

tion rather than wholesale assimilation by average crustal material. The process of wall-rock reaction detailed previously goes some way towards indicating a mechanism for such selective contamination but requires that the average lower crustal material will only be melted to a very limited extent by the tholeiitic magmas and that the bulk of the wall-rock material would remain as refractory residue. A lower crust of anhydrous granulitic or anorthositic composition (RINGWOOD and GREEN, 1966a, b; T. H. GREEN, 1966) would possibly be suitable wall-rock material for the process and effects outlined above. The alternative explanation for the particular chemical compositions of the Tasmanian and Antarctic quartz tholeiites requires a mantle source region of high K, U, Th etc. content and high $\text{Sr}^{87}/\text{Sr}^{86}$ ratio (HEIER et al., 1965; COMPSTON et al., 1966).

If the conclusions on the behaviour of Sr at low and high pressure are correct then rocks enriched in incompatible elements at low pressure should be characterized by rapid increases in such ratios as K/Sr and Rb/Sr whereas basalts enriched in incompatible elements at high pressures should show relatively small changes in K/Sr and Rb/Sr through quite large variations in overall incompatible element abundances. Without making an exhaustive literature search we have assembled data in Table 21 which supports this hypothesis. In the oceanic tholeiite to basanite series with K contents increasing by a factor of 20 and Rb contents increasing by a factor of 40, the K/Sr ratio only varies between 10 and 21 and the Rb/Sr between 0.01 and 0.07. In contrast the K-enriched quartz tholeiites, with K contents only 10 times the K content of oceanic tholeiites, have K/Sr ratios increasing with increasing K content to a maximum near 90. The Rb/Sr ratio increases to 25—40 times the Rb/Sr ratio of the oceanic tholeiites. In contrast, tholeiites and quartz tholeiites of Hawaii do not show large enrichments in K_2O contents nor large changes in K/Sr or Rb/Sr ratios.

f) Summary

The slow ascent of magmas at considerable depth within the mantle, if accompanied by cooling and partial crystallization, would also cause selective enrichment in the incompatible element content (wall-rock reaction). Repetition of such processes would produce a mantle which is quite inhomogeneous in incompatible element content and, over geological time, would become inhomogeneous in Sr and Pb isotopic ratios. Less commonly, and possibly only in continental areas, slow ascent of magmas in the lower crust or uppermost mantle would be accompanied by partial crystallization and by selective enrichment in incompatible elements extracted from the wall-rock under conditions of lower pressures. The abundances of K, Rb, Ba and probably U, Th relative to major or trace compatible elements may be used to determine whether a given magma has been altered in chemistry by wall-rock reaction. The difference in partition behaviour of Sr at low and high pressures (consequent on the stability or instability of plagioclase) leads to the promising possibility of using such ratios as K/Sr or Rb/Sr to distinguish between the effects of deep-level wallrock reaction or a shallow-level process. In attempting the interpretation of isotope and trace-element abundance data there seems little relevance in the simple model of melting in which a liquid composition is determined at source (particularly in trace element and isotopic ratio contents) and thereafter remains essentially a

K/Sr and Rb/Sr for various average and individual basalts. Enrichment in incompatible elements in the presence of high pressure, enrichment in the remainder is considered to have occurred at high pressure

Rb (ppm)	Rb/Sr	Sr (ppm)	Rock and locality	
55	0.4	137	Average Pigeonite tholeiite, Antarctica	C
31	0.25	125	Average Hypersthene tholeiite, Antarctica	C
33	0.25	130	Average Hypersthene tholeiite, Tasmania	C
12	0.12	100	Olivine tholeiite, Antarctica	C
55	0.18	310	Columbia R. Plateau, Oregon	F
40	0.02	1,980	Basanite, Tasmania (Tertiary)	C
14	0.02	770	Alkali olivine basalt (Tertiary)	C
30	0.05	600	Average Alkali basalt	T
21	0.015	1,436	Hawaiiite, Hawaii	F
16	0.04	413	Alkali olivine basalt, Hawaii	F
10	0.02	515	Ankaramite, Hawaii	F
47	0.04	1,249	Alkali olivine basalt Hawaii	F
42	0.07	568	Alkali olivine basalt Samoa	F
32	0.04	643	Alkali olivine basalt Ascension	F
20	0.07	270	Tholeiitic basalt Tasmania (Tertiary)	C
10	0.04	250	Average Hawaiian tholeiite	C
10	0.04	230	Average non-submarine tholeiite	T
8	0.02	391	Quartz dolerite, Oahu	F
11	0.03	335	Quartz dolerite (vein), Oahu	F
5	0.02	297	Tholeiite, Mauna Loa, Hawaii	F
1.2	0.01	115	Average oceanic tholeiite	T