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* THERMOLUMINESCENCE STUDIES OF SHOCK LOADED OLIGOCLASE AND BYTOWNITE. Christopher P. Hartmetz*, Derek W.G. Sears* and Rolf Ostertag+. *Dept. of Chemistry, Univ. of Arkansas, Fayetteville, AR 72701. +Inst. fur Mineralogie, Univ. of Munster, West Germany.

Feldspar is abundant in crustal rocks and in meteorites, and is responsive to many geological processes (e.g. metamorphism, shock,... 1-6). Thermoluminescence (TL), which is highly sensitive to the amount and nature of feldspar, therefore provides a unique means of following these processes. Intense shock causes a 10-100 fold decrease in the TL sensitivity of ordinary chondrites (7,8), while the same class shows a 10**5-fold increase in TL sensitivity as feldspar crystallizes during metamorphism. The width and temperature of the TL peak also provides data on thermal history (9,10; see below). Here we report TL data for samples of ordered oligoclase and bytownite which have been shock loaded to 10.5-45 GPa (105-450 kbar) and their optical, X-ray, IR and EPR properties determined by Ostertag (6). We also include a glass made by annealing oligoclase at 1500 C for 6 h.

The samples and the shock loading experiments are described in ref. 6. For TL determination, 15-30 mg samples were gently ground and duplicate 4 mg aliquants used, each measurement being repeated 3 times. The methods are similar to those of ref. 11.

The TL glow curves for the oligoclase samples have three peaks (Fig. 1); for the unshocked and shocked <34 GPa samples, the dominant peak is at 132+/-8 C and there is evidence for a peak at 300+/-10 C; for samples shocked >34 GPa, a peak at 230+/-12 C dominates; the glass has a dominant peak at 230 C with peaks at 132 and 300 C. The presence of the 300 C peak in many samples precludes measuring peak width for the 130 and 230 C peaks. Shock loading causes a decrease in TL sensitivity similar to that observed in samples of the Kernouve H6 chondrite that was similarly shocked (6, Fig. 2); 25-30 GPa causing a 10-fold decrease and 34-45 GPa causing a 25-fold decrease, except that in the present case low shock levels seem to have a greater effect. This decrease is most readily interpreted as being due to the maskelynization or fusion of the feldspar. The bytownite samples displayed two peaks (Fig 3.), that at 138+/-8 C dominated in all cases but for samples shocked >25 GPa a peak at 178+/-8 C is also present. The decrease in TL sensitivity is less than for oligoclase (maximum about 1/10). The width of the composite 138/178 C peak increases from 110+/-5 C in samples shocked <15 GPa to 150+/-15 C in samples shocked >25 GPa (Fig. 4).

The similarity in the response of the oligoclase and Kernouve to shock loading demonstrates that the differences in history and composition between terrestrial and Kernouve feldspar do not significantly affect TL sensitivity, and the present data enable an estimate of the shock intensities suffered by heavily shocked ordinary chondrites. Using data for naturally shocked ordinary chondrites from ref. 6, we infer shock pressures of >26 GPa for shock facies d-f (Fig. 2).

The present data also provide evidence for the occurrence of a solid state change associated with pressures >34 GPa in oligoclase, slightly lower in bytownite. Measurements on type 3 ordinary chondrites (12), samples of annealed ALHA77011 (9)

