Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28932

Seismic evidence of thermochemical heterogeneity controlled by the stagnant Pacific plate in the mantle transition zone

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Subduction process introduces cold, hydrous and compositionally differentiated materials into the Earth's interior. The formation and long-term diffusion of these thermochemical heterogeneities modulate thermal and material fluxes across the mantle, exerting a significant influence on mantle convection. However, the location and degree of the thermochemical diffusion related to stagnant slabs in the mantle transition zone (MTZ) remain poorly constrained. Here we investigate the morphology and properties of the seismic discontinuities within the MTZ beneath northeast China, to track the stagnant Pacific slab and the resulting thermochemical anomalies. Our receiver function images show two prominent seismic discontinuities, corresponding to interfaces of the stagnant Pacific slab confined to the east of the North-South Gravity Lineament. To assess the influence of stagnant slab on upper MTZ, we integrate seismic observations (depths and amplitudes of the 410, and tomography model) with mineral physics modeling to map the distributions of temperature, composition and water content. We find a distinct high-temperature anomaly, basalt enrichment, and high-water content above the stagnant Pacific slab, which spatially coincide with the low-velocity layer atop the 410. This suggest that subduction-induced hydrous mantle upwelling leads to thermochemical heterogeneities in the MTZ and partial melting above the 410. The interaction between the stagnant slab and the MTZ facilitates the recycling of subducted oceanic crust and intensive hydration, potentially influencing Cenozoic volcanism in Northeast China. This study provides new insights into mantle convection patterns within the big mantle wedge.