Anomalous behavior of the compressibility and thermal conductivity of Fe, Al-bearing bridgmanite

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For iron-containing minerals under high pressure, it is important to understand the effect of pressure-induced spin-crossover of iron on its physical properties: spin-crossover of iron changes its ionic radius and number of peripheral electrons, thus this may change the thermodynamic and physical properties of materials bearing iron. The most abundant mineral in the Earth's lower mantle is $MgSiO_3$ bridgmanite containing a certain amount of iron and aluminum. There are two recent experimental studies on the thermal conductivity of iron and aluminum-bearing bridgmanite [1][2], but their results are inconsistent. Moreover, the effect of spin-crossover of iron in bridgmanite on its thermal conductivity is yet unknown.

Here we report the lattice thermal conductivity of Al-rich Fe, Al-bearing bridgmanite with chemical compositions of $Mg_{0.793}Fe_{0.075}Al_{0.217}Si_{0.914}O_3$ and $Mg_{0.718}Fe_{0.123}Al_{0.281}Si_{0.878}O_3$ measured up to 180 GPa and 74 GPa respectively, at 300 K using the pulsed light heating thermoreflectance technique in a diamond anvil cell. Also we experimentaly determined the compressibility of the above bridgmanite samples up to ~60 GPa at 300 K investigated by the synchrotron XRD measurements at BL10XU, SPring-8. Both compressibility and thermal conductivity of $Mg_{0.793}Fe_{0.075}Al_{0.217}Si_{0.914}O_3$ and $Mg_{0.718}Fe_{0.123}Al_{0.281}Si_{0.878}O_3$ bridgmanite showed abnormal change in the pressure range of around 20 to 40 GPa, probably due to the spin transition of ferric iron.

[1] Okuda et al., (2017), *Earth. Planet. Sci. Lett.* 474, 25
[2] Hsieh et al., (2017), *J. Geophys. Res. Solid Earth* 122, 4900