Introduction: K-Ca and Rb-Sr age determinations were made for a bulk feldspar-rich portion of an Apollo rock fragment of the pristine lunar granite clast (14321,1062), an acid-leached split of the sample, and the leachate. K-Ca and Rb-Sr data were also obtained for a whole rock sample of Apollo ferroan anorthosite (FAN, 15415). The recent detection [1] of widespread intermediate composition plagioclase indicates that the generation of a diversity of evolved lunar magmas maybe more common and therefore more important to our understanding of crust formation than previously believed. Our new data strengthen the S-K, Ca, Rb, and Sr data of that clast was obtained on a Thermo Finnigan Triton TIMS instrument. Standard mass spectrometry procedures for Sr were used. Rb and K measurements were run sequentially on the same filament and Ca analyses follow methods developed by [3]. The K abundances in samples were calculated from their $^{40}$K/$^{41}$K ratios, normalized to $^{39}$K/$^{40}$K = 13.9448. A mean $^{40}$K/$^{41}$K value of 0.001739±7 (2 sd, n=8) was obtained for the NBS985 K standard mixed with the Rb standard NBS984. The Ca abundances in samples were calculated from their $^{44}$Ca/$^{43}$Ca ratios, normalized to $^{42}$Ca/$^{43}$Ca = 0.31221 [4]. An average value of $^{40}$Ca/$^{43}$Ca = 47.160±5 (2 sd, n=8) was obtained for SRM915a and used to correct the sample $^{40}$Ca/$^{43}$Ca values accordingly based on the UC Berkeley value of 47.153 [3], cf. [5].

Results: Granitic material processed in this study was derived from several small chips originally characterized by [6]. The initial sample handling was done and described by [2]. In order to increase the spread in the K-Ca and Rb-Sr isochrons reported by [2], we processed an additional 2.9 mg aliquant of the feldspar-rich bulk rock (14321 FR), 4.15 mg of acid-washed residues of the sample (14321 FR.), and a 0.7 mg leachate derived from the washing (14321 FR.). A split of 15415 was also characterized to allow direct comparison to the initial Ca and Sr compositions of pristine lunar highland rocks.

Discussion: Granite 14321 is one of the youngest and most evolved silicic rocks collected from the Moon (6). It has been dated previously by Sm-Nd, Ar/Ar (7), and U-Pb (zircon) methods (9). As expected the precision of the K-Ca and Rb-Sr ages has been improved. Both new ages are slightly younger than previously reported. These ages are now within error of the existing mean U-Pb zircon age (3965±50 Ma).
The total release Ar/Ar age of a feldspar-enriched split of 14321 yields a slightly younger age of 3.88±0.03 Ga (2 se). The concordancy of K-Ca, Rb-Sr, Sm-Nd internal isochrons and (now) the U-Pb model age strongly indicate that the granite formed ~4000 Ma ago. The apparent Ar/Ar age suggests that it was brecciated and excavated from near the surface about 100 Ma later.

The initial Ca isotopic ratio provides a constraint on the K/Ca ratio of the source of 14321 (Fig. 3). Using the measured composition of 15415 (this study) or a combination of this and previous estimates for the initial $^{40}\text{Ca}/^{44}\text{Ca}$ of the Moon (2), a more precise estimate for K/Ca of ~0.7 is determined. This value is significantly higher than previous estimates and largely due to the new low K/Ca 14321 FR.1 datum near the origin in the K-Ca isochron (Fig. 1). This calculated mean K/Ca value is well above the upper range for the values (0.2-0.3) found in known lunar quartz monzodiorites, e.g., (10) and suggests that 14321 (that has an K/Ca value of ~5) was probably generated from an earlier episode of intermediate magmatism.


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**Figure 1.** K-Ca internal isochron for lunar granitic clast 14321,1062. New feldspar-rich bulk and sample-leachate data (this study) are combined with two bulk samples and 3 color-sorted mineral separates (2). The isochron age and initial $^{40}\text{Ca}/^{44}\text{Ca}$ ratio are calculated using Isoplot (11). The error envelope represents the 95% confidence interval of the regression. The bulk measurement of FAN 15415 is representative of primitive lunar highland rocks.

**Figure 2.** Rb-Sr internal isochron for lunar granitic clast 14321,1062. Two new bulk samples (one that is acid-washed, 14321 FR.r) are combined with data from a bulk sample, 3 feldspar mineral separates and 2 magnetic fractions (7). The isochron age and initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratio are calculated using Isoplot (11). The error envelope represents the 95% confidence interval of the regression. FAN 15415 plots off scale.

**Figure 3.** Plot of $^{40}\text{Ca}/^{44}\text{Ca}$ evolution against time. Growth curves are shown for basaltic (K/Ca=0.02), intermediate, and evolved (K/Ca≥1) crustal sources. The initial $^{40}\text{Ca}/^{44}\text{Ca}$ composition of Apollo granite 14321 when compared to primitive lunar crust (e.g., FAN 15415) indicates that it was derived from a relatively enriched source that has a K/Ca ratio (~0.7) that is equivalent to terrestrial andesite.