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Recognition and interpretation of rock heterogeneities with the help of empirical potentiometric contour maps

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ECHN Early Career Hydrogeologists' Network

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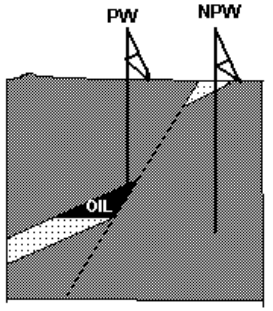
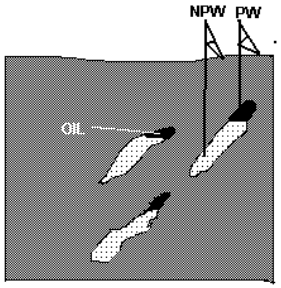
Introduction

Contour map = map based on measured well-water levels, pore pressure, water chemical compositions

1. High permeable rock pods
2. Hydraulic flow barriers
3. Changing water chemistry in flow system



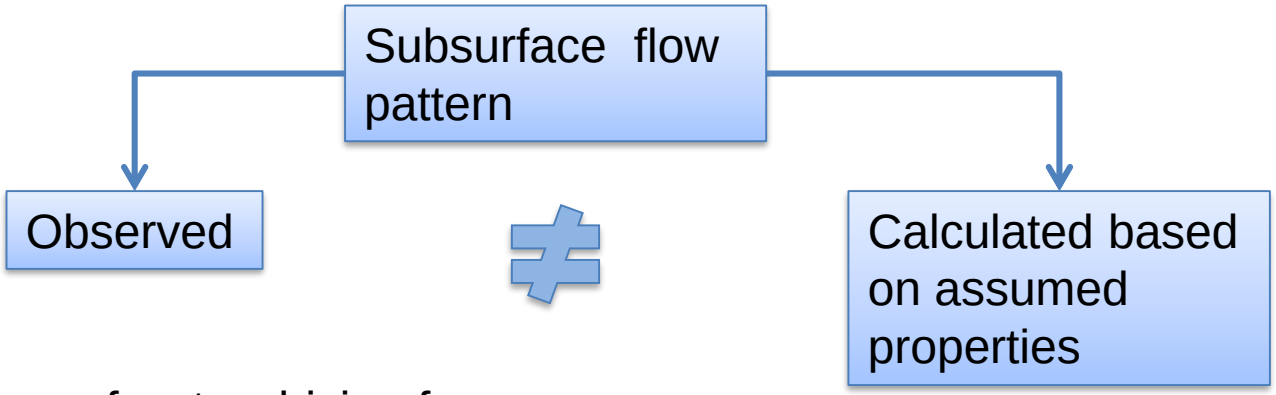
FAULT TRAP



SAND LENSES IN A SHALE SERIES

http://earthsci.org/mineral/energy/oil/oil.htm

Observed vs. calculated maps



1. Source of water driving force
2. Boundary conditions of force field
3. Values, distribution pattern of permeability
4. State of flow (steady, transient)

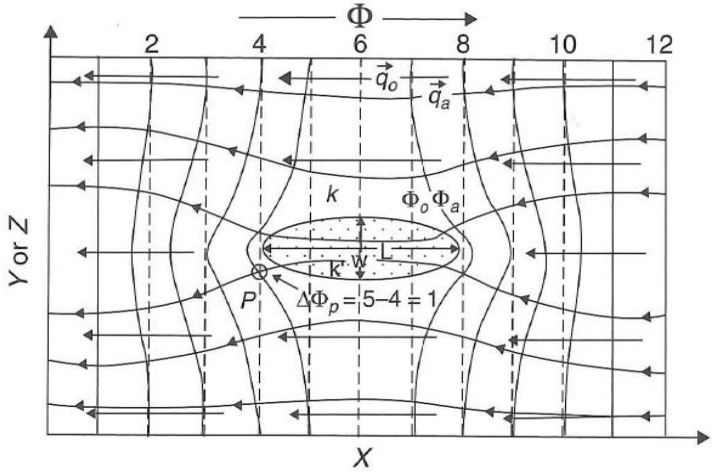
Contour maps can aid in sophistication of models

