

# **Static Reservoir Modeling in an Incised Valley Fill: A Case Study in Optimization from Postle Field, Texas County, Oklahoma\***

**Tiffany D. Jobe<sup>1</sup> and Ayyoub E. Heris<sup>2</sup>**

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<sup>1</sup>Geology & Geological Engineering, Colorado School of Mines, Golden, CO ([tjobe@mines.edu](mailto:tjobe@mines.edu))

<sup>2</sup>Petroleum Engineering, Colorado School of Mines, Golden, CO

## **Abstract**

Reservoir characterization, modeling and simulation are a necessary part of any enhanced oil recovery program. Today there have been many advances in static reservoir modeling but as new levels of complexity are introduced, we also introduce the demand for more computing power and computation time. Optimizing the modeling process without sacrificing model integrity has the potential to save valuable resources and aid in overall efficiency.

Postle Field is a mature oil and gas field in Texas County, Oklahoma which produces from Pennsylvanian valley fill sandstones. EOR practices in the form of water flood and CO<sub>2</sub> miscible flooding in the field have led to the need for reservoir modeling and simulation in order to increase recovery.

Incised valley fills are inherently complex and it is often difficult to achieve realistic static models because of severe heterogeneity, issues with data resolution, upscaling and lack of computation time and power. This study focuses on optimizing the modeling process by exploring how models change as a function of input parameters, such as cell dimensions, inclusion of stratigraphically significant surfaces, facies modeling and geo-body types, as well as incorporation of additional seismic and geo-statistical data.

A total of sixteen models each varying systematically in complexity were created. Thirty realizations of each model were run and pore-volumes were calculated and averaged for comparison. Selected models were then history matched and compared using both the full field and individual well performance history matches.

Preliminary results show similar trends in the full field history match, indicating that in complex heterogeneous systems, simpler models with coarser grids and lack of geostatistical and seismic data may be as robust as the more complex ones. A full field history match, however, is not sufficient to evaluate model quality; individual well performance matches must be considered. Results show that well performance matches are significantly improved with the addition of data, demonstrating the need for integration of multiple data sets at many scales to accurately represent geologically complex reservoirs. The results of this study help to define best practices for static modeling in valley fill systems; optimizing time and resources and increasing overall efficiency.

### **Selected References**

Jobe, T.D., M. Wiley, and A.E. Heris, 2009, Understanding Valley Fill Heterogeneity: A New Depositional Model for the Upper Morrow “A” Sands at Postle Field, Texas County, Oklahoma, American Association of Petroleum Geologists Annual Meeting, April 7-10 2009, Denver Colorado, Web accessed 4 August 2010, Search and Discovery Abstract #90090 <http://www.searchanddiscovery.net/abstracts/html/2009/annual/abstracts/job01.htm?q=%2Btext%3Ajobe>

Jobe, T.D., M. Wiley, and A.E. Heris, 2009, High resolution Geo-cellular Modeling of the Upper Morrow “A” Sands at Postle Field, Texas County, Oklahoma, American Association of Petroleum Geologists Annual Meeting, April 7-10 2009, Denver Colorado, Web accessed 4 August 2010, Search and Discovery Abstract #90090 <http://www.searchanddiscovery.net/abstracts/html/2009/annual/abstracts/job02.htm?q=%2Btext%3Ajobe>

# **Static Reservoir Modeling in an Incised Valley Fill: A Case Study in Optimization from Postle Field, Texas County, Oklahoma**

T.D. Jobe, Dept. of Geology and Geological Engineering

A.E. Heris, Dept. of Petroleum Engineering



AAPG Annual Convention, New Orleans, LA

14 April 2010

# Acknowledgements

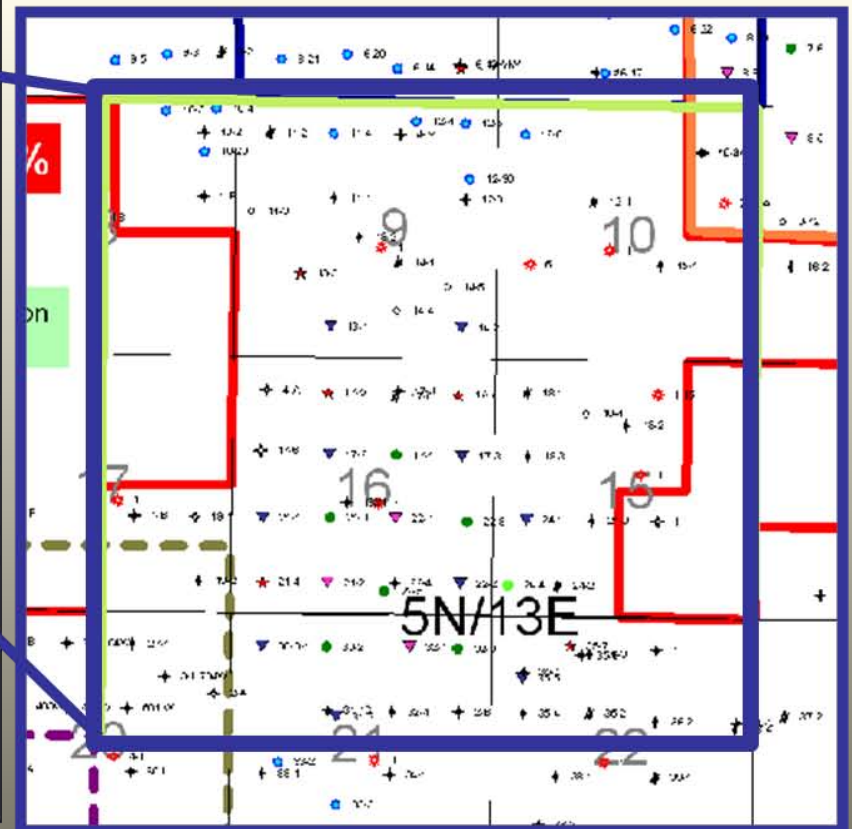
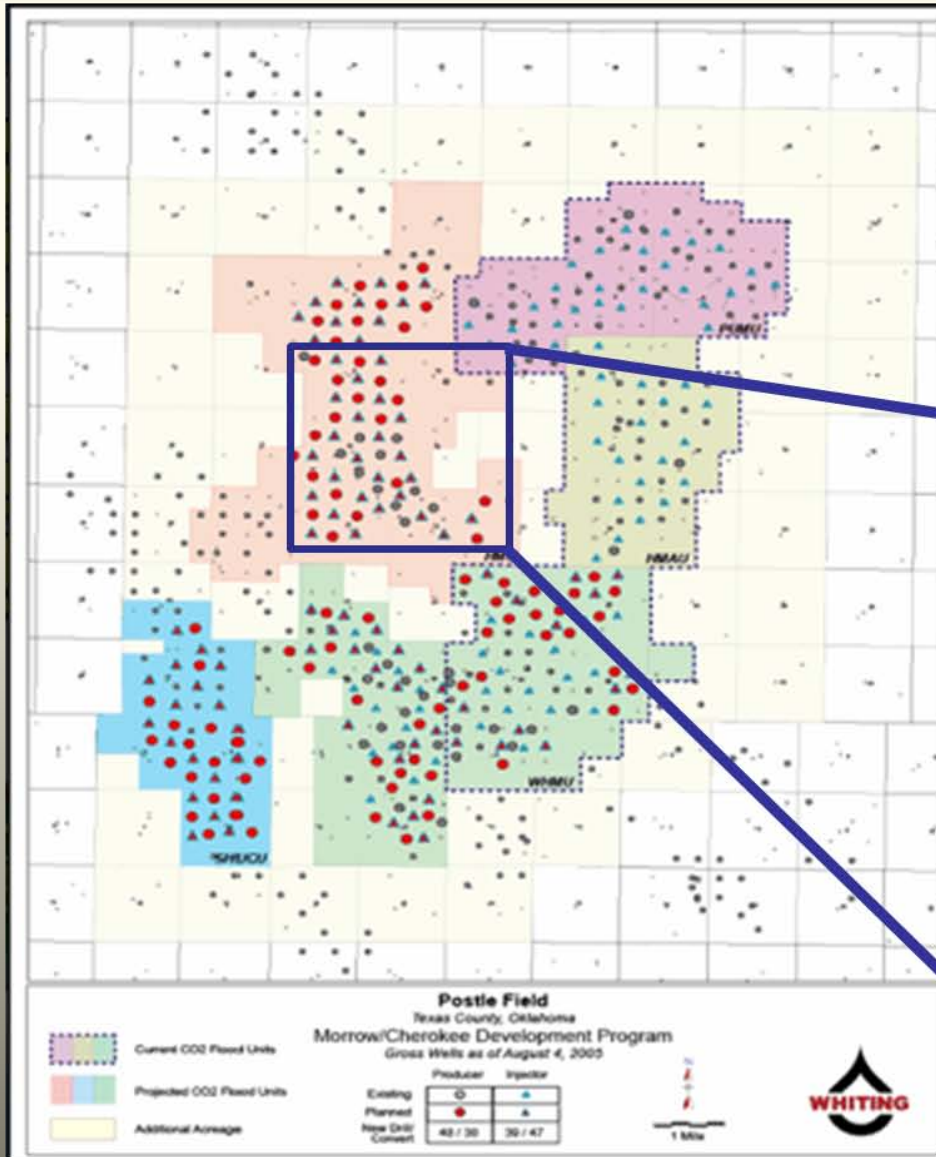


- A.E. Heris CSM Petroleum Engineering
- M. Casey CSM Geophysics/ExxonMobil
- Piret Plink-Björklund CSM Geology
- Tom Davis CSM Geophysics
- Reservoir Characterization Project
  - Students
  - Sponsors
  - Staff

# Dessert First!

- For braided river incised valley fills, its all about modeling bars!!!
- Models using bar-forms are capable of consistently reproducing reservoir volumes
- Models using bar-forms show significant improvement in history matching over models using channel-forms
- Using vertical proportion curves are capable of both improving simulation results and reducing run time.

