

SIS Global Forum 2019



**Massive-grid-model based numerical simulation study using
INTERSECT on the largest marine carbonate gas reservoir in China**



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Part One

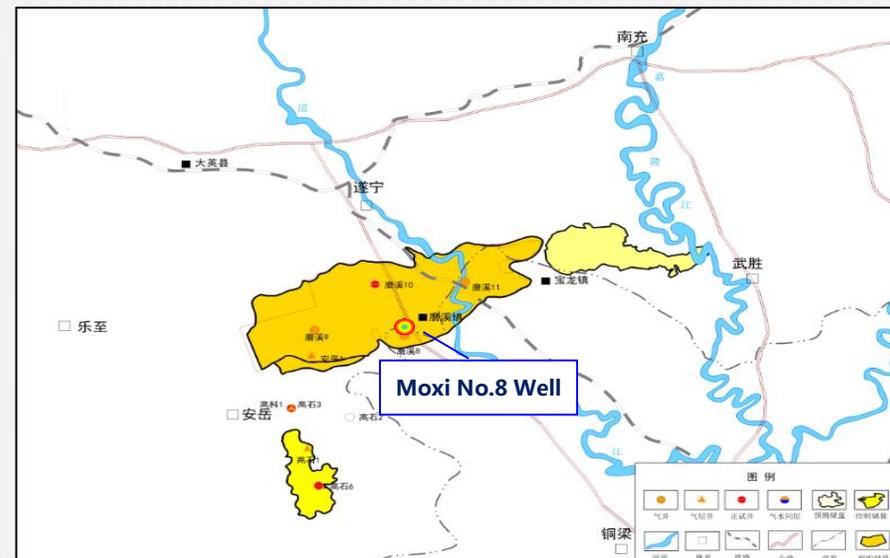
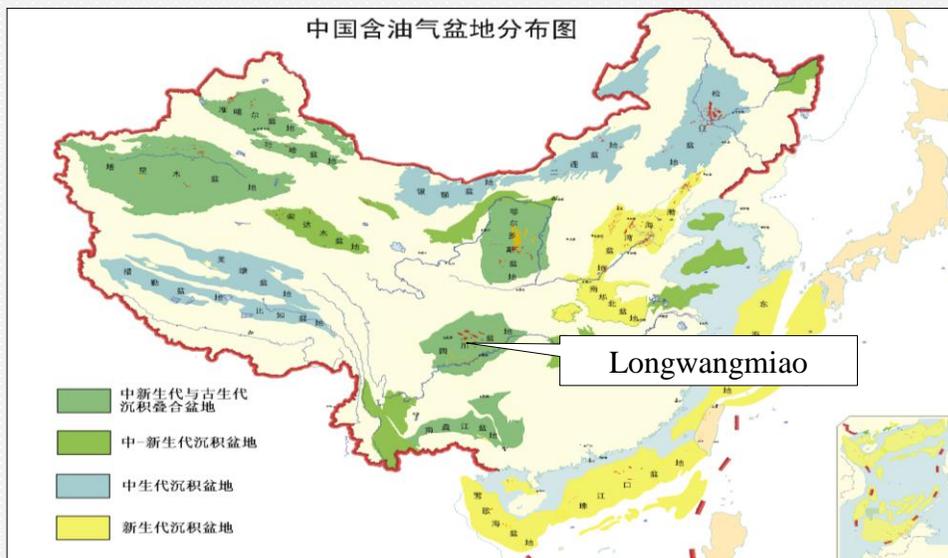
Research Background

- The largest overpressure marine carbonate gas reservoir in China
- Low porosity, Low matrix permeability, Multi-scale natural fractures and holes
- High temperature/high pressure, Complex gas/formation water distribution
- Challenges faced by geological modeling and numerical simulation

Research Background

Introduction of Gas Reservoir

- **Location:** in the middle of Sichuan basin, southwest of China.
- **Discovery:** Moxi No.8 well was discovered in Sept. 2012.
- **Reserve:** Proven reserve is 440 billion m³. The largest single carbonate gas reservoir in China.
- **Production:** Production of 48 wells is 27 million m³/d. As so far, the cumulative production is over 42 billion m³.

