

many of the rock series (e.g. Taupo, New Zealand (Grange 1937; Steiner 1958; Ewart 1965) and the Southern Californian batholiths (Larsen 1948)) are broadly similar to the calculated acid liquid fractionates from the quartz diorite at 0–9 kb (see Table IX), particularly in K_2O/Na_2O ratios.

Rare corroded plagioclase phenocrysts with albite-rich cores occur in some andesites where most of the plagioclase phenocrysts contain cores more calcic than rims (Williams 1932). These corroded albite-rich cores may represent early crystallization of the andesite at depth, where a more albite-rich plagioclase composition would be the equilibrium liquidus phase, in contrast to the more calcic composition obtained at shallower levels from the same parent.

Similarly, pyroxene phenocrysts with high-alumina contents may also indicate early crystallization at a deep level.

Conclusions

The experimental results on the anhydrous high pressure fractional crystallization of high-alumina basalt and gabbroic anorthosite effectively preclude any simple means of deriving highly aluminous magmas at depth, and it is unlikely that magmas with compositions as rich in plagioclase as gabbroic anorthosite are obtainable by hydrous fractional crystallization of a parent basaltic composition. However, the experimental results on the fractional crystallization of quartz diorite (\approx andesite) at 0–13.5 kb point to two possible geological models for obtaining anorthositic rocks, either by fractional crystallization or partial melting of a parent quartz diorite composition at lower crustal depths. In both cases the anorthositic rocks form as a crystalline residuum deep within the crust, and are essentially 'frozen' in their position of formation, except possibly for minor movement as a semi-solid crystal mush. This explains the association of anorthosites with charnockitic and granulitic rocks typically found in Precambrian metamorphic terrains. Anorthosites may well occur in younger rocks where these have been buried deep within the crust, but processes of orogenesis and erosion have not exposed these younger high-grade metamorphic terrains extensively at the earth's surface.

The models also explain the sodic nature of the plagioclase typically found in the massive

anorthosite complexes, since the soda content of the plagioclase crystallizing from a parent quartz diorite composition increases with increasing pressure. Rock types related genetically to anorthosites and gabbroic anorthosites may range from granite to gabbro, depending on the degree and nature of the separation of the crystalline residuum from the parent intermediate composition magma. Spatial association of these varied, but genetically related, rocks need not necessarily be maintained.

Finally, it should be pointed out that there will be a range of compositions in the calc-alkaline series from which a large field of crystallization of sodic plagioclase will occur in the pressure range of 0–13.5 kb. Accordingly there will be some variation in plagioclase composition and the relative proportions of genetically related rock types, depending on the nature of the parent magma.

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