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Thermal regime along the Antilles subduction zone: Influence of the oceanic lithosphere materials subducted in the oceanic crust

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Heat-flow measurements acquired during the Antithesis Cruise in the Northern Lesser Antilles reveal an atypical heat-flow trend, from the trench to the margin forearc, where the subducting crust consists of exhumed and serpentinized mantle rocks (see Marcaillou et al. same session).

We investigate the thermal structure of the Lesser Antilles subduction zone along two transects perpendicular to the margin located off Antigua and Martinique Islands. We perform 2-D steady-state finite elements thermal modelling constrained by newly-recorded and existing data: heat flow measurements, deep multichannel reflection and wide angle seismic data as well as earthquake hypocenters location at depth.

Along the Martinique profile, the heat-flow decreases from the trench (45 mW.m-2) to minimum in the outer fore-arc (30 mW.m-2) and increases to a plateau (50 mW.m-2) toward the back-arc area. These trend and values are typical for the subduction of a steep 80-MYr old oceanic plate beneath an oceanic margin. As a result, the 150°-350°C temperature range along the interplate contact, commonly associated to the thermally-defined seismogenic zone, is estimated to be located between 200 - 350km from the trench. In contrast, along the Antigua profile, the heat-flow shows an atypical "flat" trend at 40 $\pm$ 15 mW.m-2 from the trench to the inner forearc. Purely conductive thermal models fail at fitting both the measured values and the flat trend.

We propose that the subducting crust made of serpentinized exhumed mantle rock strongly affecting the heat-flow at the surface and the margin thermal structure. The geothermal gradient in the 5-km-thick serpentinized layer is expected to be low compared to "normal" oceanic crust because of cold water percolation and peridotite alteration. Moreover, from $\sim$50km depth, serpentine dehydration reactions provide significant amounts of hot water expelled toward the upper plate, generated heat beneath the forearc. As a result, in our preferred model: 1/ A 10% depressed geothermal gradient within the 5-km-thick upper layer of the subducting oceanic lithosphere in the trench represents the hydrothermal cooling by rocks serpentinization. 2/ A lenticular layer at the base of the upper plate at depth of 10 – 40 km with high thermal conductivity mimics heat generation by serpentinite dehydration reactions. This model result in a thermally-defined seismogenic zone 100-km shorter and shifted landward by 20-km compared to the Martinique segment.