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Brillouin scattering and radial x-ray diffraction of polycrystalline MgO to 30GPa

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Brillouin scattering on polycrystalline materials at high-pressures promises to be a direct way to obtain aggregate (bulk and shear) moduli of candidate mantle minerals which can be related to seismological observables. However, several poorly understood processes might affect the derived sound wave velocities, including a preferred orientation of the crystallites (texturing), non-hydrostatic conditions in the diamond-anvil cell and contributions of intergranular material. An understanding of these processes and their effects on the derived Brillouin frequency shift are required to adequately interpret the collected data and relate them to geophysical models. We completed Brillouin scattering experiments and radial x-ray diffraction measurements on the same loading of polycrystalline (average grain size before compression was about 1μm) MgO to pressures above 30 GPa. The derived sound wave velocities are significantly lower than the Voigt-Reuss-Hill average calculated from single-crystal data collected in quasi-hydrostatic conditions. The x-ray diffraction data collected in radial direction provide us with complimentary information about the preferred orientation of the crystallites as well as information about the stress field in the diamond-anvil cell and thus can help to unravel the physical reasons for the measured low velocities. We find that these velocities can not be explained by texturing of the polycrystalline aggregate. This indicates that the measured Brillouin frequency shift in compressed polycrystalline MgO is strongly biased by other processes, such as non-hydrostaticity or grain size reduction. Our results highlight the importance of understanding and quantifying the processes that might affect sound wave velocities derived from polycrystals, in particular, by Brillouin spectroscopy.