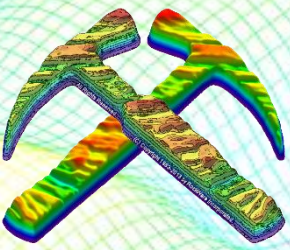




Edwards Aquifer Authority - Board of Directors - Presentation Outline



Personal Background (Who is this clown?)

RockWare (Who's he working for?)

Presentation Goal (What's he peddling?)

Terminology (What the heck is he talking about?)

The Edwards-Trinity Aquifer System (Don't we already know all this?)

RockWorks (What's so special about your software?)

RockWorks & The Edwards Aquifer (What does it have to do with us?)



Jim Reed

Education

- University of Wyoming
- Washington University in St. Louis

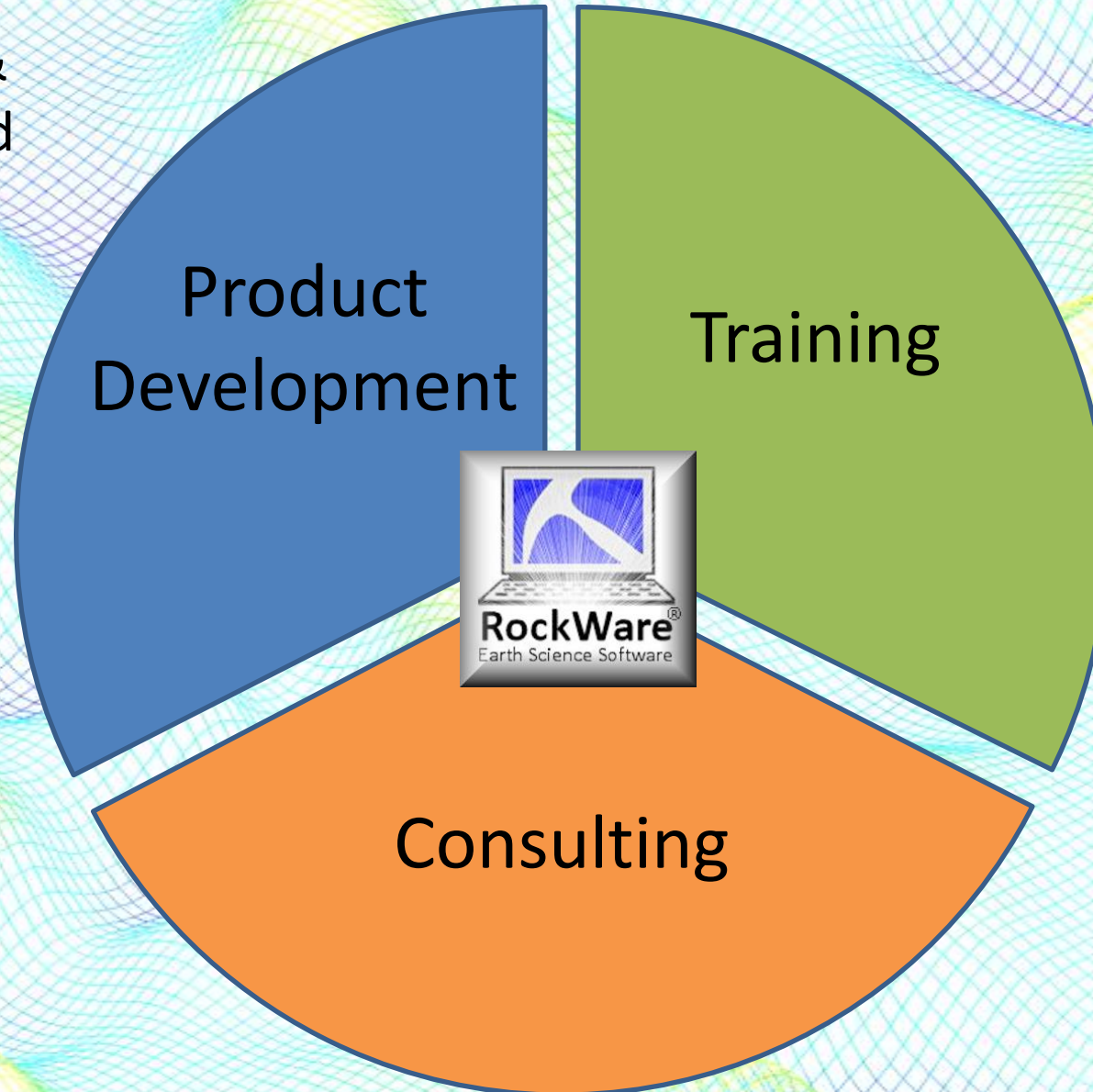
Employment

- **NASA:** Research Assistant – Mars Viking Project
- **Arch Minerals** Resource Analyst – Southern Illinois Coal
- **Freeport Minerals** Project Geologist - SW US Base & Precious Metals
- **AMAX** Regional Geologist - Western US Molybdenum
- **Wold Minerals** Chief Geologist - Texas & Montana Uranium, Gypsum, & Talc
- **RockWare:** Founder / Director of Research & Development



RockWare

- Founded in 1983
- Golden, Colorado & Lugano, Switzerland
- 30,000 Clients



- Archeology
- Education
- Geochemistry
- Geotechnical
- Hydrochemistry
- Hydrogeology
- Litigation Support
- Mining
 - Energy Fuels
 - Industrials
 - Metals
- Petroleum
- Research



Presentation Goal



November, 2016: Parking lot conversation with Mark Hamilton.

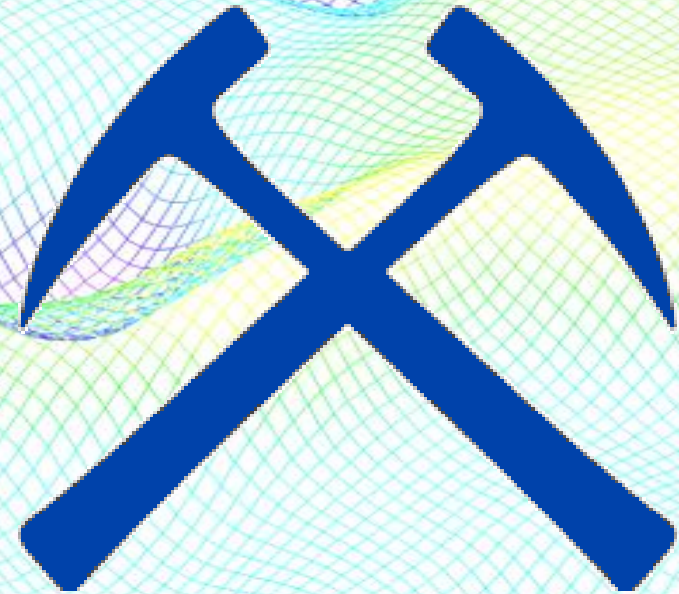


Terminology



Medicine

versus



Geology

Who has the larger vocabulary?



Terminology: Lithology & Stratigraphy

Layercake Geology

Stratigraphic
Units

Lithology

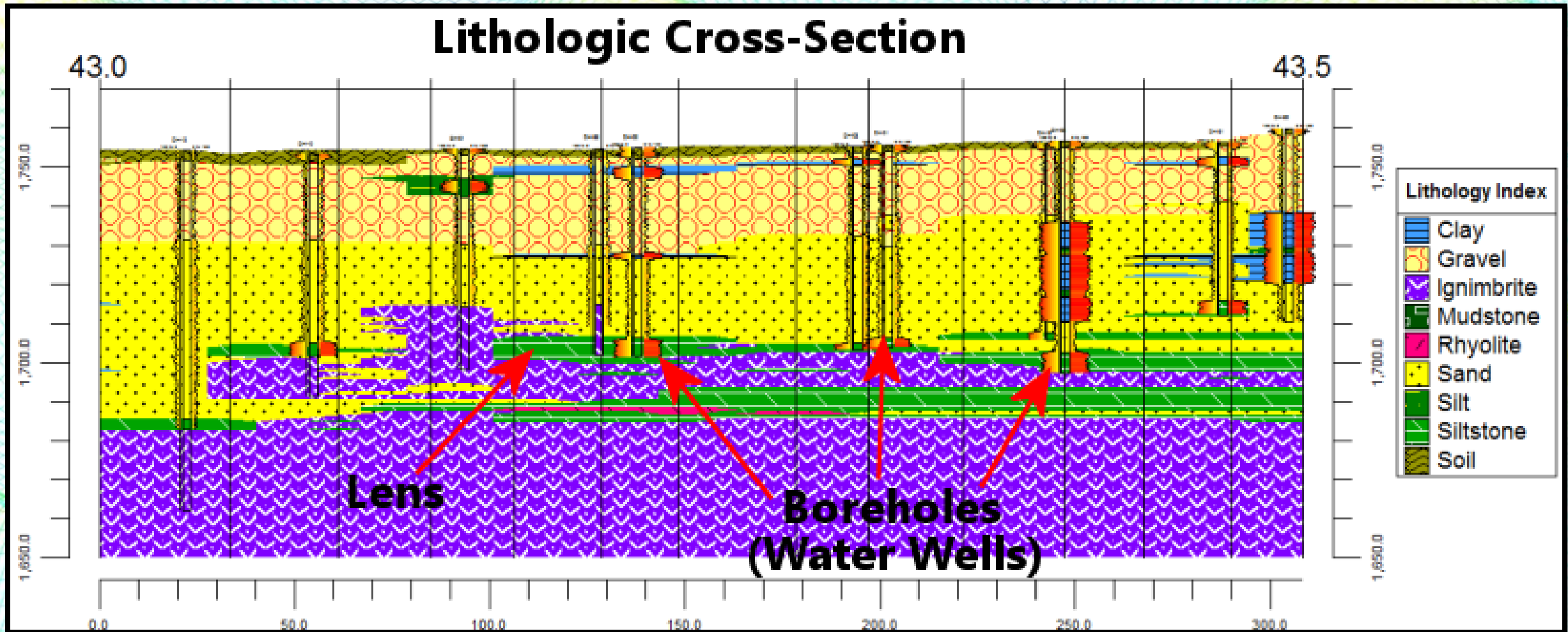


Terminology: Cross-Section

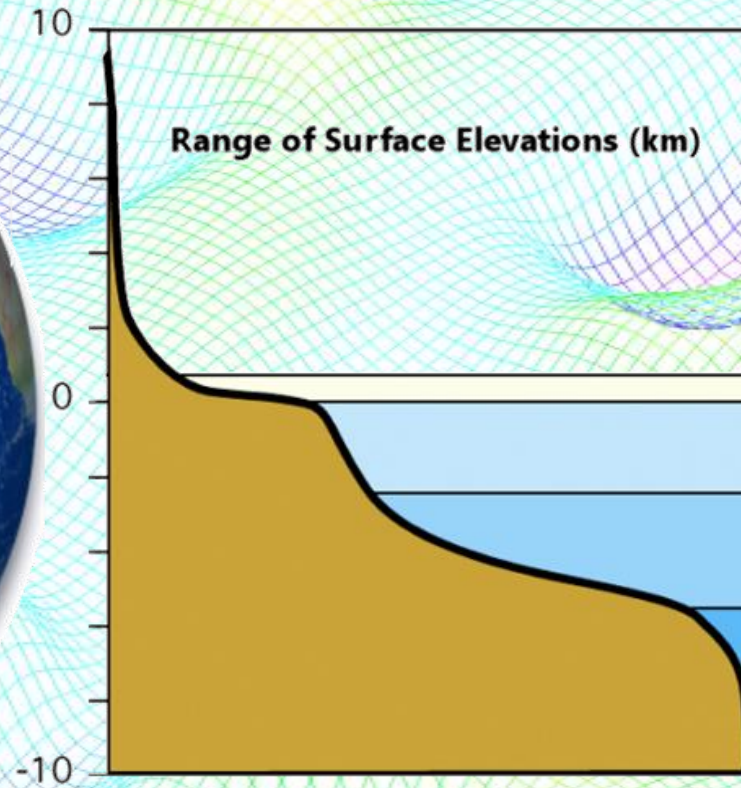


Terminology: Cross-Section (Continued)

