BALL STATE UNIVERSITY.

EOGENETIC KARST AQUIFERS AFTER A DECADE OF INVESTIGATION

(aka. The Floating Head Talk)

Lee J. Florea

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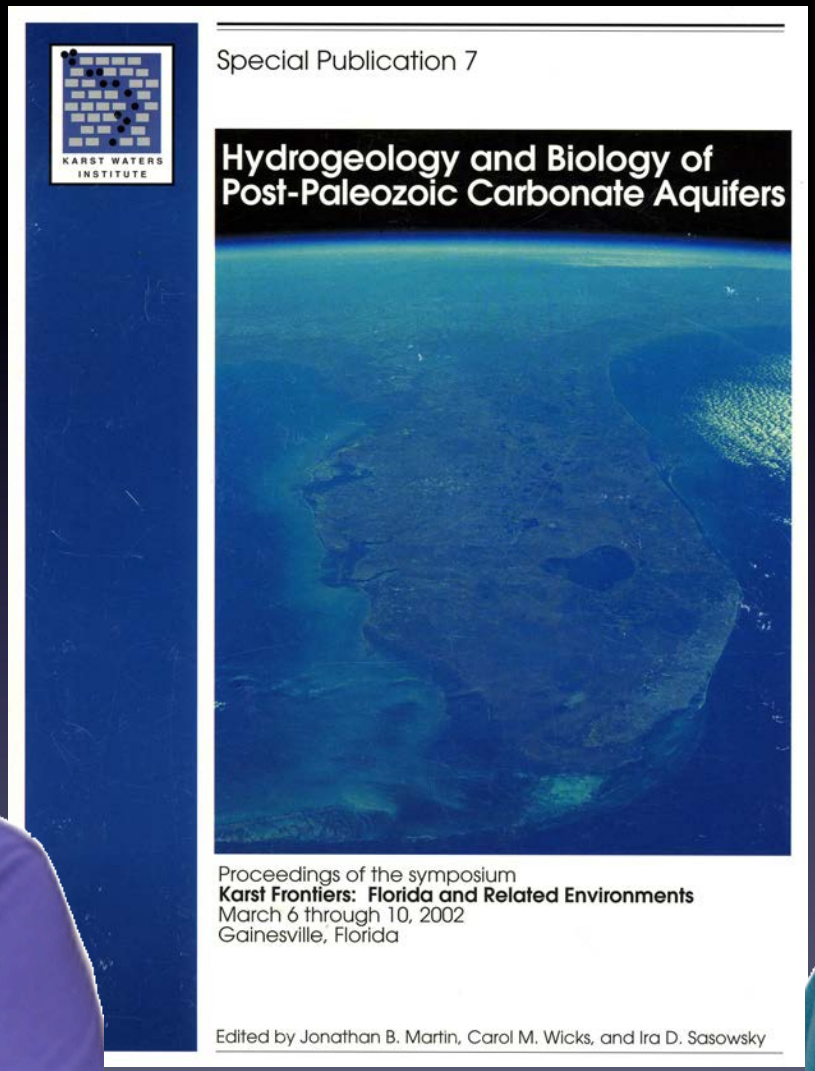


Time-Porosity Stages

‘eogenetic’ carbonates

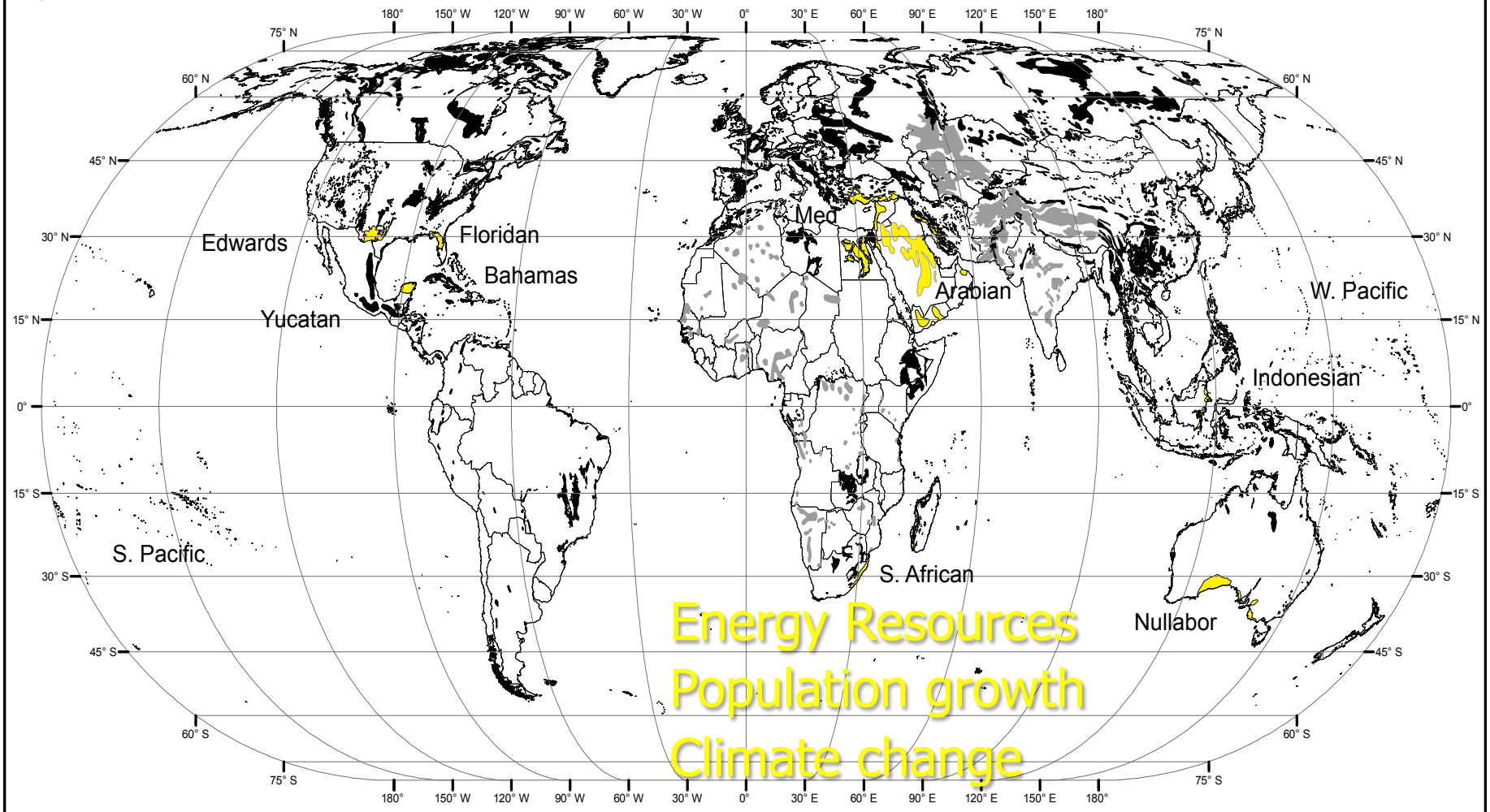
- Are in the “net depositional realm” Choquette and Pray (1970, e.g., 216)
- Have not experienced burial diagenesis.
- Retain significant depositional porosity and permeability.

In contrast, ‘telogenetic’ carbonates

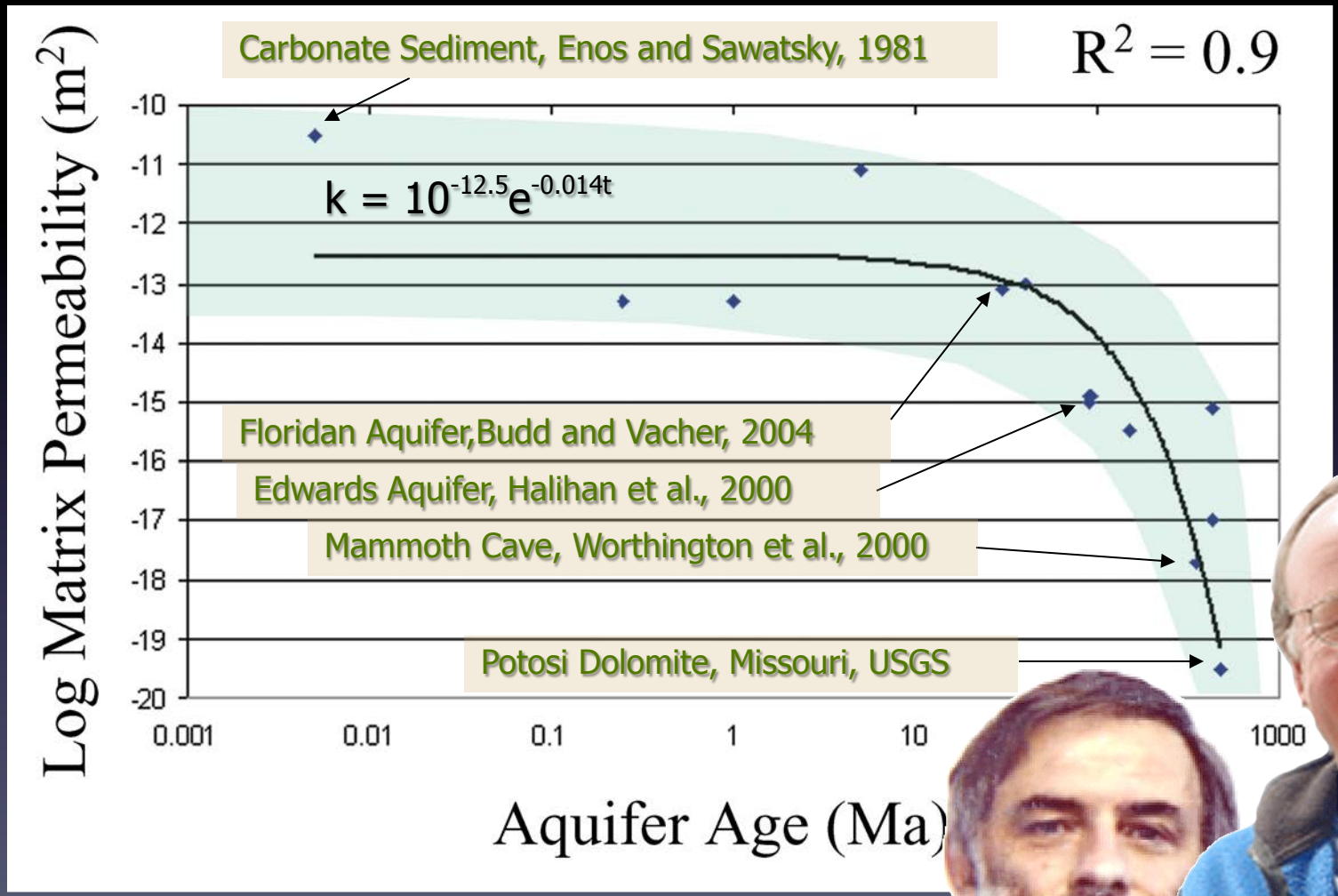
- Are in the “net erosional realm” Choquette and Pray (1970, e.g., 216)
- Associated with post burial uplift and erosion.
- Are significantly altered by compaction and cementation.
- Have greatly reduced primary porosity and permeability.
- Contain secondary permeability features associated with exhumation.

