

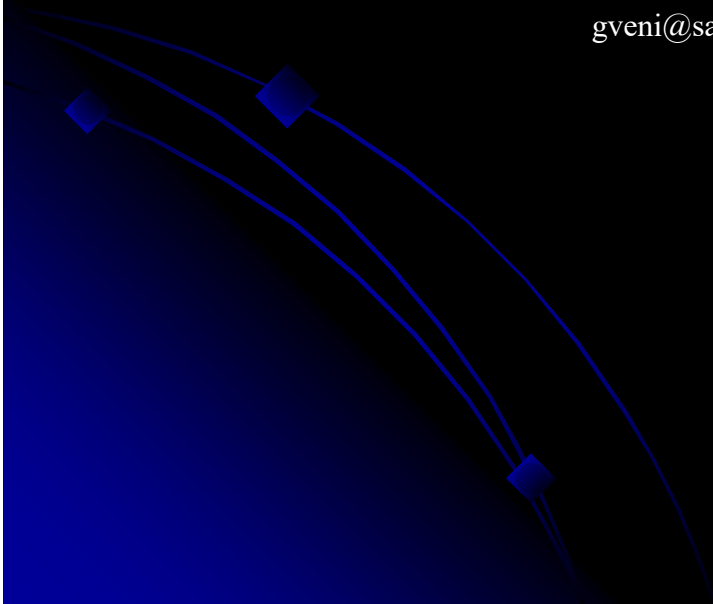
Esta ponencia fue presentado por el Dr. George Veni
en el Primer Seminario Sobre el Manejo Sostenible de Karst
en Coban, Alta Verapaz, Guatemala el 16-19 de Julio de 2003.

Algunas figuras y fotografias han sido eliminados por
falta de permiso de reproduccion o distribucion.
Si no hay indicaciones al contrario, todo el material
fue producido por George Veni.

Esta presentacion no fue preparada para ser visto sin
lectura oral acompanante, y alguna informacion sera
incompletay pudiera ser mal entendido sin la lectura.

Para mas informacion contacta a:

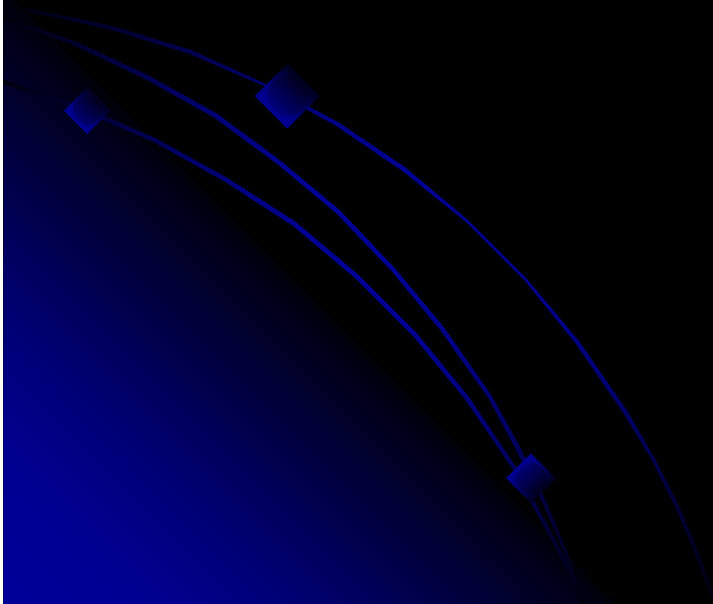
Dr. George Veni
11304 Candle Park
San Antonio, Texas 78249-4421
USA
gveni@satx.rr.com



Hydrogeologic Research Methods for Karst Aquifers

Geomorphological survey and assessment

Ideal first step for most studies and
where technology and logistics make other methods unfeasible



