THE ORIGIN OF BASALTIC AND NEPHELINITIC MAGMAS

by

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* *The Bennett Lectures*

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Preface by M. J. LeBas

In the past it has been the task of the 'hard-rock' geologist to observe and describe rocks as they occurred. In recent decades, the art of description (petrography) has been supplemented by the science of experimentation. The experiments have been directed at trying to imitate, on a laboratory scale, the processes which are believed to have occurred in nature.

The particular field of petrogenesis studied by Dr. Green is that of the basaltic magmas. The work has been done in the Department of Geophysics and Geochemistry within the Research School of Physical Sciences of the Australian National University at Canberra, Australia, where he is a Senior Fellow.

The origin of basaltic magmas which are so abundantly extruded from volcanoes over the whole world, undoubtedly gives us the key to the origin of all igneous rocks. It also tells us a great deal about the chemical and physical processes that have taken place over geological time in the Earth's crust and mantle. In the near future, we should be in a position to theorize on how the material beneath the crust of the earth, say that below Europe, has changed with geological time; perhaps quite a different state of affairs exists beneath the Atlantic.

In the 1960s the experimental investigations on basaltic rocks have become fairly sophisticated and so rather restricted to a specialist band of geologists, physicists and chemists. This being the case, it is necessary every now and again to explain to one's fellow geologists what is happening. Dr. Green's *Bennett Lecture* does just this.

Together with Professor Ringwood at Canberra, Dr. Green subjected rocks to high temperatures (1,000 - 1,500° C) and pressures (approx. 10,000 - 30,000 atmospheres, or 10 - 30 kilobars), and then 'watched' to see how the mineral components reacted during progressive crystallization under various physical conditions. From this study has emerged a hypothesis which is able to account for the known variations in time of the basaltic lavas of the world. This hypothesis, though it may be the leading one at present, is not without its rivals, and an interesting and instructive controversy is arising.

The lecture demonstrates that it is permissible to re-enact geological history in a crucible. Firstly, it reviews mineralogical evidence for the nature of the upper mantle which is considered to be the source of basaltic magmas, and defines the various magma types. Secondly, it describes what happens when model ultrabasic rock begins to melt, and traces various alternative consequences. Thirdly, it reconciles these observations on synthetic rocks with observations made on actual rocks such as the extrusive and intrusive basaltic magmas of Hawaii, Antarctica, and Iceland.

Dr. Green concludes by showing that, according to their experiments, it is possible for basaltic magmas to develop by partial (1% or more)

* Delivered in the Department of Geology in the University of Leicester on 10th November 1969.