A Review of Energy Research at the Kentucky Geological Survey

Speaker: Brandon C. Nuttall

Eastern Kentucky Society for Petroleum Engineers, Lexington

15-Jan-2015

Colleagues at KGS

- Jerry Weisenfluh
- Energy & Minerals
  - David C. Harris
  - Steve Greb
  - John Hickman
  - Cortland Eble
  - Tom Sparks
  - Rick Bowersox
  - Warren Anderson
  - Marty Parris
  - Dave Williams
- Hazards
  - Zhenming Wang
  - Seth Carpenter
- Water
  - Charles Taylor
  - Junfeng Zhu
  - Glynn Beck
- Web and Data Services
  - Doug Curl
  - Carrie Pulliam
  - Liz Adams

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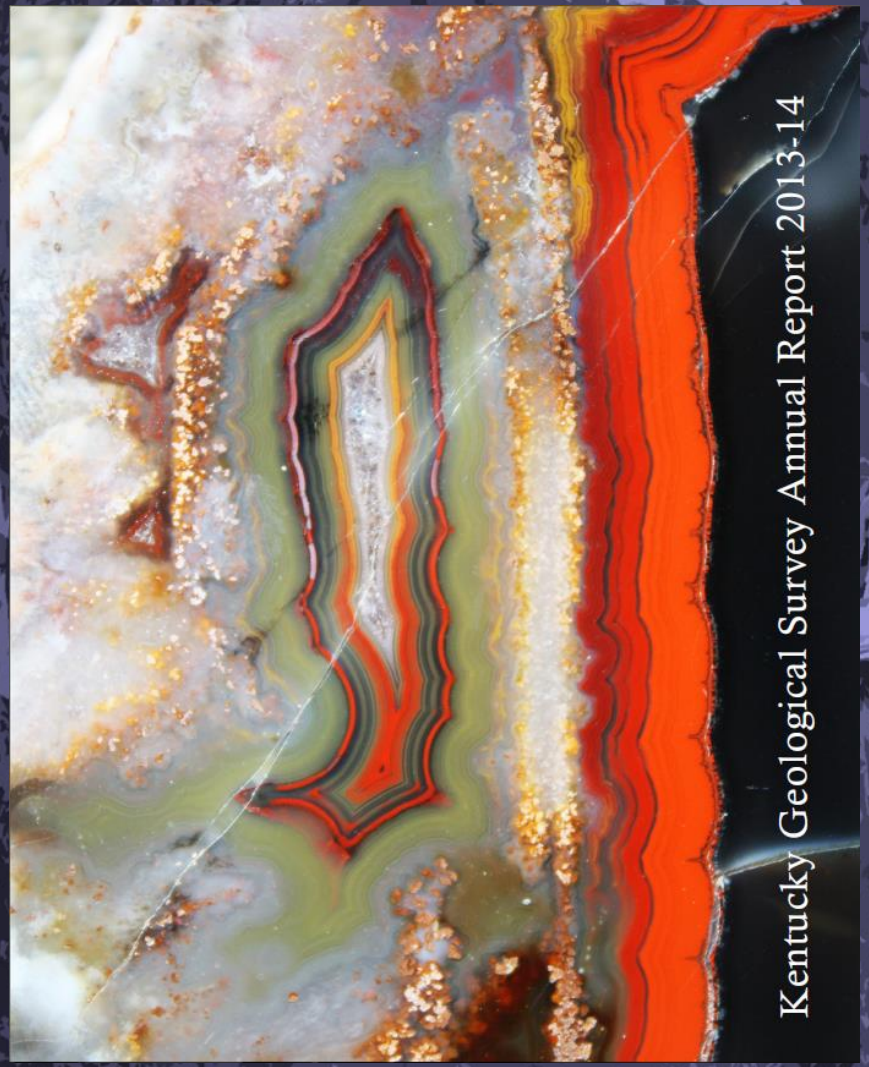
2014 Annual Report



- kgs.uky.edu/kgsweb/olops/pub/kgs/AR13-14.pdf

Scan QR code to access report with your mobile device

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New Online Map Services

- KGS Minerals Database
  - Warren Anderson, Tom Sparks, Richard Smath, Doug Curl
- UIC wells in Kentucky
  - Tom Sparks and Doug Curl

Minerals Database

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Kentucky Geological Survey

KGS Minerals Map

Explore Kentucky mineral features

About This Service | Help

- Legend
- Layers
- Find Mineral Features

Find a location:

532 Rose St, Lexington, KY

Search for mineral features using at least one of the parameters below:

Limit search to viewed extent

Site Name:

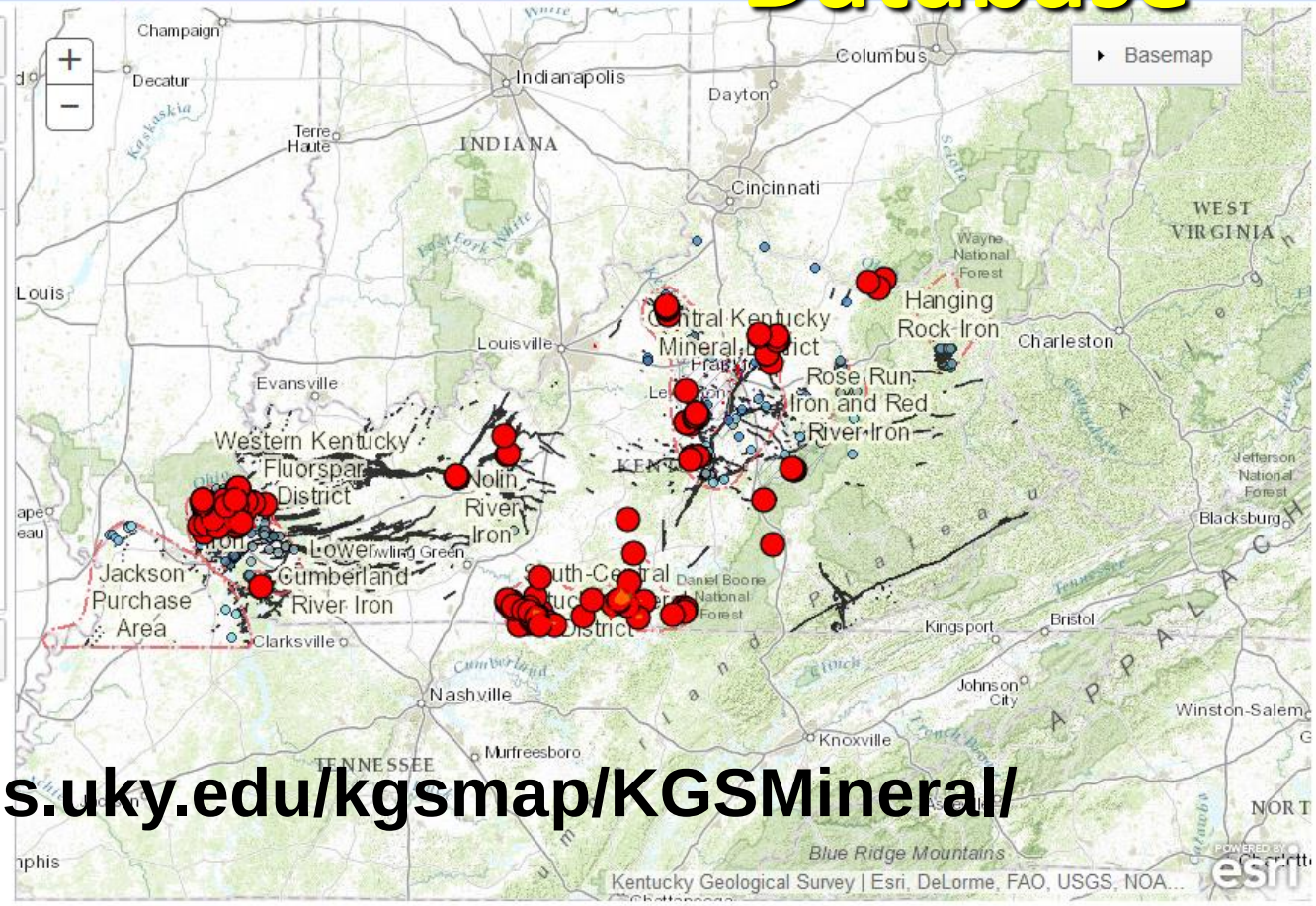
Commodity / Mineral: zinc

County:

Quadrangle (24K):

Search

- Print



http://kgs.uky.edu/kgsmap/KGSMineral/

Ore ID	Feature	Type	Name	Link	Document Types
1502	Point	Prospect	Bear Branch Creek (Routt) Vein	http://kgs.uky.edu/MineralDocs/CKMD/Anderson_County/Anderson_...	Bulletin
1508	Point	Mine shaft	Caldwell Veins	http://kgs.uky.edu/MineralDocs/CKMD/Bourbon_County/Bourbon_exc...	Bulletin
1515	Point	Mine shaft	Cassius Clay Veins	http://kgs.uky.edu/MineralDocs/CKMD/Bourbon_County/Bourbon_exc...	Bulletin
1524	Point	Mine shaft	Paris Vein	http://kgs.uky.edu/MineralDocs/CKMD/Bourbon_County/Bourbon_exc...	Bulletin
1525	Point	Mine shaft	Paris Vein	http://kgs.uky.edu/MineralDocs/CKMD/Bourbon_County/Bourbon_exc...	Bulletin
1507	Point	Mine shaft	Caldwell Veins	http://kgs.uky.edu/MineralDocs/CKMD/Bourbon_County/Bourbon_exc...	Bulletin
1532	Point	Adit	Purdy Vein	http://kgs.uky.edu/MineralDocs/CKMD/Bourbon_County/Bourbon_exc...	Bulletin

