Isotopic compositions of solar He and Ne in single lunar olivine grains. B. Frasl[1], M. Honda[1] and T.R. Ireland[1], [1]Research School of Earth Sciences, The Australian National University, Canberra ACT 0200, Australia <barbara.frasl@anu.edu.au>.

Introduction: Total fusion experiments have been conducted on single lunar olivine grains, from soil 10084, to extract solar noble gases. This pilot study was undertaken firstly, to test the analytical setup and secondly, to confirm the level of data quality of the analysis. Previous work on individual lunar grains by other authors used different mineral separates, mainly ilmenites, or different extraction methods, such as stepwise pyrolytic technique or laser vaporization (eg. [1-3]). We have compared our results to these to verify the reliability of our approach. Our ultimate aim is to correlate the fairly well established solar He and Ne ratios with oxygen isotope analyses on the same grains. This approach might offer an opportunity to unravel the various oxygen signatures found in lunar soil [4, 5]. In this study a new dataset of solar He and Ne from single lunar olivine grains is presented and compared to other results on lunar soil and the more recent findings of the Genesis mission [6].

Methods: The olivine fraction of 10084 was chosen for this trial analysis on solar noble gases. 24 large grains (>100µm) were handpicked from the mineral split and transferred into individual pits in a copper sample tray. Since the grains were not weighed, their weights were estimated geometrically. The sample tray was then heated over night at 50°C to remove possible absorbed atmospheric gases.

Analytical method. The measurements were performed on the VG5400 noble gas mass spectrometer in Canberra. For this experiment a diode laser was attached to the gas extraction system. The 810nm wavelength laser beam (10A) was used to conduct total fusion of the sample, releasing noble gases. This procedure allowed relatively short analytical time with low blank levels. HESJ ($^3He/^4He = 2.9x10^{-5}$) and Heavy Gas Pipette (with atmospheric Ne) were used as standards to determine the sensitivity and discrimination for the helium and neon measurements, respectively. The blank levels for ^4He and ^{20}Ne were $1.27x10^{-9}$±$7.21x10^{-11}$ and $2.68x10^{-12}$±$3.05x10^{-12}$ ccSTP respectively. Additionally, one sample was reheated to confirm that all noble gases were released in the first total fusion step. The first two samples were analyzed for all five stable noble gases, however krypton and xenon were not abundant enough in these grains for successful measurements. Argon was analyzed, but the extracted gas was very close to the blank levels and therefore below the expected quality.

Results: The present dataset represents the total release of noble gases from single grains analyzed. Therefore, the data pattern includes the solar component, as well as a mixing trend with a cosmogenic end member. The majority of the data, however, are in close agreement with established solar ratios found in lunar soil. The neon isotope ratio plot (Fig. 1), $^{20}Ne/^{22}Ne$ vs. $^{21}Ne/^{22}Ne$, demonstrates these trends clearly. Further, some of the 10084 grains seem to record the SEP component. The data set has not been corrected for cosmogenic influence and therefore an offset from $^{20}Ne/^{22}Ne \approx 13.0$ and $^{21}Ne/^{22}Ne \approx 0.033$ is noted. Specifically, some of the large grains display an increased abundance of cosmogenic neon.

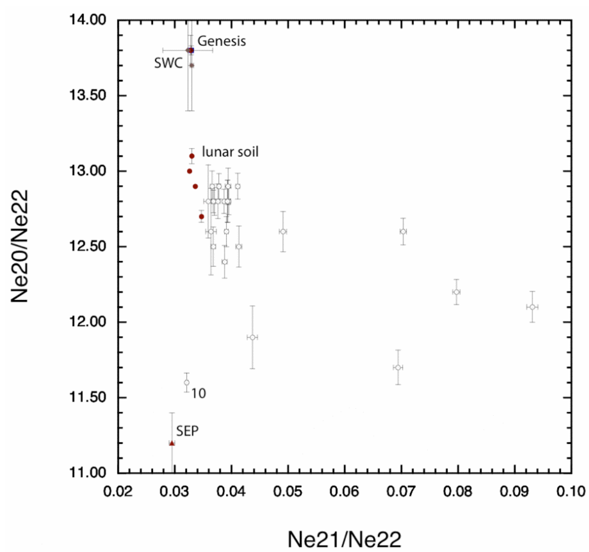

Figure 1. The three isotope plot of Ne demonstrates that all grains recorded a solar component. Additionally, a mixing trend towards a cosmogenic end member can be seen. A few of the grains also appear to record a SEP component. Open circles (this study), red circles: lunar soil [1, 7, 8], blue cube: Genesis [6], brown diamond: SWC [9], red triangle: SEP [8].

The same trend towards a cosmogenic end member can be identified in the $^3He/^4He$ vs. $^{21}Ne/^{22}Ne$ plot (Fig. 2). Again the offset from $^3He/^4He \approx 4.6x10^{-4}$ and $^{21}Ne/^{22}Ne \approx 0.033$ is apparent. Furthermore, the same larger grains stand out in both plots, demonstrating that we are able to pick up the cosmogenic input in both neon and helium isotopes.

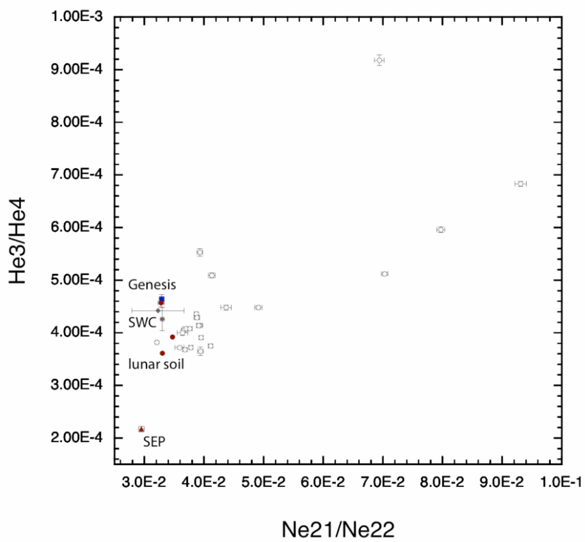

Figure 2. The same grains carrying the increasing cosmogenic component are also identifiable in the $^{3}He/^{4}He$ vs. $^{21}Ne/^{22}Ne$ plot. The majority of the data points plot close to the expected solar ratios. Open circles (this study), red circles: lunar soil [7, 8], blue cube: Genesis [6], brown diamond: SWC [9], red triangle: SEP [8].

Discussion: We have demonstrated here that high quality noble gas isotope data can be extracted from individual lunar grains using this particular method. In addition to the solar component recorded in all the grains analyzed, a trend towards a cosmogenic end member can be positively identified. Further, one could arguably see the implantation upon a fractionation trend [10, 11] between solar wind and SEP component emerging in the Ne isotope plot (Fig. 1). This, however, would only be represented by one data point (grain 10, Fig. 1), which could be interpreted as the SEP component itself.

Although this method lacked the detailed resolution obtained by stepwise release for various components trapped in lunar soil [1, 2] it still shows a distinctive pattern within. However, with future correlation between those patterns and other stable isotope analysis in mind, this approach promises to be more revealing. Additionally, this study adds noble gas isotope data on individual lunar olivine grains for further research.

Future work: The current study demonstrates that solar He and Ne can successfully be identified from an individual single lunar olivine, using a high sensitive noble gas mass spectrometer. It is expected that for future studies noble gases will provide powerful constraints on characterizing oxygen isotopes on the same lunar ilmenites and metal grains to be measured with the SHRIMP SI.

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