

CarbonSAFE Illinois: Geologic Workflows for Characterizing Commercial-Scale Geologic Storage of CO₂

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CarbonSAFE Illinois includes a Pre-feasibility study to identify commercial-scale carbon storage opportunities (50 million tonnes or more) in the east Illinois Basin, and a Feasibility study to develop an established geologic storage complex in Macon County, Illinois, for commercial-scale storage of industrially sourced CO₂. Pre-feasibility activities involve identifying potential industrial sources of CO₂ and matching these with suitable geologic storage locations that include saline reservoirs and enhanced oil recovery (EOR) opportunities. Feasibility activities are focused on the Mt. Simon Storage Complex; a step-out well will be drilled near existing storage sites (i.e., the Midwest Geological Sequestration Consortium's Illinois Basin - Decatur Project and the Illinois Industrial Carbon Capture and Storage Project) to further establish commercial viability of this complex and to evaluate EOR potential in a co-located oil-field trend. The Archer Daniels Midland facility (ethanol plant), City Water, Light, and Power in Springfield, Illinois (coal-fired power station), and other regional industries are potential sources of anthropogenic CO₂ for storage at this complex. Site feasibility will be evaluated through drilling results, static and dynamic modeling, and quantitative risk assessment. Both studies will entail stakeholder engagement, consideration of infrastructure requirements, existing policy, and business models. Project data will help calibrate the National Risk Assessment Partnership (NRAP) Toolkit to better understand the risks of commercial-scale carbon storage. This poster presents the workflow for geologic storage characterization related to both studies and preliminary work related to CO₂ sources and infrastructure. CarbonSAFE Illinois is sponsored by the National Energy Technology Laboratory.



Figure 1A The CarbonSAFE Illinois Feasibility and Pre-feasibility projects are located within the Illinois Basin, which stretches across the states of Illinois, Indiana, and Kentucky, study areas for CarbonSAFE Feasibility (box) and Pre-feasibility (oval).

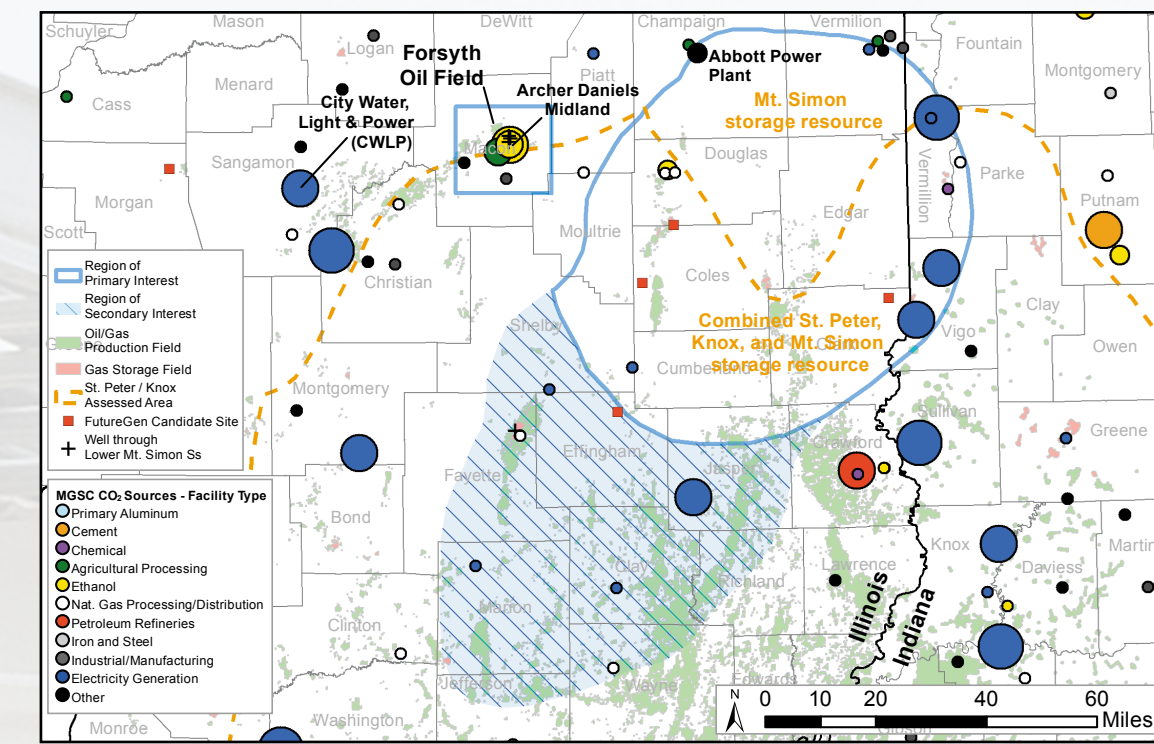


Figure 1B Pre-feasibility study area of the East Illinois sub-basin and the Feasibility study area (Forsyth Oil Field). Region of primary interest contains two storage complex configurations: 1) the Mt. Simon storage complex (Figure 2) underlies the entire area (Figure 3), and 2) the Mt. Simon, Knox, and St. Peter storage complexes (Figure 2) are suitable in the southern part of the area of investigation. Major sources of CO₂ in the broad region are shown as circles, sized by relative emissions (US EPA, 2017). Regional coal-fired power plants have expressed support for CarbonSAFE.

