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Slope Degradation and Mass-Transport Complex (MTC) Emplacement: A 3-D Seismic Reflection Case Study From the Exmouth Plateau, Offshore North West Australia

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ABSTRACT

The degradation of submarine slopes can involve large submarine landslides, which represent a significant geohazard in many offshore petroleum provinces around the world. However, the geomorphological characteristics of submarine landslides are extremely variable and there is a range of depositional processes responsible for their initiation and emplacement. We use five post-stack time migrated (PSTM) 3D seismic reflection surveys to investigate slope degradation and mass-transport complex (MTC) emplacement processes within the Cenozoic succession of the Exmouth Plateau, NW Australia. The exceptionally high seismic data quality has enabled the description of numerous kinematic indicators, which provide a new insight into the initiation, translation, and cessation processes associated with submarine slope failures. We focus on a large (>65 km long, up to 20 km wide) MTC that thickens downslope to a maximum of 200 m. The MTC originated from a 30 km wide headwall scarp (at 200-700 m water depth) that dips steeply (20o) seaward. The MTC is characterised by dominantly transparent and chaotic seismic facies. Kinematic indicators include: [1] erosional lateral margins, [2] downslope-diverging, slope-parallel grooves on the basal shear surface, [3] large remnant and deformed blocks, [4] primary and secondary flow fabrics on the MTC top surface, and [5] high-amplitude reflection thrusts in cross-section, which are expressed as sub-parallel arcuate ridges on the seabed. These kinematic indicators suggest that the MTC transport direction was to the northwest away from the scarp. MTC emplacement was followed by progradation of a gullied slope. We speculate that slope degradation and MTC emplacement were triggered by active tectonism, possibly associated seismic shaking and the expulsion of gas and/or other fluids from underlying sedimentary rocks, which host enormous volumes of thermogenic gas throughout the NW Shelf. The escape of fluids could increase rock pore pressure and reduce the shear stress required to trigger slope failure, resulting in a significant amount of mass wasting. This is supported by pockmarks on the seabed, between the outer shelf and the lower slope, which suggest still-active fluid escape. An active subduction zone along the northern margin of the Australian plate generates earthquakes and induces slope steepening, which might contribute to potential trigger mechanisms.