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The offshore record of variable Cenozoic sediment flux from Western Scandinavia

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The rates of sediment input to the North Sea and the Norwegian Shelf varied significantly during the Cenozoic. During Paleocene and Eocene times The Shetland Platform and Scottish Highlands were the main sediment sources, while with the onset of the Oligocene more sediment was coming from the Scandinavian shield (Millennium Atlas).

In general, the western Scandinavian sediment production rate increased from south to north, with more than 500m of Oligocene deposits in the central and eastern North Sea (Huuse et al., 2001) to as much as 2000m of Pliocene deposits in the Møre basin (Dehls et al., 2002). This is believed mainly to be a consequence of varying erosion rates and/or changes in sediment catchments in Western Scandinavia. This has previously been interpreted in terms of variable tectonic uplift of the area caused by a hitherto unknown tectonic agent; Neither crustal shortening and thickening or magmatic underplating onshore, as well as other plate tectonic mechanisms, are compatible with observations.

A dense grid of seismic data and well logs from numerous boreholes in the research area allow to estimate the rate of deposition of matrix mass and to localize main areas of sediment outpour as a function of time. Here we present semi-quantitative maps of sediment flux from western Scandinavia during subsequent epochs of the Cenozoic and discuss possible explanations.

After a warm and ice-free Cretaceous period, the climate remained mild during Paleocene and Eocene times. On the Eocene-Oligocene greenhouse-icehouse transition the sediment yield of the Scandinavian shield increased. Furthermore, recent results (Heilmann-Clausen and van Simayes, 2005; Nielsen et al., 2008; Sliwinska et al., 2008) show a correlation between climate fluctuations and sequence stratigraphic surfaces and lithological changes in the North Sea. Based on this evidence we suggest that a rapid cooling at the beginning of Oligocene (Oi-1 glaciation, Zachos et al., 2001) changed the erosional regime in western Scandianvia from fluvial (which is inefficient in tectonically stable settings, regardless of the amount of precipitation - Von Blanckenburg, 2005) to glacial. As, furthermore, glacial erosion (the glacial “buzzsaw” Mitchell and Montgomery, 2006; Brozovic et al., 1997; Pedersen et al, 2008) and periglacial processes (Anderson, 2002) are known to possess the potential for producing characteristic low-relief accordant landscapes at high elevation, this hypothesis also provides and alternative to understanding flattish landscape elements in the western Scandinavian highlands, which conventionally have been explained as remnants of uplifted peneplains previously graded to sea level (the Davisian cyclic landscape evolution model).

Therefore, given the Eocene-Oligocene greenhouse-icehouse transition, which must have increased the importance of glacial and periglacial erosion and transport processes in the highlands of western Scandinavia, a hypothesis of climate control on erosional and depositional history of western Scandinavia and adjacent sedimentary basins emerges. This hypothesis is to be tested using the present results. Estimation of offshore matrix mass will be the basis for reconstruction of the development of source areas with use of mathematical models of landscape evolution.