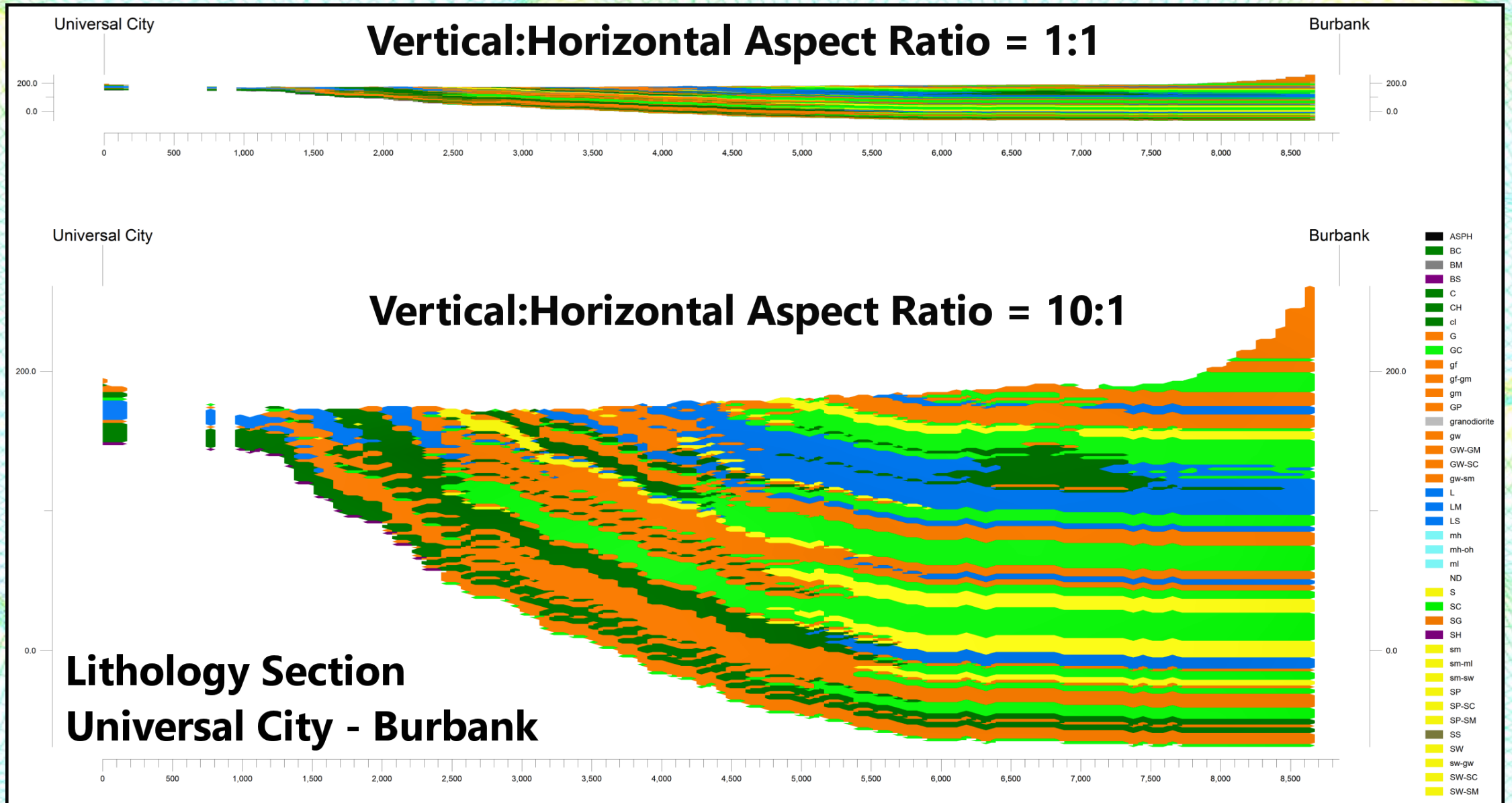
Lithologic Cross-Section



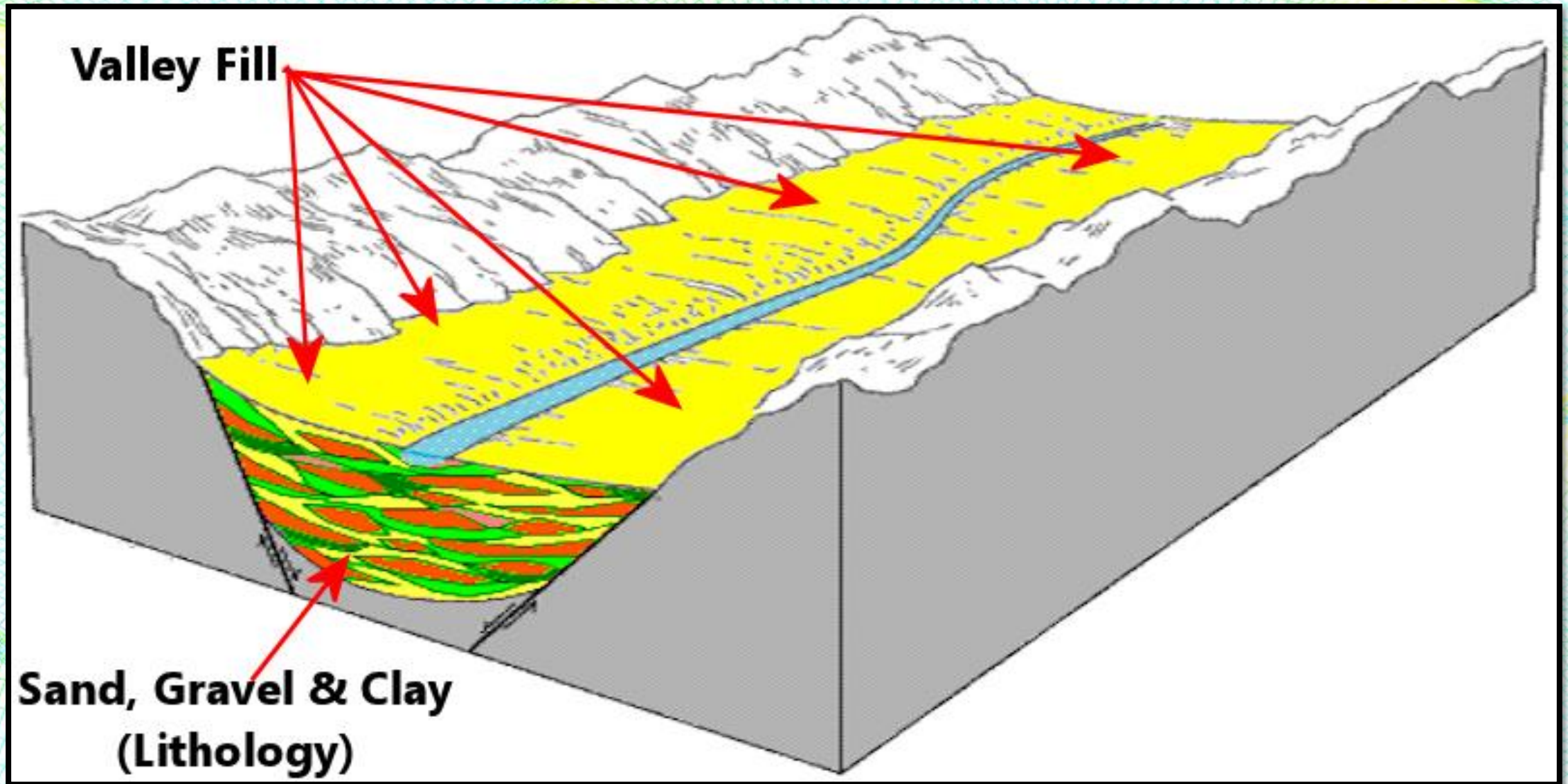
Terminology: Aspect Ratio



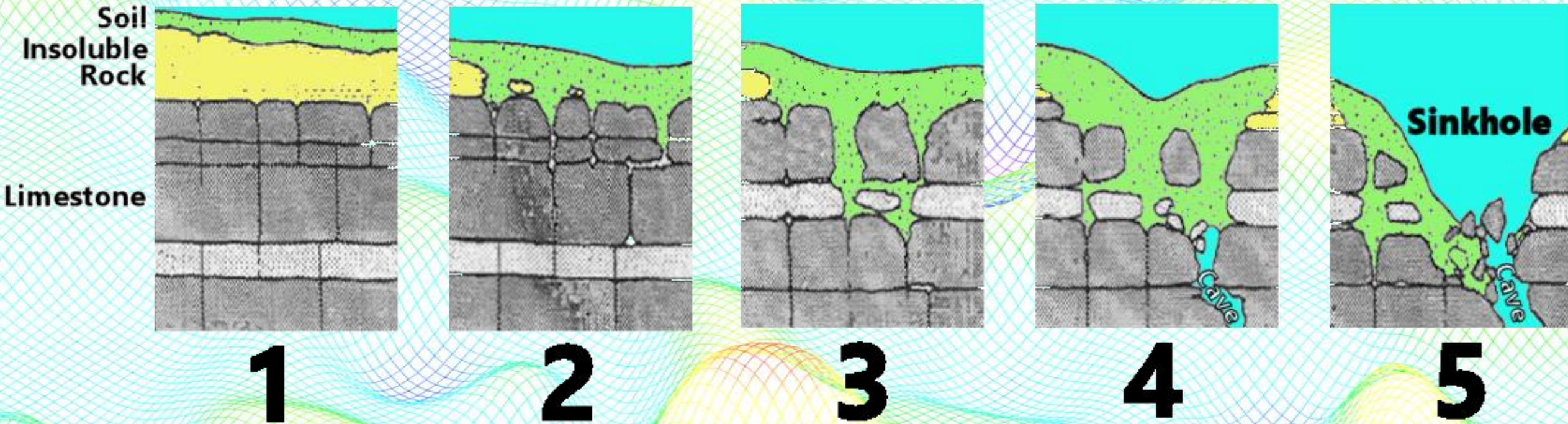
Terminology: Aspect Ratio (Continued)



