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[EA]Role of Modern Analogs in Subsurface Reservoir Modeling*

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Search and Discovery Article #51684 (2020)**
Posted October 26, 2020

*Adapted from extended abstract based on oral presentation accepted for the 2020 AAPG Annual Convention and Exhibition online meeting, September 29-October 1, 2020

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Abstract

Key Findings

• That so few cells in a reservoir model are actually populated with hard data emphasizes the importance of the concepts to be used, and the potential role that modern analogs can play in refining the concepts as well as providing model inputs.

• Results from studies of modern carbonate settings can be used to infer heterogeneity due to depositional facies and to provide geobody attributes for training images, a vertical proportion curve, and depocenter maps including widths of facies belts, configuration of facies patterns, and variation along strike.

Significance

Reservoir-modeling approaches use combinations of hard data constraints (well and seismic data) and geologic concepts (e.g., depositional models) to populate 3D grid space (Figure 1). Few cells in a reservoir model are actually populated with hard data. This challenge emphasizes the importance of the geologic concepts to be used and highlights the potential role that modern analogs can play in refining the concepts as well as providing model inputs. Thus, a motivation for quantitative studies of modern environments is to provide statistics of the type that can be used to drive ‘‘pattern replicating’’ algorithms and/or validate ‘‘process imitating’’ models.

Methods and Preliminary Results

Results from studies of modern carbonate settings including widths of facies belts, configuration of facies patterns, and variation along strike can be used to infer heterogeneity due to depositional facies and to provide geobody attributes for several of the steps in the modeling workflow of Figure 1, specifically training images (Figure 2), the vertical proportion curve, and depocenter maps (Figure 3).

As examples of quantitative results from modern studies that have potential utility as reservoir modeling input, flood tidal deltas of ooid sand in the Exumas sand body of Great Bahama Bank (GBB) occur within a >450 km^2 linear belt with: (a) delta lobes extending up to 8 km, averaging 6 km, onto the platform, (b) large deposits being highly sinuous, more irregular in shape than smaller ones, and maintaining connectivity, and (c) tidal channels averaging ~3 km in length with regular, but regionally variable, spacing (Harris, 2010). Looking at multiple ooid sand bodies from GBB to broaden the range of depositional patterns reveals that: (a) the average separation between sandbars falls within a narrow threshold of only a few hundred meters, (b) the relative proportion of area occupied by bar crests (assumed to be well-sorted grainstones) with respect to the area of sandbars (less well-sorted grainstones) is consistent, (c) the frequency-area relationship of sandbars and bar crests is exponential, (d) small sandbars tend to be rounded whereas large (>1 km^2) are exclusively elongate, and (e) more rounded sandbars are found within close proximity to one another, while those separated by great distance have a tendency to be elongate (Harris et al., 2011a).

Implications

To illustrate an application of such quantitative modern analog data, a high-energy ramp example was simulated by Playton et al. (2011) wherein the sequence stratigraphic architecture, including progradation and retrogradation, partitioning of facies belts [high frequency sequences wherein HSTs are progradational, oolitic grainstones and TSTs are retrogradational to aggradational, peloidal mud-dominated wedges], and changes in facies belt width are captured (Figure 4).

