The Morozumi Range Intrusive Complex (northern Victoria Land, Antarctica)

L. Bracciali,[1] S. Rocchi,[1] G. Di Vincenzo,[2] and A. Dini[2]

[1] Dipartimento di Scienze della Terra, Università di Pisa, Via S. Maria 53, 56126 Pisa, Italy (bracciali@dst.unipi.it)
[2] Istituto di Geoscienze e Georisorse, CNR, Via Moruzzi 1, 56124 Pisa, Italy

Summary Northern Victoria Land, the region located at the Pacific termination of the Transantarctic Mountains, is made up of three main lithotectonic units assembled during the Early Paleozoic Ross Orogeny. To better constrain the emplacement mechanisms and origin of orogenic magmatism, it is particularly valuable the study of intrusions close to major crustal boundaries, such as that cropping out in the Morozumi Range (Wilson terrane). Preliminary studies in the area were carried out in the 1970's by New Zealand geologists and by the German GANOVEX teams in the 1980's. Our recent field and petrochemical investigations of the Morozumi Range Intrusive Complex allowed to recognize different lithologic units (Morozumi granite, Jupiter Granite, Morozumi Granodiorite, Morozumi Diorite and Morozumi tabular intrusions). These units, characterized by complex evolutionary genetic relationships, possibly derived from different crustal and subcrustal sources and emplaced in a rather short time interval.

Citation: Bracciali, L., S. Rocchi, G. Di Vincenzo, and A. Dini (2007), The Morozumi Range Intrusive Complex (northern Victoria Land, Antarctica), in Antarctica: A Keystone in a Changing World – Online Proceedings of the 10th ISAES, edited by A.K. Cooper and C.R. Raymond et al., USGS Open-File Report 2007-1047, Extended Abstract 163, 4 p.

Introduction

The convergence between paleo-Pacific oceanic lithosphere and Gondwana continental margin during Early Paleozoic led to the building of the Ross Orogen at the border of the East Antarctic craton. In northern Victoria Land, the convergence processes resulted in the assembly of three main lithotectonic units, identified as terranes. The study of major intrusions close to crustal boundaries is particularly valuable in the frame of understanding the origin and emplacement mechanisms of orogenic magmatism. The good exposure and rather easy accessibility of the Morozumi Range make it a suitable case study to address these issues.

The plutonic rocks cropping out in the Morozumi Range are considered in the literature to belong to the Granite Harbour Intrusives, representing a widespread association of plutonic rocks emplaced during the Ross Orogeny (Stump, 1995, and references therein). Preliminary studies in the area were carried out in the 1970's by New Zealand geologists and by the German GANOVEX teams in the 1980's, which ascribed to the Morozumi intrusion a Ross age and a S-type granitic affinity. A detailed field and petrochemical characterization of the different lithologic units in the Morozumi Range is here presented, in order to better define their complex interaction and to understand the emplacement processes related to the Ross orogeny in this frontal sector of the former active margin.

Geological setting

Northern Victoria Land is the region located at the Pacific termination of the Transantarctic Mountains. It is traditionally referred to as the assembly occurred during the Early Paleozoic Ross Orogeny of three lithotectonic units or "terranes" (Weaver et al., 1984) which are, from west to east: the Wilson, Bowers and Robertson Bay terranes. A debate is still in progress about the hypothesis of a far-travelled exotic origin and about the timing and processes leading to the present configuration of northern Victoria Land (Roland et al., 2004; Tessensohn and Henjes-Kunst, 2005, and references therein). Yet, "terrane" is here adopted, being the term traditionally used in the literature when Wilson, Bowers and Robertson Bay lithotectonic units of northern Victoria Land are referred to.