Terminology: Valley Fill



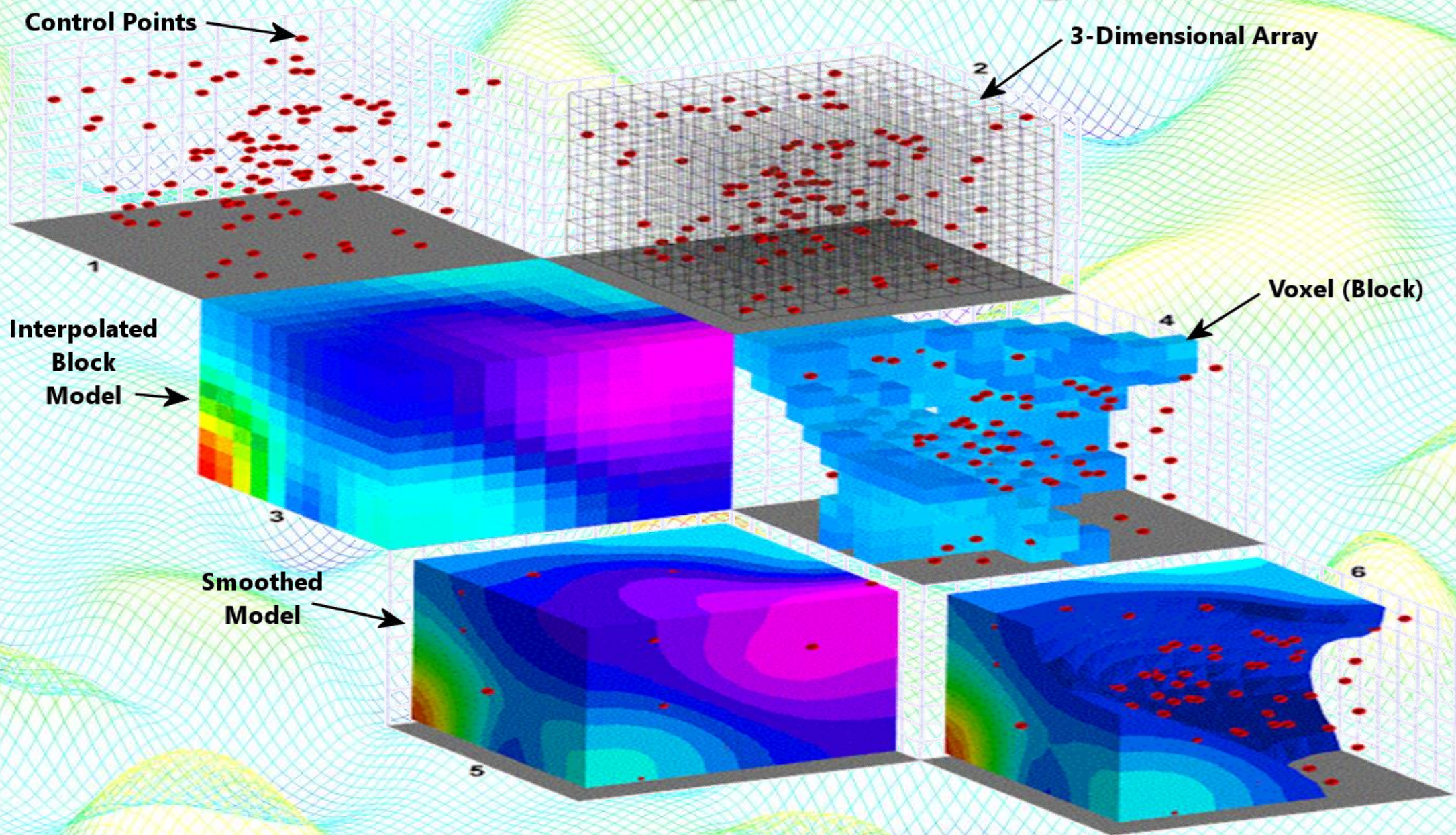
Terminology: Karst



After Palmer, A., 1981, GSA Bulletin V. 103 P. 1-21

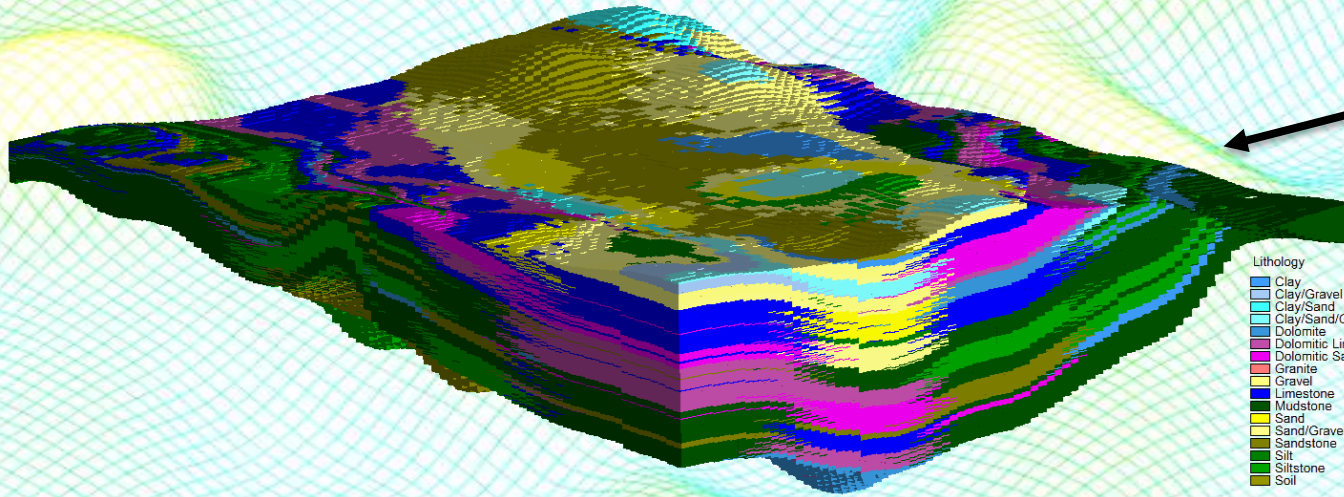


Terminology: Modeling



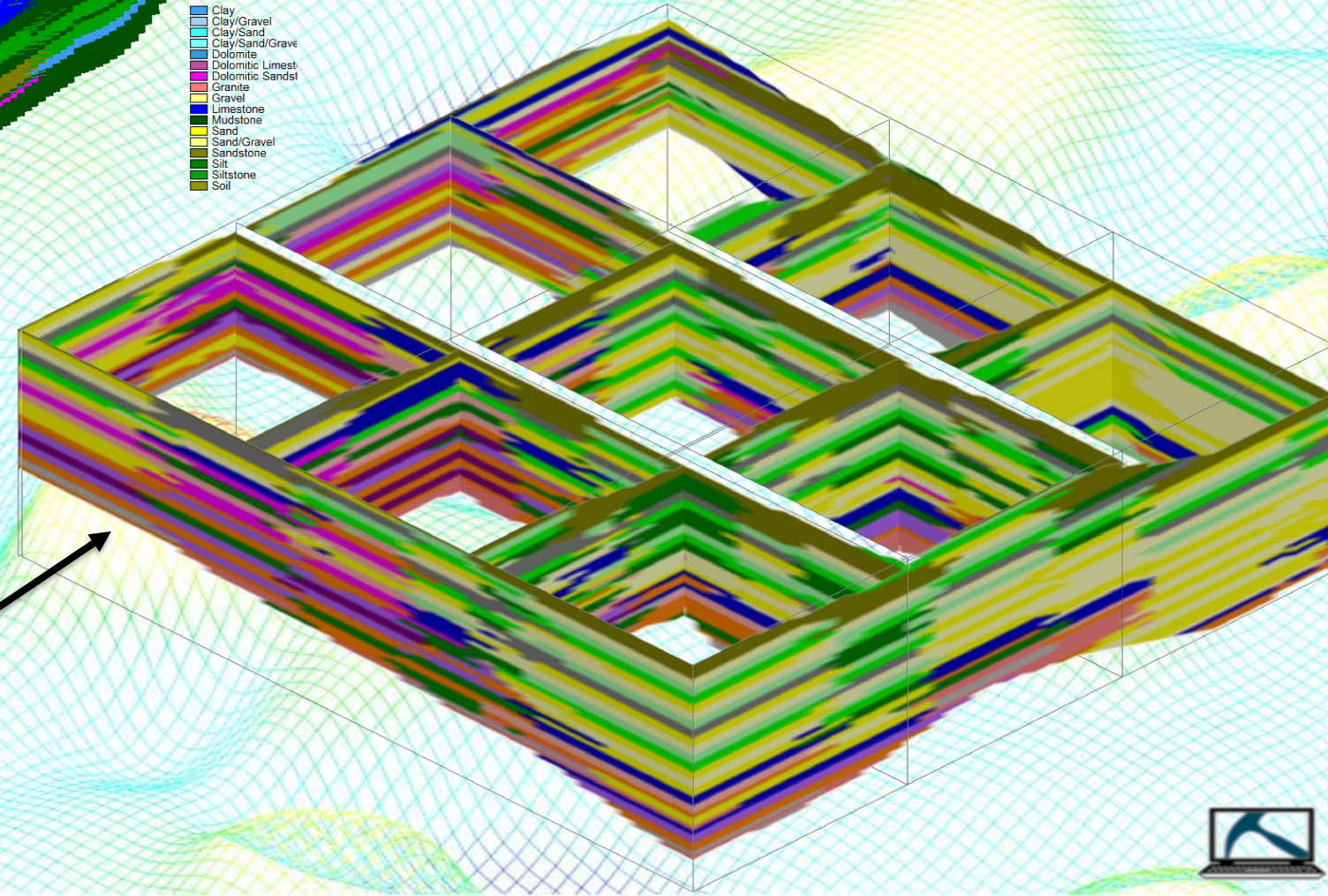
Terminology: Fence Diagram

Interpolated Block Model



Lithology

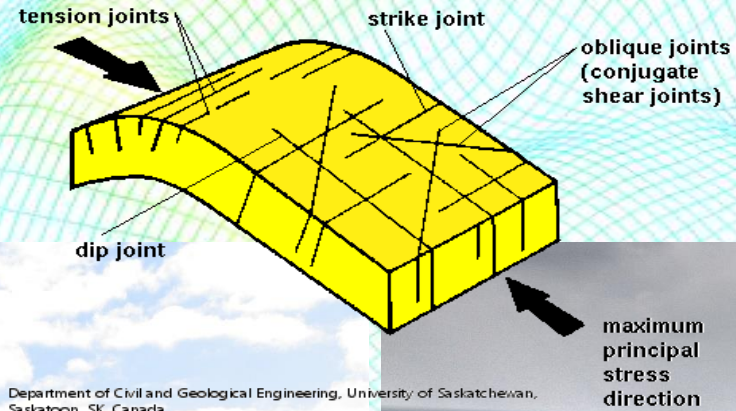
- Clay
- Clay/Gravel
- Clay/Sand
- Clay/Sand/Gravel
- Dolomite
- Dolomitic Limest
- Dolomitic Sandst
- Granite
- Gravel
- Limestone
- Mudstone
- Sand
- Sand/Gravel
- Sandstone
- Silt
- Siltstone
- Soil



Fence Diagram
(3-D Sections)



Terminology: Joints



Department of Civil and Geological Engineering, University of Saskatchewan,
Saskatoon, SK, Canada



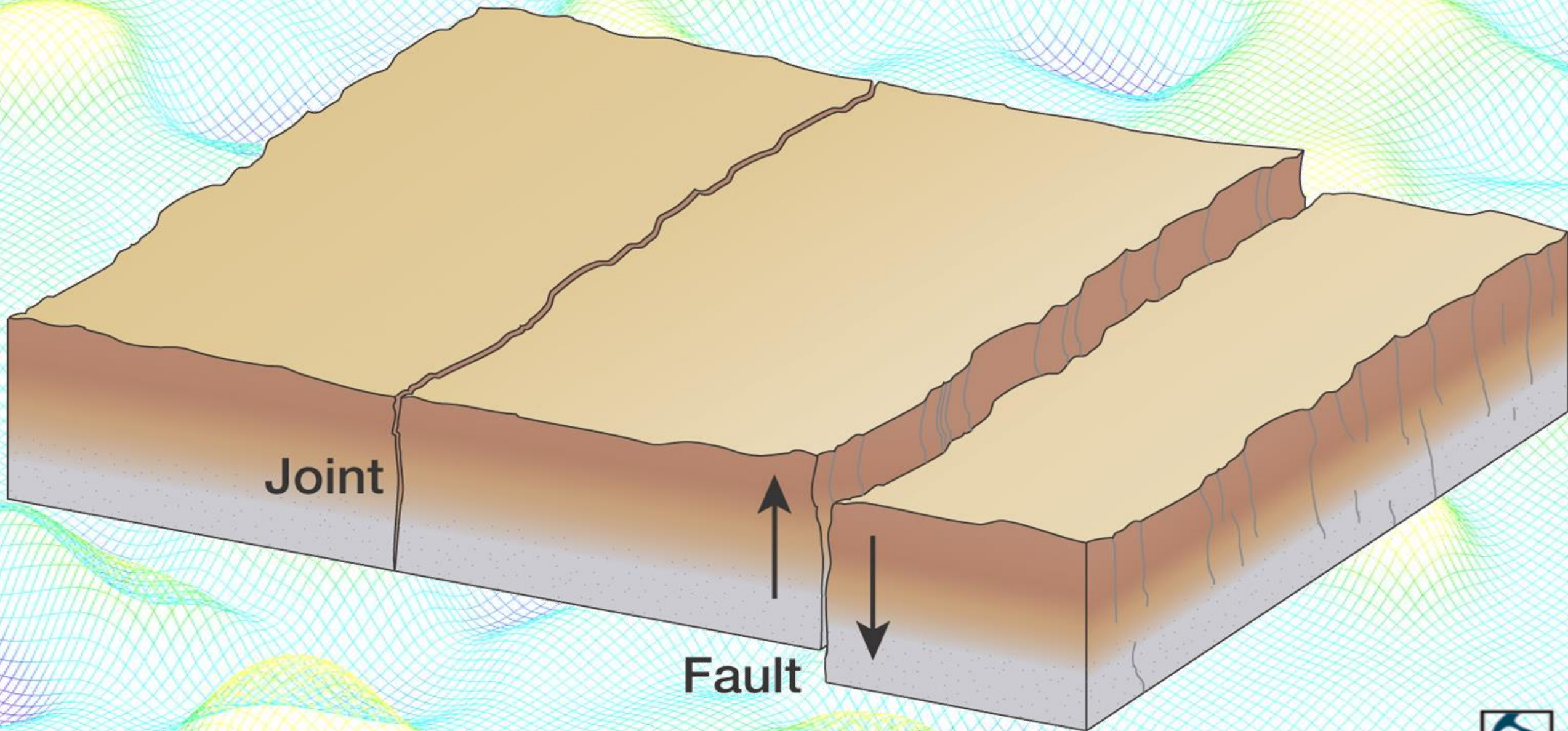
Malham Cove, North Yorkshire, United Kingdom, April, 2005



