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Subsidence induced by magmatic activity

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Significant topographic relief is identified in the basement surface of many sedimentary basins, albeit hidden by the sedimentary sequences. We discuss the possibility of formation of wide and deep sedimentary basins by thermal subsidence caused by magmatic intrusions into the crustal and mantle lithosphere. Magmatism may heat the lithosphere substantially independent of its origin, be it due to deep sources (e.g. mantle plumes) or decompression melting in high strain environments. Thermal expansion of the rocks of the lithosphere will cause uplift of the Earth's surface and erosion will bring the surface back to sea level. The subsequent cooling of the lihosphere creates the basin. Thermal sag basins are usually attributed to the heating of the crustal and mantle lithosphere due to extensional events, but here we focus on the role of heat brought into the crust and mantle lithosphere by magma. A characteristic feature of such basins is that relatively little faulting is expected in association with the subsidence. We find evidence from the Danish-Norwegian Basin in the North Sea area for significant magmatic intrusion into the crust during the Carboniferous to Permian. The subsequent Triassic subsidence shows almost no faulting, which indicates that the subsidence was not caused by tectonic stresses. The amount of magmatic rocks ($>$40-100,000 km^3) presently detected in the crust is sufficient to explain the observed subsidence as the thermal relaxation to the magmatic event together with the isostatic response to the sedimentary load. As such there is no need for invoking extensional stresses for explaining the Danish-Norwegian Basin.