The Morozumi Range extends over an area of about 10 x 40 km trending NNW-SSE in the Wilson Terrane. It is an isolated range located between the medium and high grade rocks of Daniels Range and Lanterman Range. The granitic pluton (Morozumi Adamellite of Dow and Neall, 1974), which crops out in the northern part of the Morozumi Range, intrudes the Morozumi Phyllites and Spotted Schist formation (Fig. 1), so called after the pluton-induced pervasive thermal overprint on the low regional-grade metapelites and metarenites (GANOVEX Team, 1987). In the southwestern part of the Range, the folded metasediments are unconformably overlain by the almost flat-lying Devonian-Triassic Beacon Sandstones and Jurassic Ferrar Dolerite sills.

After the first studies of the New Zealand geologists (Sturm and Carryer, 1970; Dow and Neall, 1972 and 1974), the intrusive rocks and the surrounding metasediments in the Morozumi Range have been investigated in the 1980's by the GANOVEX teams (Tessensohn et al., 1981; Kleinschmidt and Skinner, 1981; Wyborn, 1981; Engel, 1984; Vetter and Tessensohn, 1987). For the Morozumi granites a S-type affinity is indicated (Wyborn, 1981), and whole-rock Rb-Sr isochron ages of 515 ± 28, 470 ± 18 and 475 ± 12 Ma are reported for three different igneous facies of the Morozumi pluton (Kreuzer et al., 1981 and 1987, Vetter et al., 1983).

The Morozumi Range Intrusive Complex

The Morozumi Range Intrusive Complex (hereafter MoRIC) consists of several lithologic units which were defined during the field season 2005–2006 and further constrained on the basis of their petrographic features. These units are introduced in order to better represent the broad range of igneous rock types and their complex field relationships.