The Burren, County Clare, Ireland, September, 2014



Terminology: Faults



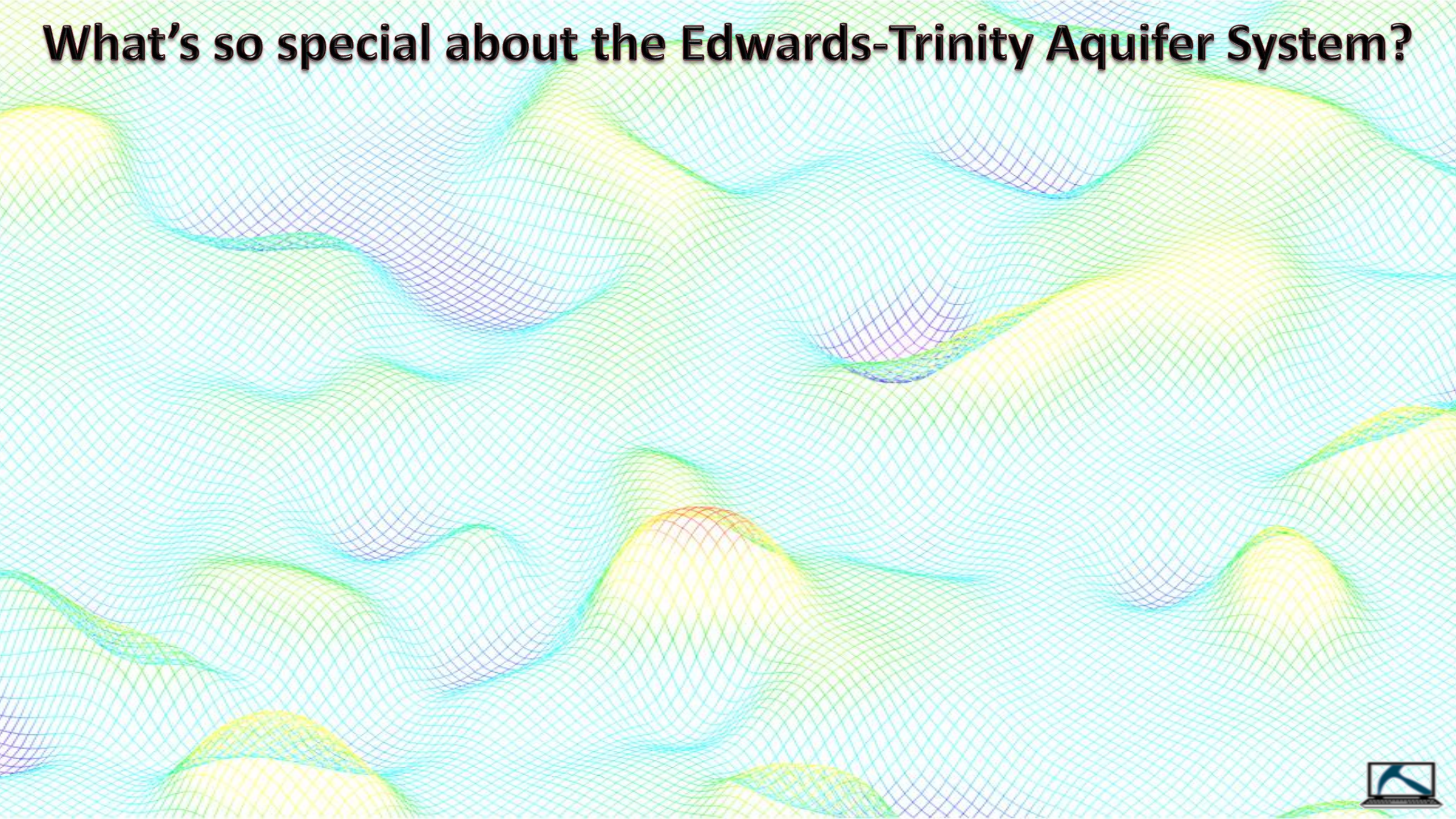
Subsurface Data

- Management
- Analysis (Modeling)
- Visualization

- **Management**
- **Analysis (Modeling)**
- **Visualization**



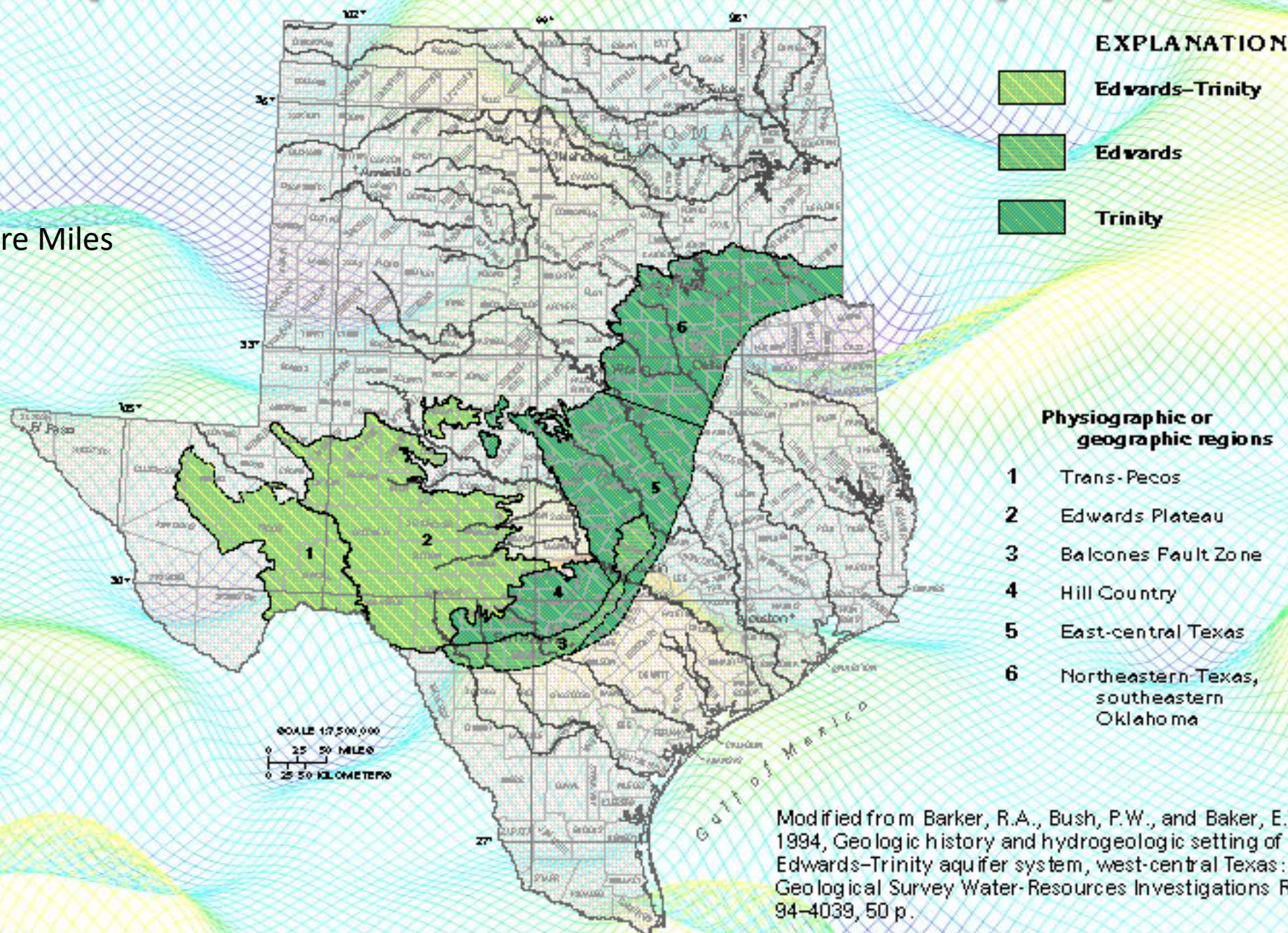
What's so special about the Edwards-Trinity Aquifer System?



What's so special about the Edwards-Trinity Aquifer System?

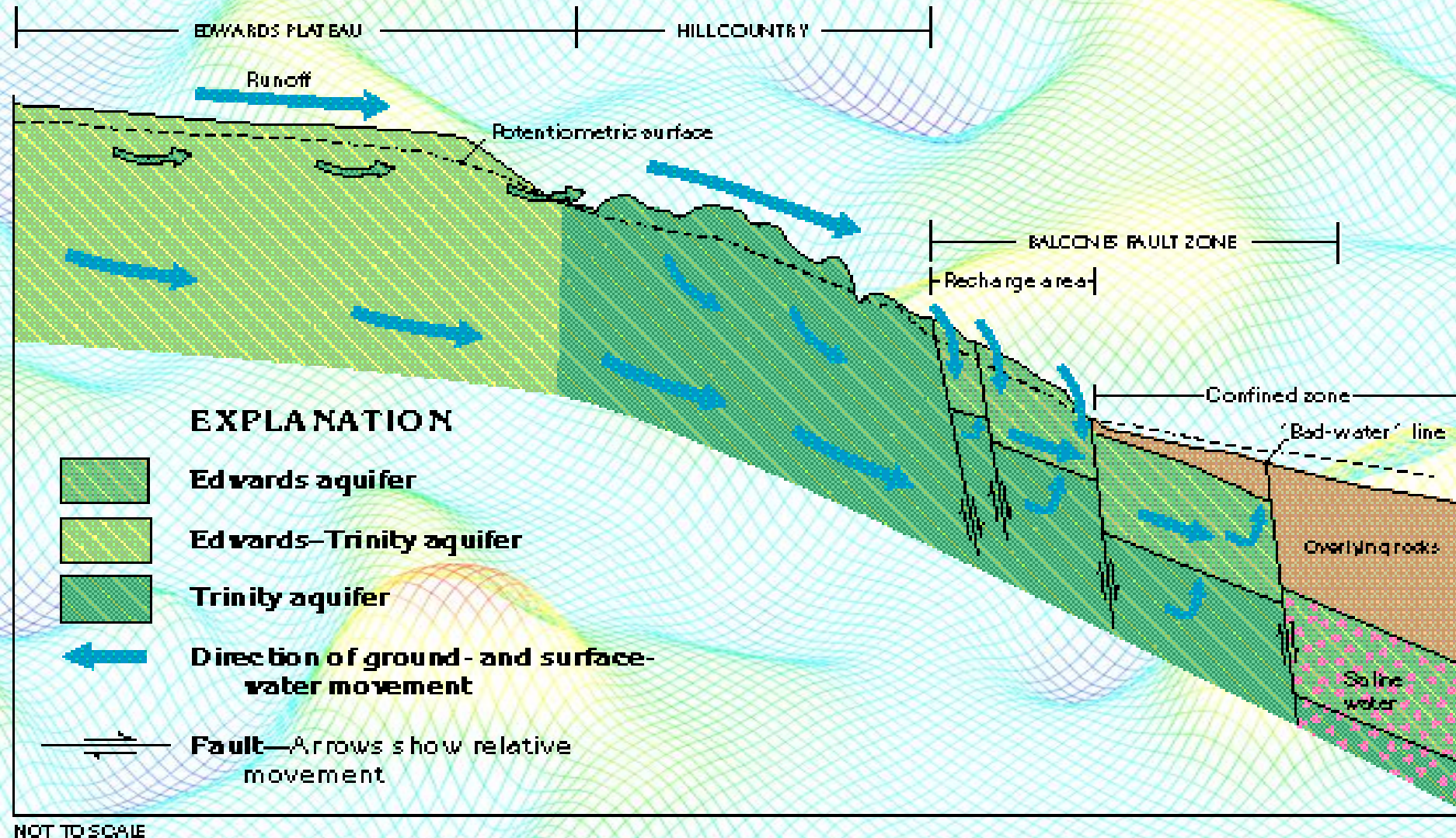
1. It's BIG!

77,000 Square Miles



What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**
2. It's **COMPLEX!**



Modified from MacLay, R.W., and Small, T.A., 1986, Carbonate geology and hydrology of the Edwards aquifer in the San Antonio area, Texas: Texas Water Development Board Report 296, 90 p.



What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**
2. It's **COMPLEX!**
 - Lithologic & Stratigraphic Variability



What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**
2. It's **COMPLEX!**
 - Lithologic & Stratigraphic Variability
 - **Jointing (Fracturing)**



What's so special about the Edwards-Trinity Aquifer System?

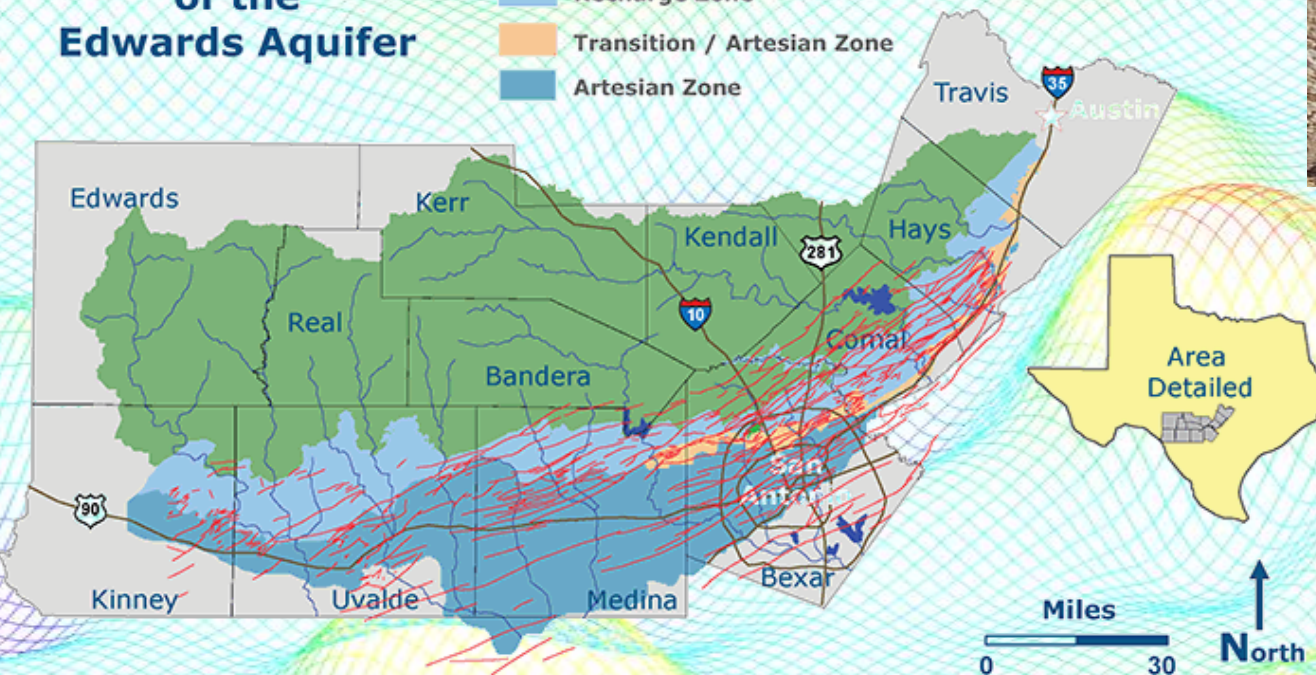
1. It's **BIG!**

2. It's **COMPLEX!**

- Lithologic & Stratigraphic Variability
- Jointing (Fracturing)
- **Balcones Fault System**