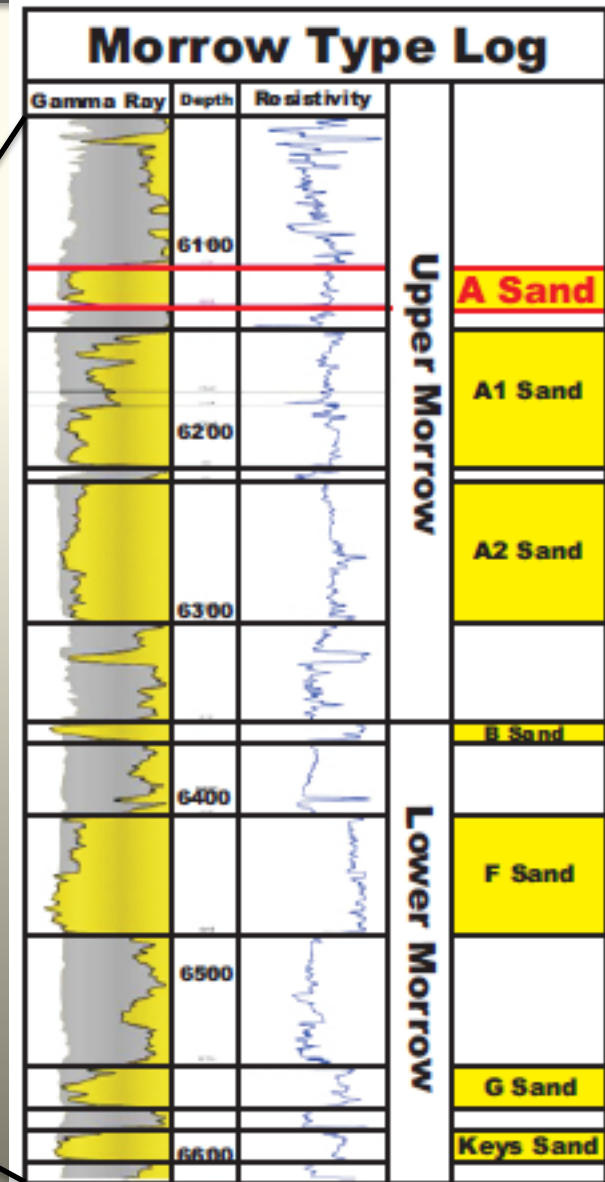
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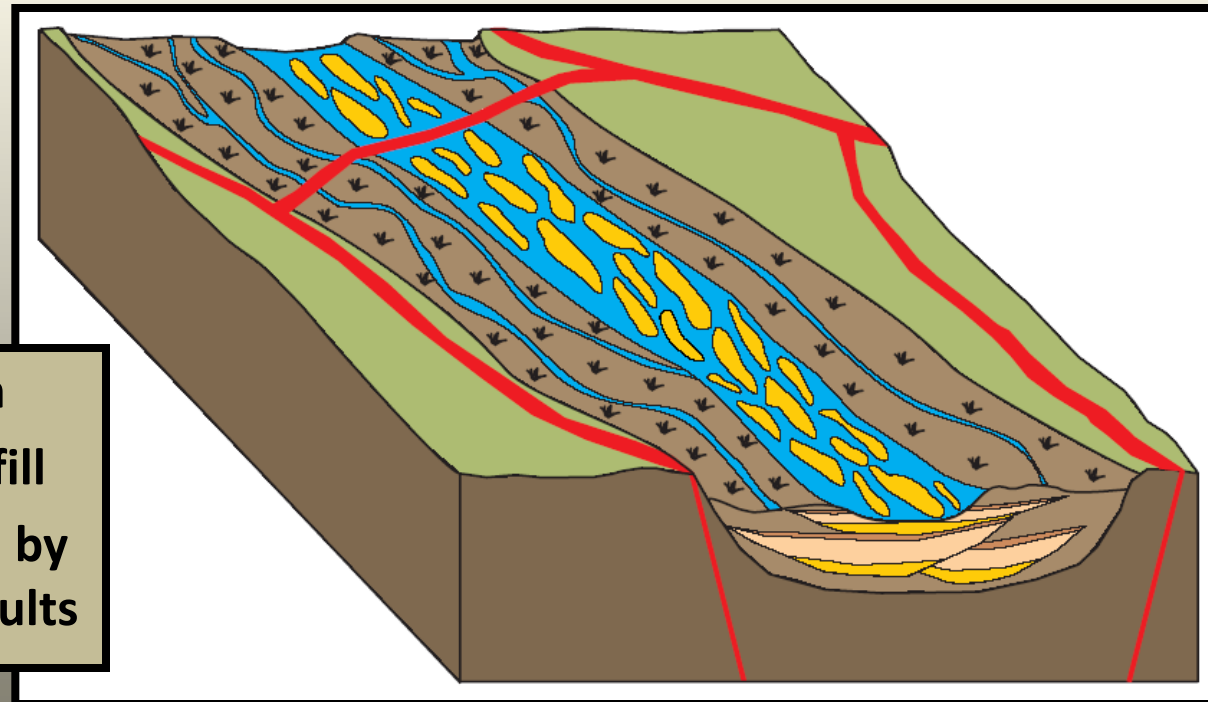
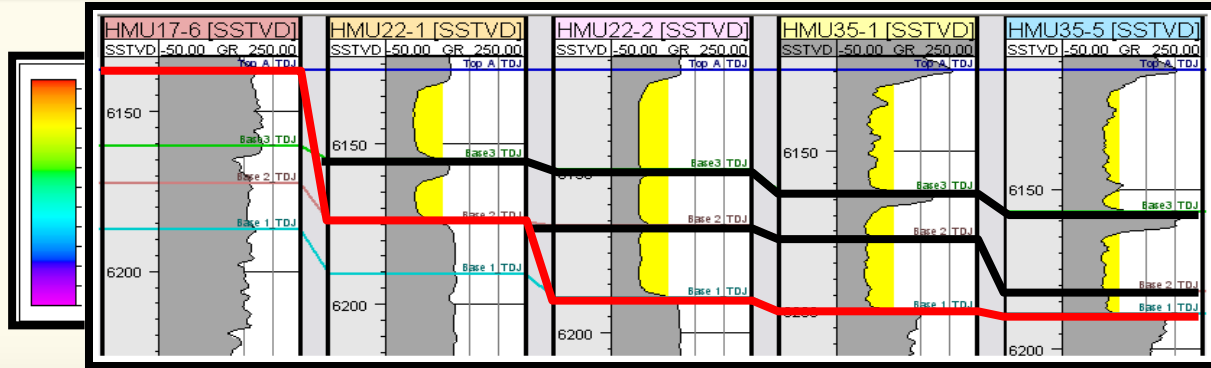
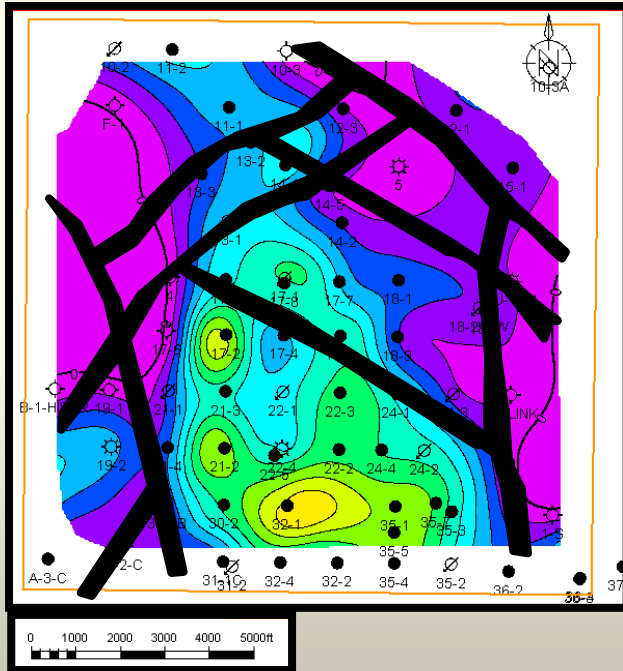
# Reservoir Interval

## Generalized Stratigraphic Column

<b>Permian</b> <i>Hugoton</i>	Ochoan			
	Gaudalupian	El Reno		
	Leonardian	Summer / Enid		
	Wolfcampian	Chase Council Grove Admire		
<b>Pennsylvanian</b>	Virgilian	Wabaunsee Shawnee		
	Missourian	Lansing Kansas City		
	Des Moines	Marmaton Cherokee		
	Atoka	13 Fingers		
	Upper Morrow	A Sand A1 Sand A2 Sand		
	Lower Morrow	B Sand F Sand G Sand Keys		
<b>Mississippi</b>	Chester	Chester		
	Merrimac			
	Osage			



# Geologic Framework



- Braided Fluvial System
- 3 episodes of cut and fill
- Structurally controlled by small offset wrench faults

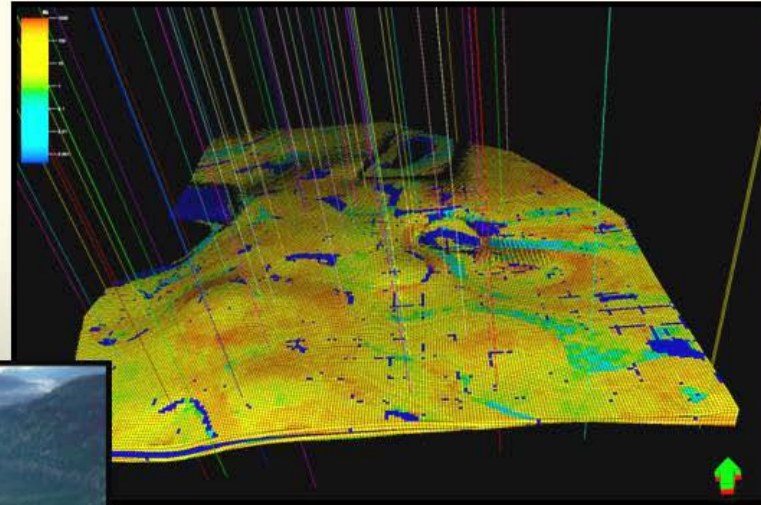


**RCP**  
RESERVOIR CHARACTERIZATION PROJECT  
COLORADO SCHOOL OF MINES



*A.E. Heris, 2007*

# Modeling Observation



*Slims River, Kluane National Park, Yukon, Canada  
(picture by H.J.A. Berendsen)*

**Braided Rivers are fundamentally different from high sinuosity meandering rivers – how do we need to modify the modeling process?**

Notes by Presenter: In addition most fluvial reservoirs are modeled as high sinuosity meandering systems which have facies relationships, related to point bars, levees and crevasses plays which are somewhat predictable. Braided river systems have none of these features and are highly unpredictable. So how does this affect the modeling process and how will it need to be modified in order to accurately model a braided river system?