References Cited

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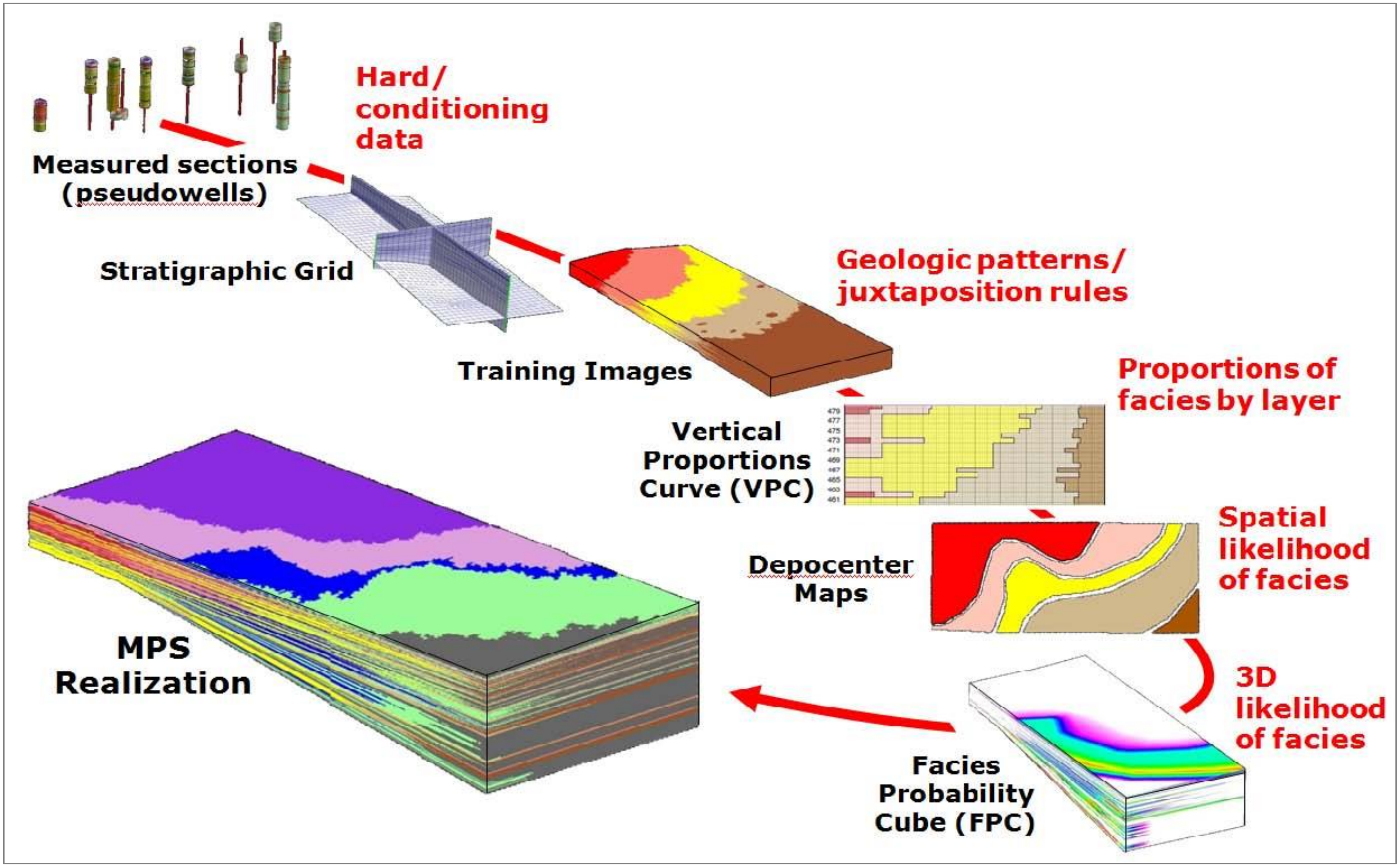

Figure 1. Summary of Multiple Point Statistics (MPS) reservoir modeling workflow modified from Playton et al. (2011) and Harris et al. (2011b).

