Conasauga Shale Research Consortium

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U.S. Department of Energy

National Energy Technology Laboratory

Oil & Natural Gas

2020 Integrated Review Webinar

Program Overview

The overall objective of the project is to evaluate the UOG potential of the Cambrian Conasauga Group, and to do the preliminary science needed to support and promote the exploitation of that resource. To accomplish this, we plan to establish a field laboratory and utilize a horizontal well of opportunity to conduct a scientific study designed to advance the understanding of the petrophysical and geomechanical properties of the Rogersville Shale. This new knowledge will improve well completion design, ultimately leading to commercial production and the acceleration of play development. The data generated and compiled in this project will then be integrated into a Rogersville Shale Development Strategy Plan that will enable oil and gas industry to accelerate the development of this emerging resource.

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Program Overview

Dates	BP	DOE	Cost Share
10/19 - 1/21	**1**	**$ 687,312**	**$ 173,095**
2/21 – 1/22	2	$1,430,446	$1,112,606
2/22 – 8/23	3	$3,062,820	$ 155,035
9/23 – 8/24	4	$ 908,912	$ 141,516
		$6,089,491	$1,582,252

Project Participants

KY Geological Survey – PI, geophysics, petroleum geology

WV Geological Survey – Petroleum geology

WVU PNGE – Petroleum engineering, completion design

WVU Geology – Sedimentology

Hay Exploration – Industry partner

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Technology Background

Our efforts to analyze this Emerging UOG Play include a portfolio of both traditional petroleum geology techniques, and some new innovative tools and methods to characterize the reservoir and predict the most effective well completion and field development scenarios.

Reservoir and source-rock characterization will be achieved primarily through lab analyses of geologic samples (both new and pre-existing samples), including %TOC (organic richness), bitumen reflectance and pyrolysis (thermal maturity), microscopy (organic petrology), XRD (clay mineralogy), XRF (elemental provenance analysis), geomechanical tests (material strength and elastic parameters), and Sm-Nd isotopic composition (clay provenance).

Technology Background

The completion design and planned stimulation techniques for the Field Lab (well of opportunity) will be guided by an in-depth, AI Machine Learning analysis of thousands of previous unconventional (Marcellus and Utica) well/completion designs and their resulting production volumes. A similar technique was used successfully in the recent MSEEL DOE project.

Several completion designs derived from the ML and modeling work will be tested in the Field Lab. During these stimulations, a surface network of seismic nodes will record microseismicity and monitor fracture propagation.

Technology Background

To determine the success/efficiency of each designed stimulation stage, a fiber optic DAS/DTS cable will be lowered into the well during initial production. Temperature and acoustic monitoring with this cable will permit the simultaneous comparisons of the flow rates through each of the stages (estimated 17 total stages, prior to drilling).

In addition to the local network of seismic nodes during completion and initial production, the CSRC is also operating a regional network of seismometers (Kentucky Seismic and Strong Motion Network). These continuously operating units are recording the background seismicity of the Conasauga Play region to help determine the potential for induced seismicity from well operations.

Technical Approach/Project Scope

10/2019 BP-1: Pre-drilling Operations

a) Compile all existing "legacy" Conasauga data and geologic samples
b) "Postmortem" analysis of recent unsuccessful Rogersville Shale wells
c) Subsurface mapping of Conasauga shale units
d) ML analysis of previous well and completion designs
e) Begin background seismicity monitoring
f) Lab testing of "legacy" Conasauga samples

~2/2021 BP-2: Drilling the Research Lateral (Field Lab)

a) Continue ML analysis of previous well and completion designs
b) Model optimal completion plans and review with operator
c) Collect new geologic and reservoir fluids while drilling
d) Lab testing of new Conasauga samples from Field Lab
e) Design online portal for project data distribution
f) Continue background seismicity monitoring

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Technical Approach/Project Scope

~2/2022 BP-3: Well completion and initial production

a) Continue background seismicity monitoring
b) Complete geological/geochemical interpretations from lab results
c) Microseismic Node monitoring of completion stages
d) Begin 3D TOC/facies/lithology mapping of Conasauga units
e) Basin modeling for regional HC thermal maturation mapping
f) Geochemical analysis of produced fluids: isotopic, biomarker, and Noble gases
g) Down-hole fiber optics production data acquisition

