The Gulf of Mexico Earthquakes of Spring 2006: A Possible Causal Association

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During Spring 2006, two earthquakes (M ~4.6 and 5.3) occurred in the Gulf of Mexico in a primarily aseismic region. However, their proximity to locations of active oil and gas production, and speculations about their tsunami generation potential caused widespread interest in additional investigations about their possible causes. We propose a hypothesis wherein stress concentration due to contrast in mechanical properties between the salt deposits and surrounding sediments, driven by background tectonic loading, may have been a cause of these unusual earthquakes. Our hypothesis stems out of earlier published analytical and case studies of stress concentration due to intrusions that are stiffer or weaker than the surrounding host rock, when subjected to tectonic loading. In the case of these earthquakes in the Gulf of Mexico we demonstrate the hypothesis by two-dimensional numerical modeling, with additional three-dimensional modeling currently in progress. Our models consist of a simplified regional geometry of the offshore salt bodies surrounded by sediments. We assign mechanical properties (bulk and shear moduli, and density) to the salt and sediments based on the known geology and seismic velocities. Finally, we load our models tectonically for a specified time period, and explore the patterns of resulting stress concentration due to different spatial extents of the salt, and also directions of tectonic loading (tensile and compressive). Our results suggest that the locations of relatively high shear stress concentrations correlate well with the spatial distribution of the Spring 2006 Gulf of Mexico earthquakes, and those documented historically in the region. We therefore postulate that stress concentration resulting from the contrast in mechanical properties between the salt and surrounding sediments may have been a cause of these unusual earthquakes.