NOBLE GASES IN INDIVIDUAL PARTICLES FROM BENNU: INVESTIGATING THE ORIGIN OF GAS-RICH ASTEROIDAL MATERIAL. B. Marty[1], L. Zimmermann[1], E. Füri[1], D. V. Bekaert[1], J. J. Barnes[2], A. N. Nguyen[3], H. Connolly[2,4,5], and D. Lauretta[2], [1]Université de Lorraine, CNRS, CRPG, 54000 Nancy, France, bernard.marty@univ-lorraine.fr, [2]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721, USA, [3]Astromaterials Research and Exploration Science, NASA Johnson Space Center, Houston, TX 77058, USA, [4]Department of Geology, Rowan University, Glassboro, NJ, USA, [5]Department of Earth and Planetary Science, American Museum of Natural History, New York, NY, USA.

Introduction: One of the driving hypotheses of the OSIRIS-REx mission [1] is that B-type asteroid Bennu formed beyond the snow line by accretion of material of the protoplanetary disk. Hence Bennu is expected to be rich in highly volatile elements. Among them, noble gases are chemically inert and their abundances and isotope compositions are shaped by physical processes such as radioactivity, irradiation, and isotope fractionation [2]. Hence studying the noble gas composition of Bennu's grains can contribute to testing Hypotheses 4 (formation beyond the snow line), 5 (geological activity), and 6 (catastrophic disruption) of the OSIRIS-REx mission [1].

Here we report preliminary data obtained on particles from asteroid Bennu using our all-noble-gas (He to Xe) analytical system installed at the Centre de Recherches Pétrographiques et Géochimiques (CRPG) Nancy (France) [3]. A companion presentation presents nitrogen-Ne-Ar data [4].

Previous Analysis of Asteroidal Material at CRPG Nancy: Our lab was involved in the noble gas and nitrogen analysis of grains returned from C-type asteroid Ryugu by the JAXA Hayabusa2 mission [5]. Material from Ryugu has been classified as closely resembling CI-type chondrites [6]. The concentration of trapped noble gases in the Ryugu samples is greater than the average composition of previously measured CI chondrites [3,7]. The noble gases are mainly derived from phase Q (an ill-defined noble gas component common to all types of chondrites), with minor contribution of presolar nanodiamond Xe-HL (a presolar xenon component rich in both light and heavy isotopes). The large noble gas concentration coupled with a contribution of presolar nanodiamonds suggests that the Ryugu samples may represent some of the most primitive unprocessed material from the early Solar System [3,7]. The analysis of grains from Bennu offers the exciting possibility to compare the volatile content of two different primitive asteroids, and to investigate another case of presumably unprocessed material from the early phases of solar system formation.

Sample Handling: Particles were handpicked from aggregate sample OREX-800032-100 in a cleanroom (ISO6) at CRPG. They were weighed using a XPR2U microbalance from Mettler Toledo@, which is not under controlled atmosphere for stability reasons. Hence the particles were briefly exposed to air before being loaded into a laser cell. Four particles were placed into different pits of a laser chamber [3,4] which was gently baked at 100 °C and pumped down to 10^{-9} mbar overnight. Each particle was sequentially heated using a CO_2 laser working at 10.6 µm. After each incremental laser power, evolved gases were purified, cryogenically separated and analyzed. Particles OREX-803039-0 (0.1190 mg), OREX-803038-0 (0.0952 mg), OREX-803037-0 (0.1792 mg), and OREX-803038-0 (0.5313 mg) were analyzed following 5, 2, 2, and 4 extraction steps, respectively.

Results and Discussion: Preliminary data indicate that: (i) $^{20}Ne/^{22}Ne$ ratios vary between 11.68 ± 0.25 and 7.15 ± 0.28. This range is very similar to the one observed for Ryugu samples [3,7]. The upper ratio indicates trapping of solar-like Ne whereas the lower end-member value is among the lowest ratios observed in bulk carbonaceous chondrites, evidencing abundant presolar material rich in nucleosynthetic ^{22}Ne. $^{21}Ne/^{22}Ne$ ratios up to 0.45 point to (limited) presence of cosmic ray–produced Ne isotopes, with an exposure duration up to a few Myr. The xenon isotope composition indicates the overarching abundance of Q-Xe with possible contribution of Xe-HL, and no evidence for cometary-like Xe, as defined by the in-situ analysis of xenon in the coma of comet 67P/Churyumov-Gerasimenko [8]. Enhancements of light Xe isotopes may also result from contribution of cosmogenic isotopes, and those of heavy isotopes could indicate contribution of fissiogenic Xe from ^{244}Pu and/or ^{238}U. Forthcoming analyses of more material will permit a more detailed analysis of the components and formation ages of material from asteroid Bennu.

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References: [1] Lauretta D.S. et al. (2023) arXiv [astro-ph.EP] 2308.11794. [2] Ott U. (2014) *Geochemistry, 74,* 519–544. [3] Broadley M. et al. (2023) *Geochim. Cosmochim. Acta, 345,* 62–74. [4] Füri E. et al. (2024) LPSC 55. [5] Tachibana S. et al. (2022) *Science,* 375, 1011-1016. [6] Yokoyama T. et al. (2022) *Science*, 379, eabn7850. [7] Okazaki R. et al. (2022) *Science,* 379, eabo0431. [8] Marty B. et al. (2017) *Science, 356,* 1069–1072.