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Loading of Young Sediments on Oceanic Lithosphere near Knipovich Ridge in the North Atlantic and its Implications for Bathymetry and Mantle and Lithospheric Rheology

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Knipovich Ridge (KR) in the North Atlantic ocean is associated with an ultra-slow spreading center. The oldest seafloor is ˜45 Ma and its distance to the KR is only ˜200 km. The seafloor topography on the eastern side of the KR has been significantly modified by accumulation of several kilometers of sediments such that seafloor depths are shallower at older seafloor. However, the seafloor on the western side of the KR has substantially less sediments, and the seafloor topography follows the standard depth- age relation reasonably well. The sediments on the eastern side of the KR were mainly deposited during the last two to three million years due to efficient erosion processes associated with deglaciation events. Detailed grids of sediment thickness between Greenland and Barents Sea have been constructed from seismic reflection profile data, and well data have been used to sub-divide the sediments into four different age units: 0.44 Ma, 0.44-1.0 Ma, 1.0-2.6 Ma, and older than 2.6 Ma. The sediment-loads cause significant vertical displacement of oceanic lithosphere by as much as two kilometers in certain regions.

The temporal and spatial distributions of sediments and sediment-induced vertical displacements of the oceanic lithosphere provide constraints on mantle and lithospheric rheology. We have formulated viscoelastic models to examine the dependence of the

sediment-induced vertical displacements of oceanic lithosphere on the rheology of the mantle and lithosphere. By comparing model predictions with the observed vertical displacements on either side of the KR, we seek to constrain the relevant rheological parameters. Our findings are summarized as following. 1) The controlling factors on vertical displacement of oceanic lithosphere are deformation mechanism (i.e., dislocation verse diffusion creep) and activation energy, while asthenospheric viscosity plays a relatively minor role. 2) The observed displacements on the eastern side of the KR is best explained by dislocation creep mechanism with activation energy of ˜300-400 KJ/mol. 3) The seafloor on the western side of the KR including the rift shoulder is uniformly uplifted relative to that on the eastern side of the KR. This is best explained as the effect of sediment-loading that depresses the eastern side of the KR due to large amount of sediments there.