CRYSTALLIZATION AGE AND IMPACT RESETTING OF ANCIENT LUNAR CRUST FROM THE DESCARTES TERRANE. M. D. Norman[1], L. E. Borg[2], L. E. Nyquist[3], and D. D. Bogard[3] [1]Research School of Earth Sciences, Australian National University, Canberra ACT 0200 AU (marc.norman@anu.edu.au) [2]Institute of Meteoritics, University of New Mexico, Albuquerque NM 87131 (lborg@unm.edu) [3]NASA Johnson Space Center, Mail Code SR, Houston TX 77058 USA (laurence.e.nyquist1@jsc.nasa.gov, donald.d.bogard1@jsc.nasa.gov).

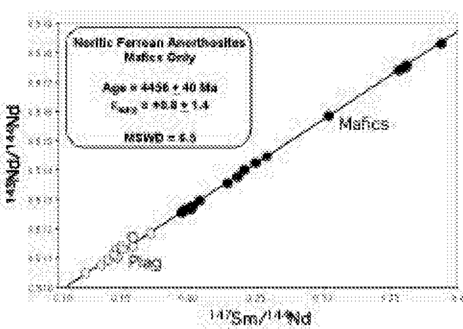
Introduction: Lunar ferroan anorthosites (FANs) are relicts of an ancient, primary feldspathic crust that is widely believed to have crystallized from a global magma ocean. Compositions and ages of FANs provide fundamental information about the origin and magmatic evolution of the Moon, while the petrology and thermal history of lunar FANs illustrate the structure and impact history of the lunar crust. Here we report petrologic, geochemical, and isotopic (Nd-Sr-Ar) studies of a ferroan noritic anorthosite clast from lunar breccia 67215 to improve our understanding of the composition, age, and thermal history of the Moon.

Significance of the Descartes Terrane: 67215 is a feldspathic fragmental breccia collected from the rim of North Ray Crater. These breccias have aluminous bulk compositions (28-30% Al_2O_3) that are poor in KREEP, low in meteoritic siderophiles, and lack solar wind carbon compared to lunar impact melts or regolith breccias [1]. Photogeologic and remote sensing data show that these breccias represent a regionally significant highlands unit exposed in the Descartes terrane to the north and east of the Apollo 16 landing site, and that their bulk compositions are broadly similar to those of large regions of anorthositic crust on the farside of the Moon. Descartes breccias may, therefore, provide a glimpse of a more representative region of the lunar crust than the KREEP-rich breccias which dominate the sample collection. Descartes breccias also carry ancient (>4.4 Ga) and relatively little modified crustal components that were derived from a region of the Moon distinct from the KREEPy hot-spot terranes [2, 3], making them useful for studies of early crustal genesis. Breccia 67215 consists predominantly of clasts and mineral fragments derived from a coherent suite of ferroan noritic anorthosites [2, 4], and one of these clasts is the subject of our study.

Results: The clast (designated 67215c) has an unusually well preserved, unbrecciated igneous texture. Mineral compositions combined with major and trace element characteristics show that 67215c is closely related to the ferroan anorthositic suite of lunar highlands rocks, but that it cooled more rapidly and at much shallower depths (0.5 km) compared to most other FANs (15-20 km).

^{147}Sm-^{143}Nd isotopic compositions of mineral separates from 67215c define an isochron age of 4.40 $\pm$ 0.11 Ga with an initial ε^{143}_{Nd} of +0.85 $\pm$ 0.53. ^{40}Ar-^{39}Ar ages of plagioclase from the clast record a post-crystallization thermal event at 3.93 ± 0.08 Ga ago, where the greatest contribution to the uncertainty in this age derives from a correction for lunar atmosphere ^{40}Ar. Rb-Sr isotopic systematics were severely disturbed by this event which likely dates emplacement of the Descartes feldspathic fragmental breccias, possibly as ejecta from the Necataris basin.

Crystallization age of the lunar crust: Four ferroan noritic anorthosites have now been dated by ^{147}Sm-^{143}Nd mineral isochrons, producing apparent ages of 4.29-4.54 Ga. However, the Nd isotopic compositions of plagioclase in some FANs appear to have been modified by post-crystallization exchange, whereas the mafic phases in these rocks remained resistant to this disturbance. ^{147}Sm-^{143}Nd isotopic compositions of mafic fractions from all four ferroan noritic anorthosites define an age of 4.456 $\pm$ 0.040 Ga which may be a robust estimate for the crystallization age of lunar ferroan anorthosites.



The best estimate for the initial ^{143}Nd isotopic compositions of FANs is provided by 60025 (+0.9 $\pm$ 0.5; [5]) and 67215c (+0.8 $\pm$ 0.5; this study). Both values are slightly higher than standard chondritic values (CHUR). An elevated initial Nd isotopic composition for the Moon might be related to early depletion of proto-lunar material by loss of small degree melts from explosively outgassed precursor planetesimals [6, 7], or accretion of the Moon from a depleted portion of a large impactor [8]. Alternatively, conventional CHUR values may not be precisely representative of material which formed the Earth and Moon.

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