Determine if a database of caves and karst features exists for the project area

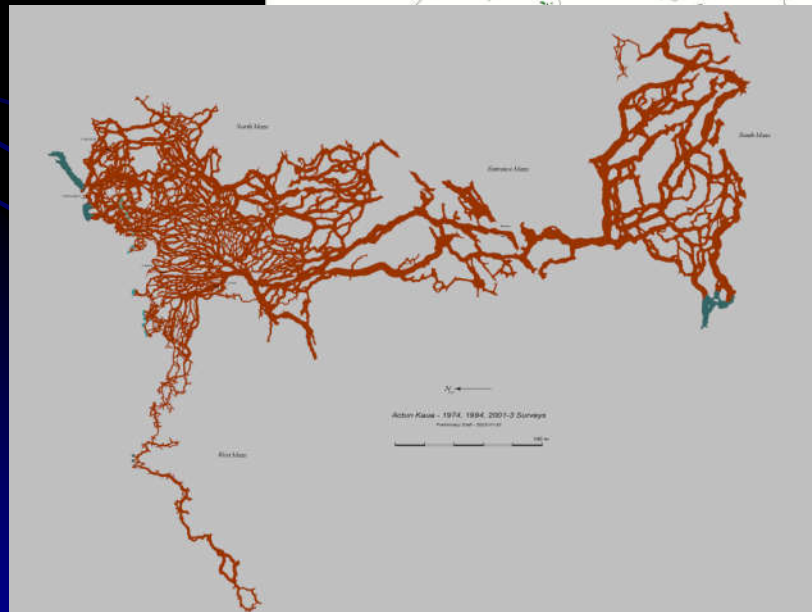
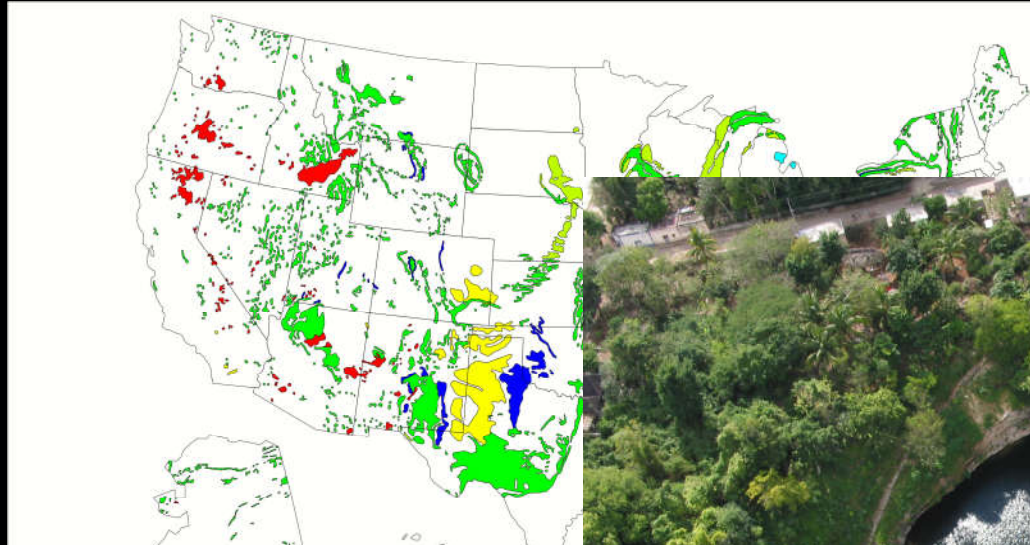


Table with 5 columns: Station, Elevation (ft), Depth (ft), Volume (cu ft), and Notes. The table contains data for various cave stations, including elevations, depths, and volumes. The notes column contains handwritten descriptions of the cave features.

Station	Elevation (ft)	Depth (ft)	Volume (cu ft)	Notes
0101-0102	19.05	355.5	4.15	4.75-2.0
0102-0103	14.6	30.5	-5	-1.3
0103-0104	10.12	118.5	-10	-1.1
0104-0105	10.95	173.5	-21.5	-1.1
0105-0106	11.8	110	-7.75	0.1
0106-0107	15.02	127	-13.3	2.15
0107-0108	9.4	228.5	-0.35	-0.3
0108-0109	10.2	271.5	-2.75	0.1
0109-0110	13.7	241	+1	0.6
0110-0111	9.1	264.75	-4	0.1
0111-0112	4.7	268	-0.05	0.0
0112-0113	9.53	5	-3	0.0
0113-0114	3.52	84	-7.5	0.0
0114-0115	10.0	191	-5.5	0.1
0115-0116	12.35	50	-4	0.0
0116-0117	13.0	78.5	-4	0.0
0117-0118	7.6	101	-3	0.1

