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Geothermal Plays, Play Analysis, And Play Fairway Analysis: Examples of Risk Maps, Resource Estimates and Strategic Decisions

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INTRODUCTION

A geothermal play is one part of a geothermal system (Figure 1). It is either an aquifer-aquitard (reservoir-seal) pair, or a permeable fault network. It hosts a portfolio of genetically related fields, discoveries, resources, and undrilled prospects (Figure 2). A geothermal play is an economic construct; It has a monetary value and a probability that the play yields a profit. A geothermal system could host a stack of plays. Selecting which play to invest millions of dollars into is a crucial decision for finance stakeholders.

Play analysis is a vital component of geothermal exploration, strategy planning, engineering, risk management, strategic decision making, and acreage evaluation (Figure 1). It is a portfolio management method to predict the results of future exploration. The total geology of nearby/analogous regions is used to map, risk and prioritize locations currently under consideration for investment/drilling. Geological analyses include the locations, quality and risk of geothermal: source, heat transfer, energy reservoir, fluid reservoir, seal, replenishment pathways, and critical moment. Play analysis puts onto maps success and failure analysis, uncertainty analysis, and risk analysis.

Play Fairway Analysis is one task within play analysis (Figure 2). It is for mapping: (a) the extent of discovered play segments, and (b) the possible extent and likelihood of undrilled play segments.

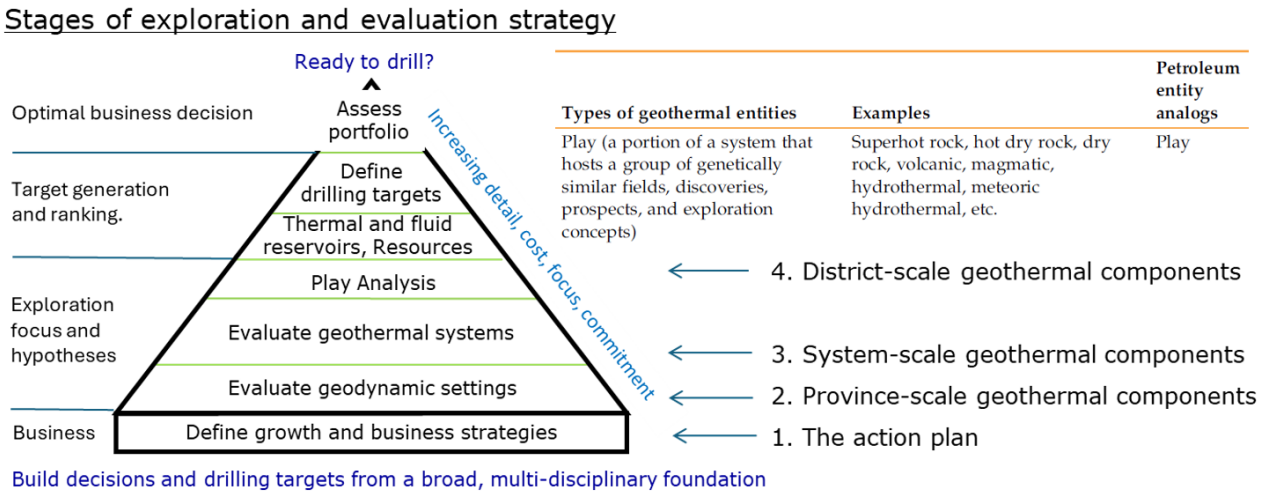


Figure 1. Play analysis is Stage 4 in a holistic sequence of evaluations that comprise Play-Based Exploration. Modified after Ball et al. (2025), Banks et al. (2022) and Banks (2018).

1 METHODS AND DISCUSSION

The published geothermal literature provides a variety of definitions and methods to analyze geothermal plays, play analysis, play fairways and play fairway analysis. Our literature study revealed eight differing perceptions of a geothermal play, including a play to be a location, a model, a fluid reservoir, or a geothermal system. Likewise, we found ten publications with differing perceptions of play fairway and play fairway analysis, either a geographic area, or a geological setting, or a method. Some geothermal play publications mix up types of geothermal play with types of geothermal system or types of tectonic setting. Compounding this confusion, few publications clearly state what a geothermal play or play fairway is. This is not helpful for investment, auditing or insurance stakeholders when they need to compare and rank geothermal regions before making multi-million dollar drilling

decisions. Geothermal stakeholders need its play analysts to follow a globally standardized set of definitions and analytical techniques.

To assist the industry, we have stated clear definitions of geothermal play, play fairway and a couple of play types (Figure 2) that adhere to the globally standardized definition of play and play fairway in other natural resource industries.

Geothermal term	Definition	Petroleum equivalent
Play	The reservoir and topseal portion of a geothermal system surrounded by low-permeability rocks. It contains a geologically related portfolio of geothermal fields, geothermal discoveries, geothermal prospects, and geothermal leads. This portfolio shares common geological risks, thermal energy source, thermal energy reservoir, insulating seal, thermal energy charge (migration) system and subsurface working fluid (either natural or introduced). The play is demarcated by geophysical surveys that indicate the possible existence of a geothermal reservoir or where fluid geothermometry suggests high temperatures associated with a thermal energy reservoir. Segments are the proven play part, the tested play part, the untested play part, the potential play part.	Play
Fault-hosted, hydrothermal play	A play type in a natural hydrothermal system where the geofluid naturally circulates through a network of connected faults (and likely other types of fractures).	A play whose reservoir porosity is dominated by fracture porosity.
Aquifer-hosted, hydrothermal play	A play type in a natural hydrothermal system where the geofluid naturally circulates through an aquifer.	A play whose reservoir porosity is dominated by matrix porosity.
Resource play	No definition found in GEA's geothermal literature search.	Resource play
Play fairway	The geographic area over which the high quality part of the play, i.e. the co-location of reservoir, traps, and seal, is believed to extend in 3D space. The mapping-out of the play fairway is an essential task in the early exploration phase and conceptual model building.	Play fairway

Figure 2. Definitions of some geothermal play-related terms and their petroleum and mineral exploration equivalents. Modified after Banks and Ball (2023).