~9/2023 BP-4: Data integration and final interpretations

a) Complete 3D mapping
b) Complete fiber optics production data acquisition
c) Supporting infrastructure analysis: pipeline and road access to play areas
d) Produce Conasauga Development Strategy Plan

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Progress and Current Status of Project

Research began in October 2019 with efforts focused on:

- Compilation and inventory of donated cores, well samples and several GB of digital data (Cimarex, EQT, Chesapeake, and Cabot)
- Interpretation of new seismic reflection data to update subsurface maps
- Project database (Petra) with new digital logs, seismic and geochemical data
- Utilizing machine learning to analyze a large proprietary database of unconventional well completions to improve Rogersville Shale completion design
- Detailed post-drill analysis of recent wells to better understand controls on well productivity
- Continued monitoring of regional background seismicity to provide baseline data for recognition of future induced seismic events

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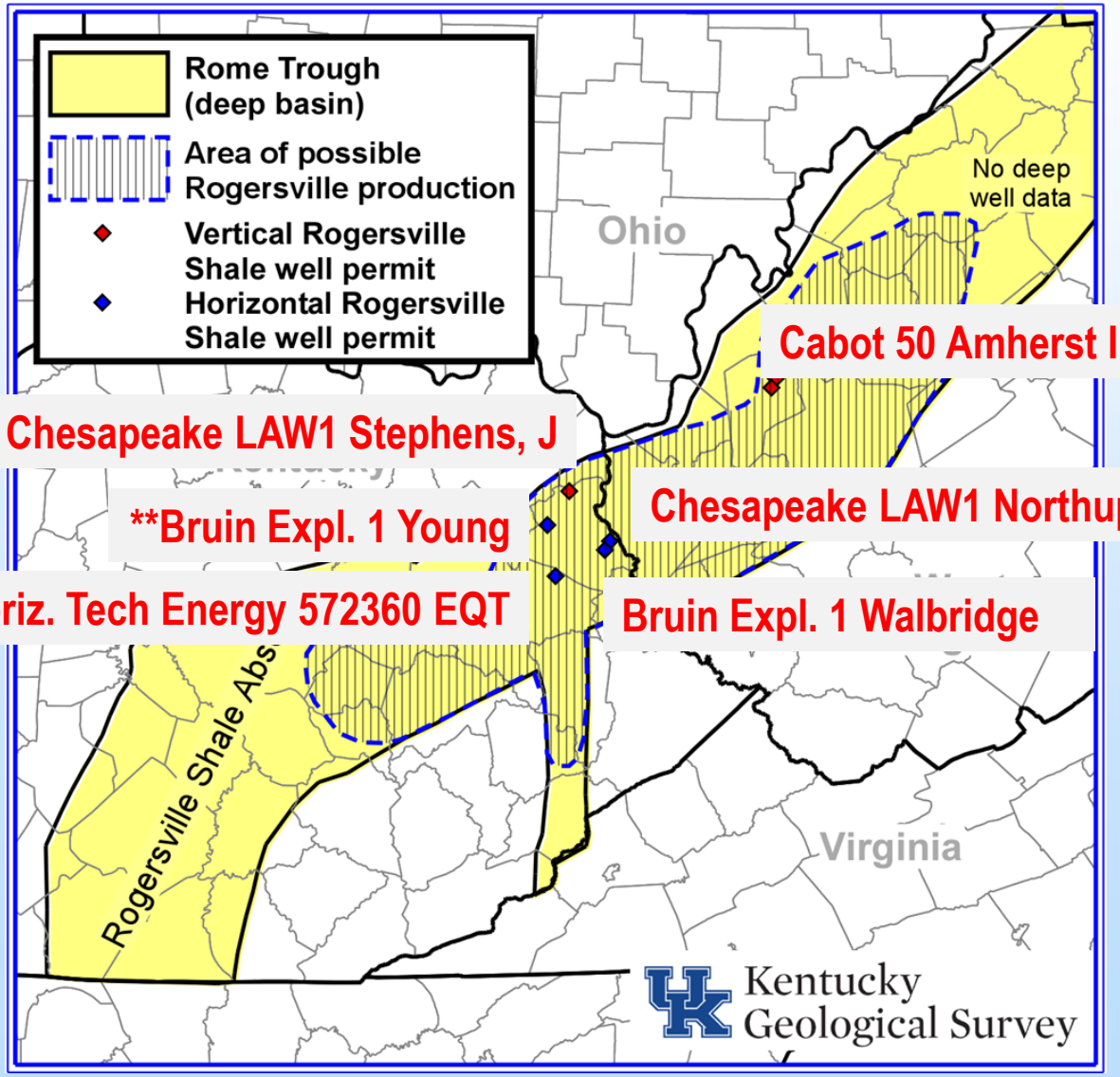
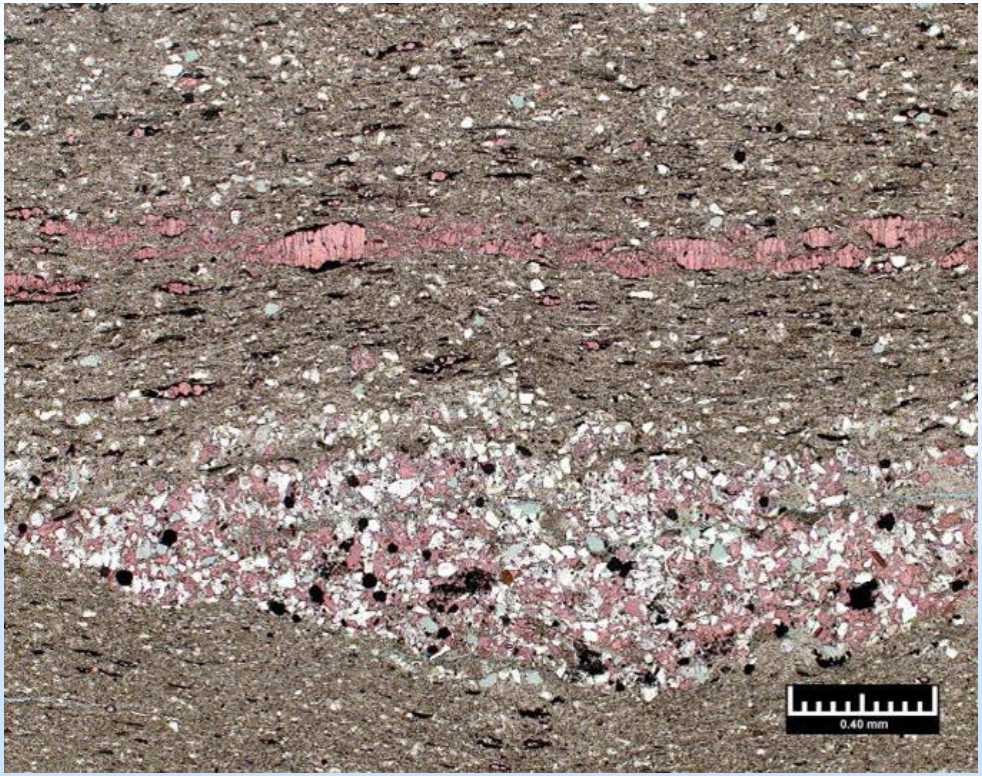
Progress and Current Status of Project