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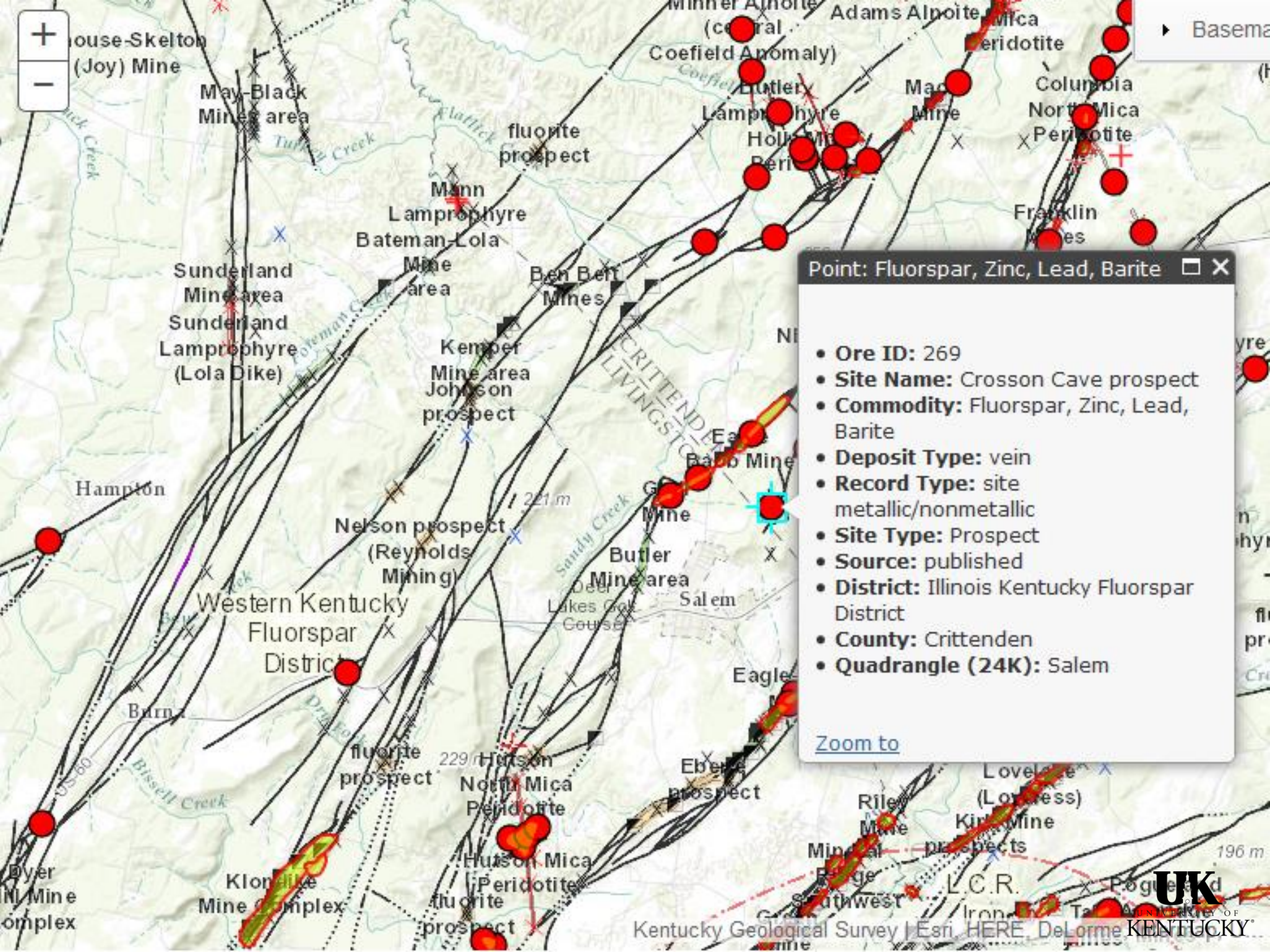
Point: Fluorspar, Zinc, Lead, Barite
Ore ID: 269
Site Name: Crosson Cave prospect
Commodity: Fluorspar, Zinc, Lead, Barite
Deposit Type: vein
Record Type: site metallic/nonmetallic
Site Type: Prospect
Source: published
District: Illinois Kentucky Fluorspar District
County: Crittenden
Quadrangle (24K): Salem
Zoom to
Western Kentucky Fluorspar District
Hampton
Salem
Nelson prospect (Reynolds Mining)
Butler Mine area
Kemper Mine area
Johnson prospect
Bateman-Lola Mine area
Ben Bell Mines
Sunderland Mine area
Sunderland Lamprophyre (Lola Dike)
Mann Lamprophyre
fluorite prospect
May-Black Mines area
Coefield Anomaly)
Columbia
North Mica Peridotite
Klondike Mine Complex
Hutson Mica Peridotite
CRITTENDEN
LIVINGSTON
Kentucky Geological Survey | Esri, HERE, DeLorme
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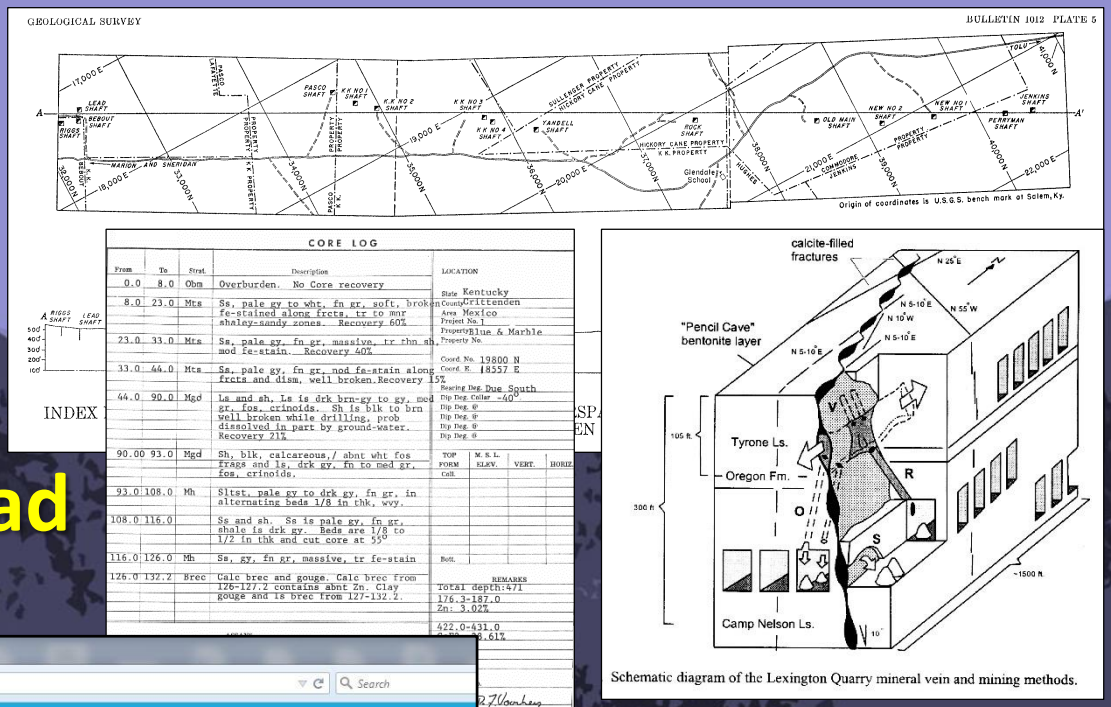
Scanned documents available for download


GEOLOGICAL SURVEY

BULLETIN 1012 PLATE 5

Origin of coordinates is U.S.G.S. bench mark at Salem, Ky.

CORE LOG

From	To	Strat.	Description
0.0	8.0	Obm	Overburden. No Core recovery
8.0	23.0	Mts	Ss, pale gy to wht, fn gr, soft, broken fe-stained along frcts, tr to mar shaley-sandy zones. Recovery 60%
23.0	33.0	Mts	Ss, pale gy, fn gr, massive, tr thn sh, mod fe-stain. Recovery 40%
33.0	44.0	Mts	Ss, pale gy, fn gr, mod fe-stain along frcts and dism, well broken. Recovery 15%
44.0	90.0	Mgd	Ls and sh. Ls is drk brn-gy to gy, med gr, fos, crinoids. Sh is blk to brn well broken while drilling, prob dissolved in part by ground-water. Recovery 21%
90.00	93.0	Mgd	Sh, blk, calcareous,/ abnt wht fos frags and ls, drk gy, fn to med gr, fos. crinoids.
93.0	108.0	Mh	Siltst, pale gy to drk gy, fn gr, in alternating beds 1/8 in thk, wvy.
108.0	116.0		Ss and sh. Ss is pale gy, fn gr, shale is drk gy. Beds are 1/8 to 1/2 in thk and cut core at 55°
116.0	126.0	Mh	Ss, gy, fn gr, massive, tr fe-stain
126.0	132.2	Brec	Calc brec and gouge. Calc brec from 126-127.2 contains abnt Zn. Clay gouge and ls brec from 127-132.2.

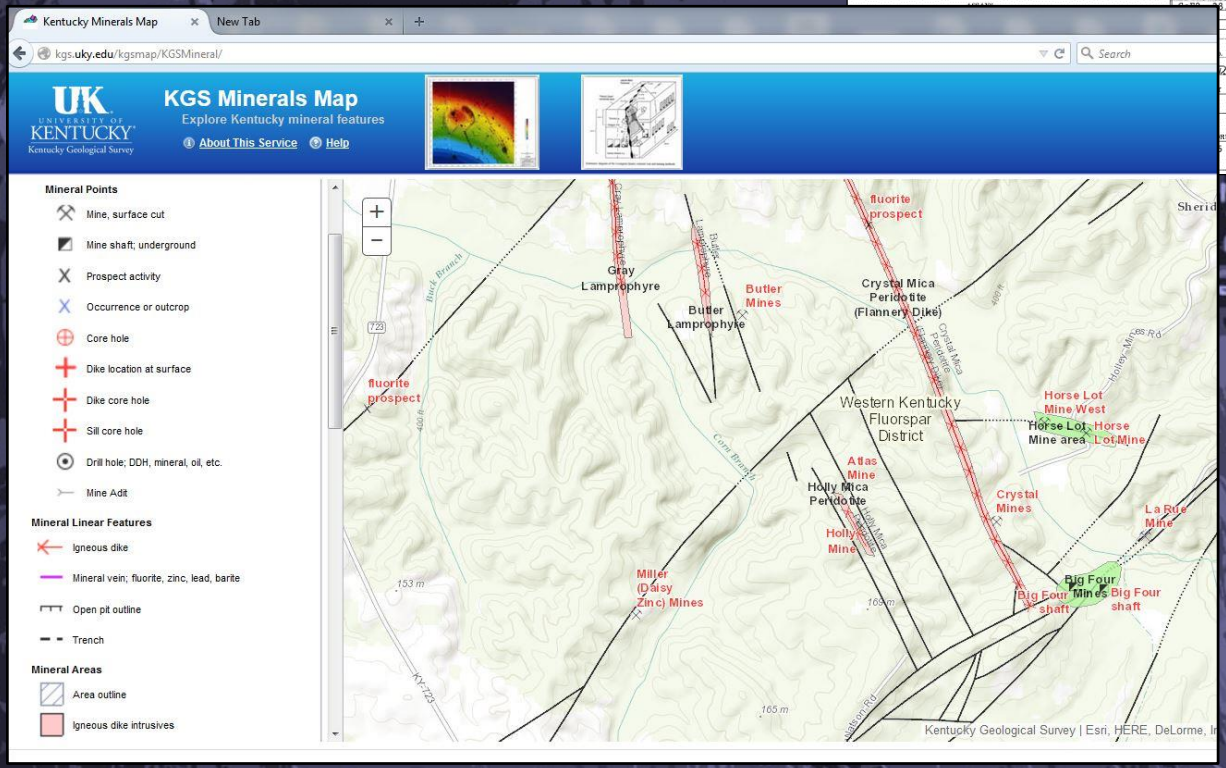
LOCATION

State Kentucky
County Crittenden
Area Mexico
Project No. 1
Property Blue & Marble
Property No.
Coord. No. 19800 N
Coord. E. 18557 E
Bearing Deg. Due South
Dip Deg. Collar -40°

REMARKS

Total depth 471
176.3-187.0
Zn: 3.02%
422.0-431.0
Zn: 28.61%

Schematic diagram of the Lexington Quarry mineral vein and mining methods.



