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Evidence for amorphous calcium carbonate originated mid-lithospheric discontinuities

MINGQIANG HOU

Innovation Academy for Precision Measurement Science and Technology, Chinese Academy of Sciences

Presenting Author: houmq@apm.ac.cn

Cratonic lithosphere is a vast host for deep recycled carbon, trapping up to several weight percent CO_2 among its compositions at depths overlapping the seismic mid-lithospheric discontinuities (MLDs). However, the role of carbonates, especially for the latest discovered amorphous calcium carbonate ($CaCO_3$), is underestimated in forming MLDs. Using the pulse-echo-overlap method in a Paris-Edinburgh press coupled with X-ray diffraction, we explored the acoustic velocities of $CaCO_3$ under high pressure-temperature (*P-T*) conditions relevant to the cratonic lithosphere. Two anomalous velocity drops were observed associated with the phase transition from aragonite to amorphous phase as well as with pressure-induced velocity drop in amorphous phase around 3 GPa, respectively. Both drops are comparable with approximately 35% and 52% reductions for compressional (V_P) and shear (V_S) wave velocities, respectively. The V_P and V_S values of the amorphous $CaCO_3$ above 3 GPa are about 1/2 and 1/3 of those of the major upper-mantle minerals, respectively, and they are the same with aragonite below 3 GPa. These velocity reduction by the presence of $CaCO_3$ would readily cause MLDs at depths of 70–120 km dependent on the geotherm even if only 1-2 vol.% $CaCO_3$ presents in the cratonic lithosphere. The $CaCO_3$-originated MLDs is weak so as to be expected to influence the stability, rifting, and delamination of the craton.