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Modern Depositional Patterns and Seismic Data Integration for Reservoir Facies Modeling in Low-Well Environments

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Abstract Summary

Constructing high-precision reservoir facies models under limited well conditions is a key challenge in oil and gas exploration and development. This paper takes the delta front reservoir of the B gas field in Bangladesh as the research object and proposes a multipoint geostatistics (MPS) modeling method that integrates modern sedimentary patterns and seismic data. By analyzing the geometric parameters of modern channels in the Ganges-Yarlung Zangbo River delta front, a training image reflecting the characteristics of underwater distributary channels is established. Using the seismic inversion volume as a soft constraint, it addresses the shortcomings of traditional two-point statistical methods in characterizing complex geometric shapes. The study shows that the lithofacies model built by the multipoint geostatistical method helps constrain the model from a geological perspective. The simulation results are faithful to well data, with the planar morphology and development scale of different microfacies quantitatively constrained by the training image. It can reproduce the geometric features and spatial structure of underwater distributary channels and mouth bars in the delta front. The reservoir model constrained by modern sedimentary patterns and seismic data outperforms traditional methods in interwell prediction, heterogeneity characterization, and uncertainty quantification.

Introduction

Located in Bangladesh, the B gas field belongs to delta front deposition. The entire area has only two exploration wells (BB-1 and BB-2) but high-quality 3D seismic data. Establishing a reservoir facies model based on the sedimentary pattern of the modern Ganges-Yarlung Zangbo River delta requires solving two problems: 1. Using modern sediments to obtain the width data of underwater distributary channels and building a training image consistent with the sedimentary characteristics of the target area; 2. Integrating seismic inversion data as soft constraints to improve the reliability of facies models in low-well areas. This study proposes a collaborative modeling scheme of "shaping by modern sedimentary patterns and controlling by seismic data," forming an efficient reservoir modeling process suitable for low-well areas.

Method and/or Theory

Based on the data of the study area and modern sedimentary research results, the reservoir facies model of the B gas field is collaboratively constructed using the modern sedimentary pattern of the Ganges-Yarlung Zangbo River delta front and seismic data. The steps include: 1. Determining the sedimentary background and reservoir facies; 2. Statistical analysis of geometric parameters of modern sedimentary channels; 3. Establishing an initial channel image; 4. Generating a facies pattern library; 5. Collaboratively building the lithofacies model.

Results

Here the results are written. In case you have a figure, chart, graphic, equation, please make sure to insert a legend. Here is an example:

