# NOBLE GASES IN GLASS AND MINERAL GRAINS SEPARATED FROM THE UNBRECCIATED LUNAR MARE BASALTS LAPAZ ICEFIELD 02205, 02224, 02226, 02436.

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**Introduction:** Large impact events on the Moon formed giant basins that were flooded by mare basalts. Continued impact bombardment over time brecciated the near-surface basalts and huge amounts of solar wind (SW) were accumulated on exposed regolith grain surfaces. Unbrecciated mare basalts (UMBs), however, must originate from deeper levels of lava flows [e.g., 1], where they evaded impacts and brecciation and were shielded from SW implantation. Thus, UMBs generally acquired a pure cosmogenic noble gas component [cf., 2]. Outermost layers of meteorites that might have collected SW during extended transfer through space are typically lost by ablation upon entry into Earth's atmosphere [3]. Surprisingly, bulk samples of the paired UMBs LaPaz Icefield (LAP) 02224 (24) and 02436 (36) contain SW, which dominates over the cosmogenic noble gas component [4], and cannot be explained by direct surface entrapment in a regolithic environment. In contrast, paired LAP 02205 (05) and 02226 (26) do not contain SW. To better constrain the enigmatic origin of the SW, glass and mineral aliquots were separated from all four meteorites and analyzed for their elemental and isotopic noble gas compositions.

**Samples:** The four lunar LAP meteorites studied here are unbrecciated low-Ti mare basalts [e.g., 5]. They are predominantly composed of pyroxene and plagioclase with minor amounts of olivine, ilmenite, chromite, spinel, and some accessory phases. Mesostasis forms irregularly shaped blebs containing abundant glass. Later fractures cross-cutting the basalts are filled with highly vesicular, dark-colored glass [6]. Shock-induced twinning and deformation in pyroxenes and maskelynization of plagioclase indicate moderate levels of shock overprint [7]. The LAPs represent comparably young lunar mare basalts with crystallization ages of ~2.99 Ga [8]. They were ejected about 55 ka ago, and fell in Antarctica 20 ka before present [9].

**Methods:** Six mineral separates of each of the four LAPs, containing plagioclase, pyroxene, olivine, opaque minerals, black, and transparent glass, were analyzed for their He and Ne isotopic composition using ETH's unique high-sensitivity compressor-source noble gas mass spectrometer [10]. The individual mineral grains were degassed for 1 min using an infrared laser (Nd:YAG; 1064 nm). Released gases were purified by non-evaporable getter materials, and cold traps held at the temperature of liquid nitrogen. Helium and Ne isotopes were measured following the method described in [11]. Total degassing of the mineral grains was verified by occasional measurements of re-extractions, which showed no deviation from blank levels. Repeat whole rock fragments with weights of ~20 mg were analyzed on a different instrument for their He-Xe noble gas contents following the methods in [4,12].

**Results and discussion:** As previously observed [4], LAP 05 and 26 show a pure cosmogenic component, whereas LAP 24 and 36, surprisingly, reveal abundant fractionated solar wind with $^{20}Ne/^{22}Ne$ ratios of ~12.5. Comparable radiogenic $^{40}Ar$ contents in all LAPs support the hypothesis, based on textural and geochemical observations, that the LAPs are paired [5]. Their unbrecciated texture and neutron capture-induced Kr and Xe isotope compositions suggest that the LAPs never resided at the lunar surface, in agreement with textural analyses [1] indicating crystallization within a lava flow of about 10-20 m thickness [13].

The mineral and glass separate analyses remarkably revealed that SW is present only in glasses from LAP 24 and 36, trapped in addition to the cosmogenic noble gases. Two major geological settings on the Moon might explain the origin of the SW in the glasses: 1) glasses of impact origin produced by melting of crustal rocks and possibly some impactor material [e.g., 14] found in shock veins, 2) glasses solidified from residual melts after incomplete crystallization of mesostasis [e.g., 7] occupying irregularly shaped blebs in the rock. Noble gas abundances and elemental compositions of the SW in the glasses of LAP 24 and 36, and its possible origin from the interior of the Moon or by impact melting, as well as further examinations of the glass and mineral separates will be discussed at the meeting.

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