Seismic constraints on deep Earth structure and mantle melts

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Seismic results of recent years characterize Earth's lowermost mantle to be highly heterogeneous on many scale lengths. Structures found using seismic means include sharp horizontal discontinuities (although strong topography on these might be present), thin ultra-low velocity zones (thin regions of strongly reduced seismic velocitites), anisotropy and large anomalously slow regions with sharp vertical boundaries. Therefore, the lowermost mantle and core-mantle boundary region is a likely location of untapped, "hidden" reservoirs in the Earth which might be detectable by seismic means.

The scales of these heterogeneities span several magnitudes from 1000's of km to the smallest detected structures with scalelengths of only a few 10's of km. Smaller structures are likely and their detection depends on increased seismic resolution.

These results indicate a highly dynamic and complicated region that can only be understood by combining seismological, geochemical, geodynamical and mineral-physical results. Current models of the lowermost mantle, the D″ region and the core-mantle boundary include the post-perovskite phase transition to explain the D″ discontinuity and possibly other regional layers, partial melts to explain ultra-low velocity zones and chemically distinct regions to both explain large-scale and small-scale structures.

This presentation will highlight recent seismological results of the structure of the D″ discontinuity focussing on the structure of the structure of the post-perovskite phase transition beneath the Cocos plate (central America). The second part of the presentation will focus on the fine scale structure of ultra-low velocity zones. The seismic data sampling ultra-low velocity zones can be well explained by the existence of dense partial melts in thin layers. Geodynamic modeling shows that ultra-low velocity zones could be the dominant structures at the edges of large-scale thermo-chemical piles as have been detected beneath the Pacific and Africa. These partial melts could be iron enriched and might be connected to plume genesis.

The Italian contribution to Stardust

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We report combined micro-infrared, micro-Raman, and Field Emission Scanning Electron Microscope analyses of five particles collected by the Stardust spacecraft during its fly-by of comet 81P/Wild2 on 2 January 2004 and returned back to Earth on January 2006.

The CH_2/CH_3 ratios inferred from the infrared data are greater than those seen in organics in the diffuse interstellar medium, possibly indicating the presence of longer or less branched aliphatic chains. The micro-Raman data offer insights on the state of order of the carbonaceous component present in the particles. A comparison with spectra of Interplanetary Dust Particles (IDPs) and meteorites yields for most of the particles analyzed that the cometary carbonaceous material span a similar range to those of IDPs and the most primitive meteorites (see Figure 1).

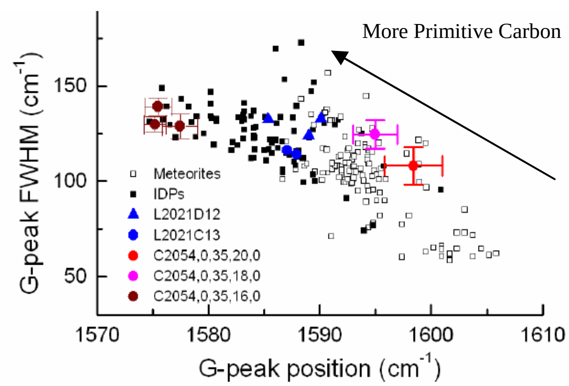

Figure 1: FWHM versus peak position for the G band measured for Stardust particles and IDPs (circles and triangles, LANDS team) compared to several IDPs (Wopenka 1988; Raynal *et al*. 2001) and Meteorites (Raynal *et al*. 2001).

Hydrated minerals seem to be present in one particle which seem to contain also carbonates, but further investigations with other techniques need to be performed to confirm these findings. Analyses interpretation is difficult because of the presence of aerogel mixed with the grain.

The analysed grains result to be: 1) rich in complex organic compounds; 2) compositionally and structurally heterogeneous. Suggesting that cometary particles consist of a mixture of subgrains of various sizes and compositions.

References

Raynal PI *et al*., *LPSC XXXII*, **1341**, LPI, 2001
Wopenka B., *EPSL*, **88**, 221 231, 1988