

## Why do geothermal play evaluation?

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November 2020*

Development and recovery of geothermal resources are one of the key stones in the green energy transition towards renewable energy. The business case of a geothermal development project is directly linked to factors like the flow potential of the geothermal reservoir, the temperature and geochemistry of the formation water, the design of the plant - including well designs and surface facilities – as well as the customer potential.

The geothermal effect at surface is highly dependent on the subsurface geology and it is not always a given that the available subsurface resource corresponds to what is desired at surface. To that end Play-Based Evaluation (PBE) is a powerful assessment tool that aids decision making during the early stages of a geothermal development project.

So - what kind of geothermal effect are we looking for? Do we understand the diversity and distribution of the geothermal resource potential in the subsurface well enough? Where do we want to drill our geothermal wells and where to drill successfully next? Is the geothermal business biased in resource estimates? These are some of the early stage questions that needs to be addressed.

Here implementation of processes from the oil and gas industry such as PBE or play analysis in the geothermal sector becomes valuable. Together with a value of information (VOI) of the project it will create synergies, save time and money, and pave the way for strategic right decisions.

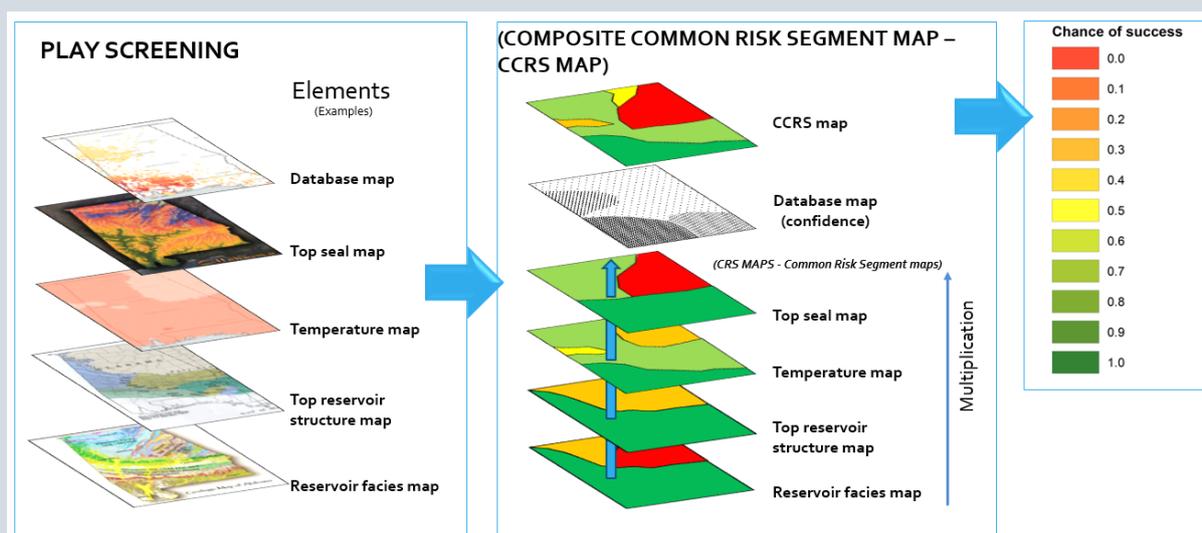


Figure 1. Play-based exploration process showing an example of the evaluation and the risk segment maps.

### Play-based evaluation

PBE is more than just making colourful maps (Figure 1). It is a dynamic process and with minor adjustments to the key elements of an oil and gas evaluation it can be used for mapping of geothermal resource potential.

Segments with the highest chances of success for geothermal resource potential are identified from defining and mapping geological trends in a consistent manner within the area of interest (AOI). In doing so the area(s) where to focus geothermal exploration is highlighted (Figure 1).

PBE is a phased process where identification and understanding of specific subsurface elements (e.g. reservoir presence and properties; temperature) is undertaken to perform an assessment of the available geothermal resources. It is important to be aware that there are significant differences in the evaluation of the subsurface- and geological setting whether the target is low-, medium-, or high enthalpy geothermal resources. The PBE activity can be carried out independent of the desired surface geothermal effect.

The individual key element maps, the so-called Common Risk Segment (CRS) maps, describes the “Change of Success” (probability) throughout the AOI for the investigated key elements (Figure 1). Subsequently all the CRS maps are multiplied together into the final product referred to as the Composite Common Risk Segment (CCRS) map. Critical subsurface observations annotated on this CCRS map exposes the uncertainties and focused de-risking can begin.

The resulting CCRS map delivers a clear understanding of the resource potential, the confidence in the resource based on the available data and what kind of data should be obtained within a certain area to reduce the uncertainty. The amount of data in conjunction with the research undertaken in the AOI is important in the decision whether to drill an exploration well, to acquire further data in an attempt to de-risk the project or to proceed directly to development.