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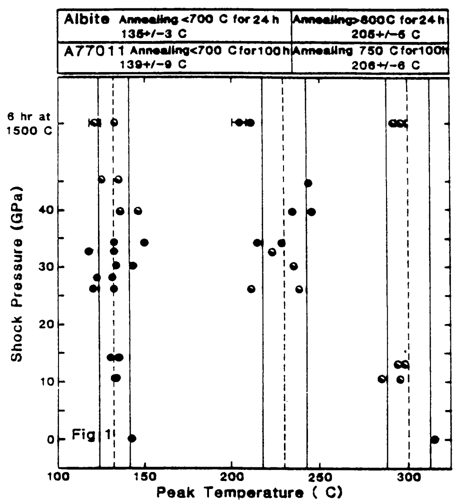
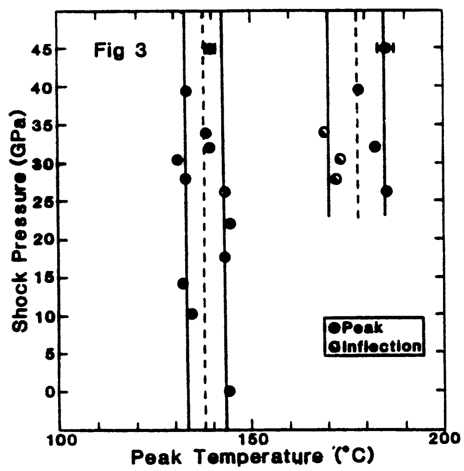
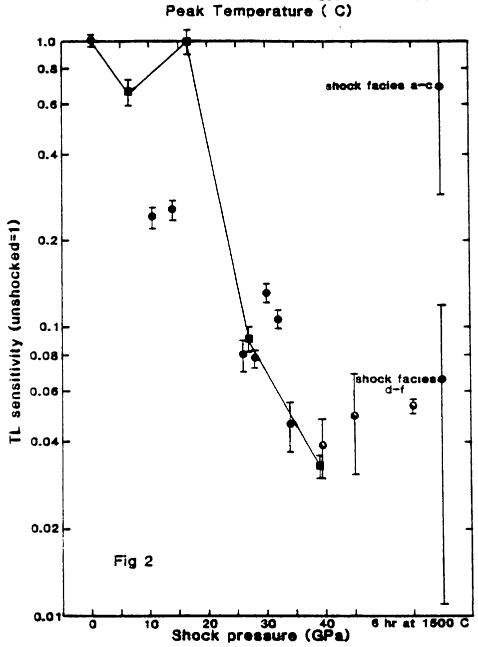
and Amelia albite (10) have shown that such peak shifts (and broadening) are related to the thermal history of the sample; the data on Amelia albite suggest that they may be associated with the onset of disordering in the Al,Si framework. There is no X-ray diffraction or IR spectral evidence for disordering below 30 GPa for these samples (6), data are not available for samples shocked at higher pressures, but samples shocked to >22 GPa and then annealed at 1000 C for 100 h disordered more rapidly than unshocked samples (13). We suggest that our data are providing evidence for shock-induced disordering >34 GPa which was not detectable by the other techniques because only a small fraction of the feldspar avoids fusion or maskelynization at these pressures. Even small increases in pressure (1.8 GPa) are known to greatly facilitate disordering (14).







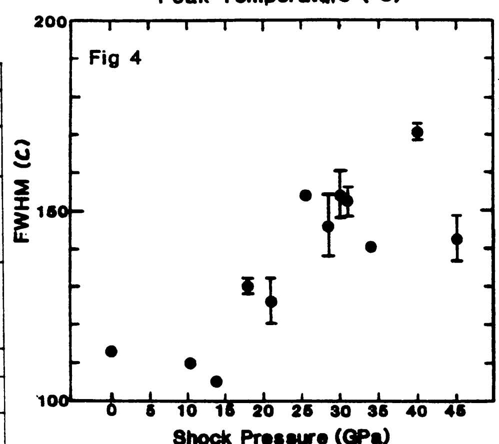


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Fig. 1 Positions of TL peaks for samples shocked at each pressure: closed symbol, discrete peak; half-filled symbol, inflexion. (1 sigma uncertainties for the pressures are 3% and for the temperatures are 4 C). Vertical lines refer to mean +/- 1 sigma for all samples for a given peak. Fig. 2 TL sensitivity at 132 C for oligoclase as a function of shock pressure: filled symbol, peak; half-filled symbol, inflexion; square, the Kernouve meteorite (6). Fig. 3 As Fig.1 for bytownite. Fig. 4 Full width at half maximum for the 138/178 C peak of bytownite against shock pressure. (Errors are 1 sigma, < symbol if missing).

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