The Canadian Mineralogist
DOI: 10.3749/canmin.46.4.737

THE MINERALOGY AND PETROLOGY OF CARBONATITES:
A TRIBUTE TO JOHN GITTINS

PREFACE

This volume is published as a recognition of the long and distinguished research career of John Gittins, Professor Emeritus of Geology, University of Toronto, Canada. John is one of those unusual persons who has an extraordinary breadth of general geological knowledge, a comprehensive knowledge of alkaline rock petrology, and is able to integrate both field and experimental studies in the formulation of petrogenetic hypotheses. Although his name has become synonymous with carbonatite petrology, his research program has covered all aspects of alkaline rock genesis. Significantly, the eponymous mineral gittinsite (CaZrSi2O7) was discovered in an agpaitic syenite and not a carbonatite! John’s international reputation in the field of alkaline rock and carbonatite studies rests upon his keen observational skills, careful assessment of data gathered in the field and laboratory, coupled with his attention to detail in his experimental work. He is a critical thinker and does not tolerate ill-conceived or poorly constructed hypotheses, and is not hesitant in informing the perpetrators of their shortcomings. Consequently, the literature on the genesis of carbonatites is replete with papers containing John’s vigorous critiques of the work of those with whom he disagrees; fortunately, his scientific disputes do not devolve into personal animosities. Although John has ceased to undertake experimental work, he continues to play an important and active role in reviewing papers on carbonatites and related rocks.

John left Lancashire in the United Kingdom for Canada in 1948 and eventually began his scientific career at McMaster University (Hamilton, Ontario), where he obtained a B.Sc. in 1955 and an M.Sc. in 1956. This was followed by doctoral studies at Cambridge University (UK) under the supervision of one of the pre-eminent petrologists of the era, Cecil E. Tilley, with cosupervision by the famous geochemist S.R. Nockolds. His doctoral work was on Canadian rocks and culminated with a thesis entitled “Petrology of the Nepheline-Bearing Rocks of Glamorgan and Monmouth Townships, Ontario, Canada”. In recognition of this work, John was awarded the Peacock Prize of the Walker Mineralogical Club in 1959 and, in addition, the then substantial sum of $200. Two very significant papers (Gittins 1961, Tilley & Gittins 1961), which have stood the test of time, resulted from his thesis.

Subsequent to his Ph.D., in 1959, John undertook postdoctoral work at the Pennsylvania State University in cooperation with O. Frank Tuttle, who was then one of world’s leading experimental petrologists and inventor of the Tuttle cold seal externally heated pressure vessel. It was this device that led John into the world of experimental petrology and his long-time association with carbonatite petrology. In the late 1950s, carbonatites were not believed to be igneous rocks, and it was experiments at Penn State by Wyllie & Tuttle (1960) that ushered in the revolution in thinking about these rocks, as they demonstrated that low-temperature carbonatitic magmas could exist. John’s work continued these major advancements with an important study of the ternary system CaF2–Ca(OH)2–CaCO3 (Gittins & Tuttle 1964). Simultaneously, John coedited with Tuttle the seminal volume Carbonatites (Gittins & Tuttle 1966), which provided the definitive compendium of carbonatite research up to 1966.
John Gittins at work in the laboratory, at the University of Toronto, and in the field, sampling carbonatite in 1981 at Howard Creek, British Columbia (photo courtesy of Anthony N. Mariano).
Following his Penn State work, John was appointed as Assistant Professor at the University of Toronto, where he established an experimental petrology laboratory, and remained until his retirement from teaching in 1997. During those years he, his students and collaborators continued to build their international reputation in the experimental and field investigation of carbonatites. Particular highlights are the experimental work on the ternary system $\text{Na}_2\text{CO}_3–\text{K}_2\text{CO}_3–\text{CaCO}_3$ (Cooper et al. 1975), calcite–dolomite geothermometry (Gittins 1979), the role of fluorine in reducing the liquidus temperatures of carbonatitic melts (Jago & Gittins 1991, Jago et al. 1993), and dolomitic carbonatites (Gittins & Harmer 1997, Harmer & Gittins 1998). The calcium–alkali carbonate system is especially relevant to the origin and evolution of the natrocarbonatites erupted at Oldoinyo Lengai, the world’s only active carbonatite volcano [see the photo chosen for the front cover, courtesy of Frederick A. Belton. The black natrocarbonatitic lava from hornito T58C flowed on a brown substrate of weathered natrocarbonatite (July, 2005)]. As a result of these and other studies, John has become a leading advocate for the existence of high-temperature calcite- and dolomite-producing parental magmas, and their relationships, or not, to geographically associated silicate rocks (Gittins & Harmer 2003). The latter paper in particular has raised a storm in the carbonatite world in claiming that nepheline-bearing rocks, such as ijolite, are genetically unrelated to spatially associated carbonatites. Naturally, John defends his views with some stubbornness.

