Comparative Morphometrics of Facies Patterns of Isolated Carbonate Platforms: Holocene, South China Sea

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SUBSURFACE APPLICATION: Understanding and predicting facies distribution and sizes in isolated carbonate platforms, probably most directly related to Cenozoic systems of southeast Asia
STATUS: Project completed, not yet published
TIMING: Final results to be reported
FUNDING: Funded by KICC

Objective and Relevance to Sponsors
Carbonate strata form important reservoirs in southeast Asia. Many of these systems represent Eocene-Miocene isolated platforms, in which reservoir quality is highest in depositional facies associated with coarse, reef-derived sand and gravel. Although seismic data from some platforms illustrate platformward progradation of reef sand aprons, in most, such direct facies indicators are absent (e.g., Masanfero et al., 2003). In such scenarios, geological analogs can provide conceptual models and as raw data to predict facies dimensions, orientation, and configuration. Modern SE Asia carbonate systems have been interpreted to be grossly analogous to the region’s Cenozoic systems (e.g., Wilson, 2011), but the Holocene carbonates of this area have not been examined systematically. To fill this gap, the overall objectives of this study are to systematically examine and quantify spatial facies patterns of Holocene southeast Asia isolated platforms.

Background and Methods
Recent efforts (Rankey and Garza-Perez, 2012) focused on mapping spatial patterns of facies on isolated platforms using lower-resolution (25-30 m² pixel) Landsat data, and compared the spatial patterns to oceanographic processes. In addition to mapping and quantifying facies patterns at a higher level of detail (<2.5 m² pixels), this project will build on that earlier project in three important ways: A) Mapping more platforms, and at a higher resolution; B) Expanding the range of “process space” to include more southeast Asian examples of more direct relevance to sponsors; and C) Examining the nature and rates of change on platforms. It will provides data that will be linked to the subsurface by construction of seismic models to explore the geophysical expression of different geological scenarios (see Duarte and Rankey proposal).

Phase one of this project includes analysis of a suite of multi-temporal remote sensing images from 25 isolated platforms in South China Sea (Spratly and Paracel islands) (Figure 1). For each area, QuickBird, WorldView or GeoEye 4-band multispectral remote sensing data (<2.4 m² pixels) over each platform provide the fundamental data; for a representative subset (n=7), several images from different years will be acquired. The data will be analyzed as follows:
1) Remote sensing data were queried to derive thematic maps of spectral lithotopes, interpreted in the context of depositional facies/geomorphic elements. These maps were generated using a mix of unsupervised and supervised classification

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techniques (e.g., Rankey, 2002, Purkis et al. 2005; Rankey, 2015) (e.g., Figure 2A,B).

2) These thematic maps form the basis for the quantitative analysis of spatial patterns. Utilizing a GIS, the data were queried and characterized in terms of facies element composition (what is there), size (how big are they) and configuration (how are they spatially arranged) (e.g., Rankey, 2002, Rankey and Garza-Perez, 2012) (Figure 2C,D).

3) Multi-temporal data from several areas provide the foundation for analysis of change on these systems, with focus on reef sand aprons. Data from 2001-2004 (the oldest commercially available high-resolution remote sensing images) and 2010-2013 (“recent”) from the same platforms illustrate changes in spatial extent of facies (and military constructs).

**Deliverables**

The primary results of the study include qualitative and quantitative analyses of facies patterns of South China Sea isolated carbonate platforms. The results of this study were reported in a presentation at the 2015 KICC annual meetings. The presentation and the data are available presently on the KICC sponsors web page, and ultimately, will be expanded in publications.

**References**


Figure 1. Map of general location of data. Data include a suite of platforms, in a range of settings, to attempt to sample the range of oceanographic and tectonic variability.

Figure 2. Representative facies attribute data from Pigeon Atoll (Spratly Chain). A) Uninterpreted remote sensing image; B) Thematic map of facies; C) Width of reef sand apron vs. orientation of the margin (direction the margin faces); Note the wide aprons of NW-facing margin; D) Probability of occurrence of a given facies with distance from margin. Colors correspond to those in part B.