

Resource Assessment of Deep Coals in Eastern Montana: Potential Targets for Commercialization by In-Situ Gasification

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Statement of Problem:

Montana's vast coal reserves account for about 25% of the nation's total demonstrated reserve base – about 120 billion tons (US Energy Information Administration). At least 60% of these coal deposits, representing billions of dollars worth of mineral resources, lie more than 500 feet below the surface and cannot be accessed using conventional mining methods (figure 1). However, new technologies such as In-Situ or Underground Coal Gasification (UCG) make our “deep coal” resources economically attractive.

During the past few years, the State of Montana has received multiple inquiries from private industry regarding our overall potential for underground coal gasification and for specific UCG sites. This interest has not translated into investment in the State, in part because geologic data to clearly identify our deep coal targets are not available. This is a significant obstacle to future development of Montana's coal resources. Other states able to provide such information currently hold a significant competitive advantage over Montana.

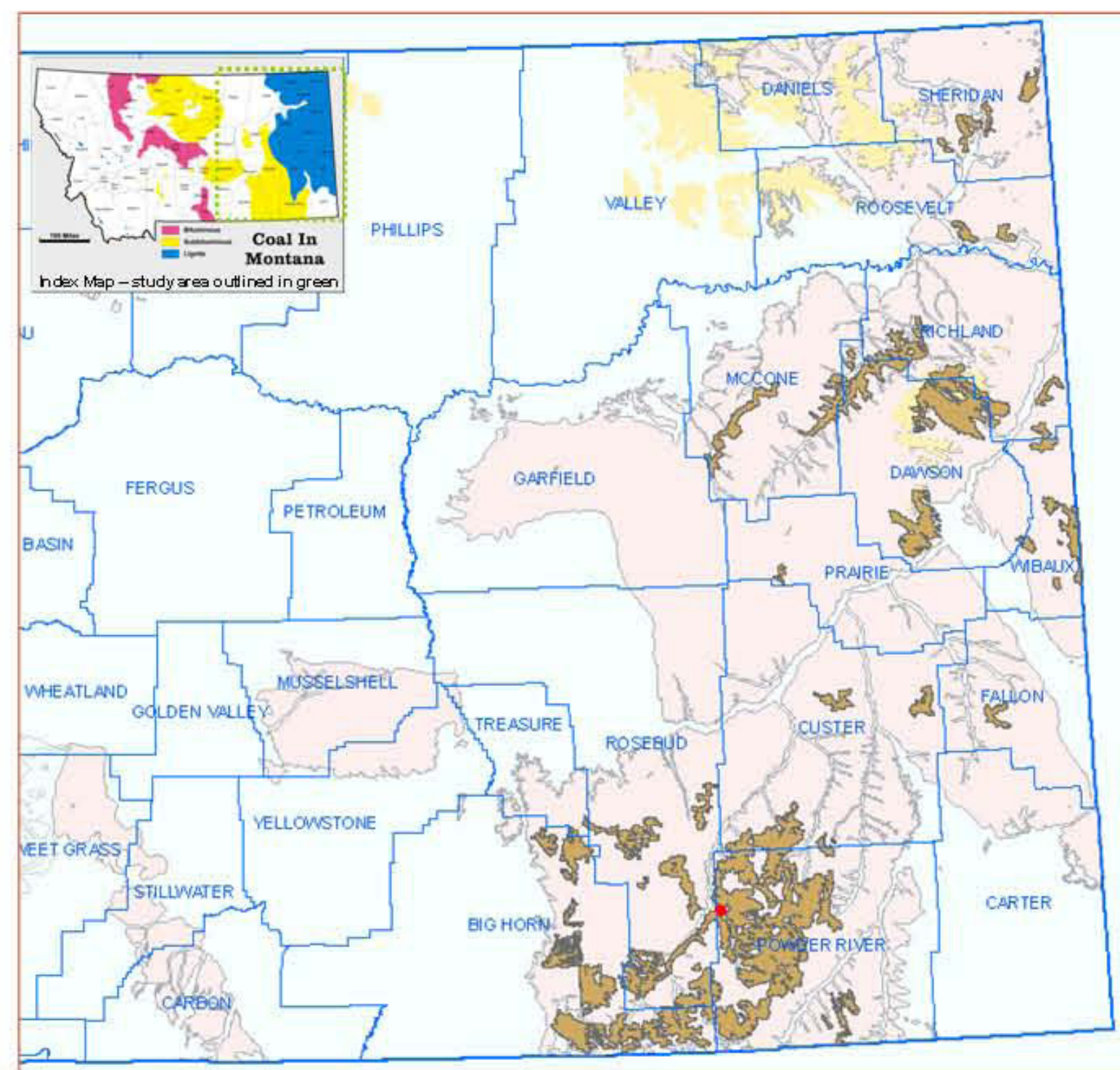


Figure 1. Map of Eastern Montana showing the extent of the Fort Union Formation – the primary coal-bearing unit – in pink. Areas shaded brown represent near-surface, strippable coal deposits. County boundaries and names are shown in blue.

Goal:

The objective of this project is to complete a regional assessment of “deep” (500-3000 ft) coal seams in eastern Montana. It is the critical first step toward commercializing Montana's deep coal resources.

Benefits:

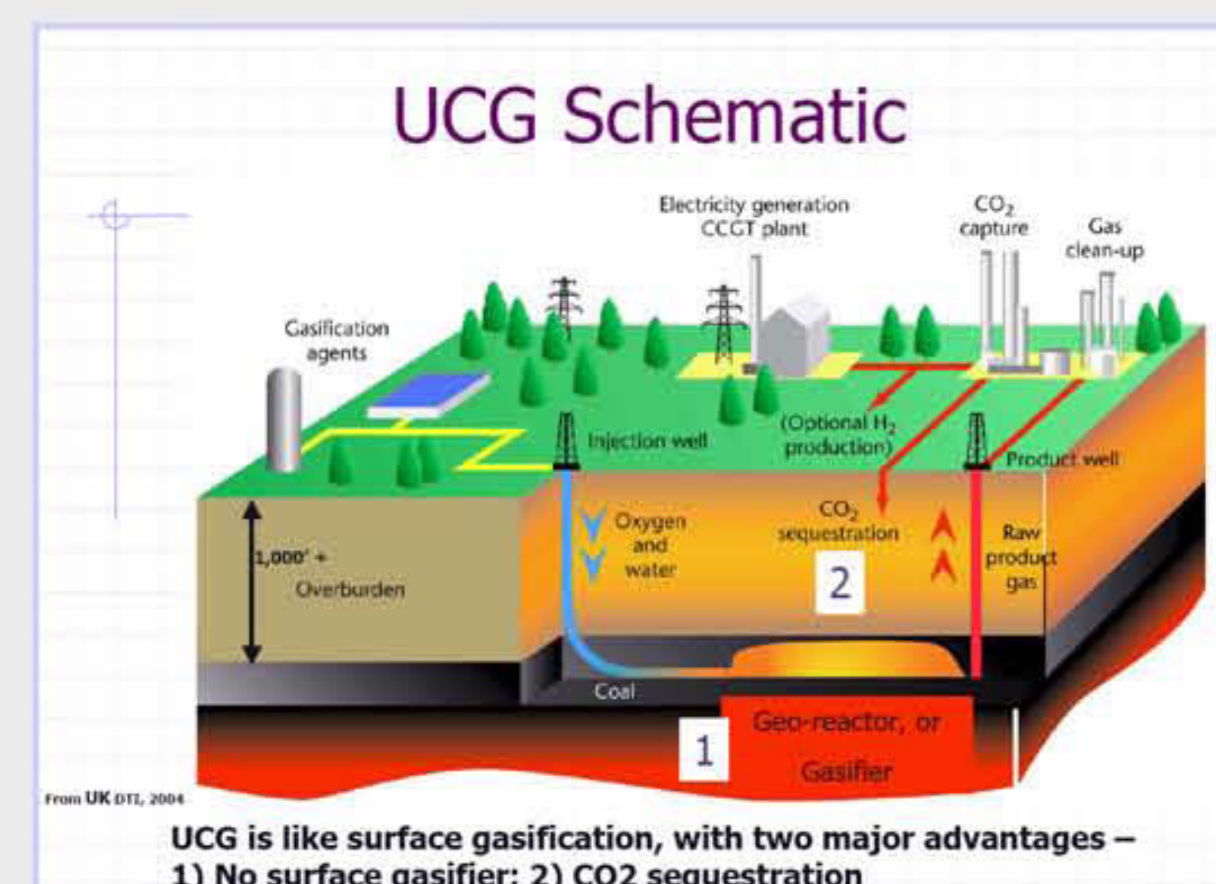
Immediate benefits of this study are:

- Information needed by potential investors and developers. It will put Montana on “equal-footing” with other coal-rich states.
- A set of tangible results to use as a basis for policy and management decisions for Montana's coal resources, whether they are owned by State, Federal, or private interests.
- It puts Montana in position to progress beyond the “interest” stage with private industry by providing a foundation that must precede pilot-scale testing and full-scale investment in the State.
- These same data will also be necessary and applicable as other technologies become available that could exploit the intermediate to deep coal resources of the State.

Long-term benefits include:

- Potential development of otherwise inaccessible energy resources.
- Economic growth – revenues and jobs, if development occurs.
- Overall increased knowledge of Montana's geology and energy resources that is valuable for scientific, technical, and resource-management purposes in the future.

What is In-situ Coal Gasification?



UCG is like surface gasification, with two major advantages – 1) No surface gasifier; 2) CO2 sequestration

In-situ or Underground Coal Gasification is a “clean coal” process, capable of extracting the energy content of deep, unminable coal resources while minimizing environmental impacts.

In the UCG process, injection and production wells are drilled from the surface and linked in the coal seam below the water table. Air and/or oxygen are injected and the coal is ignited in a controlled manner. As the coal burns, combustible product gases – called syngas – are collected by the production well. At the surface, syngas is cooled and cleaned for use in power generation or manufacturing synthetic natural gas, liquid hydrocarbons, or petrochemicals.

Progress:

□ A database of nearly 6,000 oil and gas wells that penetrate the coal-bearing Fort Union Formation in Eastern Montana has been constructed for use in the study. Approximately 10,000 coal drill-holes will be added to provide additional information for shallow to intermediate depths.

□ The base of the Fort Union Formation has been identified in all wells. Structure and thickness maps of the Fort Union Formation have been generated and provide a “coal-potential” map for Eastern Montana. Areas with the highest likelihood of containing deep coals suitable for UCG include the Powder River Basin and the Williston Basin as shown in figure 2.