- Discovery of unsuspected properties (fluid potential anomalies)
- Fine tuning of model

High permeable rock pods

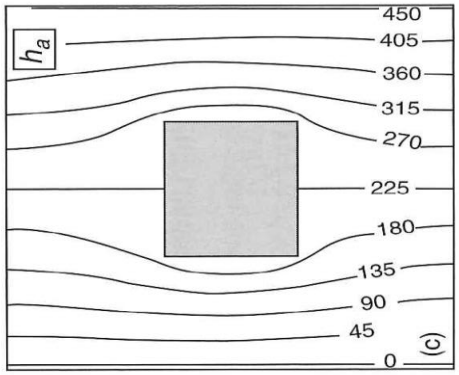
Permeability of rock body relative to surroundings

- High: flow lines converge through
- Low: flow lines bend around



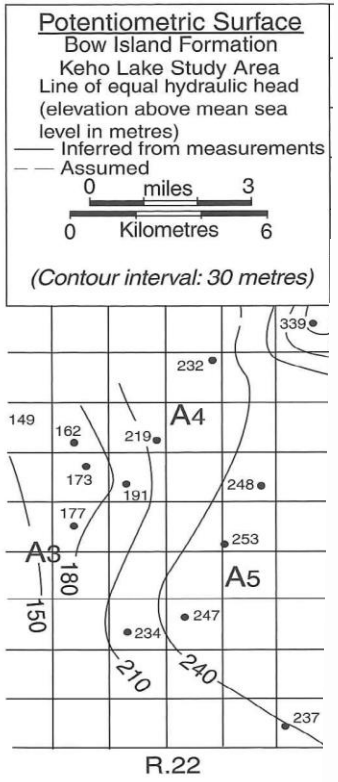
Potentiometric anomaly = Difference between original and modified fluid potential values

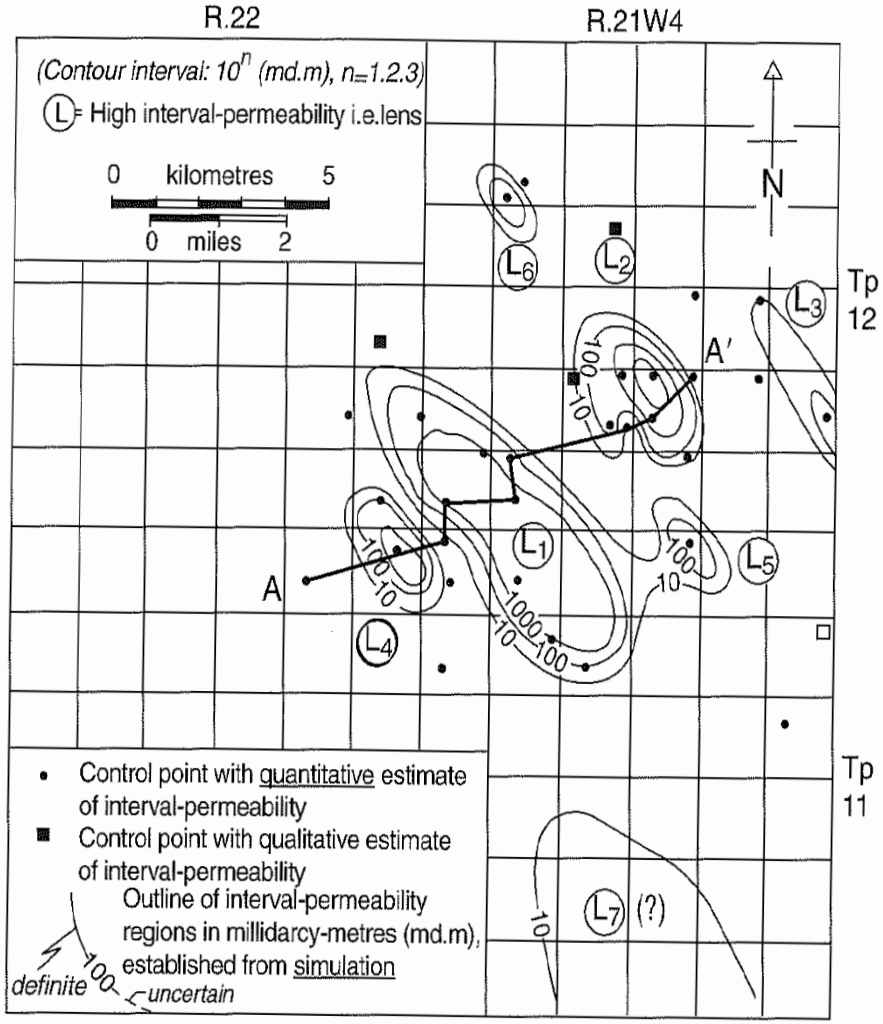
High permeability lenses can capture and retain oil/gas reservoirs – high economic value

