Geophysical Research Abstracts
Vol. 14, EGU2012-14251, 2012
EGU General Assembly 2012

Interaction between turbidite systems and MTDs at the sea-bottom of the Eastern Nile Delta Offshore

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We combined geophysical data from the seafloor and sub-bottom (bathymetric data, backscatter imagery, seismic-reflection profiles and sediment cores) and Plio-Pleistocene sequence (3D seismic, well logs and cores), to reconstruct the evolution of depositional processes in the Eastern Province of the Nile Deep-Sea Fan. The use of advanced interpretation and visualisation techniques helped providing insight into the shelf and upper slope seismic stratigraphy and the characterization of subsurface channel complexes, buried canyons and mass transport deposits throughout the Quaternary series.

The Eastern Province of the Nile Delta Offshore is strongly affected by salt tectonics that generated normal faults on the upper slope and compression and large-scale folds at the base of the slope. Channel levee systems were built offshore the Damietta branch of the delta but became inactive some 125.000 yrs ago. Processes of sediment transfer and deposition evolve downslope alongside variations of salt-tectonic structures. On the upper slope, channelized systems are characterized by strongly segmented features feeding and connecting numerous micro basins controlled by salt-tectonics. The middle slope is characterized by more continuous channels, detected along tectonic axes of subsidence or relief and feeding subsiding basins. On the lower slope, channels terminate in an area of pressure ridges and salt domes, with sandy lobes nestled in confined areas.

In the sedimentary pile of the Damietta upper slope, channelized systems are commonly associated with MTDs as channel-levee edifices and sand-sheet units are either reworked and included in MTDs or built in depressions on top of MTDs. This suggests that MTDs occur commonly during the development of channelized system. Periods of higher sediment flux likely initiated the development of channels and lobes and modified the conditions of slope stability, thus facilitating the triggering of giant mass-transport events. Climatic and/or eustatic variations are thought to be one of the major factors controlling the triggering of large MTDs. Active salt-tectonics are also a likely factor for slope destabilization. Seismic data show a large MTD (>350 km3) emplaced shortly before a significant episode of gravity sliding that generated multiple large tilted blocks.

On the seafloor, the highest concentration of pockmarks is identified above buried MTDs, where numerous channel edifices are trapped and where the hemipelagic cover is thinnest. Pockmarks are located at the top of columns of fluids along faults and fractures across the MTD, suggesting that MTDs are fluid rich and that processes of de-fluiding occur along faults as preferential pathways. But MTDs also possibly played a role in the upward migration of fluids as a sudden overloading caused by the catastrophic emplacement of a mass-movement leading to fluid overpressure in the underlying units. Fluid-escape structures are also located along stratigraphic level overlying sand bodies like channel-fill deposits and lobes. In that case, origin of pockmarks is attributed to the de-fluiding of sand-prone turbidite edifices.