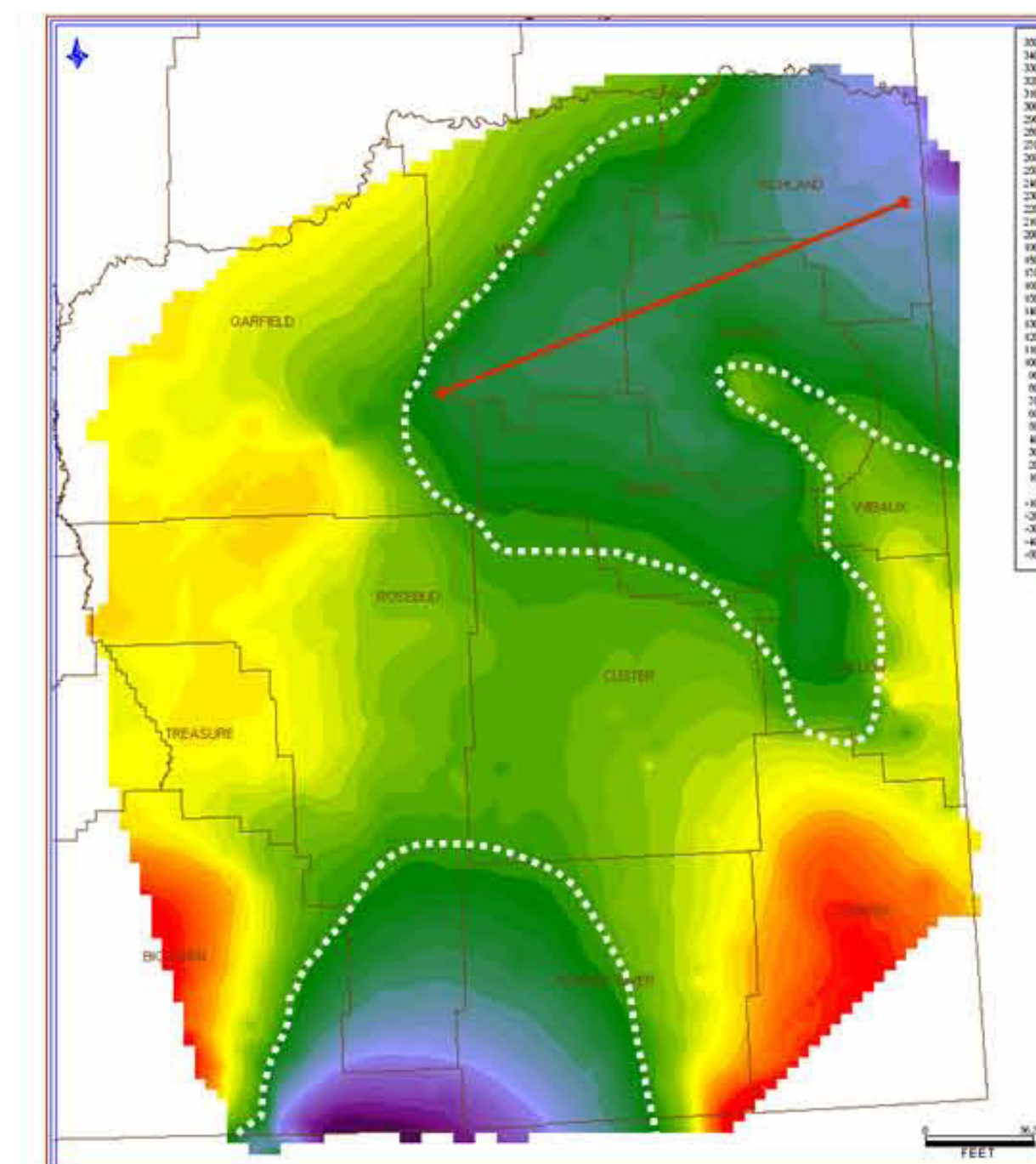


Figure 2. This map shows the subsurface elevation of the base of the coal-bearing units (top Bearpaw Shale). The purple and dark green areas (outlined in white) are the deepest and correspond to the Powder River Basin to the south and the Williston Basin to the east. They are more likely to contain deep coals suitable for UCG.

