ANALYSIS OF COMPOSITION VARIATIONS IN HIGH TITANIUM BASALTS AND RELATED MATERIALS. M. J. O’Hara and D. J. Humphries, Grant Institute of Geology, Edinburgh University.

A projection to display composition relationships in high titanium basalts has been devised. Six basic coordinates are (all oxide symbols=number of moles):

\[ F = 71.846 \times (MgO + FeO + MnO + NiO + O_2 + Fe_2O_3); \]
\[ A = 101.961 \times (Al_2O_3 + Na_2O + K_2O); \]
\[ C = 56.06 \times (CaO + 2Na_2O - 3P_2O_5 - 3SiO_2 + 2K_2O); \]
\[ T = 79.90 \times (TiO_2 + Cr_2O_3 + Fe_2O_3); \]
\[ S = 60.085 \times (SiO_2 - 2Na_2O - 2K_2O); \]

The F-TIT-S-C and C-K-A-S subfigures of the hypervolume are shown in figs 1 and 2 to illustrate the mineral phases which are represented. The projection provides for the independent representation of the major TiO_2-bearing phases and for the independent treatment of orthoclase from plagioclase, although the C and K components may be combined, when plagioclase and orthoclase are superimposed in a single component (FELS). The subvolume FEM-TIT-SIL-DIOPS-FELS is of particular relevance to the high titanium basalts, where FEM=71.846 (F^* + A^* - C^* - K^*); SIL=60.085 (S^* - 2C^* - 2K^*); DIOPS=248.1 (C^* + K^* A^*); FELS=278.2 (A^*), where A^*, C^* refer to the molar sums used in the basic coordinates, and all coordinates represented in any projection must of course be rescaled to 100%.

Two representative subprojections within the hypervolume are illustrated in figs 3 and 4 (larger prints available on request).

The figures illustrate: (1) effective discrimination (other than in K_2O) between hand specimens from two Apollo 11 and perhaps two Apollo 17 flows, A, B (see preceding abstract); (2) the high TiO_2 content of Fe-Ti oxide saturated (low alkali) liquids; (3) close correspondence between phase equilibria in the simple system C-M-F-A-T-S (see ref 1) and those in natural rocks; (4) cotectic liquids from simple system \( \equiv \) plagioclase saturated cotectic liquids from natural rocks \( \equiv \) groundmasses quenched around phenocrysts of plag, etc in Apollo 11 soils \( \text{average target rock compositions from lithic fragments in soils (Apollo 11) or preferred Mare glass composition in soil (Apollo 17) } \equiv \) some hand specimens; (5) liquids saturated simultaneously with ol, pig, aug, plag, ilm, (arm) sp (metal?) change little in major element composition during crystallization, which is pseudo-eutectic. Incompatible elements may however be enriched many times; (6) most hand specimen compositions fall in region olivine+iron titanium oxides+pyroxenes (dense phenocrysts)+plagioclase saturated cotectic liquids. Their compositions agree better with phenocryst accumulation into such liquids (allowing some variability and according with petrography (ref 2) than with derivation by fractional crystallization of parental liquid P? (If P?, where are the complementary cumulates, especially when at least top flow appears to have been penetrated in regolith formation?); (7) the melt inclusion in olivine from 10020 must have been entrapped early (<7% olivine in rock). It lies on the line between cotectic plagioclase-saturated liquid and olivine itself, and indicates the magma composition from which the olivine crystallized; (8) floor soils can be orange soil+highland soil+cotectic liquid or orange soil+highland soil+hand specimens in terms of projections. Only former answers low proportion of highland derived materials (ref 2) and is consistent with similar mare-wide effect (ref 3); (9) samples of 75035 distributed for analysis and experiment were severely inhomogeneous.
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Fig 1

PROJECTION FROM OL, ILM, ORTH INTO PLANE OF ANORTHITE AND PYROXENES.

Fig 2

Figure 3

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References
(1) O'Hara et al., 1974, Earth Planet Sci Letters 21, 253-268.
(3) Reid and Ridley, 1973, RSC, 54, 607-609.