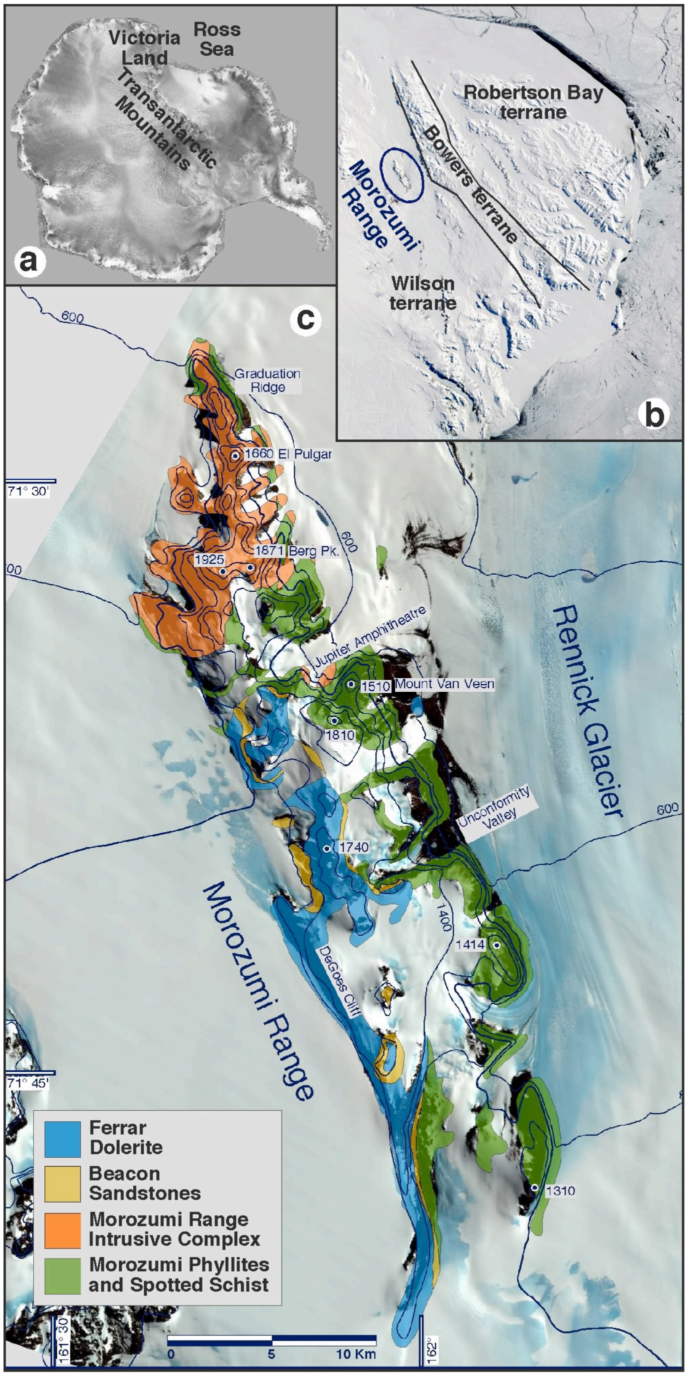

Figure 1. (a) Sketch map of Antarctica. (b) Satellite view of northern Victoria Land (modified from http://rapidfire.sci.gsfc.nasa.gov). (c) Sketch geological map of the Morozumi Range (geological data after GANOVEX, 1987, on a Landsat Image, courtesy of Museo Nazionale Antartide, Siena).

Morozumi Granite

The Morozumi Granite dominates the central part of the complex. Samples from the crest (south of El Pulgar) and from the western side of the Range typically consist of a porphyritic monzogranite with white to pink K-feldspar megacrysts (up to 5 cm) set in a medium-grained groundmass with 10-15 vol% red-brown biotite. Allanite is a common accessory phase, while samples from the northern tip of the Range (Graduation Ridge) exhibit primary muscovite. Megacrysts from granite apophyses in the north-western side of the pluton are locally iso-oriented with respect to the foliation of the metasediments in which they are intruded.

Jupiter Granite

This unit is named after the main spectacular outcrop in the southern part of the Jupiter Amphitheatre, where a medium- to coarse-grained massive body of peraluminous monzogranite with biotite (about 3 vol%) and primary muscovite neatly crosscut the country rock (Fig. 2a). Field relationships with the Morozumi Granite have not been observed, while peraluminous syenogranitic massive bodies of the Jupiter Granite unit are intruded by tabular bodies along the western flank of the MoRIC (Western tabular intrusions, next paragraph). Here the Jupiter Granite medium to coarse-grained rocks contain abundant muscovite (up to 5-10 vol%).

Morozumi tabular intrusions

This lithologic unit includes samples from tonalitic/granodioritic dikes which, on the basis of their field occurrence, have been grouped into: (i) *Eastern tabular intrusions*: subvertical tabular bodies intruding the metasediments, consisting of medium-grained foliated tonalites and granodiorites with 5 to 10 vol% biotite ± muscovite (Fig. 2b); (ii) *Western tabular intrusions*: W-dipping tabular bodies intruding both the Morozumi and Jupiter Granite at high angles, in the first case consisting of fine-grained foliated tonalites with about 15 vol% biotite, in the second of medium-grained granodiorites with about 20 vol% biotite and up to 5 vol% muscovite; (iii) *Tabular intrusions from the crest*: W-dipping tabular bodies intruding the Morozumi Granite with gentle dip, locally cutting the intrusive foliation of the granite; they are fine-to medium-grained leucomonzogranites to leucogranodiorites with less than 5 vol% biotite and minor muscovite.

