INFORMATICS JOURNALS

Online ISSN : 3049-3455

Mineral Metal Energy Oil Gas and Aggregate

Contents available at: *www.informaticsjournals.co.in/index.php/2MEOGA*

2MEOGA

Seven Geoscientific Practices for Effective Hydrocarbon Exploration: A Holistic Approach

Pratap V. Nair

Retired Exploration Geologist, Devidarshan, Kawdiar, Trivandrum - 695003, Kerala, India; vpratapnair@gmail.com

Abstract

Oil and gas exploration is a risk intrinsic activity. The risk cannot be eliminated but can be controlled and reduced by adopting appropriate workflow, and conceptual and technological innovations. Finding new economically viable oil and gas fields has become increasingly challenging. My experience says seven practices are imperative for effectively exploring oil and gas. Three are classified as dominantly technical; two have a behavioural focus, whilst two illustrate the requirement for an integrated, commercial business mindset. Each of these seven practices is described in the paper. I argue that these practices would define robust exploration to discover oil and gas.

Keywords: *Storage, Stages, Weight, Trial, Paint, Commit, Valued*

1.0 Introduction

Seven geoscientific practices have become imperative for effective exploration of oil and gas. Three are classified as dominantly technical; two have a behavioural focus, whilst two illustrate the requirement for an integrated, commercial business mindset (Figure 1). These could form the basic drives of conducting an exploration project.

1.1 Know Your Data

Data management is the essence of which all evaluations flourish or ultimately perish. There are data issues centring origin, quality, conditioning time, integration, resolution and archiving that all need to be understood and managed efficiently. Recognizing where the gaps in our database and knowledge is crucial. The limitations caused by the paucity of data must be defined. In many cases, not all available data are commonly used in defining the subsurface realizations. Logging the available data is a useful habit to develop at the project initiation stage: register multi-disciplinary sources, confirm validity and reliability, and define the vintage, as techniques and tools have become more sophisticated. Always data mining, manipulation and conditioning take longer than anticipated, as corruption and mistakes need to be rectified before loading and utilization. Do the integrity check early?

Raw data becomes information when they have been processed and interpreted in some mode. There are finite limits to how much information can be extracted from any dataset. These limits are set by the methods of acquisition and processing. Whether it's signal processing in seismic or the sampling constraint on bio-stratigraphic dating techniques, there are always boundary conditions.

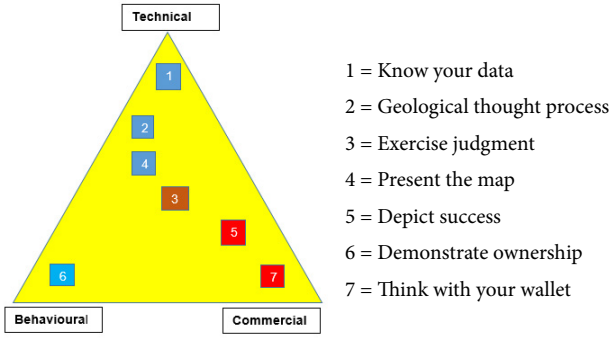


Figure 1. 7 practices diagram.

Good explorers know what these affecting factors are and know how to push the data to their limits, but not beyond. Whilst the focus on data is typically at the start of a project, very often the post-evaluation phase of data management is neglected. Archiving is crucial for corporate memory and value protection, so spend time properly archiving, cataloguing and recording where the data are stored for the next generation.

In summary, it is important to remember **STORAGE**:

- **S**ource – the origin, age, and validity of your raw data
- **T**ime – just how long it takes to condition your data into a reliable, robust, reusable format
- **O**wnership – licensing restrictions, national export limitations, usage conditions
- **R**esolution – acquisition and processing constraints that define extractable information limits
- **A**rchive – preserve for posterity in our cyclical business, the data will be needed again one day
- **G**aps – recognize your data white space and therefore your understanding of blind spots
- **E**xhaustion – keep mining, conditioning, and integrating, because it is the foundation of all that follows

2.0 Geology Thought Process

Geological thoughts centre on the notion of processes that shaped the environment of deposition through time and space. The emphasis is undoubtedly on thinking, not quantification, not volumes, not risk, not application toolkits, not process or mechanistic workflow, but a geological understanding of the petroleum system as it applies to the basin, play or prospect.

