COSMIC RAY EXPOSURE HISTORY OF LUNA 16, 20, AND 24 SAMPLES. B. A. Cohen[1], C. M. Hall[2], L. A. Taylor[1], G. A. Snyder[1], and M. A. Nazarov[3]; [1]Planetary Geosciences Institute, University of Tennessee, Knoxville TN 37996 (bcohen@utk.edu); [2]Department of Geological Sciences, University of Michigan, Ann Arbor MI 48109; [3]Vernadsky Institute, Moscow, Russia 117975.

Introduction: High-quality Ar-isotope data is used to examine the cosmic-ray exposure (CRE) histories of Luna 16, 20, and 24 fragments and their implications for lunar regolith development. The Soviet Luna missions returned mare basalt and HMS-suite rocks from the Moon's eastern limb. We previously reported petrology and ^{40}Ar-^{39}Ar ages [1-3] on these rock fragments.

CRE ages: Cosmogenic ^{38}Ar is produced by cosmic-ray spallation on Ca, K, Ti, and Fe in the top ~100 cm of lunar soil, with ^{38}Ar/^{36}Ar = 1.54 and ^{37}Ar/^{36}Ar > 0 [4]; solar wind ^{38}Ar is implanted into the soil with ^{38}Ar/^{36}Ar = 0.18 and ^{37}Ar/^{36}Ar = 0 [5]. Three-isotope correlation plots (after blank, decay, and interference corrections) show that ^{38}Ar in these samples is a mixture of cosmogenic and trapped components, with only a small contribution from Fe in the basalts and negligible contributions from Cl, Ti, and K. The slope of the correlation was used to calculate Ca-derived ^{38}Ar; nominal CRE ages were computed using a ^{38}Ar production function of 1.4×10^{-8} ccSTP/gCa/Myr [6] (Table 1). CRE ages are consistent with previously determined values [3]. The ^{38}Ar from Fe and Ca in more-retentive pyroxene sites was used to estimate the depth at which these rocks were exposed to cosmic rays [7].

Discussion: The Luna 16 basalts were exposed during or after an inferred ^{40}Ar loss event at ~1 Ga, with no equivalent stepwise loss of ^{38}Ar. These samples may have been disturbed in the creation of a young crater, which threw them onto the surface. The shallow depth (~5 cm) and relatively old CRE ages of the samples and soil imply that the Luna 16 regolith is thin and turnover is slow, consistent with an interpretation that the Luna 16 module landed on a young ejecta blanket with limited regolith development.

The depth of the Luna 20 samples could not be inferred because of their low Fe content. The CRE ages of Luna 20 plutonic rocks are generally the same age or younger than the Luna 20 soil age, but older than the 125 Myr CRE age of the Apollo 16 highlands site [8], implying that the gardening rate is slower in the eastern highlands than at the A16 site.

The Luna 24 samples received their exposure at deeper levels than the Luna 16 samples. The Luna 24 basalt fragments have shorter CRE ages than both Luna 16 and the Luna 24 bulk regolith, suggesting that the Luna 24 regolith is deeper and has been overturned more than at Luna 16. This is a more well-developed regolith, and it may be that gardening of the basalt flow is the mechanism for bringing the Luna 24 samples to the surface.

References: [1] Snyder *et al.* (2000) LPSC XXXI, #1221 and 1222. [2] Cohen *et al.* (2001) *MAPS* 35, A43. [3] Cohen et al. (2001) *MAPS*, in press. [4] Hohenburg *et al.* (1978) *PLPSC* 9th, 2311. [5] Swindle (1985) in *Meteorites*, UA Press, 535. [6] Turner *et al.* (1971) *EPSL*, 19. [7] Hennessy & Turner (1980) *Phil. Trans. R. Soc. Lon.* A297, 27. [8] Bogard & Hirsch (1976) PLSC 7th, 241. [9] Kaiser (1972) *EPSL* 13, 387. [10] Agrawal *et al.* (1974) *Pramina* 3, 176. [11] Eugster *et al.* (1973) *GCA* 37, 1991. [12] Eugster *et al.* (1975) PLSC 6th, 1989. [13] Bogard & Hirsch (1978) in *Mare Crisium*, Pergamon Press, 105.

Table 1: CRE ages and estimated depths of Luna samples and soils

Sample	Type	CRE age (Myr)	Depth (cm)
1609A	basalt	1060	< 5
1609B	basalt	241	> 100
1635A	basalt	649	< 5
1607-1608	basalt	582	< 5
1609C	glassy fragment	1281	—
1635A	glassy fragment	905	—
Luna 16 bulk soil [9-10]		*~900*	
Luna 16 bulk soil [11-12]		*360*	
2004C	troctolite	236	—
2003	troctolite	403	—
2004B	gabbro	1133	—
2004D	gabbro	340	—
2002	anorthite	234	—
2004A	anorthite	459	—
Luna 20 bulk soil [13]		*459*	—
24067,3-6A	basalt	1370	—
24067,3-6B	basalt	618	~ 25
24184,4-6A	basalt	158	—
24143,4-6L	basalt	393	< 25
24184,4-6B	basalt	208	—
24184,4-6C	basalt	294	—
Luna 24 bulk soil [14]		*>300-400*	—