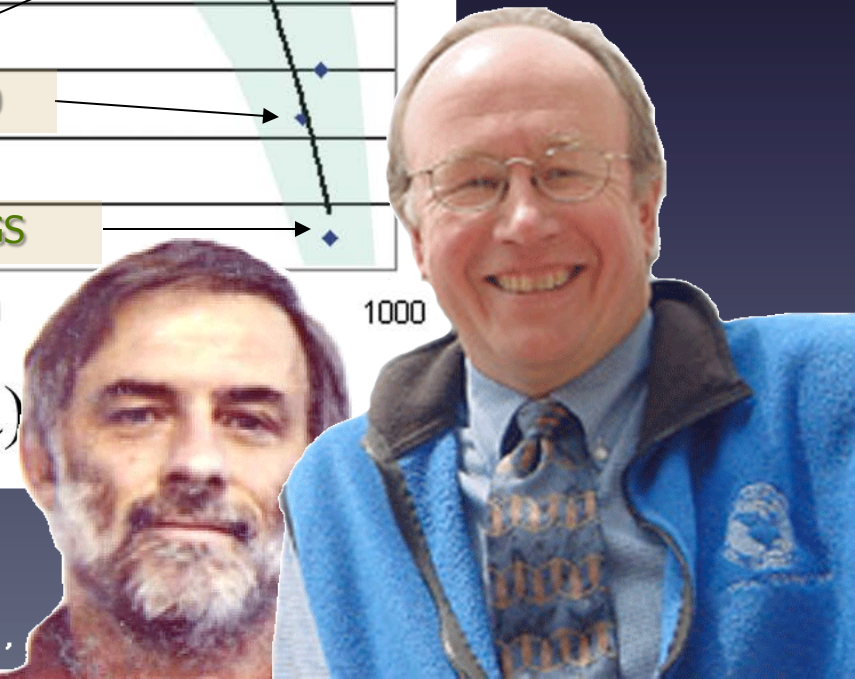
Choquette, P.W., and L.C. Pray. 1970. Geologic nomenclature and classification of porosity in sedimentary carbonates. *American Association of Petroleum Geologists Bulletin* 54(2): 207–250.

The global distribution of karst

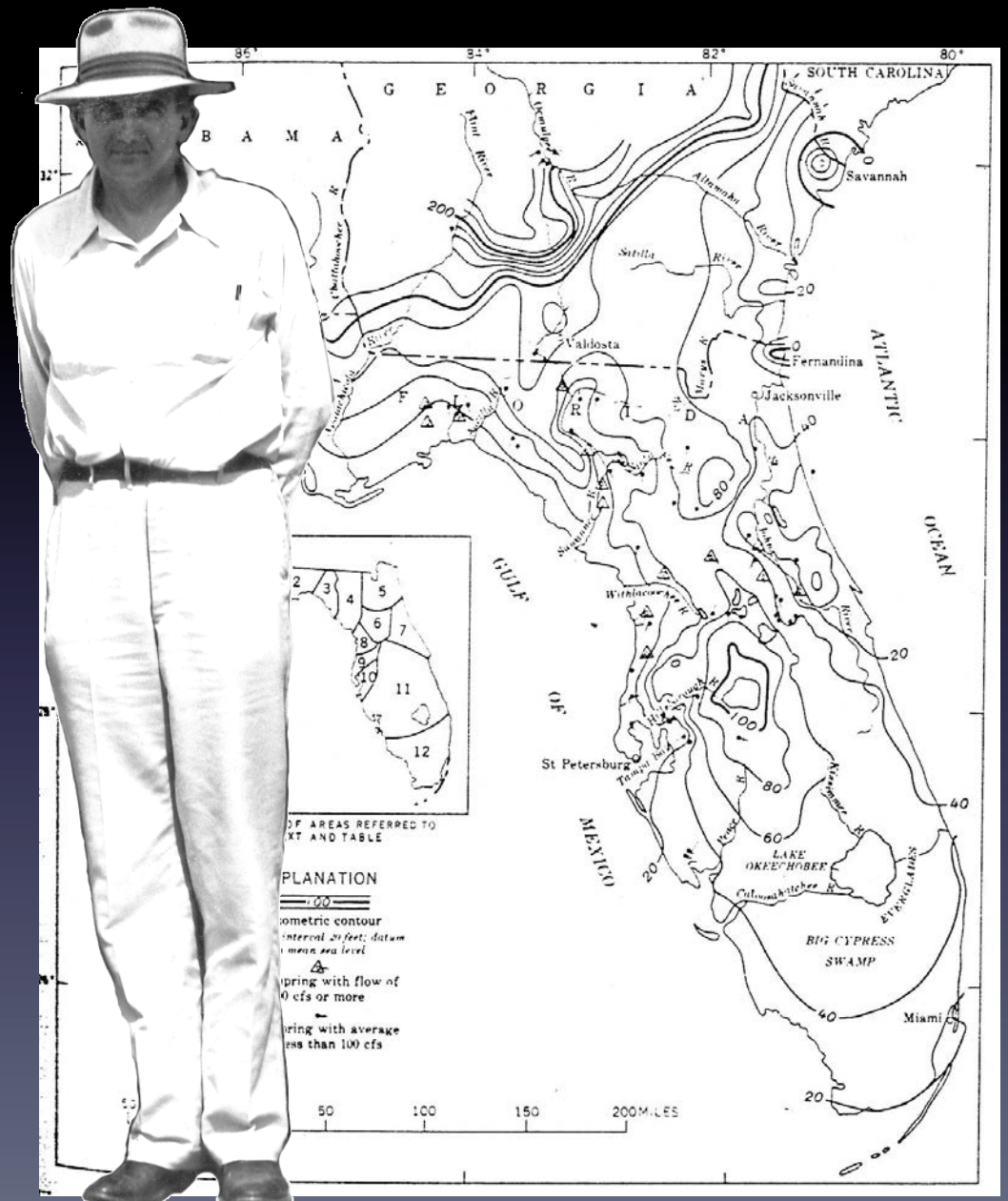


The global distribution of 'eogenetic' karst


Carbonate Sediment, Enos and Sawatsky, 1981
$R^2 = 0.9$
$k = 10^{-12.5}e^{-0.014t}$
Floridan Aquifer,Budd and Vacher, 2004
Edwards Aquifer, Halihan et al., 2000
Mammoth Cave, Worthington et al., 2000
Potosi Dolomite, Missouri, USGS
Log Matrix Permeability (m^2)
-10
-11
-12
-13
-14
-15
-16
-17
-18
-19
-20
0.001
0.01
0.1
1
10
1000
Aquifer Age (Ma)



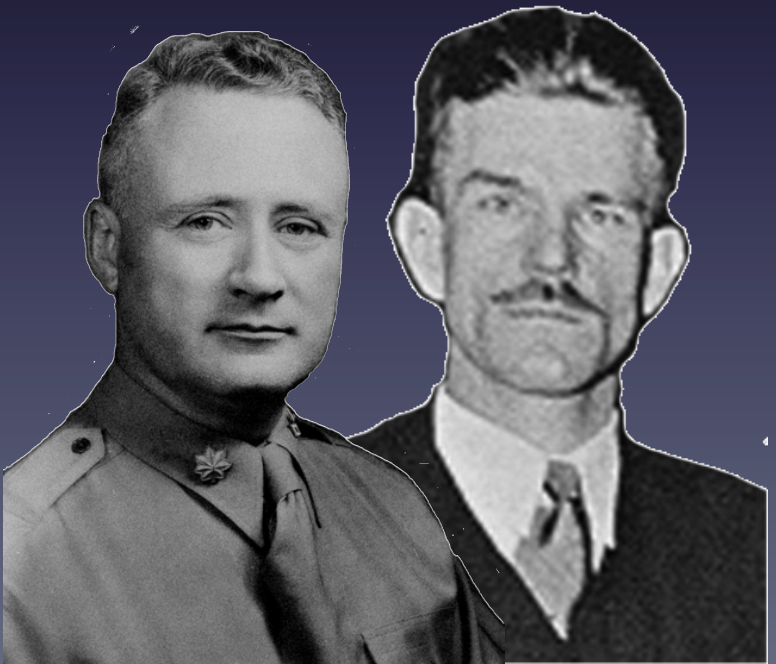
In the late 1960s, as part of the National Hydrologic Decade, Vic Stringfield tried to bridge karst and traditional hydrogeology from his studies of a renowned, limestone aquifer. The Floridan aquifer, however, is as unlike the Appalachian karst as karst can be, and his effort was largely unsuccessful.

