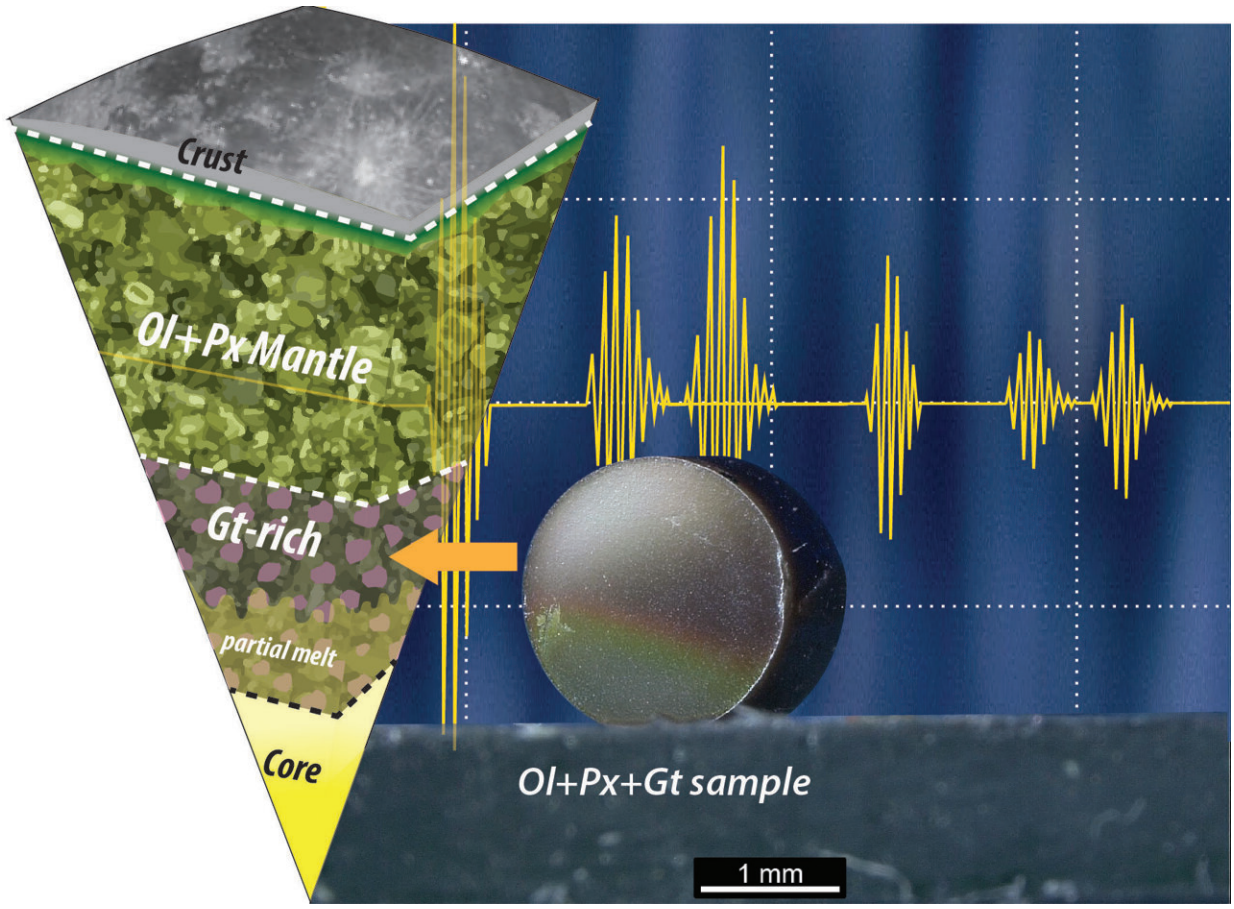
Researchers synthesize garnet-rich lunar rock to study moon's mantle

July 4 2024



Schematic representation of the moon's interior featuring a garnet-rich lunar mantle atop the core-mantle-boundary, and a picture of the synthetic lunar mantle aggregate investigated in this study. Credit: Geodynamics Research Center, Ehime University

Our present-day moon has an interior structure containing a central metallic core, overlain by a mantle comprised of minerals such as olivine and pyroxene (e.g. Ol+Px mantle) underneath a shell of crust. Such a picture of the moon's interior has been formed from analyses of returning lunar samples and records of deep seismic events collected during missions to the moon.

Despite the wealth of literature, there is still a longstanding debate as to the existence of garnet (Gt) within the deeper part of the lunar mantle. Reflecting upon the existence of garnet, the pivotal question first posited 50 years ago has remained unanswered: are laboratory measured sound velocities in realistic lunar aggregates containing garnet compatible with the seismic profiles of the deep lunar interior?

To provide answers to this question, Ehime's researchers first synthesized garnet-rich lunar rock assemblages (Ol+Px+Gt sample) at high pressures and high temperatures using the multi-anvil press apparatus "ORANGE-2000" at the Geodynamics Research Center.

The findings are published in the journal *Earth and Planetary Science Letters*.

These samples were then transported to SPring-8, the Large-scale Synchrotron Radiation Facility, located in Hyogo Prefecture, where experiments were carried out at the high pressure and high temperature beamline BL04B1. Here the researchers subjected the lunar rock assemblage to pressure and temperature conditions similar to those of the moon's deep interior while they measured the propagation speed of sound waves in the lunar rock assemblage.

Combining the results of their experiment with a modeling component, the researchers concluded that the sound velocities in lunar assemblages containing large amounts of garnet were compatible with the seismic and

density profiles of the moon's deep interior, between depths of 740–1,260 km.

Furthermore, they found that rock assemblages containing little to no garnet are unlikely to explain the observed seismic velocities and densities of the lunar mantle at those depths.

These intriguing results have significant implications for the moon and its interior dynamics, including its composition and formation, the interior temperature, as well as implications for the lunar core and the now defunct lunar dynamo.

More information: Marisa C. Wood et al, Sound velocities in lunar mantle aggregates at simultaneous high pressures and temperatures: Implications for the presence of garnet in the deep lunar interior, *Earth and Planetary Science Letters* (2024). DOI: 10.1016/j.epsl.2024.118792

Provided by Ehime University

Citation: Researchers synthesize garnet-rich lunar rock to study moon's mantle (2024, July 4) retrieved 6 July 2024 from https://phys.org/news/2024-07-garnet-rich-lunar-moon-mantle.html

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