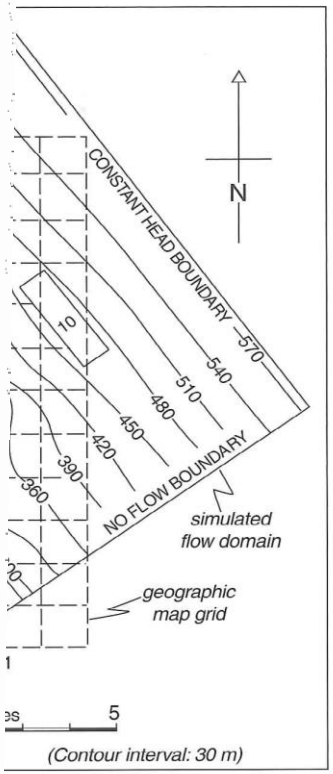


Toth and Rakhit, 1988

High permeable rock pods - example







Toth and Rakhit, 1988

Hydraulic flow barriers

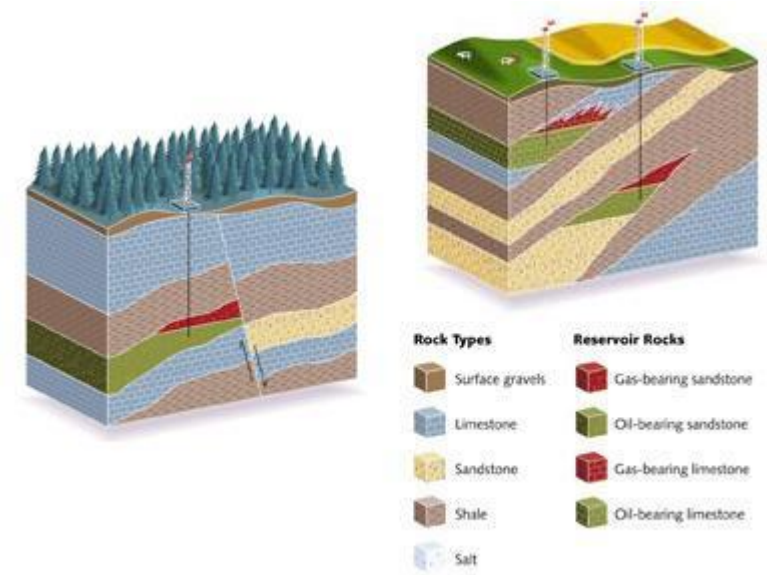
Barriers = slightly permeable fault plains, unfractured igneous dykes, lithologic pinch-outs, argillaceous walls of buried river valleys, …

