MINERAL-CHEMICAL PROPERTIES OF APOLLO-17 MARE BASALTS AND TERRA FRAGMENTS. G.M.Brown, A. Peckett, C.H.Emeleus and R. Phillips. Dept. of Geological Sciences, Durham University, England.

Nine polished thin-sections have been studied petrographically and the mineral assemblages characterised by electron microprobe analysis. The mare basalts are from the LM-ALSEP site (70017,109; 70035, 16; 70215,142), Station 1A (71055,66), Station 4 (74275,83) and Station 5 (75035,72). Terra samples from Station 6 (76535,50) and 7 (77017,69) of the North Massif, and Station 3 (73235,59) near Lara crater.

The three terra samples are characterised by very calcic plagioclase (An95) in contrast to the mare basalts (An87-79). One is a plutonic fragment (allivalite), one a troctolite-rich breccia enclosed by titaniferous basalt, and the third a complex breccia with rhyolite fragments and allivalite-type fragments. The six basalts are broadly comparable with the Apollo 11 basalts in their titaniferous character and in the remarkable uniformity of the Al:Ti ratio of 2:1 in all but the latest-stage pyroxenes. However, the group can be sub-divided into two different types (olivine basalts and ferrobasalts) with possibly a third transitional type, based chiefly on olivine, pyroxene and oxide amounts and compositions.

Terra allivalite (76535). Plagioclase (56%), olivine (38%) and two pyroxenes (5%) make up this ultrabasic, coarse grained (av.8mm) rock, with only traces of Ni-iron and chrome-spinel. The plagioclase is An95 and contains abundant planar "decorations" of a metal phase. The olivine is Fo87 and its Cr_2O_3 is very low (0.04-0.12%). The iron contains 22% Ni and 4% Co. Pyroxenes and chrome-spinel occur as a reaction symplectite along olivine-plagioclase boundaries, where bars of olivine (5-10 μ) alternate with bars of Opx + Cpx (5-10 μ) or chrome-spinel (1 μ). The Opx is magnesian bronzite (Wo2 En87 Fs11) and the Cpx is diopsidic augite (Wo46 En50 Fs4). Both have relatively low Al, Ti and Cr but show an equilibrium-type distribution between the two phases. The spinel is extremely rich in Cr and Al but variable from grain to grain (e.g. Al_2O_3 from 14.7 to 19.2 wt %). TiO_2 is remarkably low ($< 1\%$). The rock is typical of the ANT suite in being rich in Mg and poor in Cr. In its low Ti content it represents the opposite extreme from the Apollo 17-type mare basalts. Olivine banding and symplectite intergrowth suggest some deformation and recrystallisation.

Troctolitic breccia (77017). An oval fragment (1 x 1⅓cm section) of feldspathic breccia contains patches of troctolite, and the whole is rimmed by a skin of titaniferous basalt. The troctolite contains calcic plagioclase (An95) but the olivine is not very magnesian (Fo61). The breccia matrix contains the same olivine and plagioclase compositions, and fragments of pigeonite (Fs30). The material is not therefore comparable with the allivalite. The fragment must have been transported in a young mare basalt flow. The olivine basalt rind contains augite rich in Al and Ti, very similar to the local Type I (see below).

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Thin veins of yellow glass pervade the breccia and are also of titaniferous olivine basalt, suggesting rapid chilling of the lava against the xenolith.

Polygenetic microbreccia (73235). Contains fragments of calcic plagioclase (An94) and zoned magnesian olivine (Fo87-81) with low Cr_2O_3, indicating a source related to the allivalite. Also bronzite (no Cpx), patches of potassic rhyolite (SiO_2 74%, K_2O 10.2%, Na_2O 0.4%), and purple chromian pleonaste. Grains of chrome-alumina spinel show the unusual composition of those in the allivalite, supporting a related source.

Mare basalts I. Two basalts (70215 and 74275) resemble the rind to the breccia (77017) in being strongly titaniferous. They are olivine basalts, with distinct and often skeletal phenocrysts of a fairly magnesian olivine (zoned, Fo80-69). Modally they are richer in opaque oxides then the other basalts (31-37%) and poorer in plagioclase (6-19%), while they lack free silica and contain the most olivine (9-14%). The texture is very fine-grained, being dominated by acicular laths of ilmenite. Sample 70215 is strongly quenched and heterogeneous, with dark patches of variolitic, feldspar-poor areas. The plagioclase is An83-85. Armalcolite and intermediate chromian ulvöspinel are common to all the Apollo 17 basalts examined, and exsolved rutile in the low-magnesium ilmenites. The pyroxenes are unique to the Type I basalts. They are all purplish calcic augites (ca. Wo45 En38 Fs17) with high contents of TiO_2 (to 6.8%), Al_2O_3 (to 8.3%) and Cr_2O_3 (to 0.8%). Even so, they retain the Al:Ti ratio of 2:1 characteristic of Apollo 17 and Apollo 11 pyroxenes.

Mare basalts II. A tendency (shown by Type III) is characterised particularly by sample 75035, which is a "ferrobasalt" and an extreme case. It contains no olivine, the most cristobalite (6%) and the most plagioclase (33%) of the basalts. Also abundant tranquillityite, ilmenite with low Mg/Mg+Fe (0.5 to 5.3), and ulvöspinel with little Cr. The pyroxenes show the continuous-series feature shared with Apollo 11, from subcalcic augite (ca. Wo30 En45 Fs25) to pyroxferroite (Wo16 En3 Fs81). They contain only moderate Al,Ti and Cr, with Al:Ti from 2:1 to 1:1 in the pyroxferroites (suggestive of trivalent titanium).

Mare basalts III. This third type shows affinities with both I and II, and may be an intermediate stage either in a crystal fractionation or a partial melting sequence. Samples are 70017, 70035 and 71055. They contain much less olivine (1%), less opaques (23%), more plagioclase (25%), and some cristobalite (1.5%) compared with Type I, and differ from Type II in the same constituents conversely. The olivines are less magnesian (Fo71-58) than in Type I, whereas in Type II, olivine is absent. The irons are virtually Ni-free (Type I irons contain 1% Ni). Tranquillityite, baddeleyite, Zr-armalcolite, armalcolite, ilmenite, troilite and rutile are present, in common with Type II in particular. Sample 70035 shows most affinity with Type II, having ulvöspinel rims to chromian ulvöspinel cores, and pyroxferroite-type

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rims to the pyroxenes. The probable "link" feature of Type III is shown especially by the pyroxenes. The cores are of calcic augite (4.3% Al_2O_3, 3.5%TiO_2) and they zone in a complex manner to either subcalcic ferroaugite or to pigeonite. Pigeonites are unique to Type III. A preliminary look at 71055 (work in progress) indicates crystallization of extreme Type I pyroxene cores (6%Al_2O_3, 5%TiO_2) before plagioclase and ilmenite began to crystallize.

Basalt relations. There appears to be a sequence, Types I→III→II, related to decreasing melt temperatures. Early phases in the sequence are Al-Ti-rich augite, magnesian olivine and armalcolite. Pigeonite, ilmenite and plagioclase follow and are succeeded by ferropyroxene, ulvöspinel and cristobalite. The allivalites from the terrae are, in sharp contrast, greatly depleted in Ti and Cr, and greatly enriched in Mg (olivine and pyroxene), Ca (plagioclase) and Ni (iron).

NOTE: 9 SECTIONS RECEIVED FROM 34 ALLOCATED. THE CONFERENCE PAPER MAY THEREFORE DIFFER IN EMPHASIS FROM THIS ABSTRACT!