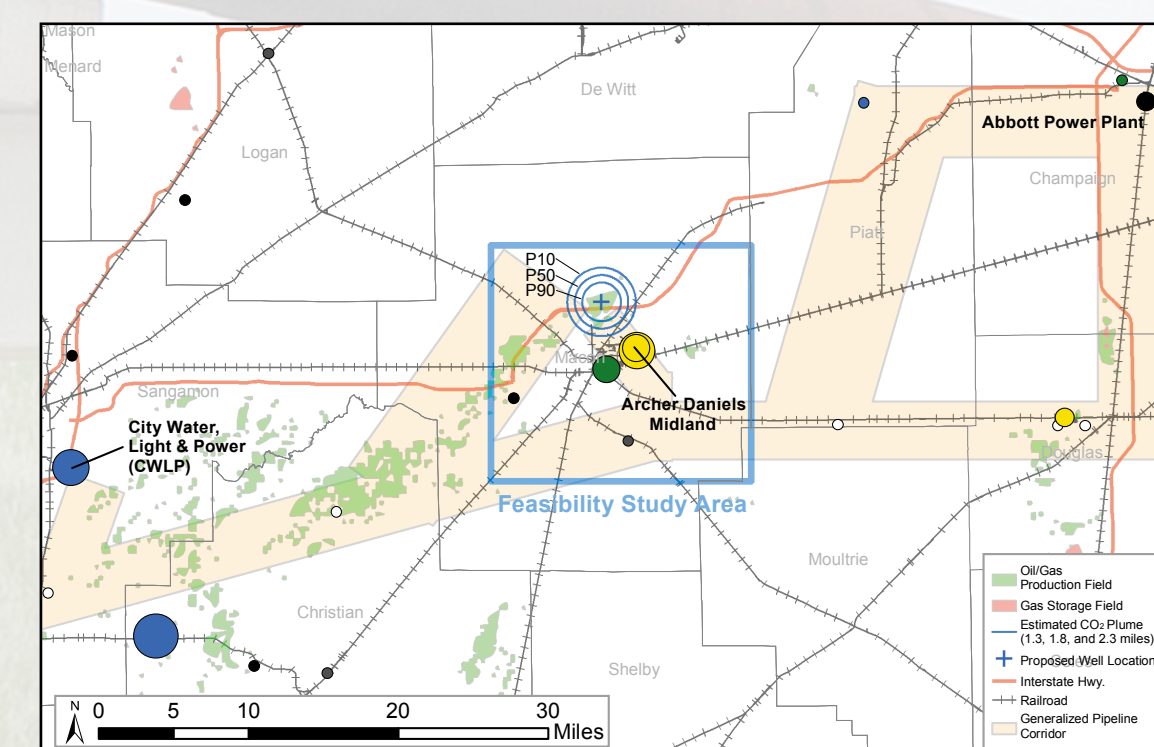


Figure 1C Together, capture off the Abbott Power Plant and the CWLP Dalman #4 unit can provide up to approximately 4,800 Tons/day of CO₂ at full capacity. Both plants are in close proximity to a rail line, making rail transport a near-term option, but at commercial scale, a pipeline is likely needed. Pipeline and rail corridors exist, directly connecting to or terminating near the Abbott and CWLP plants, which can be followed into Decatur from the south and west to within two miles of the proposed well location at Forsyth Oil Field. By leveraging existing corridors, financial, environmental, and social benefits can be achieved, which help minimize the impact of any new potential pipeline construction. Existing rail, pipeline, and interstate highway corridors between the cities of Springfield (CWLP) and Champaign (Abbott) to Decatur are among the more promising pipeline routing options, but will require further evaluation.

