OXYGEN ISOTOPE COMPOSITIONS OF MINERAL SEPARATES FROM NWA 7325 SUGGEST A PLANETARY (MERCURY?) ORIGIN. I. Jabeen[1], A. Ali[1], N. R. Banerjee[1], G. R. Osinski[1], S. Ralew, and S. DeBoer. [1]Department of Earth Sciences/Centre for Planetary Science and Exploration (CPSX), University of Western Ontario, London, ON, Canada. Email: neil.banerjee@uwo.ca. Email: ijabeen@uwo.ca.

Introduction: NWA 7325 is an extremely unique meteorite because it is the only specimen that has been suggested to be from the planet Mercury [1]. Triple oxygen plots are considered one of the most important tools to help understand the parent body origins of meteorites as this technique provides quantitative compositional ranges for different planetary/asteroidal bodies. These plots can thus be used to infer the origin of a certain unknown meteorite from its oxygen isotope data [1]. For example, we know exactly where a sample from Mars, Earth, Moon and certain asteroids would plot on a triple oxygen isotope plot. A considerable amount of work has allowed classification of our Solar System's planetary bodies' on these diagrams but there are still blank areas where other inner planets such as Mercury, Venus, the outer planets and their rocky moons may lie.

NWA 7325 is a 2012 find from Morocco. Petrography, FTIR and Raman spectroscopy have shown its large crystals are primarily plagioclase and diopside [2]. NWA 7325 has low magnetic intensity that is similar to that of the planet Mercury as seen in magnetic intensity data gathered by NASA's Messenger spacecraft. It is classified as an ungrouped achondrite in the Meteoritical Bulletin on the basis of geochemistry and its unique elemental/mineral composition. Its low elemental ratios like Al/Si and Mg/Si and presence of virtually no iron are interpreted to closely resemble the surface properties of the planet Mercury [3].

In this present study we have investigated, for the first time, the triple oxygen isotope data of NWA 7325's major minerals, plagioclase and pyroxene to better understand its oxygen isotope composition/classification, to understand its parent body signatures, and to explain/justify whether it belongs to a planetary body. The only triple oxygen isotope data available so far is work done on whole rock analyses [1], which verifies that it is an ungrouped achondrite but does not shed light on its parent body signatures and the processes involved therein.

Analytical Setup: CO_2 laser-BrF_5 fluorination mass spectrometry is used to extract oxygen for triple oxygen isotope analyses. A typical sample size of 1-2 mg is used. After laser irradiation liberated oxygen is purified cryogenically and then collected onto molecular sieve 5A tablets for analyses. The plagioclase and pyroxene fractions were hand picked and acid leached prior to laser irradiation. Details of the analytical protocols are given in [4].

Figure 1. Photograph of NWA 7325. Image © S. Ralew.

Results and Discussion: The average oxygen isotope composition of plagioclase is $\delta^{18}O$ = 8.0 ‰, $\delta^{17}O$ = 3.2 ‰ and $\Delta^{17}O$ = -1.00 ‰ and for pyroxene it is $\delta^{18}O$ = 6.4 ‰, $\delta^{17}O$ = 2.4 ‰ and $\Delta^{17}O$ = -1.00 ‰. The complete data set and its comparison to [3] is given in Table 1.

Table 1. New and compiled triple oxygen isotope data for NWA 7325. Pl, Px and Ss stand for plagioclase, pyroxene and subsample respectively.

ID	$\delta'^{18}O$	$\delta'^{17}O$	$\Delta^{17}O$	Reference
NWA 7325 mineral separate data				
Pl	8.04	3.20	-1.00	this study
	7.95	3.17	-0.98	
	7.99	3.16	-1.01	
	8.13	3.23	-1.01	
Px	6.42	2.35	-1.00	this study
Ss	7.566	3.214	-0.781	[1]
	8.207	3.670	-0.662	
	7.957	3.249	-0.952	

The oxygen isotope data of plagioclase and pyroxene from NWA 7325 make a slope ½ line on the triple oxygen isotope plot that lies parallel and below the terrestrial fractionation line (TFL). This ½ slope line suggests that this meteorite belongs to a igneous differentiated parent body where mass dependent fractiona-

tion of oxygen isotope is a major phenomenon as it is on the planets Earth and Mars or larger differentiated asteroids like 4 Vesta. The oxygen isotope composition of NWA 7325, however, does not match any of these parent bodies.

