A Preliminary Review of Beach Profile and Hardbottom Interactions

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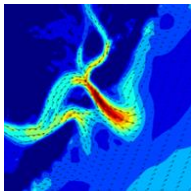
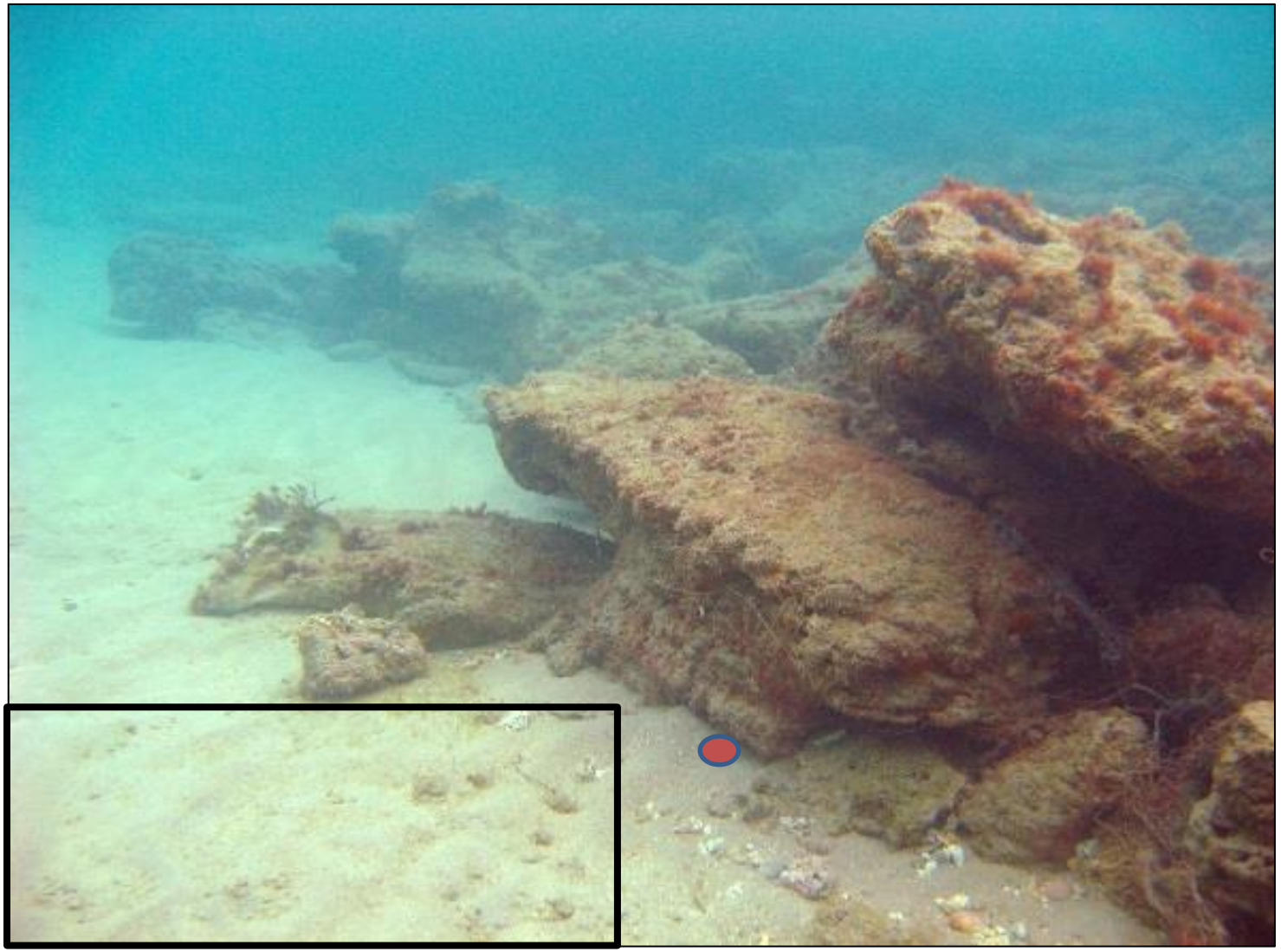
Presentation Goal

- Lead to a better understanding of the challenges regarding the estimation of sediment transport in the vicinity of hardbottom resources
- Review the basic understanding of typical beach profiles
- Review some tools to describe beach profile behavior during wave events
- Review some information regarding wave transformation over obstacles





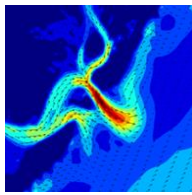


Dean (1977)

- Reviewed 502 beach profiles on the U.S. east coast
- $Y = A x^{2/3}$ where Y is the water depth , X is the distance offshore , and A is a coefficient with units of $Length^{1/3}$
- Balance between gravitational forces and onshore directed wave forces

