

Congestion in the Earth's mantle: Why plate tectonics stagnates in some places

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Credit: NASA

The Earth is dynamic. What we perceive as solid ground beneath our feet, is in reality constantly changing. In the space of a year Africa and America are drifting apart at the back of the Middle Atlantic for some centimeters while the floor of the Pacific Ocean is subducted underneath the South American Continent.

"In 100 million years' time Africa will be pulled apart and North Australia will be at the equator," says Prof. Dr. Falko Langenhorst from the Friedrich Schiller University Jena (Germany). [Plate tectonics](#) is

leading to a permanent renewal of the ocean floors, the mineralogist explains. The gaps between the drifting slabs are being filled up by rising melt, solidifying to new oceanic crust. In other regions the slabs dive into the deep interior of the Earth and mix with the surrounding Earth's mantle.

The Earth is the only planet in our solar system, conducting such a 'facelift' on a regular basis. But the continuous up and down on the Earth's crust doesn't run smoothly everywhere. "Seismic measurements show that in some mantle regions, where one slab is subducted underneath another one, the movement stagnates, as soon as the rocks have reached a certain depth," says Prof. Langenhorst. The causes of the 'congestion' of the subducted plate are still unknown. In the current issue of the science magazine *Nature Geoscience* Prof. Langenhorst and earth scientists of Bayreuth University now explain the phenomenon for the first time.

According to this, the rocks of the submerging ocean plate pond at a depth of 440 to 650 kilometers – in the [transition zone](#) between the upper and the lower Earth mantle. "The reason for that can be found in the slow diffusion and transformation of mineral components," mineralogist Langenhorst explains. On the basis of high pressure experiments the scientists were able to clarify things: under the given pressure and temperature in this depth, the exchange of elements between the main minerals of the subducted ocean plate – pyroxene and garnet – is slowed down to an extreme extent. "The diffusion of a pyroxene-component in garnet is so slow, that the submerging rocks don't become denser and heavier, and therefore stagnate," the Jena scientist says.

Interestingly there is congestion in the earth mantle exactly where the ocean floor submerges particularly fast into the interior of the Earth. "In the Tonga rift off Japan for example, the speed of subduction is very

high," Prof. Langenhorst states. Thereby the submerging rocks of the oceanic plate stay relatively cold up to great depth, which makes the exchange of elements between the mineral components exceptionally difficult. "It takes about 100 Million years for pyroxene crystals which are only 1 mm in size to diffuse into the garnet. For this amount of time the submerging plate stagnates," Langenhorst describes the rock congestion. It can probably only diffuse at the boundary of the lower [Earth mantle](#). Because then pyroxene changes into the mineral akimotoite due to the higher pressure in the depth of 650 kilometers. "This could lead to an immediate rise in the rock density and would enable the submerging into greater depths."

More information: Van Mierlo VL et al. Stagnation of subducting slabs in the transition zone due to slow diffusion in the majoritic garnet. *Nature Geoscience*, [DOI: 10.1038/NGEO1772](https://doi.org/10.1038/NGEO1772)

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