Regardless of whether it is frontier basin analysis or mapping another prospect in a mature proven play, several geological perceptions always need to be considered to enable a reliable interpretation to emerge from the data. Basin classification and the driving mechanisms behind the subsidence and creation of accommodation space will fundamentally determine the way you interpret the subsurface, typically through seismic 'plus' other data types. Tectonic evolution will determine the style, density, and connectivity of faults (Figure 2). This must be understood, and past and present analogues researched, to know what we are looking for in the seismic image when traversing such systems in different orientations. Analogues supplement your experience base and extend beyond the simplistic, conveniently available local examples. Look for analogues in realms of similar structural style, similar depositional environments and potentially similar 'mirror image' basins when seafloor spreading is removed through plate tectonic reconstruction. Age is not always the best criterion on which to search for analogues, except when searching for times of equivalent sea level and climatic conditions that supported certain environments at a global scale.

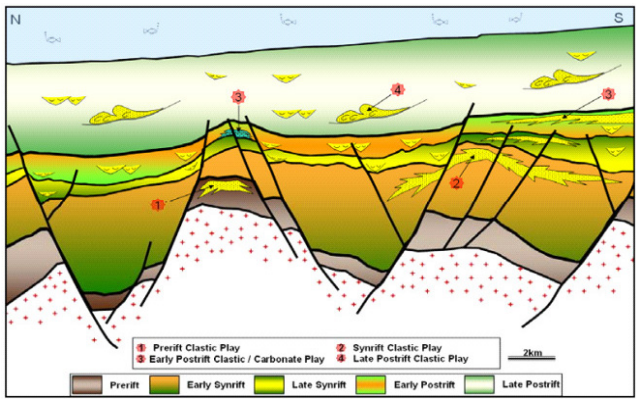
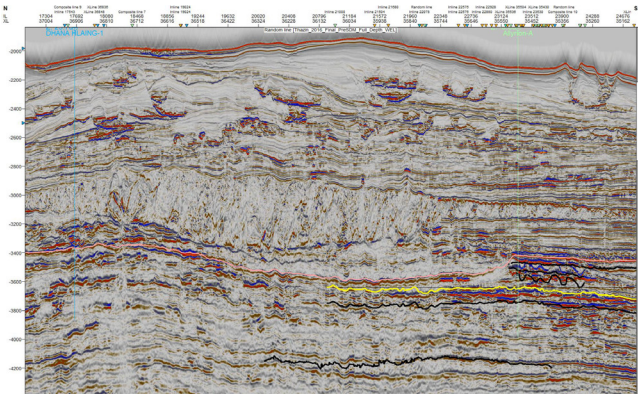


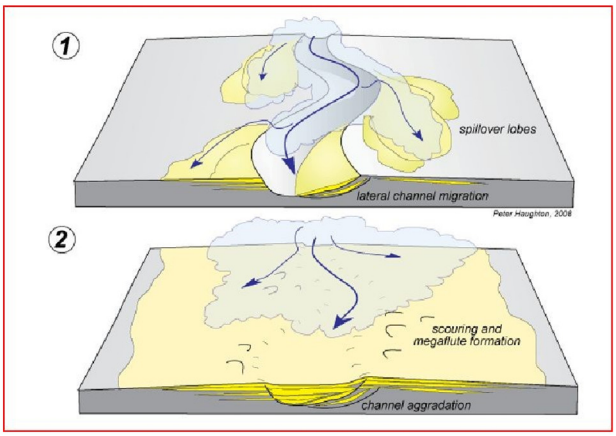
Figure 2. Tectonic evolution of the basin.

Time adds a fourth dimension beyond the spatial domain of any subsurface interpretation. It is critical in defining that the components of a working petroleum system have been brought into effective confluence and remained so until drilled, in an optimum manner. Many expensive well failures can be traced back to a poor understanding of play dynamics, most notably the requirement for peak charge expulsion and migration to be after trap formation. Play-based exploration is still an effective approach to defining how the individual elements 'hang together.' Likewise in exploration, it is better to think chrono-stratigraphically than litho-stratigraphically to avoid over-correlation of known lithologies away from well control.