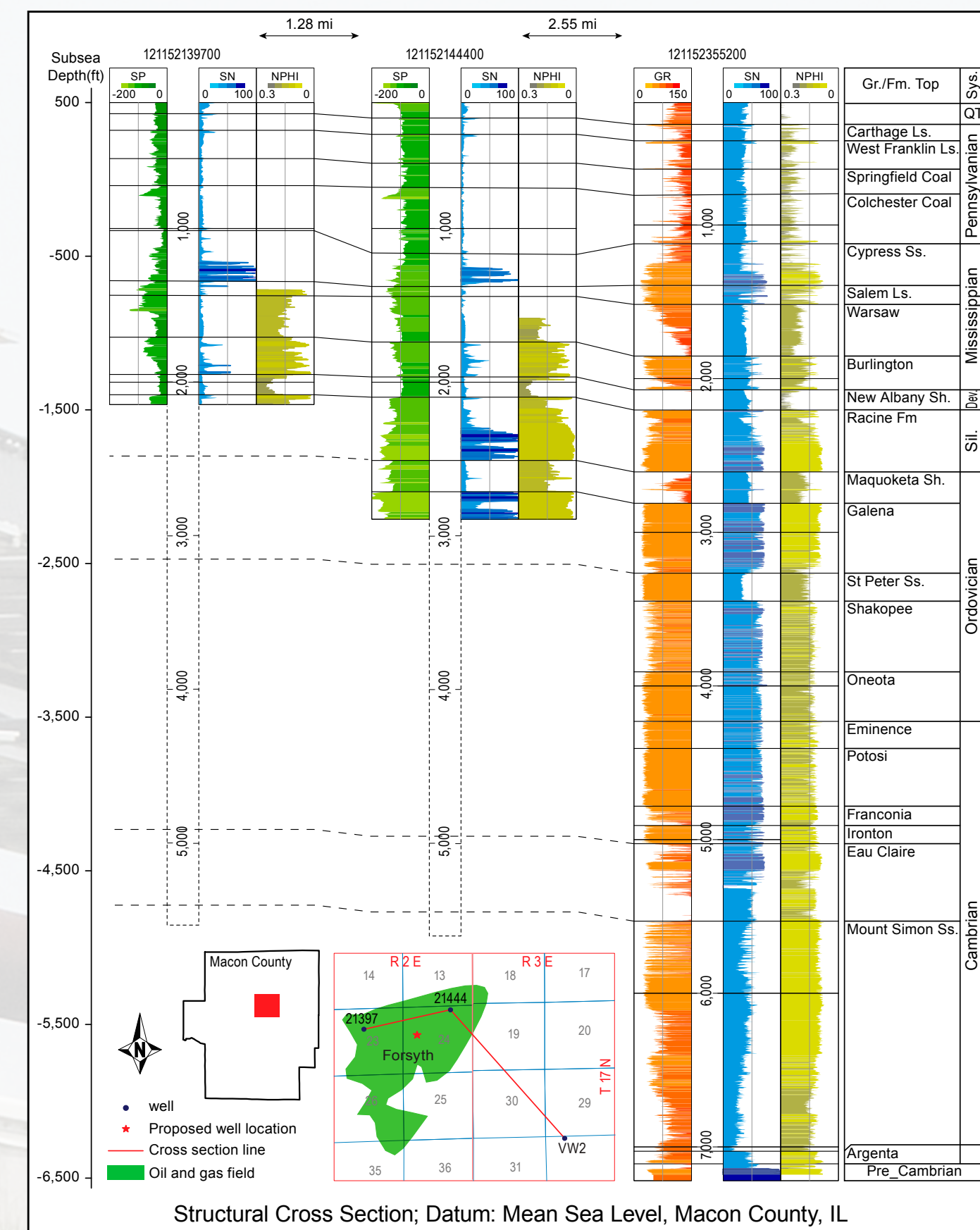


Figure 4A Cross Section across Forsyth Oil Field to the Illinois Basin Decatur Project-Illinois Carbon Capture and Storage Project (Verification #2 Well). Note that no wells within Forsyth field penetrate sub-Ordovician Galena Formation.