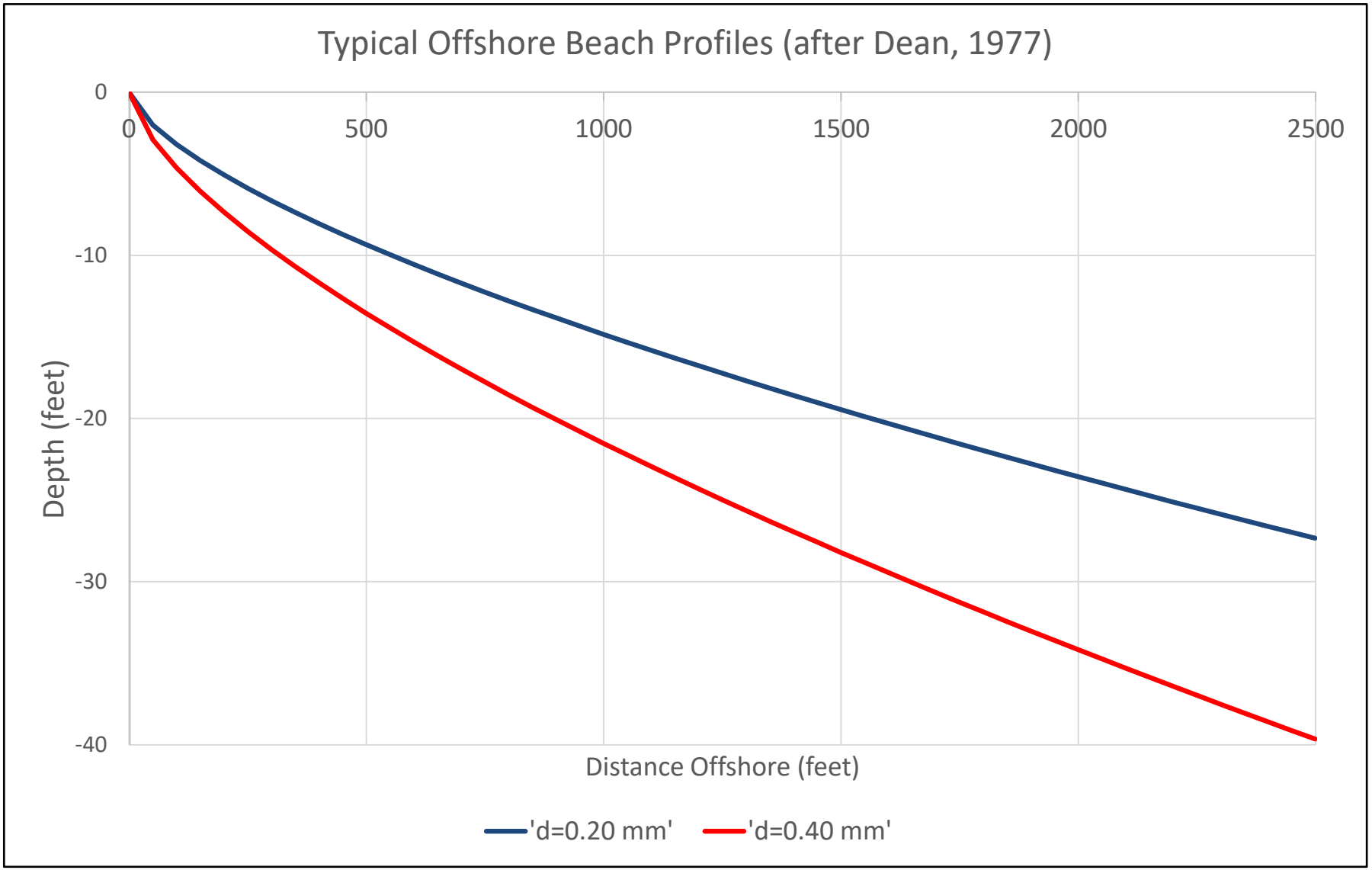




Offshore Beach Profiles

- Moore (1982) determined that coefficient A is a function of the mean grain size. Larger grain size yields larger A values and steeper beaches.


Typical Offshore Beach Profiles (after Dean, 1977)
0
-10
-20
-30
-40
Depth (feet)
0
500
1000
1500
2000
2500
Distance Offshore (feet)
'd=0.20 mm'
'd=0.40 mm'

Valid Range of Coefficient A

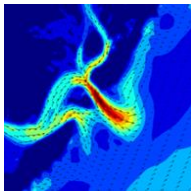
Chenier Ronquille, LA

Jaspar Beach, ME

- Munoz-Perez et al. (1999) evaluated A values landward of coral reefs in Spain and found that profiles with reefs had a greater A value (steeper profiles) than that predicted by grain size alone.





Munoz-Perez, J., et al., “Equilibrium Profile for Reef-Protected Beaches”, JCR, Vol 15, No. 4, pg. 950-957, 1999.

Depth of Closure, after Hallermeier (1981)

- Depth of closure is a depth where there is no net sediment transport during a particular time frame
- $D_{oc} = 2.28H_s - 68.5(H_s^2/gT^2;)$, relative to MLW
- H_s is the significant wave that occurs for 12 hours per year

Hallermeier, R. J. (1981). "A profile zonation for seasonal sand beaches from wave climate," *Coastal Engineering 4, 253-277.*

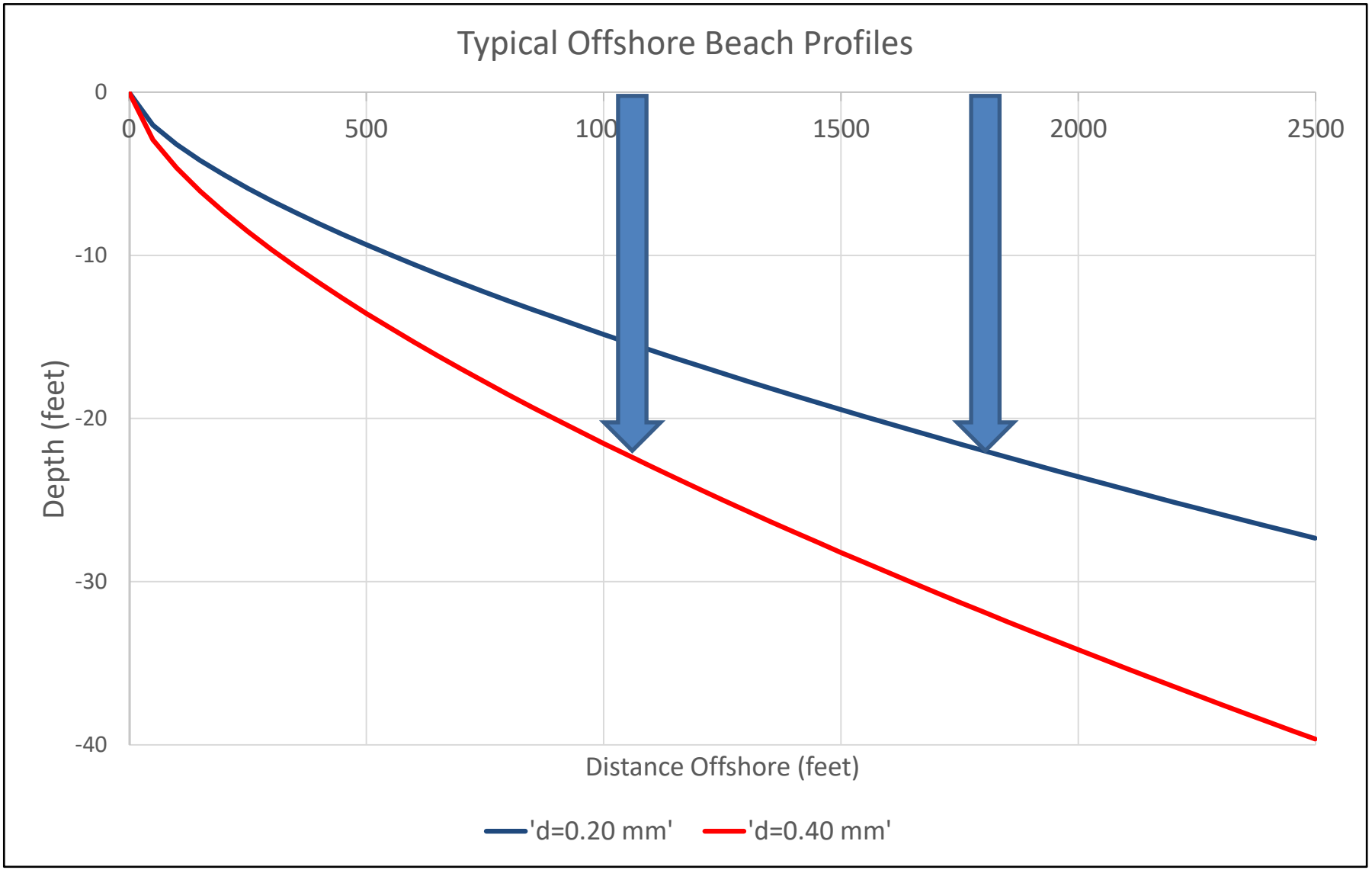
Depth of Closure, after Houston (1995)