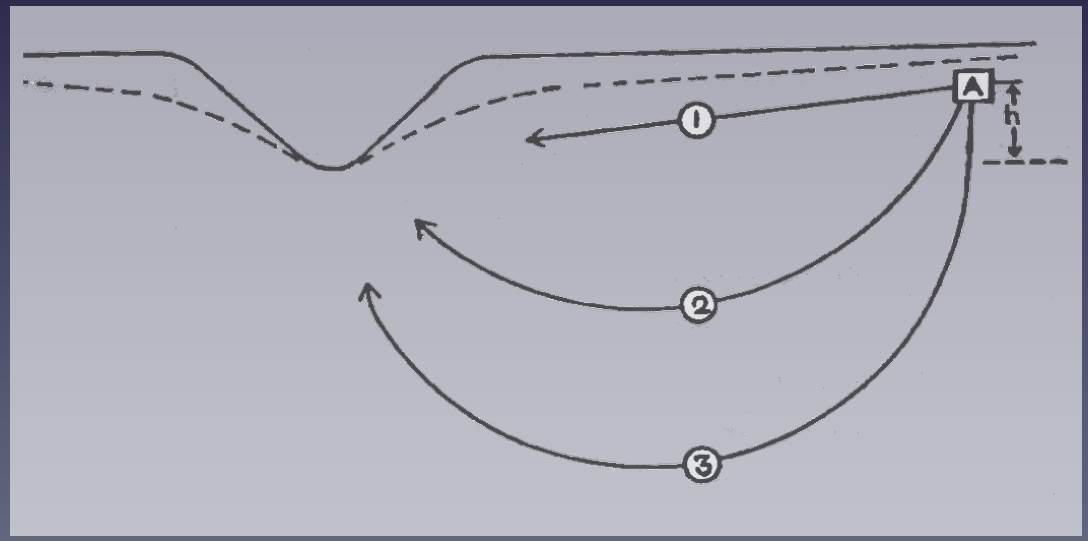


"Aside from any question of frictional resistance, this involves directly a violation of the principle of the conservation of matter."

Hubbert, Theory of Ground-Water Motion, Journal of Geology, 1940, vol. 48, p. 927.

- Hubbert's analysis was beside the point.
- He was not at all interested in the origin of caves.
- Swinnerton's diagram was used to illustrate his point about ground-water flow. Even more generally, he was strenuously promoting an entire point of view that is fundamental to physics: the concept of a field.





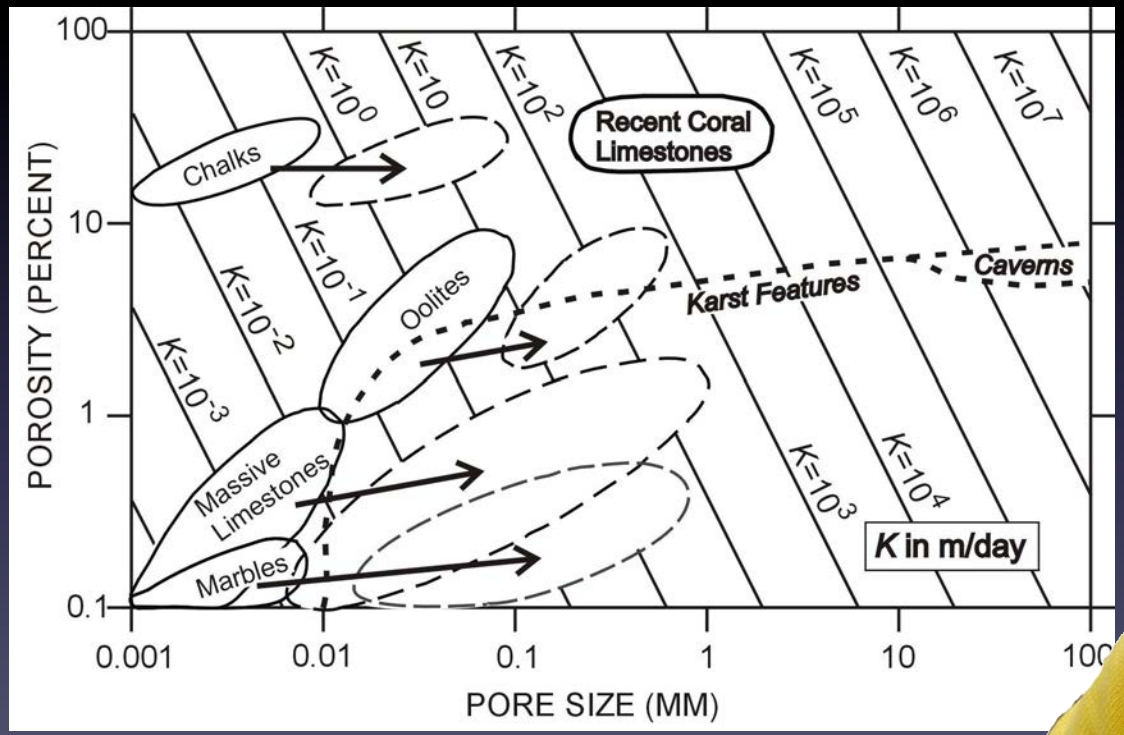
- Study of cave-forming processes became a study of geochemistry and flow in conduits. The perspective of such a study is inherently *Lagrangian*. – a focus on parcels of water flowing through the flow system.

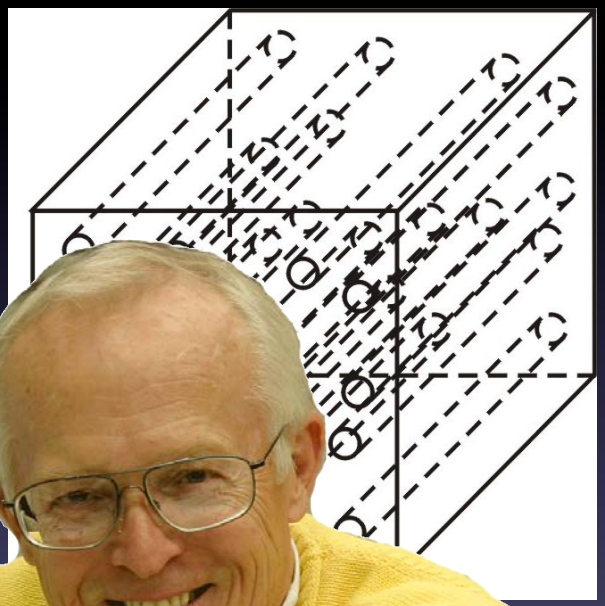
- The alternative point view is the *Eulerian* perspective of fields. Mainstream hydrogeologists did not think in terms of underground rivers, springs, turbulence. To the extent that they thought of karst conduits as anything more than local peculiarities, they assumed that those heterogeneities could be averaged out by representative elementary volumes.

- Karst hydrology in the U.S., with a focus in the Appalachians, was born largely outside of mainstream hydrogeology, developed in part in the Great Plains.

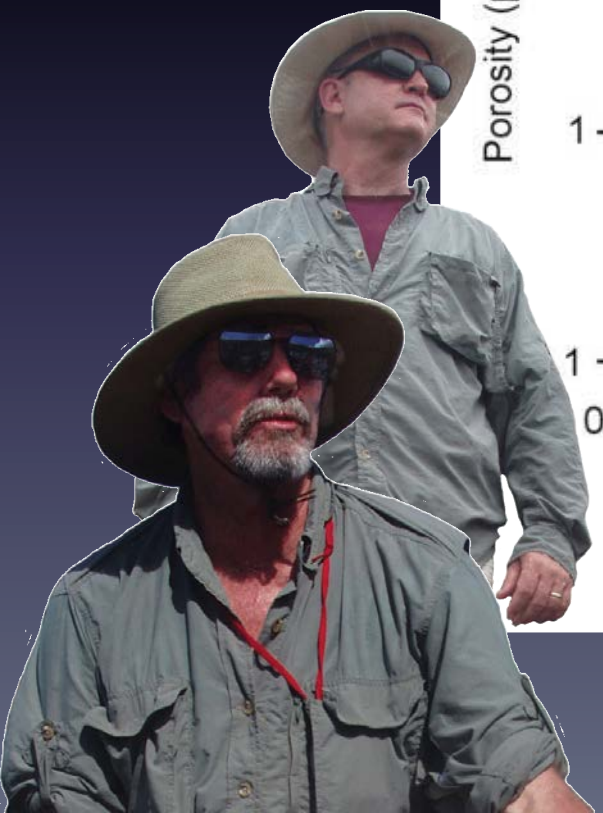
Lake Room in Briar Cave, Florida – Sean Roberts.

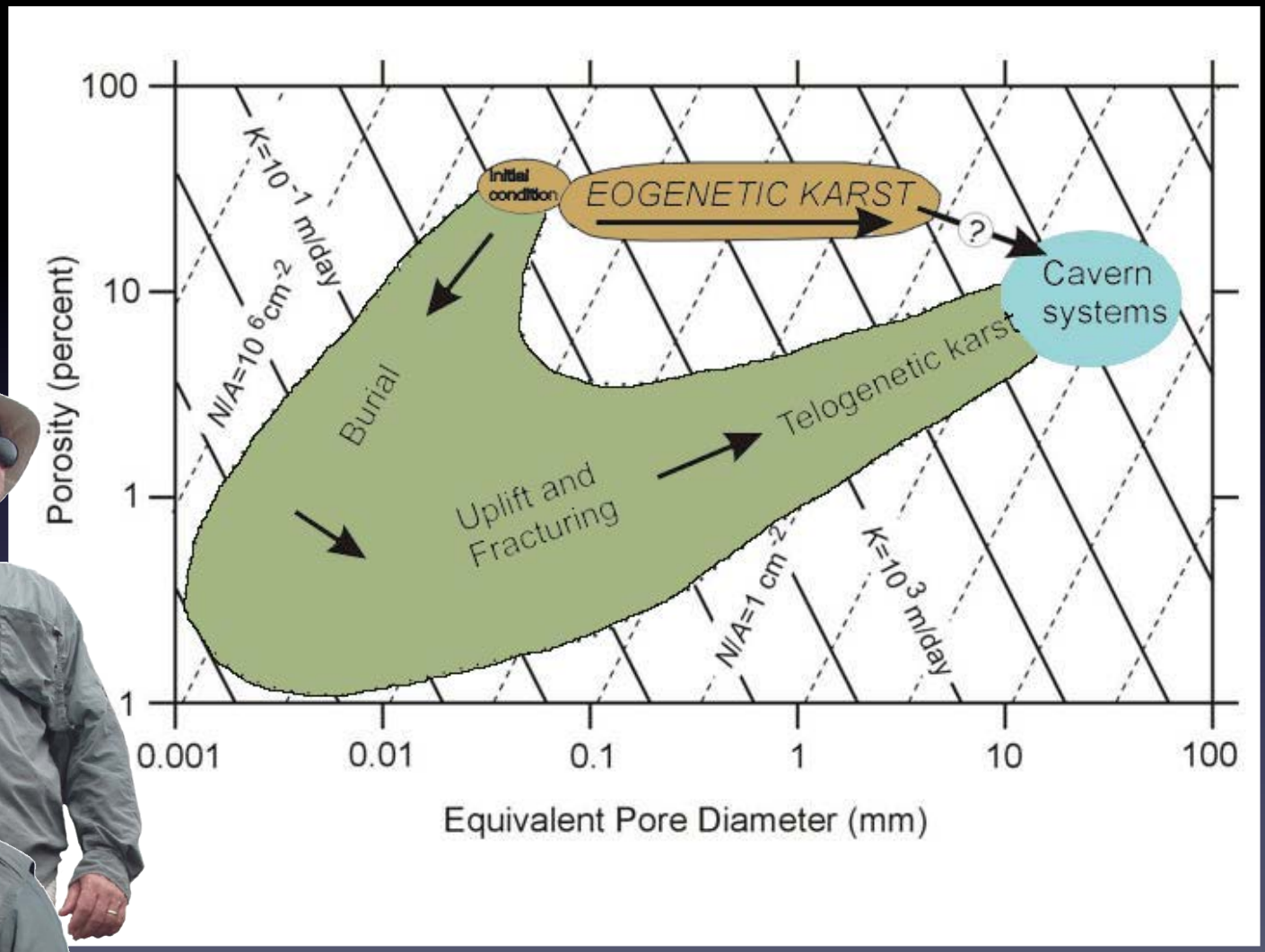
$$Q_T = -\frac{nD^2}{32}\frac{\rho g}{\mu}\frac{dh}{dx}.$$