Geological fieldwork (outcrop study) and an understanding of current geomorphological processes are core skills and experiences to assimilate, not only because they educate through direct observation of processes and patterns, but also because they allow an appreciation of scale. Lateral variation and general complexity are constant reminders about how detailed sedimentary geology and structural modification need

to be considered when interpreting subsurface models through remote data images (Figures 3 and 4).





Figures 3 and 4. Typical seismic section and geological model.

The ultimate independent reality check of geological thinking is to draw, unaided by technology, two schematic cross-sections defining the key elements of the subsurface area under consideration. This could be for two different periods in a basin's evolution or crystal and critical spill point located sections for a prospect. Accomplish this and you'll know that your geological thought processing has been thorough and will be considered credible.

In summary, it is important to remember **STAGES**:

- **S**tructural style – basin architecture, subsidence mechanism, trap formation, trap modification
- **T**iming – dynamics, order of events, 4th dimension, does it hang together consistently?
- **A**nalogues – unbiased, success and failure, conjugate basins, across multiple criteria
- **G**eomorphology – current landscapes as clues to the past, outcrop studies, lateral variation impact
- **E**nvironments – depositional systems, palaeogeography, climate influence
- **S**cale – working scale (basin -> prospect), observation scale, opportunity scale

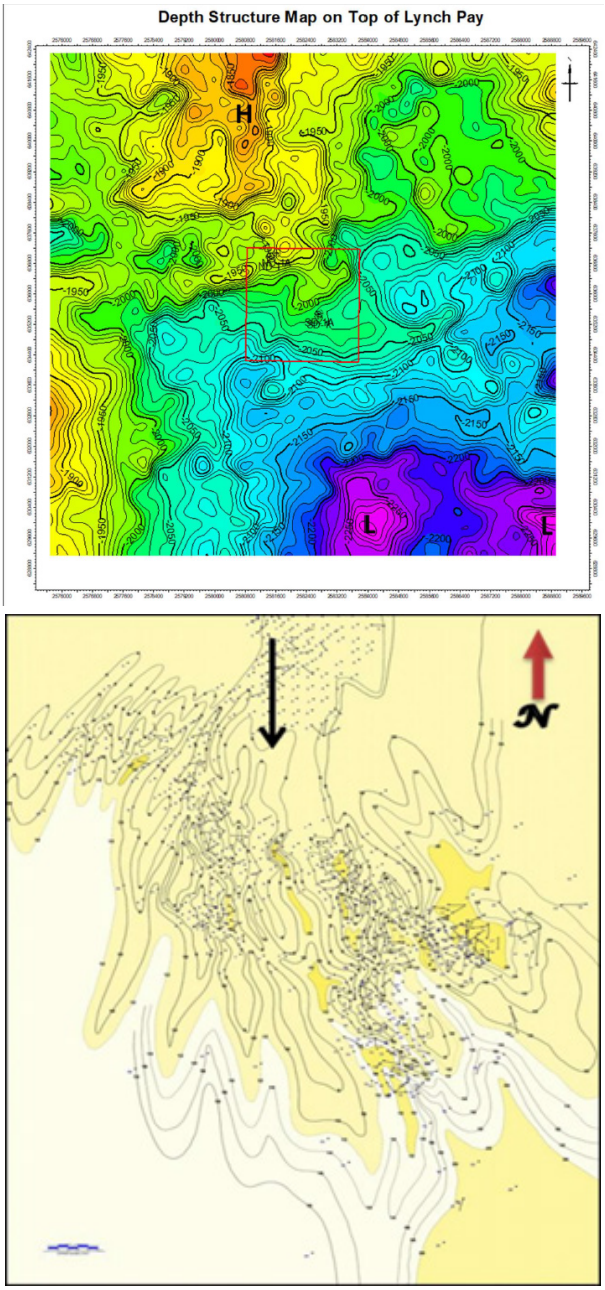
Now that's all been considered, and a mental model transferred through interpretation of the data to build a subsurface model realization(s), and only now, should the process of quantification of risks and volumes begin in earnest. Now that the understanding has been developed, the framework has been thought through, and the "math" can be done in the correct context.