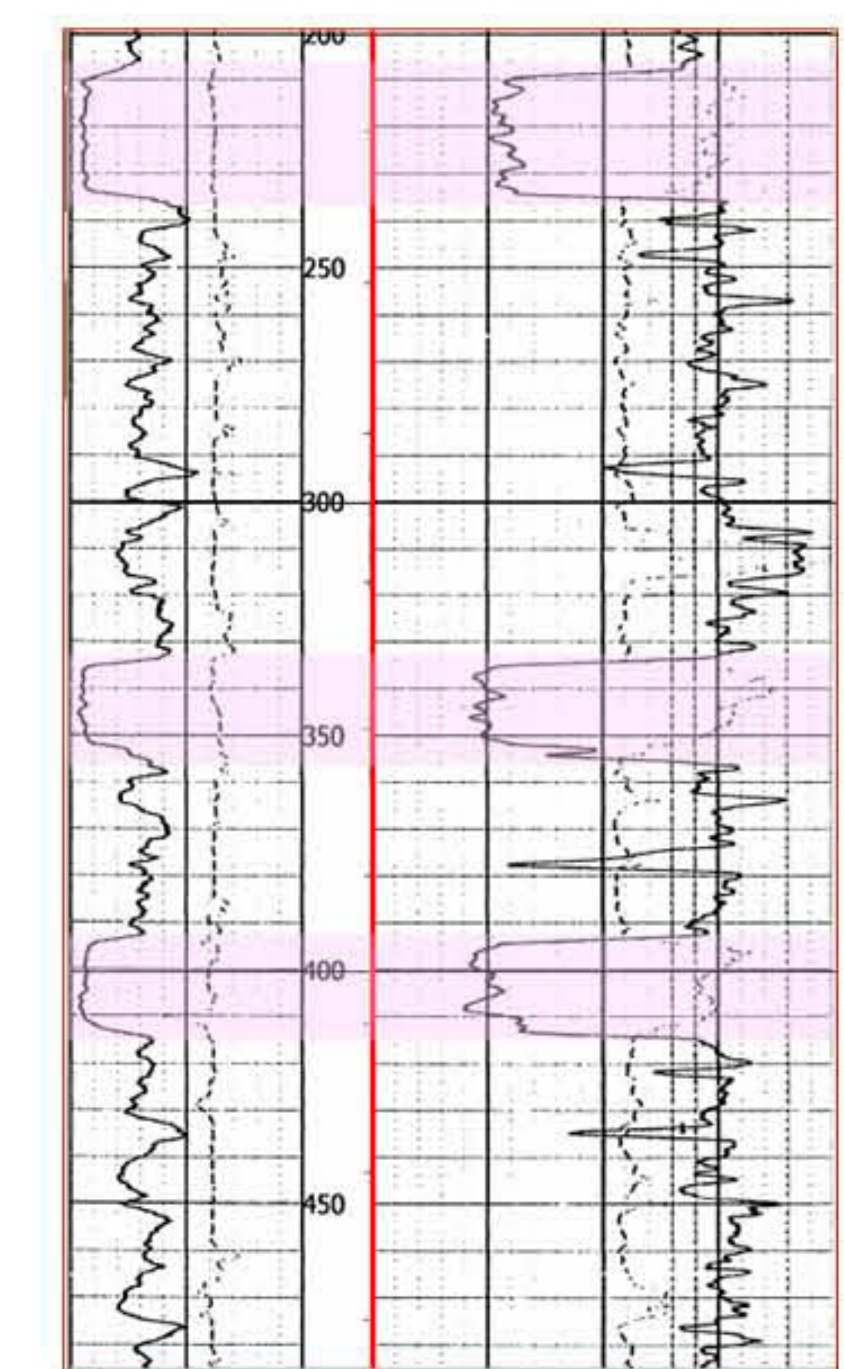


Figure 3. Geophysical logs acquired from oil and gas wellbores provide information about subsurface rocks and fluids. Coal beds (highlighted pink) can be identified by their distinctive characteristics on geophysical logs.

□ Individual coal beds are being identified using oil & gas well geophysical logs which provide information about subsurface geology (figure 3).

□ Regional correlation of coal seams to determine lateral extent and continuity is on-going (figure 4).