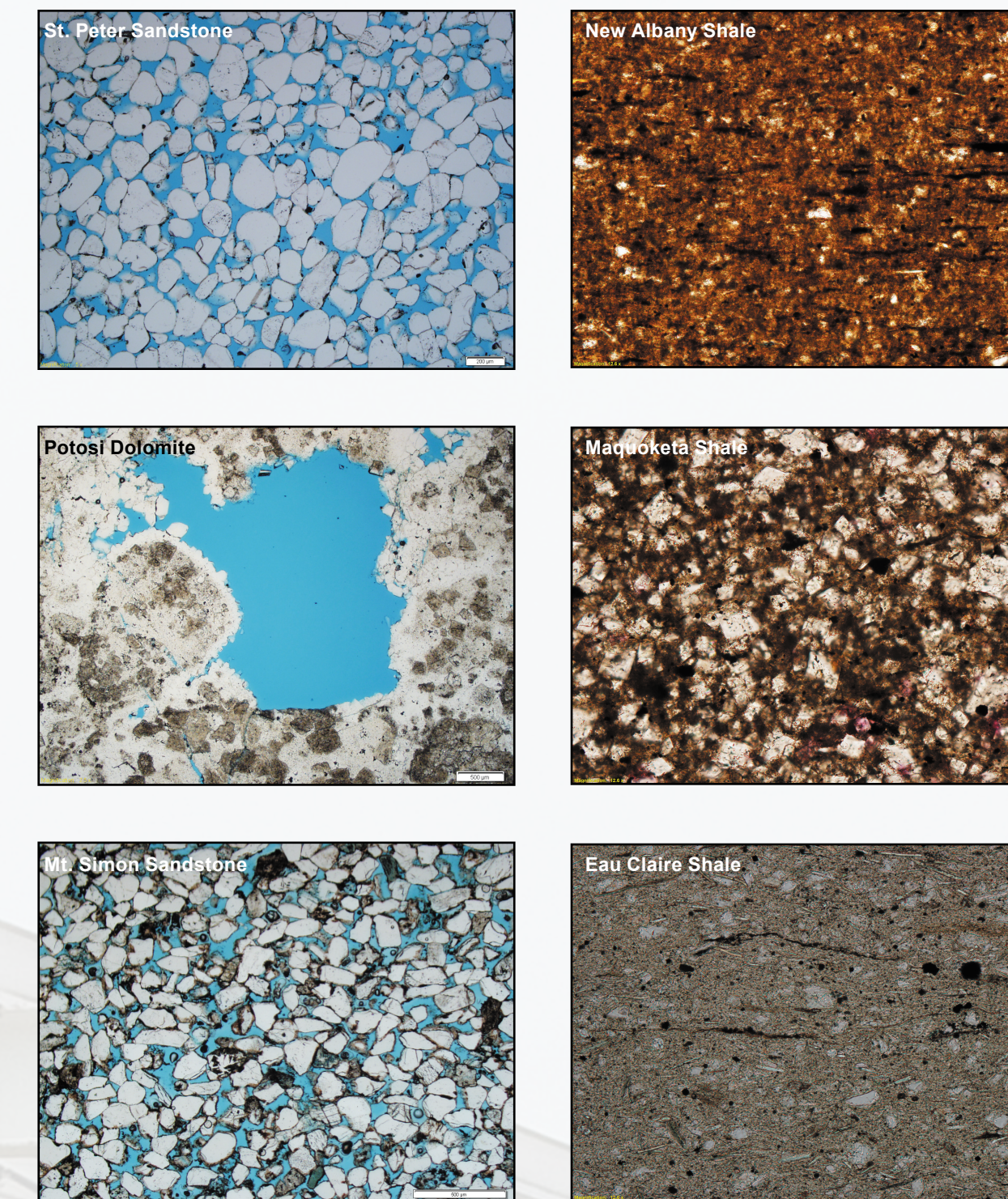


Figure 4B Thin section photomicrographs of representative samples of target formations within prospective storage complexes. The Mt. Simon Sandstone is the primary storage target with porosity up to 30% and permeability up to one darcy. The Mt. Simon is overlain by three thick, impermeable, shales: Eau Claire, Maquoketa, and New Albany. The Potosi Dolomite and St. Peter comprise the Knox Group storage complex, which is a secondary storage target. The Potosi may have cavernous porosity in areas across Illinois. The St. Peter reservoir properties are highly variable across Illinois but the reservoir has excellent storage potential. Porosity is represented as blue epoxy impregnation.

