American Mineralogist, Volume 100, issue Aug-sept 2015, Supplemental Material
McCubbin et al.: Experimental investigation of apatite-melt partitioning; AM-15-85233
article DOI = http://dx.doi.org/10.2138/am-2015-5233

Appendix A

Piston Cylinder Pressure Calibration

Pressure calibration of the talc-pyrex cell assembly was conducted using the melting point of natural NaCl (Clark 1959; Pistorius 1966). The NaCl was ground to a fine grained powder and kept in a vacuum oven at 100 °C until the time of each experiment. Before each calibration experiment, all inner parts of the talc cell assembly were dried at 800 °C for 20 min and then kept in a vacuum oven at 100 °C. The melting T of NaCl was bracketed using a variation of the falling sphere method. A thin layer of natural NaCl ($\rho \approx 2.16$ g/cm^3) powder was loaded into a molybdenum capsule, followed by 2–3 Fo_{90} ($\rho \approx 3.31$ g/cm^3) or Fo_{83} ($\rho \approx 3.44$ g/cm^3) spheres. The remainder of the capsule was then filled with ground NaCl powder. The assembly is inverted during the experimental run, so the bottom of the capsule with olivine spheres is now at the top of the assembly during the experiment. An experimental assembly identical to those described in the "Piston Cylinder Experiments" section of this manuscript was employed unless otherwise noted. Exceptions to the procedure include using run durations of 10–20 min and using a Type B ($Pt_{30}Rh_{70}/Pt_6Rh_{94}$) thermocouple and Eurotherm (2416) controller to control and monitor temperature throughout the duration of the run. For each experiment, the temperature was initially raised to 800 °C at 200 °C/min, then to 20 °C below the target temperature at 125 °C/min, and finally to the target temperature at 50 °C/min. The temperature of our thermocouple was calibrated against the melting points of NaCl (801 °C), $MgCl_2$ (714 °C), and Na_2CO_3 (851 °C) (Vander Kaaden et al. 2015) at 1 bar. The estimated thermal gradient over our capsule is ≤12 °C, which results in an uncertainty of 0.1 GPa when this T uncertainty is propagated as a function of pressure. Experiments were quenched at ~90 °C/s. Cross sections of the quenched capsules were polished dry using boron nitride powder as a lubricant. If the spheres were still at the top of the cell assembly after quench, the NaCl was assumed not to have melted. If the spheres were at the bottom of the assembly at the end of the experiment, the NaCl was assumed to have melted. The experimental results used to bracket the melting point of NaCl are shown in Figure A1A and converted to kbar using the melting point of natural NaCl as a function of pressure in Figure A1B.

We also provide an update to the pressure calibration of our salt-pyrex cell that was initially described by Vander Kaaden et al. (2015). The pressure calibration for this cell was inconsistent with the melting temperature of diopside at 1 bar (1392 °C), and based on all of the diopside melting data, additional checks were needed for the portion of the curve at 100 bars of oil pressure. Consequently, we conducted NaCl melting experiments at 100 bars of oil pressure, identical to those described above for calibration of the talc-pyrex cell. We determined that a pressure adjustment to the calibration was needed, and we provide the adjusted pressure calibration in Figure A2. The NaCl melting calibration experiments are consistent with the diopside melting experiments conducted at 75 and 50 bars of oil pressure by Vander Kaaden et al. (2015) as well as the 1 bar melting point of diopside.

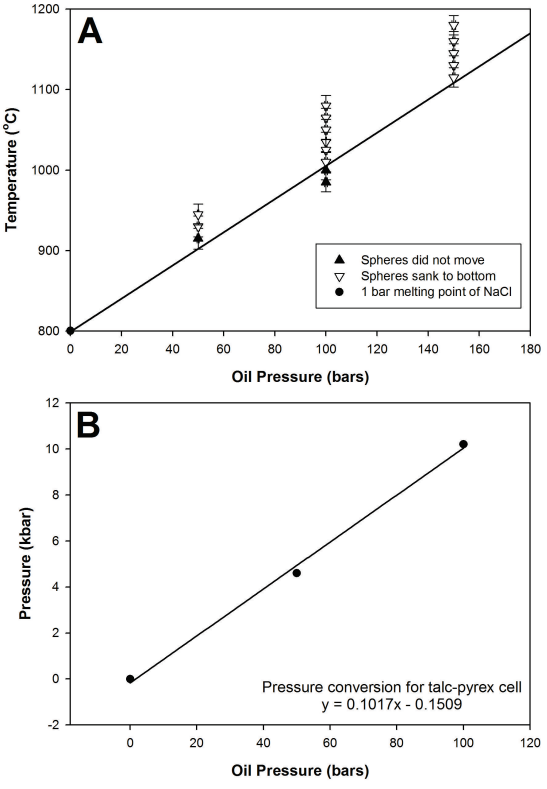

Figure A1. A) Results from NaCl melting experiments in talc-pyrex cells. The black line shows the best fit through this data. Downward facing triangles indicate that the NaCl melted and upward facing triangles indicate that the NaCl did not melt. The best fit line is anchored at the 1-bar melting T of NaCl (800.5 °C). **B)** Conversion of pressure in oil bars to pressure in kilobars for the talc-pyrex cell. The black line shows the best fit through this data ($y = 0.1017x - 0.1509$, $R^2 = 0.9974$). This calibration line is used to determine the kbar equivalent of the applied oil pressure (in bars) using the talc-pyrex cell assembly.

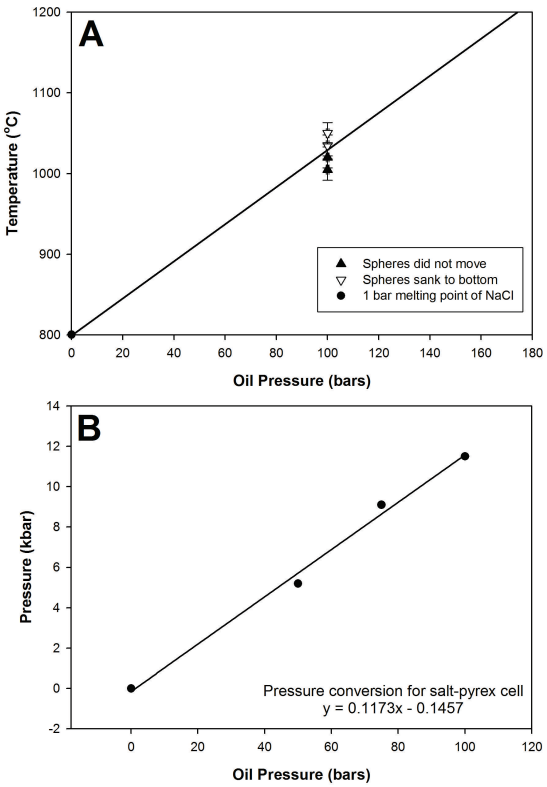

FIGURE A2. A) Results from NaCl melting experiments in a salt-pyrex cell. The black line shows the best fit through this data. Downward facing triangles indicate that the NaCl melted and upward facing triangles indicate that the NaCl did not melt. The best fit line is anchored at the 1-bar melting T of NaCl (800.5 °C). **B)** Conversion of pressure in oil bars to pressure in kilobars for the salt-pyrex cell. Data points from 50 and 75 oil bars are from Vander Kaaden et al. (2015) using the melting point of diopside from Williams and Kennedy (1969). The black line shows the best fit through this data ($y = 0.1173x - 0.1457$, $R^2 = 0.9934$). This calibration line is used to determine the kbar equivalent of the applied oil pressure (in bars) using the salt-pyrex cell assembly.