Progress and Current Status of Project

Slabbed core photos



Thin section photos

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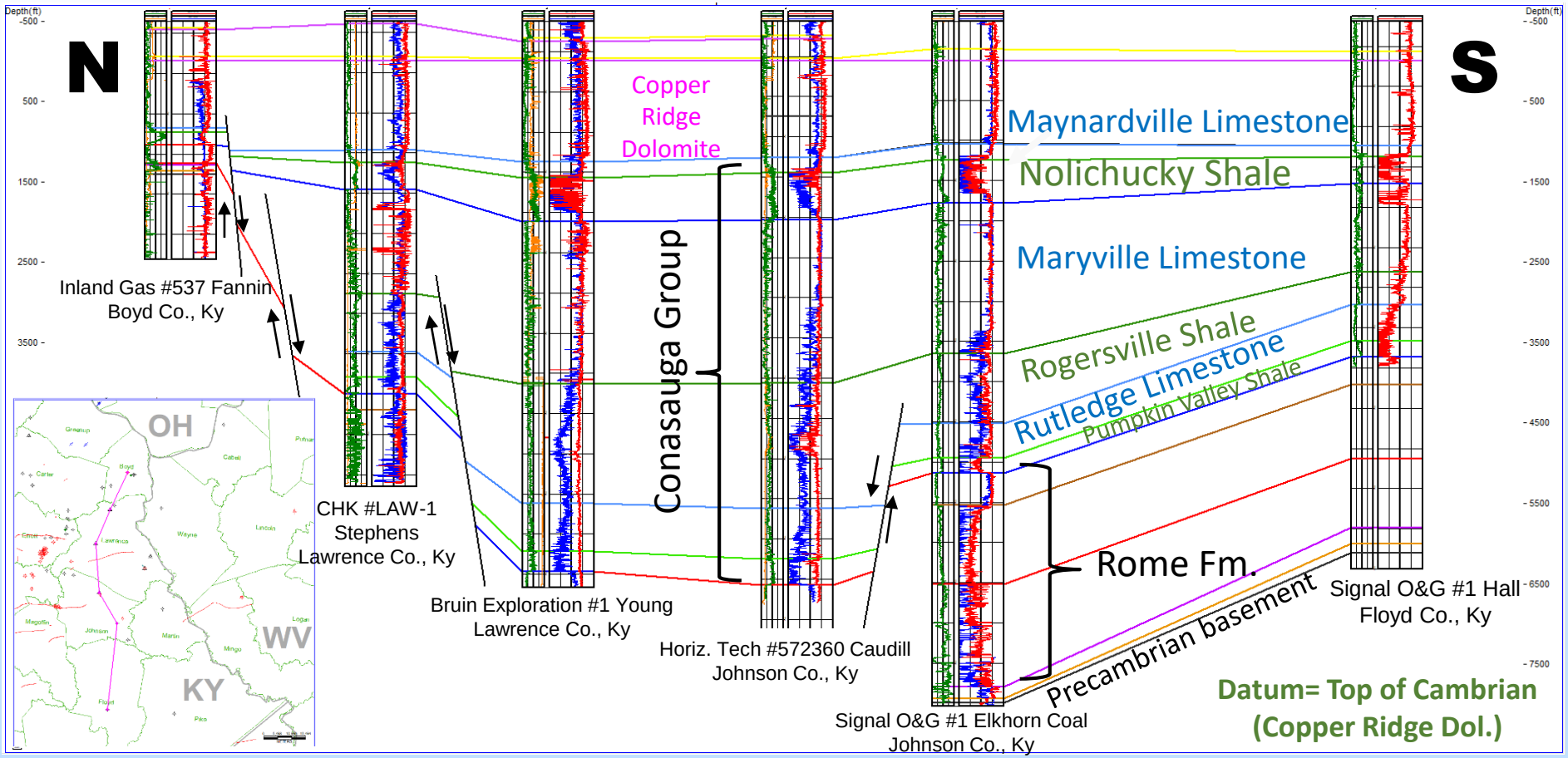
Progress and Current Status of Project



Cross section through Lawrence and Johnson Counties, Ky.

