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Seismological constraints on the evolution of oceanic lithosphere

Ocean basins preserve the life history of a tectonic plate: its birth at a mid-ocean ridge, its thickening and modification through time, and its destruction through subduction. Knowledge of the thermal evolution and chemical structure of the oceanic lithosphere is key for understanding the connection between mantle convection and plate tectonics today and in the geological past. In this talk I will present two new sets of results that bear on the thermal and chemical structure of oceanic lithosphere. First, we have analyzed the dependence of seismic velocity and seafloor bathymetry on seafloor age along numerous spreading-history trajectories in the Atlantic and Pacific basins. I will show that the age at which half-space cooling fails to explain these data is spatially variable and correlated with mantle potential temperature beneath the present-day ridge. Several mechanisms that could be responsible for these observations are considered. Second, we have measured seismic-wave attenuation across the NoMelt array of seismometers located on ~70 Ma Pacific seafloor. I will show that the data require two layers: a shallow one with low attenuation (Q>300) and a deeper one with higher attenuation (Q~100). The transition between the layers happens in the depth range 50-100km. We use laboratory measurements of anelastic relaxation to interpret the observed attenuation in terms of the temperature structure and volatile content of the upper mantle in the NoMelt region.