ÉCOLE DOCTORALE SCIENCES DE LA TERRE

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**TITRE du SUJET : Structure et anisotropie de la graine**

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Le noyau interne - la graine solide - représente seulement 1/6 du volume de la Terre, et pourtant il joue un rôle fondamental dans la dynamique de notre planète. La sismologie permet de contraindre sa structure actuelle, qui se révèle complexe et pleine de surprises. L'accumulation d'une grande quantité de données large bande de qualité au niveau global et régional, surtout dans les régions polaires très importantes pour l'étude de l'anisotropie de la graine est une motivation pour examiner à nouveau un certain nombre de questions relatives à sa structure: anisotropie et sa distribution spatiale et en profondeur, topographie de la limite noyau externe/graine, structure et atténuation en cisaillement.

Je propose un sujet de thèse centré sur la collecte, l'analyse et l'interprétation de données sismiques globales d'ondes de volume sensibles à la structure du noyau et à celle de la base du manteau, pour séparer, en particulier, les effets des hétérogénéités du manteau et celles de la graine.

The inner core represents only 1/6 of the volume of the Earth, yet it plays a fundamental role in Earth dynamics. As it grows, the solidification process expulses lighter elements, which contribute to driving convection in the liquid outer core , which in turn affects heat loss from the core as well as the generation of the magnetic field.

Seismology provides unique information on inner core structure that can help understand its formation and evolution. For example, the solidity of the inner core has been inferred from the measurement of frequencies of earth's free oscillations; the density jump at the inner core boundary (ICB) is an important constraint on the dynamics of the core which can be estimated using reflected phases at the ICB. A major discovery in the late 1980's was that of seismic anisotropy in the inner core, inferred from two observations: (1) the fact that core sensitive PKP phases travel faster along paths aligned with the Earth's rotation axis, than along equatorial paths and (2) that normal modes sensitive to the earth's core are anomalously broadened, or "split", indicating the presence of a distinctive structure in the core that can be effectively modeled by introducing the same type of anisotropy in the inner core.

Since then, much work has been done to constrain the anisotropic structure of the inner core better and other intriguing features have been found, such as the presence of an "innermost inner core" with different properties in the central part of the inner core, hemispherical structure at the top of the inner core, and , more generally, much heterogeneity within the inner core.

A "holy grail" of seismology has been the detection of the elusive phase PKJKP which travels as a shear wave through the inner core. While travel time and amplitude measurements of this very faint phase would provide important constraints on the shear structure of the inner core, only a handful of "sightings" have been made so far.

A complicating factor in the study of the inner core using seismic waves is that these waves travel through the very heterogeneous mantle, where they are advanced or delayed in a way that cannot yet be corrected for very accurately, for different reasons, resulting in "mapping" of mantle structure into the inner core. Further advances in constraining inner core anisotropy, in particular cannot be made until we can confidently separate the contributions from the core and the mantle to both PKP and normal mode observations.

Over the last ten years, much new high quality data from global and array broadband stations have been collected to justify a new look at inner core structure and anisotropy.

In this thesis topic, I propose a variety of approaches to further investigate the structure and anisotropy of the inner core. In particular, I propose to collect a dataset of PcP-P differential travel times for polar regions in the earth (both around Alaska and around Antarctica) to investigate the mantle contribution to PKP travel time anomalies on polar paths. The core reflected PcP phase is difficult to observe because it comes in the coda of the P phase - so targeted data processing schemes need to be developed and applied. Preliminary results indicate that with the appropriate care, coherent results can be obtained. This study will also involve the collection of a dataset of PKP phases to complement my existing collection assembled up to 5 years ago through several PhD theses in my group (see references below).
If time permits, we will also consider other phases and, why not, try to find more PKJKP's.

References


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