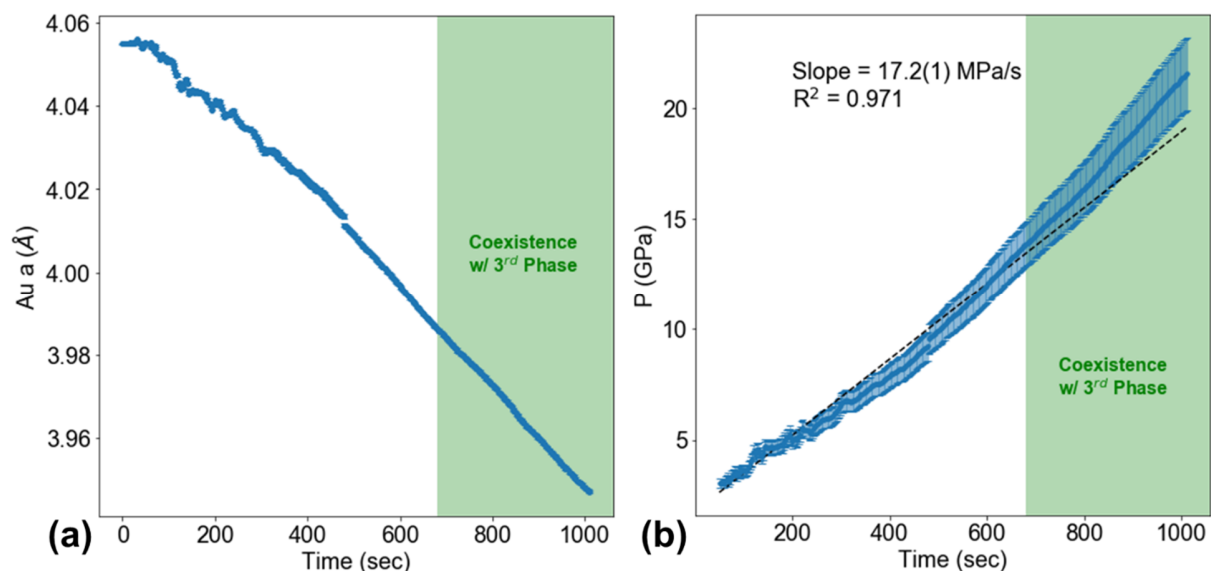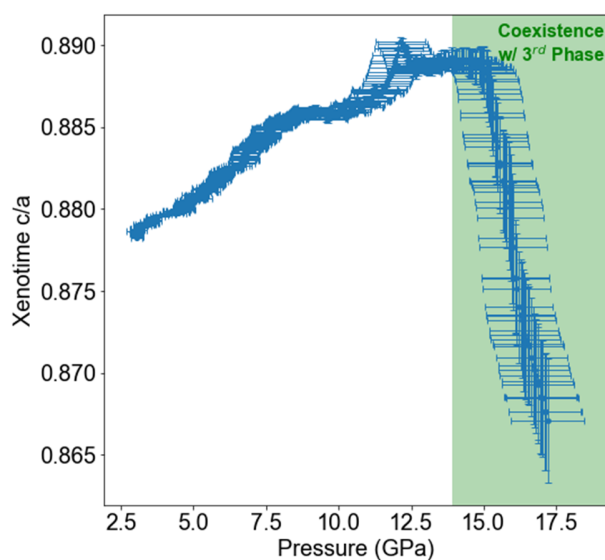**SUPPLEMENTAL MATERIAL**

Figure S1. Plots showing **(a)** gold lattice parameter and **(b)** pressure against time. Error bars represent standard deviation. A linear fit of pressure yields an effective loading rate of 17.2(1) MPa/s. Green, shaded areas represent the pressure range in which a 3rd (post-monazite) phase of $DyPO_4$ exists.

Figure S2. Pressure dependence of the tetragonal distortion (c_x/a_x) of the xenotime unit cell. The green, shaded area represents the pressure range in which a 3rd (post-monazite) phase of $DyPO_4$ exists. Tetragonal distortion begins a dramatic downturn at ~14 GPa, coinciding with the emergence of the 3rd (post-monazite) phase of $DyPO_4$.
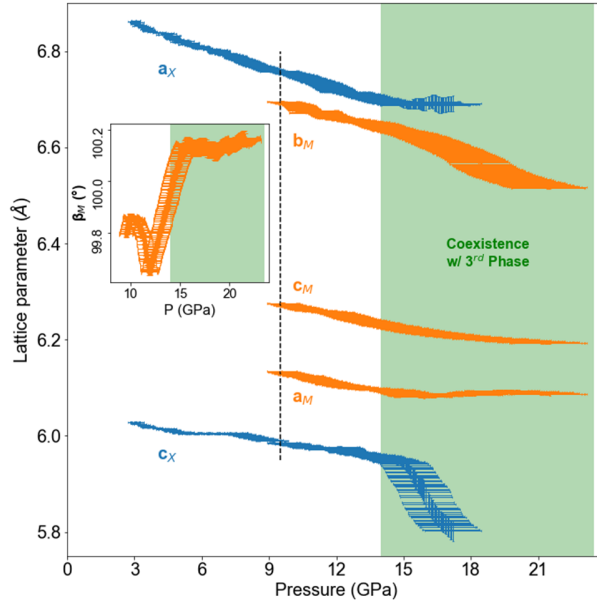
Figure S3. Pressure evolution of all $DyPO_4$ lattice parameters for the xenotime (a_x and c_x) and monazite (a_m, b_m, c_m, and β_m) phases. Error bars represent standard deviation. Vertical dashed lines indicate the xenotime→monazite P_{onset}. Green, shaded areas represent the pressure range in which a 3rd (post-monazite) phase of $DyPO_4$ exists. (a) Unit cell volumes are normalized by the xenotime unit cell volume at 0 GPa, $V_{0,X}$ (in which X denotes xenotime). The inset shows the monazite beta angle with standard deviation error bars. Certain lattice parameters show significant changes in behavior beginning at ~14 GPa, coinciding with the emergence of the 3rd (post-monazite) phase of $DyPO_4$.