Major Faults of the Edwards Aquifer

- Contributing Zone
- Recharge Zone
- Transition / Artesian Zone
- Artesian Zone

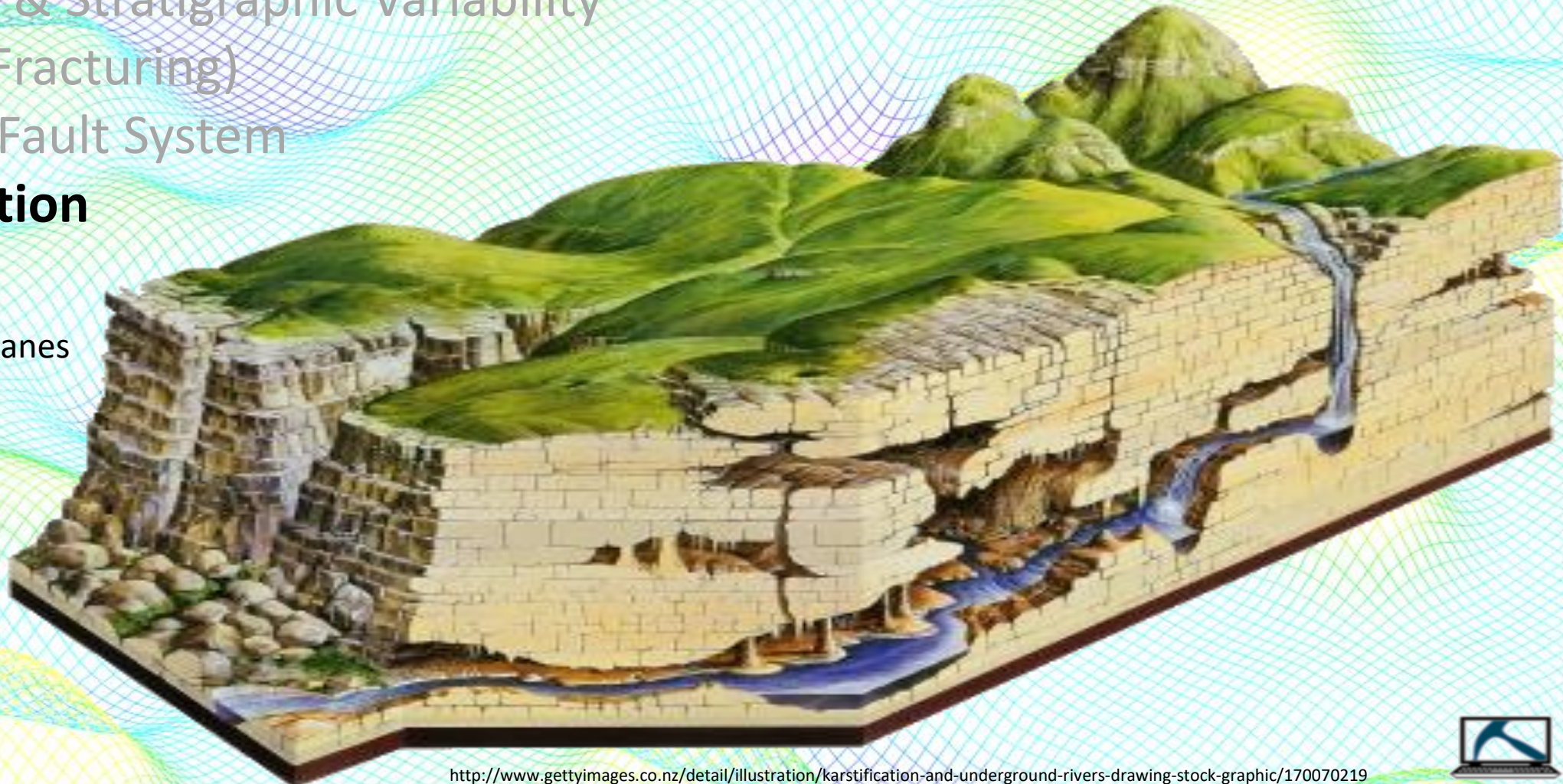


What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**

2. It's **COMPLEX!**

- Lithologic & Stratigraphic Variability
- Jointing (Fracturing)
- Balcones Fault System
- **Karstification**
 - Joints
 - Faults
 - Bedding Planes



What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**

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- Lithologic & Stratigraphic Variability
- Jointing (Fracturing)
- Balcones Fault System
- **Karstification**
 - Joints
 - Faults
 - Bedding Planes



Left: Jim Reed, RockWare
Center: Donna Taylor, Cibolo Preserve
Right: Marcus Gary, Edwards Aquifer Authority

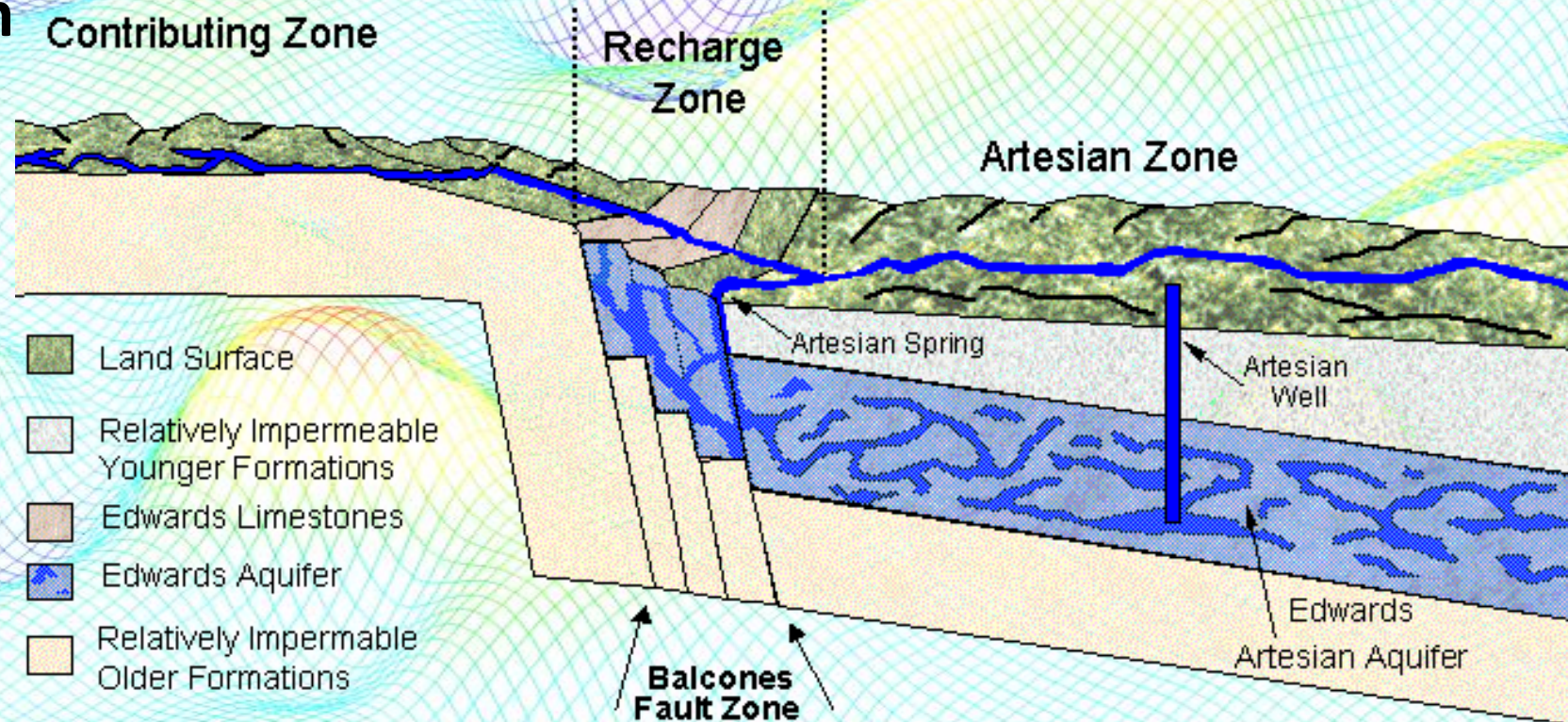


What's so special about the Edwards-Trinity Aquifer System?

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- Jointing (Fracturing)
- Balcones Fault System
- Karstification



What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**

2. It's **COMPLEX!**

- Lithologic & Stratigraphic Variability
- Jointing (Fracturing)
- Balcones Fault System
- Karstification
- **Time**



What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**

2. It's **COMPLEX!**

- Lithologic & Stratigraphic Variability
- Jointing (Fracturing)
- Balcones Fault System
- Karstification
- Time
- **Long-Term Storage**
(Firm Yield / 10 yr supply)



What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**
2. It's **COMPLEX!**

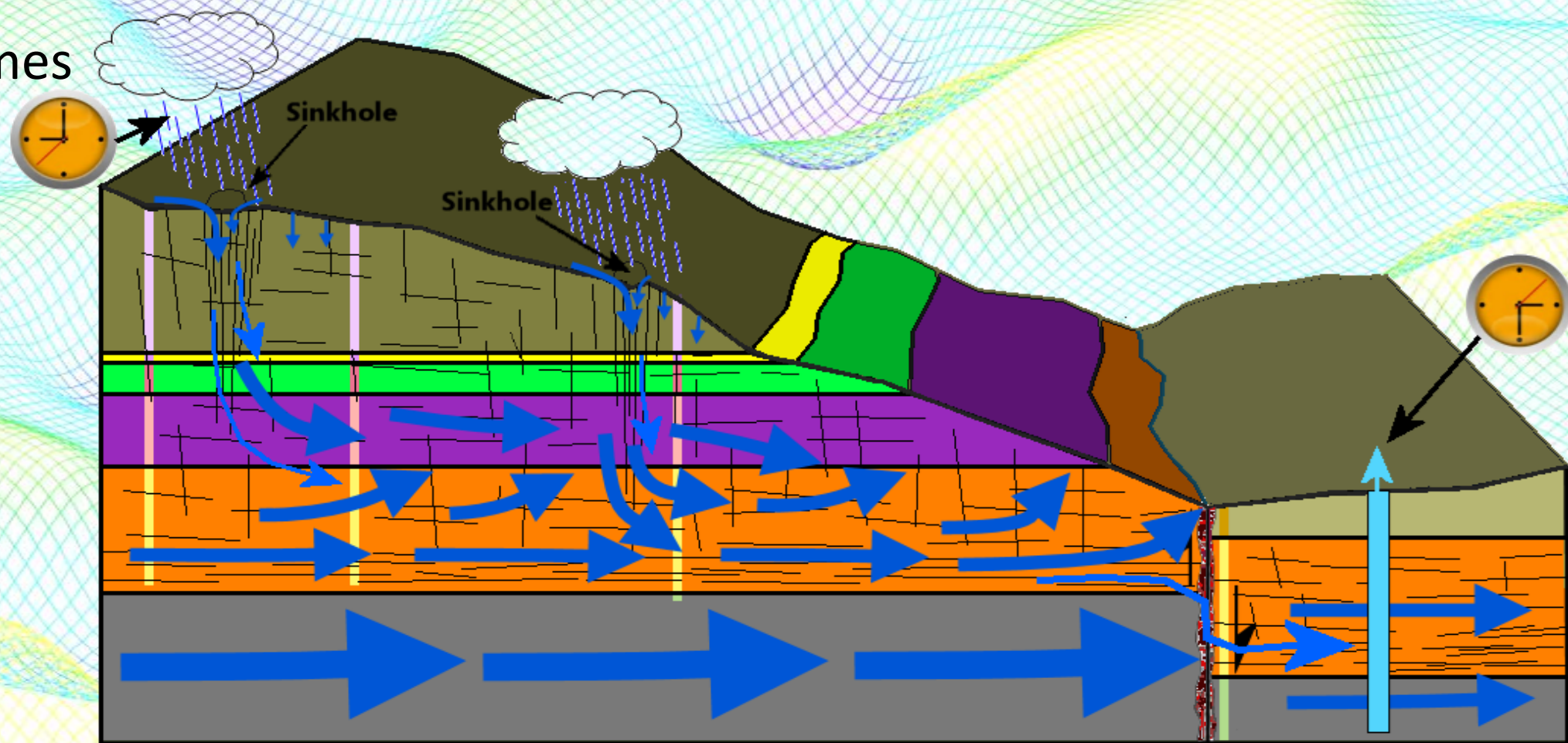
Complexity has attracted scientific heavyweights.



What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**
2. It's **COMPLEX!**
3. It's **SENSITIVE!**

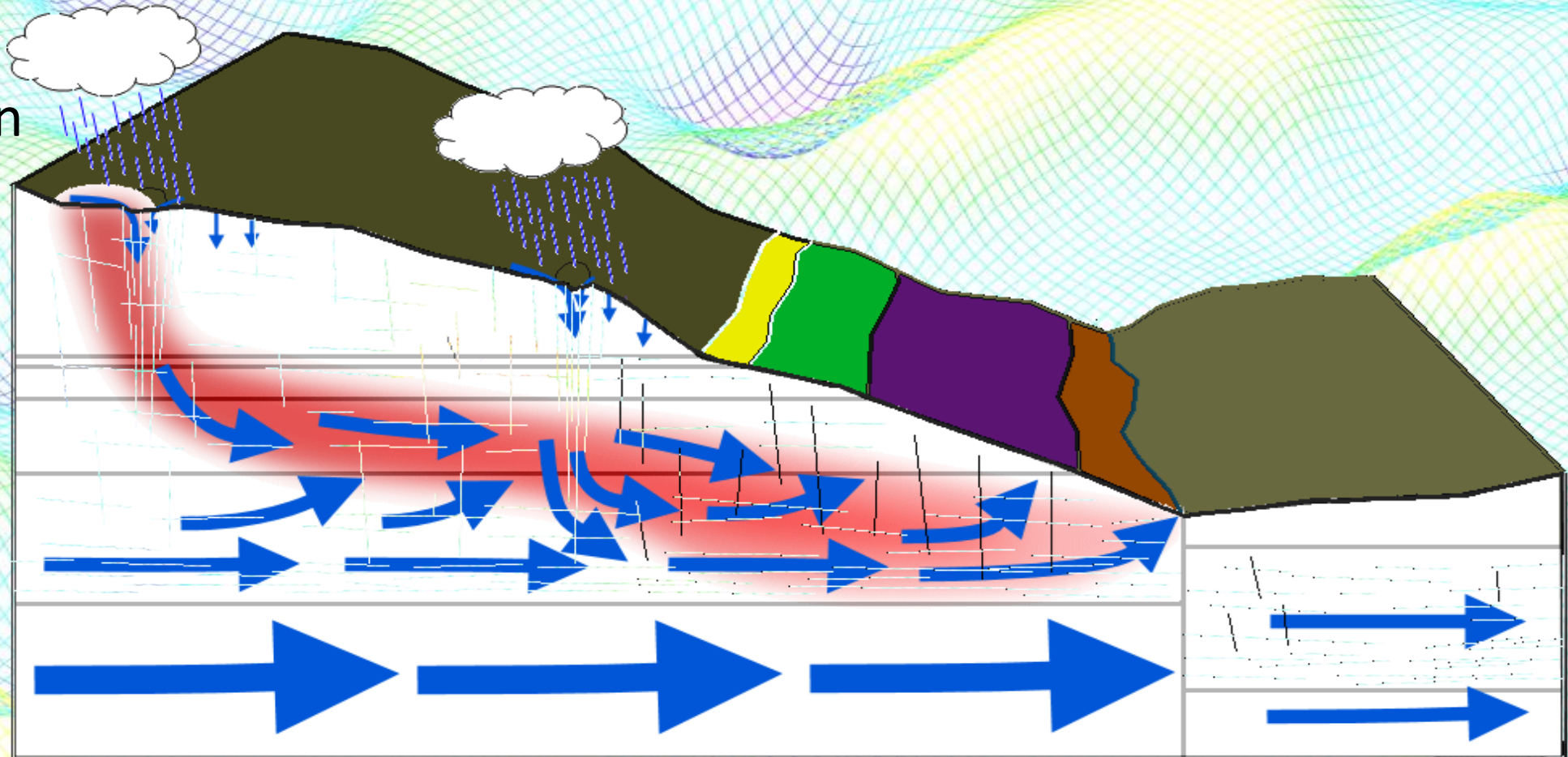
- Transit Times



What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**
2. It's **COMPLEX!**
3. It's **SENSITIVE!**

