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Making and altering the crust: A global perspective on crustal structure and evolution

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Crustal structure preserves a unique record of physical and chemical conditions of its formation and later modification by geodynamic processes. The existence of broad global correlations between crustal structure and tectonic settings led to models of crustal typization by 1D crustal columns based on absolute thicknesses of crustal layers and the Moho depth.

Here we propose a fundamentally different approach to typify the crust and geodynamic models of crustal evolution. We demonstrate that the relative ratio of the thicknesses of three principal crustal layers (sedimentary/felsic-intermediate/mafic in continents and (Layer1/Layer2/Layer3 in oceans) is a fundamental characteristic of the crust. The relative ratio uniquely specifies the crustal structure in different tectonic settings and is independent of the absolute values of thickness of the crustal layers and the Moho depth. We analyze this new fundamental characteristic of the crust by ternary diagrams based on seismic models for continental and oceanic crustal structure in the northern Eurasia – northern Atlantics region and for selected oceanic provinces of different geodynamic origin, where seismic models for the crust are available. We present global and regional trends of crustal evolution and, as a practical application of the new approach, calculate average crustal densities in different continental and oceanic tectonic settings. These values range from ca. 2700 kg/m3 in deep basins, to 2775 kg/m3 in orogens and shelves, 2800 kg/m3 in rifts and some ocean hotspots, 2800-2850 kg/m3 in shields and platforms, 2900 kg/m3 in back-arc basins and aseismic ridges, and may reach 2950 kg/m3 in the Pacific hotspots.

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