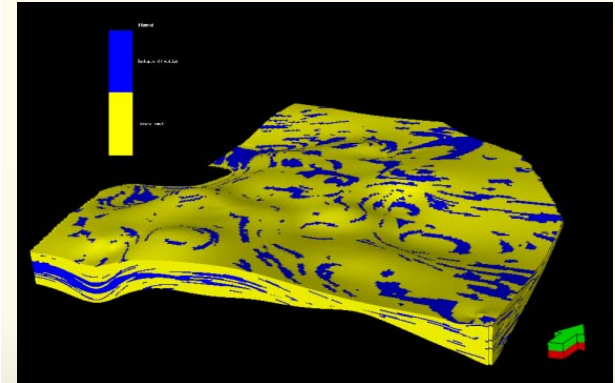
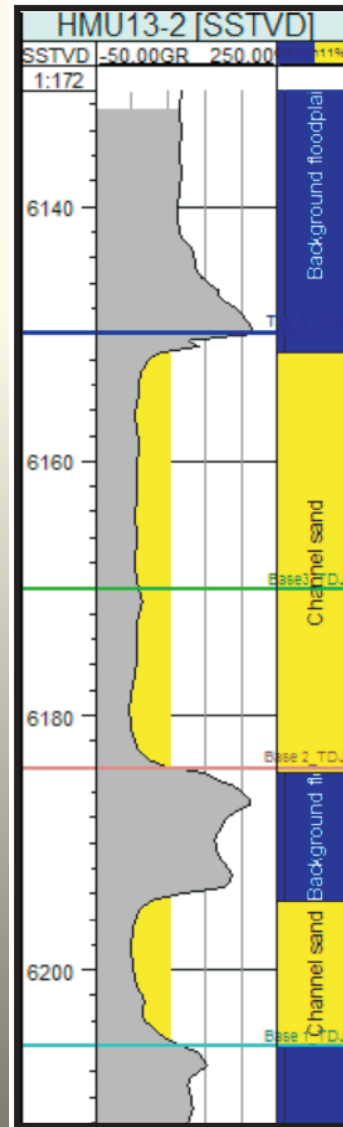
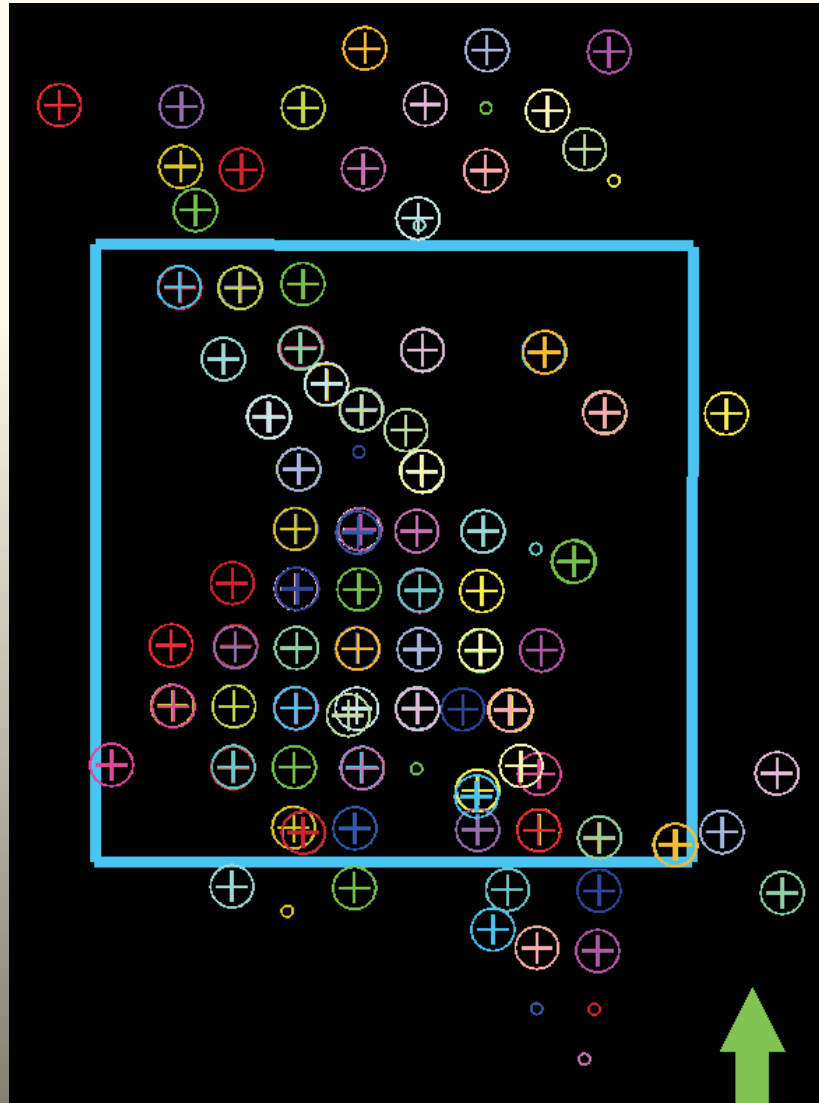
# Modeling Investigation



	Channel Forms		Bar Forms	
	Top to Base	Stratigraphic Framework	Top to Base	Stratigraphic Framework
2 ft. cells	1	3	5	7
	1V	3V	5V	7V
	1S	3S	5S	7S
	1VS	3VS	5VS	7VS
4 ft. cells	2	4	6	8
	2V	4V	6V	8V
	2S	4S	6S	8S
	2VS	4VS	6VS	8VS

Notes by Presenter: A series of 32 different model types were created. Each model type is volumetrically the same; the boundary conditions were kept constant. What changed was how the model space was divided in the gridding process, through reservoir zonation and differing cell sizes. I also explored how the model space was populated with geologic information, through differing geo-bodies, and the use of vertical proportion curves and seismically guided flow lines. Both of which help redistribute facies through model space.