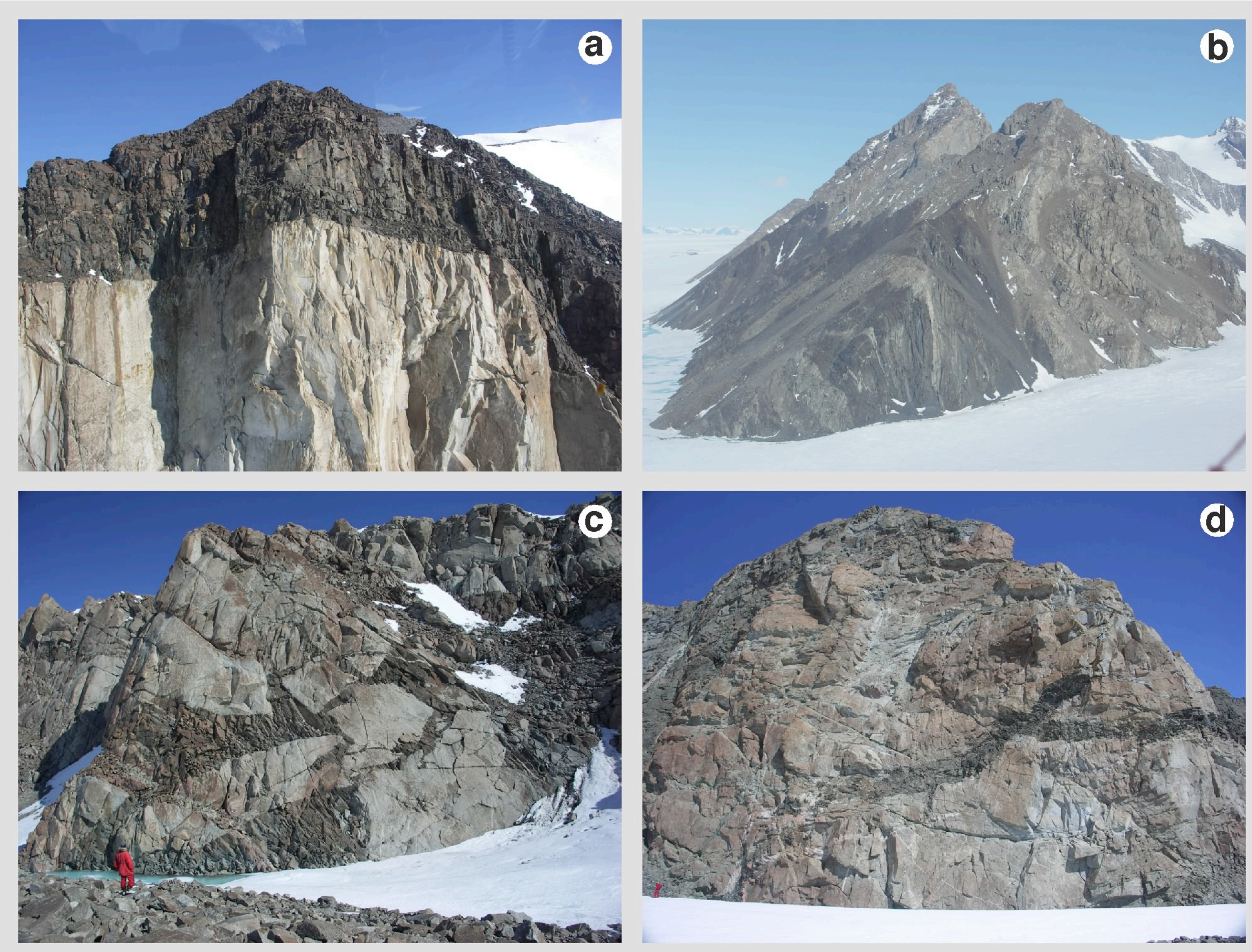

Figure 2. (a) Contact between light-colored Jupiter Granite and black metasediments of the country rock, Jupiter Amphitheatre; vertical relief ca. 200 m. (b) Aerial view of the northern tip of the Morozumi Range from NW showing subvertical Eastern Morozumi tabular intrusions cutting the metasedimentary country rock (dark colored) and the Morozumi Granite (right); vertical relief ca. 1000 m. (c) Morozumi Granodiorite (dark) crosscutting the Morozumi Granite, western side of the Morozumi Range; vertical relief ca. 50 m. (d) Morozumi Granite intruded by Morozumi Diorite (dark), as both a massive body (left) and branching dikes (right), southwesternmost flank of the Morozumi Range; vertical relief ca. 100 m.

Morozumi Granodiorite

These rocks from the base of the western side of the MoRIC represent a minor lithologic unit, and consist of a network of irregular bodies crosscutting the Morozumi Granite with sharp contacts (Fig. 2c). Angular fragments of the granite are occasionally included in the Granodiorite. A fine-grained texture and high biotite content (about 20 vol%) make these rocks distinctive with respect to the surrounding the Morozumi Granite.

