Thermal Infrared Spectral Deconvolution of Experimentally Shocked Basaltic Rocks Using Experimentally Shocked Plagioclase Endmembers. J.R. Johnson[1], M.I. Staid[2], [1]U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ 86001, jrjohnson@usgs.gov, [2] Planetary Science Institute, Tucson, AZ.

Introduction: Thermal infrared laboratory spectra of experimentally shocked bytownite feldspars [1,2] were combined with standard mineral libraries to deconvolve the spectra of experimentally shocked basaltic rocks [3] to determine the accuracy with which pressures can be estimated in shocked basalts. High shock pressures cause disorder in the mineral lattice of plagioclase feldspars (whereas pyroxene and olivine spectra are more resilient). This affects thermal infrared absorption bands owing to an increase in diaplectic glass content, particularly at shock pressures above ~20-25 GPa [1,2]. Our results indicate that average shock pressures derived from spectral deconvolutions are relatively good, with 10-15 GPa deviations at intermediate pressures and by ~5 GPa at other pressures.

Samples. Emission spectra of experimentally shocked anorthosite (bytownite, An_{79}) were described by [1] (Figure 1a). Emission spectra of experimentally shocked basalt (Grand Falls, AZ) are shown in Figure 1b [3]. Grand Falls basalts are fine-grained with ~25% pyroxene, ~20% olivine, and ~40-50% feldspar.

Spectral Deconvolutions. We used a version of the multiple endmember spectral mixing algorithm (MESMA) [4] to deconvolve the shocked basalt spectra using a spectral library composed of 35 minerals and glasses, plus 10 spectra of anorthosite shocked 17-56 GPa. This version initially compares all possible three-endmember combinations plus a blackbody component used to compensate for grain size variations between the library and sample spectra. The best model containing positive endmember abundances for each input spectrum is identified via the rms error computed for each combination. Then each unused library endmember is alternately added to the three endmembers and a new rms error is calculated. The spectrum that provides the best improvement (and is selected with a positive abundance for all endmember components) is then kept as an additional endmember. If no additional spectrum results in all positive fractions and an improved error, the previous best solution is kept. This procedure is then repeated until as many as 12 mineral endmembers are selected. We ran the algorithm over the spectral range 400-1400 cm^{-1} with and without inclusion of the shocked feldspar spectra. Derived mineral abundances were normalized to 100%. Average shock pressures were determined by weighting the modeled shocked feldspars' pressures by their abundance.

Results. Model results demonstrate a large increase in rms error with increasing shock pressure when shocked feldspars are not included in the spectral library (Figure 2), similar to the deconvolution results demonstrated by [2] for shocked feldspars. Models of unshocked basalt spectra selected no shocked feldspars and modeled total feldspar abundances as 60%, i.e., within 10-20% of the known feldspar abundance. Modeled pyroxene abundance is 11% and olivine 11%. Figure 3 demonstrates that the total feldspar abundance (unshocked+shocked) is within 10% of this value except for the highest shock pressures. Assuming no significant variations in the feldspar content of the individual basalt sample splits, the higher overall feldspar content could be consistent with a greater areal dispersal of melted materials within the matrix of the shocked basalt at higher pressures.

Figure 4 shows that the modeled spectra for the unshocked basalt (0 GPa) and a highly shocked basalt (46.5 GPa) provide a relatively good fit to the measured spectra. Figure 5 compares the known laboratory shock pressures for the basalts to the average pressures of the shocked feldspars selected by the model. The correlation is relatively good: 10-15 GPa deviations occur at intermediate (~30-40 GPa) pressures, and ~5 GPa at other pressures. These results are consistent with those presented by [5], who used the shocked feldspar spectra (Figure 1a) to deconvolve laboratory spectra of naturally shocked Deccan basalt from Lonar Crater, India. They also demonstrated that no shocked feldspars were chosen for unshocked basalt, but abundances ~45% of shocked feldspars (56.3 GPa) were selected for highly shocked Lonar samples.

This work provides further evidence that shocked feldspar spectra are selected by deconvolutions only when shocked materials occur in a sample and that the modeled pressures are relatively accurate estimates. Future work will concentrate on deconvolutions of experimentally shocked basaltic andesite spectra.

References: [1] Johnson, J.R., et al., *JGR* 107(E10), 2001JE001517, 2002; [2] Johnson, J.R.,et al., *Amer. Mineral.*, 88,1575-1582, 2003; [3] Johnson, J.R., & F. Hörz, EOS, P21B-053,2003; [4] Johnson,J.R.et al., LPSC XXXIII, #1345, 2002; Staid, M.I.,et al. LPSC XXXV,#1778,2004; Staid, M.I. et al. EOS, S2(47), P42A-0553, 2001; [5] Wright, S.P., et al., *LPSC,* #2179, 2004.