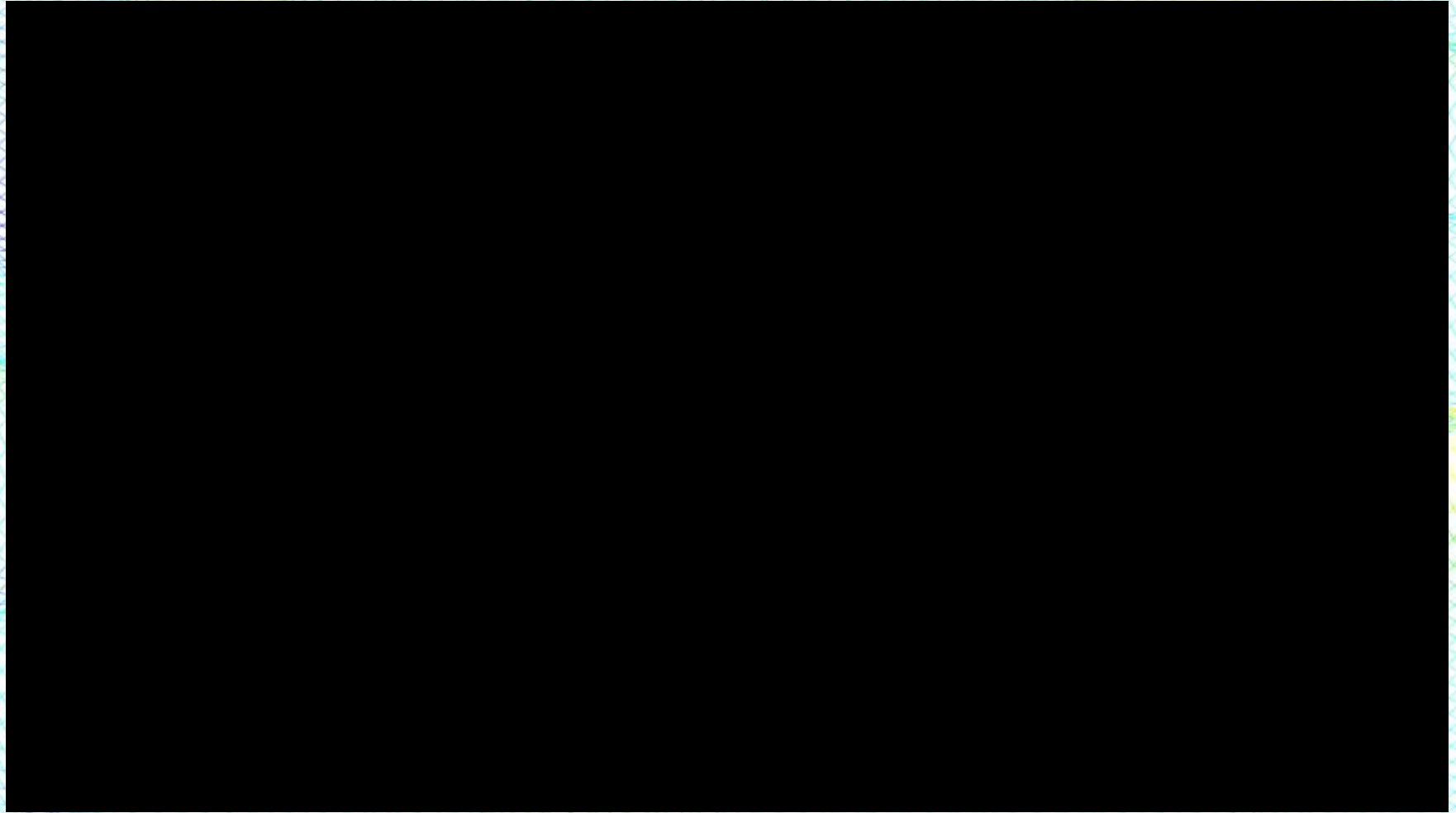
- Transit Times
- Contamination



What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**
2. It's **COMPLEX!**
3. It's **SENSITIVE!**
 - Transit Times
 - Contamination

A true and
scary horror
story!

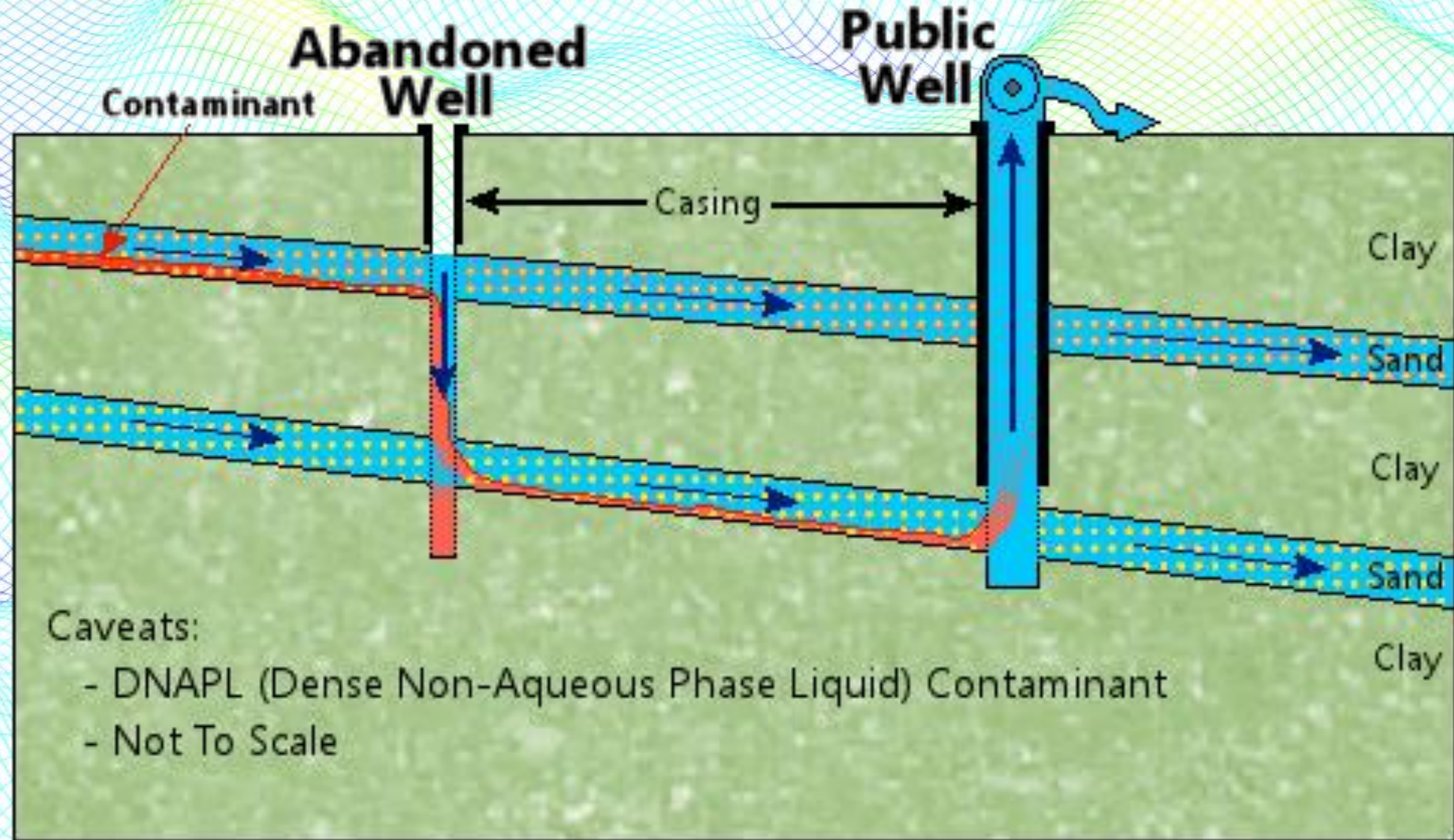


What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**
2. It's **COMPLEX!**
3. It's **SENSITIVE!**

- Transit Times
- Contamination

Abandoned Wells



What's so special about the Edwards-Trinity Aquifer System?

1. It's **BIG!**
2. It's **COMPLEX!**
3. It's **SENSITIVE!**
4. Ever-Increasing **DEMAND!**

#1 Millennial Growth Rate

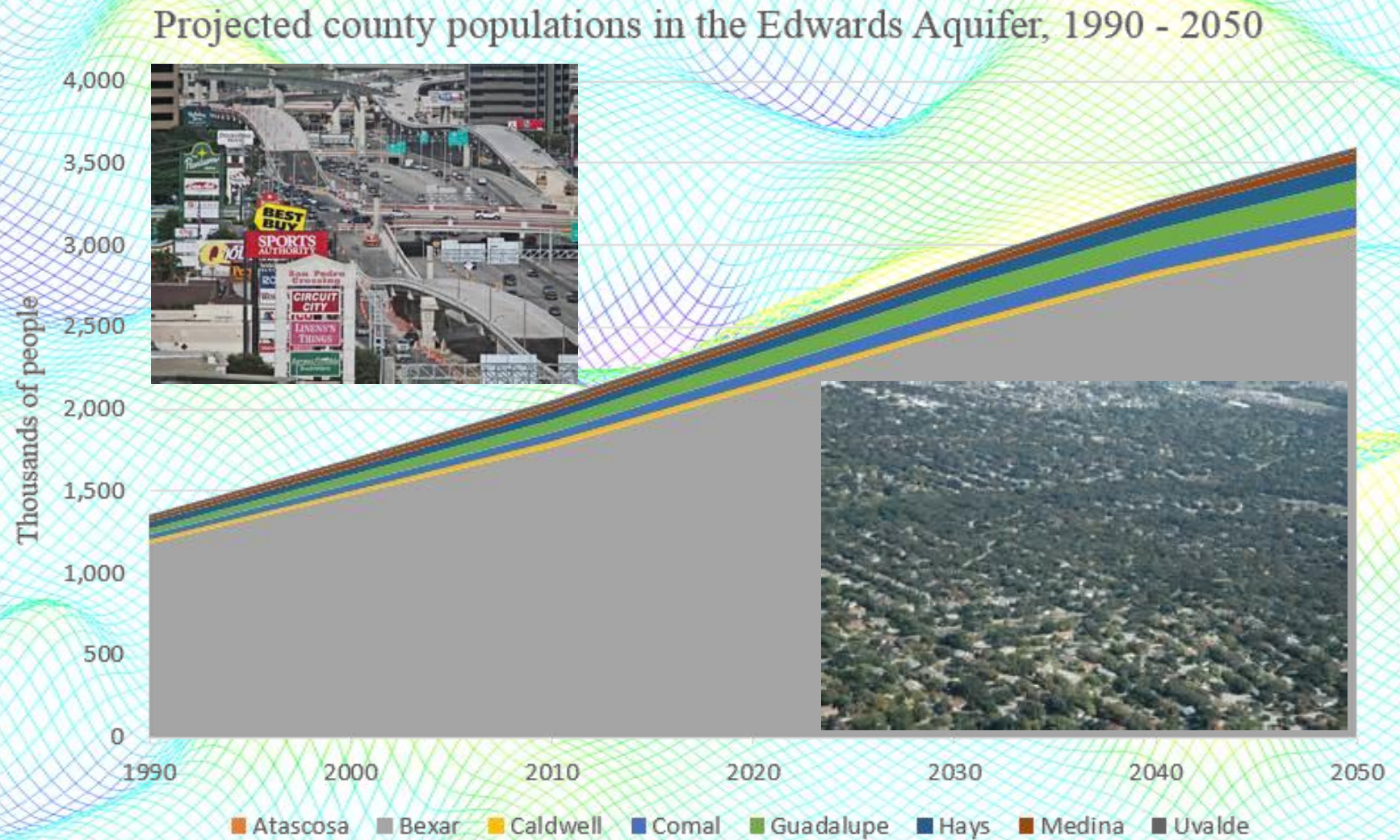
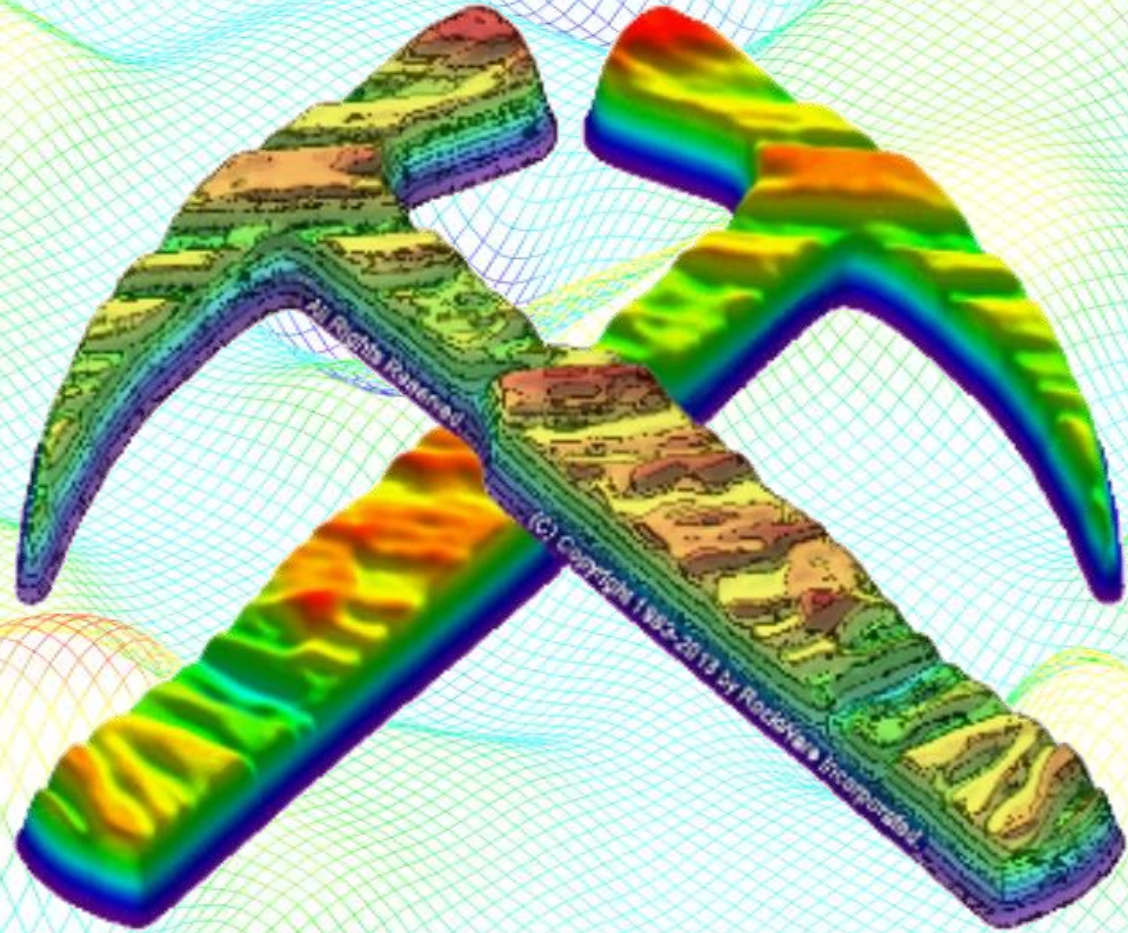