3.0 Exercise Judgment

Judgment indicates choices are available and unless we possess an uncanny extra-sensory perception, we will need alternative information to make a choice. Well-informed or balanced judgments put the conflicting lines of evidence in context. Information may be qualitative or more frequently reduced to a mathematical quantification. Scenario trees are often an effective way of ensuring that some elements are neither neglected in the quantification of issues nor inappropriately biased. There are many times when it is prudent to not blindly believe the end numerical result. A common example is the risk coverage equation for exploration prospects. A certain amount of experience shows that if the prospect volume and hence value is made large enough, any amount of risk can be carried and still deliver a positive estimated monetary value. Does that mean it is a justifiable prospect to drill? Possibly yes, but probably not. To arrive at a decision, other criteria need to be weighed into such a decision, such as affordability, alternative options, contribution to our priorities, do-ability, and dependence (what does it open for us if successful?). Experience will also help sniff out what is the 'priority.'

Judgment is very underrated and undervalued most of the time. However, most of us will undertake our biggest judgment calls on what matters, petroleum geology (see, Think Geology) and there are many judgment calls involved in our industry. Whether it is reviewing offset well data, trying to determine fault correlations on 2D seismic data, or deciding great benefit can be gained by obtaining a second opinion. Simply asking another pair of eyes to look over the data, or a colleague how they would tackle your dilemma can gain valuable additional insight

and more confidence the issue has been thought through in Figures 5 and 6.



Figures 5 and 6. Prospect structure map and sand isopleth map.

Once your decisions have been made, it is important to be prepared to defend your rationale, choice of priorities, lines of evidence and supporting figures. As explorers, we ought to have a strong but reasonable view of a basin or prospect. Be willing to listen and adapt your views. Recommendations on prospects come from those people who know them best, the interpreters. Ownership cannot be divorced from the actions of making judgment calls, so be prepared to follow through.

In summary, it is important to remember **WEIGHT**:

- **W**hat if? – scenarios, balance the evidence, alternative models
- **E**xperience – has a $ value, your opinion counts, 'gut feel' and does it intuitively feel right?
- **I**nformation – make sure all the information is available, conclude and decide
- **G**ravitas – recognize the importance of the decisions
- **H**onour – Honour your experience, defend your judgments
- **T**ackle – issues head-on, take responsibility

The trick in exercising judgment is not in simply being able to list what is important to consider, but in deciding which criteria are priorities and for what reasons. Bring your experience to the fore, because it is appreciated, and no amount of 'process' can be a surrogate for good oil field thinking. Finally, remember the adage, 'If it looks too good to be true, it probably is.'

4.0 Present the Map

Explorers are judged not on what they say, but on what they can demonstrate to be valid in their interpretations. Missing evidence always becomes obvious in its absence, usually sooner than you might wish to believe. It should not be forgotten that as explorers you evaluate opportunities using scientific methods. Scientists use observations, hypotheses, and logic to propose explanations for natural phenomena in the form of theories. Scientists use scientific methods to build a supportable, evidence-based understanding of our world. Explorers do the same, using databases of hard physical evidence regarding petroleum systems, coupled with their less tangible but equally important knowledge of what governs the generation, distribution, and hosting of hydrocarbons in sub-surface traps. Predictions that follow are called play maps or well proposals. Testing the predictions ultimately happens with drilling.

However, there is often disagreement in the geoscience world over the various aspects of these understandings, especially where there is missing data, or the ideas

proposed are less than familiar to the audience. Rather than try and be selective with evidence and economical with the facts in certain areas at certain times, presenting all the material in an integrated way that best tells the storyline in its totality would seem a good approach. Sometimes in exploration, the storyline is incomplete or manipulated to favour the positive aspects of what people think others want to hear. Reviewing all the evidence allows the viewer to confirm what is being proposed and differentiates honest 'class act' from flannel technical perjury is inexcusable. "Robust, integrated, considered and relevant", are all ticked on the mental checklist when such products are delivered.

