MEASUREMENTS OF COSMOGENIC NUCLIDES IN LUNAR ROCK 64455 ; J. R. Arnold, C. P. Kohl, K. Nishiizumi*, Department of Chemistry, University of California, San Diego, La Jolla, CA 92037-0317, M. W. Caffee, R. C. Finkel, J. R. Southon, CAMS, Lawrence Livermore National Lab., Livermore, CA 94551-9900

Eleven samples were ground from the glass coated surface of lunar rock 64455,82 with an average depth resolution of 50 μm and were measured for ^{10}Be, ^{26}Al, and ^{36}Cl using AMS (accelerator mass spectrometry). Results show no evidence of SCR (solar cosmic ray) effects. The flat cosmogenic nuclide profiles and activity levels are consistent with a 2 My exposure history for the rock and a sample location on the bottom of the rock. These AMS measurements are some of the most precise ever obtained for these three nuclides. This precision and the demonstrated fine depth resolution will enable us to conduct a number of detailed studies of depth effects in lunar and meteoritic samples, including investigating SCR effects in the surface exposed top of the glass coating of 64455 and possibly in the underlying rock. This work is underway.

Concentrations of cosmic ray produced nuclides in lunar surface rocks provide important information on past solar activity. The most detailed study to date has been done on the highland breccia 68815, which experienced a relatively high erosion rate [1]. In this work we extend our studies of detailed depth profiles to the glass coated rock 64455.

The Apollo 16 impact melt breccia 64455 was collected from the northeast slope of Stone Mountain. It is a small object, 5.6x4.0x2.5 cm weighing 56.7 g, which was coated with a very thick (more than 2 mm) smooth glass layer. It has been concluded that the glass coating did not result from fusion of the surface of the rock itself but is actually a splash coating of impact-melted material with chemical composition similar to that of 64455 [2, 3]. This conclusion is supported by the existence of a thin (~1 mm) partially melted thermal aureole between the basalt and the glass coating.

Marti (pers. comm.) obtained a 2.01 My ^{81}Kr exposure age for the glass portion of 64455,17 making it clear that 64455 was associated with the South Ray cratering event. The ^{21}Ne age, 1.2 My, and the ^{38}Ar age, 1.8 My, are somewhat shorter than the ^{81}Kr age [4, 5]. Although its lunar surface orientation has not been definitely identified photographically, the distribution of microcraters suggests a simple lunar surface irradiation [6]. Blanford et al. measured cosmic ray tracks in 64455,14 and 64455,16 [7, 8]. The surface subsample, 14, was heavily damaged by microcraters and contained high solar flare track densities. They compared the track densities of 64455,14 with those of 68815 and concluded that the surface of rock 64455 had no erosion and that the top half of the rock had not been covered by soils [7, 8]. A slice of sample 64455,82 (10x24x19 mm) was selected for our study based on microcraters and cosmic ray tracks in the rock. In this slice all sides of the basaltic core were completely covered by glass.

This slice of sample 64455,82 was mounted on an X-Y-Z stage [1]. About 10mm x 20 mm of surface area was ground using a dental drill with measurements at each point of a 1 mm x 1 mm grid. The grinding method was similar to that used in our previous work on 68815, but achieved a depth resolution for 64455 more than two times better [1]. In this work, we report data on 11 samples from the smooth glass surface and the rock below it. The depth intervals were 0-0.12, 0.12-0.31, 0.31-0.60, 0.60-0.90, 0.90-1.33, 1.33-1.83, 1.83-2.50, 2.50-2.93, 2.93-3.76, 3.76-4.44, and 10.7-17.7 mm. The recoveries of ground materials were usually over 90%, somewhat less for the smaller samples. The density of the glass, calculated from the grinding dimensions and the weight removed, is 2.74 g/cm^3. This density is in good agreement with the density of Ca Feldspar, 2.76. Be, Al, and Cl were chemically separated from each sample. ^{10}Be, ^{26}Al, and ^{36}Cl were measured by AMS at LLNL [9]. The concentrations of major target elements were determined by atomic absorption spectrometry.

^{10}Be and ^{26}Al depth profiles in 64455,82 are shown in Fig. 1. The ^{36}Cl profile is shown in Fig. 3. Fig. 2 shows ^{10}Be and ^{26}Al profiles in 68815 for comparison [1, 10]. ^{10}Be and ^{26}Al concentrations were corrected to saturation using 2.0 My exposure ages for 64455 and 68815. Note the different depth scales in Fig. 1 and 2. Concentrations of the cosmogenic nuclides in 64455 are constant and do not show the SCR signature which was observed for ^{26}Al in 68815 (Fig. 2). This uniformity is expected since we ground rock 64455 from its lunar subsurface side. The depths of our samples were equivalent to 6 - 7 g/cm^2 (2 -2.5 cm) on the moon. The differences

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of cosmogenic nuclide concentrations in this depth range are expected to be less than a few percent [11]. Measured activities were constant within experimental errors (0.8 - 3 %). The magnitude of the ^{10}Be activities and the flat ^{26}Al profile are consistent with the fact that rock 64455 was exposed to cosmic rays for only 2 My and that the rock has not tumbled within the last 2 My. This experiment demonstrated the efficacy both of our high resolution grinding method and of the AMS measurements. At present, we are grinding samples from the surface which was exposed on the moon.

