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MICROBEAM TECHNIQUES IN THE EARTH SCIENCES

PREFACE

For many years, the term *microprobe analysis* has been synonymous with electron-microprobe analysis (EMPA) within the Earth Sciences. The development of the electron microprobe in the late 1950s revolutionized Mineralogy and Petrology as the analysis of minerals and glasses became rapid and fairly straightforward. Our knowledge of mineral chemistry improved greatly as the determination of chemical composition was no longer adversely affected by exsolution and the presence of inclusions. In addition, microfeatures such as zoning, exsolution lamellae and inclusions became chemically accessible, thereby greatly increasing the amount of information that we could record from a single grain of a mineral. As the formation of a rock is not an instantaneous process, spatial resolution often translates into temporal resolution; the great spatial resolution of EMPA has allowed us to view Petrogenesis in a much more process-oriented fashion. However, powerful as it is, EMPA can only document the concentration of elements (and not all of them) present in major and minor quantities; some of the light lithophile elements (H and Li, in particular), trace elements and isotopic ratios are beyond the capabilities of the technique. Yet these elements and isotopes also are important components of minerals and glasses, and their ordering and distribution carry a lot of information on the petrological and geochemical processes that have affected any rock or larger system of interest. In the past, much of Geochemistry was concerned with the behavior of elements and isotopes in Earth processes, first by characterizing the distribution of these components in different rock-types, and then by examining their temporal variation within specific geochemical environments. However, the lesson learned from Petrology was clear: in order to see the progress of Earth processes in general, one needs to look at the minerals involved, and on as fine a scale as possible. Thus many people are now doing Mineralogy, people who do not consider themselves mineralogists: geochemists, geochronologists, petrologists, sedimentologists; everyone has realized that if one grinds up a rock for analysis of any sort, one loses an enormous amount of information (Fig. 1). It is far better to analyze the individual minerals for the elements required to evaluate a process: *LLE* (light lithophile elements), *REE* (rare-earth elements), *HFSE* (high field-strength elements), oxygen isotopes, carbon isotopes, U/Pb, $^{40}Ar/^{39}Ar$, *etc.* So we need microbeam methods for this type of work, and the last ten years have seen their development. Some are becoming mature, others are still in the throes of development.

Most papers in this thematic issue of *The Canadian Mineralogist* were presented at a Special Session of the GAC–MAC Annual Meeting in Waterloo, Ontario. The intention of the Special Session was to familiarize us, the Earth Sciences community, with the range of microbeam techniques currently available, and to show us the kind of work that can be done with them. Our analytical capabilities for the characterization of minerals are much greater than seemed possible ten years ago. However, the process of development does not stop here. We now need these facilities dispersed throughout the Earth Sciences community so that they become as much a part of our general experimental approach as the electron microprobe has been for the last twenty-five years; this is the challenge of the next ten years.

Frank C. Hawthorne

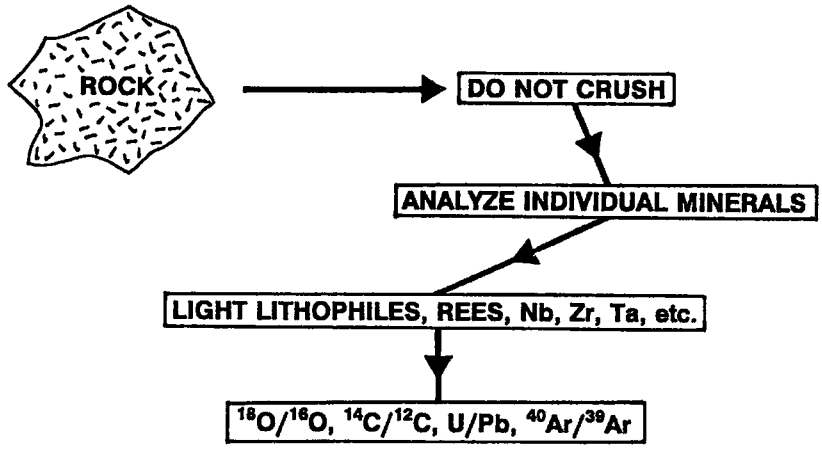

FIG. 1. How to treat a rock.

The timely production of a thematic issue like this one depends on the cooperation of key individuals and organizations. Firstly, on behalf of the Mineralogical Association of Canada, I thank the convener of the Special Session of the GAC–MAC meeting, Frank C. Hawthorne, for his foresight and editorial involvement. All contributions were subjected to the customary and well-known rigor of our refereeing process. I thank all who shared freely of their expertise in order to improve the caliber of these contributions. Finally, I acknowledge receipt of a grant in aid of publication of this thematic issue from the Geological Survey of Canada.

Robert F. Martin