THE NATURE OF THE CHROMITE TO ULVOSPINEL TRANSITION IN MARE BASALT 15555. J. Dalton, L. Hollister, C. Kulick, and R. Hargraves, Department of Geological and Geophysical Sciences, Princeton University, Princeton, New Jersey 08540.

Sample 15555, 171, a relatively coarse-grained mare basalt, is distinctive amongst the mare basalts described to date in the variety of host-inclusion mineral combinations. The most abundant are chromite in olivine and pyroxene; ulvospinel in olivine and pyroxene; and olivine in pyroxene and plagioclase. Most of the inclusions appear to have been crystallizing from the melt at the time they were included in the host minerals. Some chromites, for which the data are ambiguous, may have crystallized before the host phase.

The evidence for co-crystallization of inclusion and host is most clear in those cases where both inclusion and adjacent host show zoning in the same direction. This relationship was found for olivine in pyroxene and for chromite-ulvospinel in olivine. The co-crystallization of the host mineral and unzoned, small inclusions is suggested by changes of melt-composition-sensitive parameters in the hosts versus those in the inclusions. The best of these compositional parameters in both the chromite and the ulvospinel is weight percent MgO, because it zones smoothly, without discontinuity, from chromite to ulvospinel. For early pyroxene, prior to plagioclase nucleation, Al/(Al+Ti+Cr) is the best compositional parameter; for late pyroxene and for olivine, Mg/(Mg+Fe) is the best.

Based on 10 data points for ulvospinel-pyroxene pairs, 11 for chromite-pyroxene pairs, 13 for olivine-pyroxene pairs, and 6 for olivine-spinel, and based on the previously demonstrated dependence of the relative proportion of Al, Ti, and Cr in pyroxene to the presence or absence of plagioclase on the liquidus (Weill, 1970; Hollister, 1971; Bence and Papike, 1972), the history of mineral crystallization in 15555 appears to be as illustrated in Fig. 1 (vertical lines connect representative adjacent host-inclusion compositions; we have neglected the late crystallization phases fayalite, hedenbergite, crystobalite, ilmenite, etc.).

It appears from the relations in Figure 1 that the transition from chromite to ulvospinel closely coincides with the onset of plagioclase crystallization and that it does not coincide with either the transition of pigeonite to augite or with the cessation of crystallization of olivine. This conclusion

