magmatic history than previously thought, beginning with Late Triassic rhyolitic volcanics, followed by co-genetic rhyolitic volcanics and granitoids, then Late Jurassic and Early Cretaceous rhyolitic volcanics, terminating in Mid Miocene mafic volcanism.

Key words: Lorne Basin, volcanic, rhyolitic, granitoids

INTRODUCTION

The Lorne Basin on the mid north coast of New South Wales, is a small (35 x 30 km in diameter) circular-shaped basin within the southern margin of the New England Fold Belt. It was filled with Early Triassic continental sediments (the Camden Haven Group) and overlain by extrusive Late Triassic felsic volcanics (Pratt & Herbert, 1973). It was subsequently intruded by high-level Late Triassic – Early Jurassic granites (the Brothers) of calc-alkaline affinity (Knutson, 1975). Basin thickness is in the order of 1000 – 1500m (Gilligan and Brownlow, 1987). More recently, Tonkin (1998) suggested that the Lorne Basin was of impact origin.

Over the last 5 years, the first two authors have conducted periodic fieldwork within the Lorne Basin. Significant samples collected during these fieldtrips were subsequently sent-off for XRF and ICP-MS geochemical analysis, and K-Ar, Ar-Ar and zircon FT dating. The results of this study show that the Lorne Basin has undergone a more complex and protracted magmatic history than previously thought and some of this magmatism can be both geochronologically and geochemically linked to magmatism outside of the basin.

METHOD AND RESULTS

Field investigations have been periodically carried-out by the first two authors for the past 5 years. This fieldwork has largely concentrated on the magmatic rocks. Samples collected during fieldwork were firstly thin-sectioned to assess viability for geochemical and geochronological investigations. Those deemed suitable for geochemistry were then crushed and sent to the XRF/XRD Laboratory of the Department of Geology, University of Pretoria, South Africa for XRF analysis, and to the Department of Earth Sciences, University of Cape Town, South Africa, for ICP-MS trace and rare earth element analysis. Approximately 500g wholerock samples were then sent to Horst Zwingmann of CSIRO Petroleum, Perth, Western Australia for the K-Ar and Ar-Ar dating. Significant outcrops (such as intrusive dykes) from which samples were deemed too weathered/altered when thin-sectioned, were then re-investigated, and zircons extracted from their easily-crushable weathered portions. These zircons were then sent to Geotrack International, Melbourne, for zircon fission track dating.

The fieldwork itself has shown that the Early Triassic rhyolitic volcanics of the Lorne Basin are more extensive than previously mapped, due to most of them being rhyolitic tuffs, similar in appearance to psammitic sediments of the Camden Haven Group. Fieldwork also identified extensive rhyolitic dykes on the western side of the South Brother and SW side of the Middle Brother, which clearly intrude through the microgranitoids. Mount Juhle was identified as a Middle Miocene composite volcanic centre, comprising an early trachyte plug?, and later basaltic flows. Other Middle Miocene basaltic flows occur further to the north, to the west and northwest of Hannan Vale.

The combined K-Ar, Ar-Ar and zircon FT dating is listed in Table 1, in chronological order with the youngest dated units at the top and the oldest at the bottom. These results show that:

- Initial magmatism in the Lorne Basin is expressed as widespread Late Triassic rhyolitic flows and volcaniclastics. These are of similar age and geochemistry to the rhyolitic ignimbrites of the

Werrikimbe Volcanics to the north (Veevers et al., 1994).
- Intrusion of the Brothers granitoid suites occurred ~ 20 Ma later, and was accompanied by associated rhyolitic volcanics. Granitoid rocks of similar age (~ 205 Ma) occur within breccia pipes on the Barrington Plateau.
- Middle Jurassic volcanism, expressed as rhyolitic flows occurred some 30 Ma later. Rhyolitic rocks of similar age outcrop around Stroud to the southwest.
- Rhyolitic dykes of Early Cretaceous age intruded the granitoids of the Brothers.
- There is no evidence for later magmatism until the Middle Miocene, when mafic volcanism was concentrated around the southern part of the Lorne Basin.

Scheibner and Basden (1998) stated that: 'Undated felsic rhyolitic volcanics in the Lorne Basin area are either Late Triassic in age or could be somewhat younger and related to the latest Triassic – Jurassic Brothers granite'. Our study has shown that felsic volcanism spans a wide age range throughout the Lorne Basin, but with those in the immediate vicinity to the Brothers being coeval to them. The Middle Miocene mafic volcanism (18 – 13 Ma) spans a longer age range than the nearby Comboyne Volcanic Province which is centred around 16 Ma, and lacks the more felsic lithologies (comendites) that are prevalent within the Comboyne Province.

CONCLUSIONS

The Lorne Basin has undergone a more complex and protracted magmatic history than previously thought. Initial magmatism began in the Early Triassic as rhyolitic volcanism ~ 20 Ma before intrusion of the Brothers granitoids. Rhyolitic volcanism then occurred episodically throughout the basin until ~ 126 Ma. The last phase of magmatism was confined to the southern part of the basin and expressed as mafic volcanism in the Middle Miocene.

REFERENCES

Gilligan, L.B., and Brownlow, J.W. (eds), 1987, Tamworth-Hastings 1: 250 000 Metallogenic Map, SH56-13, SH56-14. Mineral Deposit Data Sheets and Metallogenic Study: Geological Survey of New South Wales, Sydney.

Knutson, J., 1975, Petrology and geochemistry of igneous rocks in the Comboyne Plateau – Lorne Basin area, New South Wales: Ph.D. Thesis, Macquarie University.

McDougall, I., and Wellman, P., 1976, Potassium-argon ages for some Australian Mesozoic igneous rocks: Journal of the Geological Society of Australia, 23 (1), 1-9.

Pratt, G.W., and Herbert, C., 1973, A reappraisal of the Lorne Basin: Geological Survey of New South Wales Record, 15, 205-212.

Scheibner, E., and Basden, H., 1998, Geology of New South Wales – Synthesis, Volume 2: Geological Evolution: Geological Survey of New South Wales, Memoir Geology 13 (2).

Tonkin, P.C., 1998, Lorne Basin, New South Wales: evidence for a possible impact origin?: Australian Journal of Earth Sciences, 45, 669-671.

Veevers, J.J., Conaghan, P.J., and Powell, C. McA., 1994, Eastern Australia, IN: Veevers, J.J., and Powell, C. McA. (eds), Permian-Triassic Pangean Basins and Foldbelts along the Panthalassan Margin of Gonwanaland: Geological Society of America, Memoir 184, 11-171.

Location	Field setting	Rocktype	Age (Ma)	Period	Dating Method
Juhles Mtn, Hannan Vale	flow	basalt	15	Mid Miocene	WR K-Ar
	plug	trachyte	18	Mid Miocene	WR Ar-Ar
The Farm, Hannan Vale	flow	basalt	13 – 16	Mid Miocene	WR K-Ar
W-end, South Brother	dyke	rhyolite	126	Early Cretaceous	Zircon FT
Broken Bago	flow	rhyolite	160	Mid Jurassic	Zircon FT
Middle Brother	dyke	rhyolite	186	Early Jurassic	Zircon FT
Middle Brother	intrusion	microgranodiorite	209 – 210	Late Triassic	Hrbl K-Ar
Broken Bago	flow	rhyolite	221	Late Triassic	Zircon FT

WR = whole rock FT = fission track Hrbl = hornblende separate

Table 1. Radiometric dates for the Lorne Basin sequence (Middle Brother K-Ar date from McDougall and Wellman, 1976; all other dates this study).