ACTIVE SEABED PROCESSES AND POTENTIAL GEOHAZARDS IN THE CENTRAL NILE DEEP-SEA FAN FROM INTEGRATED SWATH BATHYMETRY AND 3D SEISMIC DATA

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Abstract
Geohazards are consequences of geological processes. If not identified, they may put at risk industrial activity such as subsea installation or drilling, with potential impact on safety and environment. Previous studies showed that the Central Nile Deep-Sea Fan (NDSF) is characterized by a rough and chaotic seabed surface and affected by numerous gravitational instabilities such as landslides as well as by fluid seepages [1]. Mapping this area from swath bathymetric and seismic investigation of the seafloor allowed identify several features directly on the seabed such as active fault scarp, fluid seepages, mass-wasting and mass-flow, or detected in subsurface sedimentary layers such as shallow fault, buried channels, mass transport deposits (MTDs), and shallow gas-charged sediments, which may induce potential and considerable geohazards.

Keywords: South-Eastern Mediterranean, Nile Delta, Bathymetry, Geohazards

Different types of geological geohazards are known to affect continental margin environments. Following a nomenclature defined by Stauffer et al (1999) [2], they can be divided into seabed geohazards (fault scarp, fluid venting, landslides, debris flows) and subsurface geohazards (shallow faults, buried channels and landslides, shallow gas-charged sediments). Among these processes, submarine landslides are among the most abundant and are the main causes for remobilization and transfer of large volumes of sediments on continental margins. Slope destabilizations may cause destruction of infrastructures like drilling platforms, posed or anchored at the seafloor, and may also induce tsunamis in coastal areas. In marine environments, geohazard and risk assessments are thus requiring valuable identification of the different geohazard-related structures and of their signatures, as well as a tentative evaluation of their recent and past activity. This study focuses on the Central NSDF where numerous shallow submarine landslides and abundant fluid seepages have already been identified [3; 4]. Based on a dataset including multibeam bathymetry and backscatter, Chirp and seismic-reflection profiles (Géoazur laboratory) together with 3D seismic data (Total Company), a detailed mapping of the main geohazard-related structures has been established for the study area. On the seabed, failure-related structures are the most abundant and cover up to 25% of the surface of the studied area. Three types of mass-wasting and mass-flow events were observed on the continental slope: (a) Debris flows, characterized by 25-50 km long and 3-5 km wide bodies elongated in the main slope-angle direction; these features were triggered along the upper part of the continental slope where they left spoon-shaped scarps 25 m high. Some debris flows exhibit hundreds of scattered blocks (up to 3 m high and 40-100 m wide) rafted on top of the flows and arranged into linear segments. (b) Slumps are mainly located on the upper slope between 300-435 m water depths; they show as scarps (5 m high) followed downstream by lobate remobilized deposits (3-6 km long, 0.3-1.5 km wide). (c) Finally seabed sedimentary undulations are observed in the northwestern part of the study area, by water depths greater than 1200 m, and cover about 15% of the studied area. These features are 0.05-3 km long and oriented W/E to N-NW/S-SE. On seismic data, they are seen as overlying MTDs. We interpret them either as creeping/extensional features associated with shallow rotational faults or as sediment waves as described elsewhere [5]. Dendritic network of curved grooves lies on the upper continental slope around 900-1100 m water depths; they represent about 5% of the studied area. They are also seen on top of buried MTDs and are interpreted as extensional seabed fractures. Fluid seepage areas, which include large fields of pockmarks and seven mud volcanoes (MV) represent about 5% of the surface of the studied area. Some MVs exhibit recent activity markers such as mud flows. Finally, normal fault scarps, up to 70 m high and few kilometers long, were observed. They are oriented N/S to W/E. On seismic profiles, they can be recognized up to more than 1 s penetration below seafloor and clearly affect deep sedimentary layers; they are believed to be part of the deep Rosetta Fault system. Most of these structures exhibit a well-developed expression at the seafloor, suggesting they have been triggered/deposited (failure-related structures), active (fluid seepages) and/or rejuvenated (fault scarps) during recent times. From 3D seismic, shallow fault, buried channels, MTDs, and shallow gas-charged sediments, were identified within the first 300 ms below the seafloor. The different types of processes affecting the present-day seafloor should thus have had a recurrent activity for a long time period of time. Because of their number and of their distribution, mass-wasting and mass-flow events represent the strongest geohazard within the studied area. Together with fluid ventings, they could have a high hazard potential. Since only few historical earthquakes are known on the Egyptian margin, faulting should represent by opposition a relatively low hazard potential. Our interpretations should however be confirmed by attempts of dating of these processes.

References

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