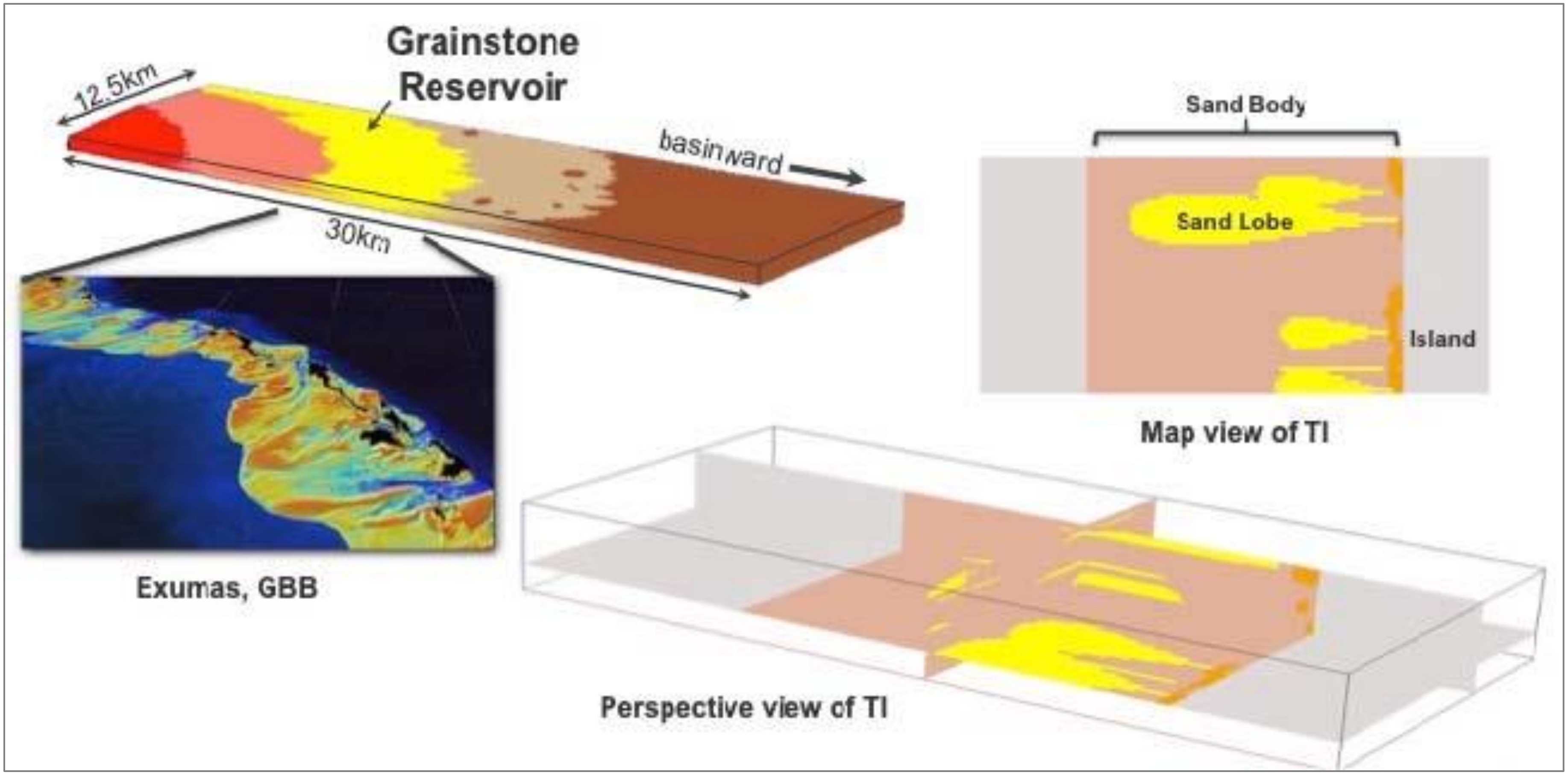

Figure 2. Concept of training image based on a modern analog modified from Harris et al. (2011a).