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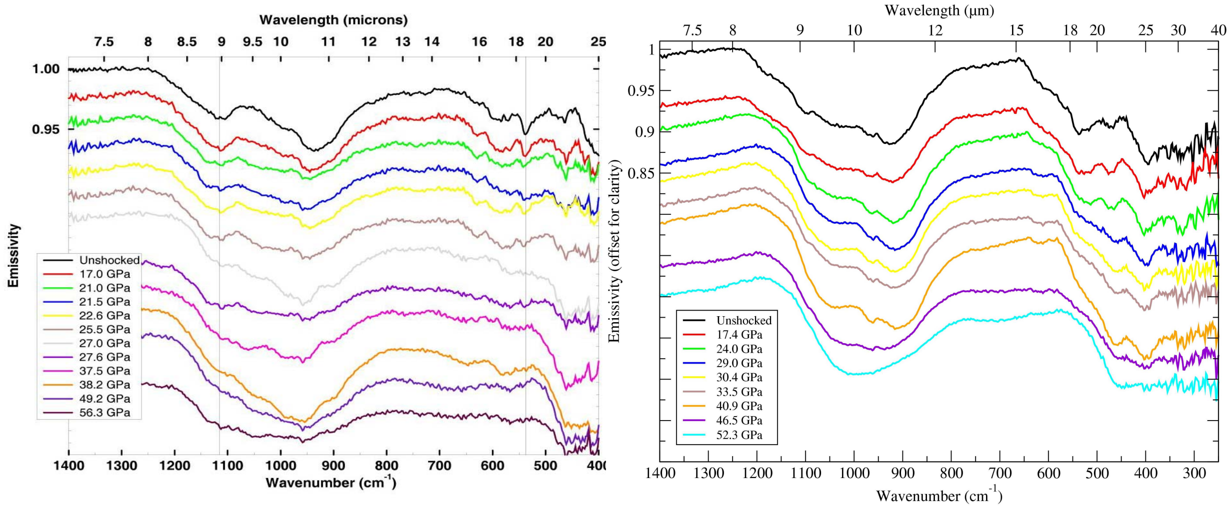

Figure 1. Thermal emission spectra (offset for clarity) of experimentally shocked (***a***) anorthosite (bytownite; 0-56 GPa) [1], and (***b***) Grand Falls basalt (0-52 GPa) [3] showing spectral changes with increasing pressure.

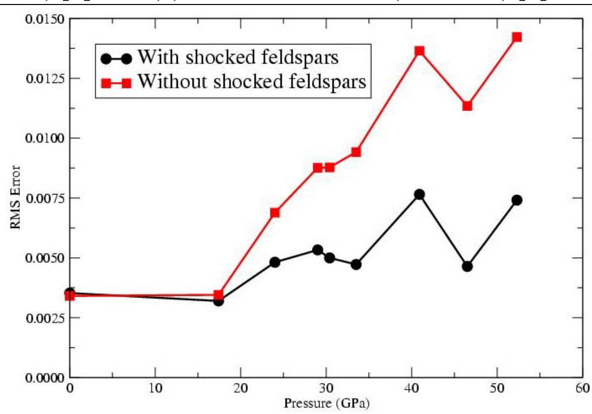

Figure 2 RMS errors for spectral deconvolutions of shocked basalts performed with and wihtouth shocked feldspar spectra in the endmember library.

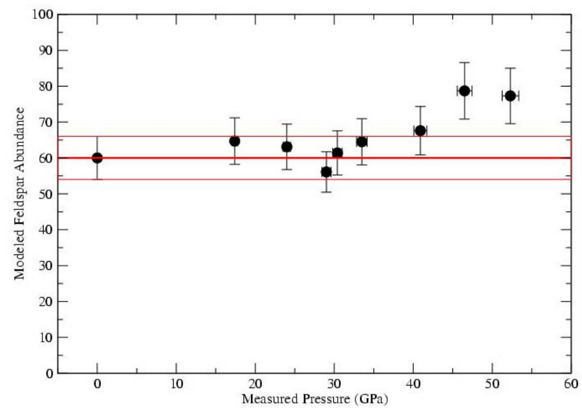

Figure 3 Modeled abundances of total feldspar (unshocked and shocked) for each shocked basalt sample. Red box represents 10% uncertainty on total feldspar in unshocked sample. Highly shocked basalts overestimate feldspar abundance by 10-15%.

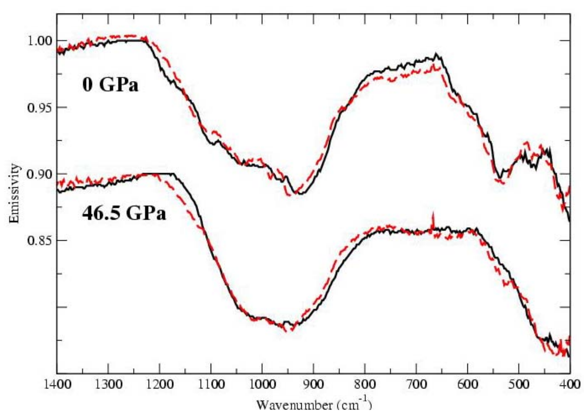

Figure 4. Measured (black) and modeled (red) emissivity spectra for unshocked (0 GPa) and highly shocked (46.5 GPa) basalts. See Figure 2 for rms errors.

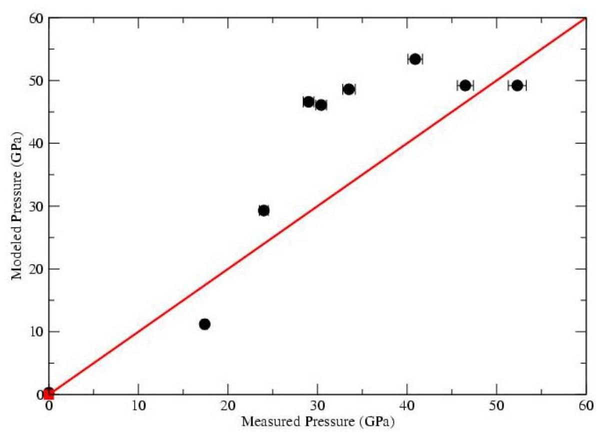

Figure 5. Comparison of average shocked feldspar pressure from deconvolutions compared to laboratory shock pressures of shocked basalts. Error bars are estimated 2% errors on measured pressures [1]. Line represents 1:1 correlation.