Brahana, J.V., Thrailkill, J., Freeman, T., and Ward, W.C. 1988. Carbonate rocks, *in* Back, W., Rosenshein, J.S., and Seaber, P.R., eds., Hydrogeology: Boulder, Colorado, Geological Society of America, The Geology of North America, v. O-2, p. 333-352.





Vacher, H.L., and J.L. Mylroie. 2002. Eogenetic karst from the perspective of an equivalent porous medium. *Carbonates and Evaporites* 17(2): 182–196.

	TYPE OF RECHARGE				
	VIA KARST DEPRESSIONS		DIFFUSE		HYPOGENIC
	SINKHOLES (LIMITED DISCHARGE FLUCTUATION)	SINKING STREAMS (GREAT DISCHARGE FLUCTUATION)	THROUGH SANDSTONE	INTO POROUS SOLUBLE ROCK	DISSOLUTION BY ACIDS OF DEEP-SEATED SOURCE OR BY COOLING OF THERMAL WATER
	BRANCHWORKS (USUALLY SEVERAL LEVELS) & SINGLE PASSAGES	SINGLE PASSAGES AND CRUDE BRANCHWORKS, USUALLY WITH THE FOLLOWING FEATURES SUPERIMPOSED:	MOST CAVES ENLARGED FURTHER BY RECHARGE FROM OTHER SOURCES	MOST CAVES FORMED BY MIXING AT DEPTH	
FRACTURES	ANGULAR PASSAGES	FISSURES, IRREGULAR NETWORKS	FISSURES, NETWORKS	ISOLATED FISSURES AND RUDIMENTARY NETWORKS	NETWORKS, SINGLE PASSAGES, FISSURES
JOINTING PARTINGS	CURVILINEAR PASSAGES	ANASTOMOSES, ANASTOMOTIC MAZES	PROFILE: SS SHAFT AND CANYON COMPLEXES, INTERSTRATAL SOLUTION	SPONGEWORK	RAMIFORM CAVES, RARE SINGLE-PASSAGE AND ANASTOMOTIC CAVES
INTERGRANULAR	RUDIMENTARY BRANCHWORKS	SPONGEWORK	PROFILE: sandstone RUDIMENTARY SPONGEWORK	SPONGEWORK	RAMIFORM & SPONGEWORK CAVES

Palmer, A.N. 1991. Origin and morphology of limestone caves. *Geological Society of America Bulletin* 103: 1–21.

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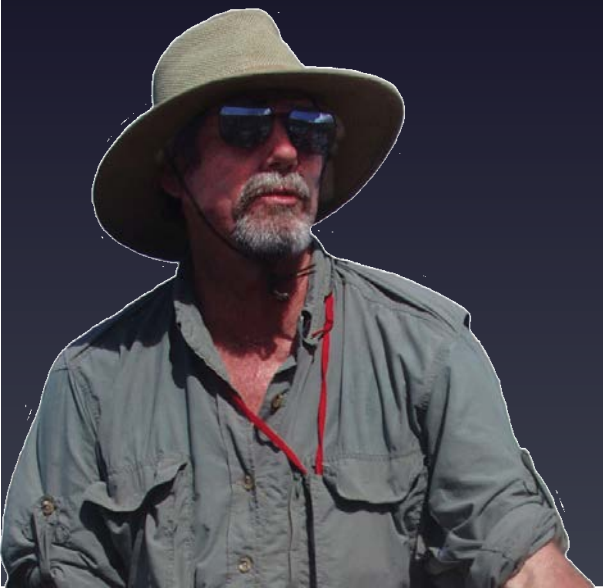
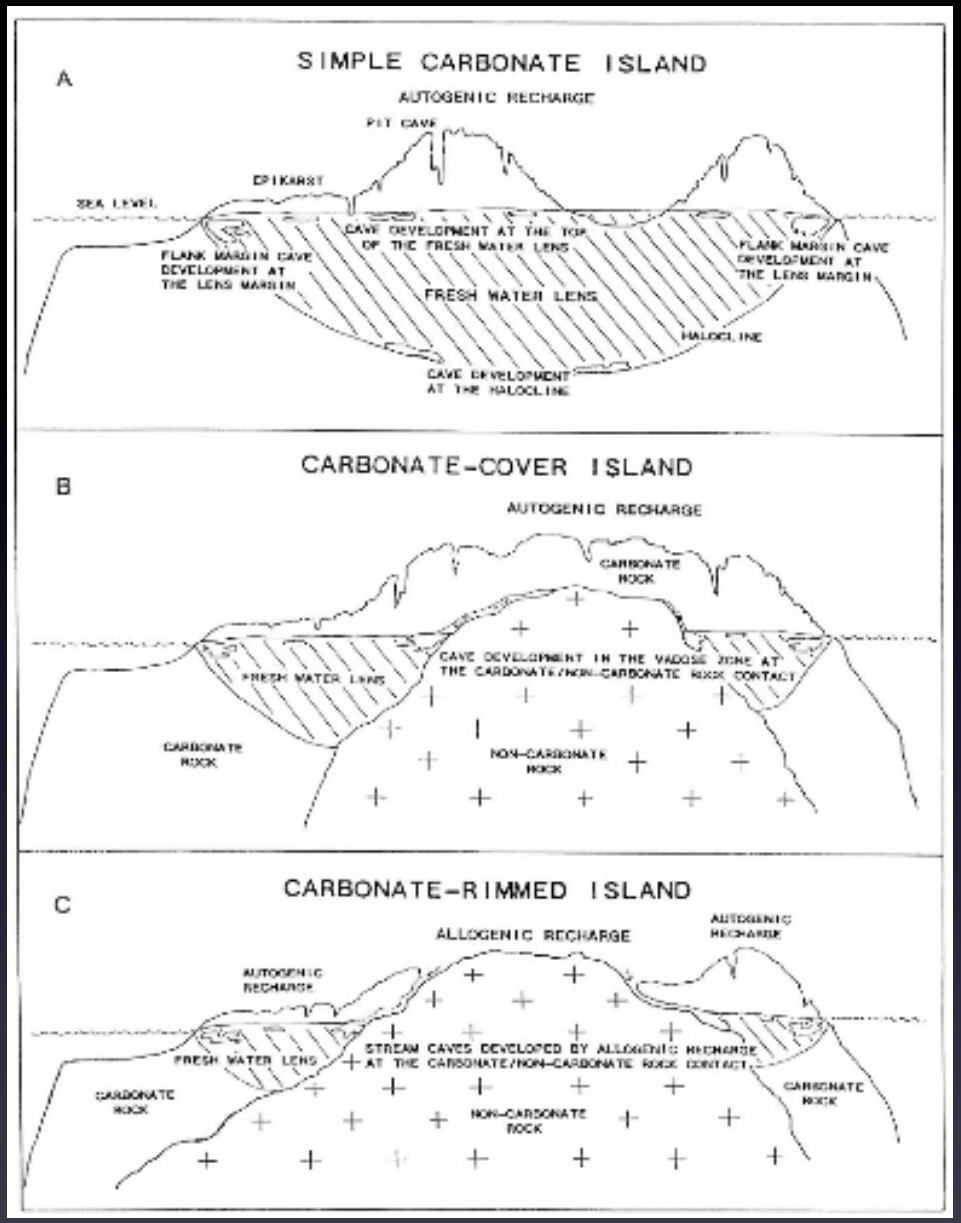
Mylroie, J.E., Carew, J.L., and Vacher, H.L. 1995. Karst development in the Bahamas and Bermuda. In, Curran, H.A. and White, B., eds. Terrestrial and shallow marine geology of the Bahamas and Bermuda, Geological Society of America Special Paper, Boulder, Colorado, v. 300, p. 251–267.