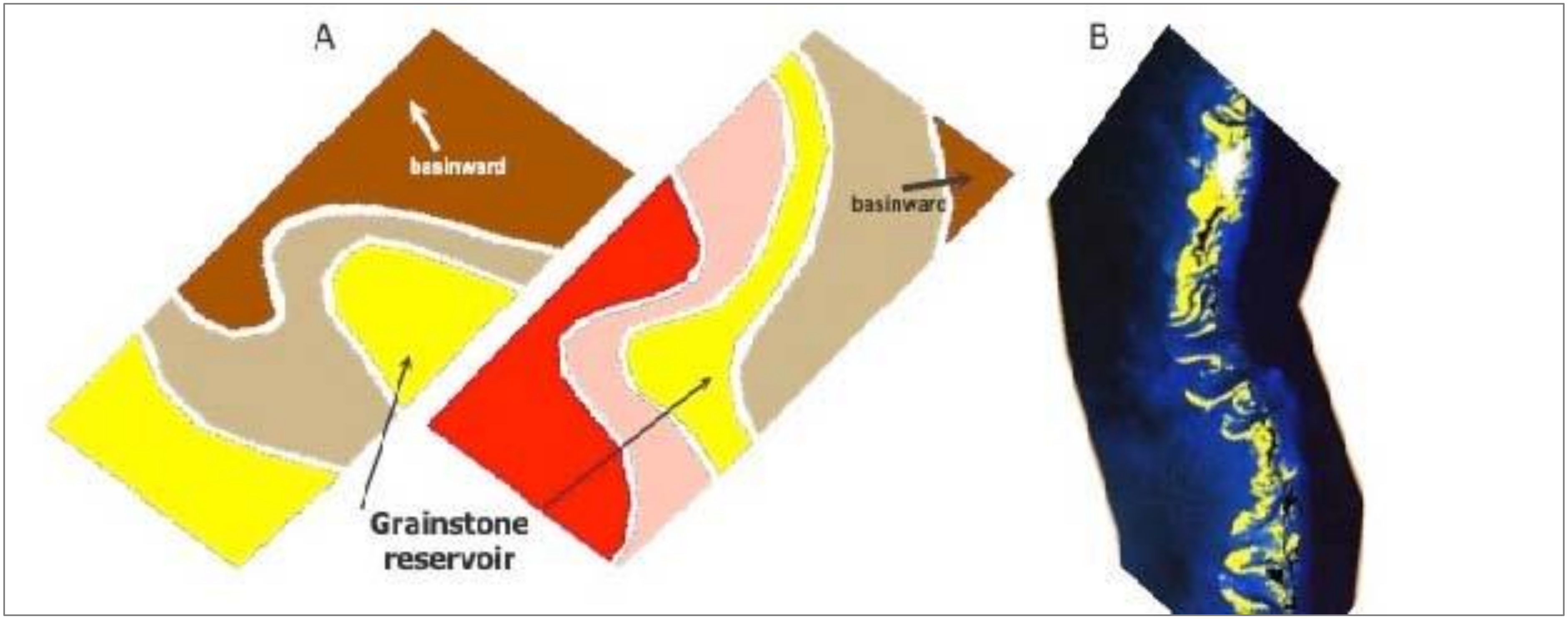

Figure 3. Examples of depocenter maps modified from (A) Playton et al. (2011), and (B) modern facies map analog from Exumas GBB modified from Harris (2010) showing width and configuration of sand body.

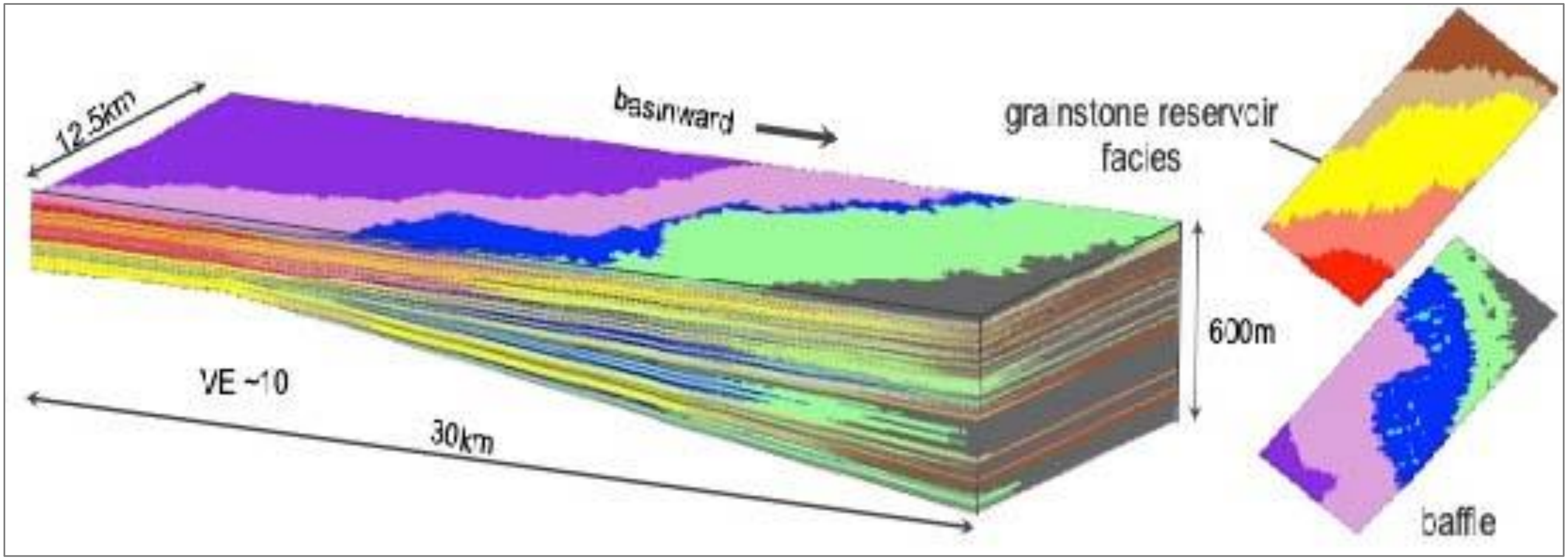

Figure 4. Example of reservoir model output, in this case based on a Jurassic high-energy ramp example from the Middle East modified from Playton et al. (2011) and Harris et al. (2011b).