Subject offered for a contract starting October 2019

SUBJECT TITTLE: Inversion of attenuation and scattering of SEIS InSIght data: water and layering of the Martian crust.

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IPGP- Equipe Planétologie et sciences spatiales– UMR7154

Financing: Doctoral contract with or without teaching assignment

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Presentation of the subject: (1 or 2 pages)

It is widely accepted that Mars contains some water below the subsurface layer. At the same time, it is highly possible that such water is localized at some part of Mars or has regional variation. One possibility is that they differ between northern and southern hemisphere. Another is that they vary with latitude. In this study, we take into account such local and regional variety of water content in evaluating the Q structure of Mars. The estimation of water content from the seismic Q is ambiguous because Q is sensitive to both scattering by heterogeneities and dissipation phenomena activated by the presence of water. In order to resolve this difficulty, we will combine attenuation measurements performed on direct waves with the modeling of the energy envelope of coda waves (i.e. scattered seismic waves). This approach will allow us to separate between structural effects (scattering Q) and genuine attenuation effects related to the presence of water (intrinsic Q).

The scattering Q will also provide us with informations on the layering of the crust and the extension of the impact generated fracturation as a function of depth.

Laboratory and field experiments have clearly demonstrated that the value of intrinsic Q is closely related to the water content of rocks. This remarkable property provides a unique opportunity to study the water content of the deep interior of Mars: upper and lower mantle. We will reclassify observed seismic event with their source regions and for each subset, we will evaluate the Q

structure independently. Then we will compare the Q structures from different source regions and discuss the variety of water content.
The data to be used will be both the VBB and the SP data of the inSight mission. We will also perform comparisons with Lunar data, as the later are expected to be an end member with extremely low and mostly scattering. Both data from events (e.g. quakes and events), but also from continuous seismic noise will be used. Final analysis on water content in the crust will be made in collaboration with University of British Columbia, in collaboration with co-I C.Johnson, who is developing the inversion of the water content in the crust through the inversion of the Martian crust conductivity with InSIght IFG.
The Thesis will be co-directed by T.Kawamura (Maitre de Conférence IPGP) and by Ludovic Margerin (Chargé de Recherches HDR, IRAP), who have both been selected as PS for InSight. Collaboration with other InSight team members at IPGP and IRAP will also be performed.
The thesis will be made in the frame of the IPGP STEP'UP Ecole Doctorale and will be primarily located in IPGP, but regular visit to IRAP will be made.