Conduct a field survey for caves and karst features

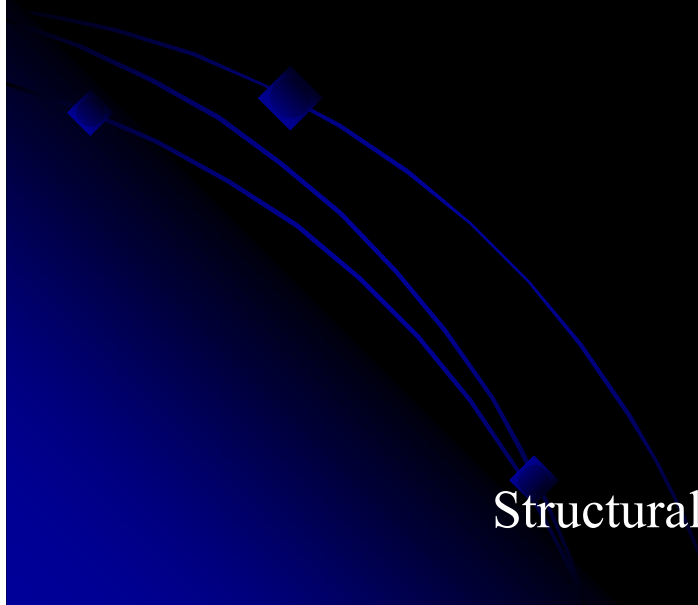
Survey & evaluate
surface & subsurface features

Geologically
assess all features



Analyze the karst feature database

Lithologic analysis



Structural analysis

Analyze the karst feature database

GIS analysis



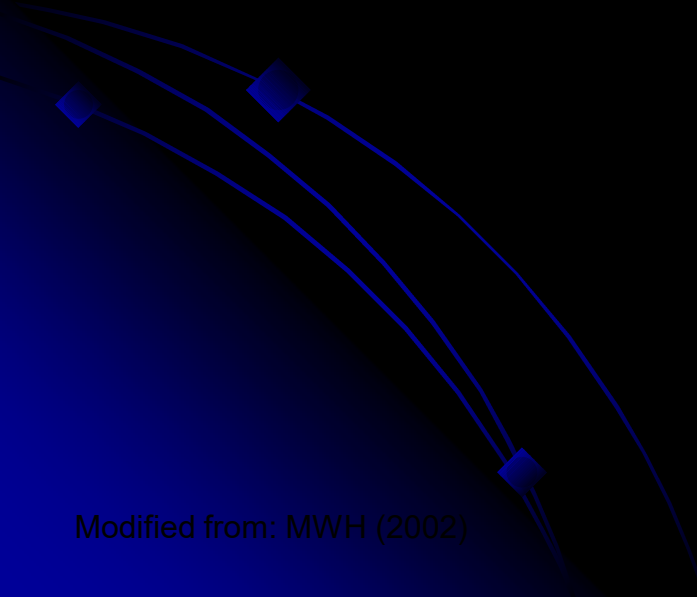
Hydrologic
analysis



Epikarst
analysis

Photo courtesy of Jason Pielemeier

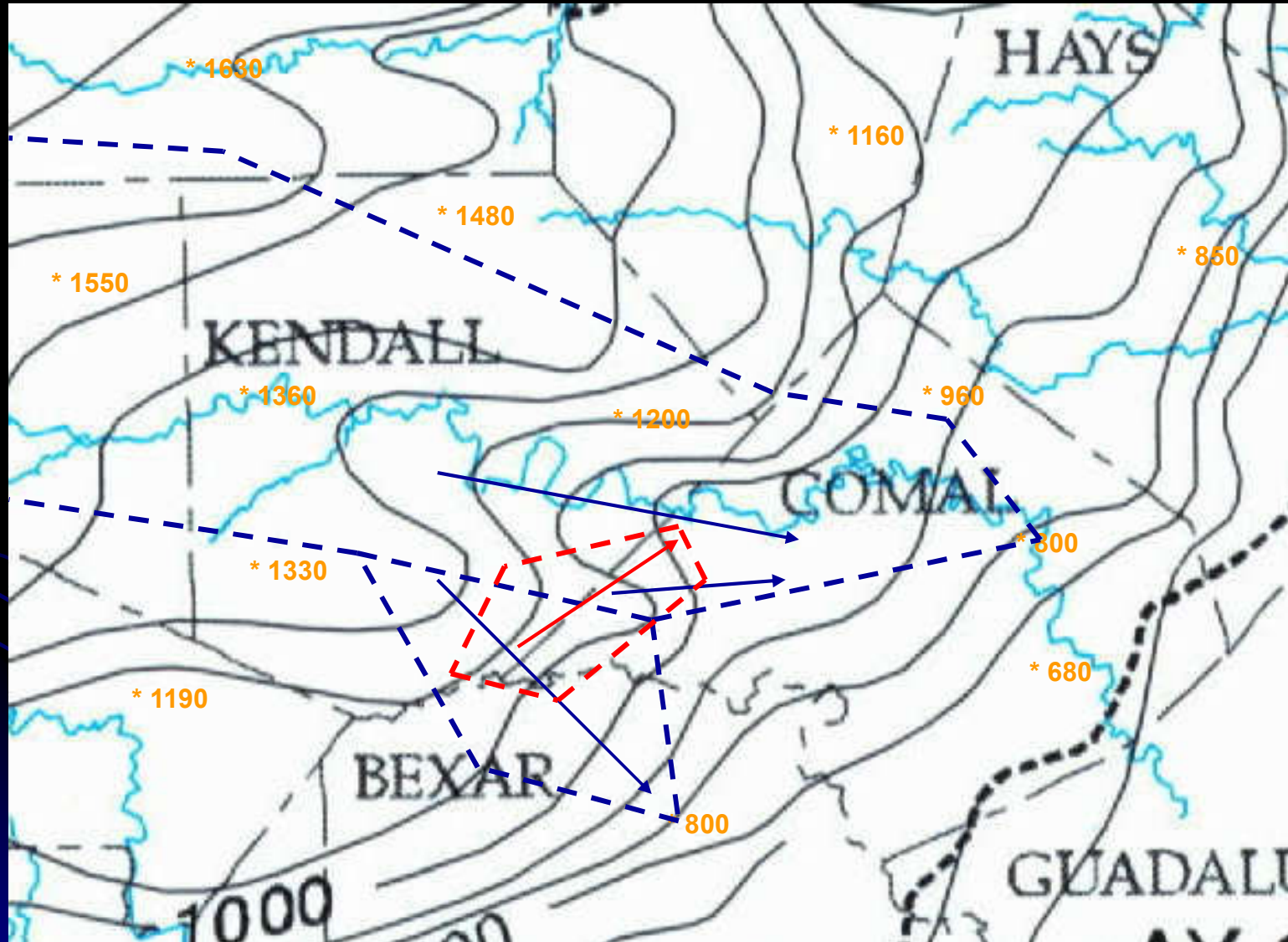
Create an evolutionary model of cave and karst development
in order to create a conceptual groundwater model