Mines, pits, shafts, prospects, veins, and other occurrences

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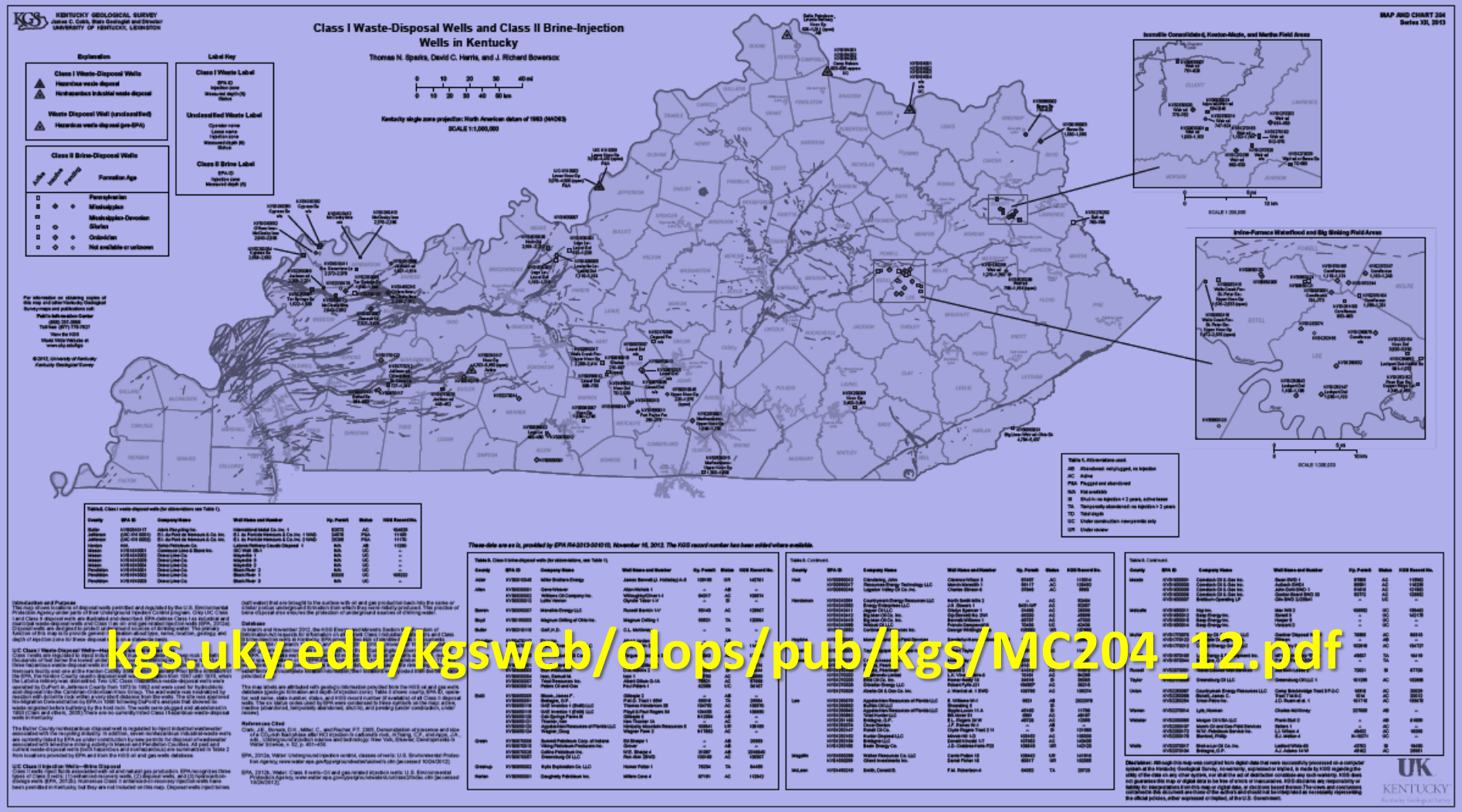
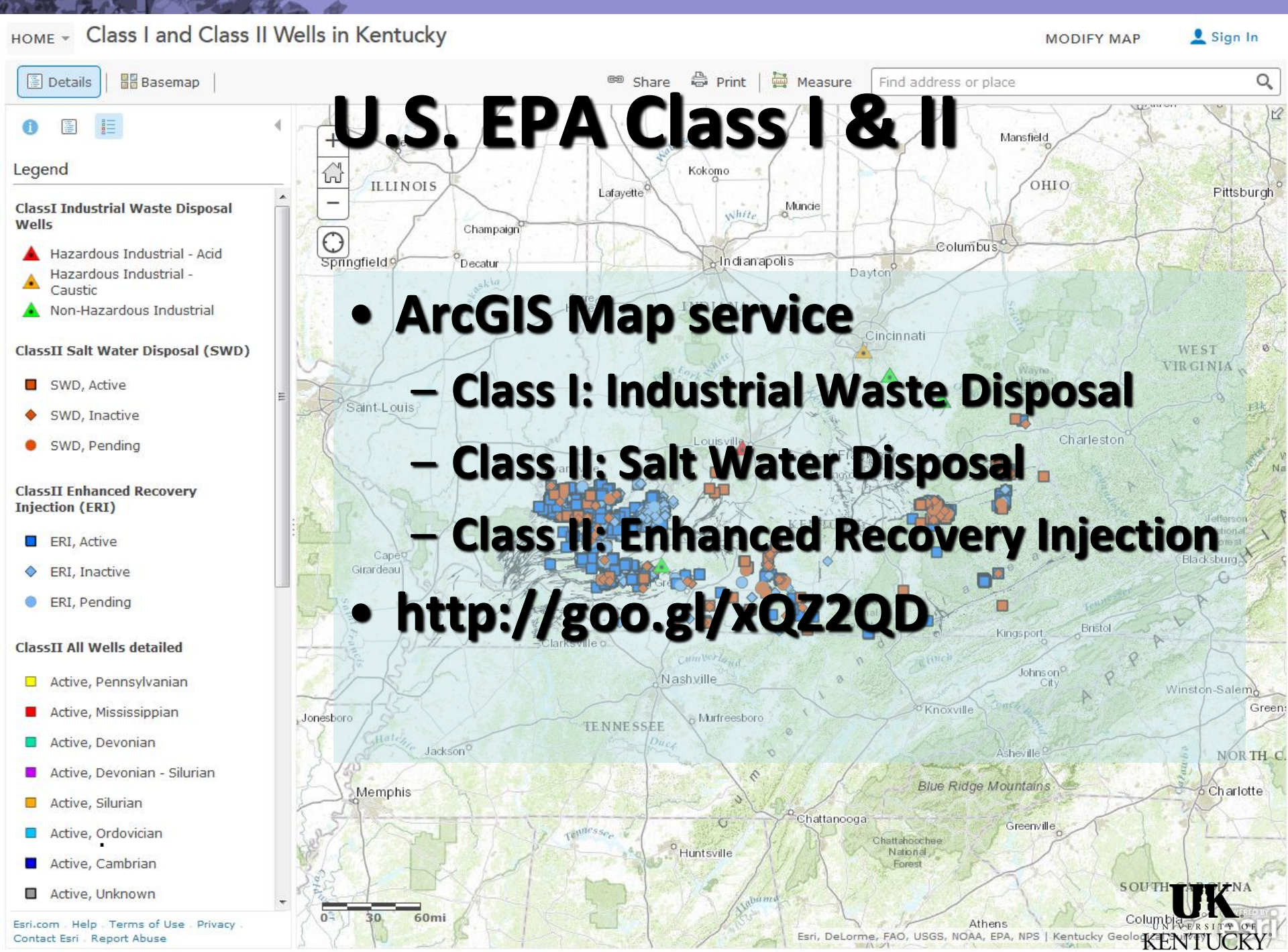
Waste Disposal and Brine Injection, 2013





U.S. EPA Class I & II

- ArcGIS Map service
  - Class I: Industrial Waste Disposal
  - Class II: Salt Water Disposal
  - Class II: Enhanced Recovery Injection
- http://goo.gl/xQZ2QD

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HOME

Class I and Class II Wells in Kentucky

MODIFY MAP | Sign In

Details | Basemap | Share | Print | Measure | Find address or place

Legend

ClassI Industrial Waste Disposal Wells - labels

- Hazardous Industrial - Acid
- Hazardous Industrial - Caustic
- Non-Hazardous Industrial

ClassII Salt Water Disposal (SWD) - labels

ClassII Salt Water Disposal (SWD)

- SWD, Active
- SWD, Inactive
- SWD, Pending

ClassII Enhanced Recovery Injection (ERI)

- ERI, Active
- ERI, Inactive
- ERI, Pending

ClassII All Wells detailed

- Active, Pennsylvanian
- Active, Mississippian
- Active, Devonian
- Active, Devonian - Silurian
- Active, Silurian

(1 of 5)

ClassII_SWD_detailed: BRETAGNE, G.P.

EPA_ID	KYS2370104
COMPANY_NAME	BRETAGNE, G.P.
WELL_NAME	A.J. ADAMS
WELL_NO	14 W
WELL_CLASS	2
WELL_TYPE	D
ClassII_Type	Salt Water Disposal
STATE	KY
COUNTY	WOLFE
STATUS	AC

Zoom to

Meteorite Collection Donated

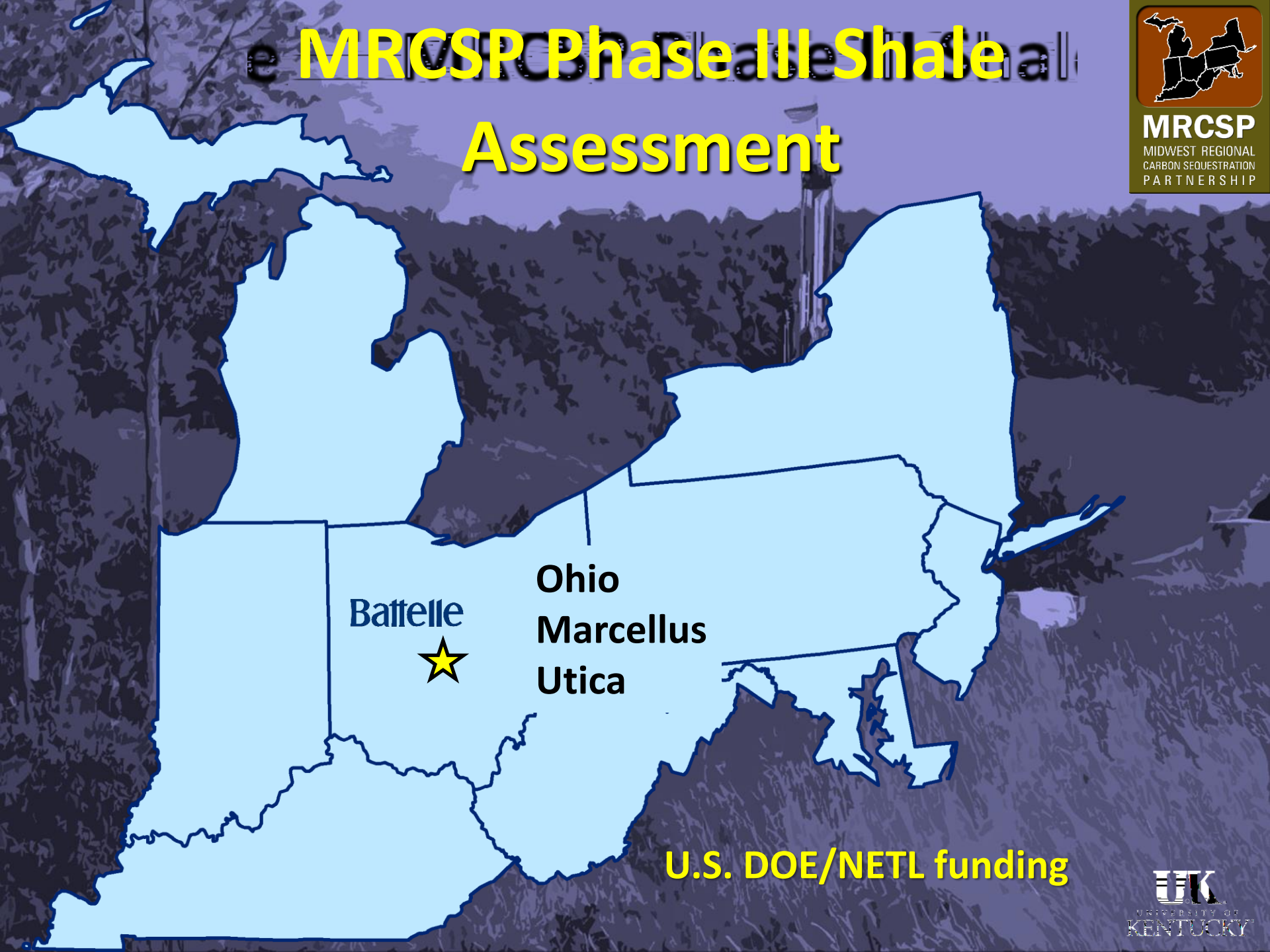
- William Russell, Civil engineer, Goshen, Ky.
- Being catalogued and indexed
  - ≈ 200 specimens
  - 10 from Kentucky

Widmanstatten pattern

BOXHOLE
Plenty River, Northern Territory, Australia
Found: June 1937
Iron Octahedrite, medium (IIIAB)
Total known weight: 500 kg

See also Ehmann (2000) Space Visitors in Kentucky, KGS Series 12, SP 1

MRCSP Phase III Shale Assessment



U.S. DOE/NETL funding

MRCSP
MIDWEST REGIONAL
CARBON SEQUESTRATION
PARTNERSHIP

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Goals and Objectives

- Digital well log data
  - LAS curves, formation tops
  - TOC: proxy for storage capacity
- Geospatial distribution TOC
  - Marcellus
  - Utica

$$TOC = 55.822\left(\frac{\rho_B}{\rho} - 1\right)$$

Schmoker (1993)

