

The Golden Age of “Shale” Exploration*

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Abstract

Unconventional “shale” resource plays are experiencing a Golden Age of discovery across North America and this explosive growth is beginning to go global. As in previous Ages, such as the Dutch Spice Trade or Industrial Revolution, ground-breaking and seemingly radical concepts in the oil-patch are finding alignment with new technologies and realizing unprecedented outcomes – economically recoverable hydrocarbon volumes recently unimaginable that are changing the energy balance of North America and beyond. And, perhaps analogous to the 1920’s rush of discoveries after the “anticline theory”, duration of this Golden Age will be all-too-brief given the velocity at which our Industry evolves and adapts.

Geoscientists and organizations have a truly unique opportunity to discover vast new resources and create compelling value during this historic period. Behaviors and methods that can spark the fuse of discovery include learning on the fly, focusing on the “right” questions, taking informed risks, working collaboratively and pragmatically in interdisciplinary spaces, and focusing on results over process.

Innovation and Discovery - Figure 1

The veracity and bottom-line impact of visualizing a geologic discovery, athletic achievement, or scientific innovation, and then relentlessly pursuing it, is well established in research and case studies. Wallace Pratt’s landmark insight that oil is found in the mind has never been more relevant than in today’s flurry of activity around unconventional resources and, more specifically, in this Golden Age of Shale, geoscientists are well-advised to further acknowledge the guidance of Albert Szent-Gyorgyi, the Hungarian winner of the 1937 Nobel Peace Prize in Medicine for the discovery of vitamin C: discovery is about seeing what “everybody has seen” and then “thinking what nobody has thought”.

How do we bridge this gap and “think what nobody has thought”? It starts with how we perceive and respond to our world. The reticular activating system (RAS), more commonly known as “finding what you’re looking for”, plays a key role. Our RAS influences what we see and, because it is triggered by one’s priorities, environment, and emotions, research has shown that it can be trained and focused with new information (Miller, 1968).

Related research led to the discovery of “7+/-2”, a concept that the human brain can consciously process between 5 to 9 “chunks” of information simultaneously and, more significantly, the size of a “chunk” depends on knowledge, expertise, etc. Think of a “chunk” as the size of a file (perhaps in megs) and the brain is a dual quad core processor – the larger the 5 to 9 “chunks” of information, the more network connections, computations, and ultimate computing power we can yield. Meanwhile, our central nervous system is subconsciously sorting, 24/7, millions of additional stimuli - perhaps the human brain is a million or even billion core processor! And it well documented that we can increasingly tap our potential through the power of positive thinking, continuous learning, passionately pursuing our dreams, effective communication and collaboration, etc. Fine, we’ve likely already heard this, perhaps read a few books about it, maybe even attended a seminar or two, however, it’s not about what we “know” but if, and how, it’s practiced. So, is there a simple process that we can follow to help lead us toward innovation? The thesis herein is “YES” and termed ACB in which a focus on RESULTS facilitates discovery.

The ACBs of Golden Age Exploration - Figure 2

Two basic approaches that have led to discovery are presented. There can be little doubt that the Scientific Mode, herein termed ABC - one with which we’re intimately familiar - is pervasively used across our industry and culture, is tried and true, and requires no additional elaboration. A second proposed method, ACB, may start with similar questions and issues as ABC and, in both methods, it’s mission-critical to identify and characterize the relevant starting parameters. However, the path forward may significantly diverge between the two methods because ACB implicitly acknowledges that the initial issues are often poorly understood or perhaps even irrelevant and have a tendency morph with further examination. In contrast to ABC, where one works the problems and issues ‘A’ through ‘B’ (How) to achieve the ‘C’ (Result). ACB starts with the desired Result and, through collaboration with varied subject matter experts, some perhaps far-afield of the traditional oil patch, plus learning on the fly, adaptation, dreaming, and plain old resilience, uses our “7+/-2”, re-iterating “back on How”, to find a solution. New and very different questions, issues, and associations, may result. A hypothetical exploration example, from SE Asia, will demonstrate how the ACB mode may reframe ‘How’, leading to a very different set of exploration goggles, helping discover a play that has eluded others.

Beware “Secret Sauce” Models - Figure 3

In our journey toward shale exploration success, it's advantageous to remain mindful that our RAS, especially when operating in ABC mode, can lead to very comfortable “secret sauce” recipes. In such analog-based “recipe space”, the closer the prospect is to the analog, the higher our confidence may become and, as result, the easier it might be to “sell” to our Company or investors. Competition inevitably escalates if the recipe has been successful, making it increasingly difficult to “get-on-base”, let alone “hit-a-home-run”, because of a plays’ discovery “creaming curve”. And, if competition is chasing that 800# elephant with a hazel eye that's only visible on a Blue Moon, that leaves plenty of uncontested exploration opportunity in the rest of the resource triangle jungle. Furthermore, given that shale plays are unique, at least in their own way, a model may literally evolve from an exploration asset to an expensive liability. Examples from two famous play “secret sauce” recipes, 1) CBM: San Juan 30-6 Unit, San Juan Basin, NM and 2) Shale gas: Barnett, Fort Worth Basin, TX, that were exploration model “poster children” for years, are posited to have inhibited subsequent discovery, through their specificity and our RAS, because the new plays did not appropriately fit the criteria of THE model.