The PBE methodology and the final CCRS play map easily allows relevant non-geological data such as proximity to consumers and density of same, infrastructure and potential end-user compatibility to be incorporated. This can be done from high enthalpy energy for electrical power generation to low enthalpy energy for heating regardless of targeting industrial-, agricultural- or residential consumers.

### **Example of a play screening study**

In 2020 WellPerform conducted a high-level play screening of the geothermal potential in the states of Mississippi, Alabama, and Georgia (USA) in collaboration with our partner Petrolern LLC on behalf of Southern Company. The scope of the study was to deliver maps showing the areas (segments) associated with the best geothermal potential. At the same time, the chance of success was assigned to the mapped segments as seen in Figure 2 and 3.

Due to lack of evidence of high enthalpy potential in these states the objective of the assessment directly led to mapping of low- to medium enthalpy (50°C/122°F to ~125°C/257°F) regional trends.

A high-level investigation was performed for the reservoir assessment due to allocation of time, the massive extend of area, complexity of geology in the study area and the high number of potential fair to good reservoirs (aquifers) in all three states.

It was concluded that reservoirs (sandstones) of Late Cretaceous to Late Miocene age hold the best reservoir/resource potential and the more speculative potential associated with basement “reservoirs” were merely flagged.

### **Outcome of study**

During the evaluation, it became evident that the basement play needs more detailed research in order to understand the density and connectivity of fracture- and fault systems of the igneous basement rocks - either by drilling of deep exploration wells or through detailed outcrop analysis.

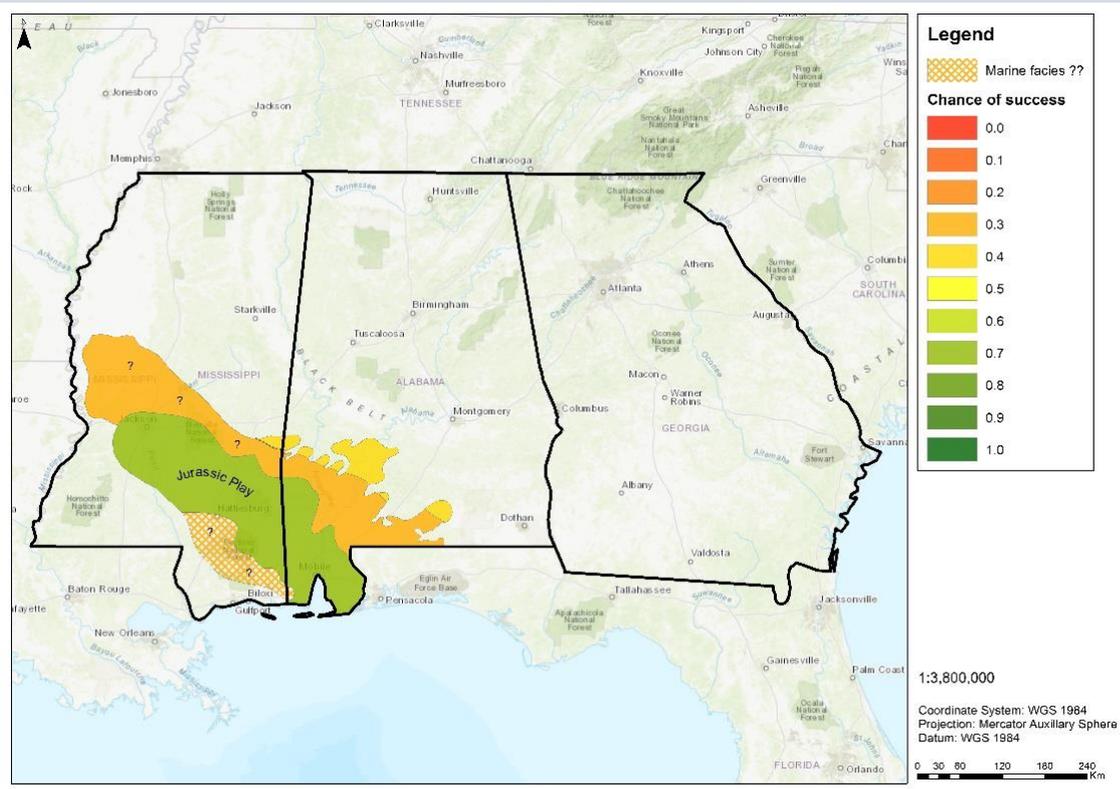


Figure 2: Compiled CCRS map for the Jurassic Norphlet Fm Play in the states of Mississippi and Alabama. The colours indicate “chances of success” (COS) in finding a reservoir with a geothermal potential in the play area.