MRCSP
MIDWEST REGIONAL CARBON SEQUESTRATION PARTNERSHIP

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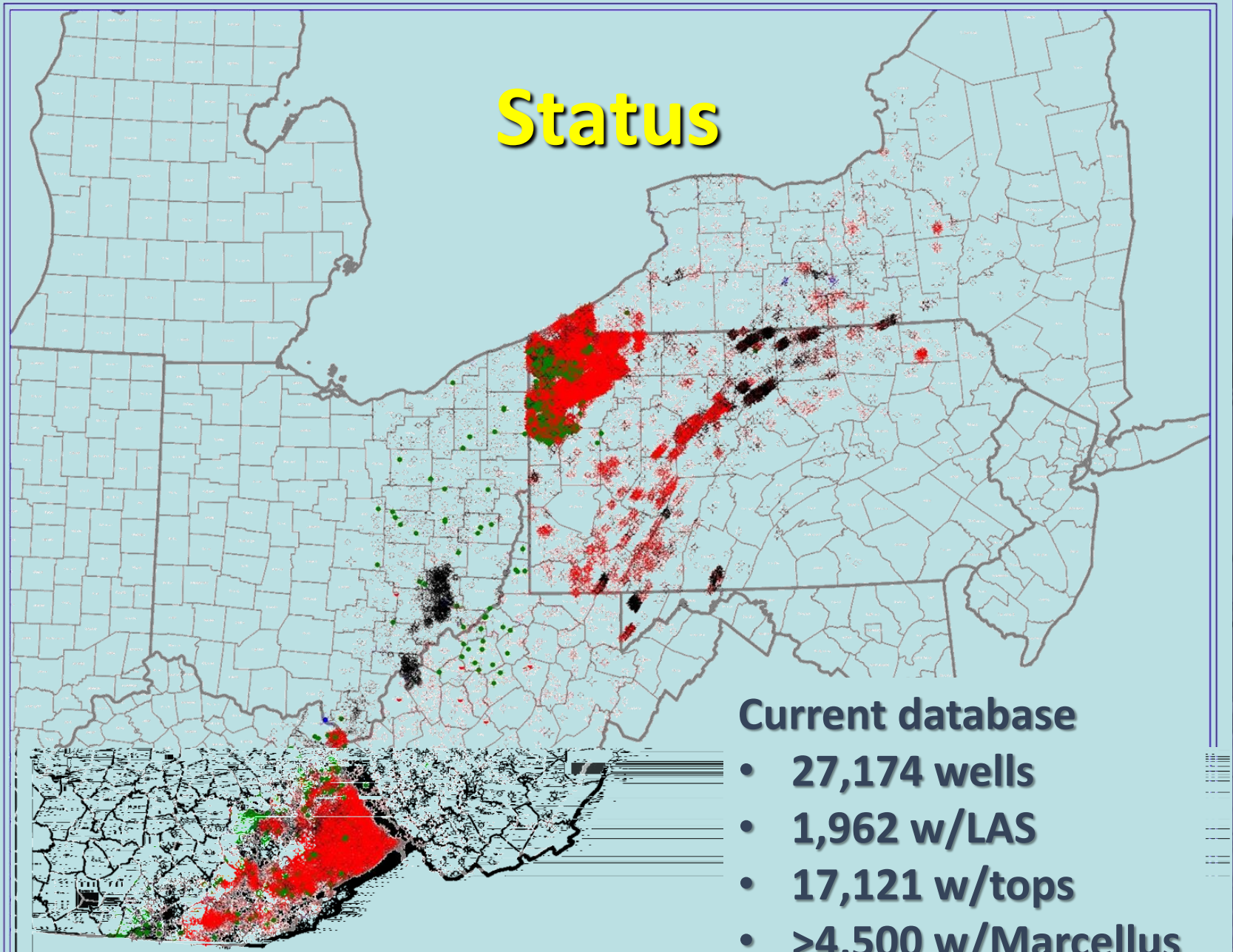
Status



Current database

- 27,174 wells
- 1,962 w/LAS
- 17,121 w/tops
- >4,500 w/Marcellus

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MIDWEST REGIONAL
CARBON SEQUESTRATION
PARTNERSHIP

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sustain
a journal of environmental and sustainability issues

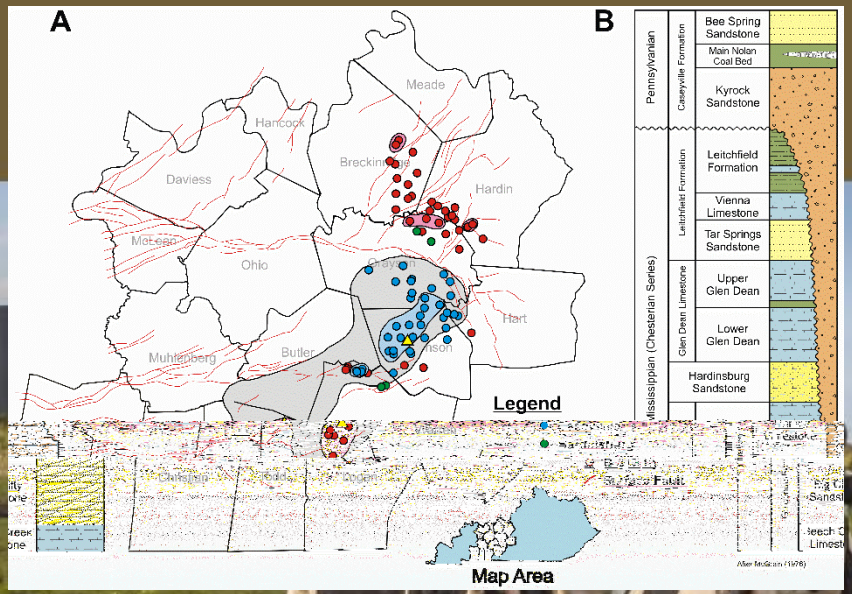
Issue 31
Fall/Winter 2015

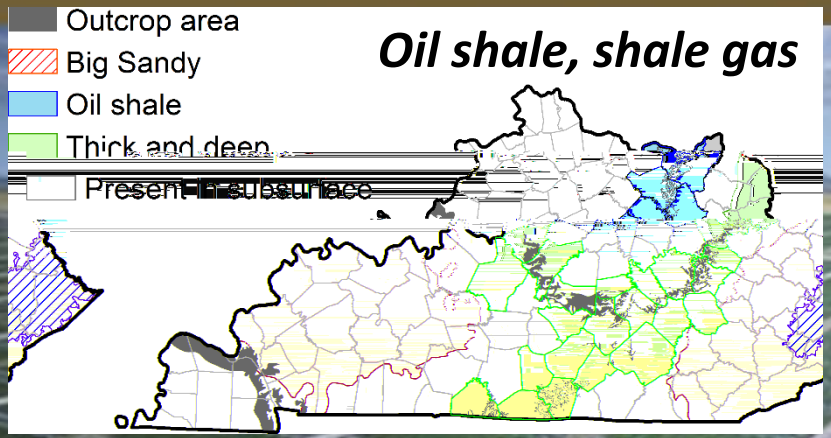
The
Kentucky Institute
for the Environment
and Sustainable
Development

Brandon Nuttall & Rick Bowersox

Kentucky's Unconventional Hydrocarbon Resources

Heavy oil, KGS publication pending





http://louisville.edu/kiesd/sustain-magazine/SUSTAIN_31.pdf

Development of a Brine Disposal Framework for the Northern Appalachian Basin

Marty Parris, Tom N. Sparks

Kentucky Geological Survey

Funding: RPSEA 2011 Unconventional Resources Program

RPSEA
Research Partnership to Secure Energy for America

O.D.N.R. GEOLOGICAL SURVEY

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Kentucky Geological Survey

Battelle
The Business of Innovation

PENNSYLVANIA GEOLOGICAL SURVEY EST. 1836

WVGES
West Virginia Geological and Economic Survey

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Goals and Objectives

- Develop regional geologic framework
- Reservoir simulation
  - Injectivity, pressure response, geomechanical
- Evaluate disposal
  - Demand, storage capacity, costs
- Provide guidance for stakeholders
  - Developers, producers, government, public

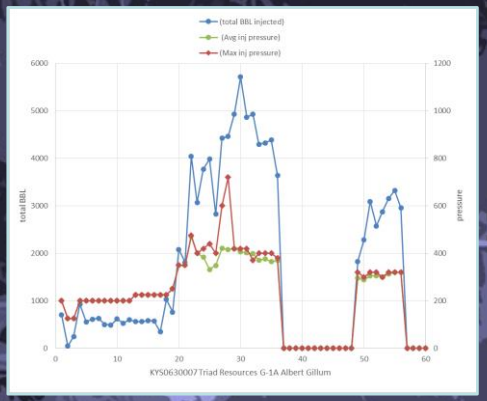
Progress

RPSEA
Research Partnership to Secure Energy for America

Geomechanics

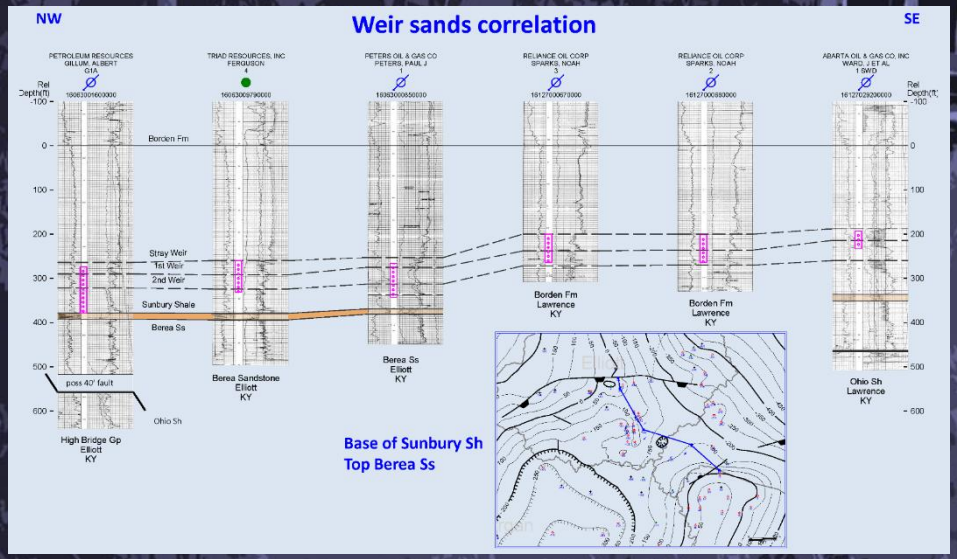
KGS 1 Hanson Ag.: Rose Run, Copper Ridge, Mount Simon

Brine Disposal



US EPA FOIA operational data for 21 active Class II wells

Modeling



Case Study: Weir Sand, Isonville, Elliott Co

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Final Report

- March 2015, due to RPSEA
  - State summaries
  - Products and tools for industry
  - Class II data compilation and summary

Berea Sandstone Consortium

Sunbury

Berea

Marty Parris, Stephen Greb, Cortland Eble,
Brandon Nuttall, Dave Harris

Develop a better understanding of the distribution and preservation of organic matter and maturity with respect to occurrence of production.

Berea & Bedford

Berea

AA Highway, photo courtesy S. Greb

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Consortium Partners

Funding Partners

- Nytis Exploration
- Cimarex Energy
- Abarta Oil & Gas
- Hay Exploration
- EQT Production
- Vinland Energy
- Fireborn
- CountryMark

In-Kind Research Partners

- U.S. Geological Survey
- Ohio Division of Geological Survey
- R.J. Lee Group, Inc.
- Universal Well Services

KGS Principal Investigators

- Marty Parris
- Steve Greb
- Cortland Eble

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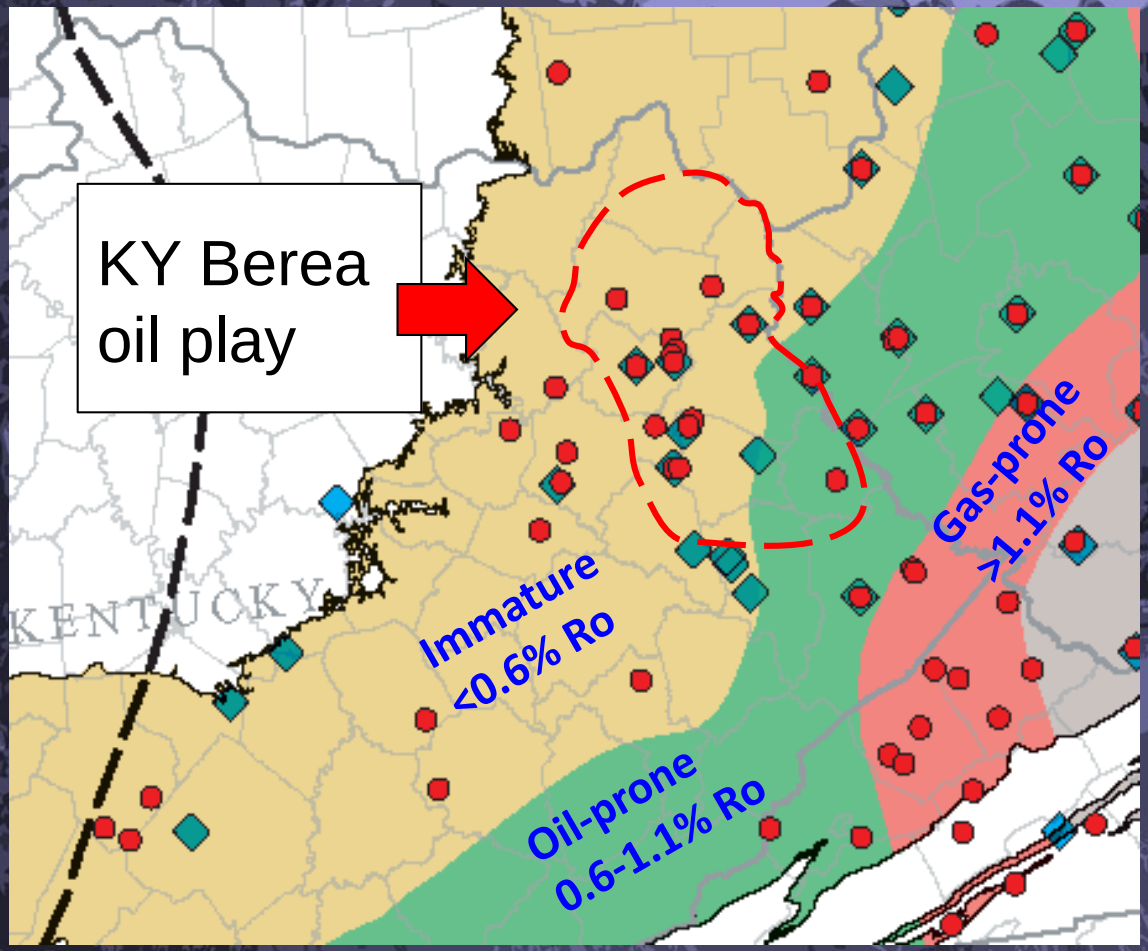
Key Research Question



What are the controls on Berea production where it is thermally immature?