Alternatively,

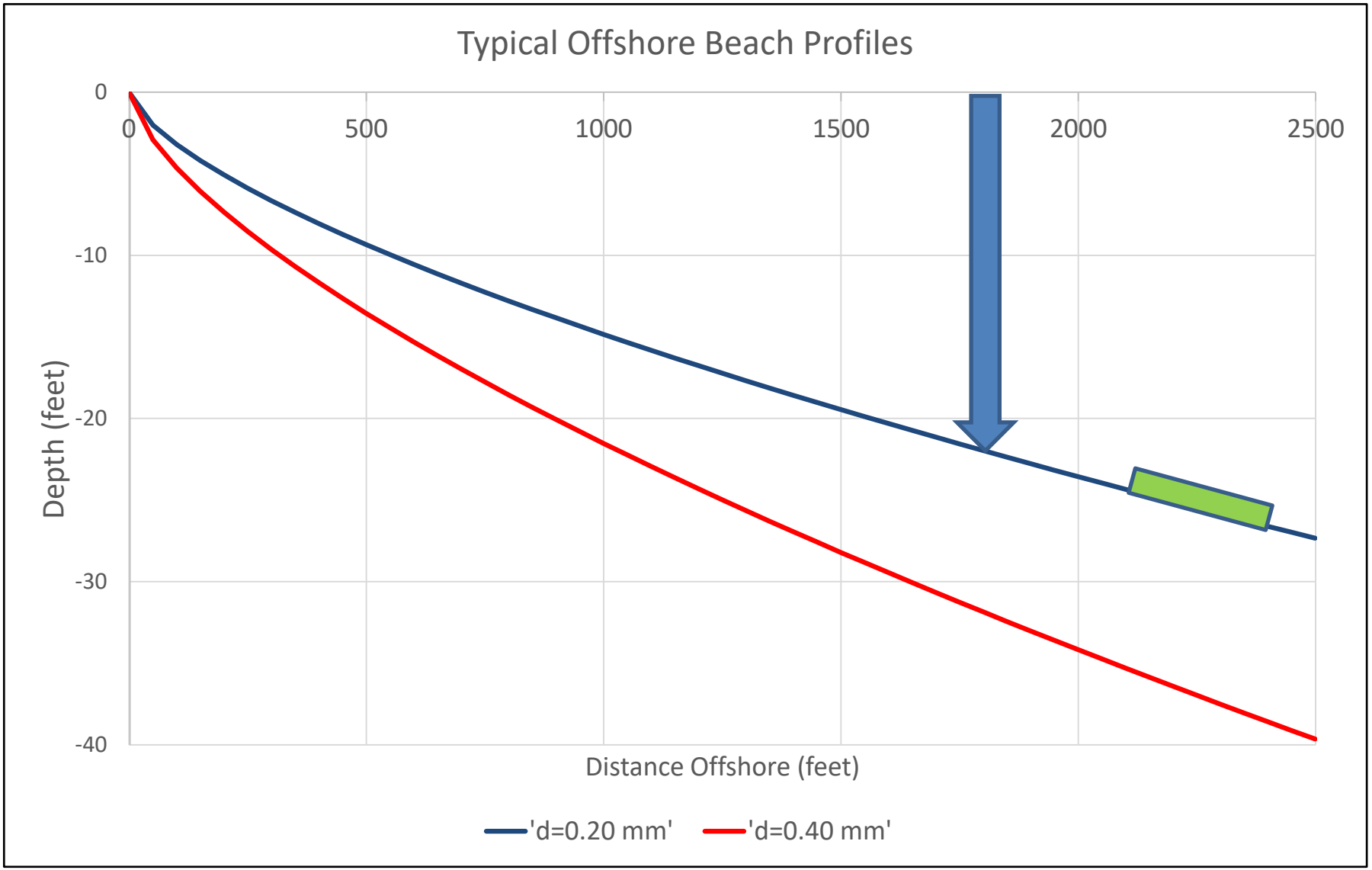
- $D_{oc}=8.9\ H_s$, MLW
- H_s = mean annual significant wave.

