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# PERALUMINOUS GRANITES

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## INTRODUCTION

Peraluminous granites constitute a chemical subdivision of the granite family in which the whole-rock molar ratio of alumina to lime, soda and potash [$Al_2O_3/(CaO+Na_2O+K_2O)$, abbreviated A/CNK] is greater than unity. Silicate melts with such compositions, of necessity, crystallize a characteristic suite of minerals that may include one or more of muscovite, highly aluminous biotite, cordierite, andalusite, sillimanite and garnet. Owing to their chemical and mineralogical similarities to metapelites, peraluminous granites are often considered to be genetically linked with these metasediments as source rocks, and are thus referred to as S-type granites. In fact, as the papers in this volume show, such a genetic relationship is rarely so straightforward.

The studies presented here arise from an MAC-sponsored symposium held in Halifax in May 1980 as part of the annual GAC–MAC annual meeting. The contributors have employed a full range of mineralogical, petrological, experimental, geochemical and isotopic tools to address specific cases of peraluminous granites from areas as widely separated in space and time as the Precambrian Canadian Shield, the Appalachian–Caledonian orogenic belt, the Hercynian of Brittany, the Tasman Fold Belt of Australia, the western Cordillera of the United States and the nonorogenic complexes of Nigeria. Each presents its own unique perspective on the formation, chemical evolution and origin of peraluminous granites.

The papers appear in the volume in a progression from mineralogical and field-based studies through phase-equilibrium studies to geochemical and isotopic work. Clarke, Allan & Clarke, Miller, Stoddard, Bradfish & Dollase, Speer, Phillips, Wall & Clemens, Martin & Bowden, and Anderson & Rowley pursue some of the mineralogical aspects of peraluminous granites, and demonstrate the use of these mineralogical features to gain some insight into the origin of such granites. In general, these authors do not accept that characteristic minerals such as muscovite, cordierite and garnet represent restite phases. Then Abbott and Clemens & Wall bring theoretical and experimental phase relations to bear on the questions of (1) possible evolutionary paths from metaluminous to peraluminous bulk compositions, and (2) the highly probable primary crystallization of many of the characteristic minerals from magmas, respectively. Then Muecke & Clarke, Pajari & Currie and Goad & Černý examine paths of chemical evolution within peraluminous granite complexes for clues to their origin and to their relationship with the host rocks. Furthermore, Strong & Hanmer, faithfully following field facts from France, fabricate a formidable framework of frictional forces and fluid fluxing to form fractional fusion in fissures and faults. Finally, Longstaffe, Černý & Muehlenbachs and Halliday, Stephens & Harmon demonstrate the importance of isotopic work in unraveling the complex evolutionary history of peraluminous granites.

Four principal mechanisms for the formation of peraluminous granites have previously been advocated; all of them, with varying degrees of

emphasis, are considered and developed in this volume as follows: (i) the composition of the peraluminous granite is directly linked to peraluminous source rocks (Phillips *et al.*, Pajari & Currie, Strong & Hanmer, Halliday *et al.*, Anderson & Rowley and Speer); (ii) the composition of the peraluminous granite may, at least in part, be the result of reaction with host rocks (Goad & Černý, Longstaffe *et al.*); (iii) the composition of the peraluminous granite has been derived from metaluminous magmas by fractional crystallization (Abbott); (iv) the composition of the peraluminous granite is, at least in part if not wholly, the result of interaction between late-stage magmas or subsolidus rocks and hydrothermal fluids (Muecke & Clarke, Martin & Bowden, Goad & Černý, Pajari & Currie).

As illustrated by many papers in this volume, one or more of these petrogenetic mechanisms may operate during the generation and emplacement of a single batholithic complex, so that the possible petrogenetic paths become legion. It is clear that only careful consideration of a large body of mineralogical, experimental and chemical data will be sufficient to yield a satisfactory interpretation for any given occurrence of peraluminous granite.

As an update on one of the major siliceous magma types, this volume should be of value to teachers as well as to researchers in related fields. In addition, this collection of papers should serve to stimulate further ideas among those already actively working on peraluminous granites. It is to all of these individuals, and to the solution of the many problems of peraluminous granites, that this volume is dedicated.

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D.B. Clarke, *editor.*