USGS Thermal Maturity Map
(East and others, SIM 3214, 2012)

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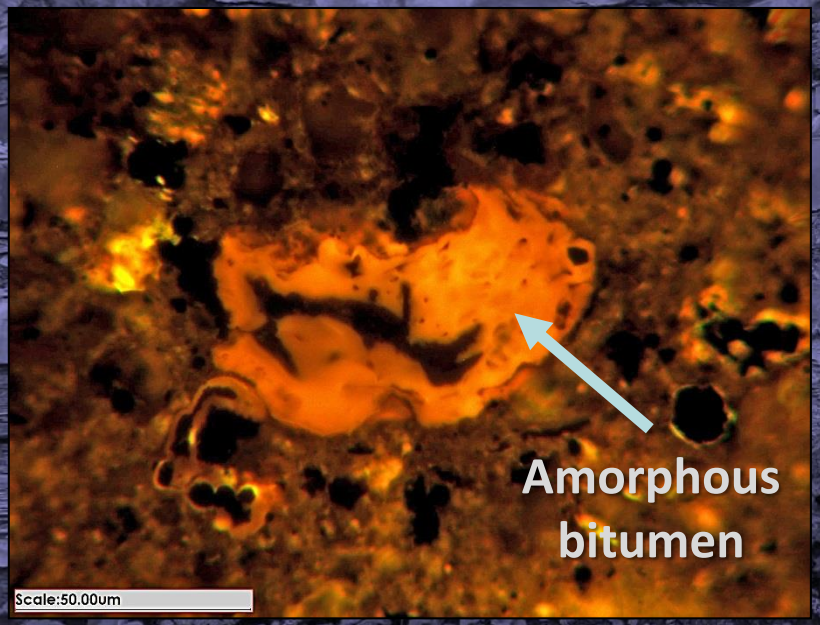
Tasks

- Thermal maturity assessment
- Stratigraphic & structural analysis
- Organic geochemical analysis



UV image courtesy of C. Eble

Final report publication expected December 2016

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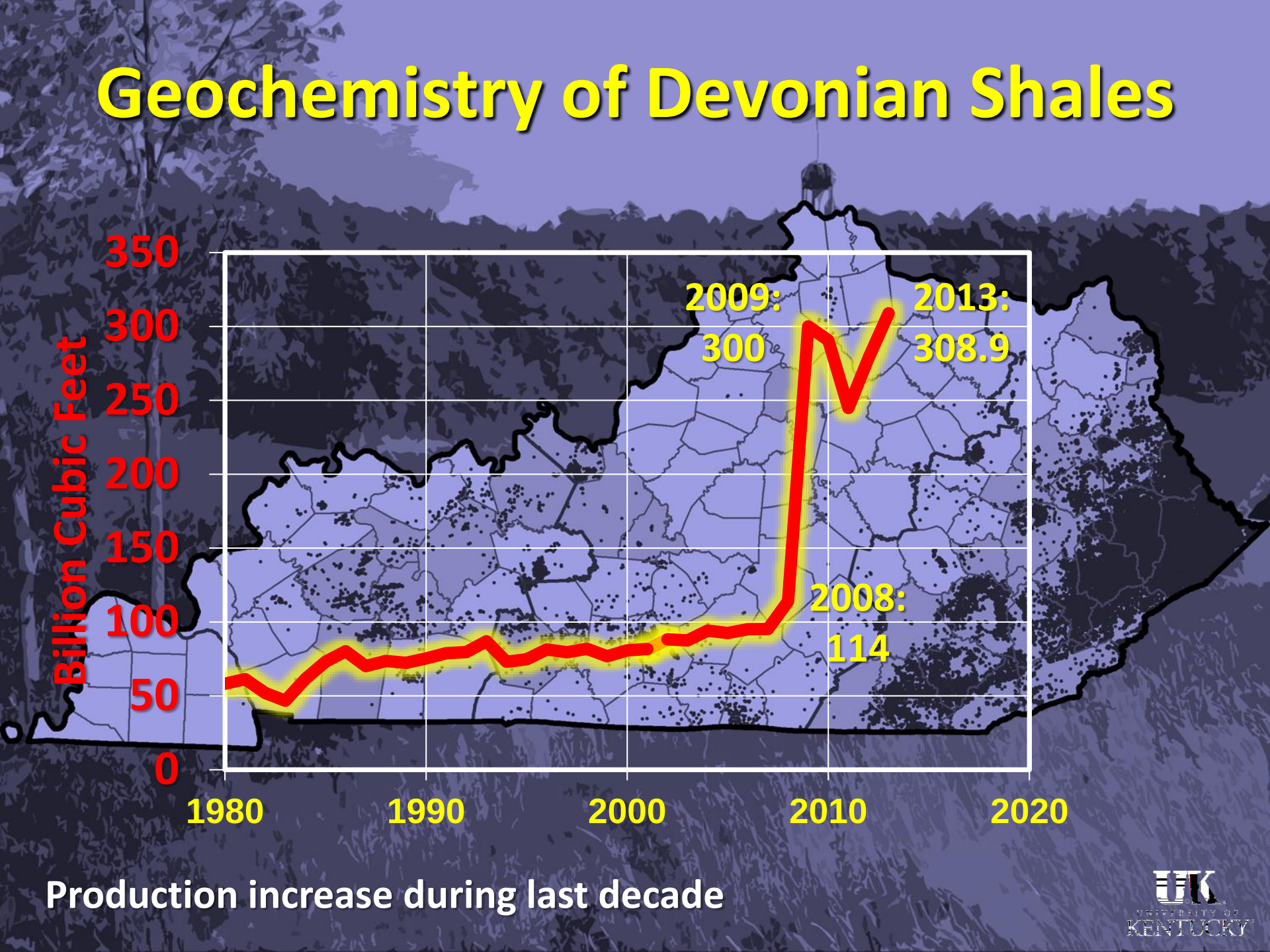
Geochemistry of Devonian Shales



Production increase during last decade

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Gas/Oil Ratios (Mcf/bbl)

Hardrock 1 Pullen

2

Endeavor 5 Whitfill

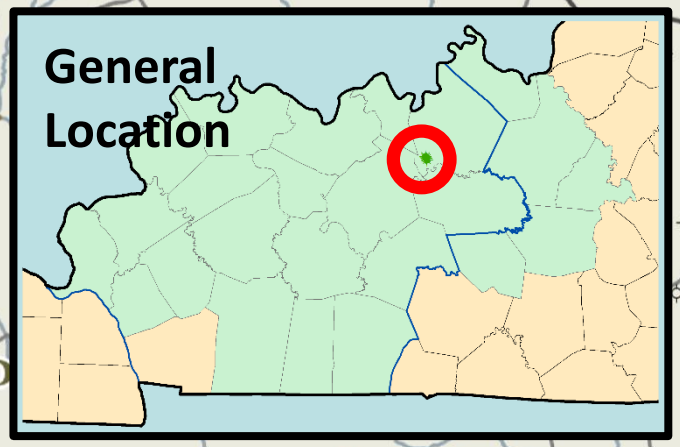
1.8, *5.7 GPM*

3.6

3.8, *5.0 GPM*

Endeavor 4 Burton-Whitfill

4



5,482 bbls (2012)

BRECKINRIDGE

GRAYSON

Vanzant

Askin

Rockdale

Dempster

Glen Dean

261

629

108

2201

110

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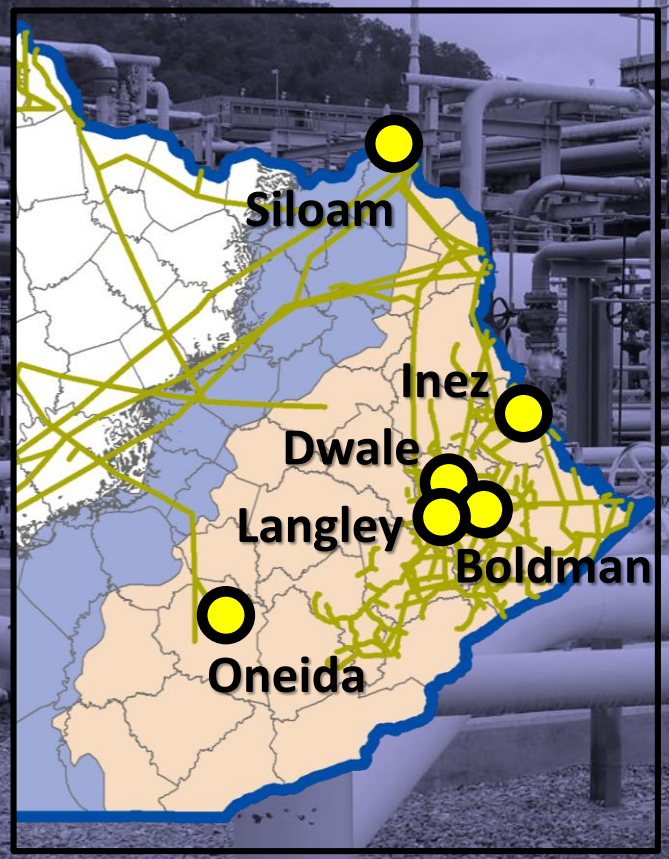
5MM Barrels of NGL



MarkWest Langley Plant

- 50% capacity
- No ethane cracker
- Ranger – Y-grade liquids pipeline (ethane)
- Big Sandy – natural gas pipeline (ethane)

www.rtknet.org
www.eia.gov/dnav/ng/ng_prod_ngpl_s1_a.htm (2012)

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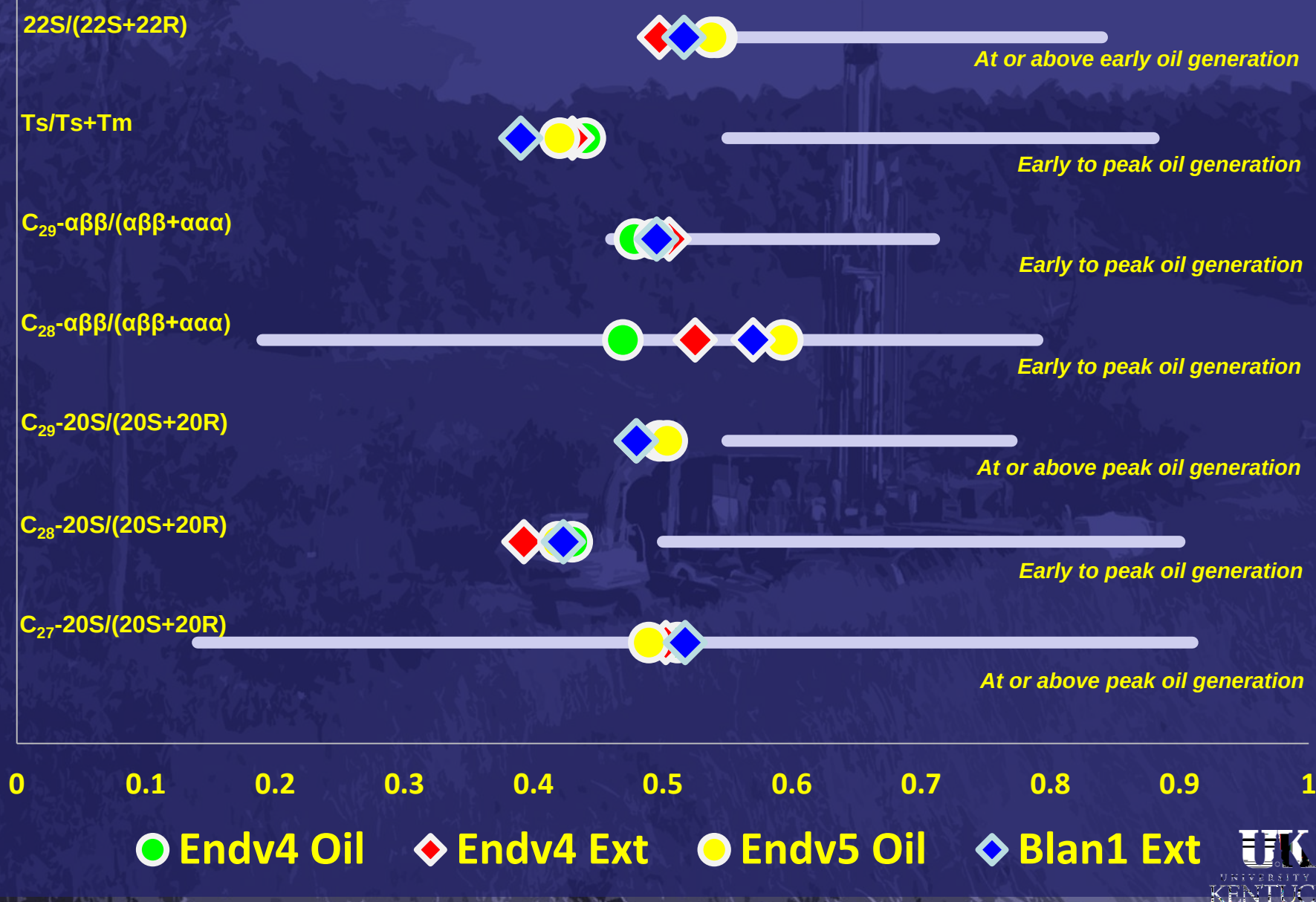
Biomarkers: Early Mature



