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ORIGIN AND SIGNIFICANCE OF ZONING IN MINERALS

PREFACE

The phenomenon of chemical zoning in minerals has attracted attention from the early days of optical mineralogy. It has been found in minerals grown in most, if not all, geological environments and has inspired many different hypotheses for its origin. However, our science has become sufficiently diverse that publications in, for example, a sedimentology journal may not reach the eyes of a specialist in another branch of petrology or in mineralogy.

In an attempt to bring together specialists from diverse areas of the Earth Sciences, a special session was held during the joint annual meeting of the Geological Association of Canada and the Mineralogical Association of Canada in Victoria, British Columbia in May 1995. In all, 19 oral and poster presentations were made; they focussed on environments from sediments to the mantle, and on approaches from the experimental to the theoretical. Of these presentations, a number had been committed for publication elsewhere, but the present set of papers is representative of the high quality and diversity of the work being carried out in this field.

Our collection starts off with a review of the prevalence of oscillatory zoning in common rock-forming and accessory minerals. M. Shore and A.D. Fowler have found examples in 75 different minerals that span the range of possible environments of formation. An enhanced appreciation of the importance of oscillatory zoning is due in large part to the availability of improved techniques of analysis and imaging. In some minerals, oscillatory zoning involves the distribution of major elements, whereas in others, trace elements are involved. N.M. Halden introduces the geological community to the benefits of Lyapounov exponents, in order to assess the degree of chaos in the zonal distribution of trace elements in growing crystals.

As students, we first came into contact with the notion of oscillatory zoning in our observations of plagioclase in thin sections of volcanic rocks. In spite of careful empirical descriptions by several generations of inspired observers, it is only recently that models incorporating diffusion theory and realistic partition-coefficients have been proposed for plagioclase. Here, I. L'Heureux and A.D. Fowler present the latest refinement of such a model.

Patterns of zoning in minerals of igneous rocks may reflect purely extrinsic controls, as for example the common case of assimilation of crustal material by a mantle-derived magma. B.R. Edwards and J.K. Russell have used the program MELTS to simulate the process and anticipated results. In addition, and especially in alkaline igneous rocks, not all incidences of zoning are due to crystal–melt equilibria. I.M. Coulson and A.D. Chambers

present a case study of fluid-dominated episodes of growth of accessory phases in relatively shallow syenitic rocks from the Gardar Province of southern Greenland.

One might conclude that zoning is restricted to minerals that grew in a near-surface environment. W.L. Griffin and collaborators remind us that a zonal distribution of trace elements also is encountered in minerals of mantle-derived xenoliths; there, zoning can best be interpreted in terms of metasomatic and thermal events affecting localized areas in the upper mantle. In a crustal environment, H.H. Stowell *et al.* focus on metasomatic influx of elements in a contact-metamorphic aureole to explain patterns of zoning in garnet. It seems likely that the fluid phase responsible also may have transported Au in other parts of the aureole.

A.D. Fowler and I. L'Heureux evaluate the origin of compositional banding in sphalerite associated with dendritic galena from the Pine Point MVT deposit in the Northwest Territories. Both minerals formed in a fluid-dominated low-temperature environment at far-from-equilibrium conditions. The last paper in the collection focuses on quartz, a mineral not generally known to show compositional zoning. Yet F. Bruhn and coworkers have applied sensitive techniques of analysis and imaging to study zoned grains of quartz in sandstone. Such studies shed new light in evaluations of 1) the provenance of the quartz detritus and 2) the diagenetic history of the sandstone.

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