By looking closely at the oxygen isotope data available so far from all meteorite groups, the $\delta^{18}O$ values of NWA 7325 minerals fall around the range for winonaites, ureilites and within the upper region of the range for the acapulcoite-lodranite clan (Figure 2). The $\Delta^{17}O$ value of -1.00 permil, however, excludes it belonging to any winonaite group because they have $\Delta^{17}O$ value of around -0.46 ± 0.08 ‰ [5].

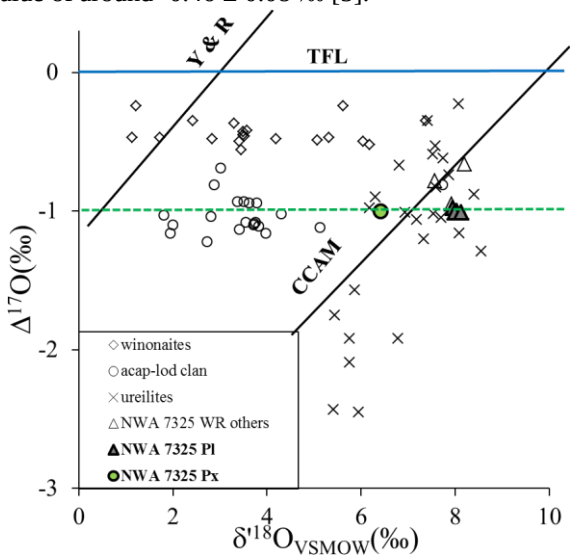

Figure 2. Comparison of oxygen isotope data of NWA 7325 to other achondrite groups. The open symbols are data from [2, 5 & 6]. The filled symbols are data from this study.

We cannot exclude a genetic relationship for NWA 7325 to the acapulcoite-lodranite clan as well as some of the ureilites because some members from both groups have similar $\Delta^{17}O$ value of -1 permil. However, there exists currently no compositional match for NWA 7325 in the acapulcoite-lodranites clan or the ureilites. If NWA 7325 does indeed represent a sample from Mercury additional samples from that planet should plot along a consistent fractionation line like that for Earth and Mars (Figure 3).

Conclusion: Precise triple oxygen isotope work on major minerals from NWA 7325 supports the evidence that this meteorite belongs to a larger planetary body. A $\Delta^{17}O$ value of -1.00 with small standard deviation of 0.01 permil suggests that this planetary body could be another planet where minerals evolved through igneous differentiation processes just like our Earth or Mars. As NWA 7325 has oxygen isotopes not matching other planets (i.e., Earth and Mars on a triple oxygen isotope plot) it is possible that it originated from the planet Mercury.

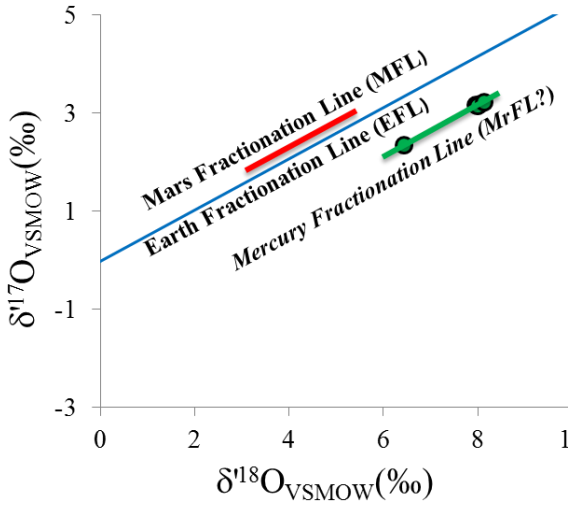

Figure 3. Planetary fractionation lines drawn on the basis of oxygen isotopes. EFL is from [4] and MFL is from [7-8]. The filled symbols are the data of NWA 7325 from this study.

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