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Influence of Peruvian Flat-Subduction Dynamics on the Evolution of Western Amazonia

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Subducting slabs are the primary buoyancy force in the Earth's mantle and provide a critical source of surface deformation via their coupling to the upper plate. The impact of variations in slab morphology on this process however remains to be fully investigated. This is of particular importance for episodes of "flat" or "shallow" subduction that are often associated with slabs that have thickened oceanic crust. The shape and buoyancy content of these flat-slabs is therefore quite different to "normal" subduction scenarios. The consequences for dynamics of the mantle and how the upper plate deforms in response are not well understood. One way we can constrain this better is to study dynamic topography produced by active flat-slab systems, such as in Peru in South America, and compare them against observations from the geological record.

Flat-subduction beneath Peru is thought to have begun during the Mid-Late Miocene. At the same time widespread subsidence occurred across western Amazonia resulting in the deposition of the Solimões Formation from the foredeep all the way up to the Purus Arch, 2000 km from the modern trench. We investigate how both long-wavelength changes of dynamic topography from the arrival of the flat-slab, as well as shorter wavelength flexure from Andean loading interacted to shape the modern day Amazonian landscape. We calculate dynamic topography of a slab model derived from the regional seismicity to provide a realistic flat-slab geometry that best defines the leading edge of subduction and therefore constrains the loci of dynamic subsidence. We find that >1 km of dynamic subsidence ($\sim$1500 km wide) is expected over 1000 km away from the trench. In contrast our flexural calculations predict 2.8 to 3.6 km of accommodation space that spans only 100 km across. We show that thick distal foreland accumulations of the Solimões Formation (up to 1.2 km deep), are beyond the influence of the narrow flexural subsidence but are well matched by our predicted dynamic topography. We therefore propose that a combination of uplift, flexure and dynamic topography during slab flattening in Peru is responsible for the sedimentation history of western Amazonia and the eventual configuration of the Amazon drainage basin we know today.