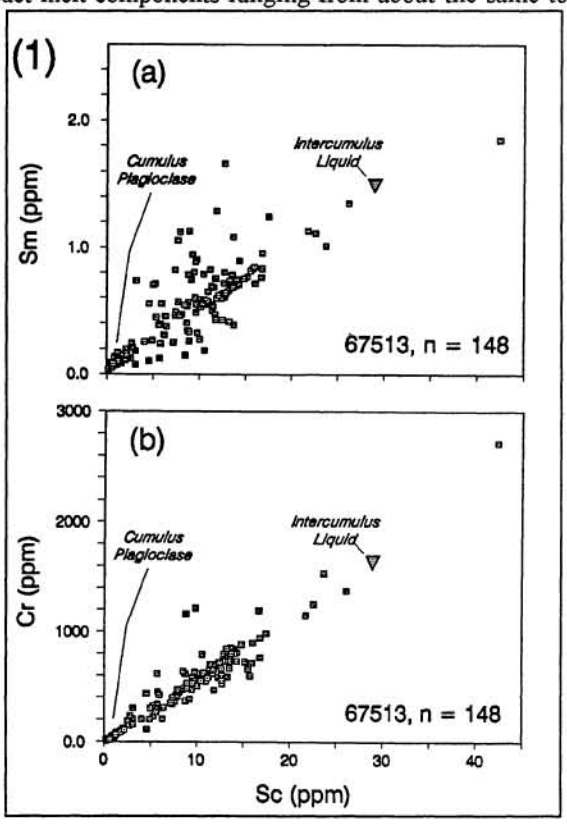
EVIDENCE FOR THE NATURE OF THE IGNEOUS PRECURSOR OF FERROAN PLUTONIC ROCKS FROM NORTH RAY CRATER, APOLLO 16. BRADLEY L. JOLLIFF AND LARRY A. HASKIN, DEPARTMENT OF EARTH AND PLANETARY SCIENCES & MCDONNELL CENTER FOR THE SPACE SCIENCES, WASHINGTON UNIVERSITY, ST. LOUIS, MO 63130.

A set of rocks from the southern rim of North Ray Crater constitutes a geochemically and petrogenetically related group that derived from a ferroan-anorthositic, plutonic igneous rock body. A subset of lithic fragments from sample 67513 forms a coherent geochemical group with mineral assemblages ranging from anorthositic to gabbronoritic. Polymict breccias, including mixtures of melt-matrix and fragmental-matrix breccias, have compositions that lie along a correlation line that has igneous-textured plagioclase-rich and pyroxene-rich end members (Fig. 1). Bulk trace-element concentrations and mineral compositions relate the polymict and igneous samples (e.g., Fig. 2). We interpret this suite of samples as having formed from an igneous body of noritic-anorthosite bulk composition wherein the mafic component resulted from solidification of intercumulus melt of cotectic composition within a plagioclase suspension cumulate (Fig. 3). Plagioclase-rich samples form three compositional groups distinguished by their plagiophile-element concentrations, for example, Na_2O (wt.%): 0.27-0.32, 0.35-0.38, and 0.42-0.45; and Eu (ppm): 0.71-0.72, 0.77-0.80, and 0.84-0.86 (Fig. 4). Results of geochemical modeling and calculations involving mass-balance of sodium suggest that either some re-equilibration occurred between cumulus plagioclase and intercumulus melt during solidification or that original cumulus plagioclase compositions spanned a range of Na concentrations such as we observe in the samples now. The possibility that re-equilibration involving Na was associated with plagioclase recrystallization during prolonged cooling is not supported by our observation that domains of coarsely recrystallized plagioclase maintain the same Na concentration as primary plagioclase. There is, however, evidence for the loss of mafic components from cumulus plagioclase by the clearing of mafic inclusions in primary plagioclase during recrystallization. The Mg' values of mafic silicates coexisting with cumulus plagioclase appear to be governed by intercumulus pyroxene as opposed to mafic components exsolved from plagioclase.

We take the bulk composition of the precursor igneous system to be that of the mass-weighted average of 148 lithic fragments from sample 67513; this composition has ~30 wt.% Al_2O_3, 4% FeO, 3% MgO, and Mg' of 0.56. Many individual lithic fragments contain similar impact melt components ranging from about the same to slightly more mafic than the inferred bulk system (Al_2O_3: 27-31%, FeO: 3.8-8.5%), suggesting that on a large scale, there was some variability in proportions of cumulus plagioclase and intercumulus melt, but that the mafic material and cumulus plagioclase were present in a single rock formation and did not form separate layers or intrusions.



The inferred bulk composition of the system corresponds to a mixture of some 70 wt.% cumulus plagioclase and 30% intercumulus material (Fig. 3). We calculated the intercumulus melt composition by mass balance given the 30:70 ratio, the bulk system composition, and an average cumulus plagioclase composition. Cumulus plagioclase compositions span a range of Na_2O concentrations (Fig. 4), and an average Na_2O concen-tration of 0.37 leaves the intercumulus melt with a low enough Na_2O concentration to produce orthocumulus plagioclase as calcic as that observed (Fig. 2).