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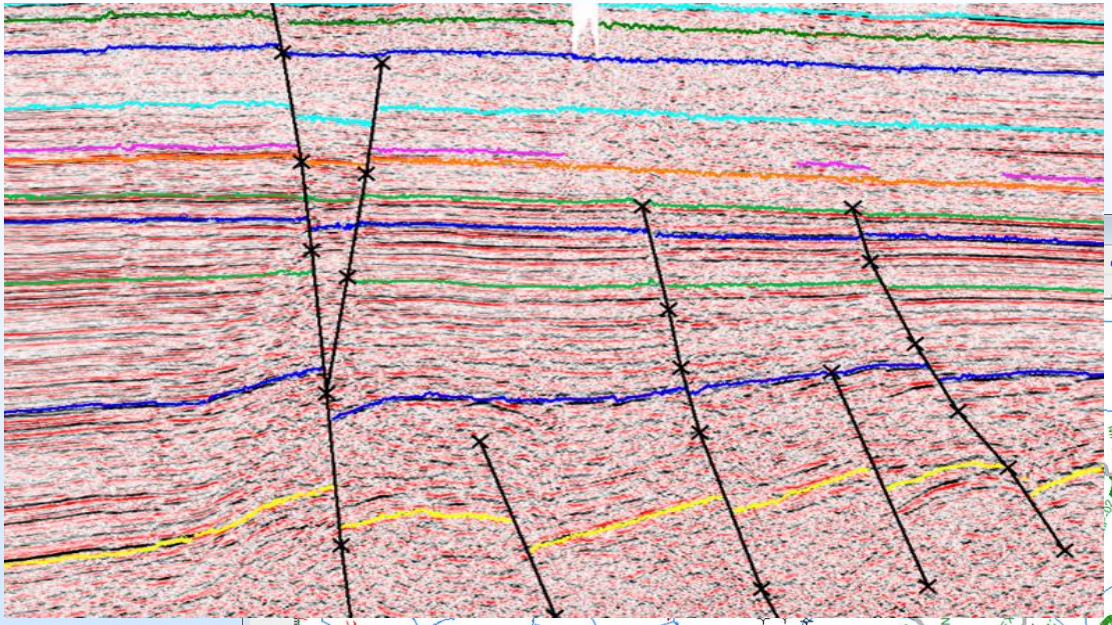
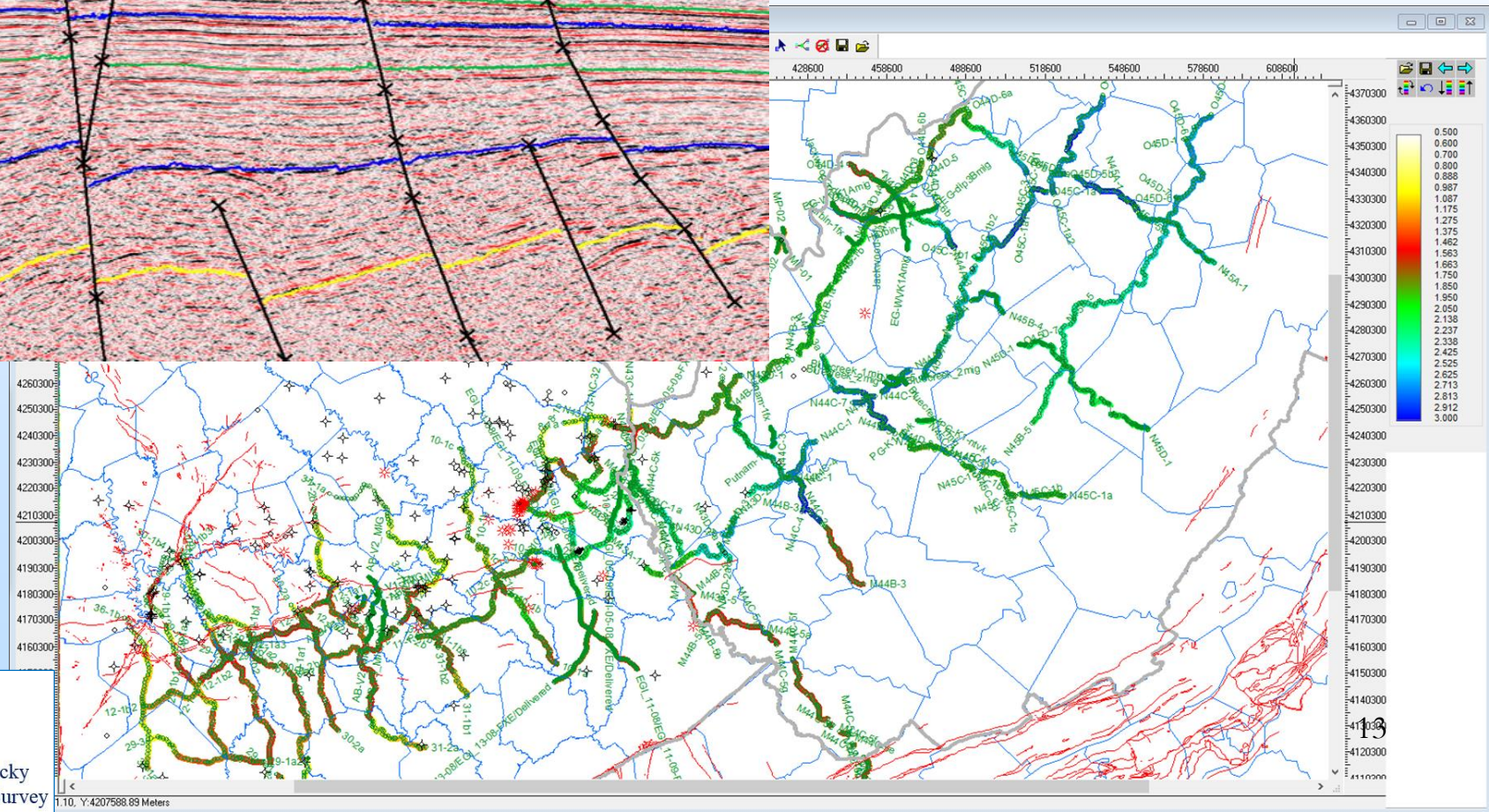
Progress and Current Status of Project



Subsurface mapping utilizing seismic profiles



Plans for future testing/development

- Budget Period 2 potentially begins on February 1, 2021
- If/when the remaining well funding is secured for our research lateral, we will begin well operations in Lawrence County, Ky. This will include a pre-stimulation hydrogeology site assessment at wellsite, sampling of well cuttings while drilling, performing multiple lab analyses on these samples, and final modelling and ML analysis for the future well completion design.