A decorative graphic in the bottom-left corner of the slide. It consists of three curved, parallel lines that sweep upwards and to the right. Each line has a small, solid blue diamond marker placed on it. The lines and markers are set against a dark blue gradient background that fades into the black background of the slide.

Modified from: MWH (2002)

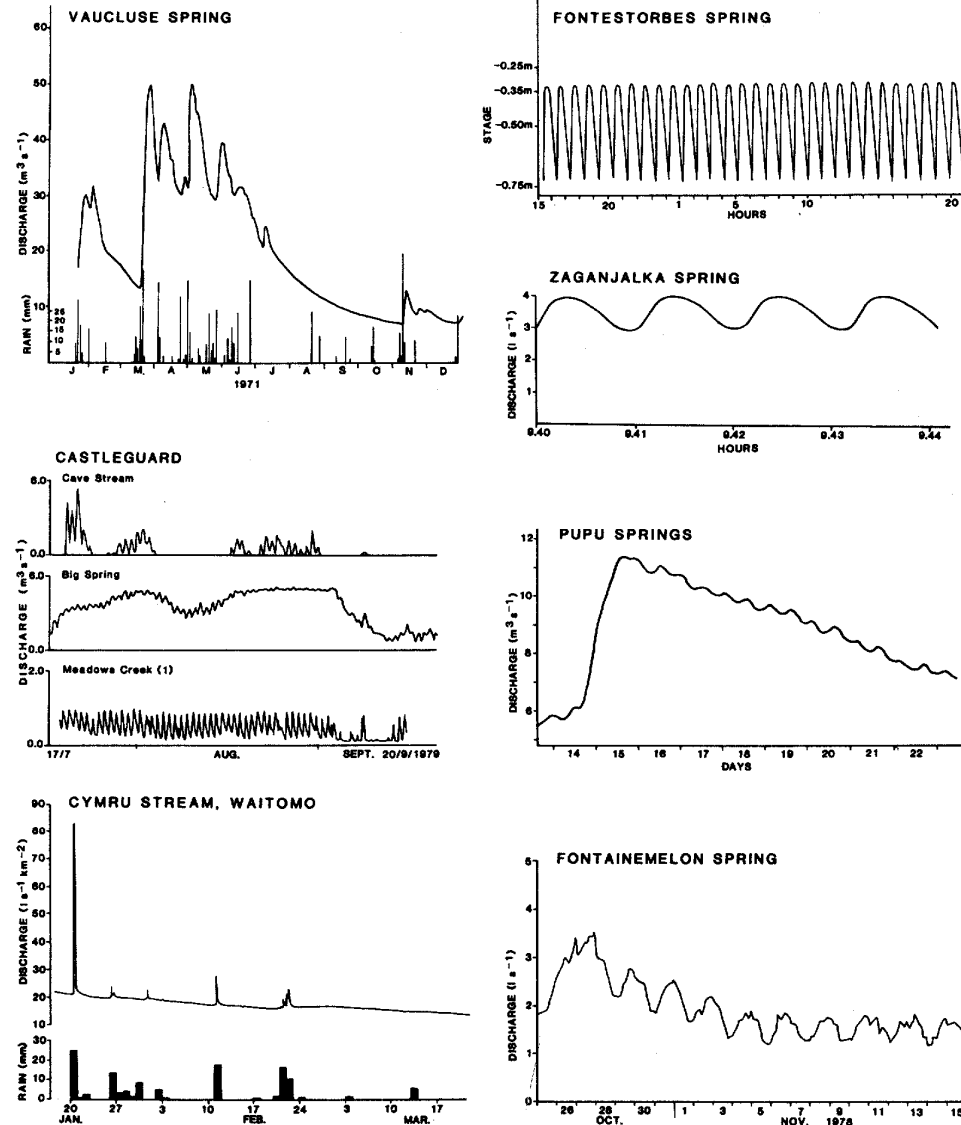
Potentiometric mapping

Useful but not always completely accurate in karst



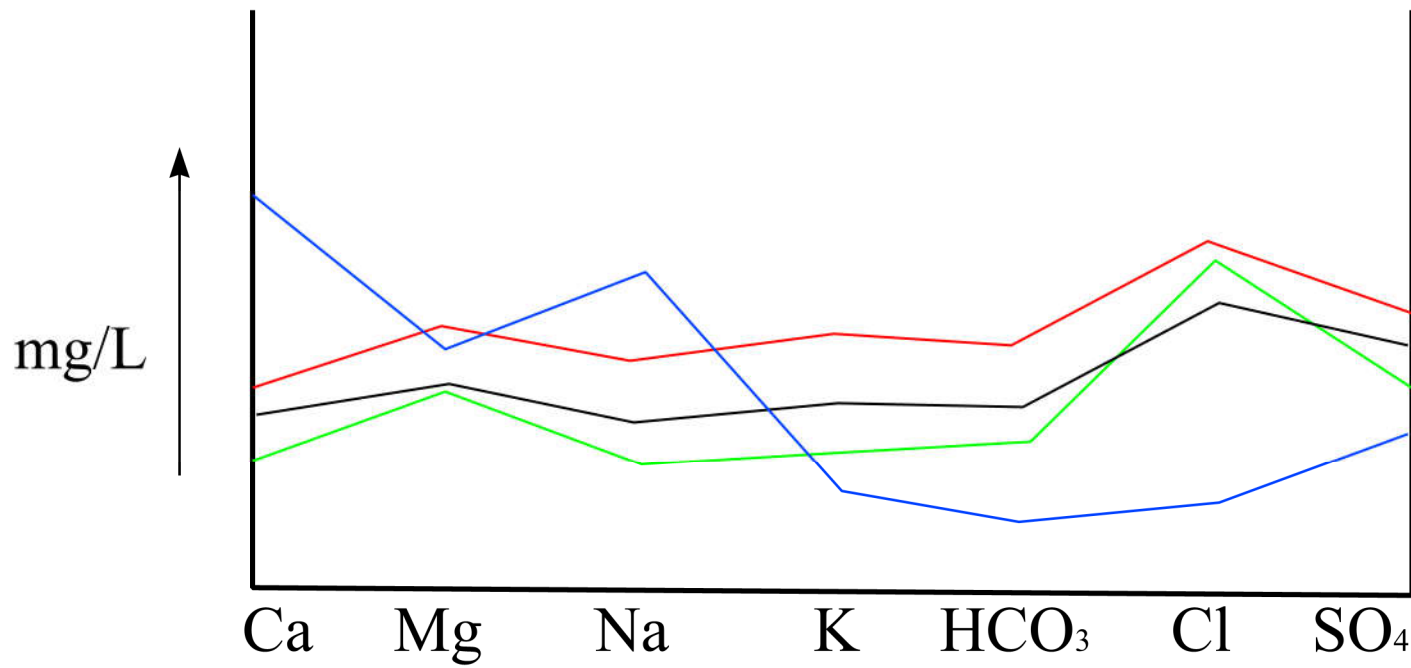
Modified from: *Hydrogeologic framework of the Edwards-Trinity Aquifer* (Barker & Ardis, 1996)

