Subsidence, Heat Flow, and Mechanisms of Extension Within Crust

There is now reasonable agreement on the fact that formation of continental margins is accompanied by thinning of the continental crust as well as the mantle part of the lithosphere. Whether or not the amount of thinning is the same in both portions has been debated. However, an equal amount of thinning is a good first approximation. We use this approximation to explore the thermal and mechanical consequences of the initial stretching as rifting proceeds. We then compute the evolution with time of the brittle ductile zone. This limit migrates upward in the thinnest portion of the crust.

We show on one hand that lateral cooling in rifts which are too narrow, thus leading to an abortion of the structure at depth. Actually, partial fusion can be prevented by lateral intrusion which the high heating rate exercised, during the period of cooling of the intrusions, on the evolution of hydrocarbon generation processes in these Lower Jurassic source beds. The established relationship between stages of petroleum hydrocarbon generation and maturity progress (expressed, e.g., as vitrinite reflectance), as it has been documented for many case histories worldwide and referred to as "liquid window," cannot be seen in this rapidly heated source rock series. The liquid window is shifted toward higher maturity stages and extends up to 1.75% R°. This is documented on the basis of maturity trends for the evolution of yields and compositional patterns of the extractable hydrocarbons. The most likely explanation for these observations is that the reaction rate causing vitrinite reflectance to increase is more temperature-dependent than the rates of the hydrocarbon generation reactions. In kinetic terms this means that, although the processes are highly complex, the effective activation energy of the vitrinite reaction is higher than that of the hydrocarbon generation reactions.

The gigantic oil and gas accumulations of the Lower Cretaceous make the Southern Norwegian Shelf an ideal area for hydrocarbon exploration. There is now reasonable agreement on the fact that formation of continental margins is accompanied by thinning of the continental crust as well as the mantle part of the lithosphere. Whether or not the amount of thinning is the same in both portions has been debated. However, an equal amount of thinning is a good first approximation. We use this approximation to explore the thermal and mechanical consequences of the initial stretching as rifting proceeds. We then compute the evolution with time of the brittle ductile zone. This limit migrates upward in the thinnest portion of the crust.