Modes of Suspended Sediment Transport in Hueneme Submarine Canyon, Southern California

INTRODUCTION
Submarine canyons are known as preferential conduits for transporting sediment and other particles from coastal waters to ocean basins, therefore are key players in the source-to-sink system. In this study, two ADCPs (one upstream-looking and another downstream) were deployed in Hueneme Canyon for 6 months (September 2007 – March 2008) at a water depth of 188 m. The measured velocity profiles and acoustic backscatter intensities are used to characterize the different modes of suspended sediment transport along the canyon.

CANYON MOORING
Water depth: 188 m
Instruments: RDI 300 KHz ADCPs

MEAN TRANSPORT
Transport by the mean current in the entire flanking (16 m deep), 330 m wide is down-canyon. Using a depth-averaged estimate of 0.01 m/s, 0.01 kg/m3 (Xu et al., 2010), the total sediment transport during the 6-month deployment is 32,700 metric tons (22,000 m3), less than one half of the transport by one 2-hr turbidity current event.

SEDIMENT TRANSPORT BY TURBIDITY CURRENTS
Integrate the bottom 20 m of the <uc> profiles then multiply the duration of the events (T) to obtain the sediment transport,

\[ W = \int_{uc > 0} |uc| \, dt \times |uc| \times T \]

An arbitrary unit of count/m^2, the transport for the two listed events is respectively 12/05/2007 event: 1.72e+6 2/25/2008 event: 3.52e+6.

When a calibration becomes available to convert 'count' to g/m^3, the unit for W is g/m^2 - flux per unit width of the flanking.

Using the depth-averaged estimate of u=1.5 m/s, c=2 kg/m3 (Xu et al., 2010), the 2-hour long event on 2/25/2008 transported a total of 69,000 metric tons (46,000 m3) of sediment downcanyon through the bottom 20 m (turbidity current thickness) of the 160 m wide flanking at the mooring site.

SUMMARY
- The mean and tidal transport at the mooring site can be divided into three layers: 30-40 m immediately below the canyon rim, the canyon interior, and the bottom 60 m near the canyon floor.
- Transports in the top and bottom layers are nearly one order of magnitude greater than in the interior layer. The diurnal transport is minimal compared to the much greater semi-diurnal or subtidal transport.
- While the semi-diurnal transport in both the top and bottom layers is up-canyon, the subtidal transport has opposite directions in the two layers.
- Transports due to turbidity currents are limited to the bottom 20 m near the canyon floor.
- The transport during two turbidity current events, a combined duration of less than 3 hours, is the same order of magnitude of oscillatory transport integrated over the whole 6-month deployment. A single two-hour event is more than double this mean transport through the cross-section of the whole flanking for the entire 6-months.

OSCILLATORY TRANSPORT

The co-spectra of along-canyon tidal currents and sediment concentrations indicate an up-canyon transport at the dominant semi-diurnal frequency, contradicting the asymmetry of the semi-diurnal currents near the canyon floor that appears to favor downcanyon transport. This discrepancy seems to be caused by the phase lag between tidal currents and the timing of the turbidity plumes.

In the mean transport, there is a layered structure in which both the magnitude and direction of transport vary with water depth. Transport in these three distinct layers are computed separately:

\[ W = \int_{uc > 0} |uc| \, dt \times |uc| \times T \]

where T=6 month.

QUANTIFICATION OF SEDIMENT TRANSPORT

Along-Canyon Velocity, Low pass (Subtidal)
Net Backscatter, Low pass (Subtidal)
Full-backscatter turbidity Currents
Semi-Diurnal
Tidal Currents
Diel Currents
Sediment Transport by Tides
Sediment Transport by Currents
Sediment Transport by Turbidity Currents
Summary of fluxes

Reference:

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**Event-driven sediment flux**

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