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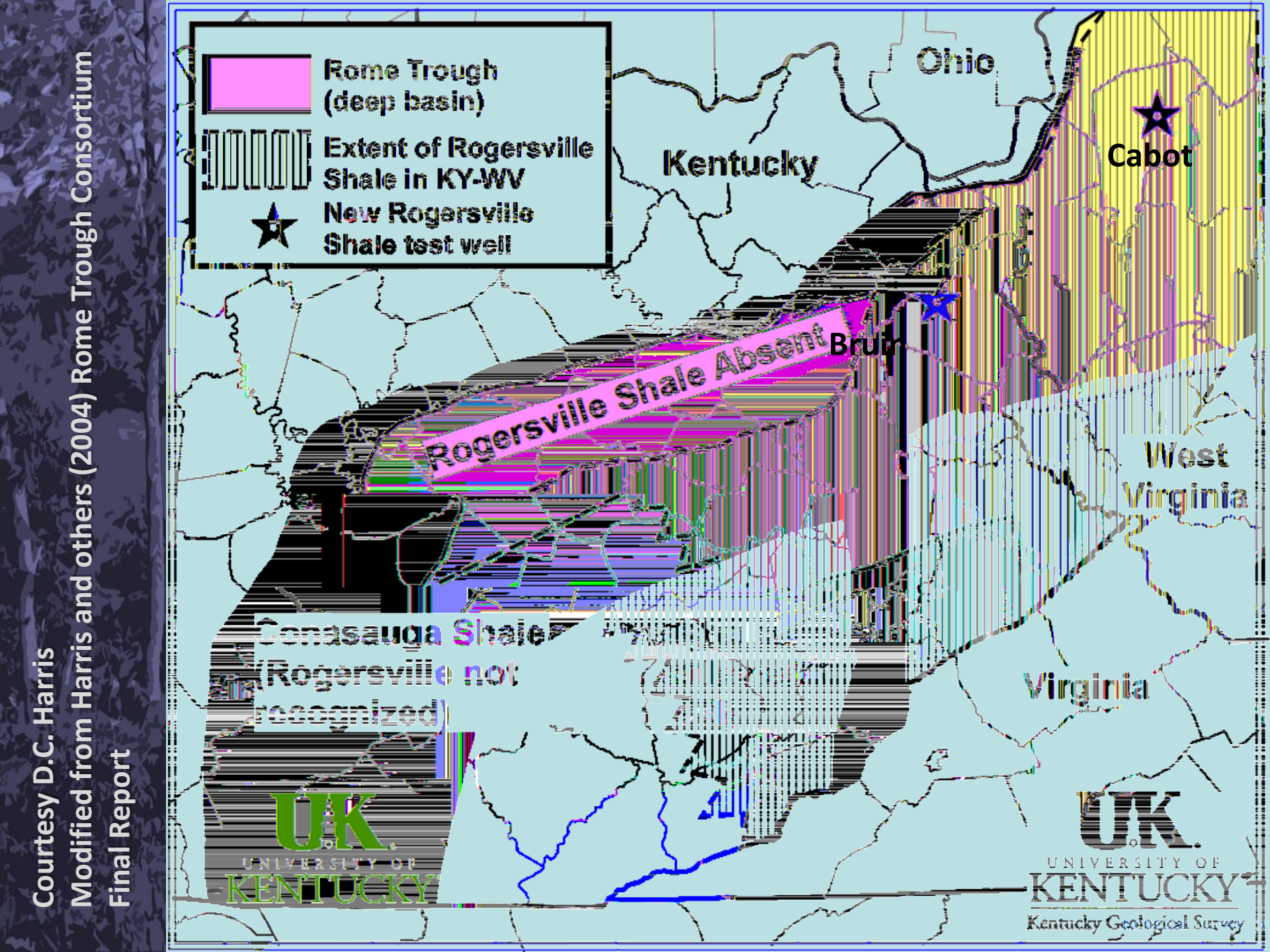

Courtesy D.C. Harris
Modified from Harris and others (2004) Rome Trough Consortium
Final Report

Induced Seismicity Fact Sheet

Induced Seismic Events in Kentucky

FACT SHEET

UK Kentucky Geological Survey

Seismic events can result from natural causes such as fault movement and volcanic activity, or human activities such as mine blasts or injection of fluids into deep boreholes. The magnitude of and distance from a seismic event, along with other factors, determines the amount of shaking that may be felt at the surface. The most frequent seismic events have very low levels of shaking—most of which are undetectable without special instruments located very close to the epicenter of the event. Seismic events that are large enough to cause considerable ground shaking and result in damage to structures and loss of life occur infrequently. With few exceptions, these are naturally occurring earthquakes. Most seismic events triggered or induced by human activity produce only very low-level shaking; however, some instances of wastewater injection have reactivated faults and caused earthquakes of moderate magnitude (Ellsworth, 2013).

Induced Seismic Events

documented in states near Kentucky (e.g., Arkansas and Ohio). Although it is likely that hydraulic fracturing induces seismic events in Kentucky, no events of this origin are known to have been detected by the KGS monitoring instruments and are unlikely to cause felt events. Waste injection in Kentucky has the potential to generate seismic events of larger magnitude that resemble natural earthquakes, but no such events have been identified.

Mining-related events (blasting and roof falls) are the leading examples of induced seismic events in Kentucky (Street and others, 2002). Figure 1 is a 24-hour seismic recording on Oct. 29, 2014, at station HZKY in Hazard. There were many small seismic events on this date that were related to mine blasts in the Eastern Kentucky Coal Field; the largest events were approximately magnitude 2. Blasting is also associated with limestone quarries and mines throughout the state.

Hydraulic fracturing is the process of injecting water, chemical additives, and fine sand into under-

- Fracking in Kentucky not likely to cause felt events
- Data lacking on injection wells
- Study needed

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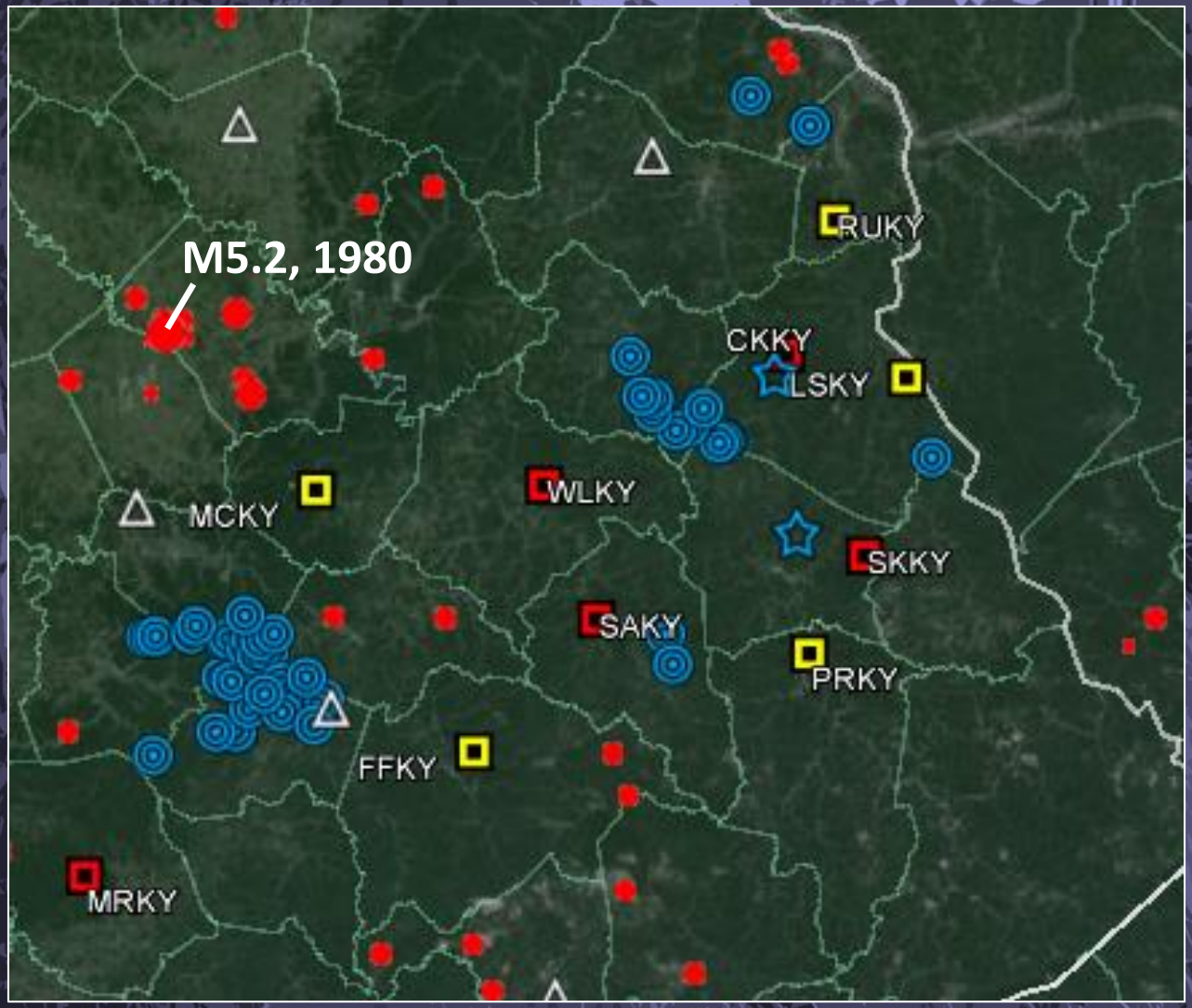
Monitoring Induced-Seismicity

