SHOCK METAMORPHISM OF THE ZAGAMI ACHONDRITE; F.Langenhorst, D.Stöffler und D.Klein, Institut für Planetologie, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str. 10, D-4400 Münster, Germany

Introduction. All known shergottites are affected by intense shock metamorphism as indicated by the presence of diaplectic plagioclase glass (maskelynite) and mechanical deformations in pyroxene (e.g.,1). A detailed study of the shock effects in Zagami is lacking although some refractive index data of maskelynite which are not consistent, have been reported (2,3). Based on these data conflicting estimates of the peak shock pressure experienced by Zagami have been derived: 27 GPa (2) and 31 +/-2 GPa (1).

Samples and general shock features. Our present investigation of Zagami has been made on sample A23.10. Subsample A23.12a3 was used for the separation of pure maskelynite grains. Thin sections (subsamples A23.12c and A23.19) were available for microscopic analyses. The main shock metamorphic characteristics of Zagami A23.10 are: (a) Clinopyroxene displays strong mosaicism, polysynthetic mechanical twinning subparallel to (001), and planar features, effects which are all well known from naturally shocked terrestrial, lunar, and meteoritic pyroxene (e.g., 4); (b) plagioclase is completely transformed to diaplectic glass (maskelynite). Its primary intragranular texture (cleavage, inclusions) and its primary crystal shape and textural relationship to coexisting minerals are perfectly preserved. No sign of vesiculation or flow structure nor any relic birefringence has been found; (c) An additional shock characteristic are less than 1 mm thick, glassy pseudotachylite-like veins (shock veins) which cut discordantly through the sample as straight or slightly curved, sometimes branching dikelets with a spacing in the order of centimeters.

Refractive index of maskelynite. High precision refractive index data were obtained by the Medenbach spindle stage (5) on five grains of maskelynite, approximately 100 µm in size (Table 1). As seen from the dispersion and Becke line behavior at the rims of each grain, the individual maskelynite grains are quite inhomogeneous with respect to their refractive index. This appears to be related to a chemical inhomogeneity (zoning?) of the measured grains. Microchemical analyses of the same grains obtained with the SEM yielded variations of the An-content of about 10 to 20 % for 4 to 5 analyses per grain. Similarly, the average An-content of the five measured grains varies by ca. 20 % (Table 1). Although there is a positive correlation between the average An-content and the average refractive index n for the 5 Zagami maskelynite grains, the $\Delta n/An$ value is much smaller for maskelynite than for synthetic plagioclase glass and quite similar to crystalline plagioclase (Fig.1). The most conspicuous finding is that the refractive index of Zagami maskelynite is higher than any measured refractive index of artificially produced single crystal diaplectic glass or natural diaplectic glass from quartzo-feldspathic rocks (assuming identical An-contents). In fact the refractive index of the Zagami maskelynite falls into a refractive index range where the terrestrial counterparts are still birefringent. This is analogous to previous results obtained for the Shergotty maskelynite (1).

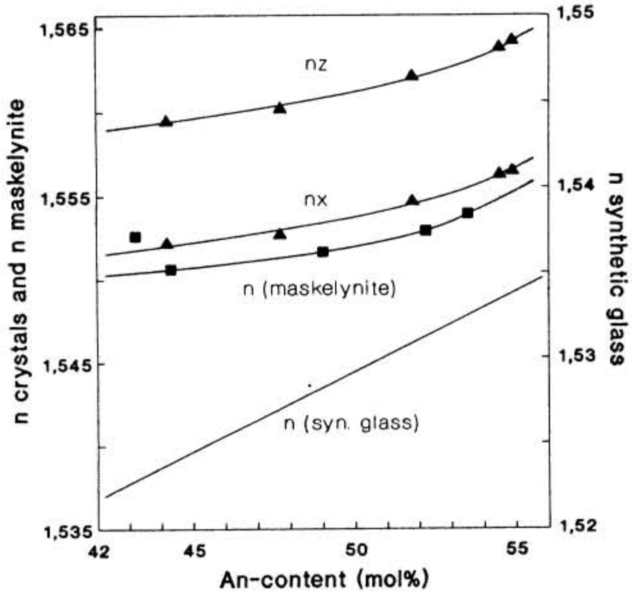
Conclusions. From the refractive index of maskelynite the average peak shock pressure can be estimated using experimental calibration data. Based on the single crystal labradorite (An_{51}) calibration curve (6, 7) this pressure would be 29.3 GPa for an interpolated 1.5521 refractive index (Fig.1) of the Zagami An_{51}-maskelynite. This value is somewhat lower than our previous estimate of 31 +/- 2 Gpa. However, there may be a problem with the pressure calibration. The highest refractive index of any known diaplectic glass of

An_{51}-composition is 1.5419 compared to 1.5521 of Zagami. Considering a similar inconsistency for the Shegotty maskelynite (1) the applicability of single crystal calibration data for plagioclase-bearing mafic rocks becomes questionable. Experimental data on basaltic-gabbroic rocks are urgently needed to solve this problem. The reasons for the anomalously high refractive index of maskelynite in shergottites are not clear. One reason may be the high shock impedance of the pyroxene "matrix" into which plagioclase is embedded. The much lower compressibility of pyroxene compared to plagioclase may lead to a densification effect upon pressure release when the plagioclase structure expands beyond its pre-shock volume against the rigid network of pyroxene whose post-shock volume is only slightly larger than prior to the shock compression. Glass densification by a confining quasi-hydrostatic pressure is well known (8).

Table 1: Average chemical composition and refractive index of 5 maskelynite grains of Zagami; n_D for 589 nm; error of n_D is ± 0.0005

Sample No.	Ab	An	Or	n_D	Sample No.	Ab	An	Or	n_D
Z1	49.5	49.0	1.5	1.5516	Z4	46.4	52.2	1.4	1.5529
Z2	45.3	53.5	1.2	1.5539	Z5	53.0	43.2	3.8	1.5526
Z3	53.6	44.3	2.1	1.5506					

Fig. 1: Refractive index of 5 maskelynite grains (Table 1) in comparison with plagioclase crystals and synthetic plagioclase glass; data for the latter two from (9)



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