Use hydrographs to identify flow regimes and aquifer properties by well and springflow calculations



From: *Karst Geomorphology and hydrology* (Ford and Williams, 1989)

Hydrochemistry



Hydrochemistry



Details in the hydrochemical record are critical
for accurate sampling of contaminants

Contaminant geochemistry
Generally no plumes

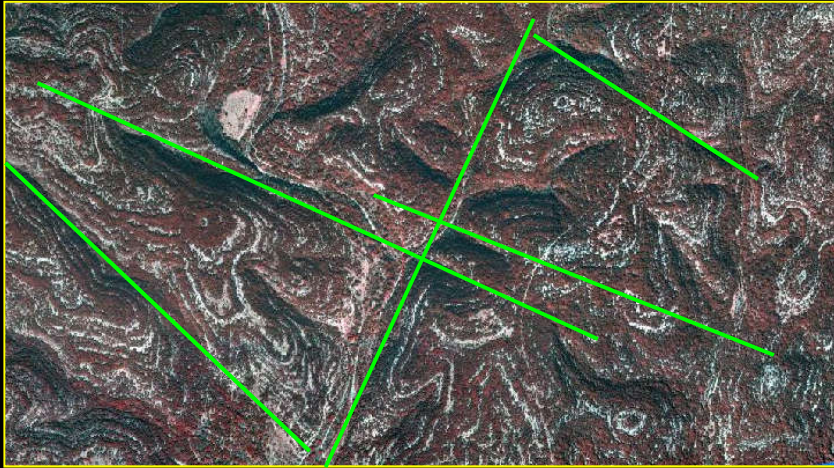


Well monitoring inadequate

Drainage basin
mapping &
spring monitoring
needed

Remote sensing

Aerial photography



Lineament analysis

Thermal infrared mapping



Well logs

Void detection
Ground penetrating radar
Natural potential/Spontaneous potential
Seismic



