Westfälische Wilhelms-Universität Münster

GEOPHYSIK WWU MÜNSTER

Institut für Geophysik

Geophysikalisches Kolloquium
Wintersemester 2018/2019

Montag, 12. November 2018

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Tokyo Institute of Technology, Japan

How Does the Earth's Core Crystallize?

In the past decade it has become possible to perform routine laboratory experiments at pressures and temperatures of the Earth's core using diamond anvil cells, and these are now yielding surprising results that are causing us to question some of our most basic assumptions about the structure and evolution of the deepest Earth. Of particular interest are the properties of iron containing alloys that exhibit densities and compressibilities compatible with seismological estimates. Our ambition has always been to find differences in various candidate alloy cocktails that may help inform which chemical composition is most plausible for the Earth's core. Most past work focused on binary systems Fe+X, where X is a single element that alloys with iron at core pressure and temperature. There were some surprises, such as a finding that the eutectic in the Fe+Si binary system is very close to pure Fe, meaning that a core containing a significant amount of Si could not crystallize hcp-Fe, the crystal phase that we believe comprises the majority of the inner core. We initially thought this meant that Si could not be an important alloy in the core (but see below). When we began looking at ternary systems (i.e., Fe+X+Y), there were further surprises. We have found that there is very little overlap between the chemical composition space that is compatible with seismological constraints that also allows an Fe-alloy to crystallize hcp-Fe. What is going on here? The answer to this riddle may have been answered long ago, in a widely cited (but rarely read) 1962 paper by S.I. Braginsky. He sought to reconcile the seismologically inferred presence of stable layering above the inner core (the so-called F layer) with fractional crystallization of a Fe-rich inner core that releases enough buoyancy to mix the liquid outer core and power the geodynamo. In his model, the core initially crystallizes on an alloy-rich liquidus, those crystals rise up into the shallower core and then melt, depleting the deeper core while enriching the shallower core in alloys. As this process progresses, the center of the core evolves to the eutectic, then crystallizing both hcp-Fe and alloy-rich phase. The heavy hcp-Fe remains to grow the inner core and the buoyant phase rises up through the F layer, melting at shallower depths and buffering the F layer at the liquidus. We are now searching the chemical composition space to find the best alloy cocktail that permits us to satisfy both energetic and seismological constraints, establishing a new method to constrain the composition of the core.

Das Kolloquium findet um **16 Uhr c. t.** im **Seminarraum GEO 315**, Corrensstr. 24, 48149 Münster statt.
Alle an dem Thema Interessierten sind hierzu herzlich eingeladen.

Die Dozenten des Instituts für Geophysik