An Eagle Ford Vignette, South Texas - Figure 4

An early-days vignette of the ConocoPhillips Eagle Ford shale discovery, South Texas, will illustrate how a “clandestine”, passionate and integrated technical Team, employing ACB and focused on RESULTS, identified, characterized, and captured a new liquids-rich shale play concept in an unfractured, carbonate-rich reservoir while much of Industry was focused on the Barnett gas “secret sauce” from fractured siliceous shale. Reality is the COP initiative was also treading on old ground, but with a new twist. The Eagle Ford, like most unconventional plays, has been “discovered” numerous times and, in 1978, was described “...full of oil in most locations...”. This was a perfectly apt contemporary description because the knowledge, expertise, and technology simply did not exist to convert resource to reserves but, in 2005, could it be a different story...?

Eagle Ford Tactics - Figure 5

The Eagle Ford play concept was created through the combination of common knowledge and well-established geologic tenets, with deduction and inference, fused with long-term Corporate alignment and support, spirited debate, “ah-ha” revelations, plenty of elbow grease, lots of Team lunches, and having fun! Knowns included: 1) Proven Austin Chalk source with ubiquitous mud gas shows from the globally recognized Turonian-age stage, 2) Carbonates can be the most prolific reservoirs; Deductions: 3) Currently active petroleum system, 4) Overpressure present-driven by oil cracking to gas at high bottom hole temperature (BHT); 5) Natural fracturing limited except around faulting; 6) Distal Austin Chalk facies highly perspective and, in many ways, analogous to the Eagle Ford (at one time termed “a difference with no distinction”); Inferences: 7) Compression storage play because BHT too high for adsorption (adsorption in Barnett was believed, at the time, to hold 50%+ of the gas), 8) The sweet spot will be a supercritical reservoir fluid

fairway from which flow, liquids, and NPV can be optimized, 9) Resource concentration will be exceptionally high, and 10) Horizontal drilling and massive multistage hydraulic fracs will be required to create a “sugar cube” reservoir to recover hydrocarbons at an economic rate; Frightful: 11) Are the reservoirs brittle enough to effectively frac and get an economic rate?, 12) Is the horizontal stress anisotropy too great?, 13) Will we have condensate drop out and liquid loading that kills production?

In retrospect, our Team had more than its share of miscues and outright surprises, both positive and negative, on the road from concept to reality. Some were simply beyond contemporary technology (i.e. flow contribution from organic matter permeability) and some self-induced (i.e. Austin Chalk did not turn out as good as the Eagle Ford for many reasons). However, by adopting ACB and remaining focused on the Result, we weathered the storms, had a blast adding a page or two to the “Book of Shale”, enriched our professional lives, and materially moved the needle for our Company securing, through 2008, >300,000 acres for <\$10,000,000 and, by 2012, a prize that had grown to 1.8 BBOe (77% liquids).

What’s a Next BIG THING? - [Figure 6](#)

Lastly, as the shale “how-to cookbook” is being “carved into stone” in North American, it is advisable to recognize that these never-better “secret sauce recipes” are biased toward marine-sourced Paleozoic plays. Given that the majority of global hydrocarbon production is from the post-Paleozoic, it is probable that numerous, altogether new, unconventional plays await discovery. SE Asia, for example, is amply endowed with productive Tertiary and lacustrine petroleum systems, and history suggests their giant unconventional counterparts will be differentially secured by those so prepared for the challenge. Golden Era anyone?

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🔍 Innovation & Discovery

"Where oil is first found, in the final analysis, is in the minds of men"
(Wallace Pratt, 1952)

"Discovery consists of seeing what everybody has seen, & thinking what nobody has thought."
(Albert Szent-Gyorgyi, 1937)



Reticular Activating System (RAS)

- "You find what you're looking for" (caveat emptor!)
- "For every expert there is an equal & opposite expert" (Arthur C. Clarke, 1968)
- Triggered by priorities, environment, emotions
- Train RAS with new information to discover & innovate
(Modified from Miller, G.A., 1968)



"7 ± 2" Principles:

- Working memory can hold 5-9 ("7 ± 2") chunks of information
- Size of chunk depends on knowledge, expertise,...
- Meanwhile, CNS is sorting millions of stimuli
(Modified from Miller, G.A., 1968; Szent-Gyorgyi, 1937)



Thesis: A focus on **Results** facilitates discovery

Beware Analysis Paralysis

"... & must have that rarest talent of all - convert information into action"
(Modified from Masters, J.A., 1996)