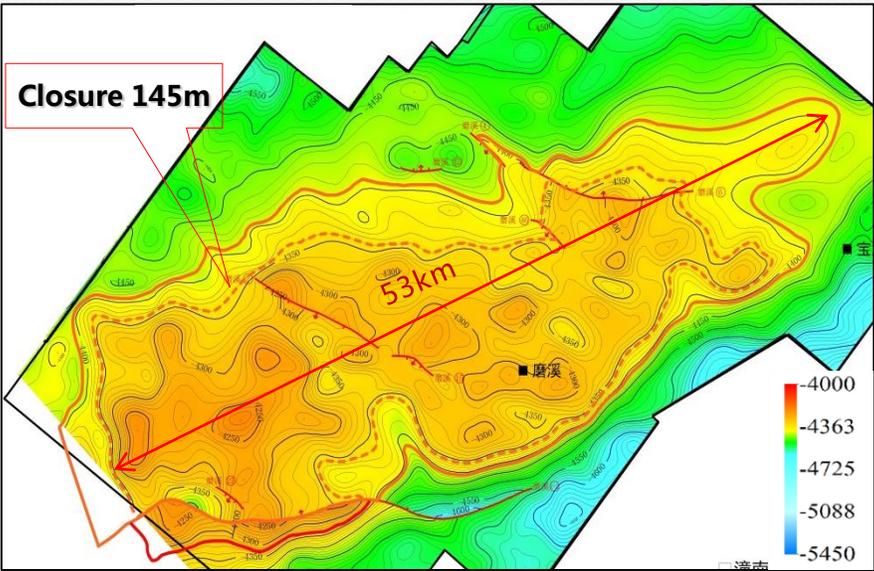


The location of Longwangmiao gas reservoir

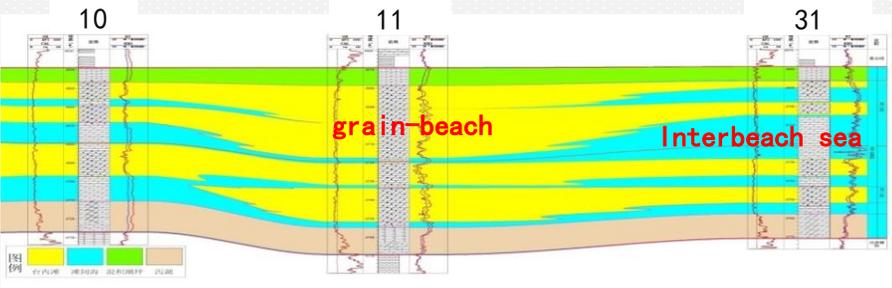
Research Background

Geological Characteristics

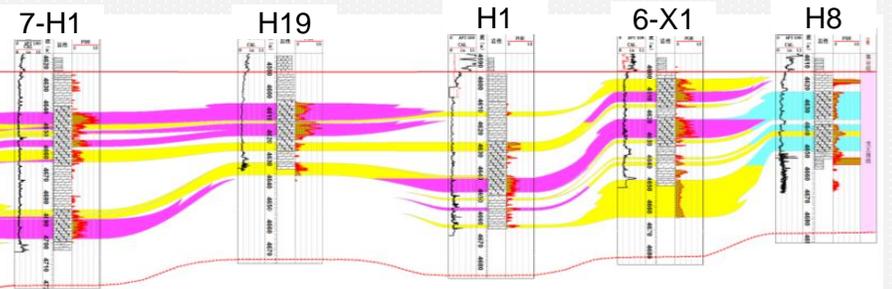
- **Ancient layer and deep depth:** Lower Paleozoic Cambrian layer. The depth is over 4500m.
- **Large and low amplitude structure:** Trap area is 520 km², and structural closure is 145m.
- **low porosity and heterogeneous dolomite reservoir:** Porosity is 4.3%, the matrix permeability is 0.75mD , micro fracture development, strong heterogeneous.
- **Gas condition:** 76MPa, 140°C. Pressure coefficient is 1.6, H₂S content is 5 g/m³ ~12 g/m³.
- **Lithologic and structural gas reservoir.**



Top surface structural map of reservoir



The contrast section of sedimentary facies



The different types of reservoir contrast diagram

Research Background

- How to Establish a Fine Geological Model to Characterize Micro-scale Fractures and Caves?



10cm



Millimeter scale karst cave

Microfissures can only be viewed under a microscope

- How to establish a numerical simulation model that can retain geological characteristics and delicately depict dynamic characteristics?

Without upscaling? Zonal description of stress sensitivity and relative permeability?

How to carry out efficient numerical calculation?

- How to use numerical simulation model to solve practical production problems?