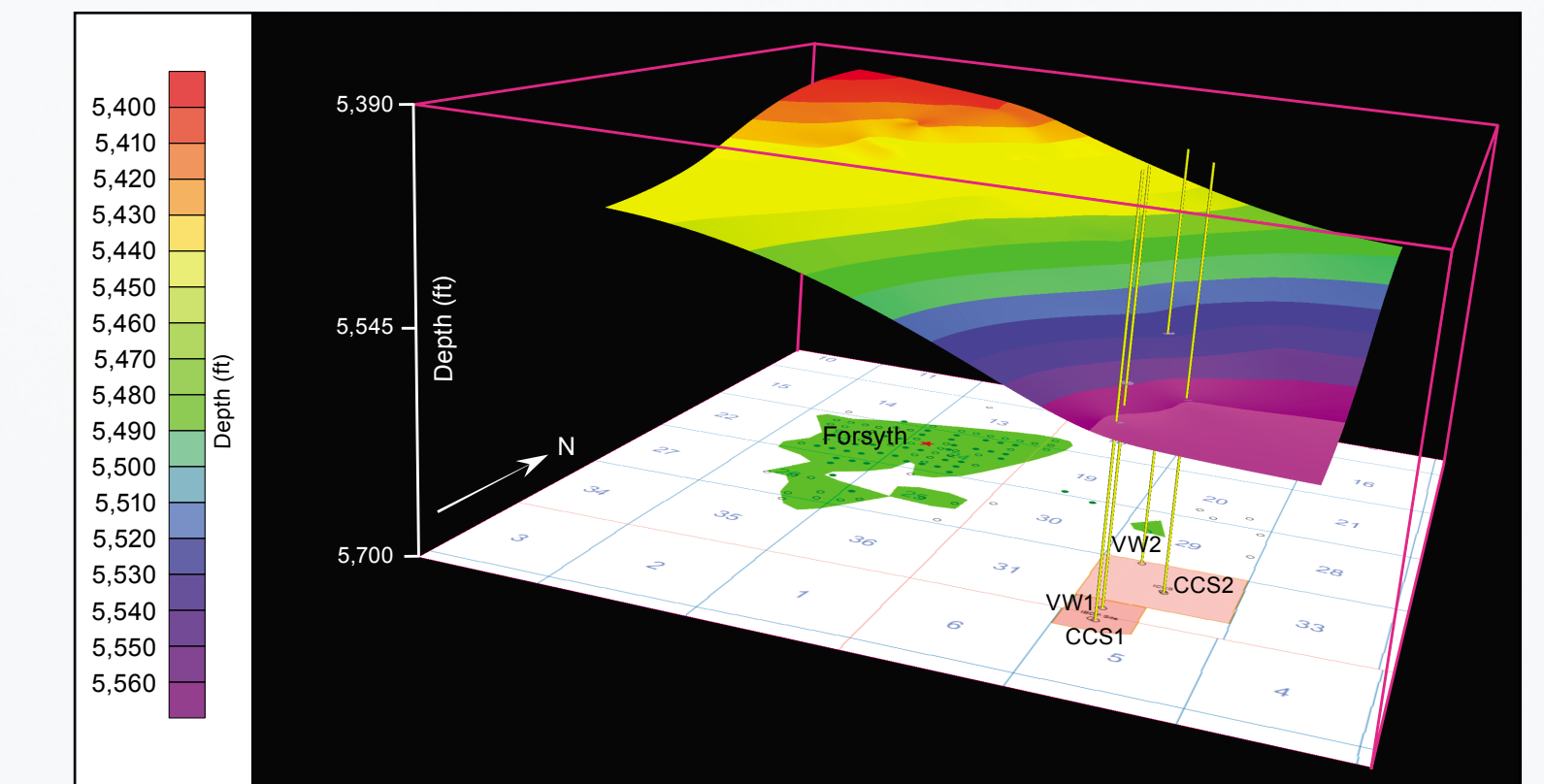


Figure 4C 3-D structure map of the Mt. Simon Sandstone from Decatur to Forsyth Oil Field. Note that the Mt. Simon deepens to the southeast (into the Illinois Basin depocenter). The top of the Mt. Simon at Forsyth is projected to be approximately 170 feet shallower than at IBDP.

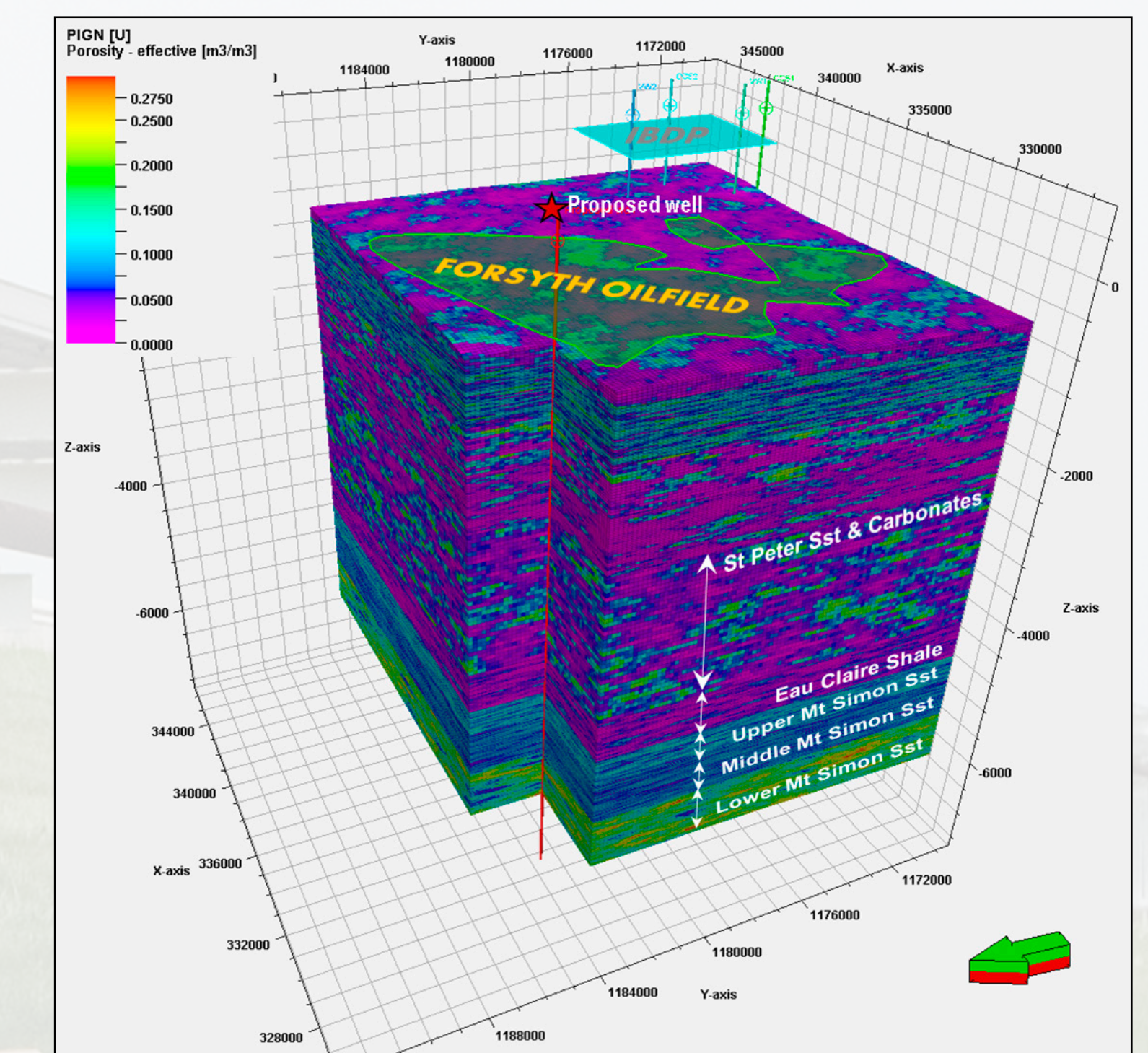


Figure 5 Static geologic model of stratigraphy from the Warsaw formation to the Precambrian basement. The model covers an area across the Illinois Basin - Decatur Project and parts of the Forsyth field. The figure also shows the location of the proposed stratigraphic well to be drilled.