Morozumi Diorite

The southwesternmost part of the MoRIC is mainly constituted of mafic stocks and dikes intruding the Morozumi Granite (Fig. 2d). The contact between the two units is diffuse, suggesting coeval emplacement relationships. The Morozumi Diorite is an equigranular (fine- to medium-grained) quartz-diorite characterized by the occurrence of both biotite and green amphibole, with a Color Index up to the 50 % of the whole rock.

Aplitic veins

These are minor bodies that can be found in two main different settings: (i) as strongly deformed and dismembered leucocratic dikes linked to Eastern tabular intrusions, both of which intruding metasediments in the northern tip area of the Range; these are foliated equigranular (fine- to medium-grained) peraluminous leucosyenogranite, with muscovite ± garnet or tourmaline; (ii) as fine-grained leucosyenogranite representing the leucocratic part of Western tabular dikes intruding the Morozumi Granite.

Chemical data

Major element composition has been determined via XRF on glass beads for selected samples. The resulting dataset span over a wide chemical range, (Fig. 3, where the lithologic units of the MoRIC are represented as fields in the Total Alkali versus Silica diagram). The lithological complexity of the MoRIC is confirmed by the large chemical variability, that rules out simple evolutionary genetic relationships among the various units. Of particular interest is the Morozumi tabular intrusions unit, which is represented by calcalkaline tonalites, grading into evolved products where white mica becomes a principal phase. This suggests a possible interaction with a peraluminous material, possibly the Jupiter granite or the metasedimentary country rock.

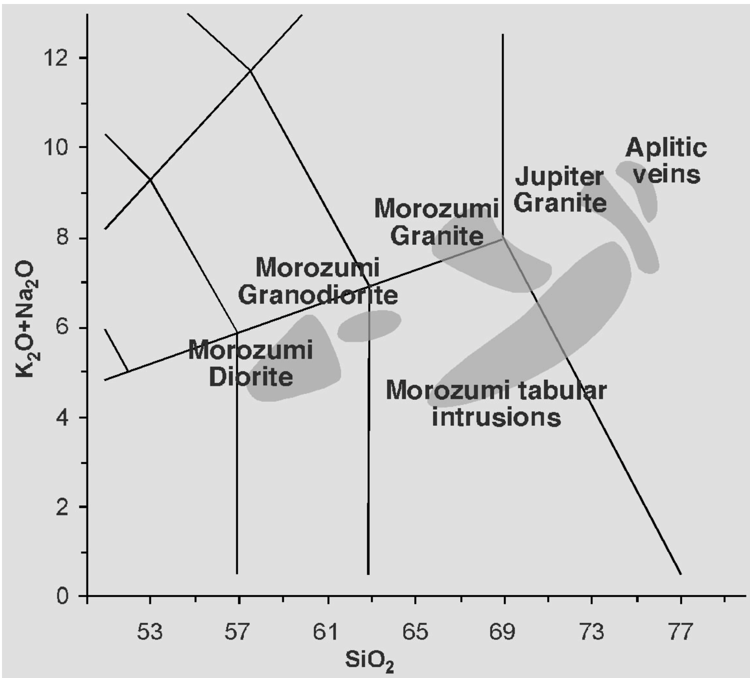

Figure 3. Total Alkali versus Silica diagram representing compositional fields of the different lithologic units of the Morozumi Range Intrusive Complex.

Discussion and conclusion

Field evidence and the petrographic and chemical data collected so far outline a complex picture for the building of the Morozumi Range Intrusive Complex. The emplacement sequence can be inferred on the basis of the relationships among the igneous units observed in the field. The main intrusive body of the Morozumi Granite can be considered coeval to the Morozumi Diorite body, both intruded by various dikes of the Morozumi tabular intrusions unit. The observed chemical variability suggests the occurrence of multiple magma pulses derived from different crustal and subcrustal sources and possibly emplaced in a rather short time interval.