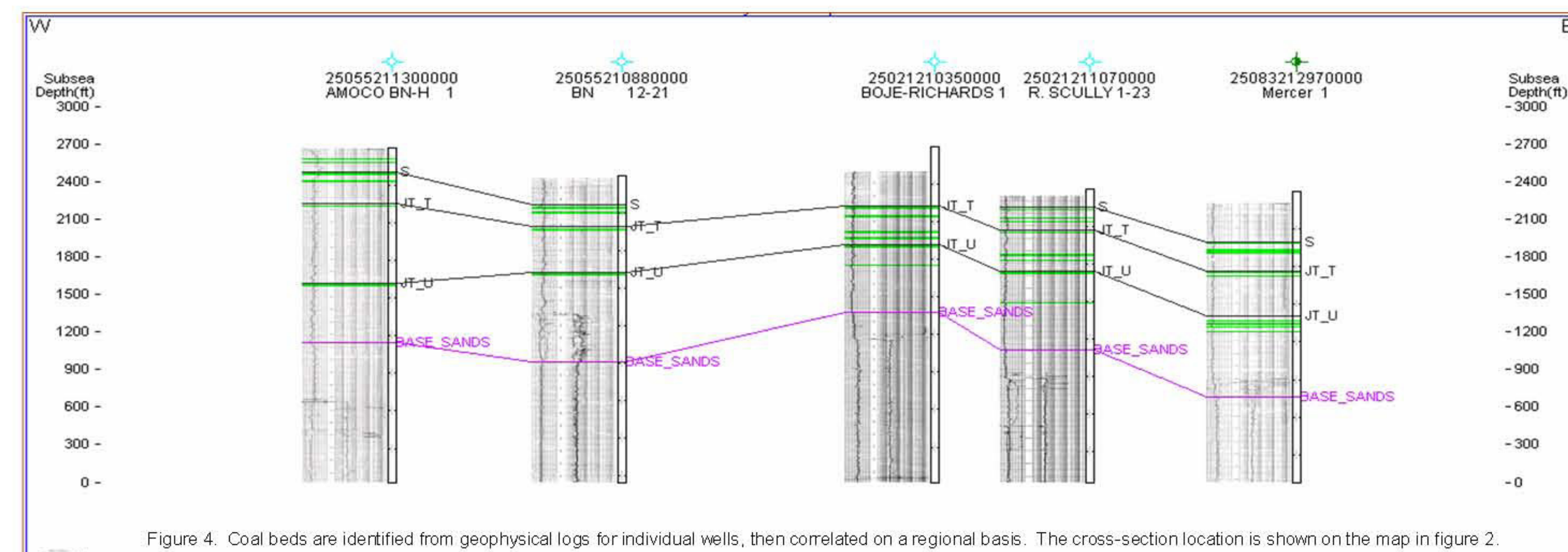


Figure 4. Coal beds are identified from geophysical logs for individual wells, then correlated on a regional basis. The cross-section location is shown on the map in figure 2.

□ Initial UCG-suitability criteria have been identified and will be applied to each coal bed (figure 5).

□ Preliminary maps such as coal thickness and coal quality maps are being generated for specific areas (figure 6.)

Factors for UCG Selection – PRB is Ideal		
Attribute	Optimal	Powder River Basin
Coal Seam Thickness	30 ft +	30 to 250 ft 70 ft avg
Coal Seam Continuity	High	Extremely high - miles
Coal Rank	Sub Bit to Low Vol Bit	Sub Bituminous “B”
Ash Content	< 40%	6-4% avg
Faulting	Rare	Rare to absent
Depth to Coal	> 1,000 ft	500 to 2,500 ft
Dip	0 to 20 degrees	1 to 3 degrees
Intrusions	Minimal	None
Immediate Roof	Strong, stable	Low perm siltstone
Hydraulic Head	> 600 ft	500 to 2,500 ft
Swelling Character	Non-swelling	Non-swelling
Coal Permeability	High	High
Water Quality	Poor	Stock quality
NG Availability	Available, low cost	Very Low Cost

Figure 5. UCG suitability criteria as proposed by GasTech, Inc. for the Powder River Basin coals. These criteria will form the basis for “ranking” Montana's deep coals for UCG-suitability.

