Lithos 232 (2015) 84–99

Contents lists available at ScienceDirect

Lithos

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

Time–space focused intrusion of genetically unrelated arc magmas in the early Paleozoic Ross–Delamerian Orogen (Morozumi Range, Antarctica)

S. Rocchi [a,*,1], G. Di Vincenzo [b], A. Dini [b], M. Petrelli [c], S. Vezzoni [a]

[a] Dipartimento di Scienze della Terra, Università di Pisa, Pisa, Italy
[b] Istituto di Geoscienze e Georisorse, CNR, Pisa, Italy
[c] Dipartimento di Fisica e Geologia, Università di Perugia, Perugia, Italy

ARTICLE INFO

Article history:
Received 12 December 2014
Accepted 15 June 2015
Available online 23 June 2015

Keywords:
Accretionary orogen
Magmatic arc
Intrusive complex
Magma source
Subduction erosion

ABSTRACT

The growth of continental crust in accretionary orogenic belts takes place through repeated cycles of subduction–accretion of rock units from continental and oceanic magmatic arcs, supra-subduction zone backarcs and forearcs loaded with continent-derived materials. An ancient example relevant to magmatic arc accretion models is represented by the remnants of the Cambrian–Ordovician Ross Orogen in the Morozumi Range, Victoria Land (Antarctica). There, late Neoproterozoic phyllites host an intrusive complex which preserves a remarkably uncommon record of genetically unrelated magma pulses emplaced under a variable stress regime in a short time span: (1) a dominant K-feldspar–phyric granite, (2) fine-grained dioritic stocks and dykes, (3) a peraluminous granite; and (4) a tonalitic–granodioritic dyke swarm. Laserprobe U–Pb zircon dates cluster at late Cambrian times for all these units, yet they carry differential cargoes of relict cores. Unique geochemical–isotopic signatures for both the less evolved magmas (diorite and dyke tonalite) and the most acidic ones (granite and peraluminous granite) indicate that each one of them originated from distinct sources at depth. Additionally, field relationships and chemical evolutionary trends testify for a variety of shallow level open-system processes, such as magma mingling/mixing between diorite and main granite magmas, as well as progressive incorporation of the host schists by the dyke tonalite magma. In summary, crustal growth in the Morozumi intrusive complex was contributed by fresh mantle magma issuing from the metasomatised mantle wedge, while the production of other melts did recycle different crustal portions/layers: the main granite derived from Grenville-age granulitic lower crust; the peraluminous granite from late Proterozoic upper crust, and the tonalite magmas derived from subduction erosion-enriched subarc mantle and evolved by ingestion of local metasedimentary rocks. Overall, the Morozumi intrusive complex yields evidence for emplacement in the same site at the same time of magmas issuing from different sources that are usually found at a different depth in the arc lithospheric section. A likely scenario to activate this specific mechanism of melt production is a subduction zone affected by subduction erosion.

1. Introduction

Magma generation in convergent settings is usually from multiple sources, including the mantle wedge, the overriding plate, and the subducting slab as well. The overriding plate can contribute as either a contaminant of uprising magmas (Davidson et al., 2005) or a direct source of melts from the upper/lower crust (Brown, 2013), and the juvenile underplates as well (Rocchi et al., 2009). The subducting lithosphere can contribute by direct partial melting (Defant and Drummond, 1990), addition to the mantle wedge of a subduction component via aqueous fluids/hydrous melts (Pearce and Peate, 1995), as well as via more massive, bulky processes such as subduction erosion (von Huene et al., 2004) and subduction of continental crust (Hacker et al., 2011). Actual arc magmas are thus the outcome of a bouquet of processes (Davidson et al., 2005), including source melting degree and regime (equilibrium/disequilibrium), fractional crystallisation, (possibly accompanied by assimilation), and hybridisation between different magmas, from deep crustal to emplacement levels (Brown, 2013). In accretionary orogens, processes of mantle modifications can occcur every time subduction takes over slab rollback and backarc opening. This variety of materials and processes makes orogenic igneous complexes a rich source of information, yet difficult to disentangle.

A magmatic arc that underwent most of these petrogenetic processes in a convergent accretionary setting was active during the early Paleozoic at the paleo-Pacific margin of Gondwana in Antarctica. The Cenozoic uplift linked to the West Antarctic rift system led to prominent exposures of arc deep-seated terrains in clean outcrops. Among these,

* Corresponding author.
E-mail address: sergio.rocchi@unipi.it (S. Rocchi).
[1] Tel.: +39 0502215710; fax: +39 0502215800.