In summary, it is important to remember to be on **TRIAL**:

- **T**otality – provide all the evidence for an integrated storyline
- **R**eputation – build one and keep it
- **I**ntegrity – of your data and you personally
- **A**ssurance – get the appropriate independent checks and balances done
- **L**imitations – Understanding effective communication material is imperative

5.0 Depict Success

"Discovery consists in seeing what everyone else has seen and thinking what no one else has thought", so said Albert Szent-Gyorgyi (1894 - 1986)[2], the 1937 Nobel Prize winner in Physiology and Medicine for his definitive work on understanding Vitamin C. '. Depict success prompts visions of the future, an ability to strive for a goal, and the requirement to think things through and not be constrained to the present activity. It comes with a strong requirement for communication skills as well. It is also a state of mind that can operate across a broad range of environments: you can just as simply envisage and communicate a successful outcome for a one-hour meeting, as you can for a more complex and stretching integrated project over many months.

One of the most obvious areas where we can picture the impacts of success is in our world of good results. Too often we pay too little regard to the possible implications of certain outcomes BEFORE the well is drilled. This can range from the very immediate 'panic' about whether to sidetrack a successful discovery, to the longer-term implications that well results have on a dependent prospect portfolio. The first can be addressed through adherence to minimum standards in all aspects of well planning, especially the conditionality of borehole evaluation programmes on the actual reservoirs and fluids encountered. Value trees and decision trees help us map through such options. The second requires longer-range thinking even earlier before the prospect has been proposed for drilling. We aspire to open new frontiers and develop significant portfolios on the back of successful wells that will fuel the exploration success rate for years to come.

So, your well has been successful – congratulations! How much genuine thought has gone into thinking about appraisal strategies? What is it I am appraising for; more volume, searching for contacts, searching for attic gas caps, proof of compartmentalization, proof of reservoir heterogeneity, the ability to test productivity and hydrocarbon compositional properties? Who do I need to engage in the discussion about what appraisal sufficiency looks like for this type of sub-surface resource? It was also a deliberately drawn-out list of questions, which you will only be able to answer if you have thought through in detail what 'success' looks like.

Optimism should not become unsustainable desire or over-promises. The creativity of ideas, whether they are untested geological concepts or novel commercial approaches to acreage access and deals, are fundamental to our exploration business. One of the key insights for being creative is to understand the difference between looking (the art of directing one's eyes towards something) and seeing (perception using the eyes). Can you 'see' your next exploration's success?

The requirement to 'depict success' demands communication with other disciplines and business units to paint a realistic picture of what is achievable: it is a doorway to personal skills growth.

In summary, it is important to remember **PAINT** :

- **P**ossibilities – are everywhere, from new concepts to increased personal development opportunities
- **A**ppraisal – think through the multitude of appraisal requirements
- **I**magination – mental images of the future in the success case
- **N**ovelty – how dependent is success on doing something differently and having new ideas?
- **T**ouch – what does success impact, and how to follow up?

6.0 Demonstrate Ownership

"Anyone who has never made a mistake has never tried anything new", so said Albert Einstein (1879-1955)[1]. The suggestion behind the quote is one of courage; a human characteristic ubiquitously quoted in the literature and media about many fields of life. It usually comes with a heroic connotation. Over time the concept has migrated into the leadership and creativity domain, where what is at risk is typically credibility and reputation 'So what?' I sense your thinking. Well, it is because as alluded to in Exercise Judgment, it's critical that explorers possess and portray self-belief in what they are doing, and more importantly, what they are proposing to the company to invest money. At the most basic level, it requires that you, the individual, the interpreter, and you the geologist, are prepared to back your productivity ideas all the way. In truly owning and defending your ideas, you can bring your experience to bear. People are increasingly talking about intellectual property, normally when the transportability of it is challenged, but here it is where it can be leveraged for the benefit of the business.

Ownership can also be a collective concept. It is just as important for your team to pull together and produce an integrated proposal as it is for you to display individual ownership. Team sports are a useful analogue to consider; all players have a defined role and without each one the function and success of the team are compromised. Not everybody is a goal-scorer, goalkeepers are just as important. The philosophy holds for all petroleum geological ideas.

"To err is human, to forgive divine" is Alexander Pope's[3] original quote, which is frequently corrupted into comical business excuses e.g. "To err is human, but to foul things up requires a computer!" You would be surprised how many excuses prevail within the organization about why projects went wrong, deadlines were missed or were simply misunderstood. Demonstrating ownership means not playing with the victim and not offering excuses. It is not the IT that spat out the indecipherable map and you can no longer blame the organization/colleagues for that.