Prediction of Water Infiltration Law and field development plan optimization





Part Two

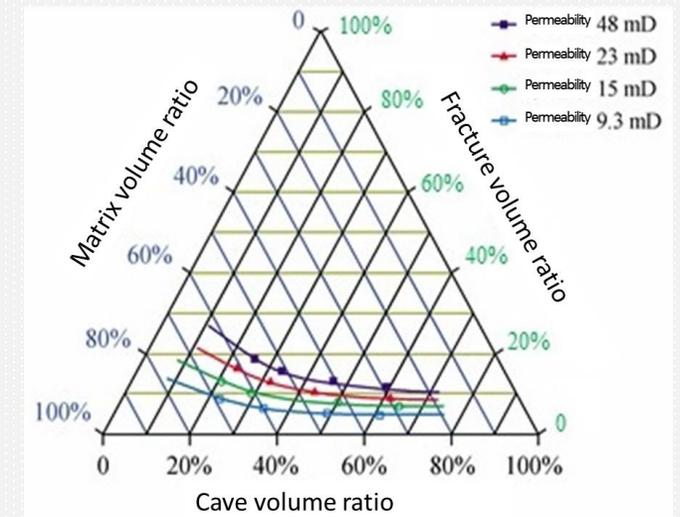
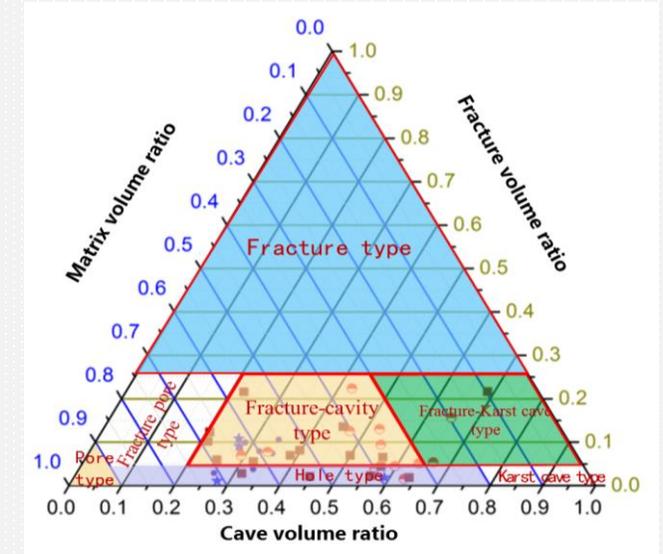
Cognition and Progress

- Quantitative relationship between void and fracture collocation in geological modeling using digital cores
- Establishing Linkage Work Environment between windows operating system and Linux clusters
- Analysis of Gas Reservoir Dynamic Characteristics and Optimum Development Scheme by History Fitting and Integrated Numerical Simulation

Cognition and Progress

Using Digital Core to to increase the veracity of the geological model

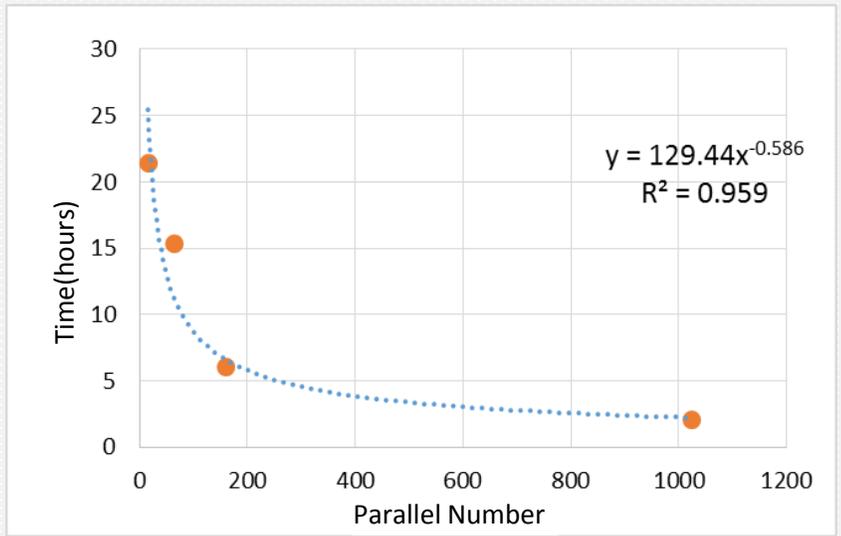
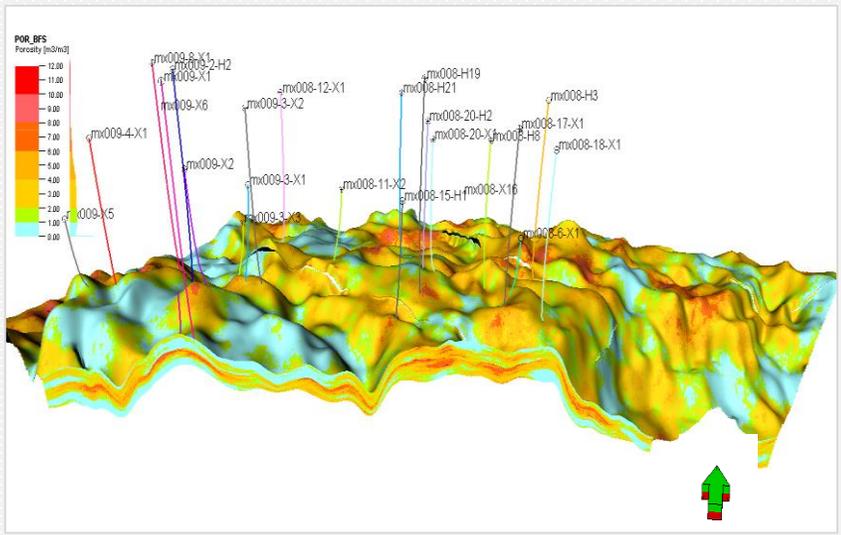
- Quantitative collocation relationship between volume of voids and fractures obtained from digital cores and its relationship with permeability
- Correction of matrix reservoir porosity obtained by logging using this relationship
- Using this relationship to subdivide reservoir types and correct matrix permeability of different reservoir types
- This solves the problem that the traditional fracture model can not characterize the reservoir and permeability characteristics of micro-fracture
- It also lays a foundation for the numerical simulation model to describe the stress sensitive characteristics and phase permeability characteristics in different zones