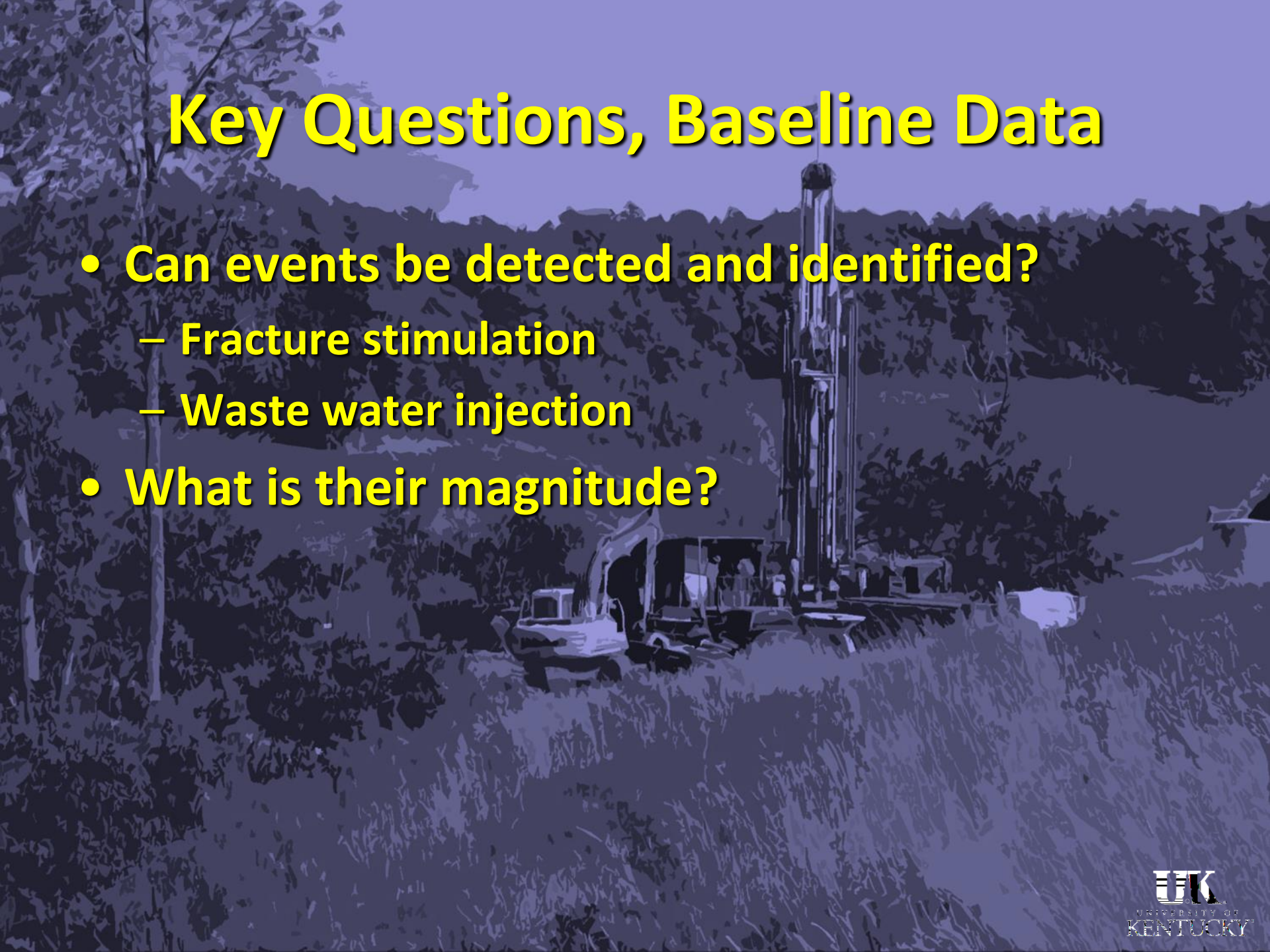


Seth Carpenter

- Earthquakes
- Existing seismic stations
- Class II SWD wells
- Deep fracked wells
- KGS proposed stations
- Nanometrics partnership stations

Key Questions, Baseline Data

- Can events be detected and identified?
  - Fracture stimulation
  - Waste water injection
- What is their magnitude?



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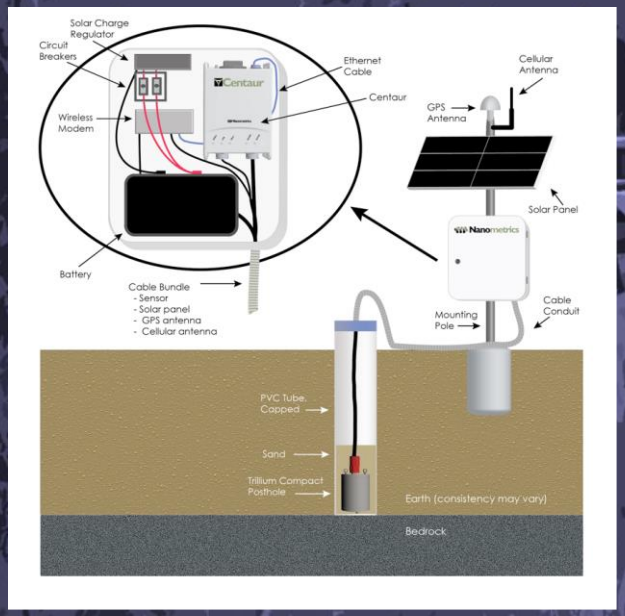
Partners

- UK Dept. Earth & Environmental Science
- Nanometrics
- Oil & gas industry?



Nanometrics is providing a station match with KGS.

If industry agrees to a 1-year lease, KGS will take ownership of the equipment.

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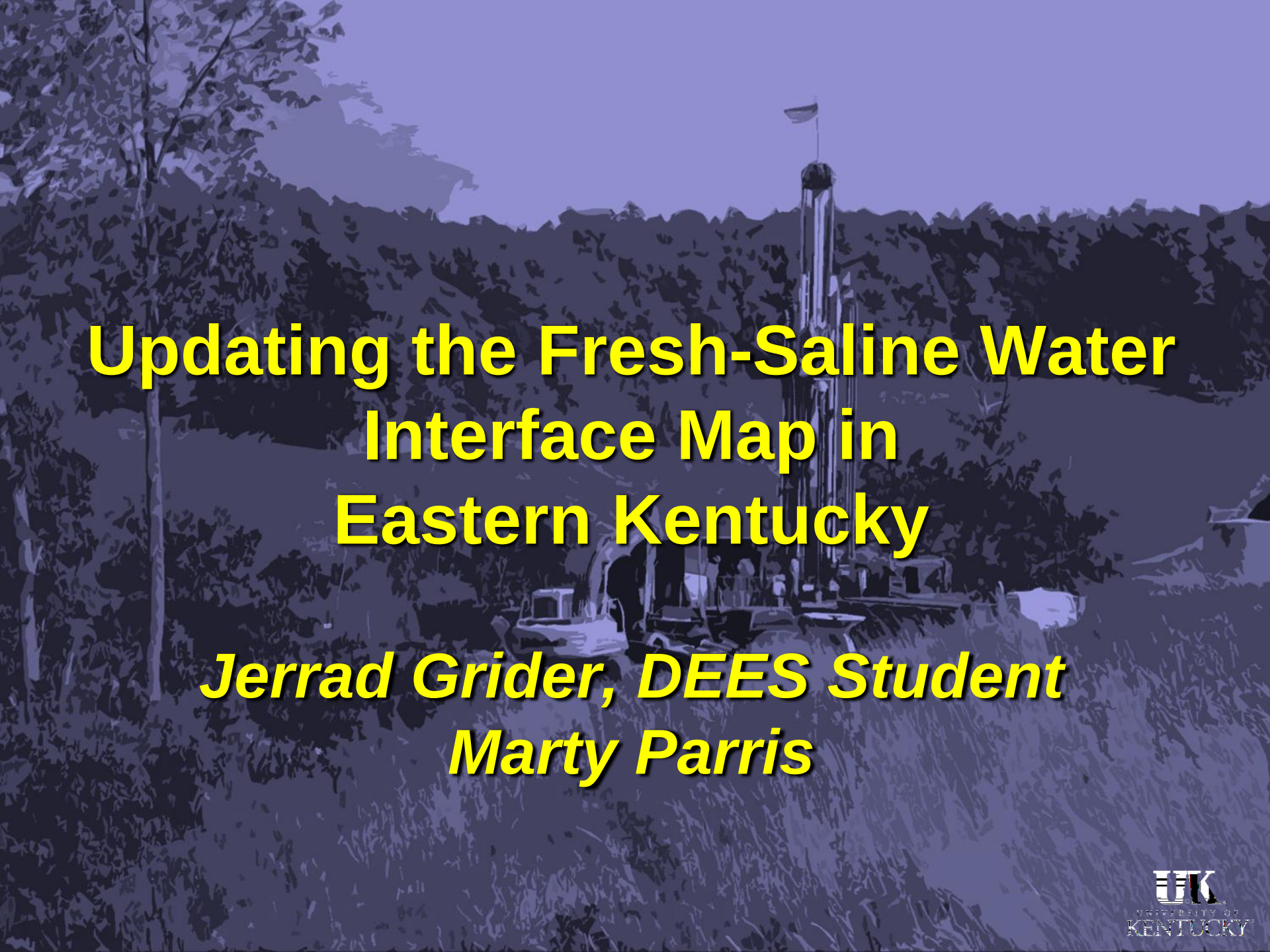
Status

- UK DEES & Nanometrics are onboard
- Preliminary network laid out
- Waiting on OK for initial deployment from Energy & Environment Cabinet
- Seeking partners for monitoring equipment leases



Updating the Fresh-Saline Water Interface Map in Eastern Kentucky

Jerrad Grider, DEES Student
Marty Parris

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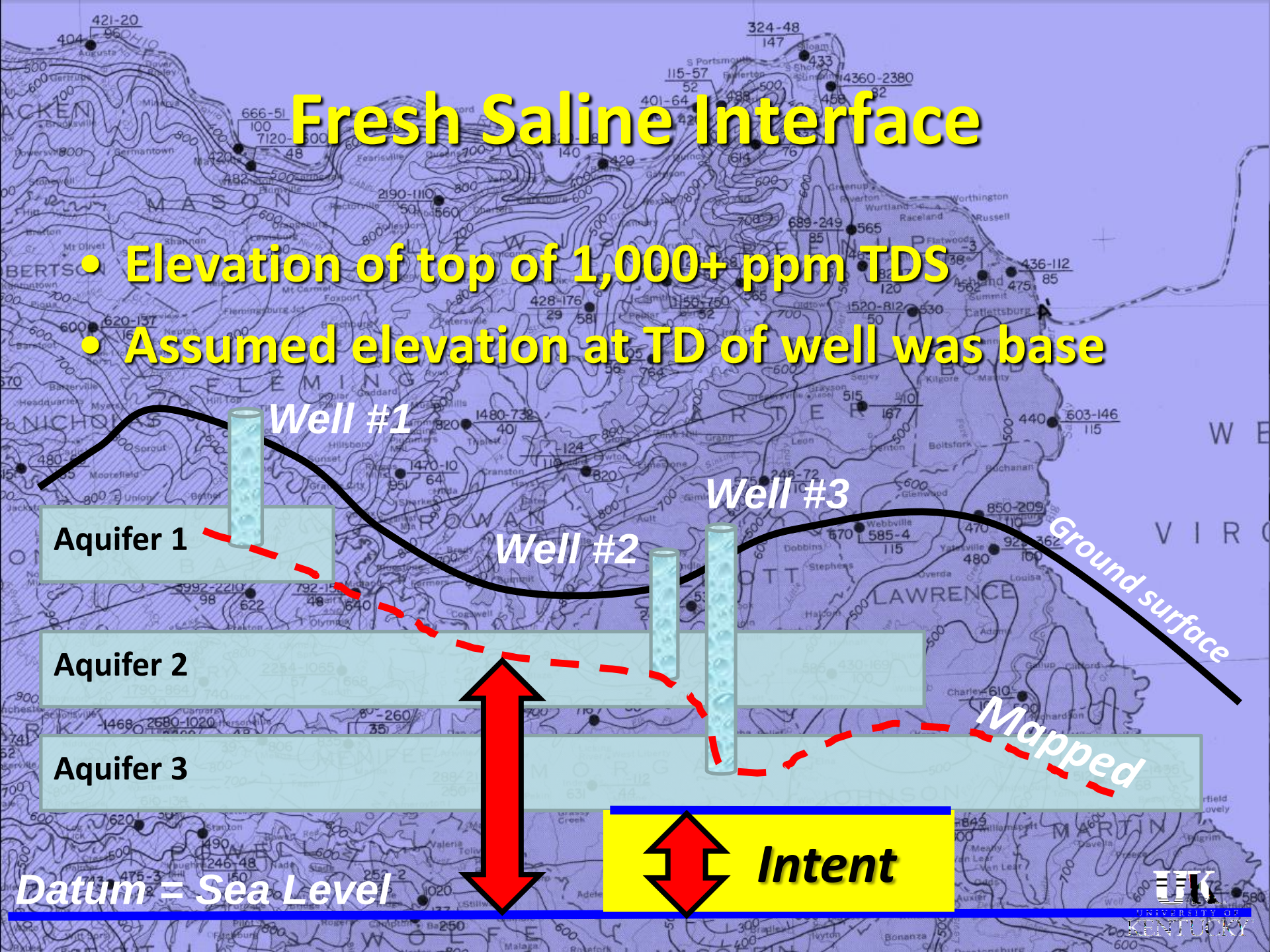
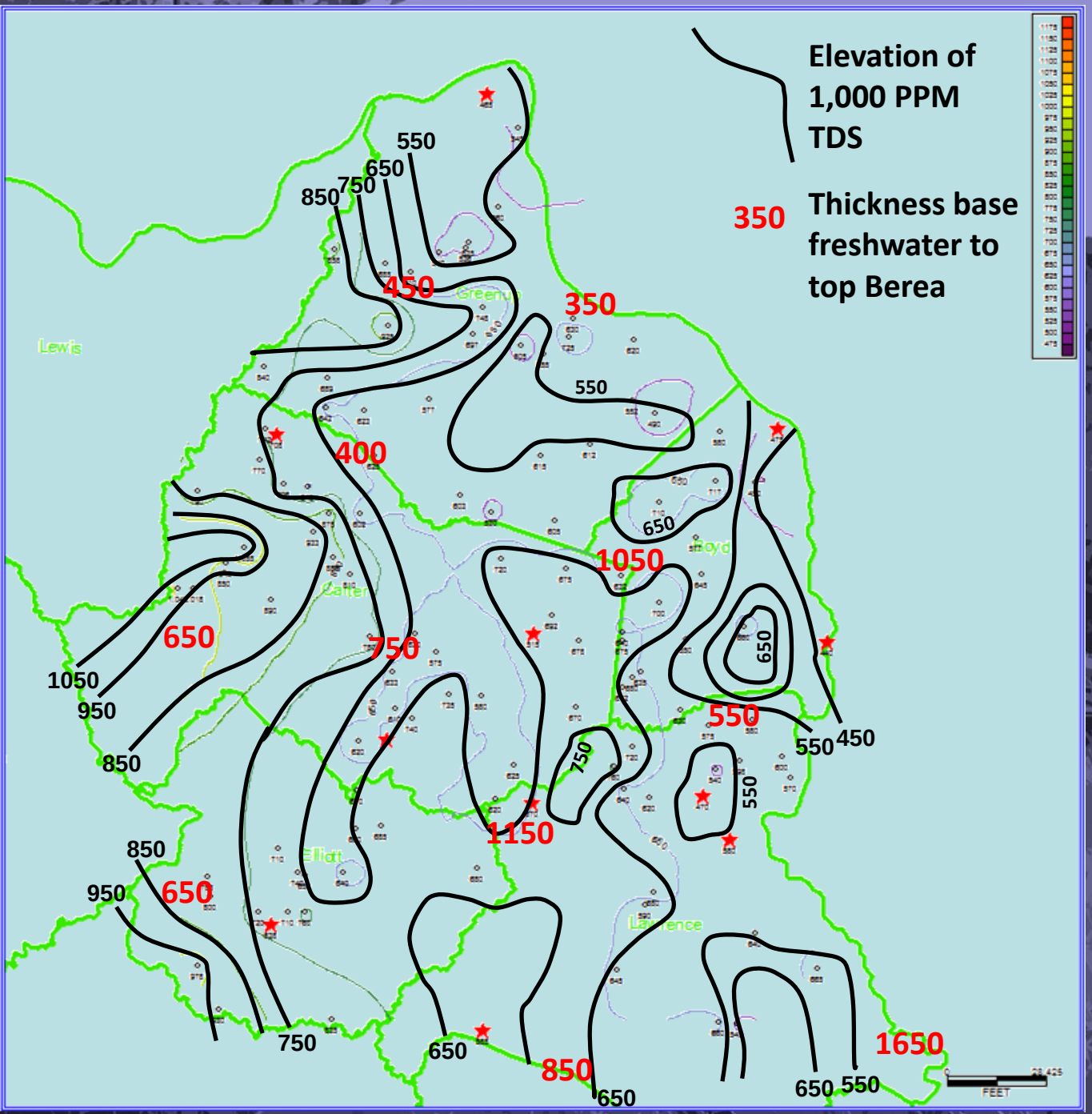
Fresh Saline Interface

