Extracting Fault and Regional Salt Flow Information from a High-Resolution, Bathymetric Map of the Shelf, Slope, and Abyssal Plain of the U.S. Gulf of Mexico

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ABSTRACT

We use geographic information system (GIS) tools and neural networks to analyze a 1.4 billion pixel, 145,000 km^2, high-resolution, bathymetric map of the U.S. Gulf of Mexico that was prepared by the Bureau of Ocean Energy Management (BOEM) using the bottom return from merged, industry 3D seismic surveys. The workflow for extracting fault data includes: (1) creation of ArcMap GIS project from BOEM bathymetry map; (2) GIS spatial analysis from the bathymetry to create slope and hillshade maps; (3) extraction of surficial faults and surficial fault scarp dips from neural network analysis; and (4) determination of fault offsets with 2D seismic reflection data. The main results from the fault map include the following: (1) in contrast to the result of a previous study that proposed on the basis of surficial faulting and minibasin shapes that regional, downslope Gulf of Mexico salt motion is to the southwest, we conclude that the main direction of salt transport is to the south and south-southeast; this direction of transport is consistent with the controlling influence of the deepest area of thinned, continental basement in the area of the Gulf of Mexico below and to the south and south-southeast of the Sigsbee salt front; (2) this south and south-southeast salt displacement direction can be combined with the 'bow and arrow rule' to calculate the frontal thrust displacement of salt lobes varying from 41 to 146 km; (3) salt lobes are controlled by the presence of deeper-penetrating minibasins that act as an obstructions in the forward motion of the salt front as proposed by previous workers; (4) an overlay of 845 natural oil and gas seeps shows that the faults bounding minibasins are the main conduit for seeps probably as a result of the 'plunger effect' of the minibasin through the underlying, hydrocarbon-bearing strata; and (5) high-standing diapirs are confined to water depths of 70 to 2100 m on the upper slope of the Gulf of Mexico and may reflect the erosive effects of the Gulf Loop current active at these water depths.

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