In parallel with his carbonatite work, John has made major contributions to several other areas of alkaline-rock petrology. Notable amongst these are studies of the metamorphosed peralkaline complexes at Kipawa (Quebec) and Red Wine (Labrador). Mineralogical studies of the latter locality resulted in the recognition of some very unusual aluminous pyroxenes termed titaniferous ferro-omphacite (Curtis & Gittins 1979). It is fair to state that coupled with his work on nepheline gneisses (Aarden & Gittins 1974, Gittins et al. 1976, Currie & Gittins 1993), John is the world expert on regionally metamorphosed alkaline rocks. Significant work on other varieties of alkaline rocks included the potassic rocks of the Batbjerg complex in East Greenland (Brooks et al. 1981) and perhaps the final word on the pseudoleucite “problem” (Gittins et al. 1980).

The impetus for this volume was the special session “Alkaline igneous systems: dissecting magmatic to hydrothermal mineralizing processes” held in Montreal during the May 2006 GAC–MAC annual meeting. The three days of technical program, complete with 40 oral presentations and 12 posters, were followed by a field excursion through the world-famous Monteregian alkaline province. Some of the papers presented in Montreal are included in this volume, together with others that reflect the breadth of John’s wider interests in alkaline rocks. Many of the contributors have known John for many years and have valued his advice and criticisms of their work; usually these lead to a much better understanding of the problems being addressed!

The contributions selected for this issue span a wide range of topics covering virtually every aspect of carbonatite petrogenesis, some clearly more controversial than others. It would be impossible to condense all carbonatite wisdom into 350 pages of text, but we feel that the present collection of papers is both an adequate reflection of our current understanding of these unusual rocks and a step forward toward the resolution of some of the outstanding controversies in the world of carbonatites. The issue opens with a summary and statistical analysis of carbonatite occurrences worldwide assembled by Alan Woolley and Bruce Kjarsgaard. Their paper also explores the petrogenetic relations between carbonatites and associated silicate rocks. The following three papers cover in detail the petrology and geochemistry of selected carbonatite localities, ranging from the well-known and well-researched (South Westland, New Zealand: Alan Cooper & Lorraine Paterson) to well-known but little publicized (Mountain Pass, California: Stephen Castor), and to those that are relatively new to the Western reader (Arshan, Transbaikalia: Anna Doroshkevich and colleagues). This theme is continued with several well-known localities, where new work by our contributors shed new light on the dark corners of carbonatite petrology, putting conventional wisdom to test. These include re-appraisals of the Goudini carbonatite by Wilhelm Verwoerd and of the Laetoli “footprint tuff” by Dan Barker & Kitty Millichen, and a re-interpretation of subsolidus processes in Oldoinyo Lengai natrocarbonatitic lavas by Anatoly Zaitsev and colleagues. The evolution of carbonatitic magmas and fluids, as reflected in the evolution of individual minerals and mineral groups, is the leitmotiv for the following three papers, focused on rare-earth phosphates (Frances Wall and colleagues), spinel-group minerals (Katya Reguir and colleagues) and rare-earth carbonates (Excelso Ruberti and colleagues). Detailed petrological analysis is taken beyond the geological boundaries of carbonatites and applied to their associated silicate rocks by Mike Le Bas (felines), Tom Andersen (Quaissiarusk volcanic suite) and Irene Rass (melilitic rocks). The importance of experimental work for tracing the roots and evolutionary paths of carbonatites is elegantly demonstrated in the contributions by Roger Mitchell & Bruce Kjarsgaard (and vice versa) on alkali carbonate–chloride and calcite – portlandite – NaTaO$_3$ systems and by Anastasia Shushkanova & Yuriy Litvin on liquid immiscibility in the aragonite – pyrope – pyrrhotite system. No carbonatite issue would be complete without some discussion of exotic accessory minerals so common in these rocks. In the present instance, the spotlight is on the Ca–Y carbonate kamphaugite (Wilhelm Verwoerd), the new Na–Ca–Nb silicate marianoite and F-rich hydrogarnets (Anton Chakhmouradian and colleagues). The final three contributions introduce (or, perhaps, re-introduce) the reader
to the problem of kimberlite–carbonatite affinity that has been passionately debated since the publication of *Carbonatites* by Tuttle & Gittins (1966). Troels Nielsen & Karina Sand explore the issue from the standpoint of kimberlitic (silicocarbonatitic?) magmatism in West Greenland, whereas Mark Hutchison & Larry Heaman bring Greenland occurrences of diamond into the discussion, and Viktor Sharygin with his colleagues scrutinize the unusual chloride–carbonate nodules from the Udachnaya-East pipe in Siberia.

It is our hope that this collection of papers will offer something to enjoy or ponder over to both established “carbonatitologists” and those just entering this exciting field. In conclusion, we acknowledge the dedicated efforts of the many referees and Editor Robert F. Martin who generously contributed their time and expertise to bring this project to fruition.

**References**


Roger H. Mitchell
Lakehead University, Thunder Bay

Anton R. Chakhmouradian
University of Manitoba, Winnipeg

David R. Lentz
University of New Brunswick, Fredericton,