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An integrated modelling approach to understanding combined geophysical-petrological processes in the lithospheric-sublithospheric mantle

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Geophysical observables such as seismic waves, potential fields, surface heat flow, and elevation provide important information on possible compositional fields present in the upper mantle. Since each of these geophysical fields is affected to a different degree by thermal and compositional heterogeneities, an integrated modelling approach that includes all of these in a self-consistent manner is highly desirable. In this session we present a first-of-its-kind combined geophysical-petrological methodology to study the thermal, compositional, density, rheological, and seismological structure of different lithospheric domains. The methodology is incorporated in a finite-element code (LitMod) that allows to perform an integrated modelling of 2-D lithospheric/sublithospheric cross-sections from the surface down to the 410-km discontinuity. The code solves simultaneously the heat transfer, thermodynamical, geopotential, isostasy, and rheological equations for a particular lithospheric structure with any given composition, and yields density, thermal and seismological structure, surface heat flow (SHF), rheological strength, gravity anomalies, elevation, and geoid height. Predictions of geophysical observables are used to control the reliability of the proposed model. This approach reduces the uncertainties associated with the modelling of each of these observables alone, or with the combinations of pairs commonly used in the literature. It also allows us to distinguish, and have a better control on, compositional (density) variations at different depths, since these observables are differentially sensitive to shallow/deep density anomalies.

This methodology has been applied to an oceanic transect in the Atlantic (crustal ages

from 0 to $\sim$ 90 Ma), a continental Archean craton (Slave craton), and a volcanic passive margin (Namibia). Modelling results will be presented and compared with available geophysical and petrological information for each transect. Particular attention will be given to analyze possible vertical and lateral compositional heterogeneities within different lithospheric domains, and to evaluate the effects that these heterogeneities may have on the relative stability of the lithosphere upon the convective sublithospheric mantle.