Ocean-floor volcanism in the Lachlan Fold Belt: new evidence from the Wyalong area, New South Wales

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Geochemical data indicate that a recently recognised sequence of Ordovician volcanic rocks (the Narragudgil Volcanics) south of Wyalong (NSW) accumulated in an oceanic environment, either in a mid-ocean ridge (MORB) or back-arc basin (BAB) setting. These volcanics occur in the same package of highly magnetic rocks with a complex magnetic signature as the Gidginbung Volcanics, host to the Temora gold deposit. They were previously considered to be part of the Gidginbung Volcanics, although Warren et al. (1995: Cootamundra 1:250 000 Sheet Explanatory Notes, Geological Survey of New South Wales) noted the presence of rocks in this area as having "…affinities to the older Jindalee Group with which they may be correlatable".

The Narragudgil Volcanics are sparsely exposed in a few localities within the Gilmore Fault Zone (Gilmore Suture) immediately south and east of the township of Wyalong (Fig. 14). In Millers Quarry, they consist of basalt characterised by a penetrative (at outcrop scale) subvertical fabric, in the form of anastomosing planes of high strain up to a few centimetres wide, produced during shearing or faulting. Because the strain was partitioned, these planes separate sheets of massive, essentially undeformed metabasalt, typically 20–40 cm across, which have the superficial appearance of sheeted dykes. This impression is further enhanced by the presence of a swarm of inter-

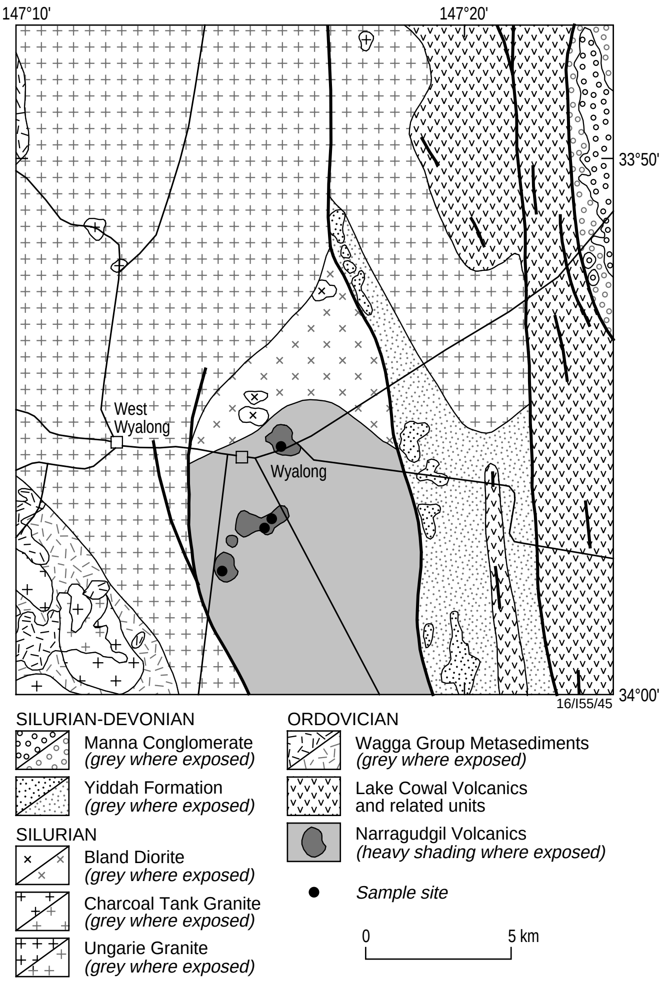

Fig. 14. Geological sketch map of the West Wyalong area showing the exposed extent (heavy shading) and interpreted distribution (light shading) of the Narragudgil Volcanics and other rock units.

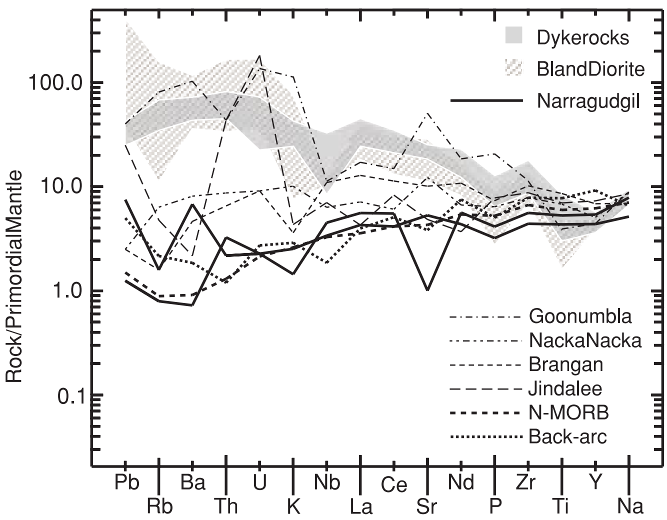

Fig. 15. Primordial mantle-normalised multielement abundance diagram (spidergram) for basalts of the Narragudgil Volcanics and other rocks. Data sources: Narragudgil Volcanics, Bland Diorite, and dyke rocks (this study); Goonumbla Volcanics (Clarke 1990: op. cit.); Nacka Nacka Volcanics (Wyborn 1996: 'Geology, chemistry and gold/copper potential of the Temora belt and adjacent Gilmore Fault System', AMIRA Project P425, Report; Brangan Volcanics (D. Wallace, personal communication); Jindalee Group (Warren 1995: op. cit.); N-MORB (Sun & McDonough 1988: in Saunders & Norry (editors), 'Magmatism in the ocean basins', Journal of the Geological Society of London, Special Publication 42, 313–345; BAB (Pearce et al. 1995: in Smellie (editor), 'Volcanism associated with extension at consuming plate margins', Geological Society, Special Publication 80, 53–75.