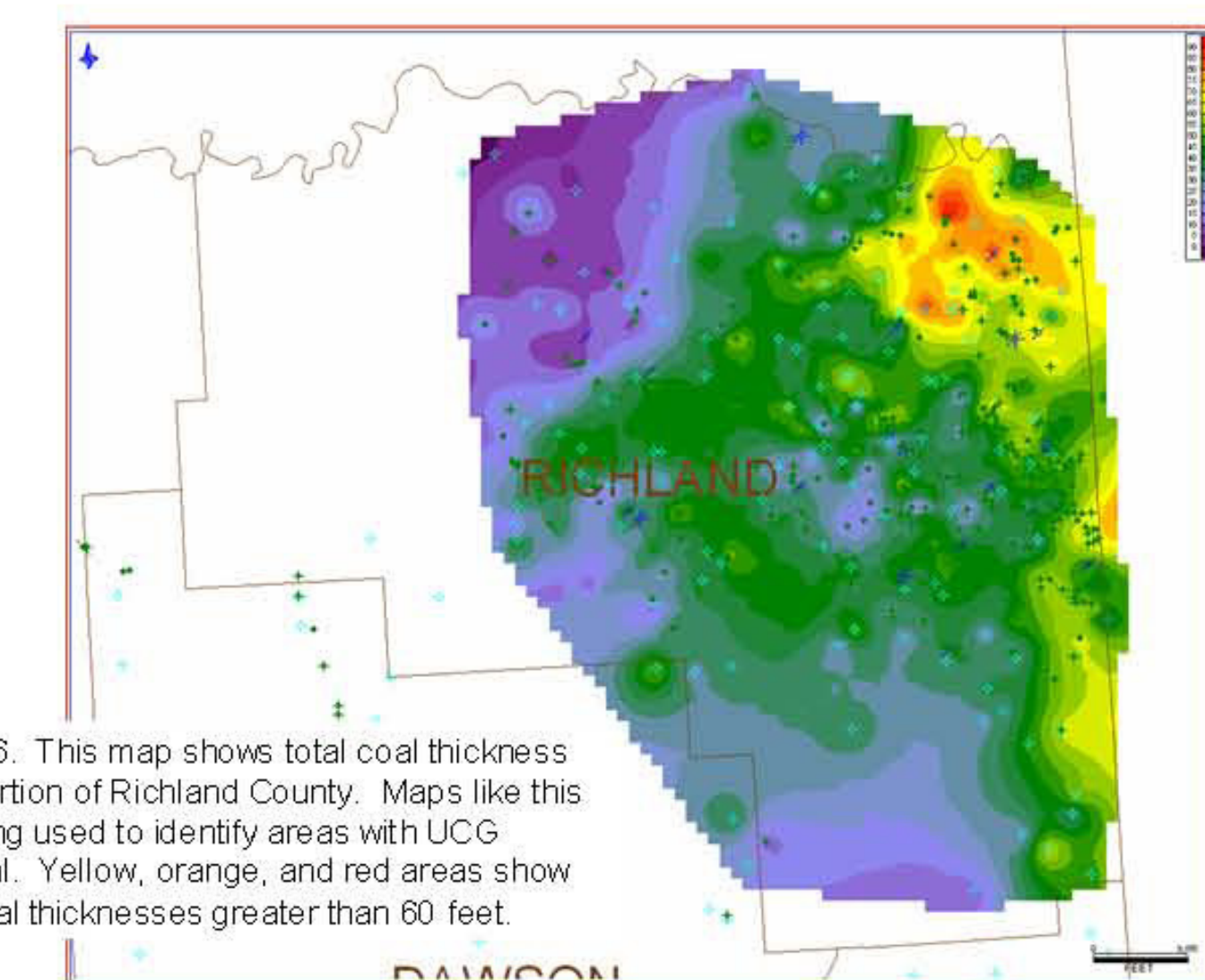


Figure 6. This map shows total coal thickness for a portion of Richland County. Maps like this are being used to identify areas with UCG potential. Yellow, orange, and red areas show total coal thicknesses greater than 60 feet.