Spatial Variability of Carbonate Sediment Textural Parameters Across a Fringing Reef System: A Comparison of Methods

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Introduction

- Common grain-size analysis techniques assume sediment grains can be modelled as idealised spheres, which may not hold for complex carbonate sands.
- Comparison of sieve and settling tube results have been shown to disagree in carbonate environments (Kench and McLean, 1997), but there has been limited comparison of these methods with more modern methods based on laser diffraction and image analysis.
- Understanding the causes of differences in results is important for determining an appropriate methodology for carbonate environments and accurate interpretation of deposit forming conditions

Methods

- 75 sediment samples were collected from the reef flat, lagoon and shoreface at Tantabiddi, Ningaloo Reef, W. Australia
- Grain-size analysis via:
  - Mechanical sieving (S)
  - -1.5 to 4 phi, 0.5 phi intervals
  - Settling tube (ST)
  - Laser Diffraction with Malvern Mastersizer (LD)
- Sample pre-sieved through 0 phi sieve
- Image analysis (IA)

![Digital images of sediment were used to (B) manually trace grain boundaries which were (C)identified in MATLAB and (D) used to calculate grainsize distributions.](image)

Variation in the classification and characterisation of carbonate deposits (Fig. 4A, 4B), can lead to differing interpretations of deposit forming conditions

![Comparison of sieve, settling tube and laser diffraction distributions with results based on image analysis for a (A) fine-grained sample (sieve-based D50 = 0.15 mm) and (B) coarse-grained sample (sieve-based D50 = 1.53 mm).](image)

Results

Comparison of Sieve, Settling Tube and Laser Diffraction

![Comparison of sieve, settling tube and laser diffraction results for a sample with sieve-based D50 = 0.62 mm (0.69 phi).](image)

Discussion

- LD and IA calculate coarser distribution than S or ST (Fig. 2) due to:
  - Rod-shaped grains pass through finer sieve screen due to minor axis
  - Broad, flat and/or large, porous grains behave like smaller particles in settling tube
- All methods showed better agreement for finer-grained samples than coarser grained samples (Fig. 3A-3B)
- S and ST calculate coarser distribution than LD due to pre-sieving of sample prior to LD analysis (Fig. 3B)
- IA produces much coarser distributions possibly due to:
  - Lack of characterisation beyond -2 phi for S, ST, LD
  - Conversion from number to mass frequency
  - Variation in the classification and characterisation of carbonate deposits (Fig. 4A, 4B), can lead to differing interpretations of deposit forming conditions
- Typical wave-induced currents at Tantabiddi = 30 cm/s
- LD and S results suggest 55 – 60% of sampled deposits mobilised under typical currents
- ST results suggest 85% of sampled deposits mobilised under typical currents (Fig. 5)

References