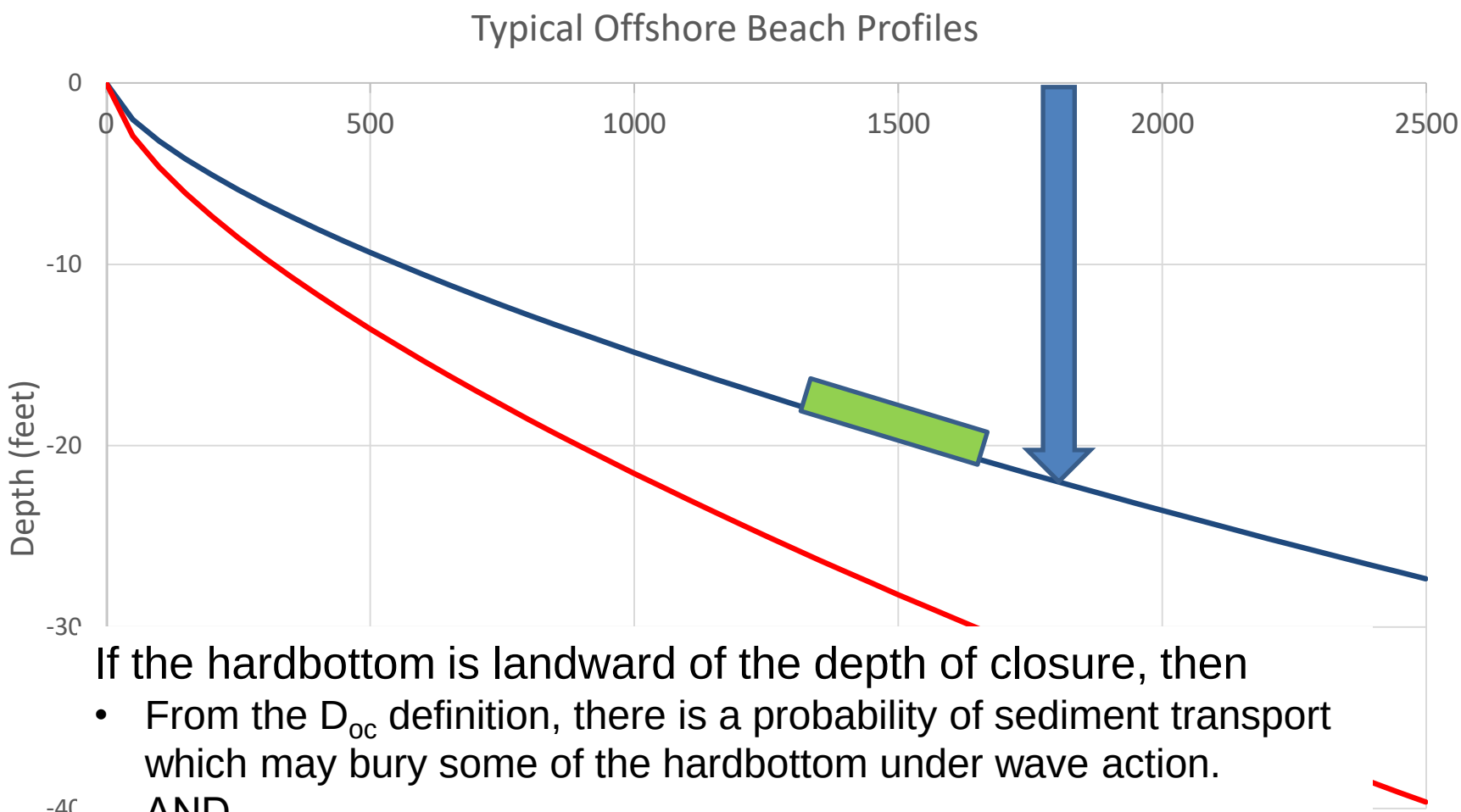
Houston, J. R. (1995). "Beach-fill volume required to produce specified dry beach width," Coastal Engineering Technical Note 11-32, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Typical Offshore Profiles and Example Depth of Closure



Illustrative Example No. 1



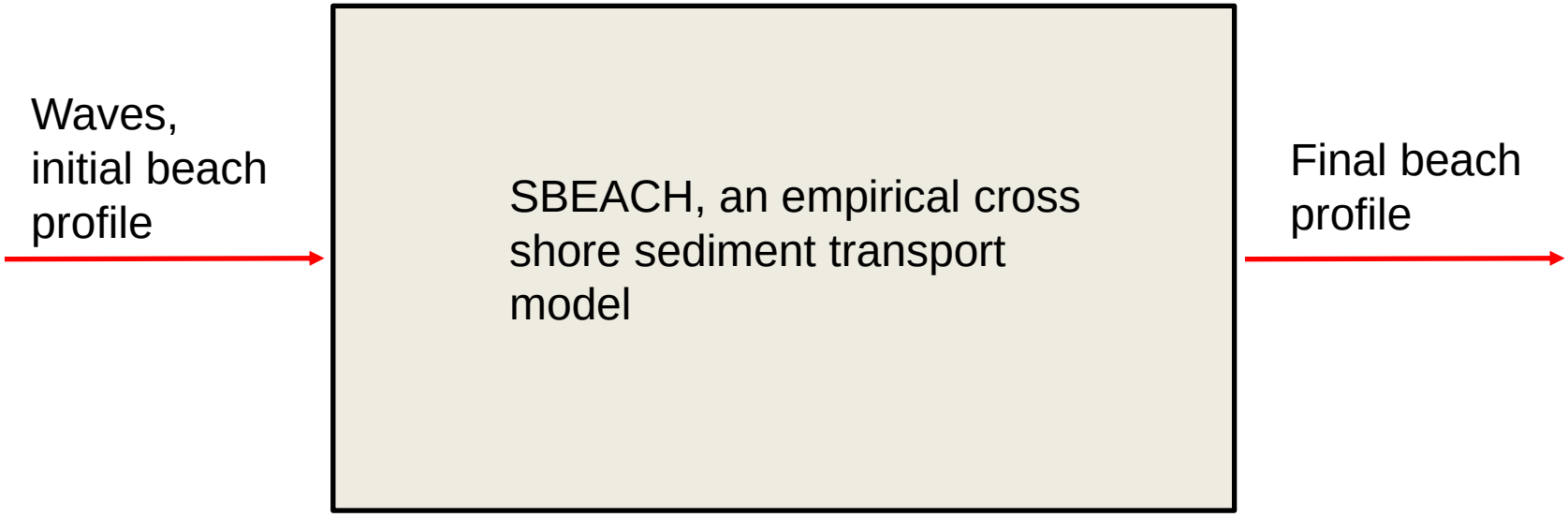


If the hardbottom is landward of the depth of closure, then

- From the D_{oc} definition, there is a probability of sediment transport which may bury some of the hardbottom under wave action. AND…

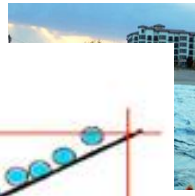
- From the equilibrium force balance, there is a probability that the net onshore wave forces which will clean the hardbottom.