A geothermal play is a reservoir-top seal (aquifer-aquiclude) pair of a geothermal system. It contains Prospective Resources of thermal energy until a geothermal discovery is made within a segment of the play. Play analysis and its Play Fairway Analysis component are evaluations conducted at the early stage of exploration (and repeatedly updated as more data is collected and its prospects are drilled) to estimate the undiscovered portion of a geothermal play within the total geothermal resource base (Figure 3).

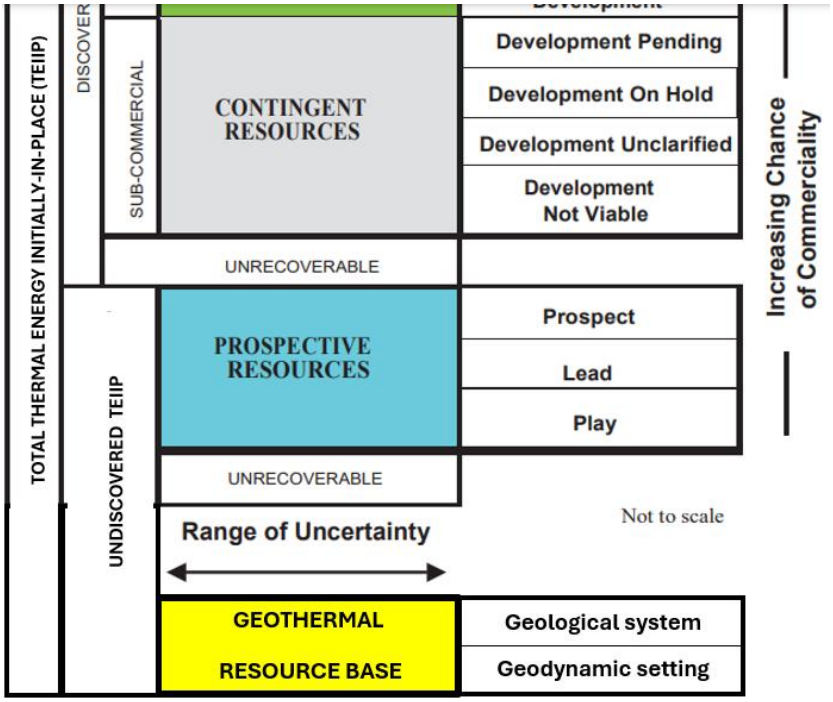


Figure 3. The position and purpose of play analysis within a geothermal project maturity and geothermal resource maturity scheme. This geothermal resource and project maturity classification scheme is based on the SPE-PRMS (Society of Petroleum Engineers, 2018) for evaluating petroleum projects. It was created by Geothermal Energy Advisors in 2025 for proprietary assignments for its geothermal engineering clients.

There are several play types, depending on the type of geothermal system they are hosted in (Figure 1, Ball et al., 2025), their porosity-permeability network, their enthalpy, their water source, etc. Examples of play types include: superhot Rock, hot dry rock, dry rock, volcanic, magmatic, hydrothermal, meteoric hydrothermal, etc. Regardless of the play type, the play analysis procedure should be very similar because the purpose and map products of play analysis are centered upon the probability of success–geological success, drilling success then commercial success–of the play and its component prospects, discoveries and fields (Figure 3).

Play analysis is resource-agnostic and technology-agnostic. Organizations conducting play analysis and play fairway analysis need to incorporate the use and implications of:

- The various types of thermal energy reservoir/aquifer (the portion of a play that stores the thermal energy and categorized by lithology and porosity-permeability) (Table 1 of Ball et al., 2025).
- The stage of project development (i.e., effort, knowledge, and yield) (Table 1 of Ball et al., 2025).
- The category of thermal resource (Figure 3 and Table 1 of Ball et al., 2025) and reserve.
- Energy extraction technique, e.g. natural, hydrothermal circuit, hydraulic fracturing, engineered closed-loop circuit, engineered open-loop circuit, etc. (Table 1 of Ball et al., 2025).

The accompanying presentation will explain for geologists and non-geologists:

- Geothermal plays, play analysis and play fairway analysis on maps and cross-sections.
- Geothermal play analysis conducted for a major energy company in two countries.
- Four types of geothermal play in one of the types of geothermal system.

2 CONCLUSIONS

The geothermal industry needs a framework for conducting geothermal play analysis and play fairway analysis that is globally applicable, globally standardized and globally accepted. The framework needs to (a) detail exploration analyses and decision milestones, (b) guide forecasting metrics, (c) provide consistency for geoscience, engineering, finance, insurance, auditing and regulatory stakeholders, and (d) match the rigor of petroleum and mineral exploration play analysis protocols. That will enable geothermal stakeholders to harmonize geothermal risk maps and resource estimates, and make strategic decisions, across national boundaries and organizations.

We advocate for a geothermal industry proponent or consortium to commission an international standard play analysis document. Authors need to be senior experts in: geothermal exploration, subsurface geoscience, reservoir/aquifer engineering, deep drilling, uncertainty, probability, geological risk, etc. Until that document, the accompanying presentation will display some examples of play analysis products generated in two countries–maps, cross sections, risk maps and subsequent strategic decisions–in a few countries.

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