SYSTEM	GROUP	FORMATION	Storage Elements
Ordovician	Maquoketa	Brainard	Secondary Seal
		Fl. Atkinson	
		Scales	
		Kimmswick	
	Galena	Decorah	Potential target
		Ancell	
	Knox	Joachim	Secondary Seal/Reservoir
		St. Peter	
		Shakoppee	
		New Richmond	
Onondaga			
Gunter			
Cambrian	Potsdam	Eminence	Potential target
		Potosi	Potential target
		Franconia	
Precambrian	Potsdam	Ironton-Galesville	
		Eau Claire	Primary Seal
Precambrian	Potsdam	Mt. Simon	Target reservoir

Figure 2 Storage complexes identified in Cambrian and Ordovician strata in central and eastern Illinois.

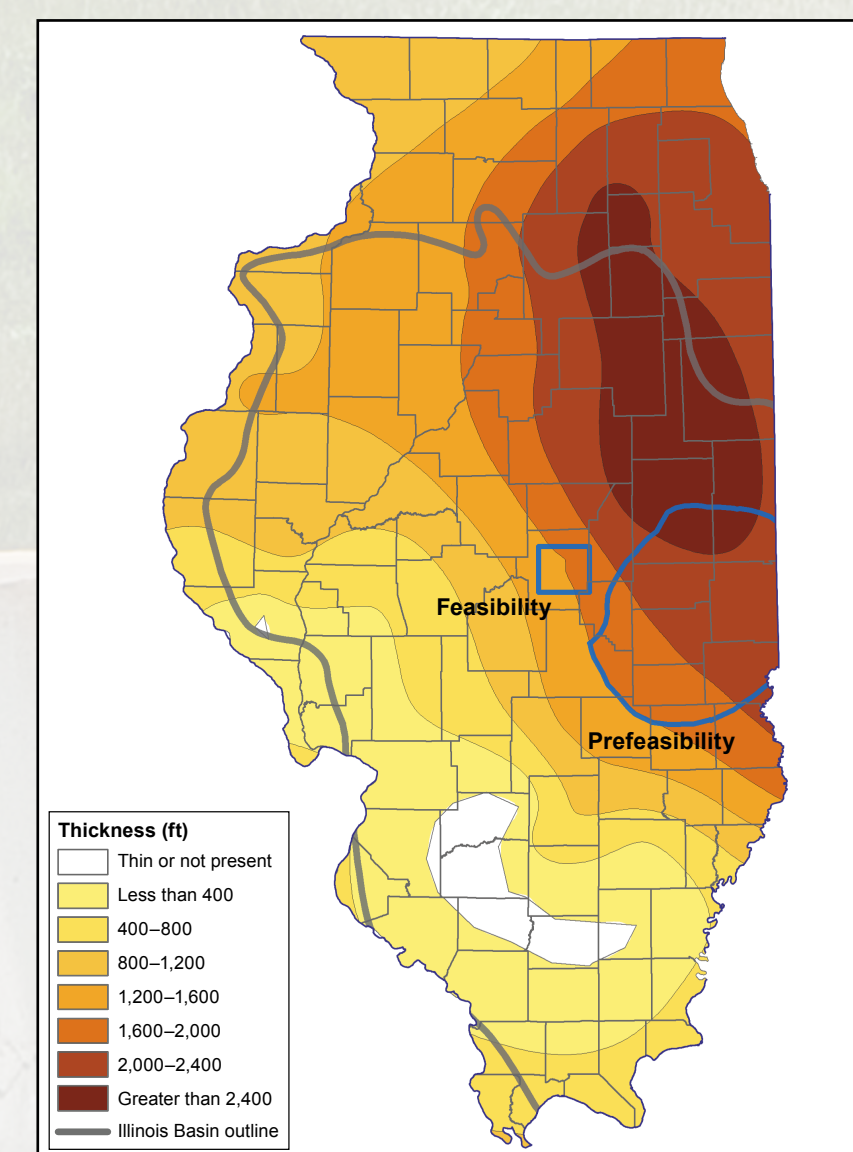


Figure 3 Thickness map of the Mt. Simon Sandstone in Illinois with the Pre-feasibility (circle) and Feasibility (square) locations. Note while the Mt. Simon thickens to the northeast it has excellent storage potential across most of the study area. The Illinois Basin depocenter is located in southeast Illinois and the depth of the Mt. Simon shallows to the northeast.

