Continental crust in the ocean

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Conventional plate tectonics envisages simple continental breakup with clean splitting of supercontinents and subsequent orderly widening of oceans by seafloor spreading about a central ridge. No sooner was this paradigm proposed when the clear, first-order misfit of intraplate and large-volume volcanism was highlighted. That was quickly accommodated by adding an additional degree of freedom into the theory of Earth dynamics, i.e., ad hoc mantle plumes. Although this simple picture was adequate in the early years of plate tectonics, the subsequent rapid accumulation of vast datasets of ever-more-precise observations has rendered a theory of such simplicity no longer tenable. Simple plate tectonics can now serve only as a basic canvas on which the complexities of the real world must be painted. There is no better region for illustrating this than the Northeast Atlantic Realm which illustrates the full range of complexities. After a history of tectonic unrest spanning several 100 Myr true continental breakup, involving fracture of the entire lithosphere and ocean widening via sea-floor spreading, finally proceeded. However, geological complications are on at least an equal level to features arguably amenable to description by simple plate tectonics. Spreading ridges developed by propagation through continental lithosphere comprising a collage of cratons separated by orogenic belts. Where these propagators met insurmountable barriers the extension demanded by local kinematics could only be accommodated by diffuse continental extension. Continual changes occurred in the direction of regional extension and these resulted in local tectonic instabilities manifest in lateral ridge migrations, jumps, and parallel-ridge-pair extension. Extreme, magma-assisted continental extension, together with intense volcanism, formed lava-capped transitional crust. As a consequence the true extent of continental crust under the oceans is unclear. The geophysical characteristics of transitional crust are ambiguous in terms of physical properties. This presents a challenge to mapping continental material in the oceans, a problem that can be mitigated by joint interpretation with gravity, heatflow and geochemical data. Known continental blocks in the ocean include the array of blocks west of the British continental shelf (the Hatton-, George Bligh-, Lousy-, Bill Bailey’s- and Faroe Bank Highs, and Wyville-Thompson- and Fugløy Ridges), the Jan Mayen Microplate Complex, the Greenland-Iceland-Faroe Ridge and likely others that remain to be found. All of the above complexities in the solid Earth have profoundly affected the natural environment in the region, especially the oceans and the biosphere, and must be taken into account in predictions of future evolution of the natural environment.

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