IV Brazilian Seismology Symposium

Detailed Structure of the South American Cratons from Seismic Tomography

Bruna Chagas de Melo[1,] Sergei Lebedev*[1], Nicolas Celli[1], Marcelo Assumpção[2]

[1]Dublin Institute for Advanced Studies (DIAS)
[2]Universidade de São Paulo (USP)

Abstract

The South American continent comprises diverse geological units, from its ancient Precambrian stable platform to the now active Andean orogenic belt. In the stable platform, we can separate two large domains, by their different geologic and geotectonic features, as for their roles in the history of supercontinents. The northernmost domain includes the Amazon craton and Parnaíba block. The Amazon craton was consolidated in Archean to Paleoproterozoic times, but models diverge when it comes to the evolution and age of its different provinces. In the second domain, the São Francisco craton and Paranapanema block are marked by events from Neoproterozoic times, related to the orogenic collage of West Gondwana.

In cratonic settings, seismic velocities are considerably higher compared to velocities under younger late Proterozoic fold belts. Because compositional effects are too small to account for the velocity difference, the higher velocities are attributed to lower temperatures. Hence, seismic tomography is a powerful tool to image the deep lithospheric structure of cratons and provide critical insight into existing tectonic and geodynamic models. However, until recently, seismic data sampling in South America was highly uneven, and high-resolution models were obtained mainly regionally. Here, we assembled all seismic data globally, including temporary deployments that recently became available, with the addition of the FAPESP “3-Basins Thematic Project”. After selecting all paths crossing the half globe centred in South America and an automatic outlier rejection, we result in a massive dataset of ~1 million waveform fits.

We compute our high-resolution, S-velocity tomographic model of the upper mantle of South America and surrounding oceans using the Automated Multimode Inversion of surface, S- and multiple S-waves. The improved data coverage of the model combined with the optimized tuning of the inversion parameters on the continent allows us to identify for the first time the fine details present on the cratonic structure. We compare seismic velocities with cratonic units, suture zones, seismicity, magmatism, kimberlites, and large igneous provinces. With these results, we correlate the newly imaged lithospheric structure to the recurring events of continental break up and amalgamation cycles. Finally, we show that this varied cratonic relief plays a significant role in the complex interaction of ascending hot mantle material and continental lithosphere.