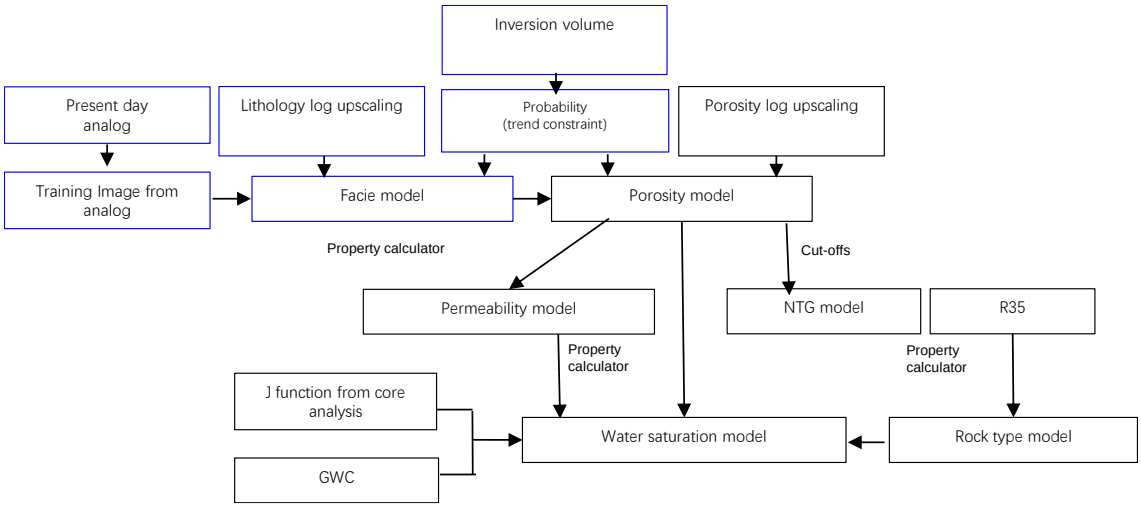

Figure 1: Workflow for facies modeling based on multipoint geostatistics methods

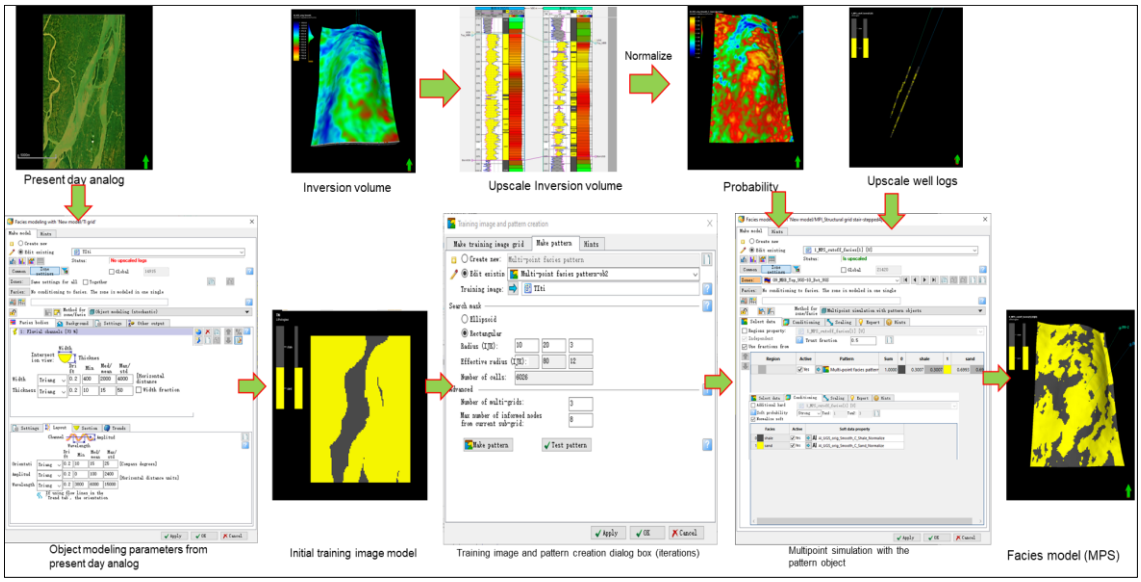

Figure 2: The map of workflow for facies modeling based on multipoint geostatistics methods

