Vertical Datums in a Fault Zone: Influences of Plate Tectonics in Trinidad, West Indies

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SUMMARY

Trinidad lies in the South East of the Caribbean Sea, seven kilometres at its closest point to Venezuela and the South American continent to which it was once joined. The fault zone of the East West lateral strike slip between the Caribbean and the South American tectonic plates has created the Gulf of Paria, which now separates the land masses. The fault zone extends across Trinidad in its entirety, with three major faults extending East West. It has been determined that in recent times it is the fault across the centre of the island that has been active, moving at a rate of 11mm a year. This fault runs North South in the Gulf of Paria before turning West again along the North coast of Venezuela. It is therefore hypothesised that the East West movement on the North South line has caused Trinidad to separate from Venezuela and created the Gulf of Paria as a pull-apart basin.

The void that has been created as Trinidad has moved away from the main continent has rapidly filled with sediments and organic material deposited by waters from the Orinoco river. Physical evidence of the rapid nature of deposition exists in the form of mud volcanoes and occasional eruptions of sub-surface natural gases that cause islands of mud to temporarily appear from the sea. Further verification is given by the local geoidal model, which shows a hollow to the South West of the island and a 3m variation in the geoid spheroid separation from a large mass comprising the Northern Range of the island to this Southern area, just 50km away.

Not only is the void filling with sediments, but it is also likely to collapse the South Western part of Trinidad and lead to a differential in the vertical displacement of the island through time. Analysis of tidal observations taken over 8 years in the North of the Gulf of Paria and 6 years in South Trinidad show that while sea level is rising at 1mm a year in the North, it is four times this amount in the South. The vertical datum that was established with reference to MSL in the North in 1938, but levelled to the South in earlier times when the railway was established, is now severely distorted. Chart datum is 0.730m below MSL in the North and 0.824m below this level in the South, but the survey marks that are in place no longer accurately represent MSL.

This contribution contrasts the advantages and disadvantages of different vertical referencing systems. This is important in the context of a small island state where the deflection of the vertical is an average of 11 seconds, the land mass is subject to vertical movement at different rates and discontinuities arise when existing standards for chart datum are adopted.