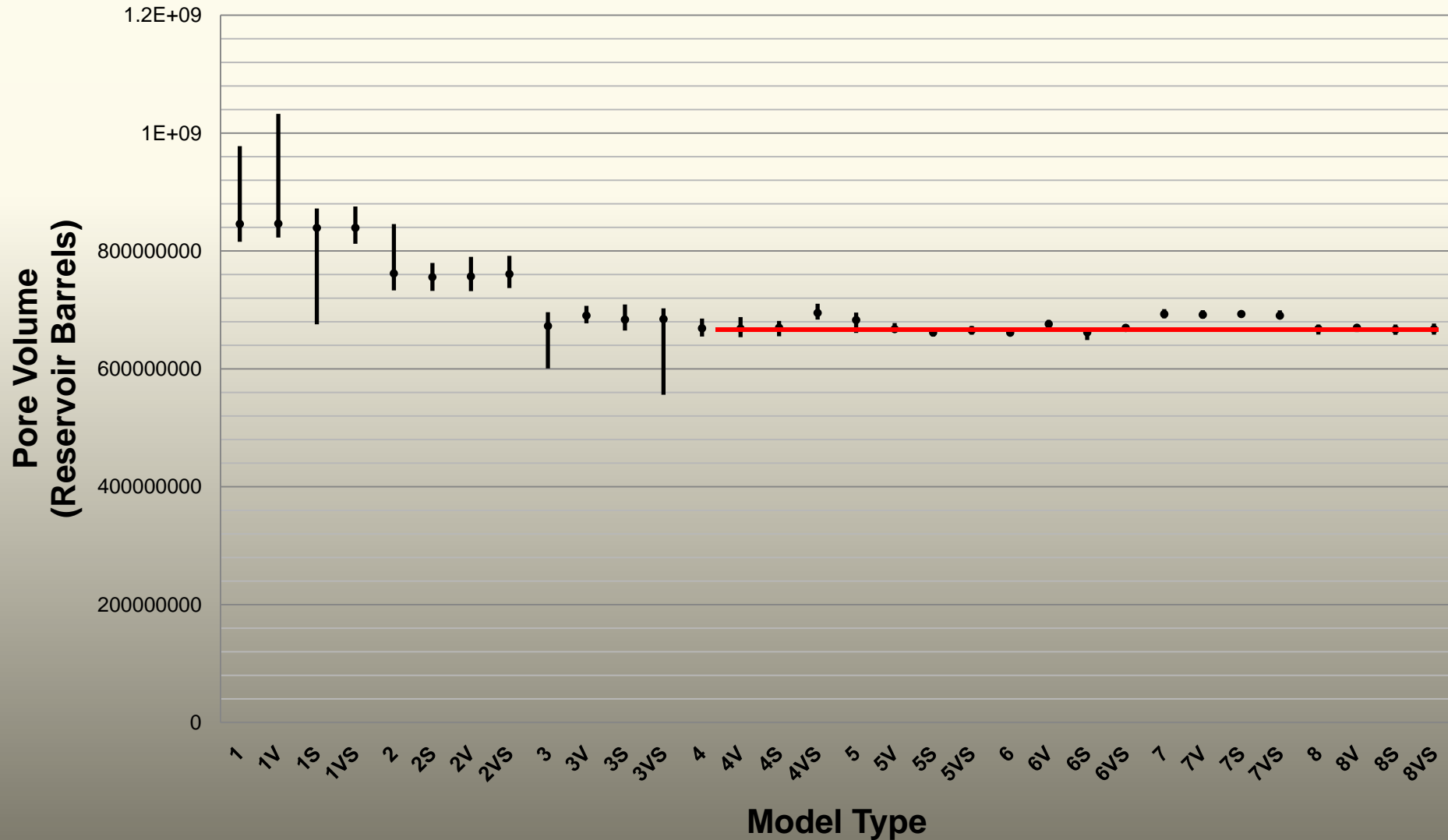
# Modeling Methodology



- **Standard Petrel™ Modeling Workflow**
- **Object Based Stochastic Facies Models**
- **Geo-body dimensions from core data and literature**