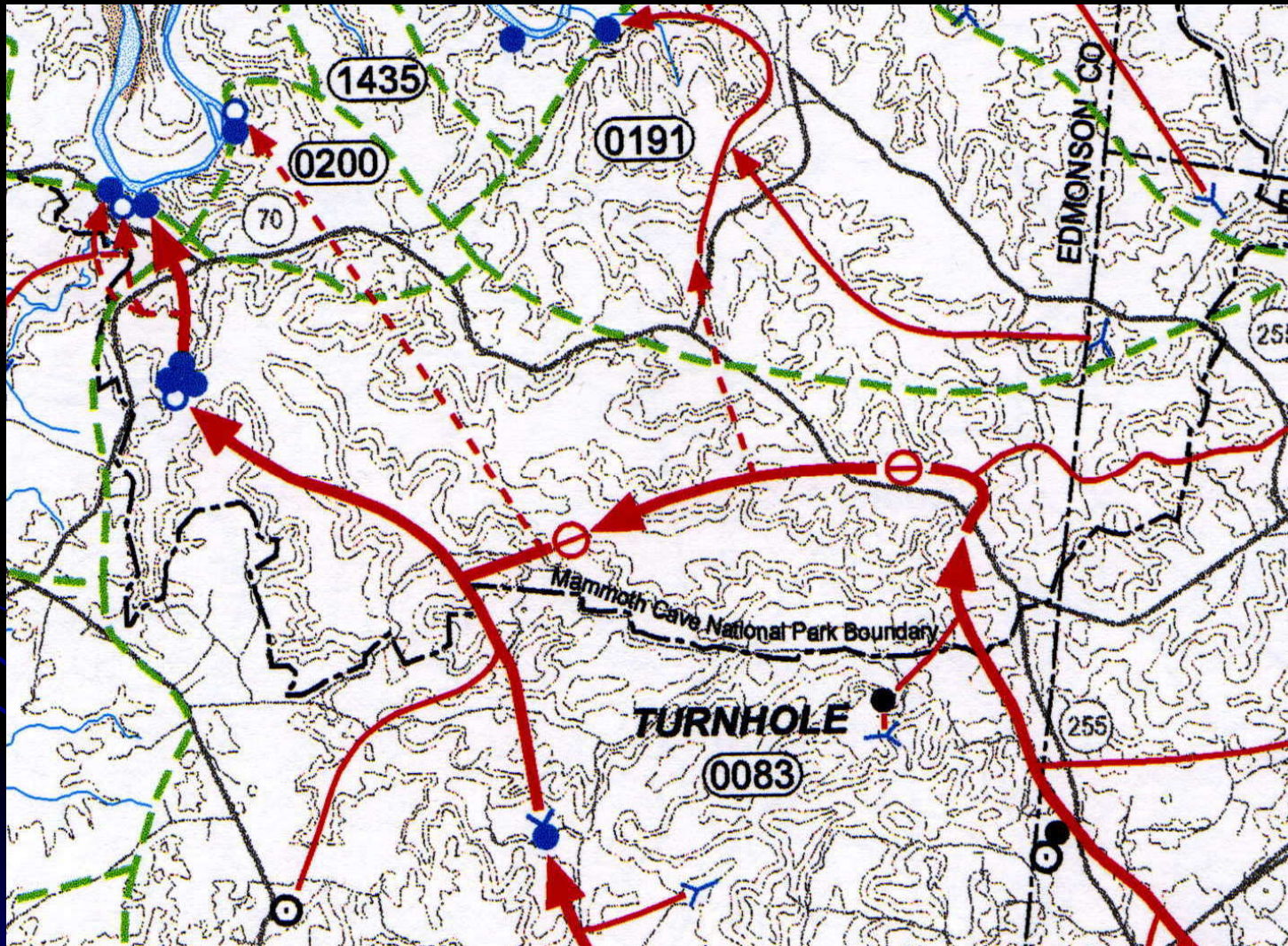
Electrical resistivity

Microgravity



Microgravity + Electrical resistivity

Tracer testing



From: Kentucky Geological Survey (2000)

Three primary types of tracers: contaminants, isotopes, and dyes

Characteristics of a good tracer:

