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Why "in dubio pro" tsunami deposits does not work: Two examples from northern Chile

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The recognition of tsunami deposits in the geological record is hampered because there are no unique sedimentological criteria that clearly define tsunami sediments, and tsunami deposits have a very limited preservation potential. We present observations on two alleged tsunami deposits exposed at the Chilean coast north of Antofagasta, at Caleta Herradura and Hornitos, of Miocene and Plio-Pleistocene age, respectively. These we interpret to be in fact mass flow sediments unrelated to any kind of tsunami depositional process.

At Caleta Herradura, Cantalamessa and Di Celma (2005) interpreted mass flow deposits arranged in a Lower and Upper Unit as the product shallow marine tsunami backwash. However, the deposits in question occur in a coeval graben as intercalations between shoreface deposits. Tracing the deposit across the downthrowing graben margin faults, we did not find any evidence of described “abrupt” lateral changes in depositional facies. When the Lower Unit is traced towards the graben margin it increases in thickness and the association to synsedimentary downthrowing faults becomes evident. The Upper Unit is described as being “distributed more widely than the Lower Unit and, where the Lower Unit is absent, it succeeds directly the lower shoreface deposits.” We disagree. The Upper Unit tapers out eastward against the inclined upper depositional surface of the Lower Unit.

We interpret the Lower Unit as a debris flow alluvial fan and fan delta deposit of the graben margin which was itself affected by synsedimentary downthrow activity. If the debris flow deposits are restored for the downthrows realized along the numerous faults, it becomes apparent that the alleged tsunami backwash deposit of the Lower Unit represents the distal part of a physically continuous coarse alluvial wedge thinning westward and towards the graben center. The Upper Unit represents a debris flow deposit at least the matrix of which was derived from marine sediments within the graben. There is no evidence permitting an interpretation of both units as tsunami deposits of any kind.

At Hornitos, a very conspicuous, coarse clastic unit is exposed along a c. 1.5 km long cliff section at the foot of the Coastal Cordillera. The unit is less than 15 m thick, has an erosive base, lacks internal stratification, and is intercalated between shallow marine sandstones. The deposit consists of abundant clasts of highly variable diameter set in a sandy matrix. Clasts are mostly angular and diameters vary between a few centimeters and c. 50 m. Oblong clasts are oriented either subparallel or at high angles to the bedding. Clast lithologies are basalt, granodiorite, shist and sandstone, which were locally derived from the nearby Coastal Cordillera and coastal region. The deposit is generally chaotically mixed, although large clasts may display local grading and are sometimes concentrated near the base of the unit. It was previously interpreted as a shallow marine backwash deposit of a giant tsunami. The largest clast size previously reported was 10 m.

The characteristics of the deposit, and particularily the presence of the giant clasts and rock slabs (50m!) makes deposition by a tsunami highly unlikely. We interpret the deposit to be the product of catastrophic rock avalanche processes connected to a mountain collapse in the nearby Coastal Cordillera. Shell debris may have been incorporated into the matrix in the same way entire blocks of the underlying shallow marine lithologies were embedded in the deposit during emplacement of the unit.