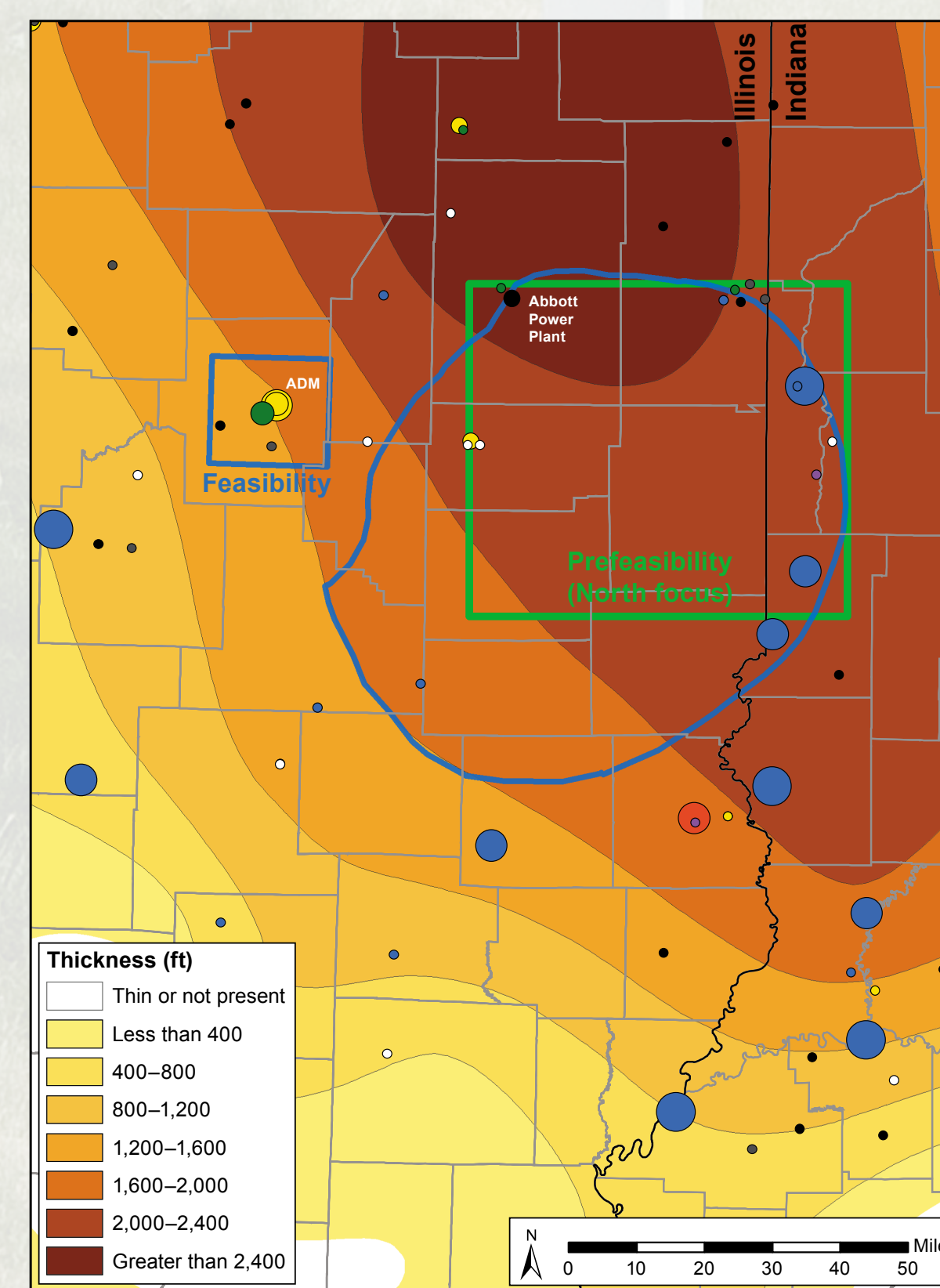


Figure 6 Thickness map of the Mt. Simon Sandstone in central Illinois with Feasibility (blue square) and Pre-feasibility (blue oval) locations, and CO₂ sources (see Fig 1B). A northern Pre-feasibility focus area (green square) will concentrate on the Mt. Simon storage complex. Electricity generation plants and other industrial sites in Champaign County, Illinois and western Indiana, are currently being considered as potential CO₂ sources for the project.