Figure adapted from Table 2-2, 2-5, HDR Engineering, 1998



So where does RockWorks fit into all this?

1. It's **BIG!**
2. It's **COMPLEX!**
3. It's **SENSITIVE!**
4. Ever-Increasing **DEMAND!**



So where does RockWorks fit into all this?

1. It's **BIG!**

SQL Server Technology

2. It's **COMPLEX!**

3. It's **Sensitive!**

4. **Ever-Increasing DEMAND!**

Windows Azure

Microsoft
SQL Server



Database hosted in the cloud

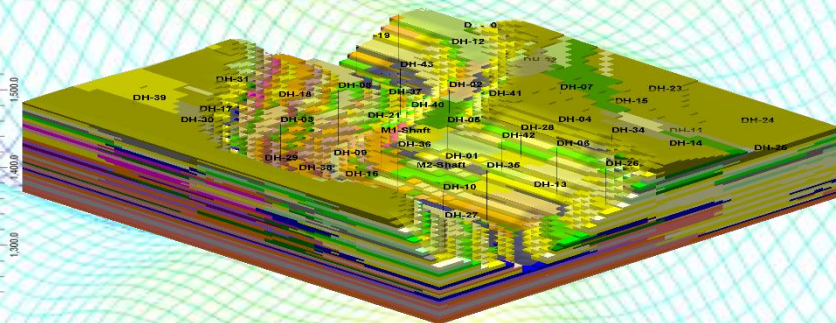
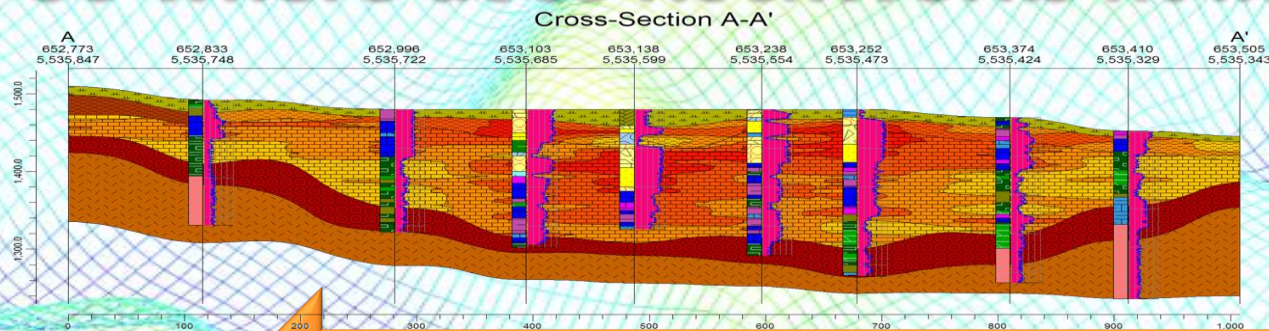


Database hosted at your office



So where does RockWorks fit into all this?

1. It's **BIG!**

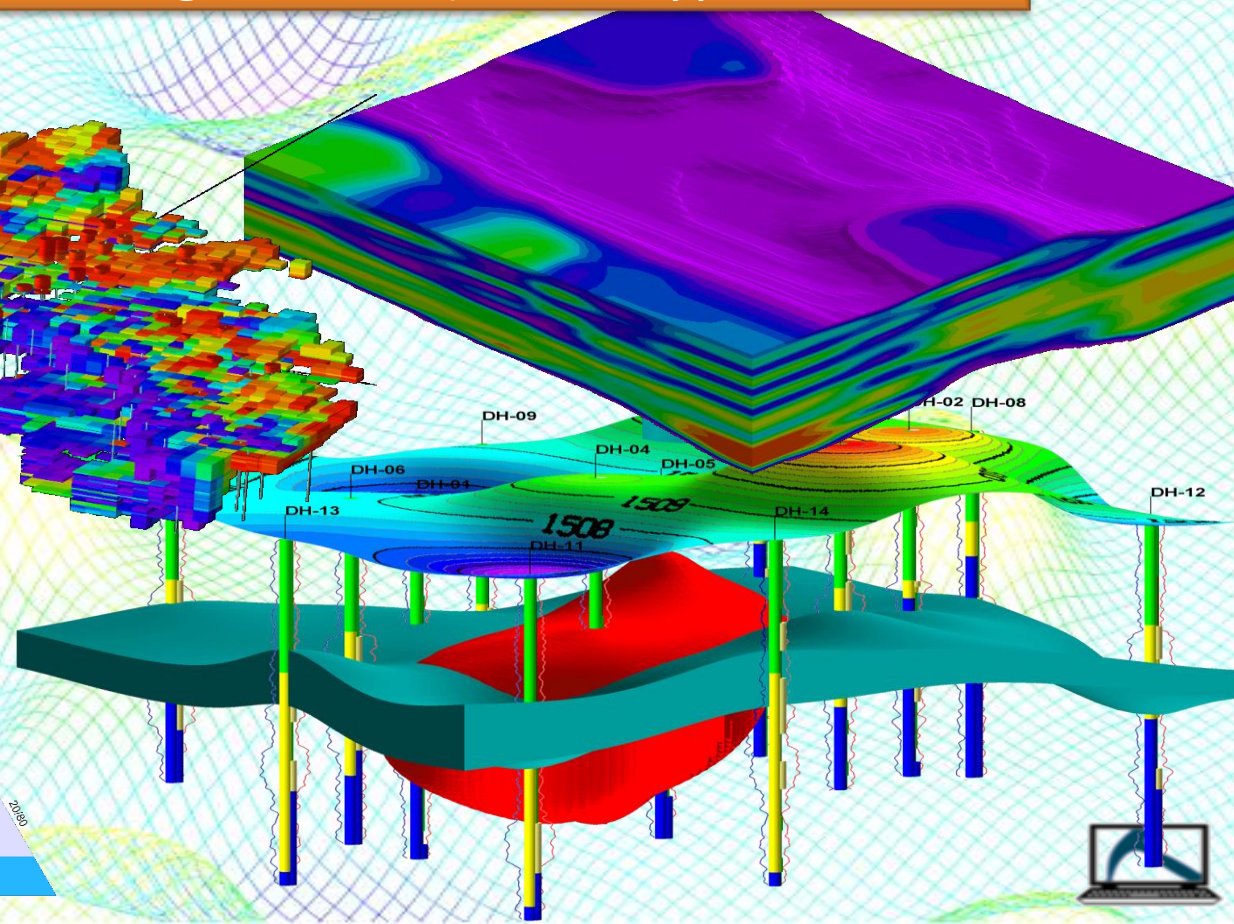
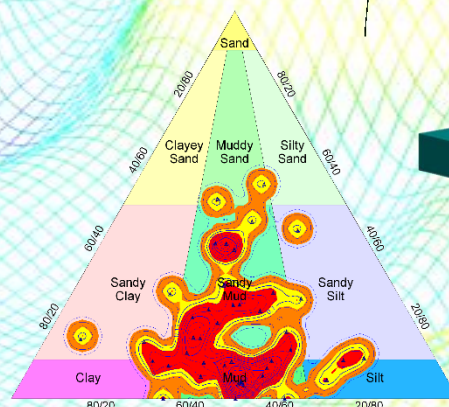
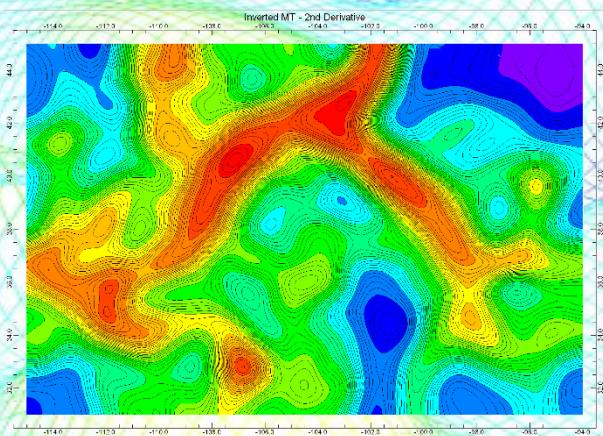


2. It's **COMPLEX!**

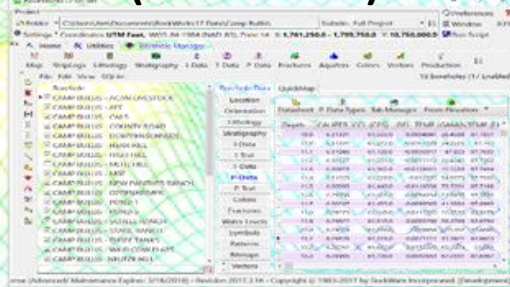
Multiple algorithms (modeling methods) for all types of data.

3. It's **SENSITIVE!**

4. Ever-Increasing **DEMAND!**



SQL Database Manager (RockWorks)