Efficient numerical calculation using INTERSECT

- Build the refined simulation model of 78M cells without upscaling
- The numerical simulation model contains more than 15 zones, such as stress sensitivity and phase permeability

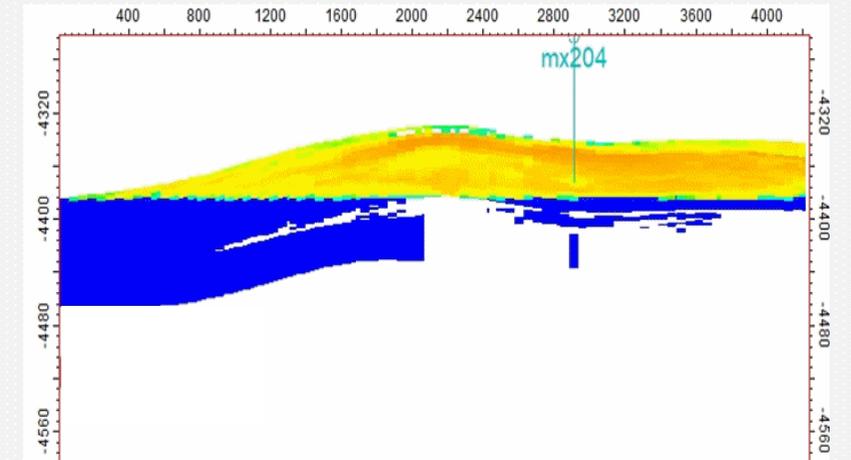
1. Establishing linkage work environment, which can implement data sharing/remote queue using/rapid data transmission
2. Controlling the Variation Range of Iterative Variables and the Iterative step size to improve convergence
3. Optimizing the Best CPU Parallel Number



