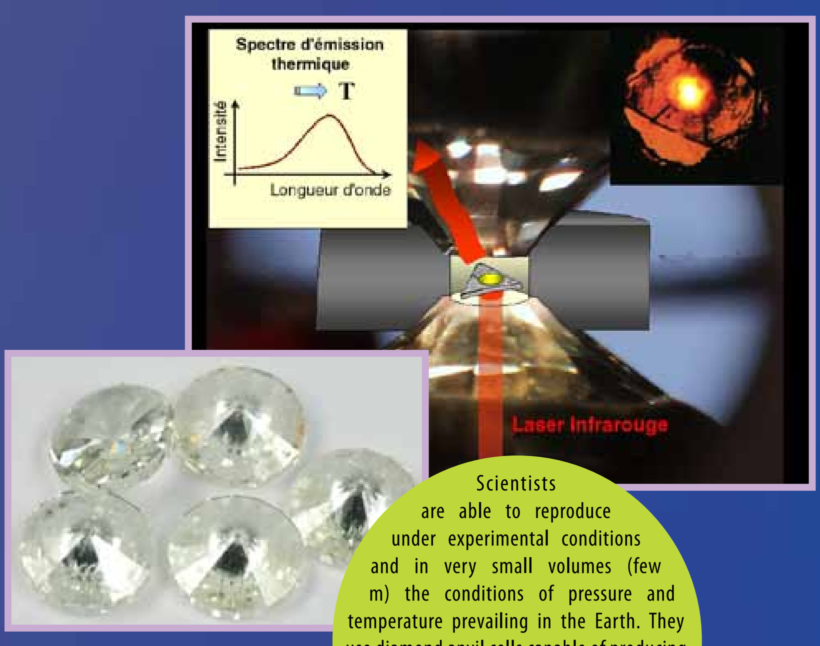
Crystals - messengers from the solar system and the Earth's core



Scientists are able to reproduce under experimental conditions and in very small volumes (few m) the conditions of pressure and temperature prevailing in the Earth. They use diamond anvil cells capable of producing very high pressures combined with a heating laser beam. These experiments are carried out in the laboratory and synchrotron facilities available at the ESRF or SOLEIL.

The crystal, through its composition, structure and density, provides precious information on the composition of the earth

The information we have on the Earth's core comes primarily from the crystals contained in the material recovered from volcanic eruptions and from the geological zones created by the formation of mountain ranges. These materials can undergo transformation during their journey to the surface and their point of departure is unknown.

Earthquakes are monitored in our quest to understand the deeper layers of our planet

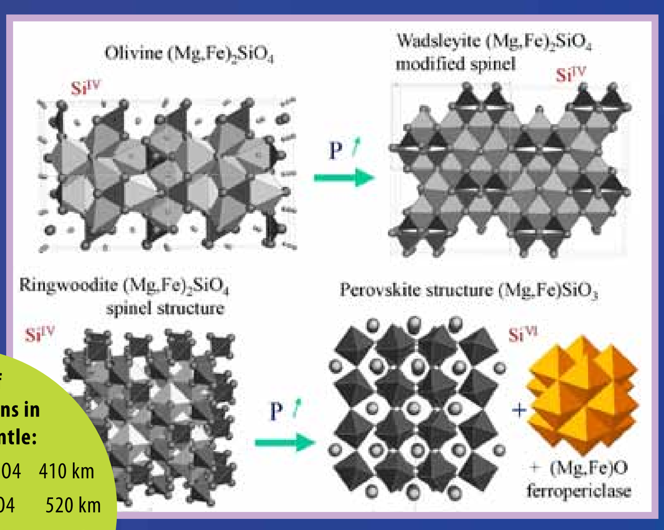
The **seismic waves** produced during an earthquake pass through the successive layers of the Earth in different ways, thus revealing essential information on the **density** of these layers. We have yet to discover materials of similar density.

To understand the deeper layers of our planet we can also «cultivate» crystals

Scientists cultivate crystals under the **same conditions as those found in the depths of the Earth**. The temperature and pressure increase the further down we go, with a consequent increase in density and changes in the materials. Crystal stability zones are compared to the different strata of the Earth (identified by the seismic waves).