From our geochemical modeling [1], we conclude that solidification of the igneous system was dominated by equilibrium crystallization of intercumulus melt once the cumulus plagioclase - intercumulus melt system became isolated from other parts of the parent magmatic system. Scatter about the correlation line of Fig. 1a is consistent with some migration of intercumulus melt during

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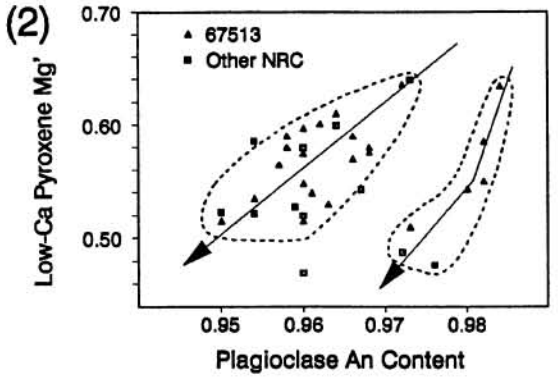
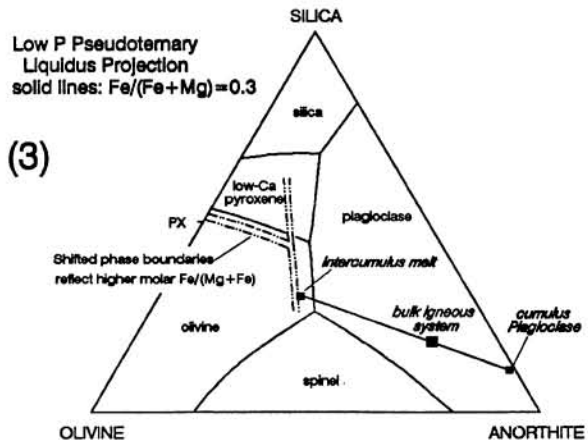
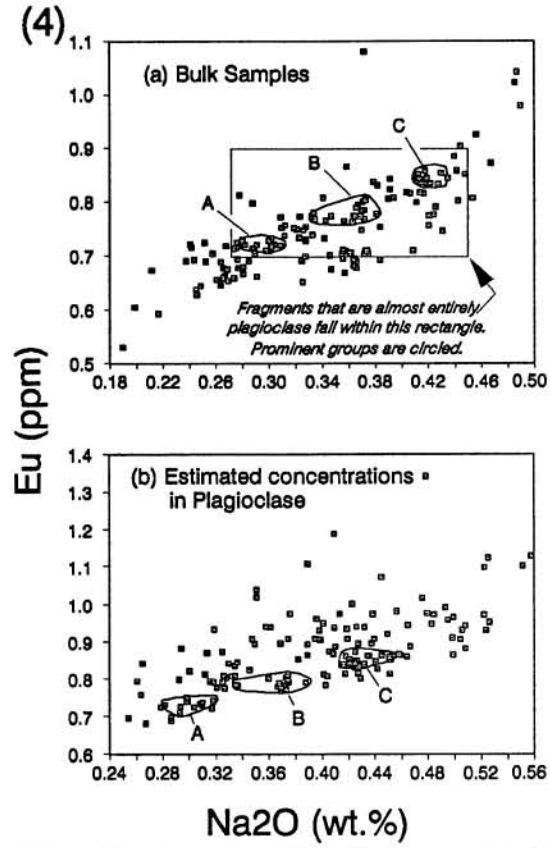
solidification, such as in tension fractures due to shrinkage, leaving compositionally less evolved (lower incompatible element concentrations) assemblages in some locations and more evolved assemblages elsewhere. However, the strength of correlations such as those shown in Fig. 1 and the limited range of mineral compositions (Fig. 2) indicate that such migration and/or fractional crystallization was minimal. Although the number of data points is low, there is some indication in Fig. 2 for the existence of two separate mineral compositional trends. Perhaps infiltration of late-stage residual melt into the most calcic regions of cumulus plagioclase (e.g., Gp. A, Fig. 4) produced the steeper trend at high An content (cf. model of [2]. All of the 67513 fragments plotted in the high-An trend are samples with Gp. A plagioclase.







The separation of the plagioclase-intercumulus melt mush from any cogenetic mafic parts of the system may have resulted from physical separation of the plagioclase-rich system as a diapir (cf. [3]), or simply when the residual porosity of the plagioclase cumulus mesh was sufficiently low as to prevent further chemical exchange with a larger body of contemporary magma. In either event, the eventual separation occurred on a large scale because we find no evidence of more mafic cumulates or rock products of a large body of contemporary melt such as gabbro or impact melt of gabbroic composition among the sample suite from North Ray Crater. Ferroan igneous rocks such as those exhumed from North Ray Crater would be expected as part of magma ocean plagioclase-rich suspension cumulates; in fact, in analogy with similar anorthositic rocks from the terrestrial Stillwater Complex, we should expect to find large bodies of noritic or gabbroic anorthosite (89-90% plagioclase) rather than anorthosite *sensu stricto* (90-100% plagioclase). We envision, however, not a horizontally-layered magma body such as the Stillwater layered mafic intrusion, but instead, a body remotely separated from any corresponding mafic cumulates, such as terrestrial massif anorthositic bodies.

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References [1] Jolliff B.L. and Haskin L.A. (1994) Igneous differentiation of ferroan plutonic rocks from North Ray Crater, Apollo 16. submitted to *Geochim. Cosmochim. Acta*. [2] Raedeke L.D. and McCallum I.S. (1980) *Proc. Conf. Lunar Highlands Crust*, 135-153. [3] Longhi J. and Ashwal L.D. (1985) *PLPSC 15th*, C571-C584..