

THE YOUNGEST METEORITES: II. Trace Element Zoning in Zagami Maskelynite. J.H. Jones*, T.M. Benjamin**, M. Hollander** and J. Conner***. *Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721. **Los Alamos National Laboratory, Los Alamos, NM 85745. ***Department of Physics, University of California Davis, Davis, CA 95616.

The zoning of major elements in the mineral phases of the shergottites appears to imply that these meteorites have suffered little or no resetting of refractory isotopic systems since their crystallization from basaltic magma [1]. However, the 180 m.y. Rb-Sr and Sm-Nd isochrons of Zagami have been interpreted as due to the shock resetting of these chronometers in a rock which crystallized at 1300 m.y. [2]. It appeared to us that the only means of reconciling these two observations was if the trace elements in Zagami were able to diffuse at much faster rates than the major elements. This hypothesis, which perhaps endows trace elements with improbable properties, is testable. If trace elements diffuse at faster rates, trace elements in shergottite mineral phases should be unzoned - in contrast to the major elements.

Accordingly, we have performed trace element analyses on Zagami maskelynite (the phase in Zagami in which diffusion should be most rapid) using the Los Alamos proton microprobe. The protons generate x-rays whose intensities are proportional to elemental abundances in the sample; these x-rays in turn are measured by an energy dispersive Si(Li) detector. Details of the analytical technique have been reported elsewhere [3,4]. The maskelynite grain on which these analyses were performed is normally zoned (electron probe analysis) with a core of An₅₅ and rims as sodic as An₄₅. These analyses are very consistent with the electron probe analyses of others [5] and indicate a modest but consistent difference in major element chemistry between core and rim.

Our preliminary results indicate that five minor and trace elements are detectable in Zagami maskelynite: Fe, Sr, Mn, Ga and Zn. Our preliminary maskelynite core concentrations for these elements are: Fe, 5500ppm; Sr, 240ppm; Mn, 96ppm; Ga, 55ppm; and Zn, 6ppm. The Fe and Sr concentrations are in acceptable agreement with other techniques. Our electron probe measurements indicate that 4000-5000ppm FeO exists in the maskelynite core and Shih et al. measured 191ppm Sr in a maskelynite-rich mineral separate from Zagami by isotope dilution [2]. We take this agreement to indicate that the thermal effects of the proton beam have not seriously affected our analyses, even though the difficulty of measuring alkalis in maskelynite is well known [5]. All elements except Zn have counting statistics errors of 3% (relative) or less; the error for Zn is 7-10%.

All the elements for which we have data show normal igneous zoning trends - except Sr, whose concentration remains rather constant. Ga increases by ~25% as more albitic regions are approached, Zn increases by greater than 50%, and Fe and Mn increase by nearly a factor of two. This large change in Fe concentration has been confirmed by electron probe analyses where spatial resolution (and the concomitant problem of analyzing inclusions and/or adjacent grains) is not an issue. Figure 1 summarizes the raw Ga and Mn data. These data are normalized to Sr, which appears to be rather constant. The change in Ga and Mn count rates is obvious.

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We interpret these zoning trends to be the preserved products of igneous crystallization rather than artifacts of different diffusion rates. Indeed, the similarity of the Zagami fractionation sequence (inferred from the maskelynite zoning) to well-documented instances of basaltic fractional crystallization strengthens this interpretation. In the Skaergaard intrusion, for example, Fe and Mn are enriched in the final liquids, Ga is enriched-but less so, and Sr remains essentially constant [5] - exactly the sequence which we observe in Zagami maskelynite.

Because Sr is not zoned, one could conceivably still make the argument that Sr diffuses much faster than all other divalent cations - major, minor and trace. Such a model would thus allow Sr isotopic equilibration while all other elements remain zoned. This type of model must also (1) require that Nd have special properties too since the Rb-Sr and Sm-Nd ages of Zagami are indistinguishable and (2) explain why divalent Sr, which is larger than divalent Ca, Mn, Zn and Fe, is apparently able to diffuse much faster than these elements. Thus, at present we question the viability of models which attribute special diffusive properties to Sr. Elements at all concentration levels in Zagami retain their original igneous zoning patterns. Again, this implies a very young 180 m.y. igneous age for Zagami and the other shergottites.

REFERENCES. [1] Jones J.H. (1985), this volume. [2] Shih C.-Y. et al. (1982) *G.C.A.* 46, 2323-2344. [3] Rogers P.S.Z. et al. (1984) *Nuc. Inst. Meth. B3*, 671-676. [4] Benjamin T.M. et al. (1985), this volume. [5] Stolper E.M. and McSween H.Y. (1979) *G.C.A.* 43, 1475-1498. [6] Henderson P. (1982) *Inorganic Geochemistry*, pp. 85-89.

Figure 1. Variation in Ga and Mn in Zagami maskelynite. Data are normalized to Sr which is essentially constant. The Ga/Sr ratio increases from 1.0 to 1.25 (core to rim) while the Mn/Sr ratio increases from 1.75 to greater than 3.0.