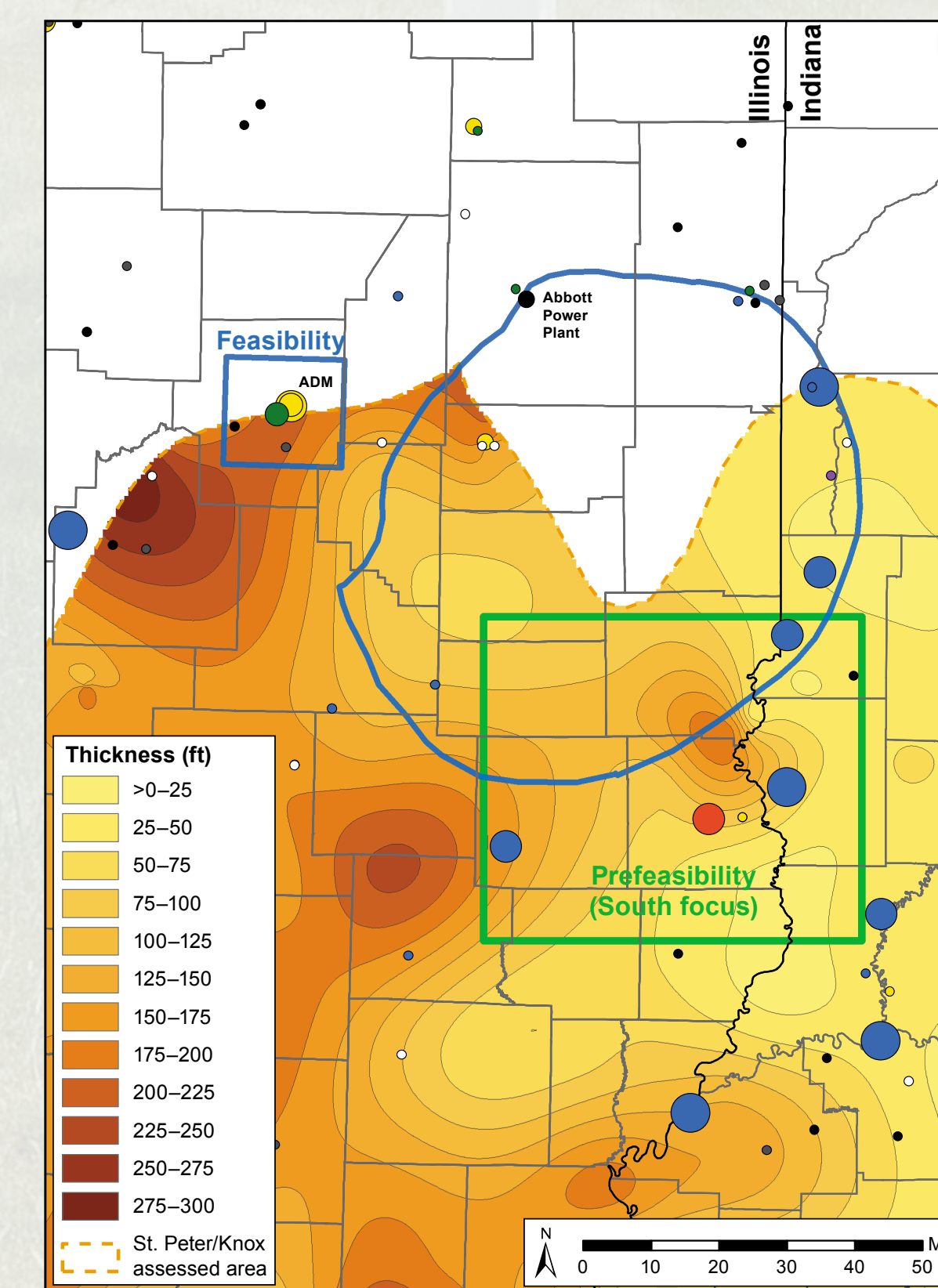


Figure 7 Thickness map of the St. Peter Sandstone in central Illinois with Feasibility (blue square) and Pre-feasibility (blue oval) locations, and CO₂ sources (see Fig 1B). A southern Pre-feasibility focus area (green square) will concentrate on the St. Peter-Knox storage complex, along with potential Cypress Sandstone and/or other EOR opportunities in the deeper IL Basin. Several large electricity generation plants and a petroleum refinery are among the potential CO₂ sources.

Conclusion

The CarbonSAFE Feasibility (Forsyth Oil Field) and Pre-feasibility (east sub-basin) projects have established support from two public sector coal-fired power plants in the region: City, Water, Light and Power (CWLP) in Springfield, and the Abbott Power Plant in Champaign, IL. The Feasibility Project is targeting the Cambrian Mt. Simon Sandstone Storage Complex that includes the most widespread saline reservoir in the Illinois Basin. Other potential storage complexes also being considered in the Pre-feasibility Project include the Knox Group, i.e. Potosi and St. Peter Formations. These storage complexes are overlain by thick, impermeable shale formations that act as regional reservoir seals.

Additionally, thick Cypress Sandstone and EOR opportunities are being investigated in the southern Pre-feasibility focus area. We are currently looking at well data from natural gas storage fields as analogs, and evaluating the relative merits and risks of both Pre-feasibility focal areas—working toward preliminary site candidates for Site Feasibility. Along with discussions with industrial plant operators, we are developing static and dynamic models based on local geology and estimated CO₂ injection as our Pre-feasibility focus areas are refined.

Acknowledgments

This work is funded by the U.S. Department of Energy through the National Energy Technology Laboratory (NETL) via the Carbon Storage Assurance Facility Enterprise (CarbonSAFE) initiative, under contract numbers DE-FE0029445 and FE-0029381.