Fe and Mg are present in relatively large amounts in bytownite-anorthite plagioclase in lunar basaltic rocks. Fe is primarily in the ferrous state and is located in Ca$^{++}$ sites and as an impurity in effective tetrahedral sites (not regular Al$^{+++}$ sites) coupled with oxygen vacancies and lattice defects (Hafner et al., 1971). It is assumed here that Mg is similarly situated. The contents of Fe and Mg in these plagioclases are not only high but are systematically related to the anorthite content, or, as illustrated in Fig. 1, to the orthoclase content. These are the feldspars of the high iron trend of Smith (1971).

![Diagram](https://example.com/diagram.png)

**Fig. 1.** Weight percent Fe and Mg in plagioclase as a function of mole percent orthoclase in rock 14053. Tie lines connect core and rim compositions. Plagioclase enclosed in pigeonite zoned to ferroaugite are labeled P; those enclosed in cristobolite and ilmenite, C and I, respectively; those bordered or partly enclosed by mesostasis, M.
Textural and compositional evidence indicates that Fe enrichment and Mg depletion was progressive during crystallization of rock 14053. The same is true of Fe and Mg in plagioclase in the rock. Brown and Carmichael (1971) noted a similar Fe enrichment in plagioclase of this compositional range in lavas of the Lake Rudolf region and, for this case where Fe was presumed to occupy tetrahedral sites, concluded that early formed plagioclase may have cooled more slowly permitting preferred Al ions to occupy most tetrahedral sites, and as cooling became more rapid with less time for diffusion, more Fe entered. In the present case, however, changes in the extent of diffusion do not explain the observed simultaneous Fe enrichment and Mg depletion. It is suggested that given conditions where Fe and Mg can enter the plagioclase structure as accidental constituents (rapid crystallization at high temperature) their abundances are a function of their concentrations in adjacent liquids. If this is true, rocks with strong Fe enrichment will have strong progressive Fe enrichment trends in plagioclase formed at successive times whereas rocks with arrested Fe enrichment should have arrested Fe enrichment in the plagioclase. This is the relationship observed for lunar basaltic rocks illustrated in Fig. 2.

Fig. 2. Fe content of plagioclase as a function of percent orthoclase for rocks 12038 (very strong Fe enrichment), 14053 (Fe enrichment) and 12036 (arrested Fe enrichment with abundant cumulus magnesian olivine with which residual liquids reacted). Data for rocks 12038 and 12036 from Busche et al., (1971).
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Thus, whereas rapid crystallization at high temperature favors entrapment of Fe and Mg in basaltic plagioclase, changes in concentrations of these constituents in successively formed plagioclases reflect changes in their concentrations in residual liquids. If these conclusions are correct, the fractionation trend of Fe with respect to Mg can be determined for lunar basalts by measuring the Fe and Mg contents of selected plagioclase crystals. Such a fractionation trend for rock 14053 is illustrated in Fig. 3 where molecular percent orthoclase is assumed to provide a measure of the extent of fractionation.

Fig. 3. Fe/Fe + Mg as a function of molecular percent orthoclase in sequentially formed plagioclase in rock 14053.

References