Storm Induced Beach Change (SBEACH) developed by Larson, Kraus and Byrnes (1990)



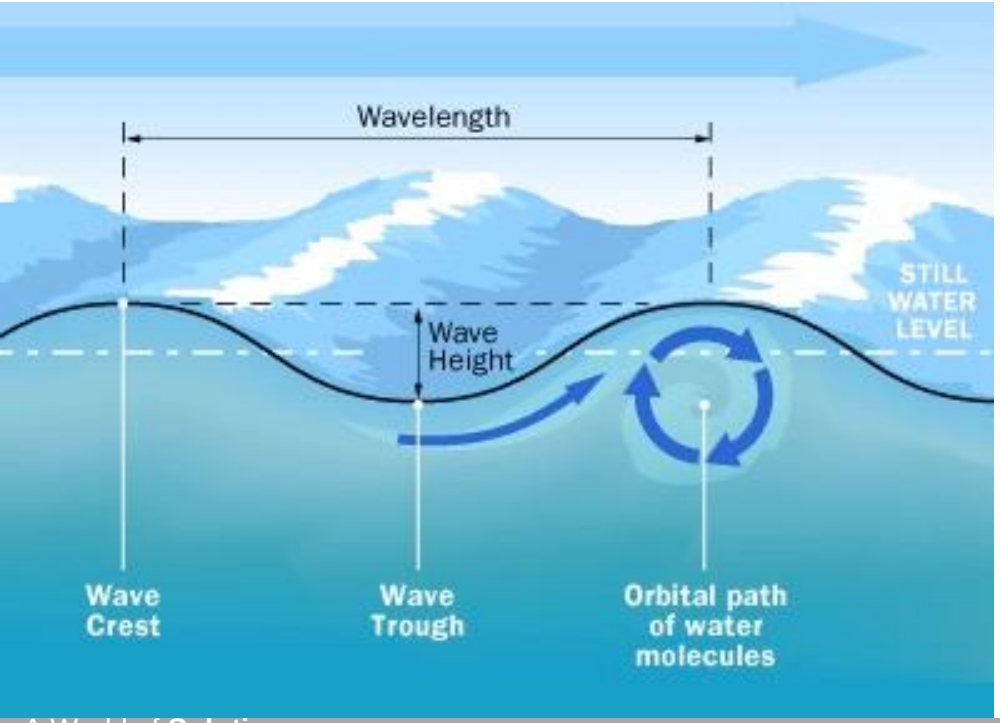
Larson, M, Kraus,N., and Byrnes,M. "SBEACH: Numerical Model for Simulating Storm-Induced Beach change, Report 2 Numerical formulation and Model Tests", Technical Report CERC89-9, May 1990.

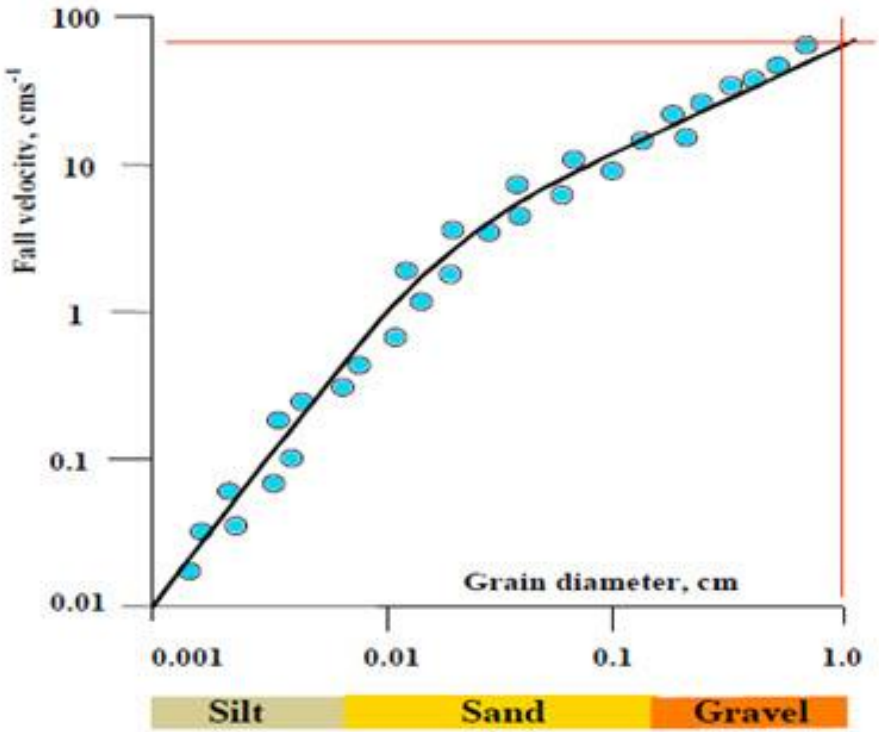
SBEACH Goal



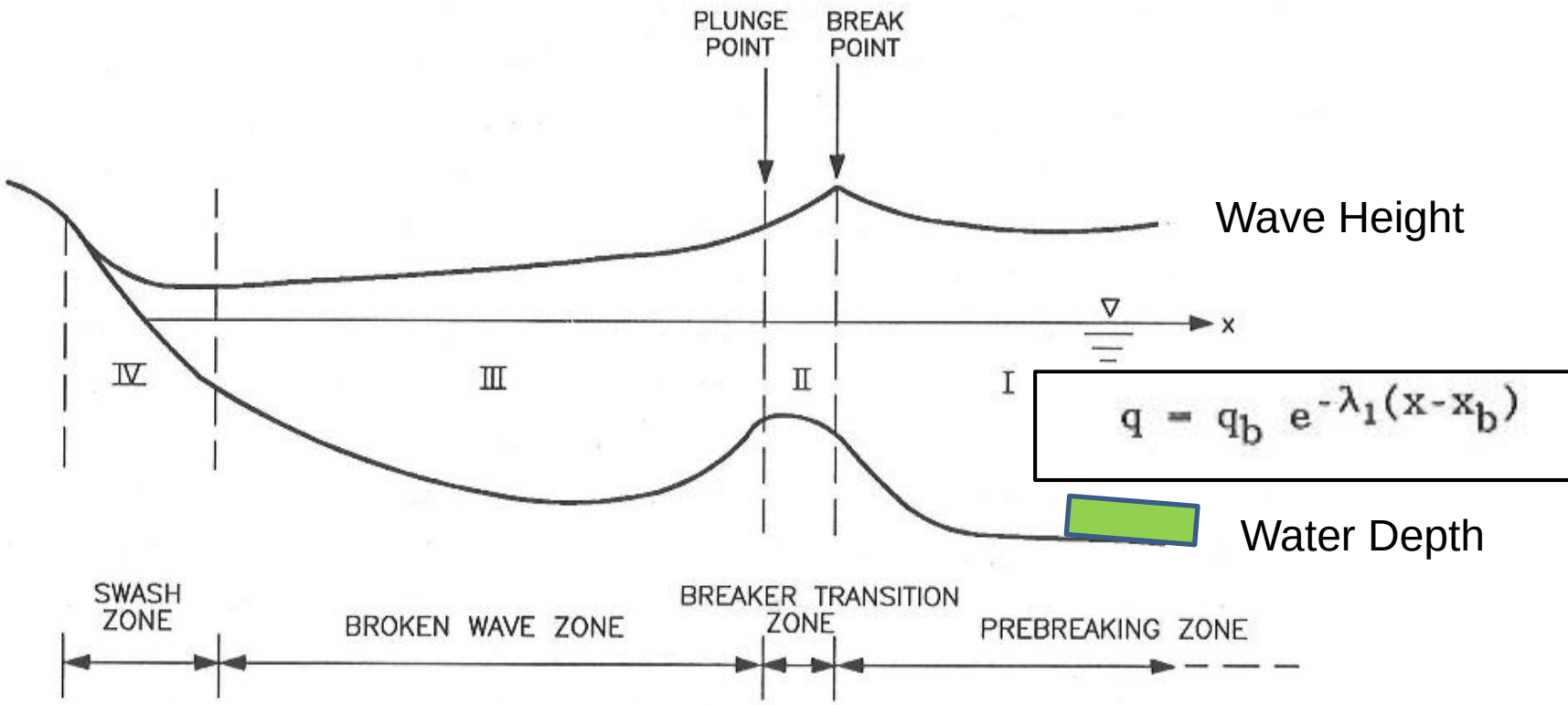
1. Do the wave conditions indicate the profile should erode?