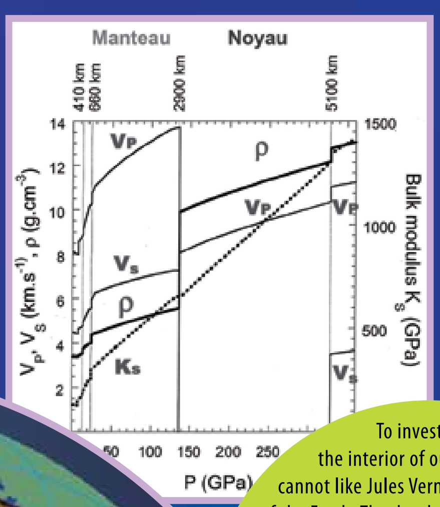
When carrying out a study of meteorites, the crystal is also a marker of the composition of the solar system

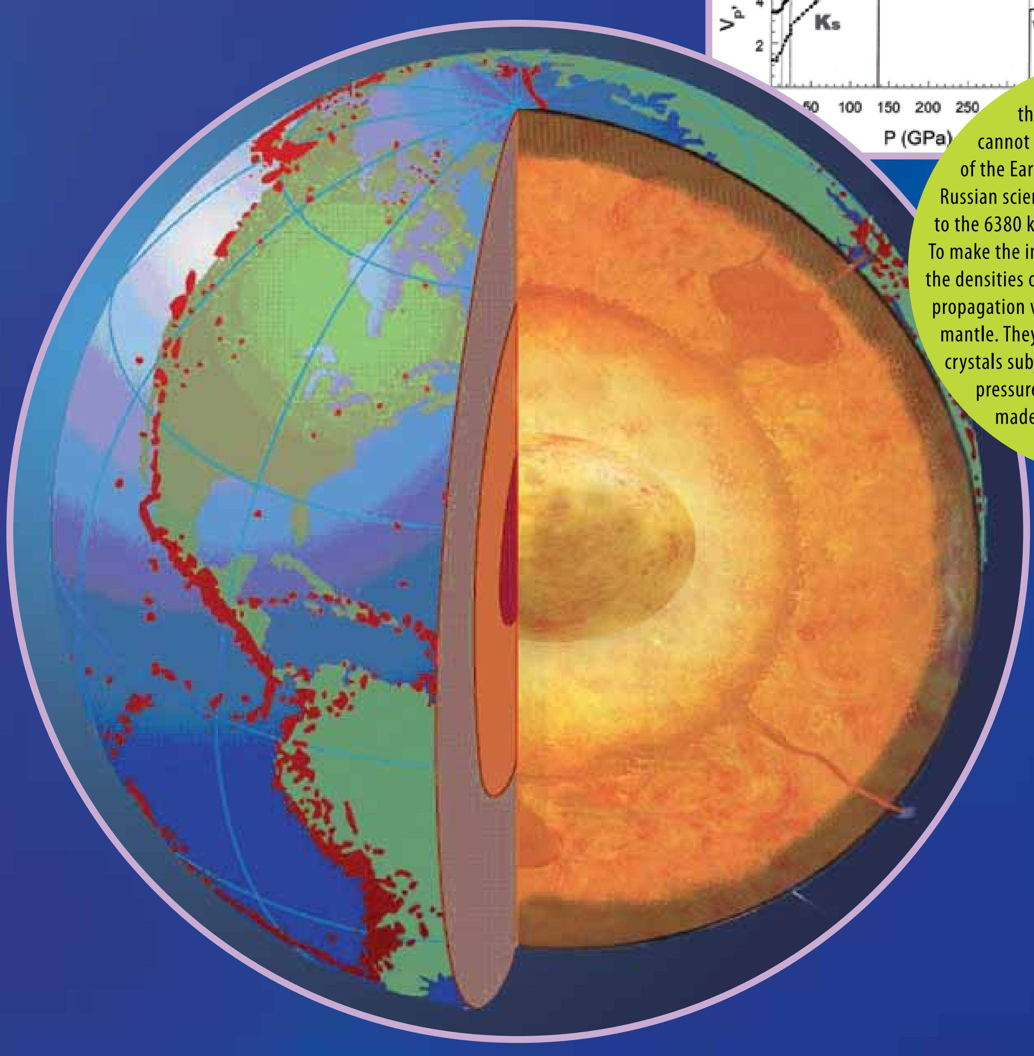
An analysis of the crystals contained in meteorites gives us a better understanding of the solar system and the history of the planets.
In the same way, missions like that of the «Stardust» to study the comets provide us with information on the Universe.



Example of phase transitions in the Earth's mantle:

α-Mg2SiO4 —> β-Mg2SiO4 410 km
β-Mg2SiO4 —> γ-Mg2SiO4 520 km
γ-Mg2SiO4 —> MgSiO3+MgO 670 km
MgSiO3 perovskite —> MgSiO3 "post-perovskite" 2700 km





To investigate the interior of our planet, we cannot like Jules Verne go to the centre of the Earth. The depth of 12 km reached by Russian scientists in 1989 seems paltry compared to the 6380 km distance to the centre of the Earth. To make the imaginary journey, scientists determine the densities of the different layers by measuring the propagation velocity of seismic waves in the Earth's mantle. They compare these densities to those of crystals subjected to high temperature and high pressure: we thus learn that the Earth is made up of different layers of solid and liquid material.

Although high pressure set-up can be very large, the pressure is inevitably lower in experiments with larger anvil cells (few mm).
Source : RoToPEC-IMPMC & ESRF