FORCE industry proposal by
Centre for Earth Evolution and Dynamics (CEED), Department of Geosciences, University of Oslo

CEED tectonic and basin modelling team:

Integrated basin studies – linking plate tectonics, mantle dynamics and surface processes to basin evolution

We are seeking funding and scientific collaboration to establish an industry-academia consortium (CEED-MOD) with focus on quantitative tectonic/geodynamic and basin analyses. The overall goal is to increase our understanding of basin formation and evolution by combining key academic competences with industry long-term experience from basin and petroleum systems studies on the Norwegian continental shelf (NCS). In this consortium we will integrate fundamental knowledge of geological structures and geodynamic processes into quantitative basin analyses for a better understanding of how sedimentary basins on the NCS have developed in time and space. By doing this we will establish an improved quantitative framework for future basin studies also having significant impact on the basin and petroleum system modelling (BPSM) carried out by industry.

BPSM links geological and geophysical observations and predictive models of where to find hydrocarbons with long-term large-scale external processes, the geodynamic processes. Generally, factors that can be imaged, or drilled, are well constrained in BPSM. This is in part why the industry generally is successful in building predictive models of structure and presence of sediments with reservoir potential and source rocks. Geodynamic processes cannot be directly imaged, but still are of key importance. For example, large-scale processes within the Earth's interior are linked to surface processes having impact on the vertical motion and temperature histories of sedimentary basins. At regional scales, plate tectonics play an important role and the associated paleogeography and paleoclimate have large impact on provenance and depositional environments (source-to-sink). Forces raised along plate boundaries and caused by lithosphere-mantle interaction lead to intraplate deformations and non-trivial stress patterns. Thus, improvements in understanding of geodynamic processes, and translating of these into BSPM have significant potential to reduce future well failures particularly when caused by lack of petroleum charge. A precondition for success with this is improved constraints for the vertical motion and temperature histories by integrating effects of mantle dynamics and plate tectonics. Furthermore, to evaluate seals improved understanding of strain related to intraplate stresses (both present and past) and pressure are needed.

The proposed research does not intend to develop new basin modelling software, but rather to understand and quantify processes that control basin evolution still largely overlooked in modern basin and petroleum system analysis. Key processes to integrate and address, which are closely interlinked, include: (1) Plate tectonics; (2) Mantle dynamics; (3) Intra-plate stress; (4) Surface processes; (5) Complex processes during basin evolution. Such processes have different spatial and temporal characteristics (wavelength, amplitude, timing/duration), but all may contribute significantly to evolution of sedimentary basins. Analysis of these processes requires identification of effects of individual processes/mechanisms, quantification of their influence, and study of interplay between such. CEED has key competences within all relevant research fields that we aim at integrating with theoretical and practical knowledge of the involved industrial partners. One of the main aims of CEED, as a Norwegian Centre of Excellence, is to link the first two major topics, plate tectonics and mantle dynamics, and thus separation in these themes is not really distinct. The proposed work is also an excellent example of how basic and applied research should be linked and how academic and industry can complement each other.