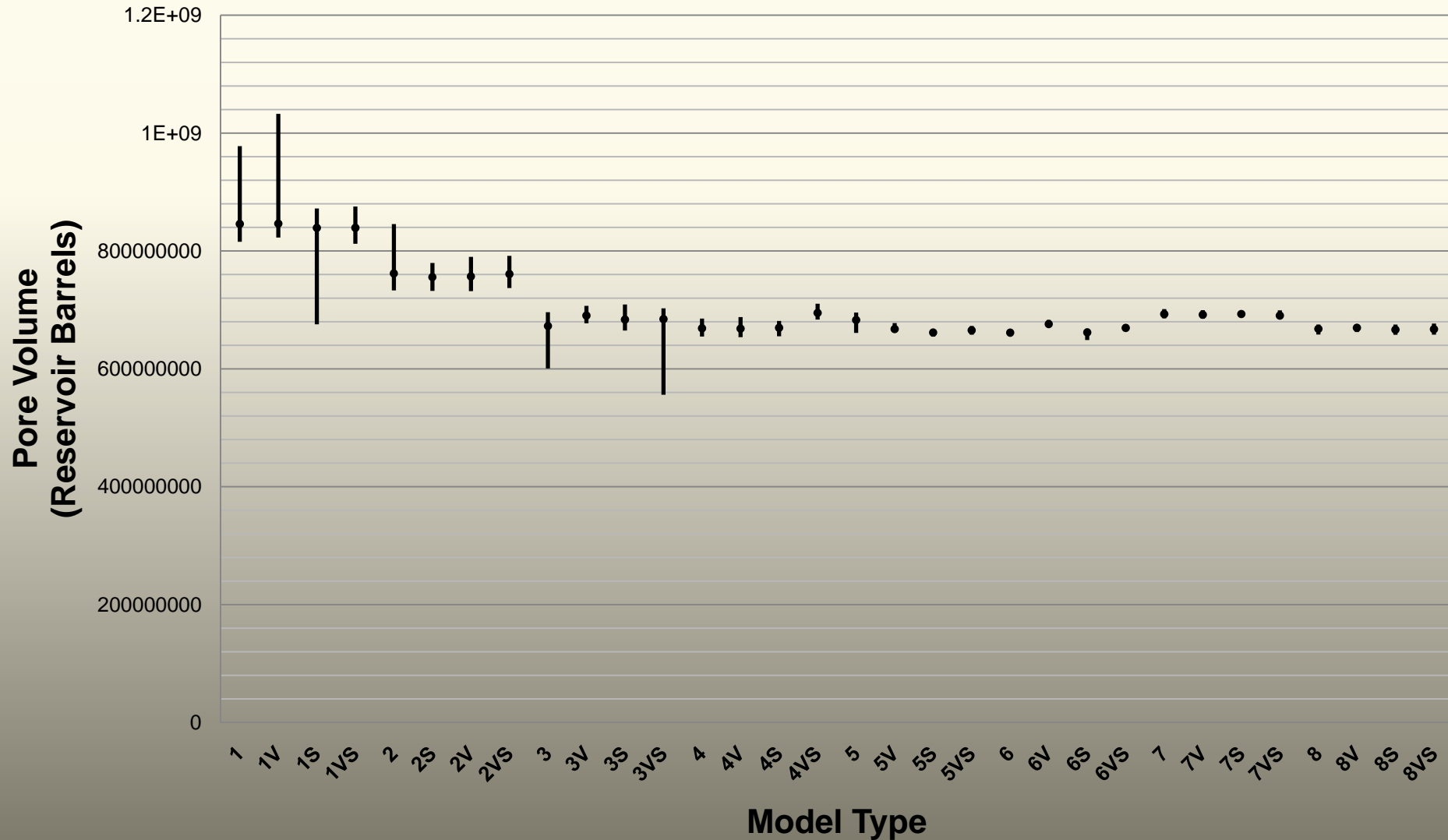
# Pore Volume Results

## Model Type vs Pore Volume



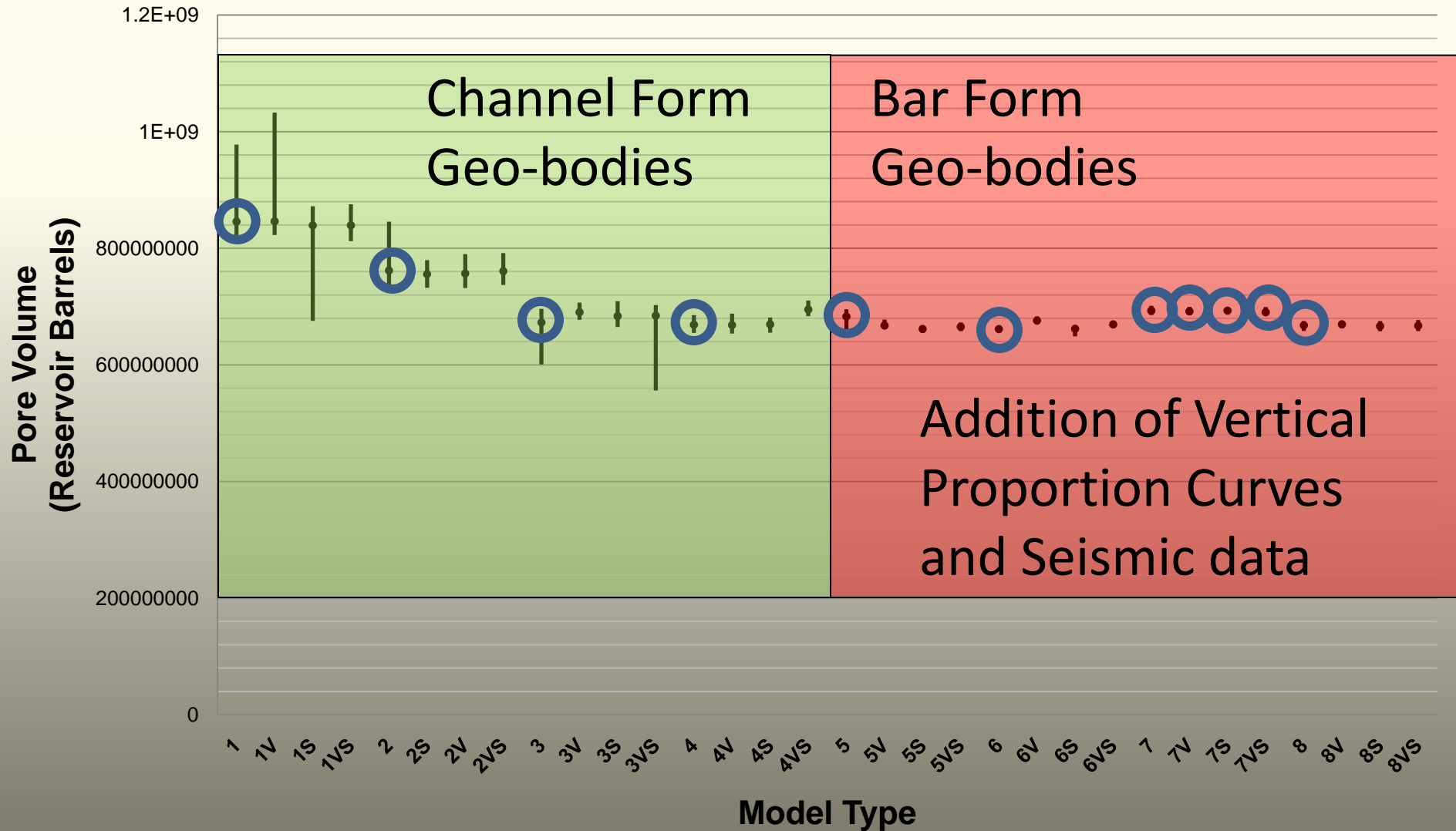
# Pore Volume Results

Model Type vs Pore Volume

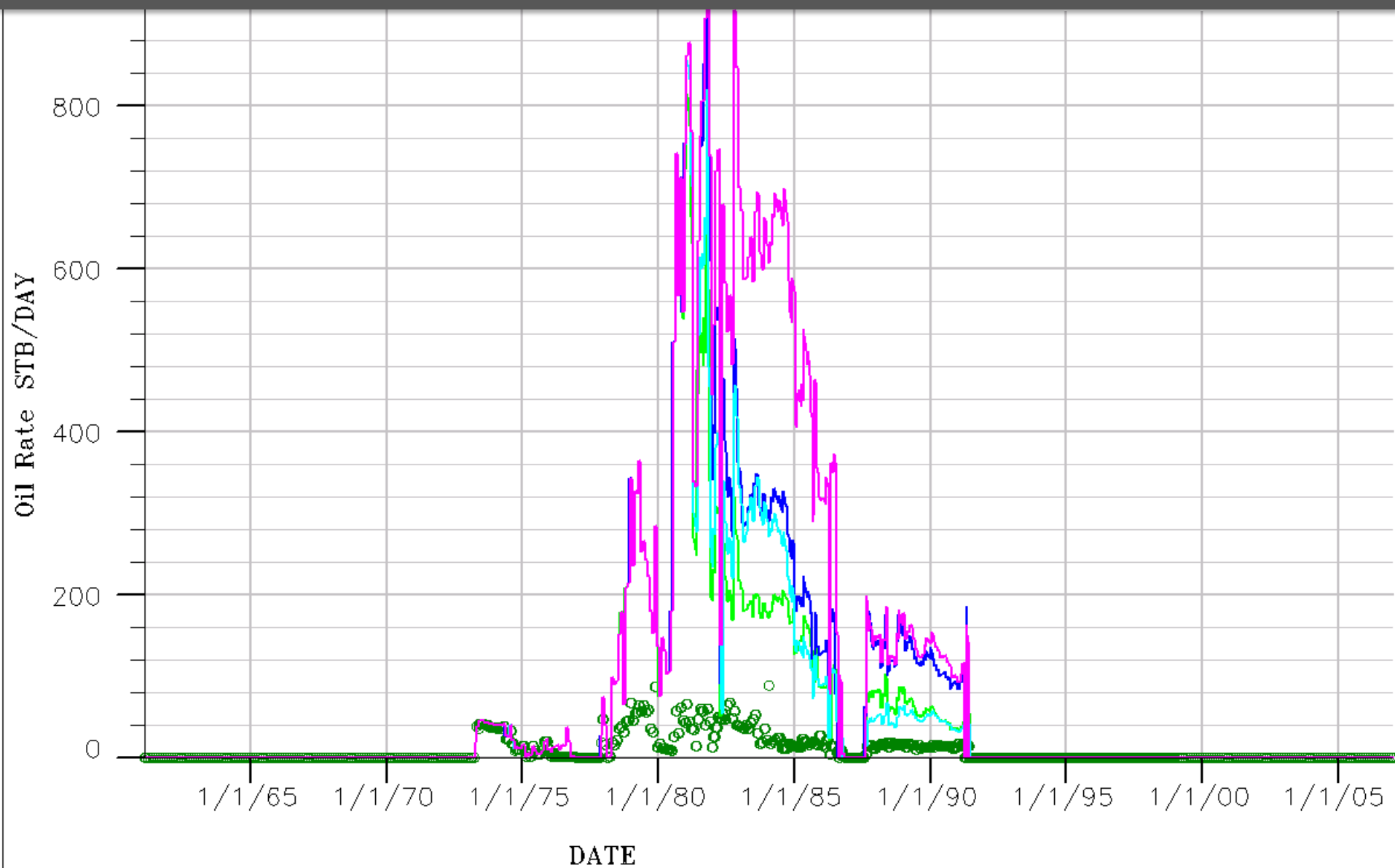


# Pore Volume Results

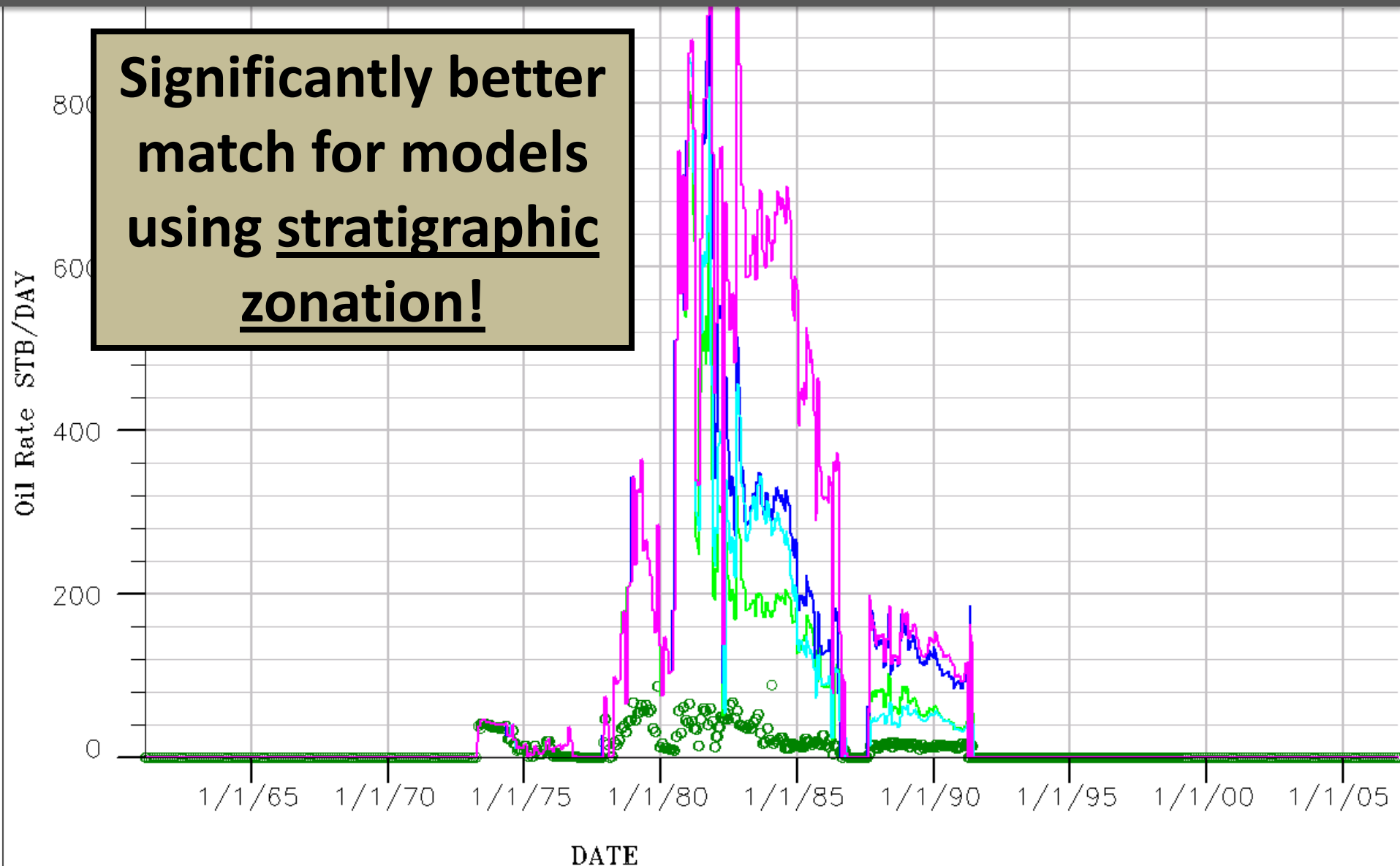
Model Type vs Pore Volume



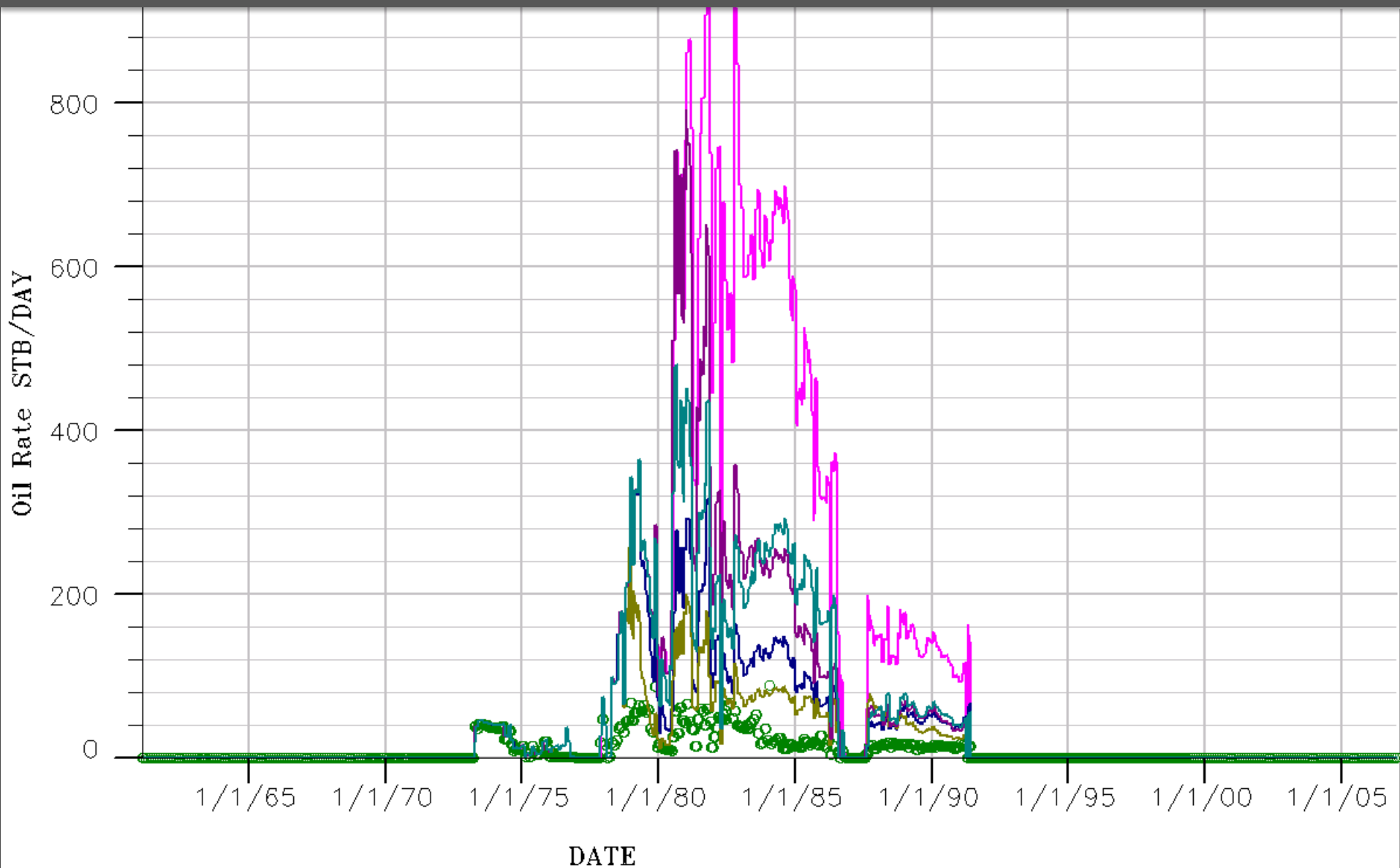
# Simulation Results - Channels



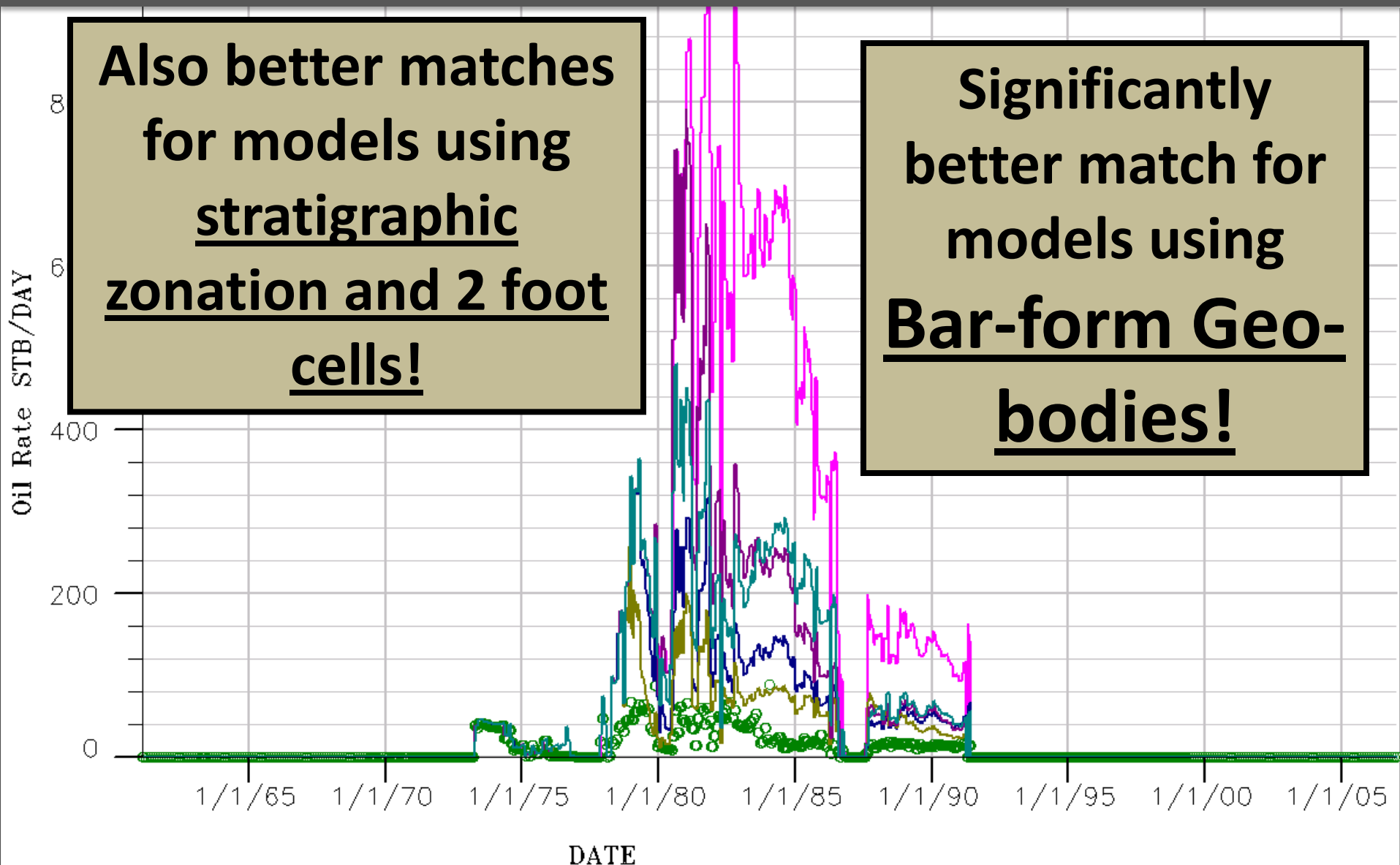
