with near-surface (porous) density ~2.76 g cm^{-3}, impact melts probably almost never managed to pool together well enough, and thus cool slowly enough, to produce coarse-grained, pristine/cumulate-seeming rocks.

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TROCTOLITIC ANORTHOSITE FROM 77115: A MAGNESIAN MEMBER OF THE ALKALIC SUITE. Paul H. Warren and Gregory W. Kallemeyn, Institute of Geophysics and Planetary Physics, University of California, Los Angeles CA 90024, USA.

Alkalic suite pristine nonmare rocks are distinctly enriched in plagiophile elements such as Na and K, as well as generally incompatible elements, despite modes and textures more characteristic of typical crustal cumulates (most commonly anorthosites) than of the basaltic KREEP rocks that appear to account for the bulk of the lunar crust's total complement of incompatible elements. Most of the ~17 previously reported alkalic suite samples have come from Apollo 14 or 12 (only 180 km to the west of A-14), except for clasts from one A-15 breccia (15405) and one A-16 breccia (67975). Our studies indicate that the 77115 troctolitic clast of Winzer et al. [1] is actually a troctolitic anorthosite (or anorthositic troctolite), probably best classified as a member of the alkalic suite. Winzer et al. [1] analyzed a 30-mg chip and found a high normative olivine content (60%, plus 40% plag. and 1% apatite) and bulk-rock *mg* = 87.3 mol%, despite high contents of rare-earth elements (e.g., Sm = 42 µg/g, or 0.88× average high-K KREEP). Norman and Ryder [2] classified this sample as KREEP, but the pattern of incompatible elements of the Winzer et al. [1] analysis was far from KREEP-like (e.g., Ba/Ce = 0.23× the KREEP ratio, Ce/Lu = 1.6× the KREEP ratio). Chao et al. [3] reported that two thin sections were made from this clast, but "only plagioclase of the clast was sectioned."

We managed to obtain a thin section with pyroxene and olivine, and analyzed a 13.4-mg chip by INAA. This chip, like all the thin sections, is highly anorthositic, with only 0.87 wt% FeO. It has an even higher LREE/HREE ratio than the Winzer sample (e.g., La/Lu = 2.2× the KREEP ratio), and extraordinarily high contents of plagiophile elements (e.g., Ga = 6.3 µg/g, Eu = 4.0 µg/g, Sr = 340 µg/g), in typical alkalic suite fashion. However, Winzer et al. [1] only found Sr = 134 µg/g. Extraordinary, by alkalic suite standards, is the magnesian nature of the mafic silicates: olivine averages $Fo_{89.3}$ (range among 14 analyses 97.5–89.1), low-Ca pyroxene clusters very tightly near $En_{87.9}Wo_{1.7}$ (average *mg* = 0.894). An uncommonly magnesian Cr-spinel is also present, containing 17.75 wt% Al_2O_3, 16.31 wt% FeO, 12.64 wt% MgO, and 2.40 wt% TiO_2. The plagioclase averages $An_{95.1}$ (range among 35 analyses: 94.3–95.8), which is extraordinarily Na-poor by alkalic suite standards.

Nonetheless, the alkalic affinity indicated by the Ga, Sr, and REE (especially Eu) data, and the strangely P-rich composition determined by Winzer et al. [1] (0.53 wt% P_2O_5), all point toward a complex petrogenesis, probably involving either assimilation of KREEP into a Mg-suite magma, or metasomatism of an Mg-suite troctolitic anorthosite by an extremely evolved fluid or melt. In the past, we were unable to resolve between these two models for alkalic anorthosites from Apollo 14 [Warren et al., 1983]. However, the mass balance for mixing KREEP into a hypothetical 77115c Mg-suite parent magma is difficult, unless the KREEP component is remarkably REE-rich and the Mg-suite component is remarkably magnesian. Thus, 77115c tends to strengthen the case for metasomatic alteration in alkalic suite genesis. However, this sort of metasomatic activity (which probably requires a volatile-rich fluid) surely only affected a tiny fraction of the Moon's crust, and tentative acceptance of a metasomatic model for one alkalic suite rock need not imply that this model is preferable over the physical mixing/assimilation model for alkalic suite rocks in general.

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LAST CHANCE AT TAURUS-LITTROW. D. E. Wilhelms, U.S. Geological Survey, retired, 2027 Hyde St. Apt. 6, San Francisco CA 94109, USA.

The Problems: By the fall of 1971 we knew that only two more Apollos would land on the Moon. Most geoscientists agreed that both should concentrate on the previously neglected terrae (highlands). In June 1971 the Apollo Site Selection Board (ASSB) had chosen Descartes as the site of the Apollo 16 terra landing, scheduled for April 1972. Therefore we had to assess how many pre-Apollo objectives the first four landings had met, how many Apollo 16 was likely to meet, and how to meet the remaining ones with Apollo 17.

Geologists convened at Caltech in November 1971 by Lee Silver and geology-team leader William Muehlberger formulated the following list of major lunar problems (edited here): (1) ancient crustal and interior materials; (2) early impact history; (3) major basins and mascons, a broad category that included the basins' ages, the petrology of their ejecta, the nature of the deep rock they excavated, the origin of their rings and radial sculpture, and the cause of the positive gravity anomalies (mascons) detected over their mare fillings; (4) large craters and their products—their ages, the subcrater rock brought up in their central peaks, their superposed pools and flows (generally assumed to be volcanic), and even the hoary question of their origin still doubted by caldera advocates; (5) highland igneous evolution, then widely believed to be an important process affecting terra morphology; (6) maria—the variability of their compositions and ages; (7) postmare internal history, mostly meaning the dark pyroclastic blankets thought to postdate the already-sampled mare basalts; (8) present physical and chemical state of the interior; (9) lunar heterogeneity, both vertical and lateral; and (10) regolith evolution and radiation record.

From this list only one major impact structure (Imbrium Basin), the maria, and the regolith were thought to have been well explored through the time of Apollo 15 (August 1971). Apollos 14 and 15 had sampled the Imbrium ejecta. Apollos 11, 12, and 15 had abundantly sampled three points on the maria. Crews of all four successful Apollo landings had collected regolith cores, and Apollo 16 could be expected to obtain comparison cores in the heart of the highlands. Before it flew, most people still thought that Apollo 16 would elucidate the types of volcanism and magmatic evolution endemic to the terrae.