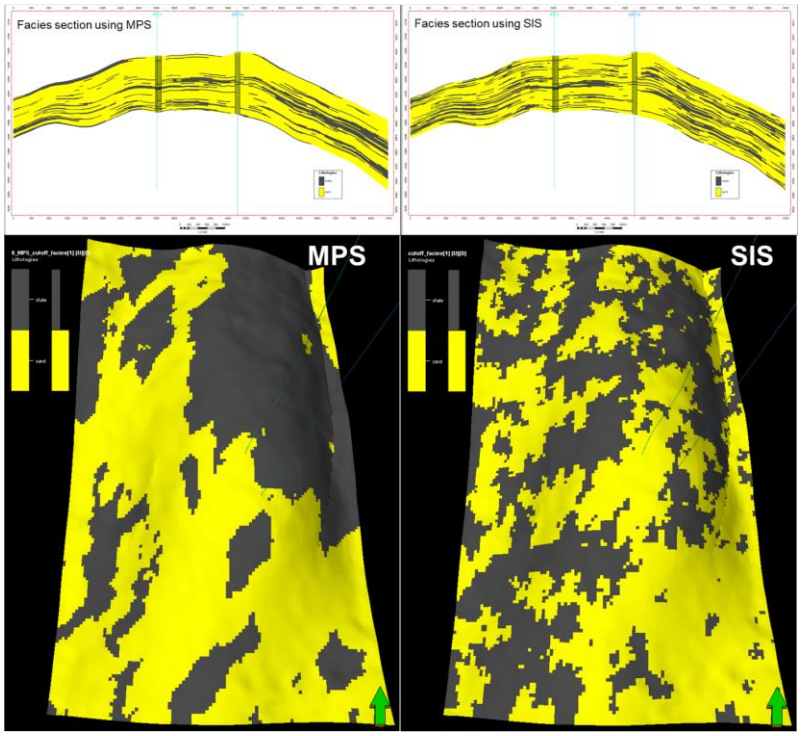

Figure 2: Comparison between Multipoint Geostatistics (MPS) and Sequential Indicator Simulation (SIS) in Lithofacies Modeling

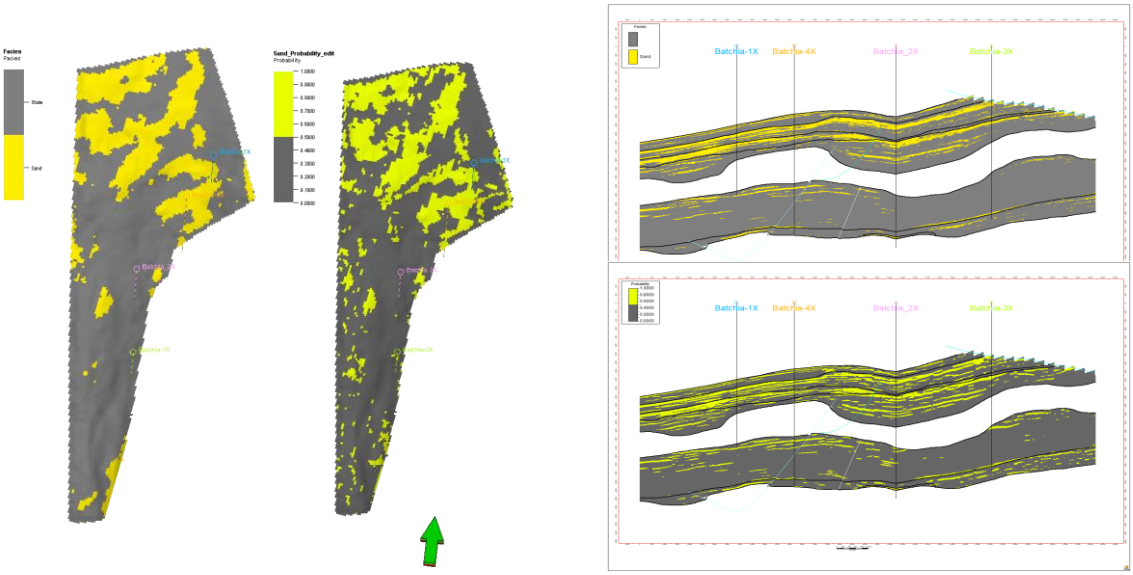

Figure 3: The left figure is a Facies model, where yellow represents Sand and gray represents Mud, showing the distribution pattern of sand bodies in planar view.The right figure is a Sand Probability model, which reflects the development probability of sandstone through the light - dark variations of colors. The brighter the color, the higher the probability of sandstone occurrence, reflecting the probabilistic characteristics of sand body distribution.

Conclusions

(1) The modern sedimentary pattern not only provides channel geometric parameters but more importantly establishes a quantitative relationship between "sedimentary microfacies and spatial structure." The channel sinuosity in the initial model matches the channel curvature interpreted from the target area's seismic data, ensuring that the simulation results conform to geological genesis. This method avoids the limitations of relying solely on well data and is particularly suitable for the early exploration stage with limited wells.

(2) The method of integrating modern sediments and actual data to build a quantitative training image and performing microfacies stochastic simulation through multipoint geostatistics is not only applicable to delta front reservoirs but also provides reference for microfacies simulation of other sedimentary types, especially fluvial reservoirs with more in-depth modern sedimentary research.

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