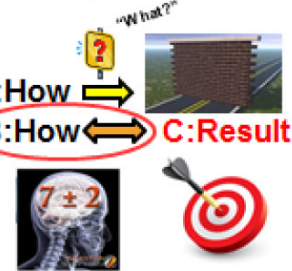


Figure 1

The ACBs of Golden Age Exploration

Discovery Processes:

Scientific Mode (ABC) A:Issues → B:How → C:Result
Innovation Mode (ACB) A:Issues → B:How ↔ C:Result



Mode similarities

- A:Issues - Critical to effectively identify

Differences

- Scientific focuses on B:How - May hit roadblocks that derail progress
- Innovation focuses on C:Result: Iterate 7 ± 2 back on How for new way

Keys to achieving **Result** using "7 ± 2 on How":

- Effectively collaborate, adapt, learn on the fly, & resilience

Warnings: 1. Innovation enters uncharted territory & anathema to convention

"Really new ideas are...usually met with derision & disbelief"

2. Maintain mental discipline

"Is this still good?...It's hardest to say no to yourself"

(From Masters, J.A., 1996)



Figure 2

Figure 1. Innovation and Discovery.

Figure 2. The ACBs of Golden Age Exploration.

Beware “Secret Sauce” Models

Coal Bed Methane: San Juan Basin 30-6 Unit

- ✓ Overpressure
- ✓ Thick seam
- ✓ Water, water, water
- ✓ Then came: Drunkards Wash, Powder River, Raton, Bowen-Surat, etc

1992 *CBM Secret Sauce*



Shale: Barnett Shale Gas

- ✓ Silica (brittle)
- ✓ Open fractures
- ✓ Ro 1.4 – 1.6
- ✓ Then came: Haynesville, Marcellus, Muskwa, Monteny, etc

2005 *Shale Secret Sauce*



Why?
Why not?
What if?

So why not...(Result)

An unfractured, carbonate- & liquids-rich play?

(aka “anti-sauce” circa 2005)

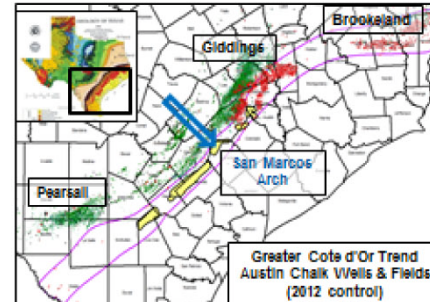


Shhhhh!

Figure 3

3

An Eagle Ford Vignette, S. Texas



Concept:

- World class Turonian source
- Known source for Austin Chalk
- Ubiquitous mud gas shows
- Carbonates are prolific reservoirs
- Significantly over-pressured
- Unstructured homoclinal trend
- Compression vs adsorbed gas
- Focus on condensate window
- High resource concentration
- HZ drill & “sugar cube” completions

Uncon plays tend to be “discovered” many times, including Eagle Ford:

“The Eagle Ford Shale is full of oil in most locations in the eastern...South Texas counties...it is brittle...black shale...there have been some recent completions...although by itself, it could not be considered a target...”

(From World Oil, 1Feb1978, P.58)

Figure 4

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Figure 3. Beware “Secret Sauce” Models.

Figure 4. An Eagle Ford Vignette, South Texas.

Eagle Ford Tactics

- ✓ Team of passionate & motivated ACB “heretics”
- ✓ Empowering, long-term Corporate support
- ✓ Fit-for-purpose multidisciplinary Team
- ✓ Project kept “top secret” for years
(Play concept unleashed across 250 km)
- ✓ Staged pilot program focused on critical path data
- ✓ State-of-the-art integrated technologies
- ✓ Leasing program aligned with pilot results
- ✓ **Creating a unique culture & having fun!**



“Nothing in this world can take the place of persistence. Talent will not; nothing is more common than unsuccessful people with talent. Genius will not; unrewarded genius is almost a proverb. Education will not; the world is full of educated failures. Persistence and determination alone are omnipotent”
Calvin Coolidge



Figure 5

5

Figure 5. Eagle Ford Tactics.

What's a Next BIG THING?

- The NAM “shale textbook” dominated by marine Paleozoic plays
- ✓ Yet the majority of global production is post-Paleozoic
 - ✓ And the richest source rocks are lacustrine

SE Asia is highly endowed with post-Paleozoic lacustrine & marine systems

- ✓ Non-sedimentary reservoirs are also more frequent

A World of new world-class unconventional hybrid plays are coming!

- ✓ And “...the next big oil will be in new fields that...have been invisible”

From Meadows, J.E., 1978

The HOW:

- ✓ Master the “textbook” but beware the “secret sauce” **Kool-Aid**
- ✓ Consider ACB to help capture your shale play in this Golden Age



The world can be your
shale oyster in SE Asia!

*“Logic will get you from A to B. Imagination
will take you everywhere”* Albert Einstein



Figure 6

6

Figure 6. What's a Next BIG THING?