Positive: containing of contaminant migration

Negative: reduce source area to water supply wells

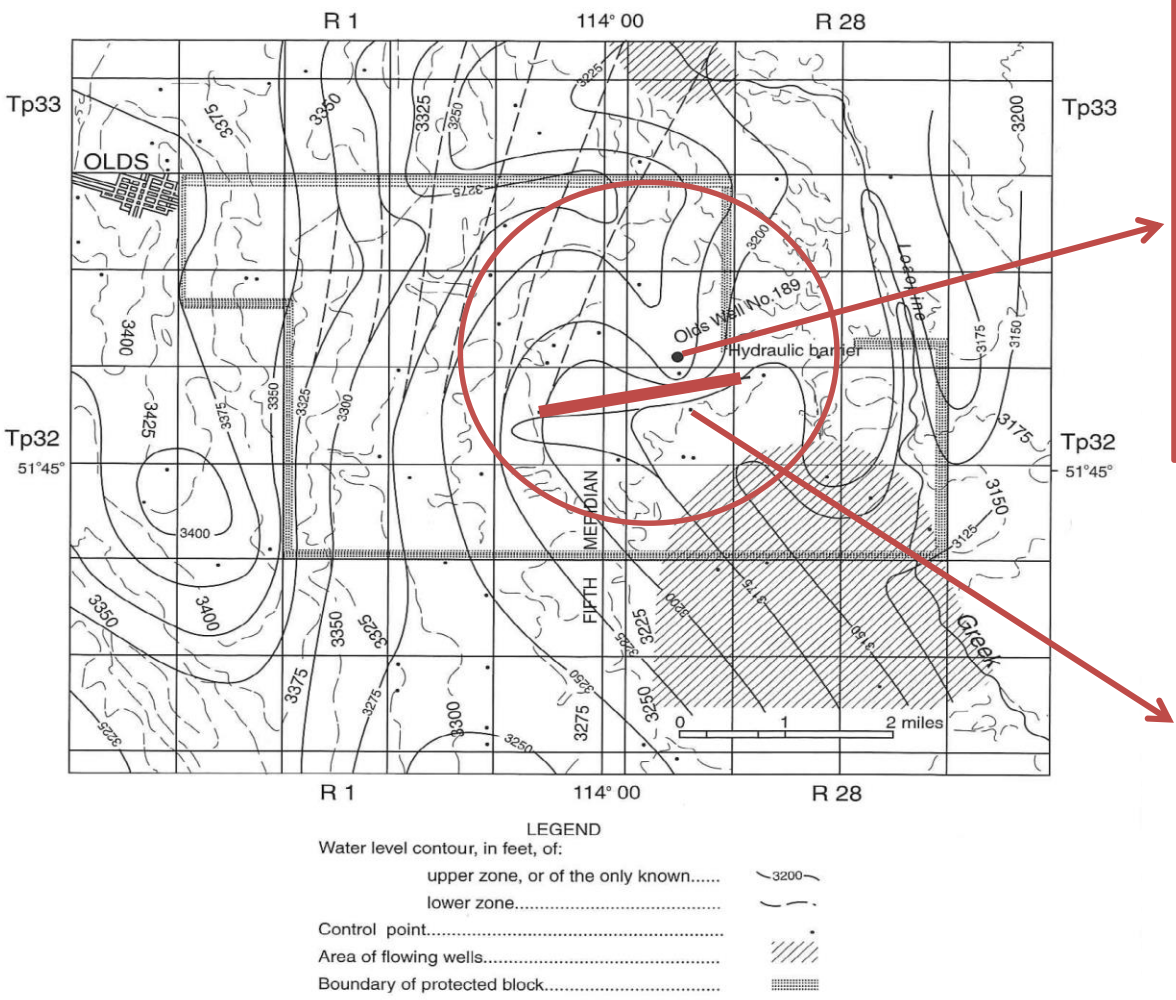
→ Detect before planning GW project

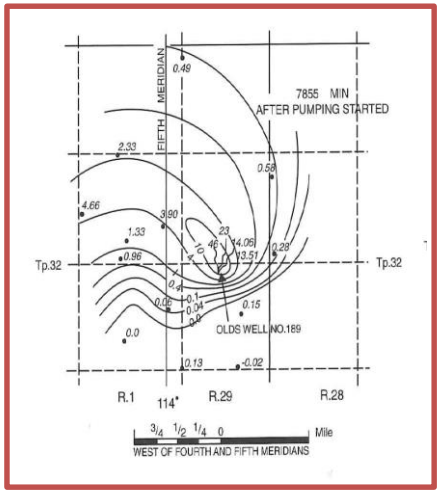
By Granitethighs - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=15481842