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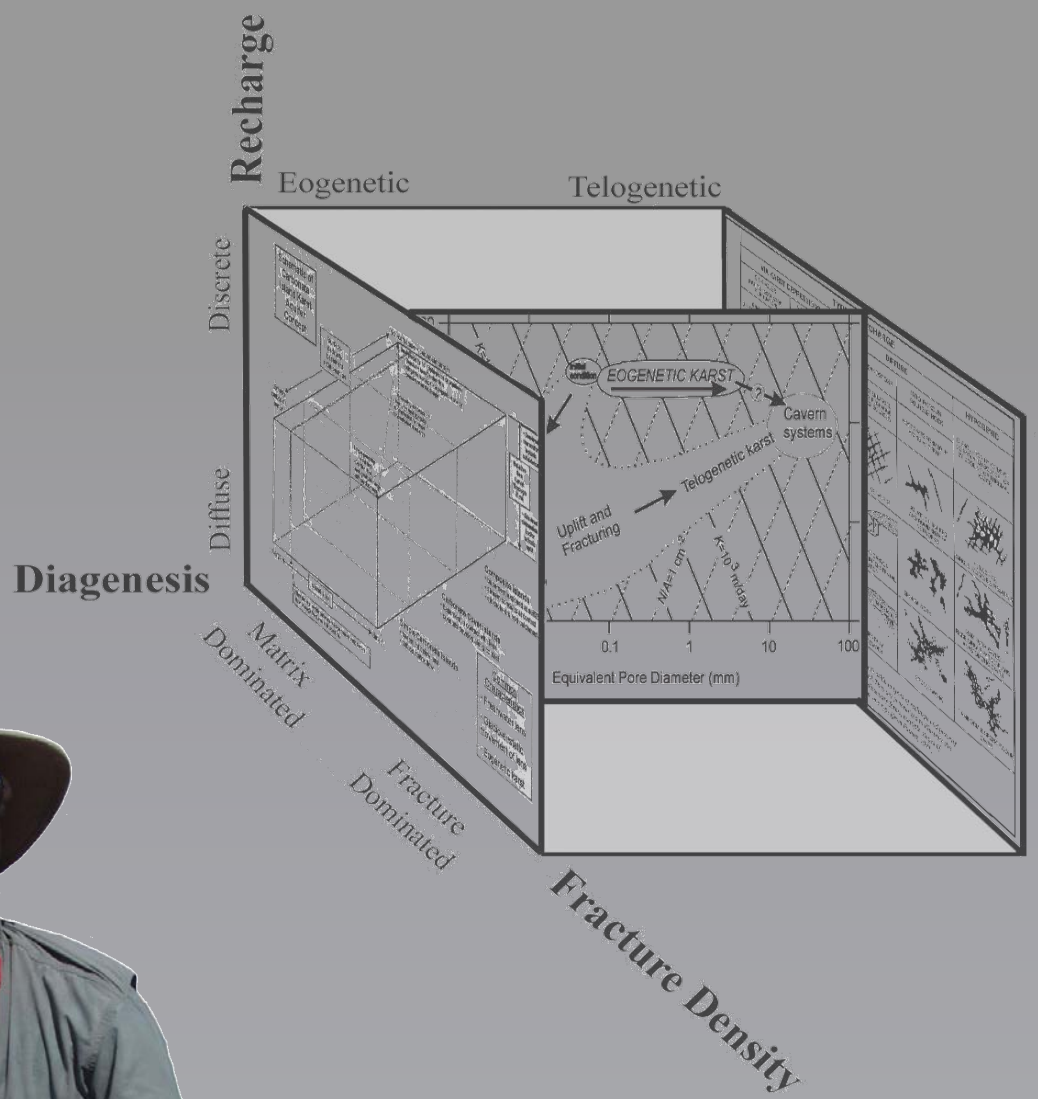

Nearly every cave contains passages at a variety of elevations, and even the casual visitor tends to group them mentally into different "levels."

- Palmer (1987, p. 50)

"Lateral zones of solution cavities at different depths were formed…when the water table stood at higher and lower levels in response to changes in sea levels in Pleistocene time."

- Stringfield and LeGrand (1966, p. 39)

Photo by Bruce LaFrenz

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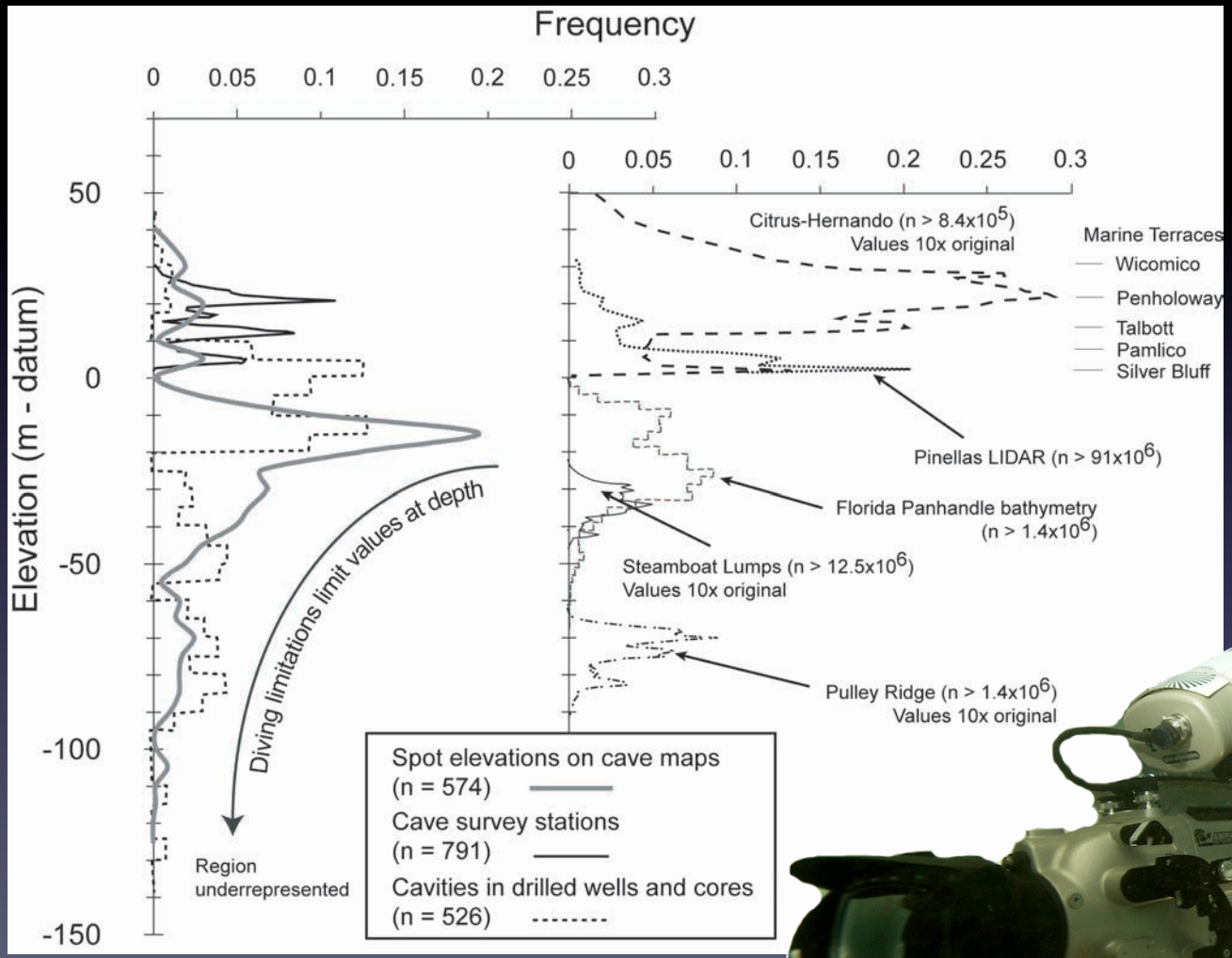

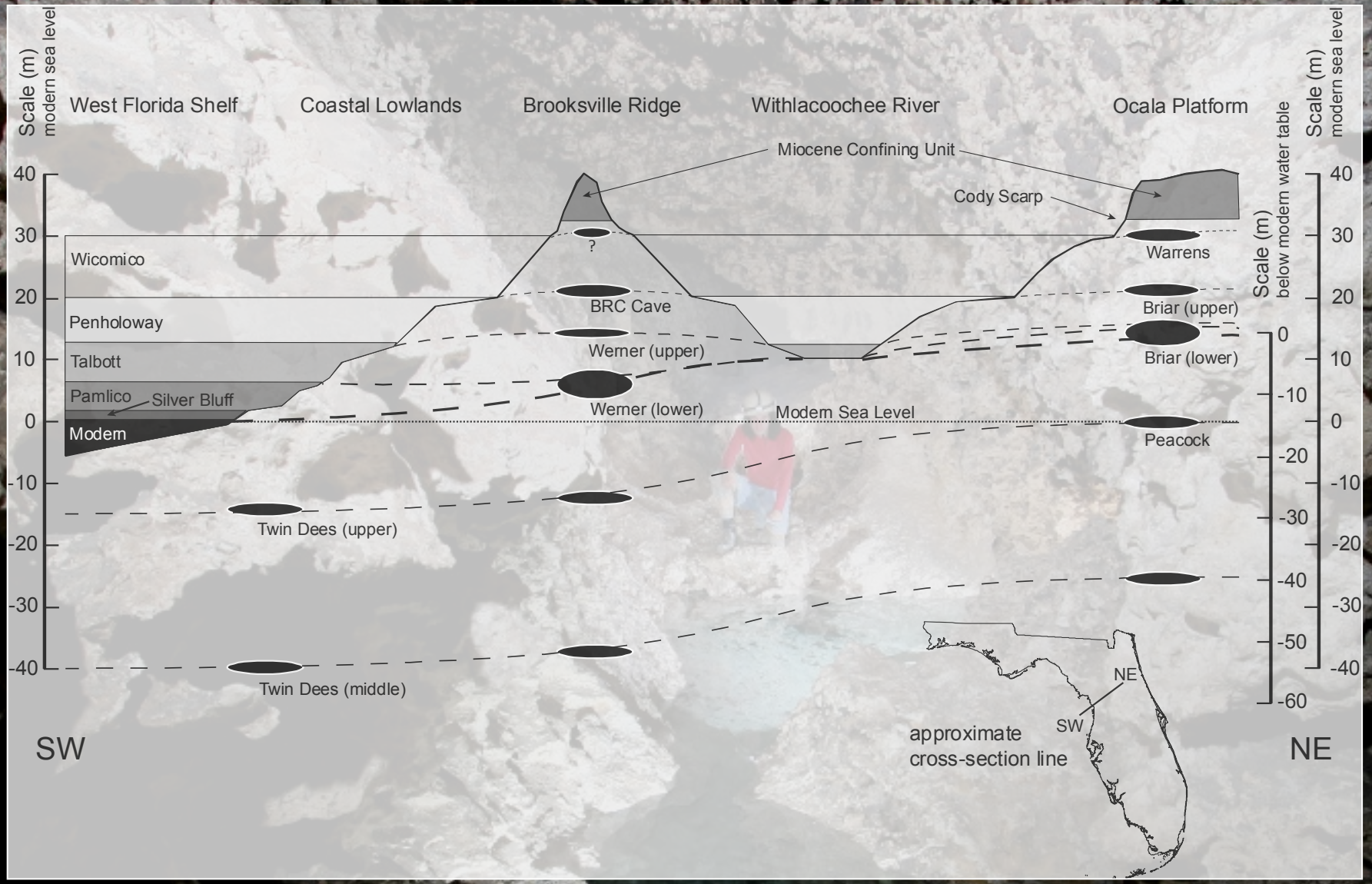
Scale (m) modern sea level
West Florida Shelf
Coastal Lowlands
Brooksville Ridge
Withlacoochee River
Ocala Platform
Scale (m) below modern water table
Scale (m) modern sea level
Miocene Confining Unit
Cody Scarp
?
Warrens
Wicomico
BRC Cave
Briar (upper)
Penholoway
Werner (upper)
Briar (lower)
Talbott
Pamlico
Silver Bluff
Werner (lower)
Modern Sea Level
Modern
Peacock
Twin Dees (upper)
Twin Dees (middle)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
SW
NE
approximate
cross-section line

