The temporal and spatial distribution of mass transport deposits offshore South West Taiwan

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In 1979, submarine mass movements off the Nice airport that removed part of the runway along with construction equipment and resulted in the loss of several construction workers (Dan et al. 2007; Kopf et al. this volume)

- In 1998 event off Papua, New Guinea that caused a tsunami resulting in 2200 deaths (Tappin et al. 2001)

- On December 26, 2006, a submarine landslide in the Luzon Strait caused failure of undersea cables (Hsu et al. 2009)

Seafloor is a dynamic environment with potential to do harm

Motivation for understanding the phenomenon of submarine mass movements
Study area

• Offshore Southwestern Taiwan
• Active margin
• Passive margin
• Ridges and gullies: perpendicular to the strike of the slope
• Deepwater area: 2600–3600 m with a gentle slope (0.2°)
DEFINITION

Mass-transport deposits are sedimentary, stratigraphic successions that were remobilized after initial deposition but prior to substantial lithification and transported downslope by gravitational processes as non-Newtonian rheological units (Bingham plastics or dilatant fluids).
Data and methods

Two grids of reflection seismic data were collected in the northeastern SCS:

<table>
<thead>
<tr>
<th></th>
<th>Large – offset seismic data (MGL0905)</th>
<th>Multichannel seismic data (MCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project</td>
<td>Taiwan Integrated Geodynamic Research (TAIGER)</td>
<td>Taiwan Gas Hydrate Research</td>
</tr>
<tr>
<td>Streamer</td>
<td>6000 m</td>
<td>1500 m</td>
</tr>
<tr>
<td>Hydrophones</td>
<td>468</td>
<td>108</td>
</tr>
<tr>
<td>Shot interval</td>
<td>50 m</td>
<td>50 m</td>
</tr>
<tr>
<td>Source</td>
<td>6600 in3</td>
<td>1000 in3</td>
</tr>
</tbody>
</table>

Data were processed using the ProMax and Echos softwares.
Data and methods
Data and methods

Seismic facies and their interpretation:

- **Seismic facies A:** Continuous and parallel reflection configuration

- Characteristics: Parallel reflectors, intermediate to low amplitude, good continuity

- Pelagic/hemipelagic sediments *interbedded* with overbanking turbidites
Data and methods

Seismic facies and their interpretation:

Characteristics: Wavy and high amplitude reflectors, good to intermediate continuity

Lateral migration and vertical accretion of deepwater sediment waves caused by oceanic bottom currents or sediment gravity flows

Seismic facies B: Wavy and continuous reflection configuration
Data and methods

Seismic facies and their interpretation:

Characteristics: Chaotic, low amplitude, discontinuous and uneven reflection signals

MTDs such as slumps and debris-flow deposits

Seismic facies C: Chaotic reflection configurations
Data and methods

Seismic facies and their interpretation:

Characteristics: High-amplitude and low continuity reflectors, sometimes its top showing cone-shaped feature, refractions tend to occur at the base of rocks

Seismic facies D: Discontinuous, high amplitude, and low frequency reflection configuration

Extrusive volcanics, lava flows, and sills related to extrusive volcanic activities
Data and methods

Three **key stratal surfaces**: base of the Pleistocene Series, base of the Pliocene Series, and the breakup unconformity (Liao, 2016)
Data and methods

Multibeam bathymetric data were obtained during the ACT (Active Collision Taiwan) survey in 1996 onboard of the R/V L'Atalante (Lallemand and Tsien, 1997)
Results and discussions

Before the base of breakup unconformity, many normal faults were identified. This faults occurred and formed Paleogene grabens/half grabens from rifting events.
Results and discussions

• The time gap between Breakup unconformity to base of Pleistocene: Pelagic/hemipelagic sediments interbedded with overbanking turbidites
• Shallow marine environment

HARPs: High Amplitude Reflection Packages
Results and discussions

MGL0905-05_UTIG

MGL0905-27_UTIG
Results and discussions

Passive margin

- Above the base of Pleistocene, MTDs occur with high frequency with very large volume.
- Four major MTD sheets
- Length: over 35km
- Thickness: 80 ~ 120m
Results and discussions

Active margin

- MTDs occur with low frequency and small amount of sediment.
- The distance of movement: < 3 km
- Thickness: 60 ~ 100m
Results and discussions

MTD sheets in the passive margin
Results and discussions

MTD sheets in the active margin
Results and discussions

MTD sheet

unconformity
Results and discussions

The expression of seismic profile:

- Sediment waves
- MTD sheets
- Pelagic sediments interbedded with turbidites
- Faulting

Legend:
- Red: Base of the Pleistocene
- Yellow: Base of Pliocene
- Blue: Breakup unconformity
Results and discussions

Two periods high sediment rate:
- Early Oligocene
- Pliocene – Pleistocene
Correlation between eustatic cycles and development of sedimentary
Conclusions

- Mass movement is implicated by sea level fluctuation and marine environment.

- MDTs occur above the base of Pleistocene (1.8 Ma).

- Mass transport deposits occur during low – stand sea level.

- On active margins the maximum run-out distances of MTD sheets across abyssal-basin floors are an order of magnitude less than on passive margin settings and the volumes of MTDs are limited on the abyssal sea floor along active margins.
Future works

- Interpretation all of profiles
- Work on sediment waves field
- Map out the MTD sheets and Sediment wave fields
- Drawing stratigraphy column