Eliminating Analytical Uncertainty: Analyzing Geological Standards Using ICP-MS

Adelaide Clark[1,3] and Dr. Fang-Zhen Teng[2,3]

[1] Emory & Henry College, Department of Chemistry
[2]University of Arkansas, Department of Geosciences
[3]Arkansas Center for Space and Planetary Sciences

Introduction

It is important to determine if the Earth has a chondritic composition

- "shed light on the accretion of the Earth" [1]

This chondritic composition is a subject of much debate.

- disagreement may be due to the analytical techniques used
  - analysis by ICP-MS is more precise than laser ablation
  - ICP-MS leads to instrument bias in elements of low atomic number. [2]

Magnesium has three stable isotopes [3]

- 24 (Relative abundance 78.99%)
- 25 (Relative abundance 10.00%)
- 26 (Relative abundance 11.01%)
  - Mass difference 4 – 8%
  - Relatively large

These stable isotopes have fractionation potential

- Must be absent in order to study basalts from the upper mantle [1]
  - proves homogeneous or heterogeneous.

To solve the analytical uncertainty, twelve homogeneous standards are distributed to different labs worldwide and analyzed using that labs analytical technique.

Results

Standards (δ^{26}Mg 2SD)

Sample ID	MgO (wt%)	Previous Value		Measured Value	
GBW07101	41.03	-0.32	0.09	-0.31	0.07
GBW07102	38.34	-0.13	0.13	-0.13	0.07
GBW07103	0.42	-0.23	0.10	-0.27	0.07
GBW07104	1.72	-0.65	0.09	-0.72	0.07
GBW07105	7.77	-0.44	0.11	-0.57	0.07
GBW07109	0.65	-0.32	0.10	-0.15	0.07
GBW07110	0.84	0.08	0.02	0.12	0.07
GBW07111	2.81	-0.25	0.07	-0.20	0.07
GBW07112	5.25	-0.21	0.05	-0.18	0.07
GBW07113	0.16	-0.41	0.14	-0.35	0.07
GBW07122	5.08	-0.21	0.09	-0.24	0.07
GBW07123	7.20	-0.29	0.07	0.12	0.07

Table 1: Values are compared side by side.

δ^{26}Mg v. MgO

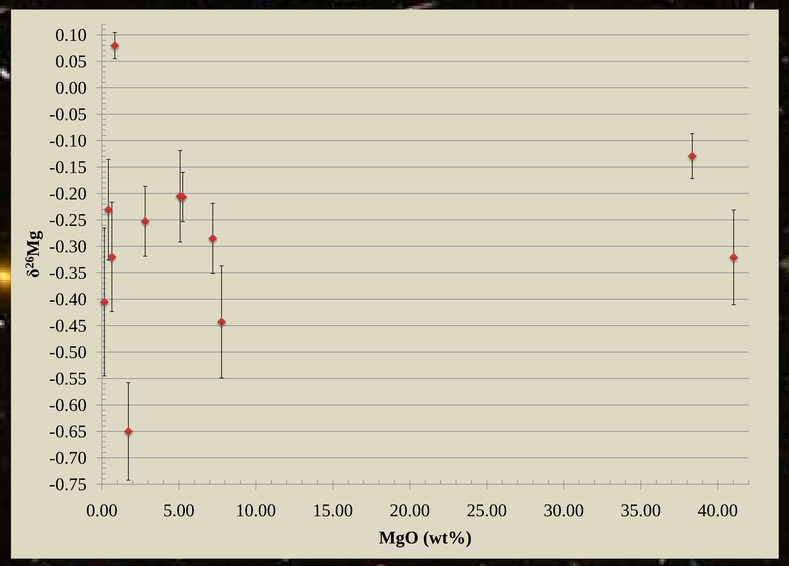

Figure 1: Previous standard measurements from our lab.