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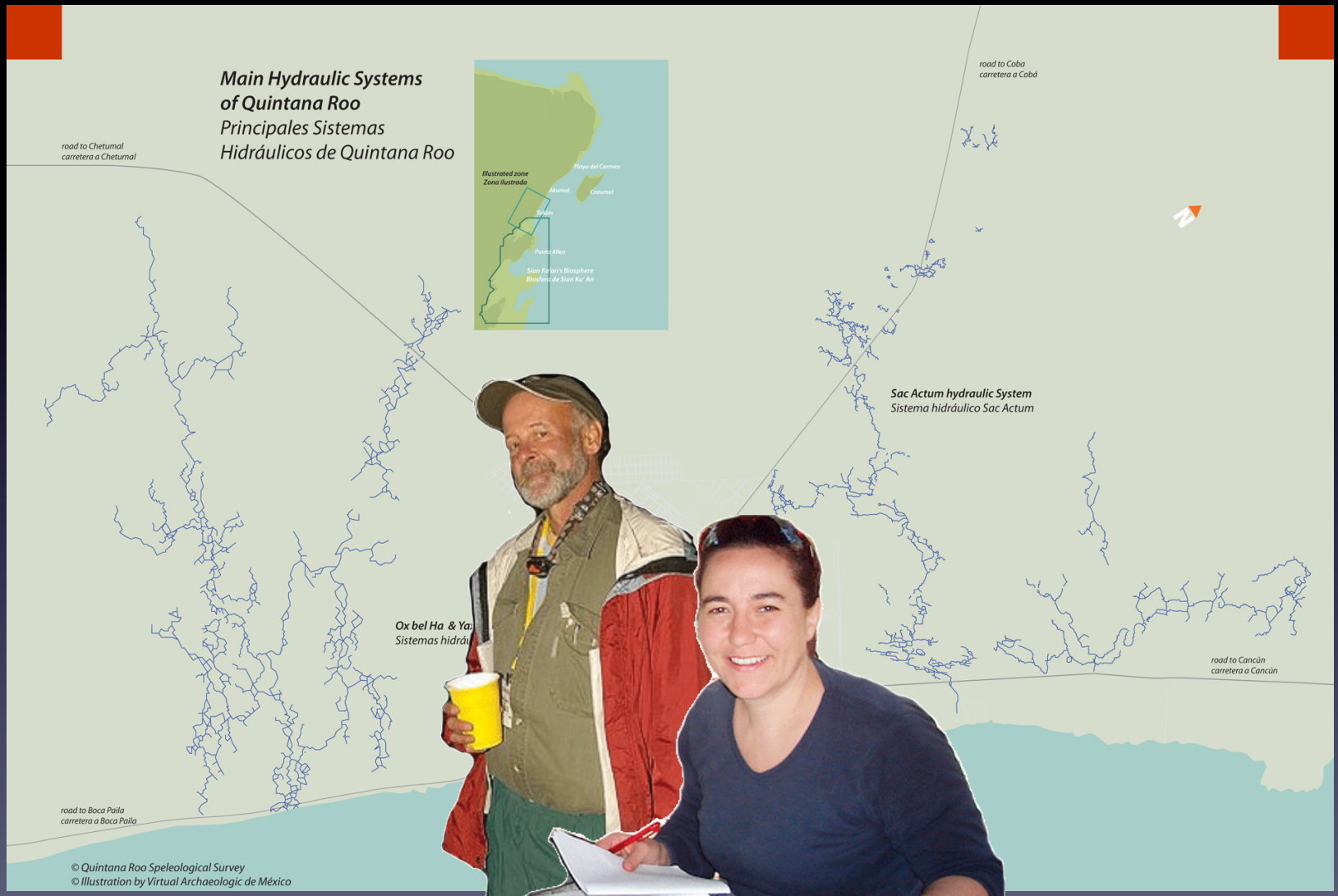
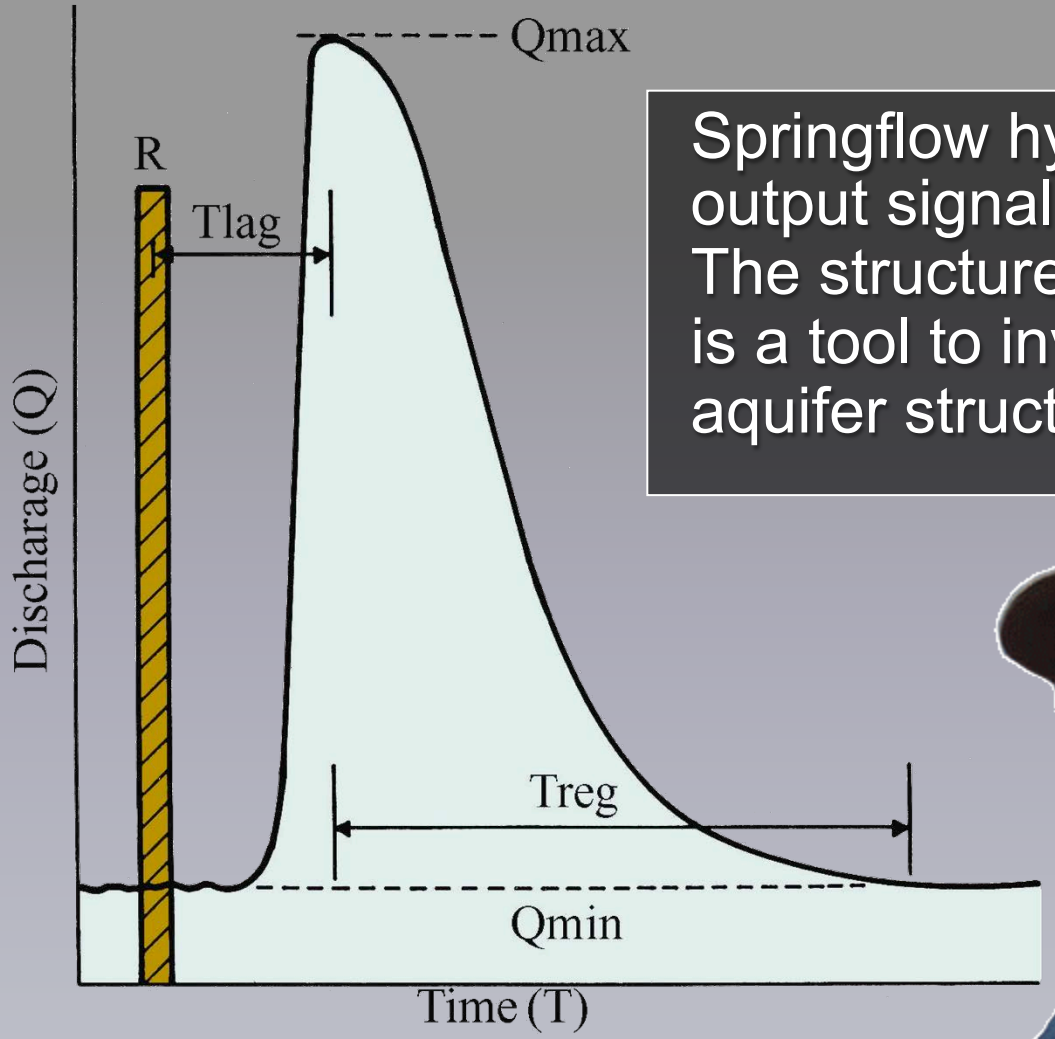


Kentucky	Florida
Continental	Coastal
Swinnerton	Stringfield
Water table	Water table
River base level	Sea level
Continental glaciers	Glacial eustacy
River terraces	Marine terraces

A common thread



(adapted from White, 1988)

Springflow hydrographs are the output signal to a karst aquifer. The structure of the hydrograph is a tool to investigate internal aquifer structure.