# Simulation Results - Channels



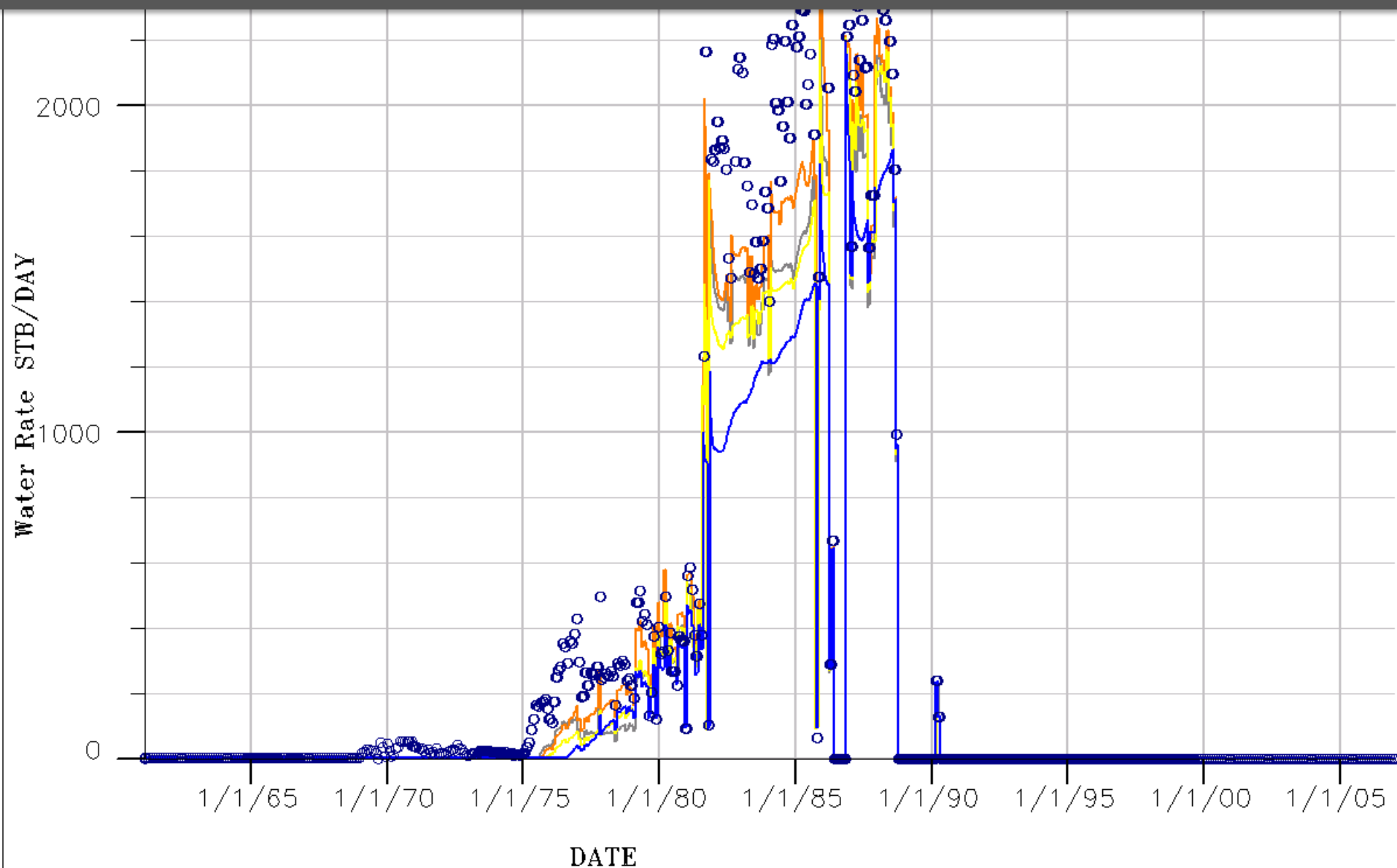
# Simulation Results - Bars



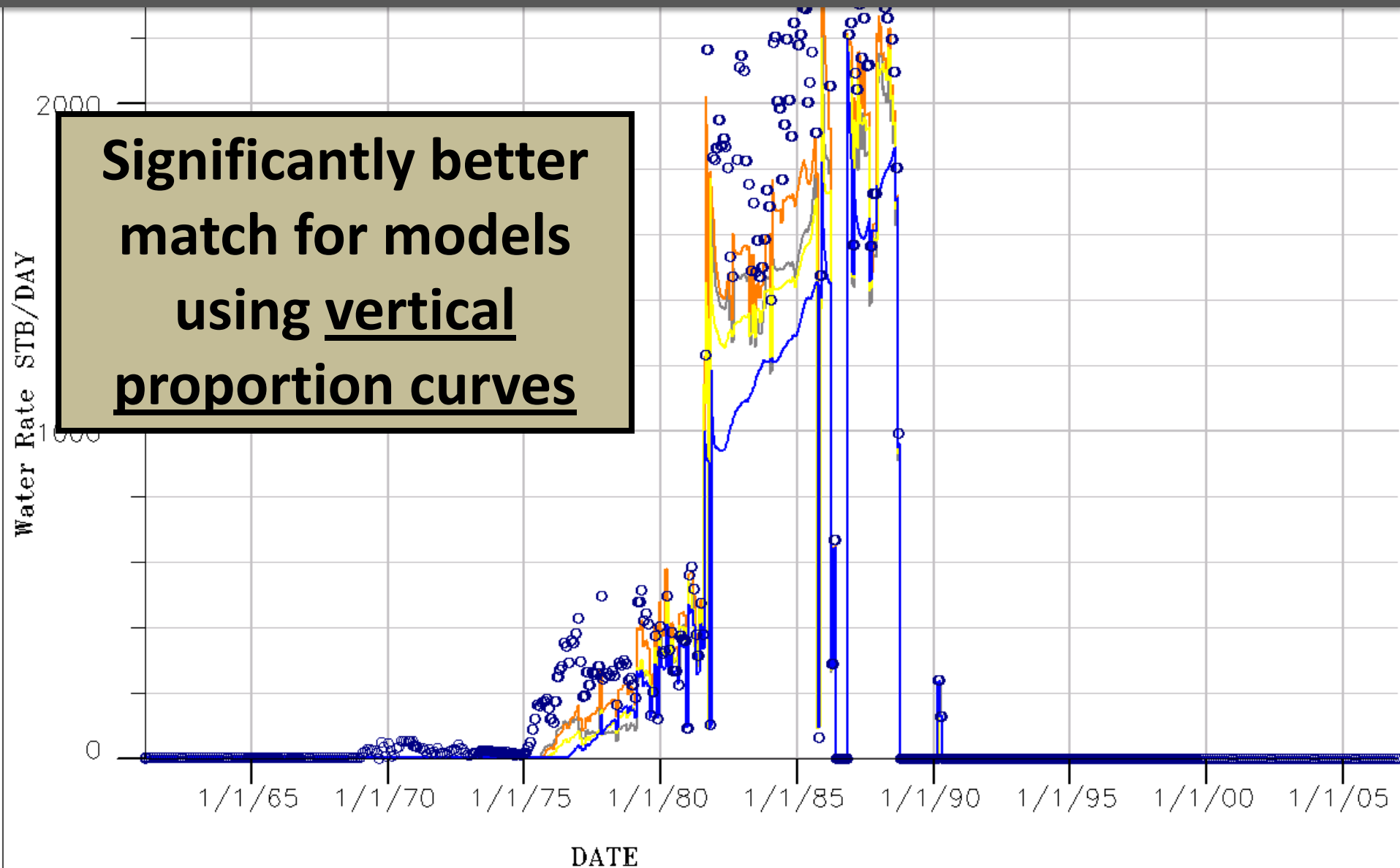
# Simulation Results - Bars



# Results – Additional Data

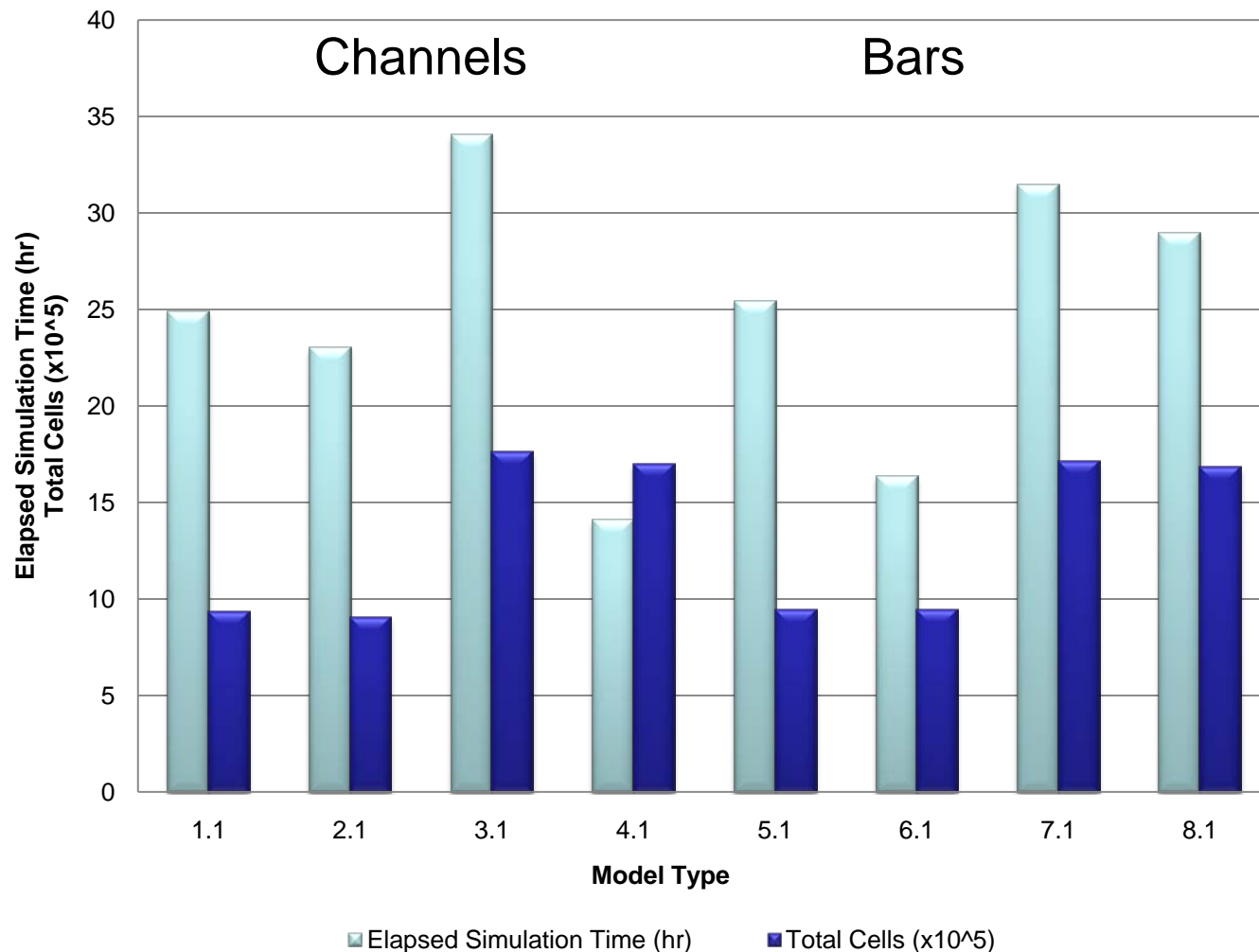


# Results – Additional Data



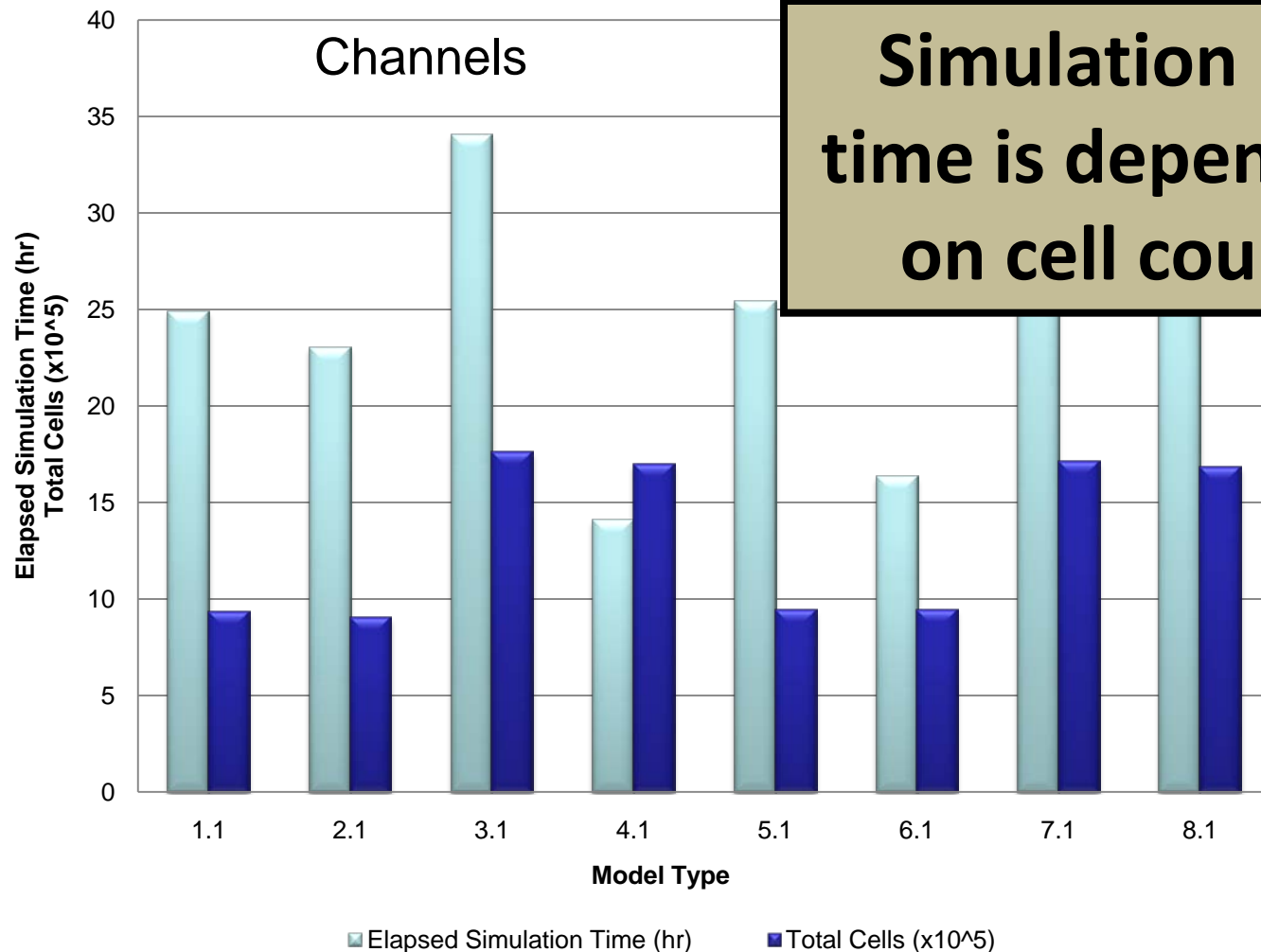
# Run Time Results

**Elapsed Simulation Times and Total Cells  
vs. Model Type**



# Run Time Results

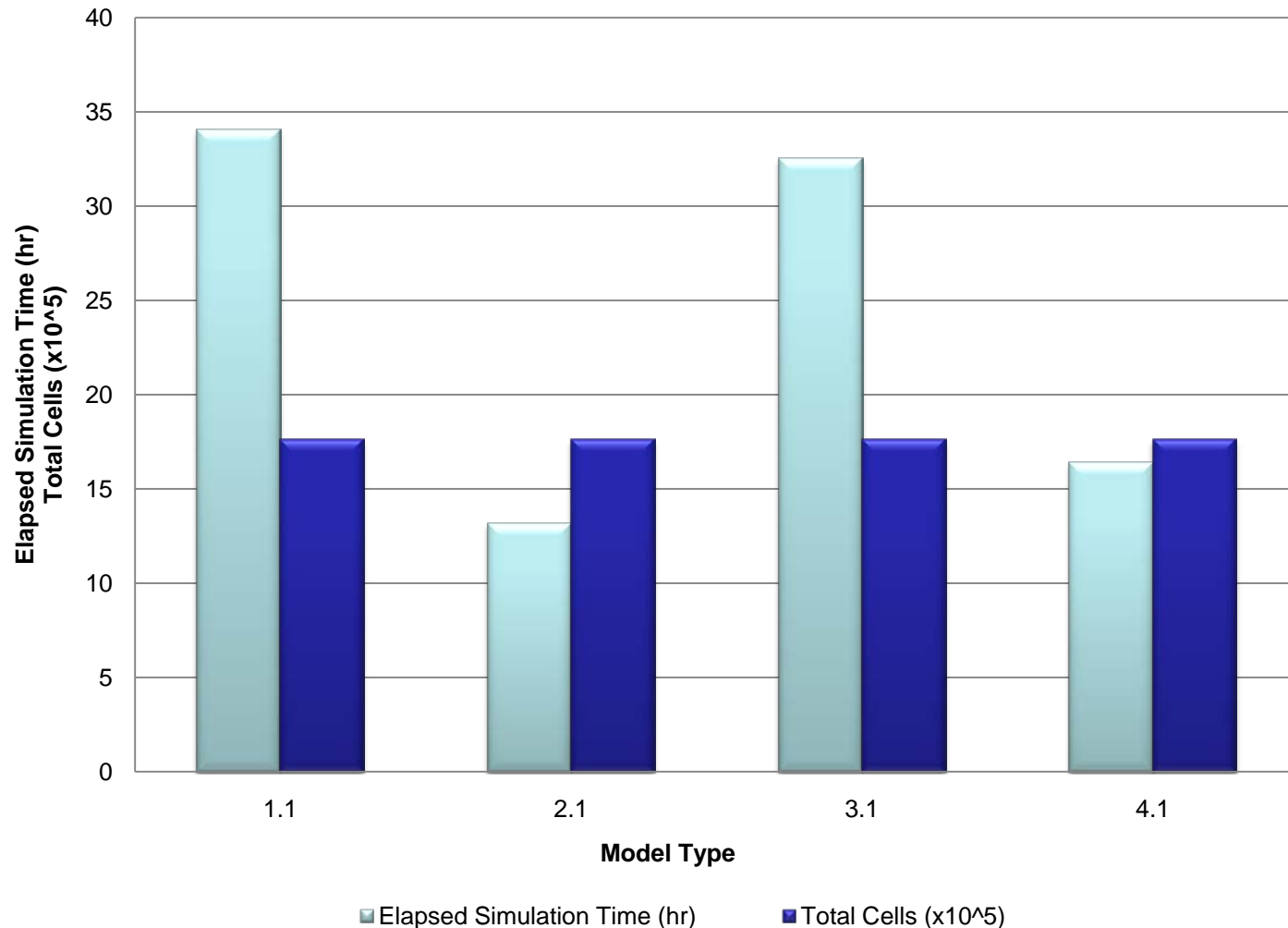
