Nature of Hydrogeologic Reality

by

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Grandfather Story #1

"It ain't what you don't know that hurts — it's what you know that ain't so."

John Minden Alexander (1873-1953)

Well 699024, Webster, MN, stratigraphy test well



Runkel and Tipping (2005)

Well 699024, Webster, MN, stratigraphy test well

Challenges

1. Aquifers are heterogeneous at the human scale. Aquifers are not isotropic and homogeneous at any useful scale.



The Spigot Spring Valley Caverns, Minnesota

Cave Diving in Florida Springs



Challenges

- 1. Aquifers are heterogeneous at the human scale. Aquifers are not isotropic and homogeneous at any useful scale.
- 2. Porous media models based on isotoropic, homogeneous assumptions currently dominate hydrogeologic theory, practice and regulation.

Well 699024, Webster, MN, stratigraphy test well

- Under the standard assumption that entire open-hole is uniformly permeable the bulk K value is 60 ft/day.
- The K value calculated for discrete fractured interval at 432' that accepts all injected water is 12,579 ft/day



1. Information; a growing engineering and science literature, and knowledge dealing with heterogeneous aquifers.



Resources

- 1. Information: a growing engineering and science literature, and knowledge dealing with heterogeneous aquifers.
- 2. New Technology: Computers, GIS, GPS, Data Loggers, Autosamplers, and new sensors.

a) Computers

"Computers are our friends – they help us be happier and more productive people."

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a) Computersb) GPS and GIS software



a) Computersb) GPS and GIS softwarec) Data Loggers & Auto Samplers

January 10, 2001 Storm 750 740 749 + 720 748 700 747 1.6" 746 745 Elevation 744 743 0.8" 742 620 741 0.4" 740 600 0.2" 0.1" 739 -0.1" 738 580 12/19 12/21 12/23 12/25 12/27 12/29 12/31 1/2 1/8 1/10 1/12 1/14 1/16 1/18 1/20 1/22 1/24 1/26 1/28 1/30 2/1 1/4 1/6 Feet H2O ——micro Siemens/cm Rain lines not to scale

Specific Conductivity and Water Elevation at Shavano Park #2 Well

a) Computers
b) GPS and GIS software
c) Data Loggers & Auto Samplers
d) New Sensors



Downhole High Resolution EM Flow Meter

Image complements of Bob Tipping, MGS, 2005

a) Computers
b) GPS and GIS software
c) Data Loggers & Auto Samplers
d) New Sensors

Obtain, manipulate and interpret aquifer information at increasingly small distance and time scales.

Grandfather Story #2

The Acceptance Sequence of Any New, Good Idea.

- 1. "This idea is totally wrong, crazy, unscientific and probably a terrorist plot."
- 2. "Ok, the idea does works, your science is sound and maybe it's not a terrorist plot

- but it's not economically feasible."

3. "Here is MY great new idea. It works, will save the taxpayers loads of money and combats terrorism. Why haven't you implemented it already? I've been telling you about MY idea for months."

4. "Regulations require that you use MY idea."

Recommendations

 Stay the course – research, collect data, develop better ideas and present all of these at mainline meetings and peer reviewed literature.

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- Stay the course research, collect data, develop better ideas and present all of these at mainline meetings and peer reviewed literature.
- 2. Organize an annual, prestigious prize for the best research or engineering in heterogeneous, turbulent flow aquifers – call it the Dracy Prize.

The Public Fountains of the City of Dijon

Henry Darcy, 1856

English Translation by Patricia Bobeck

CONDUITS RULE

Fractures Drool

Pores Suck



"One of these days hydrogeologists will think of porous media as they now think of karst *i.e.* as weird aquifers that are very unlikely to occur in nature and so are hardly worth discussing in a text book."

> Steve Worthington e-mail, 15 September 2005