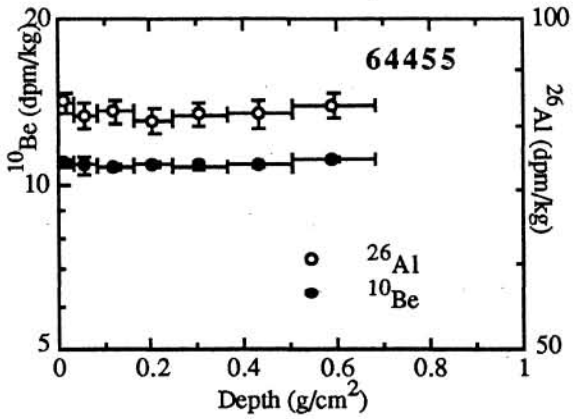

Fig. 1. ^{26}Al and ^{10}Be in 64455 (This work)

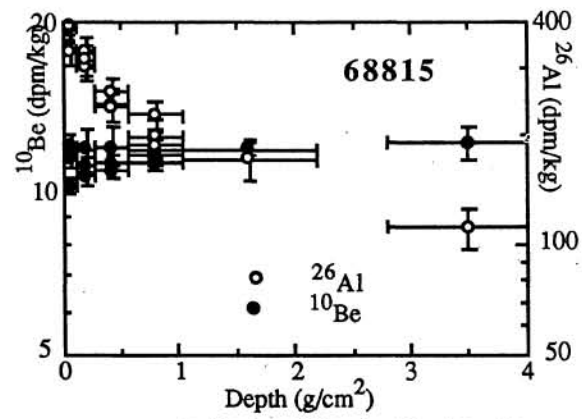

Fig. 2. ^{26}Al and ^{10}Be in 68815 [1, 10]

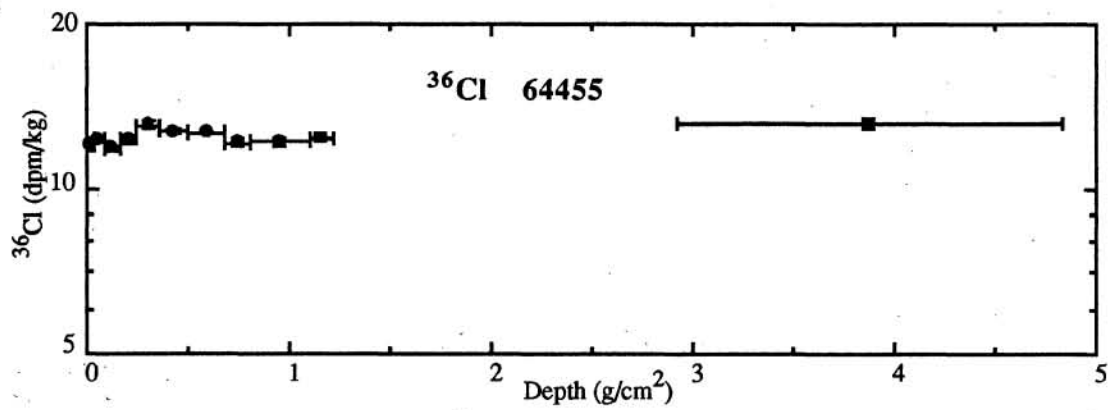

Fig. 3. ^{36}Cl in 64455 (This work)

References;
[1] Kohl C.P. *et al.* (1978) *Proc. Lunar Planet. Sci. Conf. 9th*, 2299-2310.
[2] See T.H. *et al.* (1986) *Proc. Lunar Planet. Sci. Conf. 17th, J. Geophys. Res. 91*, E3-E20.
[3] Morris R.V. *et al.* (1986) *Proc. Lunar Planet. Sci. Conf. 17th, J. Geophys. Res. 91*, E21-E42.
[4] Bogard D.D. and Gibson E.K. (1975) *Lunar Sci. VI*, 63-65.
[5] Bogard D.D. *et al.* (1973) *Earth Planet. Sci. Lett. 21*, 52-69.
[6] Schneider E. and Hörz F. (1974) *Icarus 22*, 459-473.
[7] Blanford G.E. *et al.* (1974) *Proc. Lunar Sci. Conf. 5th*, 2501-2526.
[8] Blanford G.E. *et al.* (1975) *Proc. Lunar Sci. Conf. 6th*, 3557-3576.
[9] Southon J.R. *et al.* (1990) *Nucl. Inst. Meth. B52*, 301-305.
[10] Nishiizumi K. *et al.* (1988) *Proc. Lunar Planet. Sci. Conf. 18th*, 79-85.
[11] Reedy R.C. and Arnold J.R. (1972) *J. Geophys. Res. 77*, 537-555.