- low background
- distinctive
- easy to identify and measure
- cheap
- easy to acquire



Tracer Injection

Detection
Where to look?
How to look?



Tracer test results

Aquifer flow routes

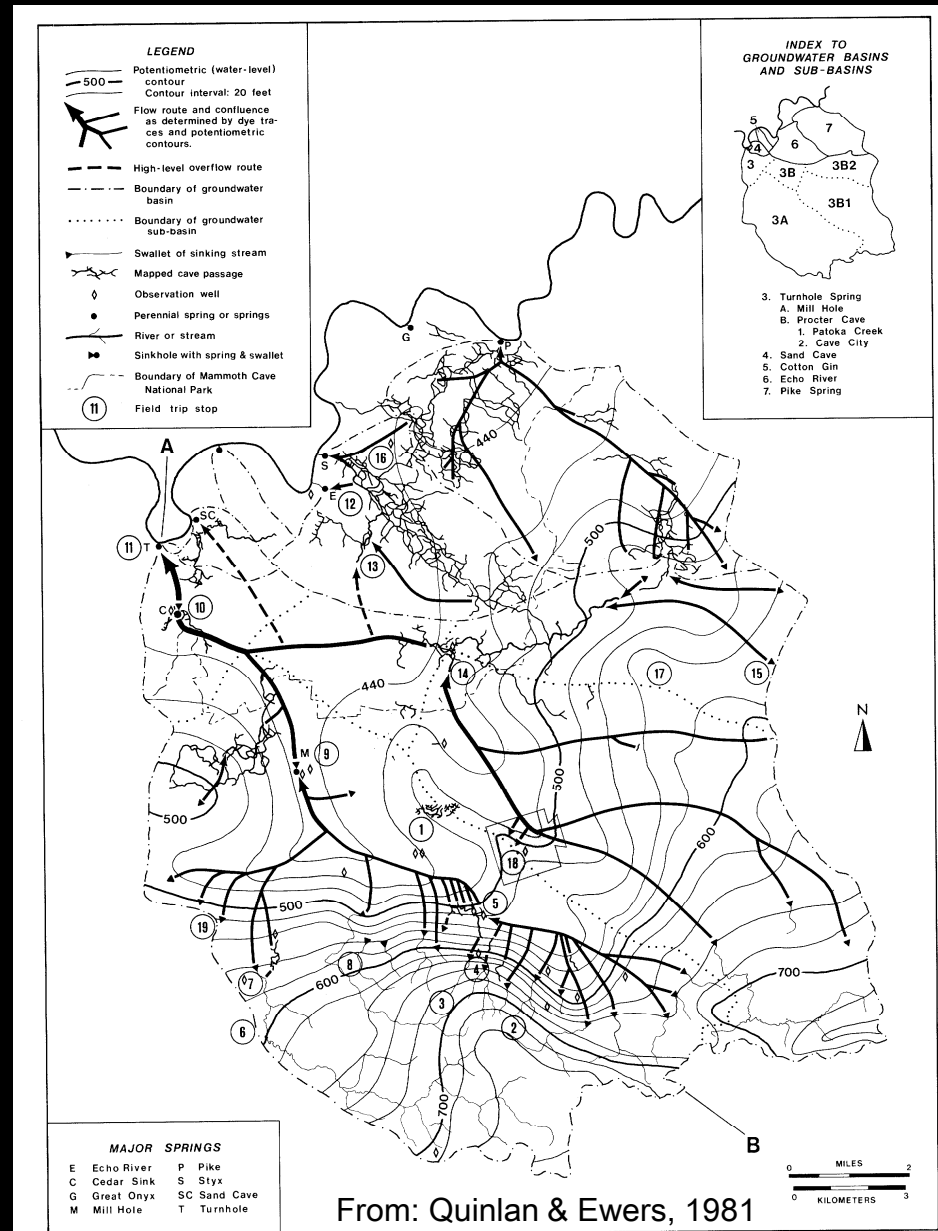
Aquifer parameters:

Time of travel

Time of travel at different
flow conditions

Dye dispersion

Dye dilution

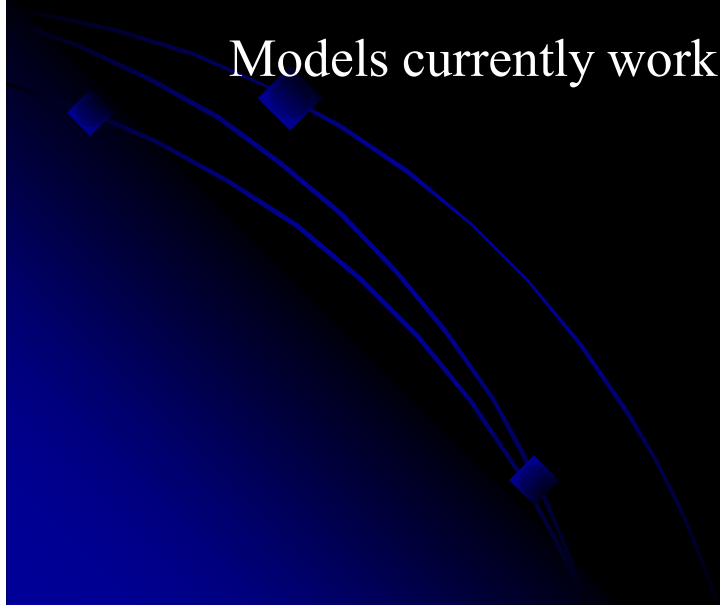


Computer modeling

“One well-designed tracer test, properly done, and correctly interpreted, is worth 1000 expert opinions... or 100 computer simulations of groundwater flow.”

James Francis Quinlan

Models currently work best in karst for large areas and deep aquifers



Cave biology research methods

Leave to experts unless properly trained
It is too easy to do more harm than good

Things you can do:

Count bats when they exit caves

Report species observed and
the conditions where they were found

Collect species only if you have a specialist ready to identify them
and who gives you appropriate collecting materials

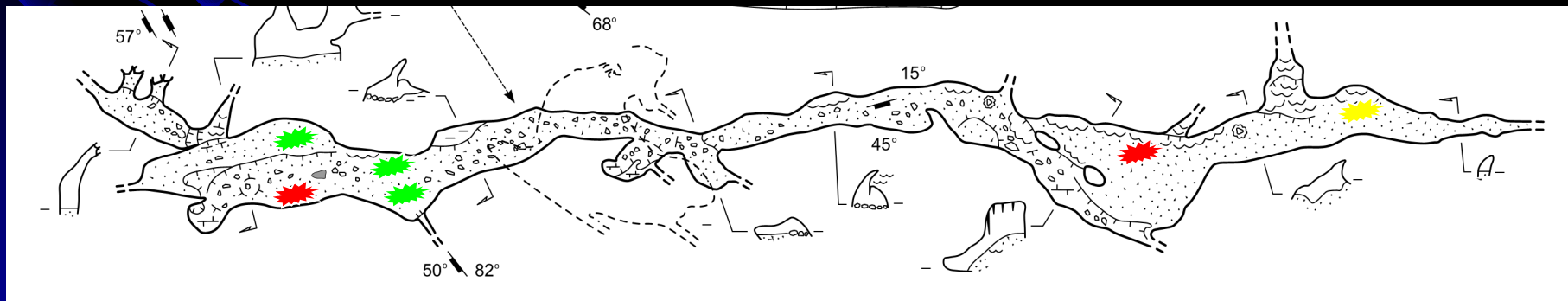


Show cave research methods

Monitor cave conditions



Impact mapping



Show cave research methods
Photo monitoring