Springflow Hydrographs

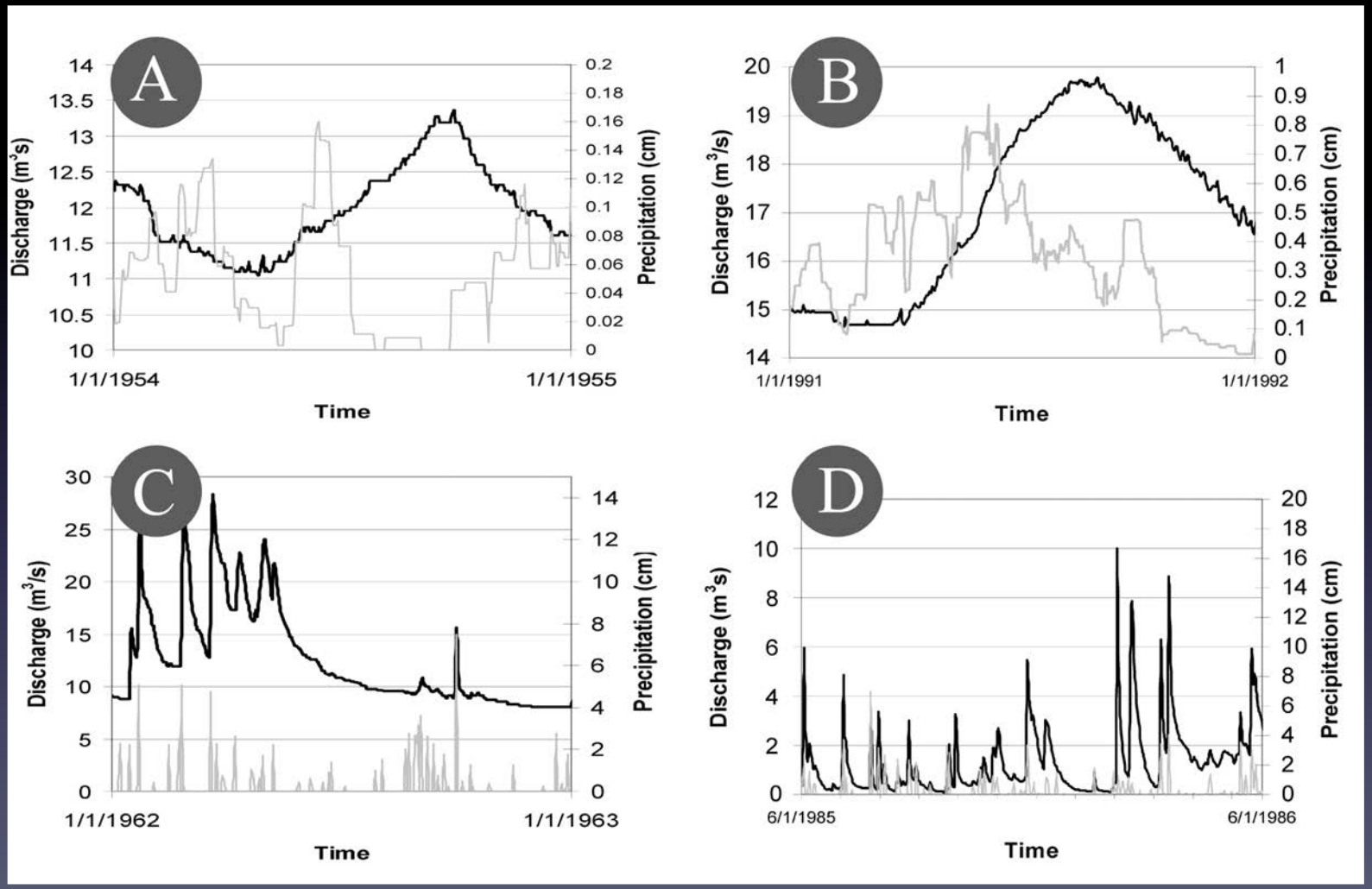
Box Canyon Springs, Idaho

Silver Springs, Florida

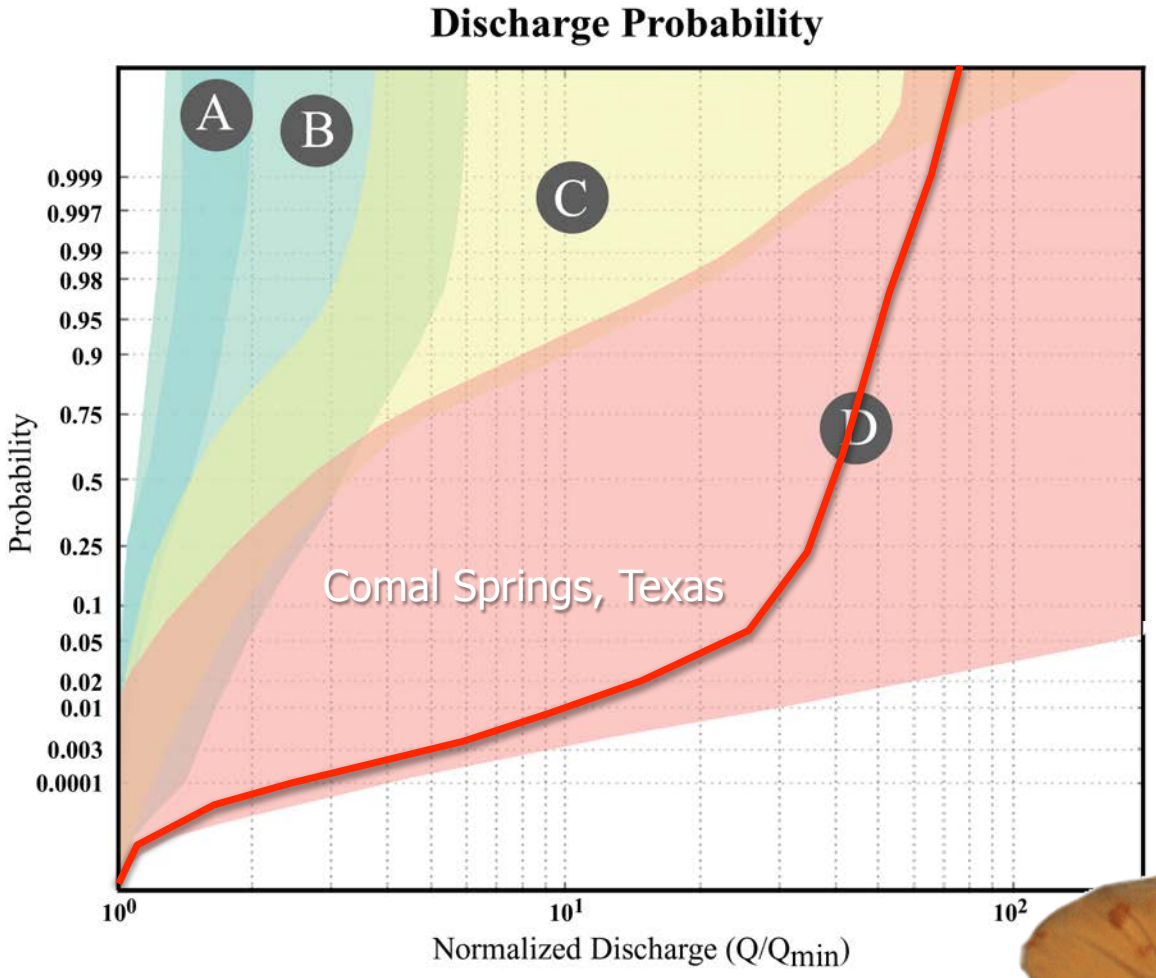
Big Springs, Missouri

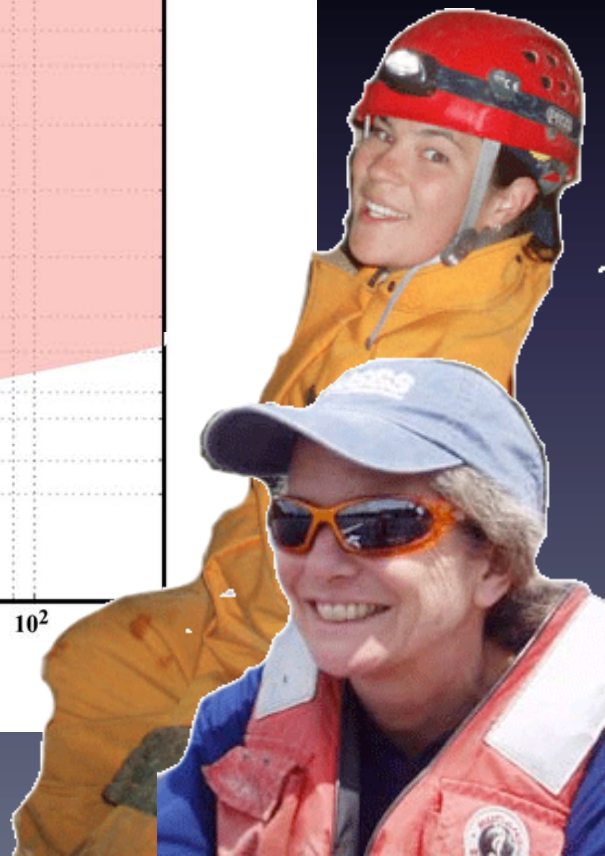
Lost River Rise, Kentucky

Springflow Hydrographs



Discharge Probability





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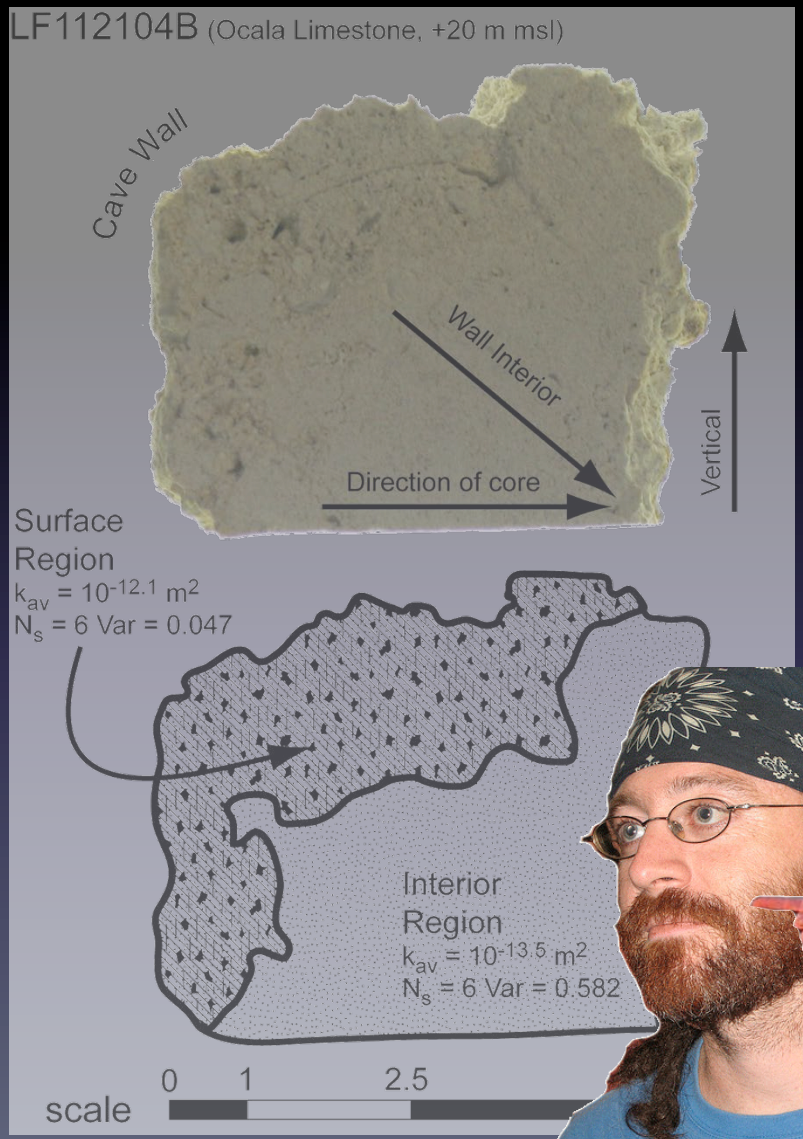