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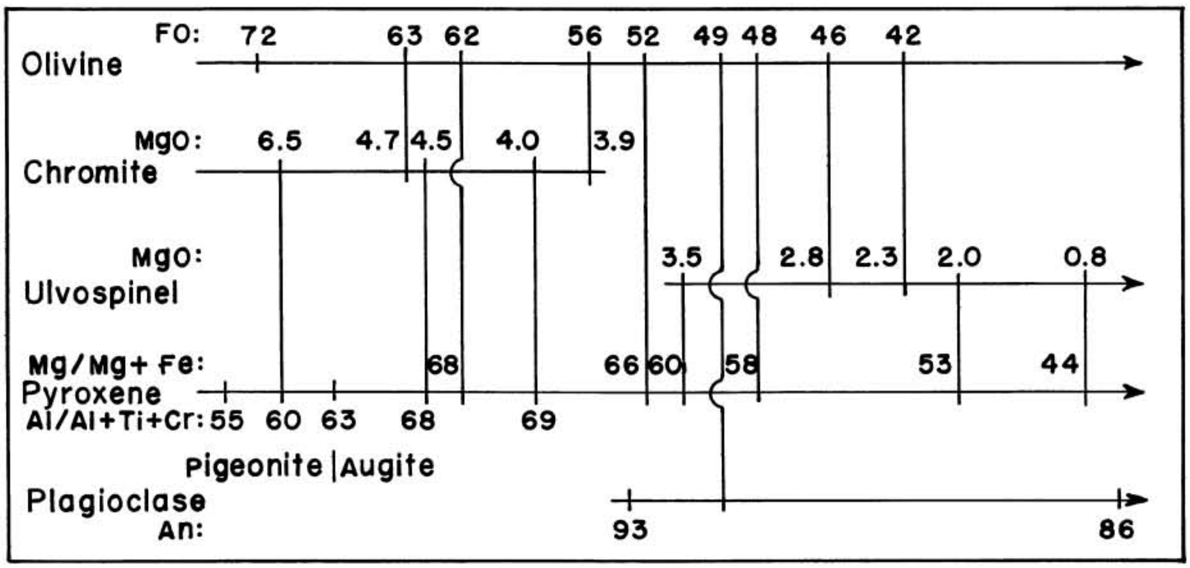
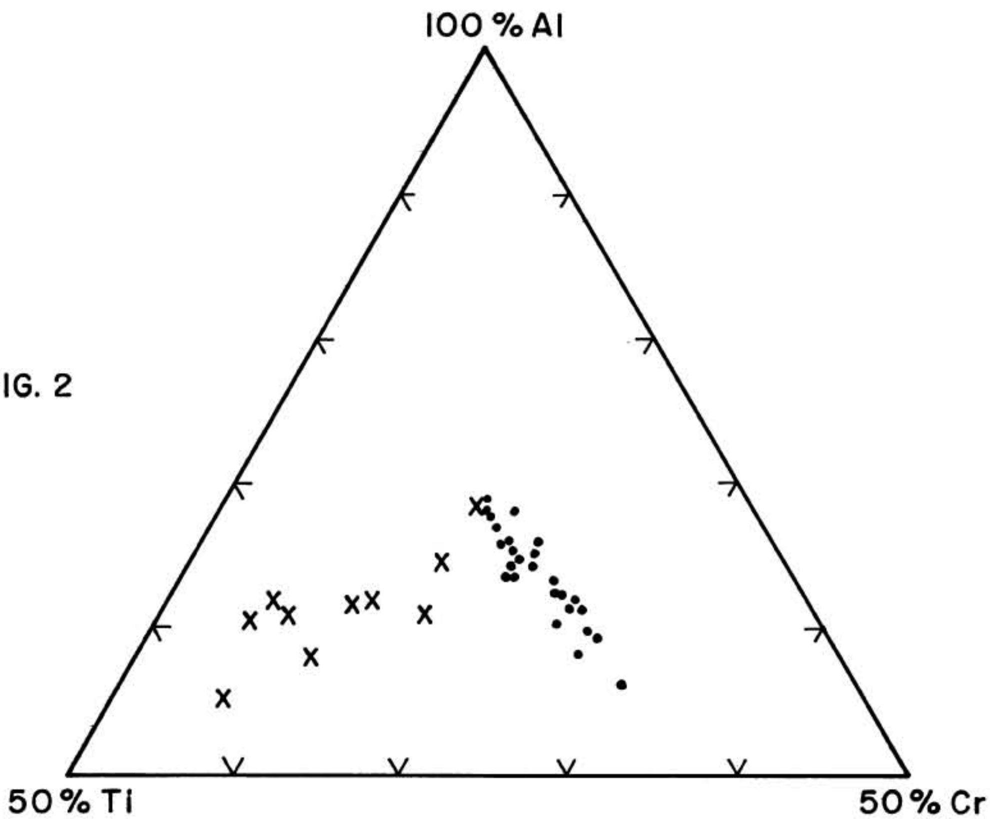


FIG. 1

FIG. 2



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is further illustrated in the Al-Ti-Cr plot (Hollister, *et al.*, 1971) of pyroxene analyses adjacent to chromite or ulvospinel inclusions (Fig. 2; an (X) indicates the opaque is ulvospinel, a (·), chromite). Clearly, the transition occurs very close to the peak in Al/(Al+Ti+Cr) in the pyroxene, which is inferred to reflect onset of plagioclase crystallization.

Compositions of spinels were found which spanned the "gap" between ulvospinel and chromite. This was also observed by Haggerty (1972) in 15555 and by Busch, *et al.* (1972) in several Apollo 12 samples. Thus, it appears that there may be no compositional gap (solvus) between chromite and ulvospinel under the conditions of crystallization of the lunar basalts. The rapid change in composition from the one phase to the other is probably related to the rapid change in the relative contents of Al, Ti, and Cr of the melt with onset of plagioclase crystallization. The later that plagioclase is delayed in the crystallization sequence, the more pronounced should be the apparent gap in the series.

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