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Coupling between rifted oceanic crust and sedimentary deformation in the Fram Strait: implications for seafloor seepage and gas hydrates dynamics.

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The continent–ocean transition along the passive margin off western Svalbard is, in places, only a few kilometers away from the formerly glaciated continental shelf. Strong bottom currents in the Fram Strait have led to the deposition of several kilometers thick sedimentary ridges that extend from continental to oceanic crust all the way onto the flanks of the oblique-spreading Molloy and Knipovich mid-ocean ridges. The sedimentary ridges represent large contourite drifts and are characterized by faults that extend to the present-day seafloor. Generally, it is argued that gravitational forcing or flexure due to fast sedimentation and/or erosion is the main force leading to deformation of Quaternary sediments, and that horizontal forcing is negligible. However, high resolution 2D and 3D seismic data along the western Svalbard margin reveal that sedimentary faults commonly propagate from the termination of rift-related faults in the oceanic crust, and are not always favorably oriented to accommodate gravitational collapse. We suggest that coupling between the slow-spreading oceanic crust and the sedimentary cover results in a transfer of stress and strain that influences near-surface sedimentary deformation. Deep crustal fluids are also transferred into the Quaternary succession utilizing faults as migration pathways. Such faults sustain shallow gas accumulations, wide-spread gas hydrate formation and cold seeps. Simultaneously, glacial isostatic rebound leads to additional lithospheric deformation and also exerts a control on fault kinematics and gas seepage. We discuss seismic examples of deep marine seepage systems and the potential implications of coupling between lithospheric deformation and sedimentation on the spatiotemporal evolution of seafloor seepage at Arctic margins.