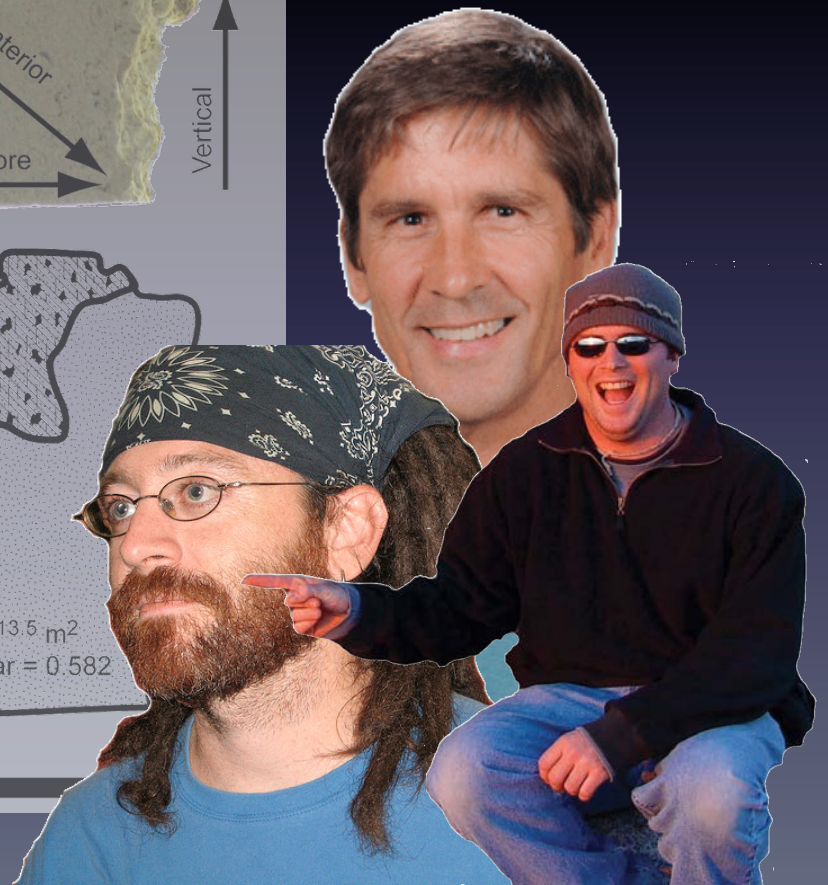

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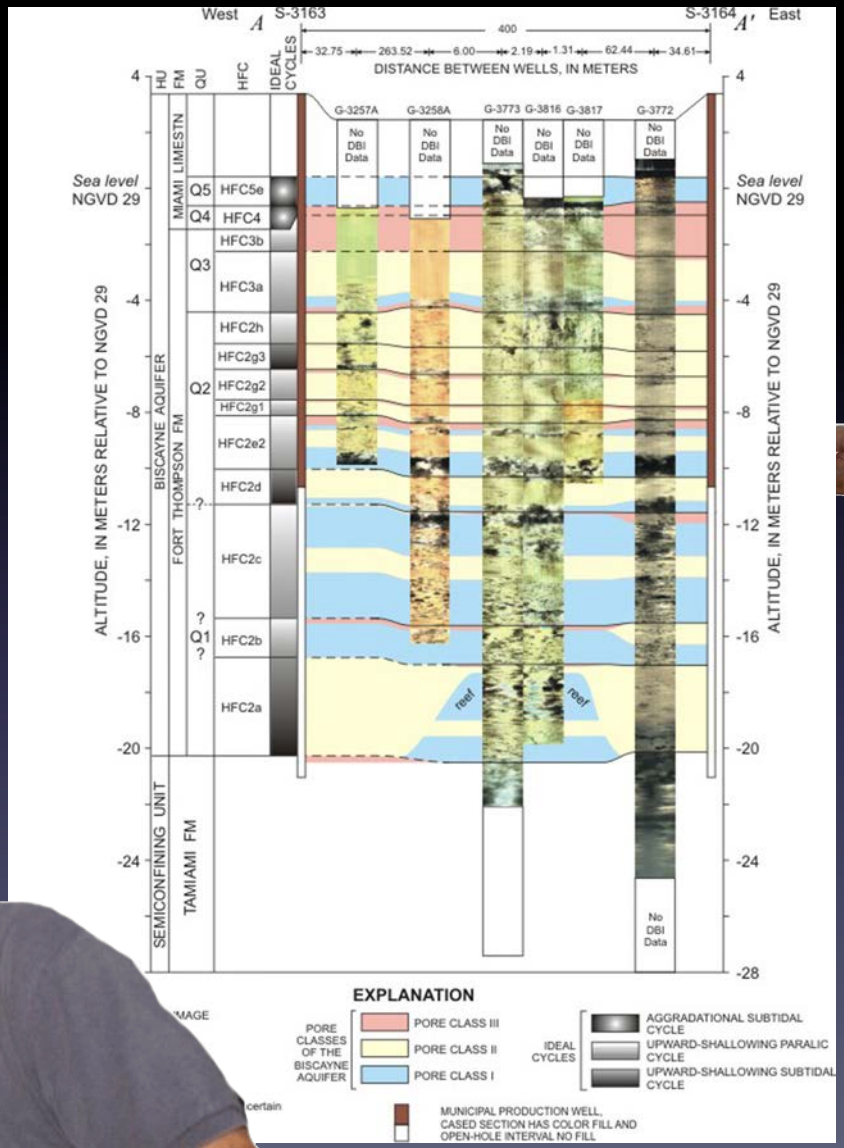
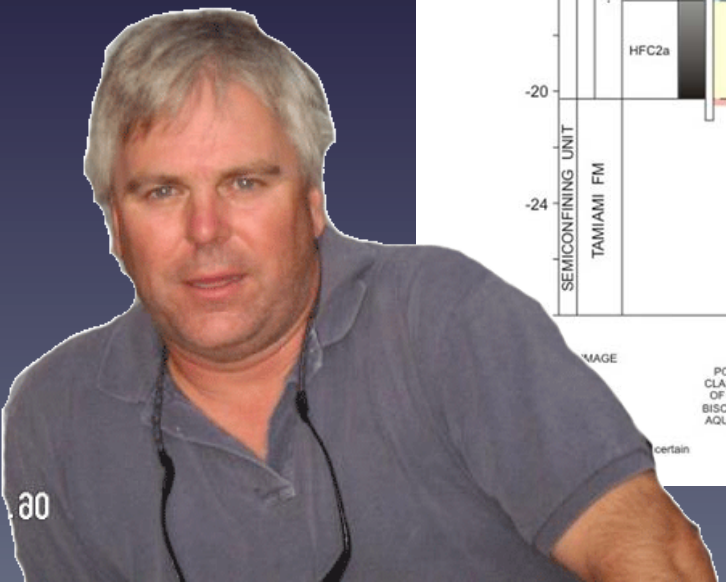
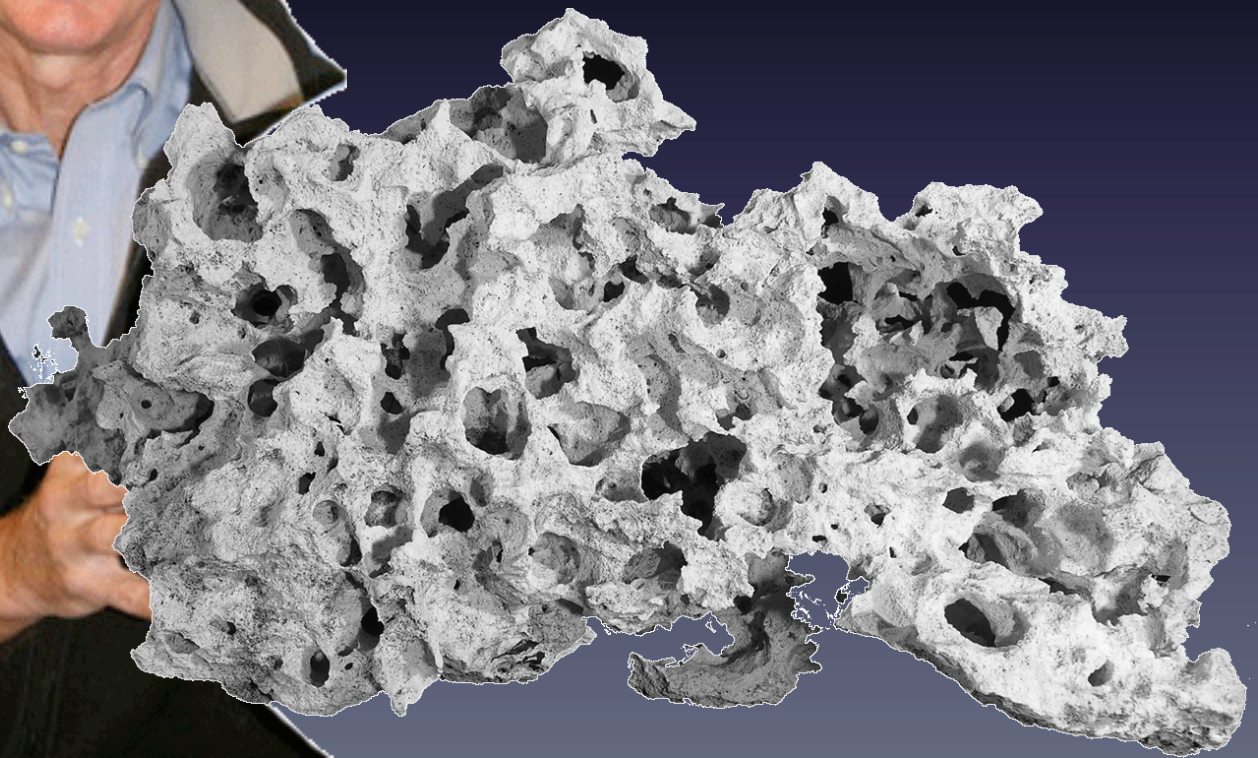




What do we do with this?



Acknowledgments

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  - Southeast section
  - Hydrogeology Division
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- National Speleological Society
- Karst Waters Institute
- Gulf Coast Association of Geological Sciences
- Society of Sedimentary Petrology
- Miami-Dade Parks and Recreation
- Withlacoochee State Forest
- Florida Cave Survey
- Florida Geological Survey
- Southwest Florida Water Management District