The Modeling Process

Well Data

- Lithology
- Stratigraphy
- Geochemistry
- Downhole Geophysics

Surface Geophysics

Block Model Initialization

Voxel Interpolation

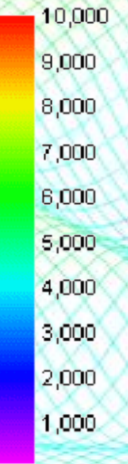
Voxel (Block) Model

Data Extraction

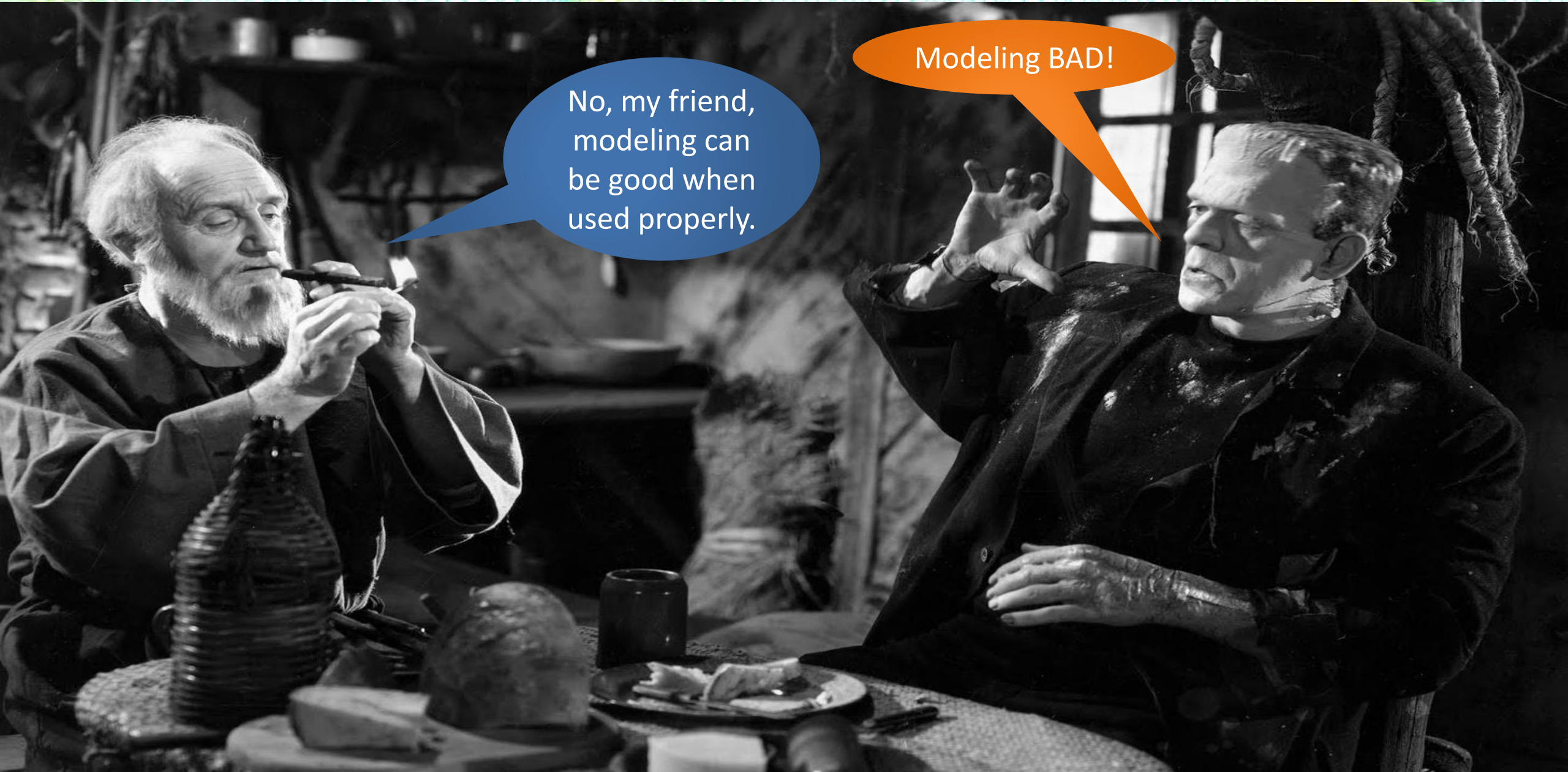
Iso-Surfaces

Smoothed Block Model

Fence Diagrams



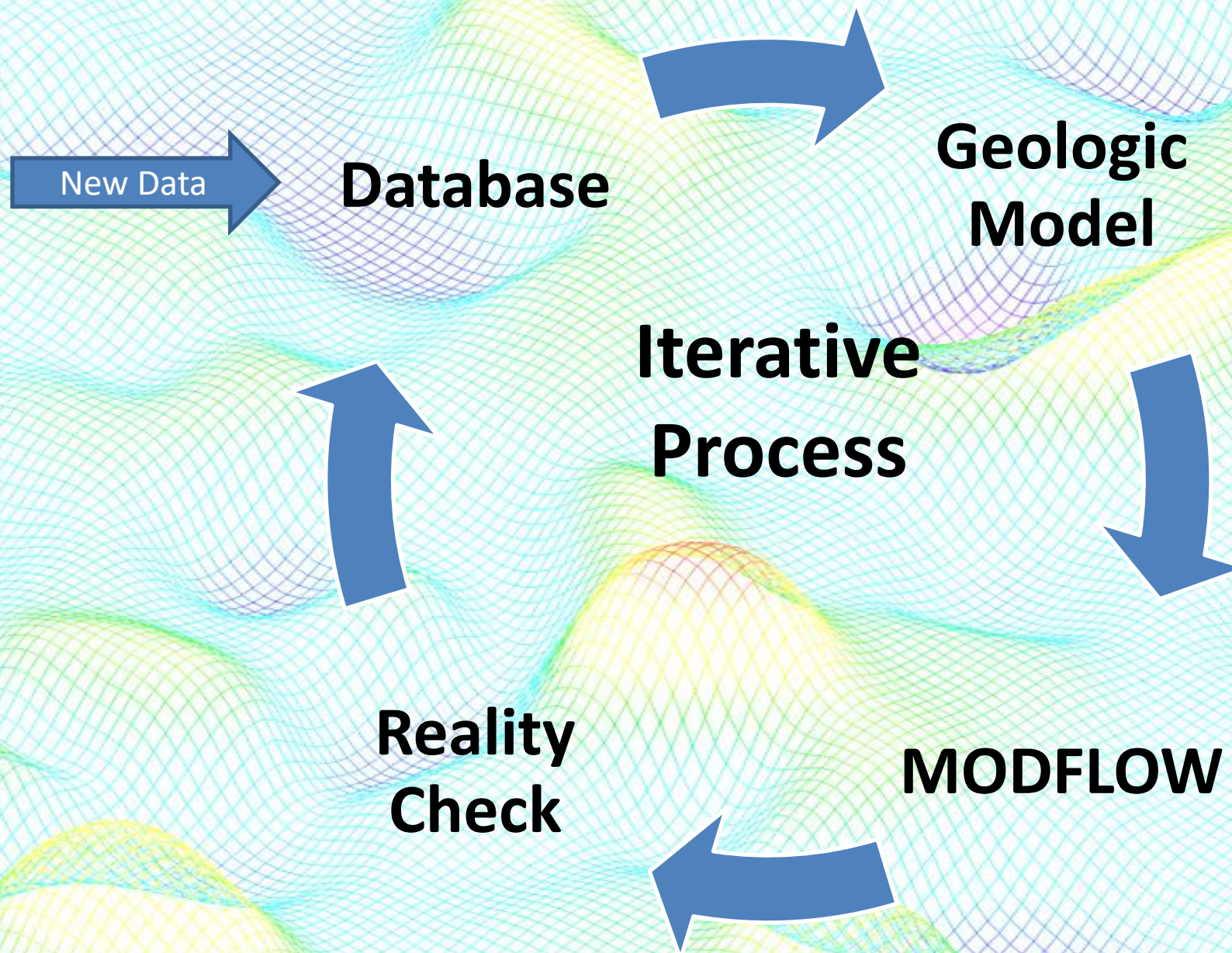
The Modeling Process (Continued)



No, my friend,
modeling can
be good when
used properly.

Modeling BAD!

The Proper Modeling Process



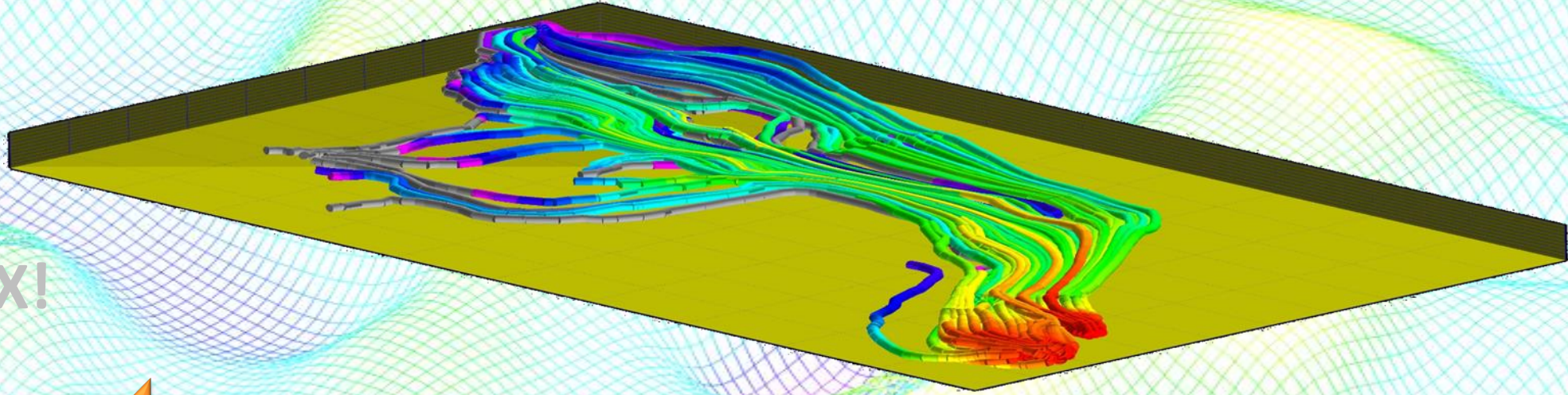
So where does RockWorks fit into all this?

1. It's **BIG!**

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4. Ever-Increasing **DEMAND!**



Contamination migration models and animations.



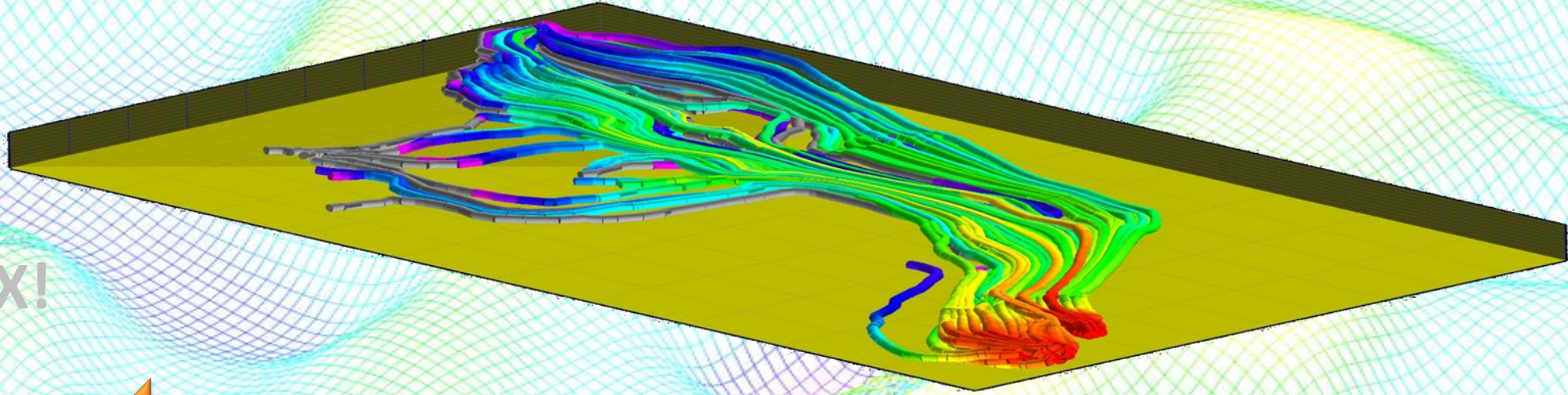
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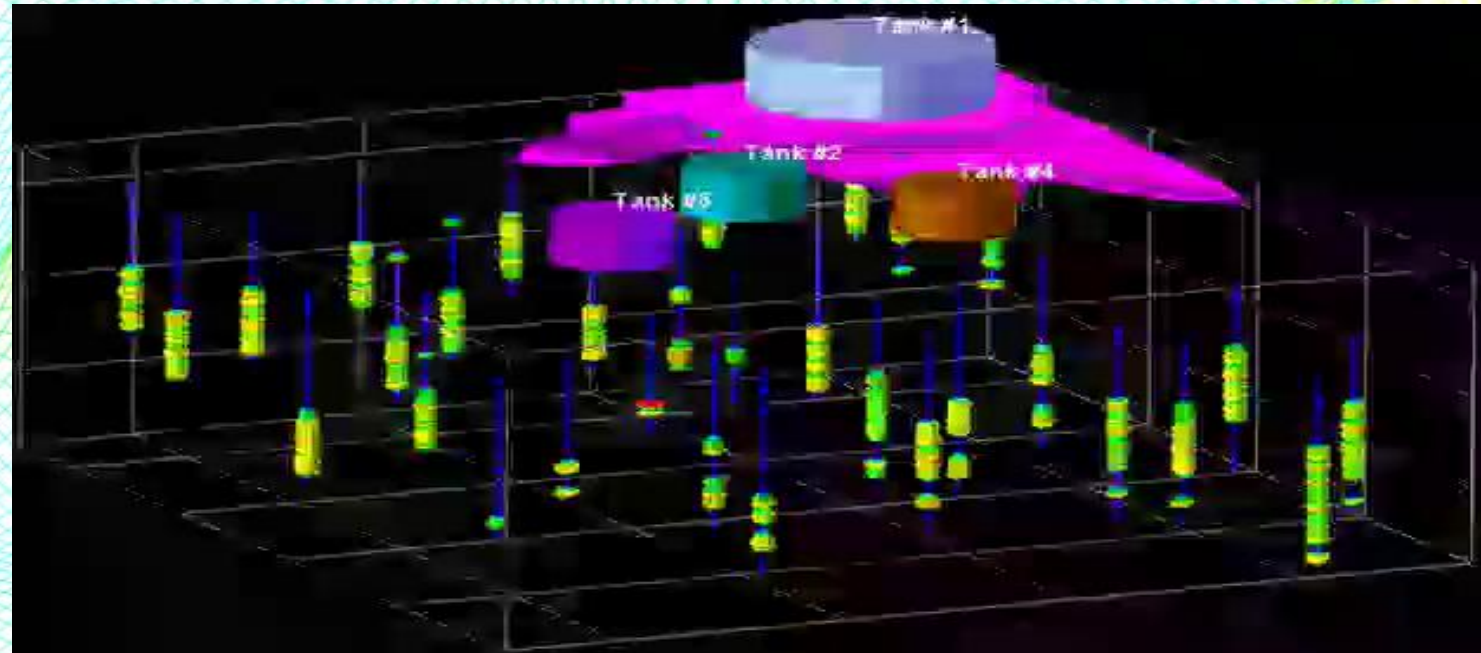
2. It's **COMPLEX!**

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Contamination migration models and animations.



So where does RockWorks fit into all this?

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2. It's **COMPLEX!**

3. It's **SENSITIVE!**

4. Ever-Increasing **DEMAND!**

Better/Faster Supply Estimates



Nailing Jelly To A Tree



Classical Strategy



Nailing Jelly To A Tree



Classical Strategy



Better Strategy



The background is a 3D wireframe landscape with rolling hills and valleys. A large, colorful, abstract shape, resembling a stylized letter 'X' or a complex geometric form, is positioned in the foreground. The shape is rendered with a rainbow color gradient, transitioning from purple at the edges to yellow and orange in the center. The word "End" is written in a bold, black, sans-serif font, centered on the right side of the large shape.

End



