Elastic wave velocities of Fe-bearing carbonates: a Nuclear Inelastic Scattering study for deep carbon

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Much compelling evidence from natural samples suggests that the fate of carbonate rocks in subduction slabs is to become part of the deep carbon cycle of the Earth's interior. The precise net sink of carbon/carbonates is a critical quantity that has long puzzled scientists. Since samples originating within the lower mantle are extremely rare or impossible to obtain, seismology may provide the key to this mystery. To date, however, knowledge of basic parameters, such as the elastic properties of carbonates, remains poorly constrained. Therefore, determination of the elastic wave velocities of carbonates in the $CaCO_3$-$MgCO_3$-$FeCO_3$ system has become a strategic imperative.

In the present work Debye velocities were derived from Nuclear Inelastic Scattering measurements performed at the Nuclear Resonance beamline, ID-18, at ESRF, France. We will present our results on the elastic wave velocities of $FeCO_3$ (siderite) and various Fe-bearing solid solutions up to ~70 GPa. Our aim is to detect *in situ* the effect of the spin transition of Fe^{2+}, the crystal orientation and the chemical composition on the elastic and vibrational properties of carbonates at Earth's mantle conditions.

Our findings provide clear evidence of a robust increase in velocities by nearly 25% above 50 GPa, where the spin transition of Fe^{2+} in $FeCO_3$ is complete. Although there is a remarkable velocity contrast for different orientations below 40 GPa, the anisotropy weakens substantially after the spin transition. In addition, we observed that velocities differ depending on the chemical composition.

Further experiments are planned to establish the seismic signature of carbonates, leading us one step closer to their seismic detectability and the determination of the carbon net sink in the inner Earth.