

period of eruption (Gill, 1970). However, in rising from great depths and passing through maximum thickness of mantle [compared with stages (1) and (2)], there is greater scope for modification in the incompatible element composition (especially K) through processes involving wall-rock reaction, breakdown of phlogopite and the possible presence of an aqueous vapour phase (D. H. Green and Ringwood, 1967; Jakes and White, 1969; Lambert and Wyllie, 1970). This stage of melting may produce the high K-calc-alkaline series (e.g. Jakes and White, 1969; Jakes and Smith, 1970).

*Acknowledgements.* This project has been supported in part by funds from the Australian Research Grants Committee (C70/17358) and by Macquarie University research funds. Much of the work has been conducted in the Department of Geophysics and Geochemistry, Australian National University, with facilities kindly made available by Professor A. E. Ringwood and Dr. D. H. Green. Messrs. N. Ware and E. Kiss provided analytical assistance. Professor A. E. Ringwood, Dr. D. H. Green and Mr. R. H. Flood critically read the manuscript.

## References

- Brown, G. C., Fyfe, W. S.: The production of granitic melts during ultrametamorphism. *Contr. Mineral. and Petrol.* 28, 310-318 (1970).
- Burnham, C. W.: Hydrothermal fluids at the magmatic stage. In: H. L. Barnes, ed., *Geochemistry of hydrothermal ore deposits*, p. 34-76. New York: Holt, Rinehart and Winston, Inc. 1967.
- Essene, E. J., Hensen, B. J., Green, D. H.: Experimental study of amphibolite and eclogite stability. *Phys. Earth Planet. Interiors* 3, 378-384 (1970).
- Fitton, J. G.: The generation of magmas in island arcs. *Earth and Planetary Sci. Letters* 11, 63-67 (1971).
- Gill, J. B.: Geochemistry of Viti Levu, Fiji and its evolution as an island arc. *Contr. Mineral. and Petrol.* 26, 179-203 (1970).
- Green, D. H., Ringwood, A. E.: The genesis of basalt magmas. *Contr. Mineral. and Petrol.* 15, 103-190 (1967).
- Green, T. H., Ringwood, A. E., Major, A.: Friction effects and pressure calibration in a piston-cylinder apparatus at high pressure and temperature. *J. Geophys. Res.* 71, 3589-3594 (1966)
- Ringwood, A. E.: Crystallization of basalt and andesite under high pressure hydrous conditions. *Earth and Planetary Sci. Letters* 3, 481-489 (1967).
- Genesis of the calc-alkaline igneous rock suite. *Contr. Mineral. and Petrol.* 18, 105-162 (1968).
- High pressure experimental studies on the origin of andesite. In: A. R. McBirney, ed., *Proceedings of the andesite conference*. Bull. Oregon Dept. Geol. and Mineral Industries 65, 21-32 (1969).
- Jakes, P., Gill, J.: Rare earth elements and the island arc tholeiitic series. *Earth and Planetary Sci. Letters* 9, 17-28 (1970).
- Smith, I. E.: High potassium calc-alkaline rocks from Cape Nelson, Eastern Papua. *Contr. Mineral. and Petrol.* 28, 259-271 (1970).
- White, A. J. R.: Structure of the Melanesian arcs and correlation with distribution of magma types. *Tectonophysics* 8, 223-236 (1969).
- Lambert, I. B., Wyllie, P. J.: Melting in the deep crust and upper mantle and the nature of the low velocity zone. *Phys. Earth Planet. Interiors* 3, 316-322 (1970).
- Leake, B. E.: A catalog of analyzed calciferous and subcalciferous amphiboles together with their nomenclature and associated minerals. *Geol. Soc. Am. Spec. Pap.* 98, 1-210 (1968).
- Lovering, J. F., Ware, N. G.: Electron probe microanalyses of minerals and glasses in Apollo 11 lunar samples. *Proc. Apollo Lunar Sci. Conf.* 1, 633-654 (1970).

- Oxburgh, E.A., Turcotte, D.L.: Thermal structure of island arcs. *Bull. Geol. Soc. Am.* **81**, 1665-1688 (1970).
- Raleigh, C.B., Lee, W.H.K.: Sea-flood spreading and island-arc tectonics. In: A.R. McBirney, ed., *Proceedings of the andesite conference. Bull. Oregon Dept. Geol. and Mineral Industries* **65**, 99-110 (1969).
- Ringwood, A.E.: Composition and evolution of the upper mantle. *Geophys. Mon.* **13**, 1-17 (1969).
- Sweatman, T.R., Long, J.V.P.: Quantitative electron-probe microanalysis of rock forming minerals. *J. Petrol.* **10**, 332-379 (1969).
- Taylor, S.R.: Trace element chemistry of andesite and associated calc-alkaline rocks. In: A.R. McBirney, ed., *Proceedings of the andesite conference. Bull. Oregon Dept. Geol. and Mineral Industries* **65**, 43-64 (1969).
- Capp, A.C., Graham, A.L., Blake, D.H.: Trace element abundances in andesites. I. Saipan, Bougainville and Fiji. *Contr. Mineral and Petrol.* **23**, 1-26 (1969).
- Kaye, M., White, A.J.R., Duncan, A.R., Ewart, A.: Genetic significance of Co, Cr, Ni, Si and V content of andesites. *Geochim. et Cosmochim. Acta* **33**, 275-286 (1969).

Dr. T. H. Green  
School of Earth Sciences  
Macquarie University  
North Ryde, N.S.W. 2113  
Australia