Analysis of Gas Reservoir Dynamic and Geological Characteristics

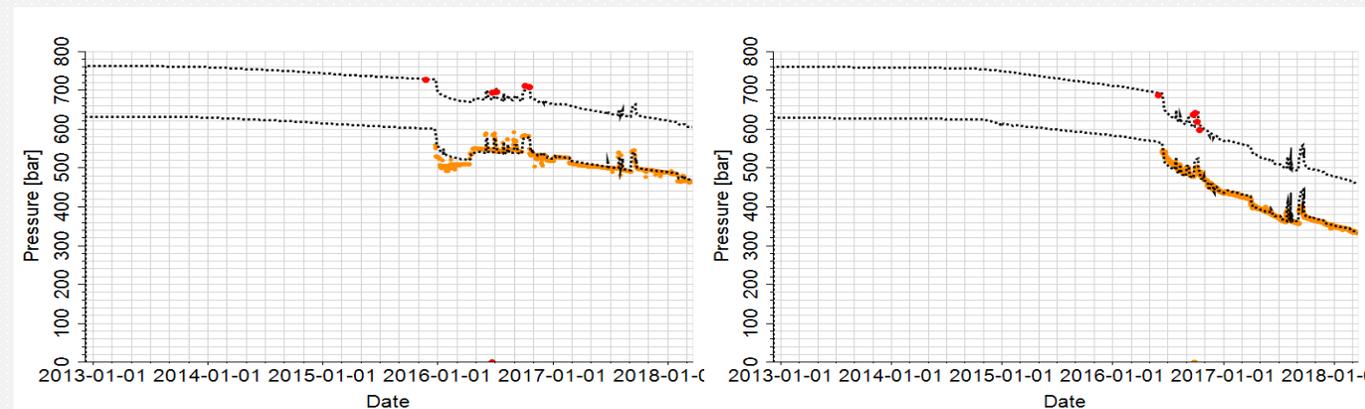
- Judgment of water invasion types of gas wells by historical fitting of fine numerical simulation

The numerical simulation results show that the northern edge water in 204 well area has a strong supply to the local bottom water of the well, which provides a new reference basis for water control of the well



- Quantification of Connectivity between Gas Wells in the Same Well Group by Fine Numerical Simulation

The permeability parameter field between two wells is calibrated to 0.1mD order of magnitude by means of high precision numerical simulation history fitting





Part Two

Example application

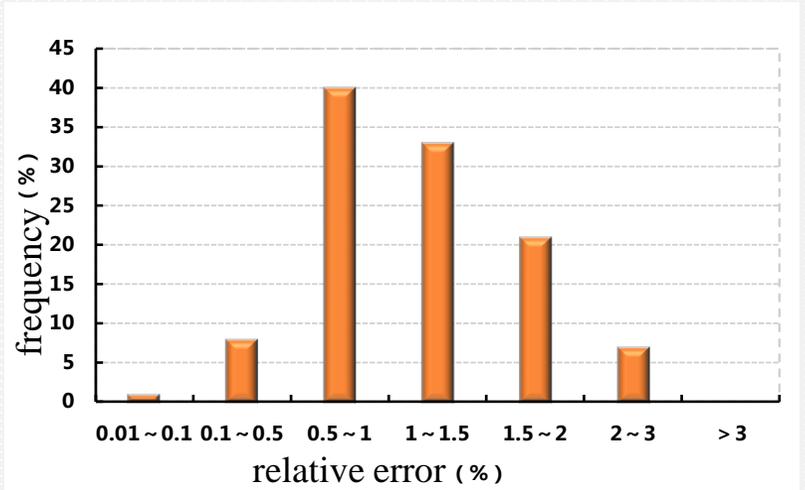
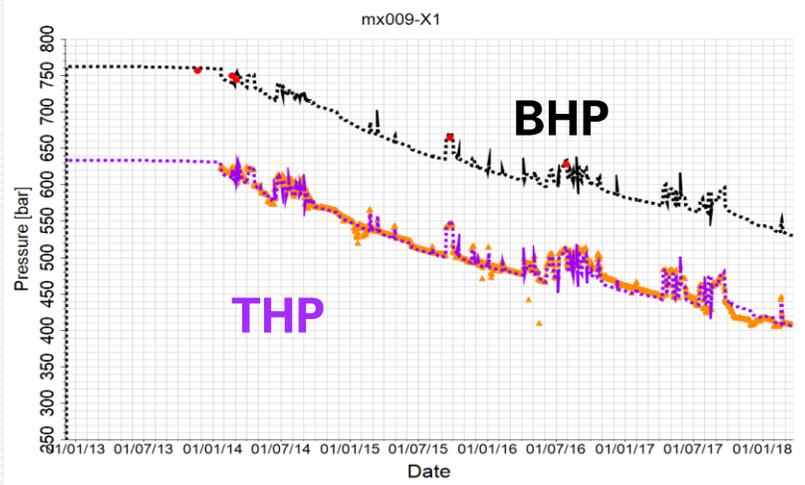
- Gas production prediction error has been decreased by 6.91%, pressure prediction error down to 0.5MPa
- obtain different types of formation water channeling and invasion model and based on this, constructive suggestions can be made on gas field development

Example application

Application effect

Gas production prediction error has been decreased from 8.34% to 1.43%, pressure prediction error down to 0.5MPa

It lays a good technical foundation for carrying out a large number of simulation and prediction studies, screening and determining optimal development strategies





The report is over
Thank you