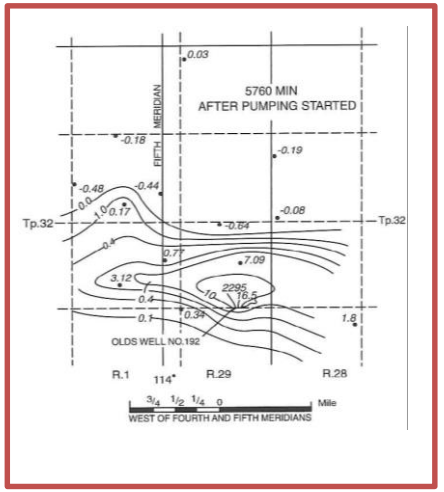


http://www.geosci.usyd.edu.au/users/prey/ACSGT/EReports/eR.2003/GroupD/Report2/web%20pages/hydrocarbon_deposits.html

Hydraulic flow barriers - example



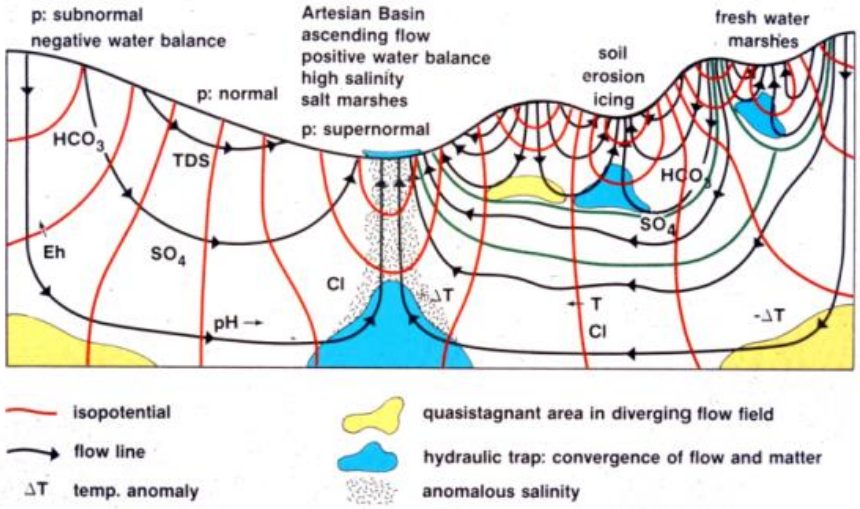




Toth, 1966

Changing water chemistry in flow system

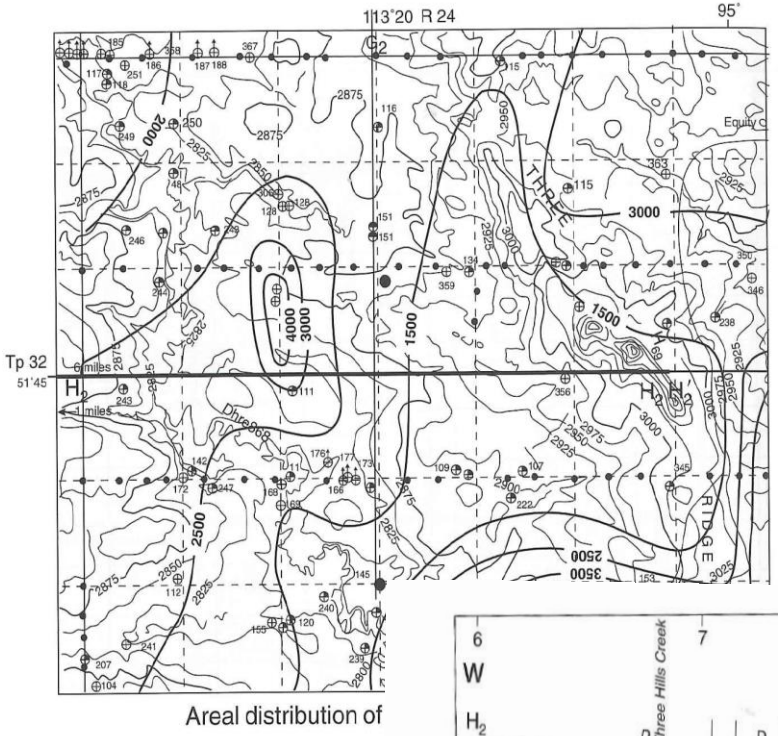
- Common phenomenon sometimes caused by distribution system of GW flow
- Flow system with common area of origin can split and terminate in widely separate locations