- Elevation of top of 1,000+ ppm TDS
- Assumed elevation at TD of well was base





Deepest Observed Freshwater

- 28 wells (Hopkins)
- 120 wells KGS Groundwater Repository
- New diligence for oil & gas development

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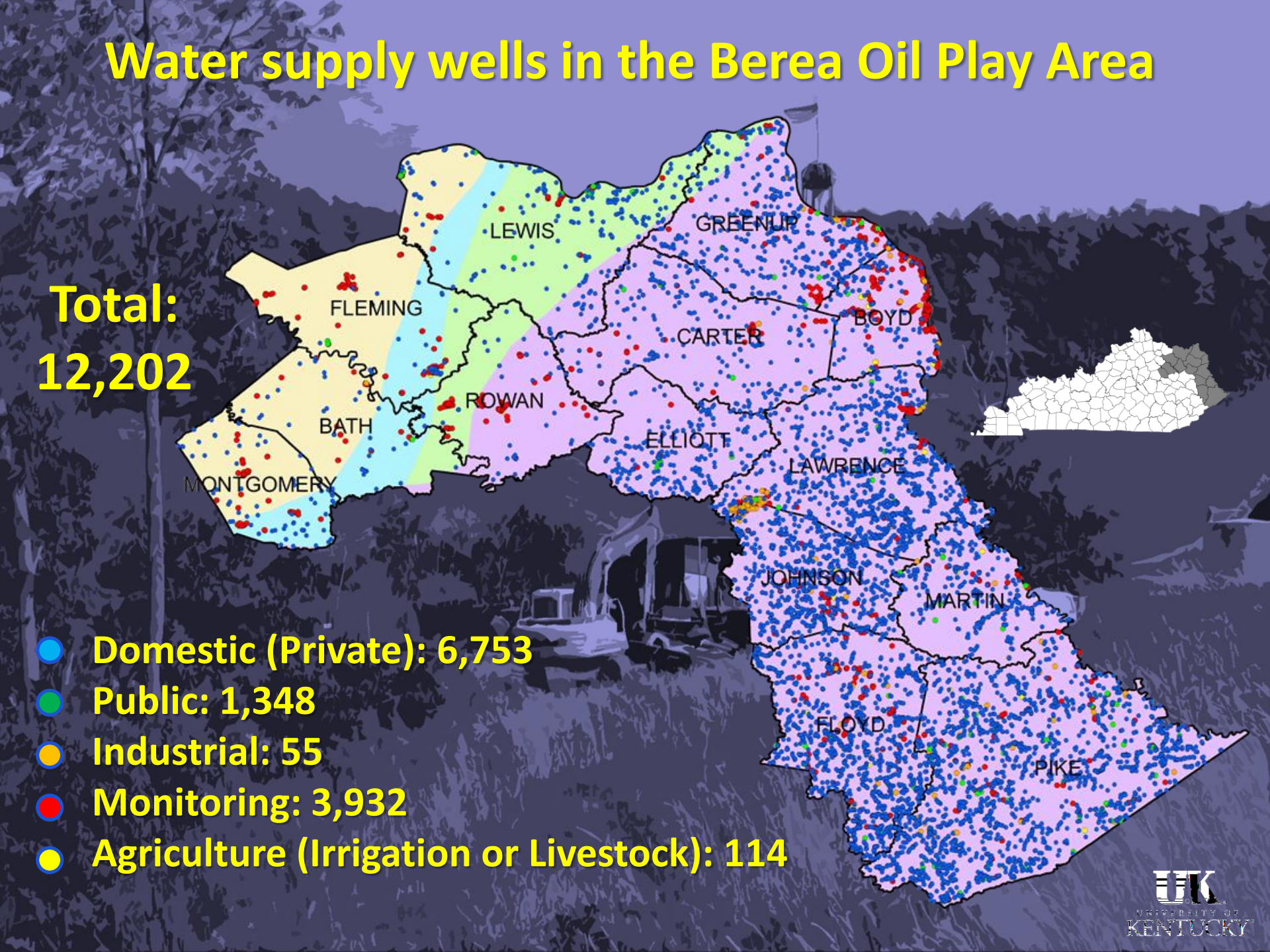
Water supply wells in the Berea Oil Play Area



Proposal: Baseline Groundwater Monitoring, Berea SS

- Characterize
  - Major producing aquifers
  - Groundwater uses
- Obtain
  - Baseline groundwater chemistry data
  - Long-term data from select monitor wells
    - Dissolved methane
    - Carbon isotopes
- Junfeng Zhu, Junfeng.zhu@uky.edu
- Chuck Taylor, Charles.taylor@uky.edu

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FracFocus Chemical Disclosure Registry

HYDRAULIC FRACTURING HOW IT WORKS | GROUNDWATER PROTECTION | CHEMICAL USE | REGULATIONS BY STATE | FIND A WELL BY STATE | FREQUENT QUESTIONS

FracFocus 2.0

HUNDREDS OF COMPANIES. THOUSANDS OF WELLS.

Welcome to FracFocus 2.0! We're excited about our latest upgrades designed to dramatically enhance the site's functionality for the public, state regulatory agencies and industry users. Our user-friendly 'Find A Well' chemical disclosure registry now includes more extensive search options.

FracFocus continues to evolve and expand, adding more participating companies and reported wells from across the country. Our continued success is the result of nationally recognized organizations working with state governments and the oil and natural gas industry to provide public transparency.

FIND OUT MORE

Welcome | Hydraulic Fracturing | Casing & Cement | State Regulations | Chemical Use

Looking for information about a *well site near you?*

Search for nearby well sites that have been hydraulically fractured to see what chemicals were used in the process.

TOTAL WELL SITES REGISTERED 62887

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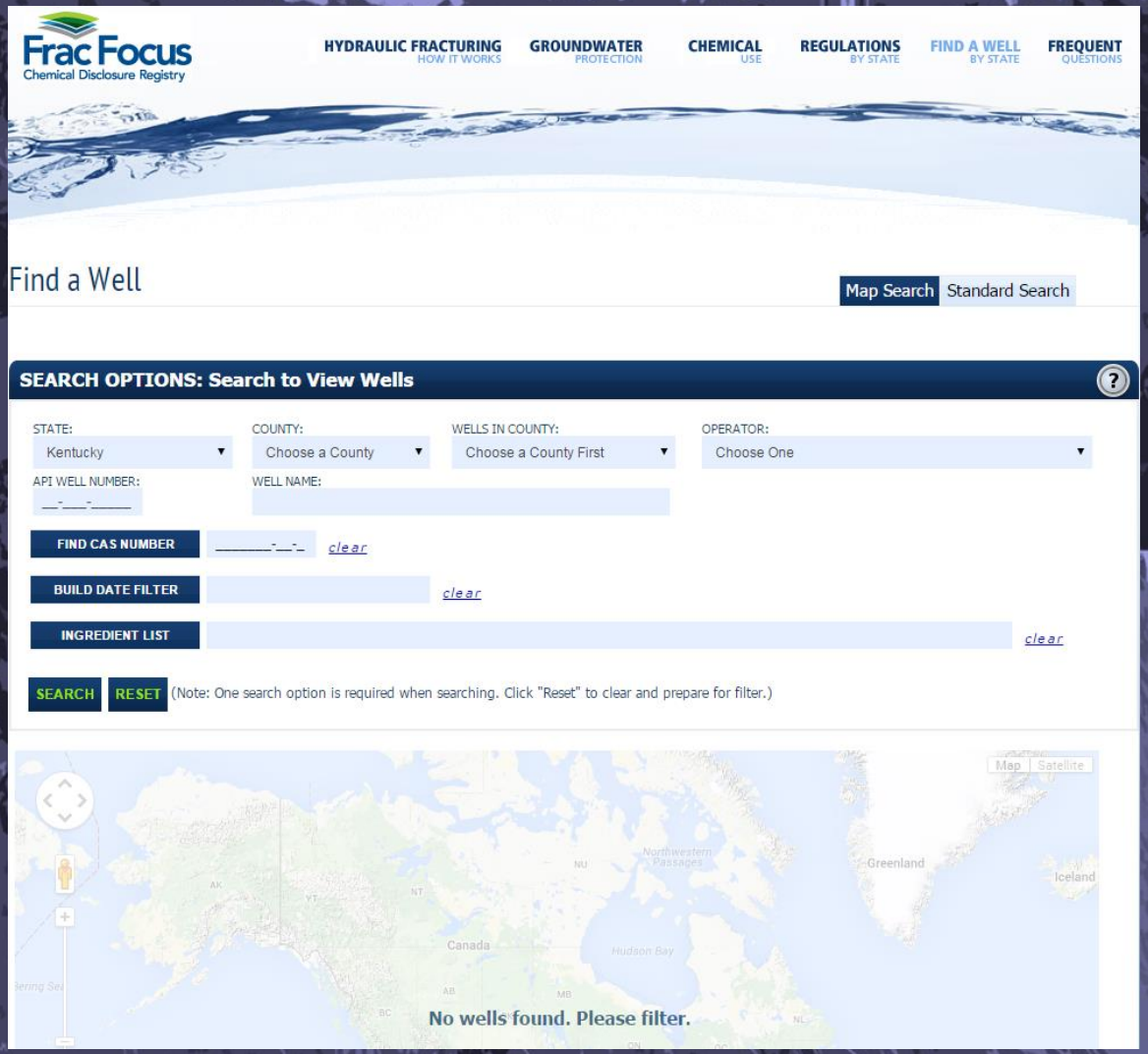
No Kentucky Data at FracFocus



Call for Participation & Support

To participate and support any of this research, contact:

- Dave Harris: Dcharris@uky.edu
- Brandon Nuttall: Bnuttall@uky.edu
- Seismicity, Seth Carpenter: Seth.carpenter@uky.edu
- Groundwater, Junfeng Zhu: Junfeng.zhu@uky.edu

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