$H_o/L_o > 0.00070 (H_o/wT)^3$



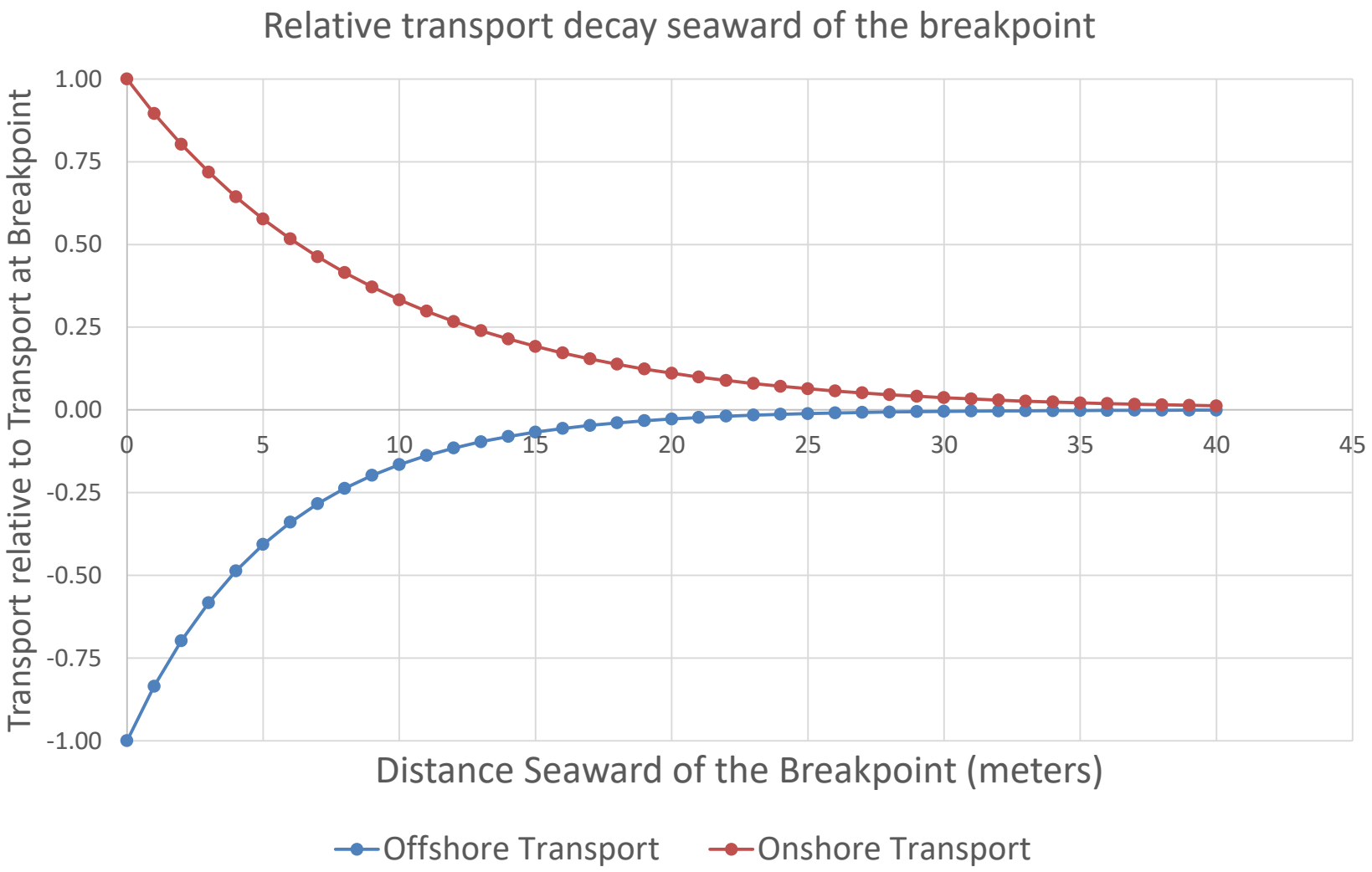


2. What is the magnitude and spatial limits of the sediment transport?



Larson, (1989)

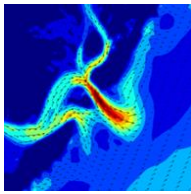
Determination of Offshore Transport Limits



- Therefore, if we know the wave conditions, the profile shape, and the sediment size, we can calculate:
  - the magnitude,
  - direction,
  - and cross shore spatial limits of the sediment transport.
- Determine the likelihood of impacts to hardbottom.