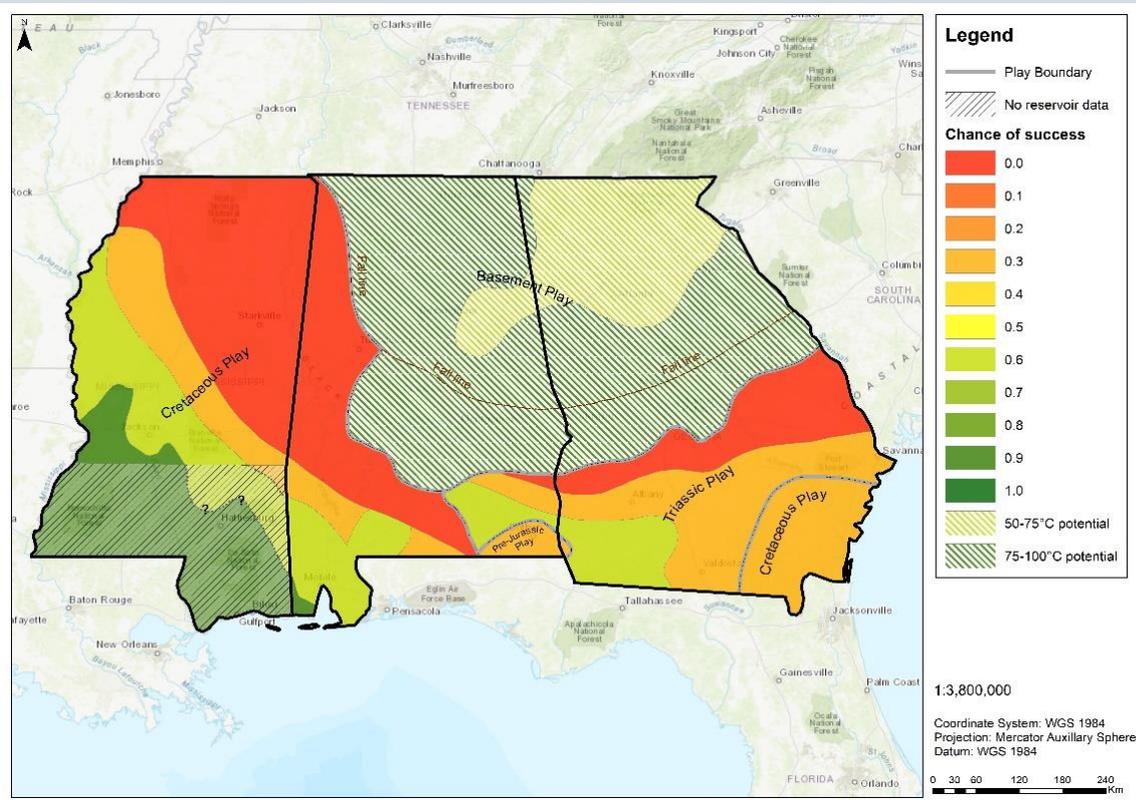


Figure 3: Compiled CCRS map for Cretaceous, Triassic and Basement Plays in the states of Mississippi, Alabama and Georgia. The colours indicate “chances of success” in finding a reservoir with a geothermal potential. The Basement play is indicated by green line shaded areas.

For the sedimentary plays the suggested next phase, is to investigate local variations in the reservoirs in selected segments and to get access to good quality data from key wells to conduct petrophysical evaluation.

Based on this study, Southern Company is now in position to formulate strategies and focus their efforts by pursuing areas where a more detailed phase of a play evaluation should be focused. This phase, based on the CCRS maps shown above, should focus on the local geological conditions, modelling of flow capacities and potential geothermal energy to be extracted from the various reservoirs.

Eventually non-geological factors should be added to fully reveal the value of the PBE. This will incorporate elements such as investigation of end users, well and facility design, well and facility cost estimates - all leading to calculation of an indicative unit energy/heat costs (cost per MW).

### **So why not benefit from a geothermal play evaluation?**

The Oil and Gas E&P business has developed and refined the concept of PBE for decades and big players familiar with operating on a large portfolio basis knows it well. The geothermal business will hopefully develop and mature in a similar way and perhaps even much faster and on a steeper curve than Oil and Gas due to the urgent need for clean energy.

Therefore, PBE will become an immensely important tool in exploration for geothermal resources and Operators should have it as an integral part of their early exploration workflow in order to de-risk the diversity and often challenging geothermal plays. Furthermore, a biased resource estimation might be avoided by improved understanding of what determines the distribution and technical recoverability of the potential resources in the subsurface.

*Performing a PBE of the geothermal resource potential in your area of interest gives a strong basis for future project decision making. In case of a successful project, you have already predicted where to drill next on your colourful CCRS map and continue developing geothermal resources. Do the PBE!*

