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GIS-based technology for marine geohazards in LW3-1 Gas Field of the South China Sea

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The exploration and exploitation of deep-water oil-gas are apt to be suffered from high-risk geo-hazards such as submarine landslide, soft clay creep, shallow gas, excess pore-water pressure, mud volcano or mud diaper, salt dome and so on. Therefore, it is necessary to survey the seafloor topography, identify the unfavourable geological risks and investigate their environment and mechanism before exploiting the deep-water oil-gas.
Because of complex environment, the submarine phenomenon and features, like marine geohazards, can not be recognized directly. Multi-disciplinary data are acquired and analysed comprehensively in order to get more clear understanding about the submarine processes. The data include multi-beam bathymetry data, sidescan sonar images, seismic data, shallow-bottom profiling images, boring data, etc.. Such data sets nowadays increase rapidly to large amounts, but may be heterogeneous and have different resolutions. It is difficult to make good management and utilization of such submarine data with traditional means. GIS technology can provide efficient and powerful tools or services in such aspects as spatial data management, processing, analysis and visualization. They further promote the submarine scientific research and engineering development.

The Liwan 3-1 Gas Field, the first deep-water gas field in China, is located in the Zhu II Depression in the Zhujiang Basin along the continental slope of the northern South China Sea. The exploitation of this field is designed to establish subsea wellhead and to use submarine pipeline for the transportation of oil. The deep-water section of the pipeline route in the gas field is to be selected to pass through the northern continental slope of the South China Sea. To avoid huge economic loss and ecological environmental damage, it is necessary to evaluate the geo-hazards for the establishment and safe operation of the pipeline. Based on previous scientific research results, several survey cruises have been carried out with ships and AUV to collect multidisciplinary and massive submarine data such as multi-beam bathymetric data, sidescan sonar images, shallow-bottom profiling images, high-resolution multi-channel seismic data and boring test data. In order to make good use of these precious data, GIS technology is used in our research. Data model is designed to depict the structure, organization and relationship between multi disciplinary submarine data. With these data models, database is established to manage and share the attribute and spatial data effectively. The spatial datasets, such as contours, TIN models, DEM models, etc., can be generated. Some submarine characteristics, such as slope, aspects, curvature, landslide volume, etc., can be calculated and extracted with spatial analysis tools. The thematic map can be produced easily based on database and generated spatial dataset. Through thematic map, the multidisciplinary data spatial relationship can be easily established and provide helpful information for regional submarine geohazards identification, assessments and prediction.
The produced thematic map of the LW3-1 Gas Field, reveal the strike of the seafloor topography to be NE to SW. Five geomorphological zones have been divided, which include the outer continental shelf margin zone with sand waves and mega-ripples, the continental slope zone with coral reefs and sand waves, the continental slope zone with a monocline shape, the continental slope zone with fault terraces and the continental slope zone with turbidity current deposits.