http://dx.doi.org/10.1016/j.lithos.2015.06.006
0024-4937/

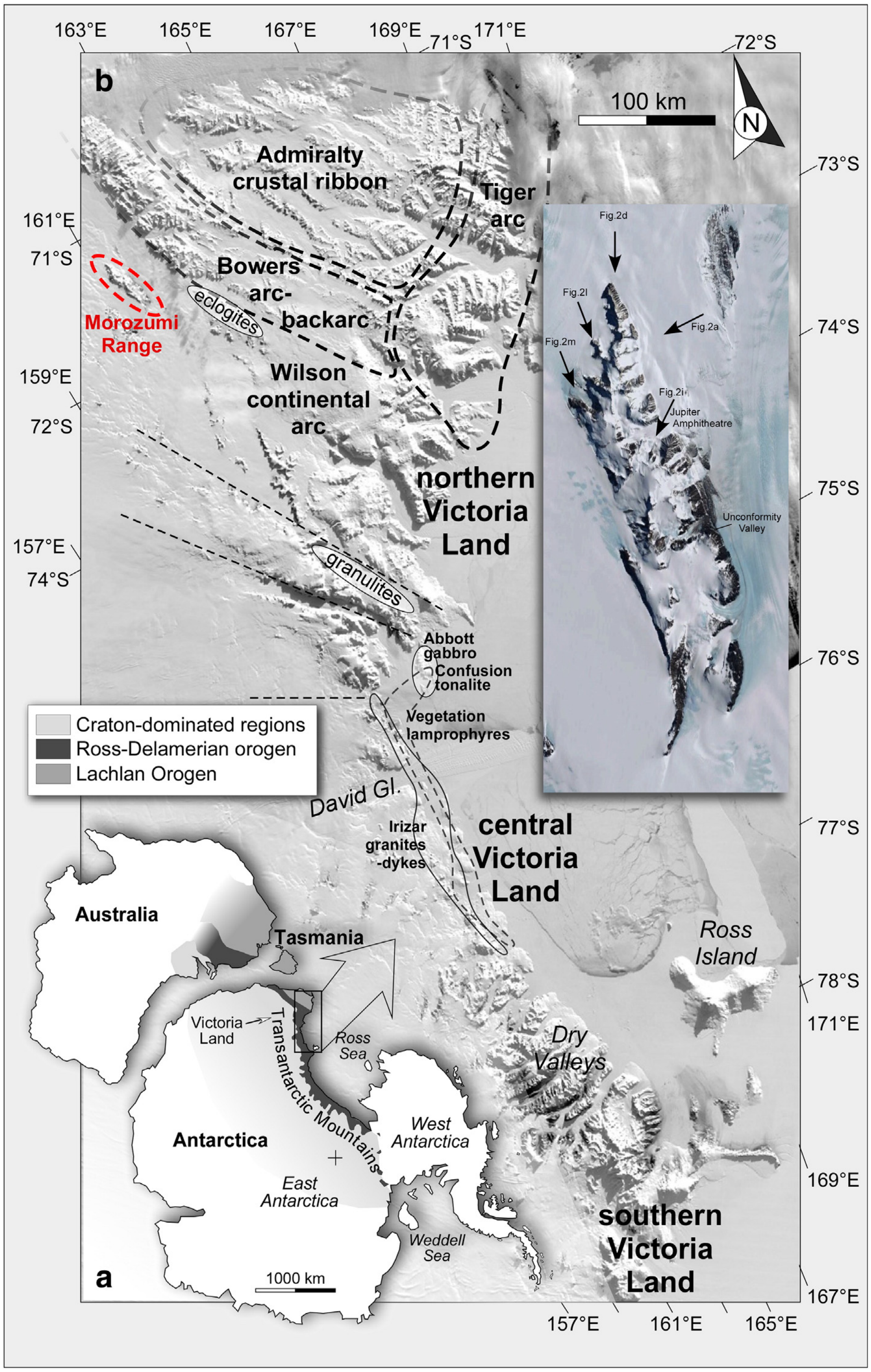

Fig. 1. (a) Location map of the Transantarctic Mountains and Victoria Land in the frame of the early Paleozoic Ross–Delamerian orogen in Antarctica–Australia–Tasmania before the break-up of Gondwana (Foster et al., 2005; Glen, 2005). (b) Satellite view of Victoria Land, based on http://rapidfire.sci.gsfc.nasa.gov. For comparison between the representation of Victoria Land reported here (Rocchi et al., 2011) and that reported in papers using the classical partition of northern Victoria Land into three terranes: (i) the Wilson terrane is here represented by the Wilson continental arc, (ii) the Bowers terrane is represented by the Bowers arc–backarc plus the southernmost part of the Tiger arc, and (iii) the Robertson Bay terrane is represented by the Admiralty crustal ribbon plus the northernmost part of the Tiger arc. IG: "postcollisional" granites and felsic dykes; VL: "postcollisional" lamprophyric dykes (Rocchi et al., 2009). (c) Magnification of the Morozumi Range, with location of field photographs reported in Fig. 2.

the Morozumi Range igneous complex in northern Victoria Land is made of a variety of intrusive rocks with well exposed mutual chronological, petrological and structural relationships. Field observations, coupled with chemical data, isotopic geochemistry and geochronology, led to the reconstruction of a scenario that shed light on potential modalities of magma formation and evolution in magmatic arcs. Additionally, new implications on the evolution of the Antarctic margin of Gondwana in Cambrian–Ordovician time are proposed to update current models.

2. Geological setting

Today's Transantarctic Mountains represent the roots of an orogen exposed on the shoulder of the Cretaceous–Cenozoic West Antarctic