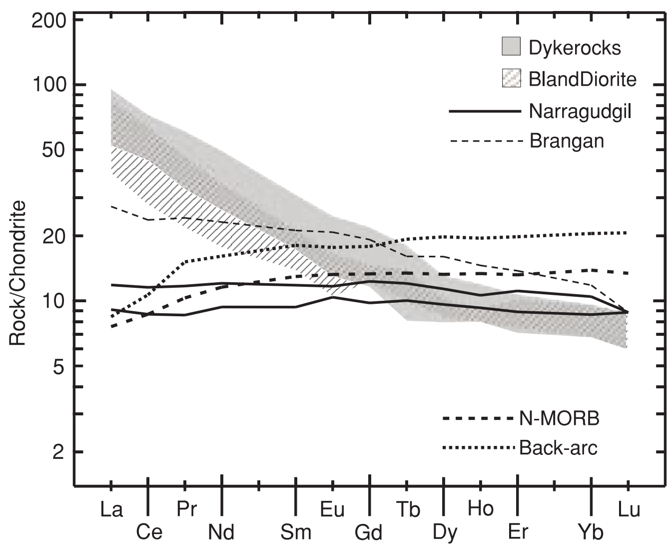

Fig. 16. Chondrite-normalised rare-earth-element abundance diagram for basalts of the Narragudgil Volcanics and other rocks. Data sources as for Fig. 15.

mediate dykes, typically 1–3 m across, subparallel to the dominant fabric. The dykes, which lack the structural fabric of the basalts and clearly postdate the deformation, have a distribution and geochemistry in common with the Lower Silurian Bland Diorite.

The Narragudgil Volcanics are geochemically primitive [$100Mg/(Mg+Fe^{2+}) = 56–64$] olivine tholeiites with low K_2O (<0.2 wt %) and K/Na ratios. Their trace-element contents — characteristically depleted in large-ion lithophile element (LILE) abundances (Fig. 15) and having a flat rare-earth-element distribution (Fig. 16) — are typical of ocean-floor basalts erupted in either a MORB or BAB setting. Some scatter in the trace-element data probably reflects element mobility during metamorphism. However, the overall character of the elemental abundances is consistent, and cannot be an artefact of the metamorphism. In addition, two other samples not plotted on Figures 15 and 16 — an altered dolerite and a fine-grained quartz-rich amphibolite with major-element abundances reflecting basalt weathered before metamorphism — show the same broad trace-element distributions, albeit with rather more scatter in some elements.

The geochemical characteristics of the Narragudgil samples contrast markedly with the associated dyke suite and the Bland Diorite, which show higher K_2O (up to 2.5 wt %) and more enriched LILE and light rare-earth-element abundances. In these aspects, the Narragudgil Volcanics also contrast markedly with the well-documented high K_20 and K/Na ratios and strong LILE-enrichment exhibited by the Ordovician Goonumbla Volcanic Group and related units of the eastern Lachlan Fold Belt — including the Nash Hill, Parkes, Wombin, and Lake Cowal Volcanics (e.g., Clarke 1990: in Clarke & Sherwin (Editors), Records of the Geological Survey of New South Wales, 23, 97–136). The Narragudgil unit otherwise shares similar geochemical characteristics, including depletion in K and LILE, with other units in the eastern Lachlan Fold Belt — namely, the Brangan Volcanics in the Grenfell area (D. Wallace, AGSO, personal communication), the Nacka Nacka Volcanics in the Tumut area, and basalt from the Jindalee Group (Fig. 15). Note that the high U, Th, and Pb shown by the Jindalee sample appear to be anomalous, and probably reflect the age and lack of precision of the analysis. The Narragudgil Volcanics evince a slight relative depletion in high-field-strength elements compared with these other units and with typical MORB and BAB compositions. Even so, the abundances in all samples fall within the range encountered in typical mid-ocean ridge and back arc settings.

It is not clear if the Gilmore Fault Zone is a terrane boundary (e.g., Stuart-Smith 1991: BMR Journal of Australian Geology & Geophysics, 12, 35–50). However, the presence of ocean-floor basalts within it opens up the possibility that the Narragudgil Volcanics represent a sliver of sea-floor obducted onto the volcanic arc during closure of the Wagga Marginal Basin in the Middle to Late Ordovician.

The ocean-floor affinity of the Narragudgil Volcanics suggests that they are unlikely to host any porphyry-related Cu–Au systems. However, they may be prospective for Cyprus-type copper deposits.

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