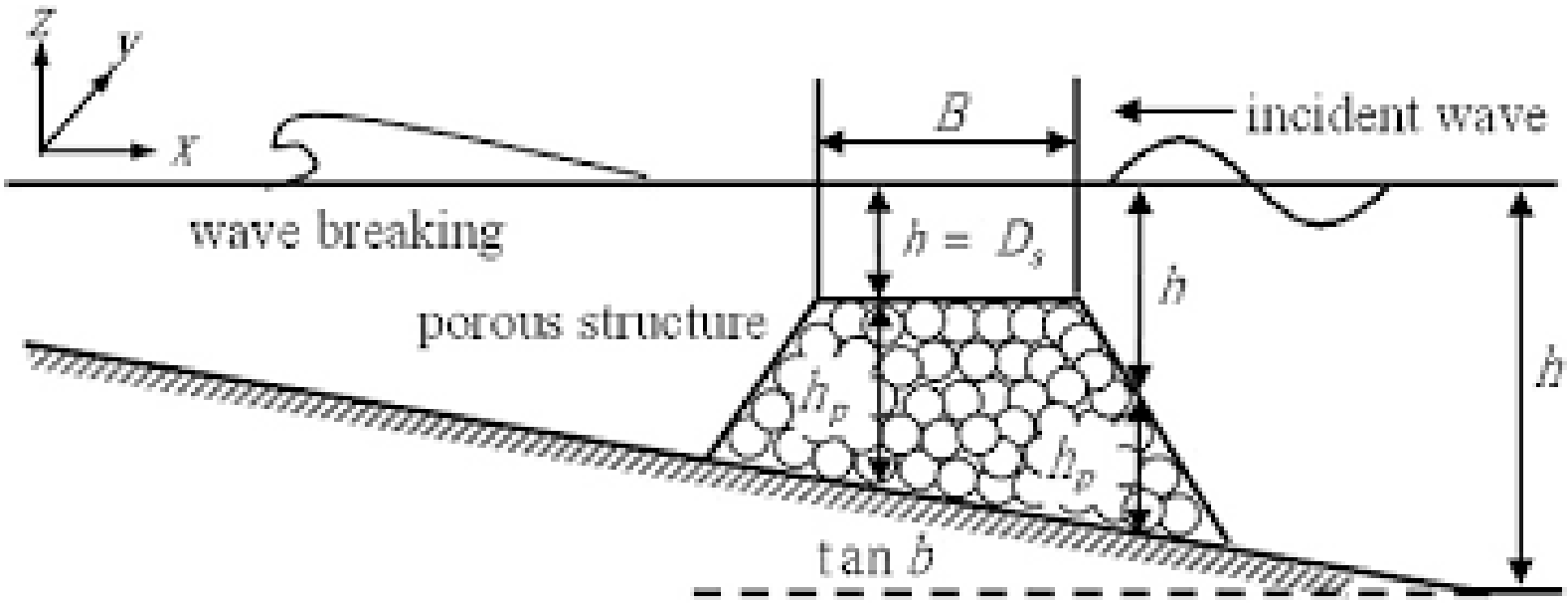




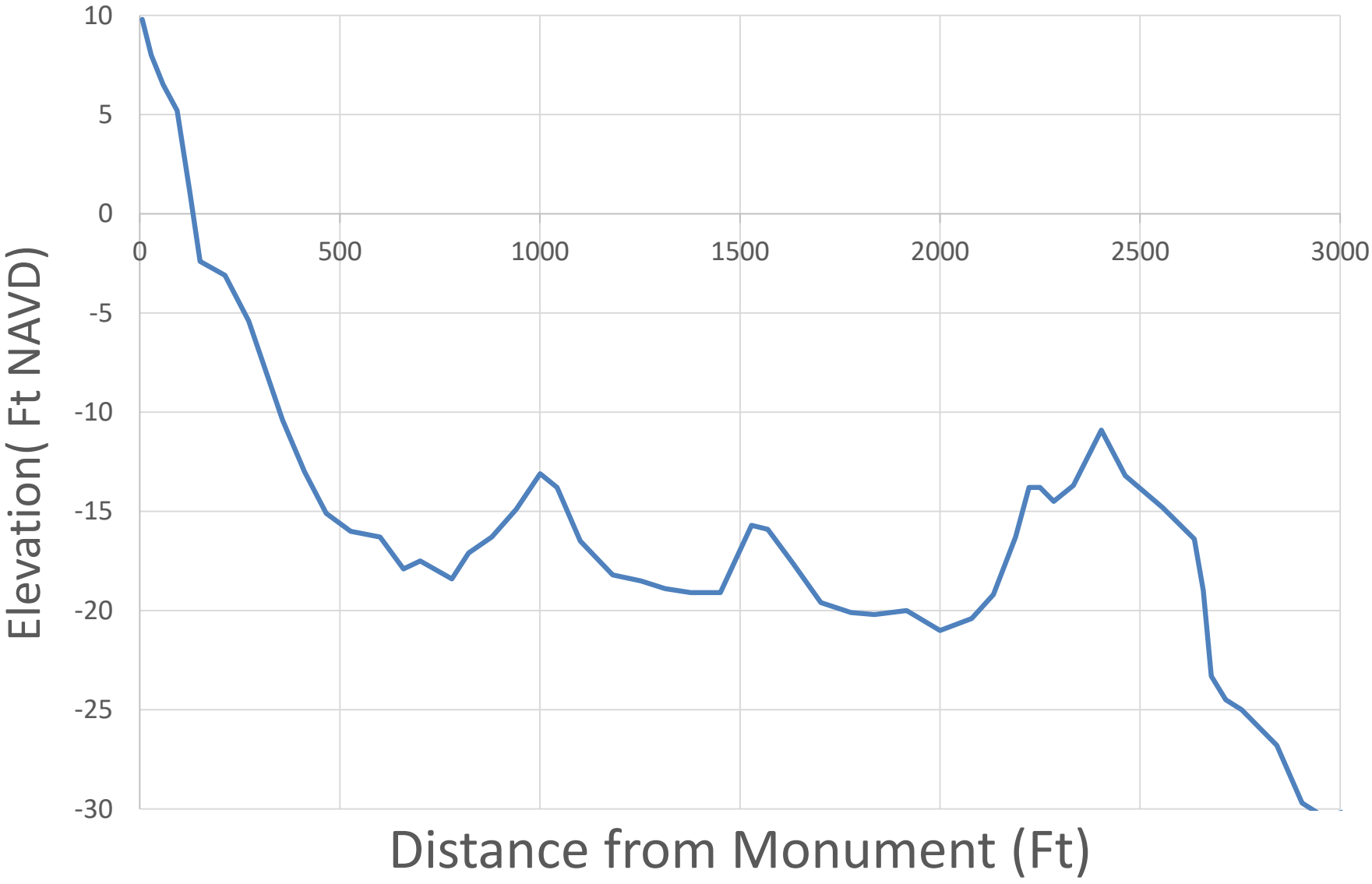



Wave Transformation over Obstacles

Schematic Wave Obstacle Interaction



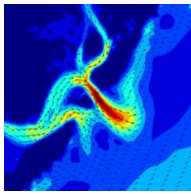
Profile with Multiple Hardbottom Ridges



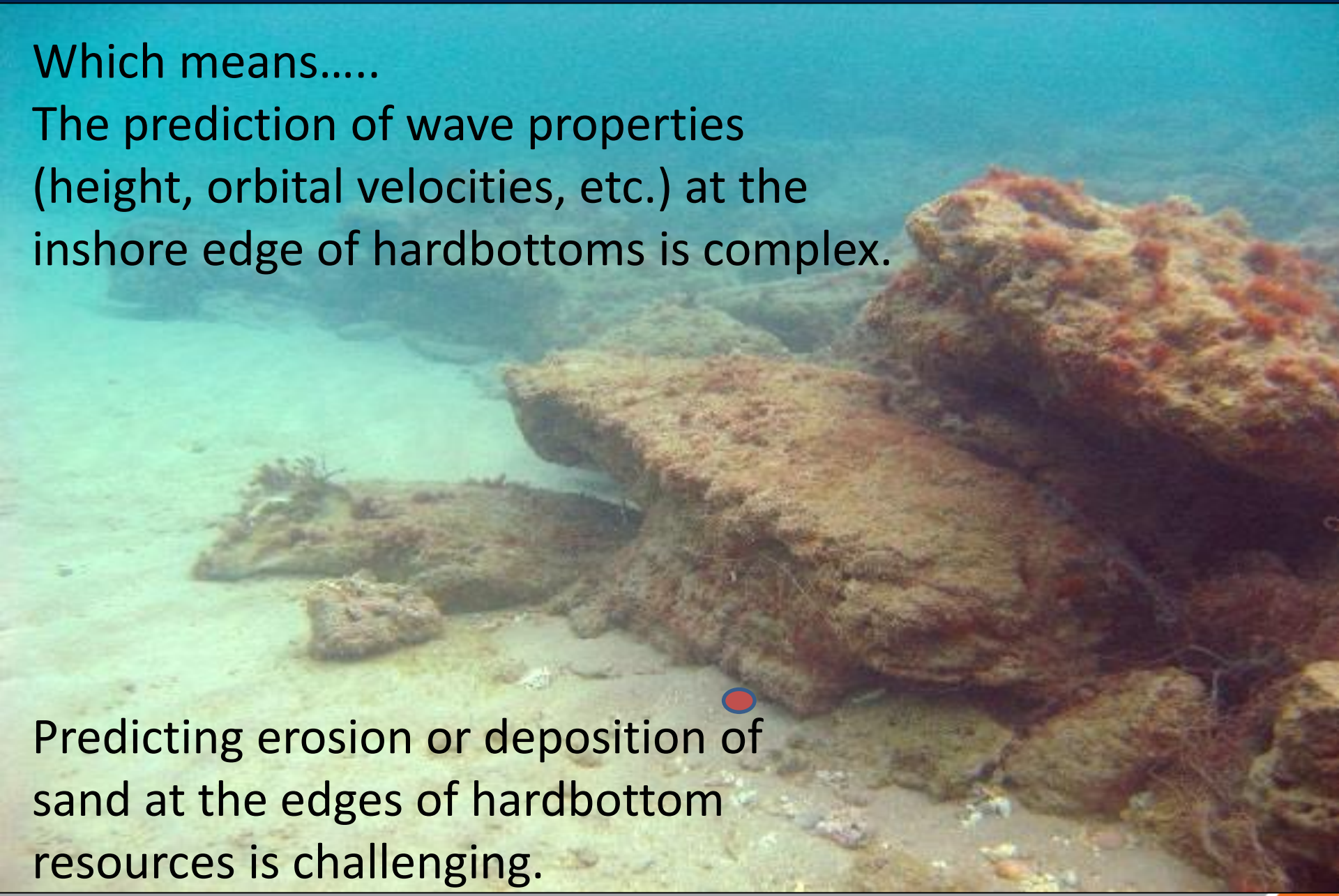
- Grilli and Horrillo (1999) investigated wave propagation and decay over submerged obstacles. They found:
  - For steep waves, the increase in depth (inshore) results in highly nonlinear wave decomposition
  - Fully nonlinear wave theory is required to estimate wave heights over and beyond the obstacles





Grilli, S. and Horrillo, J., "Shoaling of Periodic Waves over Barred Beaches in a Fully Nonlinear Numerical Wave Tank", International Journal of Offshore and Polar Engineering, Vol 9 (4), Pg 257-263, 1999.



Which means…..
The prediction of wave properties (height, orbital velocities, etc.) at the inshore edge of hardbottoms is complex.

Predicting erosion or deposition of sand at the edges of hardbottom resources is challenging.

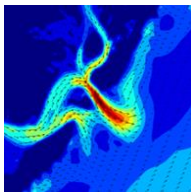
Conclusions of this Preliminary Review

- Nearshore hardbottom resources located landward of the depth of closure
  - Are susceptible to burial
  - Are subject to onshore sediment transport resulting in self cleaning forces

- Using cross shore models, such as SBEACH, for prediction of offshore sediment transport limits
  - Results in finite transports seaward of the wave breaking depth
  - Suggests onshore sediment transport occurs from distances further offshore than offshore transport for a given wave height



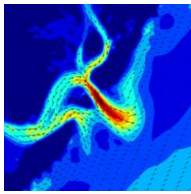


- Estimation of wave properties after propagating over obstacles (hardbottom) requires nonlinear wave theory.



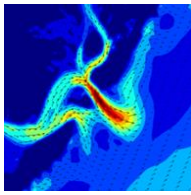


- A complete review of the science is recommended.
- Interactions between beach profiles and hardbottoms should be reflect a scientific perspective.





Questions?

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