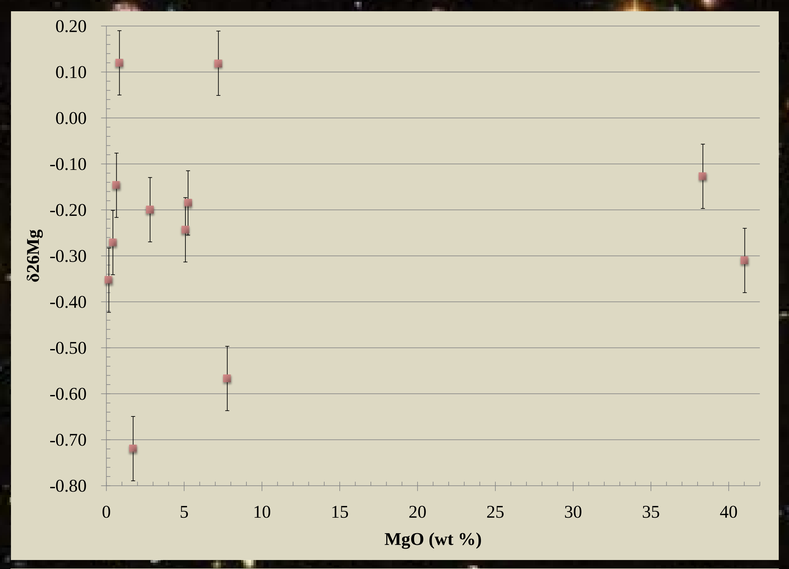

Figure 2: Standard measurements performed in this experiment.

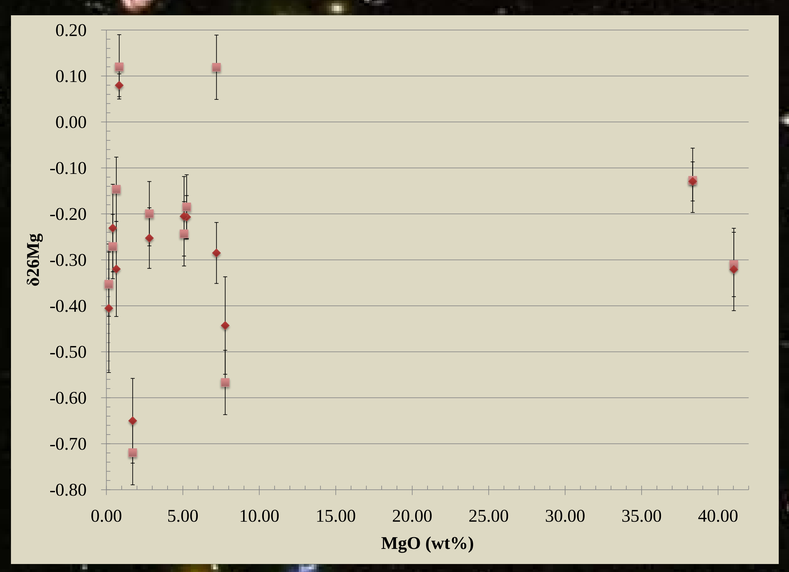

Figure 3: Composite of Figures 1 and 2 to illustrate overlap.

Discussion and Conclusion

As can be seen in Table 1 and Figure 3, most of the data ranges in this experiment overlaps with the range of the data from previous experiments.

- Only GBW07123 lies outside this

This shows that our previously measured data holds true in reproducibility.

Possible reasons of error regarding GBW07123:

- GBW07123 and GBW07109 were measured at a different time from the other 10
  - Both do not match previous data as well as other 10 samples do
  - GBW07109 still overlaps it's previous measurement range partially

Based on the data presented here, we can conclude:

- Our measurements for these standards are accurate.
- Further trials need to be completed and compiled to check this assertion of accuracy.
- Particular attention needs to be paid to GBW07123 and GBW07109 in these trials.

Our data must then be compared to data from a Laser Ablation ICP-MS laboratory.

- This will show if technique is a reason for disagreeing results in proving chondritic composition of the Earth.

References

[1] Teng, F. –Z., et. al. *Geochim. Cosmochim. Acta* (2010).
[2] Yang et al. *Earth and Planetary Science Letters 288* (2009).
[3] Teng, F. –Z., et. al. *Earth and Planetary Science Letters 261*(2007) 84 – 92.
[4] Huang, et al. *Chemical Geology* (2009).

Acknowledgements

- The National Science Foundation for providing my summer funding
- The Arkansas Center for Space and Planetary Sciences
- The team in the Isotope Lab at the University of Arkansas