Elapsed Simulation Times and Total Cells  
vs. Model Type



**Simulation run  
time is dependant  
on cell count.**

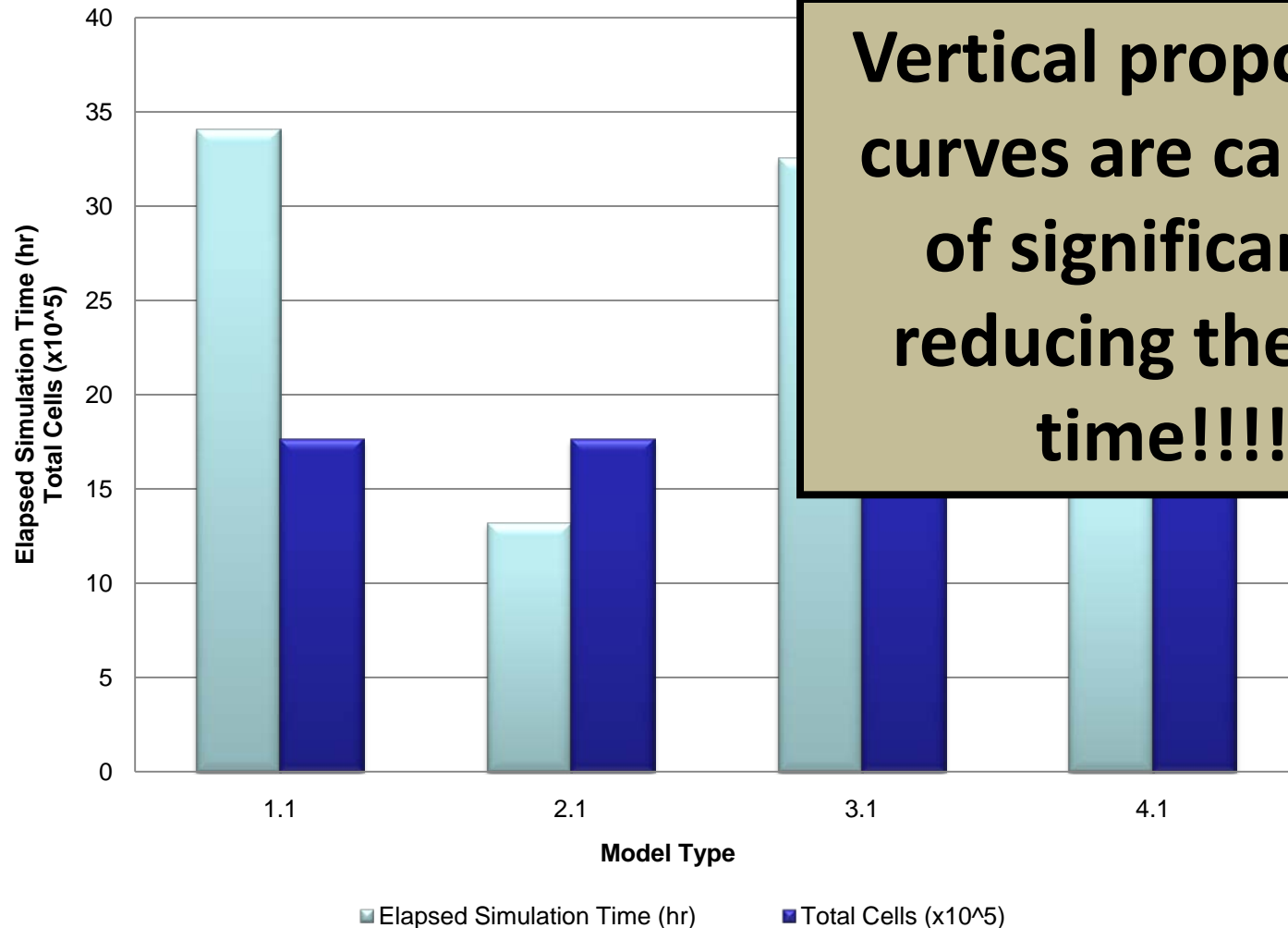
# Run Time Results

**Elapsed Simulation Times and Total Cells  
vs. Model Type**



# Run Time Results

**Elapsed Simulation Times and Total Cells  
vs. Model Type**



**Vertical proportion  
curves are capable  
of significantly  
reducing the run  
time!!!!**

# Conclusions

## At Postle Field (Braided River Incised Valley Fill)

- Bar-forms can significantly improve simulation results!!!
- Bar-forms are capable of volumetrically representing the reservoir despite the gridding parameters
- Small cell sizes and stratigraphic zonation also improve simulation results
- Vertical proportion curves have the potential to both improve simulation results and reduce simulation run time

# Questions



**Base of IVF**  
County Clare, Ireland