A VOLCANO-PLUTONIC ASSOCIATION IN NORTHEASTERN NEW SOUTH WALES

by

NEIL L. GODDEN, B.Sc. (W.A.)

Thesis submitted for the degree
of Master of Science, University
of New England, Armidale,
New South Wales.

February 1982

I certify that the substance of this Thesis has not been submitted for any degree and is not being currently submitted for any other degree.

I also certify that any assistance in preparing this Thesis, and all sources used, have been formally acknowledged.

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ABSTRACT

In the Emmaville-Tenterfield region of northeastern New South Wales, Late Permian comagmatic volcanic and high-level intrusive rocks are spatially associated with large cauldron structures. Major economic concentrations of cassiterite, molybdenite and wolframite are associated with specific leucogranitoid plutons which were intruded to subvolcanic levels in regions between discrete cauldrons. Chemical, mineralogical and field data, used to relate the associated calc-alkaline volcanic and intrusive rocks and the various types of mineralization, have led to the recognition of a volcano-plutonic association displaying features common to volcano-plutonic associations developed in evolved geosynclinal environments in many other parts of the world.

Igneous activity in the Emmaville-Tenterfield region commenced with the accumulation of large volumes of leucoadamellite and adamellite magma generated by minimum and non-minimum progressive partial melting of lower crustal rocks of presumed adamellitic composition. Intrusion of these magmas to high levels within Early Permian silicified siltstones and sandstones induced doming and fracturing of the brittle sedimentary rocks above specific magma chambers, leading to the upward venting of magmas along arcuate fractures and eventual eruption in the form of pyroclastic volcanism. The Emmaville Volcanics so formed, consist of a large number of individual ash flows, minor lava flows and rare ash-fall units which comprise a thick sequence of dominantly rhyolitic volcanics ranging in composition from dacite to high-silica rhyolite. Rare andesites and associated mafic rhyodacites are also present and constitute a geochemically distinct group apparently unrelated to the bulk of the Emmaville Volcanics. The evacuation of large volumes of magma from the high-level chambers caused subsidence of the overlying sedimentary and fresh volcanic rocks, forming simple cauldrons of the Glencoe type.

The second episode of volcanism in the region, dated at 242 Ma (Evernden and Richards, 1962), was marked by eruption of the ignimbritic Dundee Rhyodacite from central vents in the subsided blocks of a number of calderas. Mineralogical evidence suggests that the Dundee Rhyodacite magma was generated by very high temperature partial melting of an intermediate source rock and that the magma separated from the melting zone virtually devoid of incorporated partial melting refractory residua. The distinctive microgranular groundmass textures of the Dundee Rhyodacite, its remarkable compositional uniformity, lack of flow banding, welding zonation and other macroscopic volcanic structures, and the presence of only locally derived accidental xenoliths are features which indicate that eruption occurred simultaneously in all cauldron centres and that the erupted magma cooled in a manner analogous to high level plutons. In some cases cauldrons were overfilled, producing outflow facies Dundee Rhyodacite displaying microscopic eutaxitic textures and a relatively wide range in whole-rock chemical composition resulting from crystal accumulation and liquid (groundmass) separation during emplacement.

During the final stage of the second volcanic episode the ring fracture(s) partly surrounding the largest caldera near Dundee were reactivated and rhyodacitic magma from the underlying chamber was erupted in the form of numerous thin ash flows now recognized as constituting the Tent Hill Volcanics. These volcanics range in composition from dacite to siliceous rhyodacite but contain the same phenocrysts as the Dundee Rhyodacite and completely overlap whole-rock compositions of the intra-caldera and outflow facies of the Dundee Rhyodacite. All facies of the Tent Hill Volcanics and Dundee Rhyodacite collectively represent a crystal-liquid mixing series.

Immediately following the second episode of volcanism (i.e. 238 - 236 Ma) the still-fluid early phase magmas were able to rise to even higher crustal levels, ultimately to reside within the base of the Emmaville Volcanic pile. Major crustal

structures such as the Tenterfield and Demon Faults and the steeply dipping ring fractures defining individual calderas imposed controls on granitoid emplacement so that magmas were largely directed away from cauldron blocks, doming and intruding the intervening country rocks. Leucocratic magmas in pristine high-level chambers that apparently were not vented during the first volcanic episode, were also able to intrude to subvolcanic levels.

The final phase of calc-alkaline igneous activity in the region was marked by the intrusion of Early Triassic (222 Ma) leucogranitoids north of the Tenterfield Fault. These leucogranitoids are geochemically and mineralogically similar to leucocratic plutons of the first intrusive episode and probably were generated by partial melting of the same parent rock.

Specific leucogranitoid plutons of the first and second intrusive episodes are hosts for cassiterite-wolframite or molybdenite mineralization and are spatially associated with hydrothermal base metal sulfide deposits which occur as veins in the adjacent sedimentary and intrusive country rocks. Assessment of all aspects of the petrogenesis of these mineralized plutons led to the conclusion that they probably crystallized from magmas generated from the same parent as the other siliceous granitoids but, unlike their barren counterparts, were not related to earlier cauldron-forming volcanism. Residual magmas in high-level chambers partly voided during the first episode of volcanism were substantially depleted in volatile components regarded as essential for the magmatic concentration, transport and ultimate deposition of ore trace metals. By contrast, leucocratic magmas in untapped high-level chambers contained significantly higher concentrations of volatile components and were able to effect the migration of selected metals to economic concentrations in the apical regions of the chambers. Subtle differences in physicochemical conditions prevailing during the evolution and crystallization of these magmas may explain why individual plutons are hosts for specific tin-tungsten or molybdenum mineralization.

ACKNOWLEDGEMENTS

I wish to thank Professor R.L. Stanton who initiated this project, and provided useful discussions of its progress during the first half of my candidature. Professor J.F.G. Wilkinson offered invaluable support and criticism during the production of the thesis. Other members of staff unselfishly gave of their time for many fruitful discussions; these include Dr. Nick Stephenson, Associate Professor Peter Fielding, Dr. Hugh Herbert, Ken Cross and Dr. Bob Fagan in particular.

Mr. Steve Bagley kindly made available the XRF facility at the University of Queensland and, with Mr. Frank Audsley, assisted greatly in its use. Mr. Nick Ware at the Research School of Earth Sciences, A.N.U., cheerfully supervised my use of the electron microprobe.

Joe Stolz and Mrs. Wendy Roberts offered advice on analytical work and Associate Professor Ron Green and Ken Cross helped with computer reduction of the data. I thank Dr. Hugh Herbert and Dr. John Kleeman for their contributions of unpublished analytical and other data. John Cook's careful preparation of polished thin sections I gratefully acknowledge.

The manuscript was expertly typed by Gail Edwards and Jenny Morrison from a detailed draft prepared by Cheryl Chant, and Rhonda Vivian provided the captions for many diagrams. To Ruth Chant I owe a special debt. For so much support, always graciously given, thankyou Ruth.

Finance for this work was provided by a Commonwealth Postgraduate Award.

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