Acknowledgments. The co-editor Edmund Stump is kindly acknowledged for handling this extended abstract. This work has been carried out with the financial support of the Programma Nazionale di Ricerche in Antartide (PNRA).

References

Dow, J.A.S., and V.E. Neall (1972), A summary of the geology of Lower Rennick Glacier, Northern Victoria Land, in: Antarctic Geology and Geophysics, edited by R. J. Adie, pp. 339-344, Oslo.

Dow, J.A.S., and V.E. Neall (1974), Geology of the Lower Rennick Glacier, northern Victoria Land, Antarctica, New Zealand Journal of Geology and Geophysics, 17, 659-714.

Engel, S., (1984), Petrogenesis of contact schists in the Morozumi Range, North Victoria Land, Geologisches Jahrbuch, B60, 167-185.

GANOVEX Team (1987), Geological map of North Victoria Land, Antarctica, 1:500000, explanatory notes, Geologisches Jahrbuch, B66, 7-79.

Kleinschmidt, G., and D.N.B. Skinner (1981), Deformation styles in the basement rocks of North Victoria Land, Antarctica, Geologisches Jahrbuch, B41, 155-199.

Kreuzer, H., A. Höhndorf, U. Vetter, F. Tessensohn, P. Müller, H. Jordan, W. Harre, and C. Besang (1981), K/Ar and Rb/Sr dating of igneous rocks from North Victoria Land, Antarctica, Geologisches Jahrbuch, B41, 267-273.

Kreuzer, H., A. Höhndorf, H. Lenz, P. Müller, and U. Vetter (1987), Radiometric ages of pre-Mesozoic rocks from northern Victoria Land, Antarctica, in Gondwana Six: Structure, tectonics, and geophysics, Geophysical Monograph, 4, edited by G.D. McKenzie, pp. 31-47, American Geophysical Union, Washington.

Roland, N.W., A.L Läufer, and F. Rossetti (2004), Revision of the terrane model of northern Victoria Land (Antarctica), Terra Antartica, 11, 55-65.

Stump, E., (1995), The Ross Orogen of the Transantarctic Mountains, 284 pp., Cambridge University Press, New York.

Sturm, A., and S.J. Carryer (1970), Geology of the region between the Matusevich and Tucker glaciers, north Victoria Land, New Zealand Journal of Geology and Geophysics, 13, 408-435.

Tessensohn, F., and F. Henjes-Kunst (2005), Northern Victoria Land terranes, Antarctica: far-travelled or local products? in Terrane Processes at the Margins of Gondwana, Geol. Society Special Publication 246, edited by A.P.M. Vaughan, P.T. Leat, and R.J. Pankhurst, pp. 275–291, London.

Tessensohn, F., K. Duphorn, H. Jordan, G. Kleinschmidt, D.N.B. Skinner, U. Vetter, T.O. Wright, and D. Wyborn (1981), Geological comparison of basement units in North Victoria Land, Antarctica, Geologisches Jahrbuch, B41, 31-88.

Vetter, U., and F. Tessensohn, (1987), S- and I-Type granitoids of North Victoria Land, Antarctica, and their inferred geotectonic setting, Geologische Rundschau, 76, 233-243.

Vetter U., N.W. Roland, H. Kreuzer, A. Höhndorf, H. Lenz, and C. Besang (1983), Geochemistry, petrography, and geochronology of the Cambro-Ordovician and Devonian-Carboniferous granitoids of northern Victoria Land, Antarctica, in Antarctic earth science, edited by R.L. Oliver, P.R. James, J.B. Jago, pp. 140-143, Australian Academy of Science, Canberra.

Weaver, S.D., J.D. Bradshaw, and M.G. Laird (1984), Geochemistry of Cambrian volcanics of the Bowers Supergroup and implications for the early Palaeozoic tectonic evolution of northern Victoria Land, Antarctica, Earth and Planetary Science Letters, 68, 128-140.

Wyborn, D., (1981), Granitoids of North Victoria Land, Antarctica; field and petrographic observation, Geologisches Jahrbuch, B41, 229-249.