Project Summary

a. Budget Period 1 tasks are on-budget and nearing completion

b. In late 2019, a partial investor to our Industry Partner (Hay Exploration) pulled out of the well which was to become our Field Lab. Hay is currently searching for additional investors to fill this revenue gap. Passing the *Go/No-go Decision Point* in Jan. 2021 to proceed to BP-2 is dependent on having the full well funds secured.

Project Summary

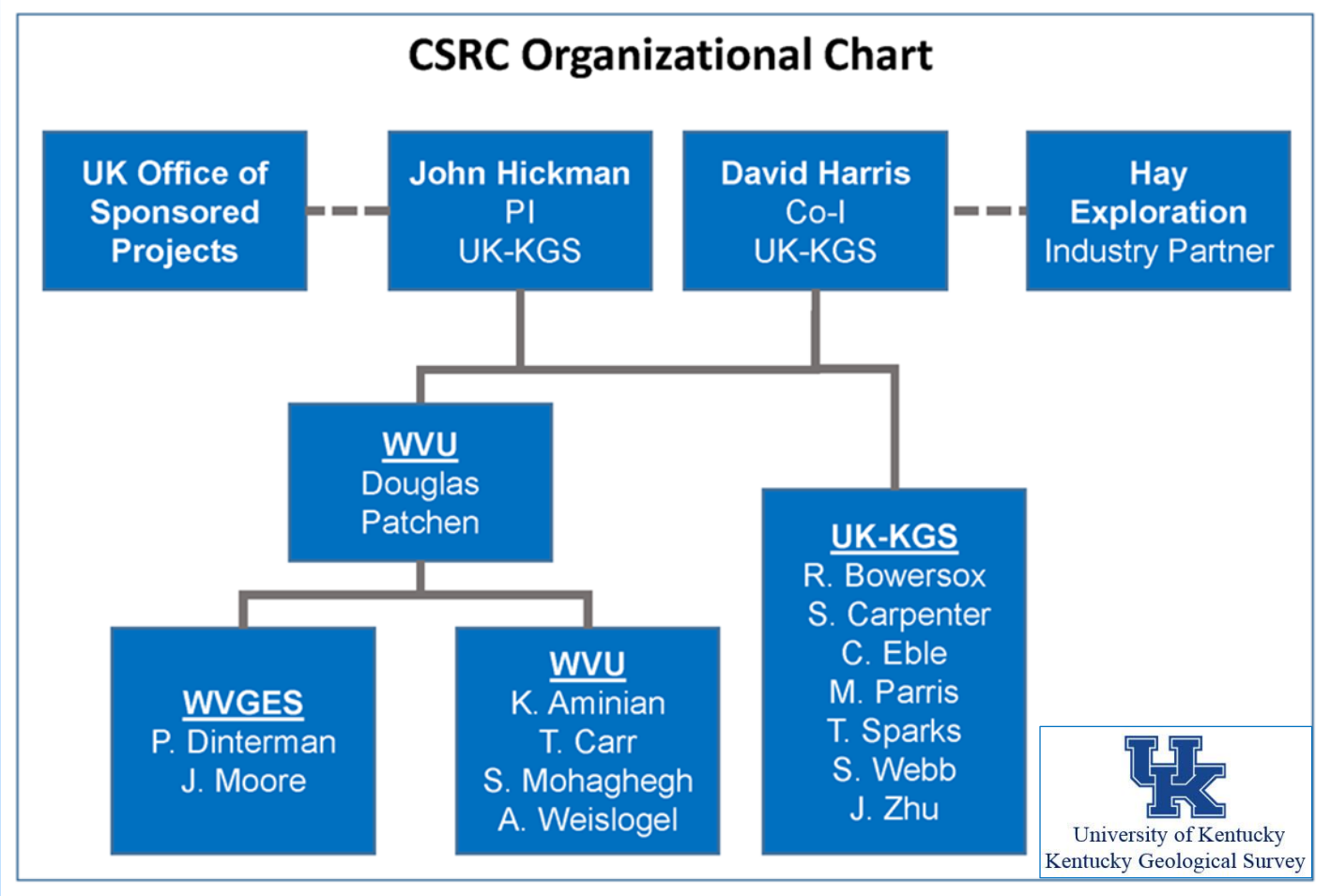
c. Current economic conditions in the oil and gas industry may prevent our industry partner from drilling the planned field laboratory well. This may shorten the project length and deliverables, but nevertheless we plan to obtain as much data from the rich set of whole core and well samples that have been donated to the project.