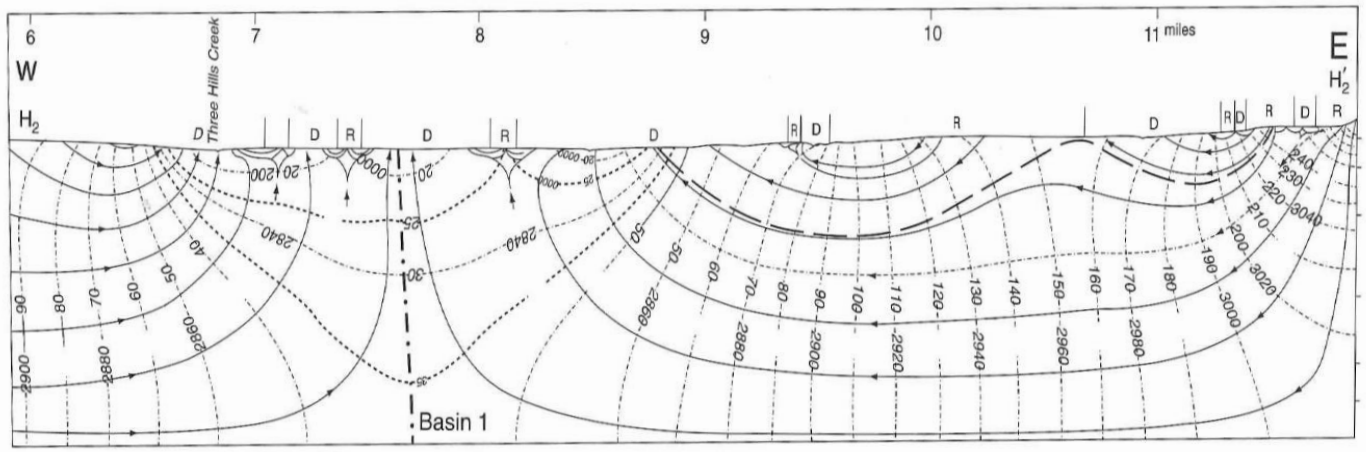
Hydrological effects of the regional gravity flow of groundwater (Toth, 1980)

- Origin in distant regions merge into common discharge area
- Migration along areas of differing hydrogeochemical history cause abrupt changes in mineralization of discharged water

Changing water chemistry - example



Areal distribution of



Toth, 1968

Conclusions

Observation data can help to identify local rock heterogeneities through comparison with calculated maps or visual interpretation of anomalies in water flow pattern

Crucial for locating petroleum reservoirs and planning of water supply systems

- Detecting natural oil/gas reservoirs through hydraulic anomalies
- Detecting hydraulic flow barriers that can influence recovery efficiency of extraction wells

Sources

http://earthsci.org/mineral/energy/oil/oil.htm
Toth, 1966: *Groundwater geology, movement, chemistry, and resources near Olds, Alberta*. Alta. Res. Counc., Bull., 17, p. 126
Toth, 1968: *A hydrogeological study of the Three Hills area, Alberta.* Alta. Res. Counc., Bull., 24, p. 117
Toth, 1980: *Cross-formational gravity-flow of groundwater: a mechanism of the transport and accumulation of petroleum (the generalized hydraulic theory of petroleum migration)*. Problems of Petroleum Migration, p.121-167.
Tóth, 2009: *Gravitational systems of groundwater flow: theory, evaluation, utilization*. Cambridge University Press.
Toth and Rakhit, 1988: *Exploration for Reservoir Quality Rock Bodies by Mapping and Simulation of Potentiometric Surface Anomalies*. Bulletin of Canadian Petroleum Geology 36/4, p. 362-378

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