In summary, it is important to remember to be **COMMIT**:

- **C**larity – provide it, don't scribble illegibly in the margins, and hope to get away with it.
- **O**wnership – if we paid by intellectual property of ideas, ownership wouldn't be questioned
- **M**e – begins with "my commitment" to deliver
- **M**indset – lose the victim mentality, become a player
- **I**ntent – check and double-check that people understand what your intent is
- **T**alent – bring yours to bear

This is the most behavioural of the seven practices. We must not operate a blame culture, but we are expected to be accountable and to deliver on promises. Genuine mistakes or compromises due to influences beyond our control are acceptable – the trick is to learn from them, avoid repetition and become wiser.

7.0 Think with your Wallet

The Exploration Game is an expensive one, increasingly so in times of high oil price times. We have all been asked the question "Would you drill this well with your own money?" usually as a test of our belief in each prospect. Of course, as a normalized fraction of our annual income, it gets scary very quickly. But if your annual earnings were what they were for the EP business, then the expensive well equates to <1% of your salary. Thinking of it this way next time you are asked, the risked value equation might become easier to swallow.

So much for 'cost'. What about the flip side of the monetary balance, value'? Easier to challenge when faced with spending today and pressures for capital discipline, value has many more controlling parameters in its makeup. The theory and math of project economics (NPV, VIR, EMV etc.…), although it's the assumptions governing the input data and multiplying metrics that are important to understand. If ever there was a subject that reverberates to the tune of "garbage in, garbage out", it is project economics. Because in the assumptions, all the underlying controls that dictate the outcome are set; price scenarios that control cash generation, tax rates that diminish profit, and perhaps most importantly, the cost basis of required investment. The two classic EP development cases are where (a) adjacent infrastructure and a lower operating cost base allow the investment profile to be reduced at no threat to the modelled income stream, thereby increasing return on investment, and/or (b) where higher forward oil and gas price assumptions increase and accelerate cash flow and ultimate project revenues. So, just like beauty, value is obviously in the eye

of the beholder. There is much common thinking with that of Depict Success, which will help define how broadly we can envision value generation, especially as it relates to other people.

In summary, for the commercial habit, it is important to remember **VALUED**:

- **V**OI – asset value with new information minus asset value without
- **A**cumen – from the Latin acquire (to sharpen), therefore financial and business acumen
- **L**ifecycle – value can be extracted at different parts of the life cycle, by swap, or by sale….
- **U**S Dollars – for better or worse, they benchmark the financial world
- **E**conomics – in our context, hopefully positive, the financial benefit from risked investments
- **D**rivers – what controls liberating value? Sensitivities?

8.0 Discover Oil and Gas

We wonder what some explorer's approach to winning "The Weakest Link" game show would be. We can think of three approaches we might take based on a variety of behaviours. The first group would just innocently be 'strategyless' and treat every question and teammate on their merits. The second group would adopt a statistical approach, which, has indicated that answering 60% of the questions correctly is the optimum pitch between 'likeable colleague' and 'know-all potential victor'. The third group would probably play based entirely on intuition and the dynamic relationships evolving with their colleagues. That doesn't mean they would be any less thorough intelligent or strategic than their counterparts, it just means they would adapt based on what they sensed happening at the time. Everybody's role is critical just like all the components of the power transmission system in a car are critical. It isn't just a failure of the clutch friction plate which can halt progress, it can equally be a simple cable break that produces the same result. So, it's all about diligence, attention to detail, and not believing in silver bullets.

Visibility through improved technology means we can see more, engineers are getting more creative about how increasingly truculent resources can be developed, and we've learned an awful lot through experience about what can and can't be realized. Things we had to ignore in the past as undeliverable, as below-par objectives, are now viable potential targets. What has become harder is making money at competitive rates from the discovered hydrocarbons. In a mature basin, we think the most important thing to remember is to not accept that there are only small opportunities left. Also, don't forget the simple ideas like drilling deeper into an area that is already encouraging. You must think like an adventurer on the hunt for that new place?"

9.0 References

1. Einstein A. Quotes [Internet]. Goodreads.com. Available from: https://www.goodreads.com
2. Szent-Gyorgyi A. The Times Great Quotation: Famous quotes to inform, motivate and inspire. London: The Times.
3. Pope A. Quotes.