d. All results and interpretations will be integrated into a development strategy plan and provided on a public web site. These results will help to guide the next phase of development in the deep Rome Trough.

Appendix

– These slides will not be discussed during the presentation, but are mandatory.

Organization Chart



Gantt Chart, Tasks 1-6

Year		2019		2020				2021				2022				2023			
Task	Title	Year 1				Year 2				Year 3				Year 4			
	Conasauga Shale Research Consortium	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Budget Periods	1		2				3						4			
Task 1	Project Management and Planning																
Task 2	Workforce Readiness for Technology Deployment																
Task 3	Technology Transfer																
3.1	Project Website and Data Portal																
3.2	Data and Sample Management																
3.3	Present Results at Public Meetings																
3.4	Compile Inventory of Rogersville Samples and data																
Task 4	Engineering analysis of previous strategies																
4.1	Full “postmortem analysis” of past Rogersville well results																
4.2	Machine learning analysis of previous completions																
Task 5	Regional mapping of Conasauga Group units																
5.1	Seismic, potential fields, and well-tops interpretation																
5.2	Detailed subsurface formation and fault mapping																
Task 6	Drilling of Rogersville research lateral																
6.1	Collect well cuttings for analysis																
6.2	Analysis of brines and gasses encountered while drilling																
6.3	Record full suite of geophysical logs of new lateral																
6.4	Site assessment analysis surrounding research lateral																
6.5	Background seismicity characterization																

Gantt Chart, Tasks 7-13

Year		2019		2020				2021				2022				2023			
Task	Title	Year 1						Year 2				Year 3				Year 4			
	Conasauga Shale Research Consortium	Q1	Q2		Q3	Q4	Q1	Q2		Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Budget Periods	1			2					3						4			
Task 7	**Reservoir and source rock characterization**			GO/NO-GO #1, Research Lateral Drilled					GO/NO-GO #2, Research Lateral Stimulate										
7.1	TOC analysis of available geological samples																		
7.2	X-ray Diffraction (XRD) lab analysis of sample mineralogy																		
7.3	X-ray Fluorescence (XRF) analysis																		
7.4	Portable XRF of available whole and rotary-sidewall cores																		
7.5	Bitumen reflectance microscopic analysis																		
7.6	Sm-Nd Isotopic composition for provenance analysis																		
7.7	Thin-section creation and optical microscopy analysis																		
7.8	SEM and Raman spectroscopy																		
7.9	Programed pyrolysis and source rock extract geochemistry																		
7.10	Detailed log analysis																		
7.11	Geomechanical testing of select reservoir cores																		
Task 8	**Well completion design and monitoring**																		
8.1	Model optimal completion plans and review with operator																		
8.2	Microseismic monitoring of well stimulation																		
Task 9	**Detailed reservoir quality mapping**																		
9.1	3D facies/lithology mapping																		
9.2	3D Organic content mapping																		
9.3	Basin modeling for regional HC thermal maturation mapping																		
Task 10	**Geochemical analysis of produced fluids**																		
10.1	Oil chemistry and biomarker analysis																		
10.2	Molecular and isotopic chemistry of natural gases																		
10.3	Noble gas characterization																		
Task 11	**Post-completion petroleum engineering analysis**																		
11.1	Down-hole fiber optics production data acquisition																		
11.2	Full review of results from Young well lateral testing																		
Task 12	**Supporting infrastructure analysis**																		
12.1	Pipelines, proximity and available capacities																		
12.2	Road network density for access to potential drilling locations																		
Task 13	**Project completion and synthesis of results**																		
13.1	Development Strategy Plan																		
13.2	Final Project Report and public release of research findings																		