Gaffney, Cline & Associates

Exploration to Reserves and Production – the monetization highway

CCOP, Bangkok

April 22, 2015

Disclaimer Statement

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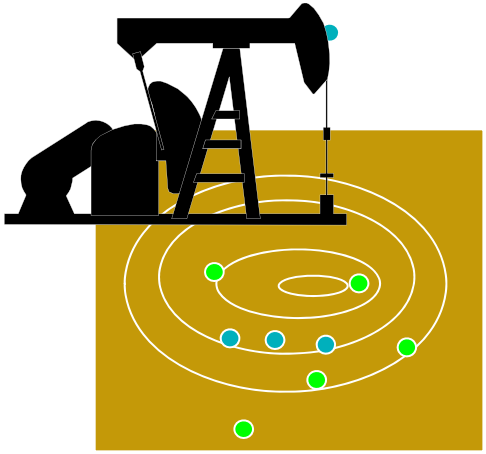
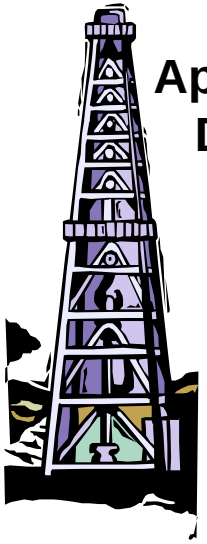
The Monetization Highway

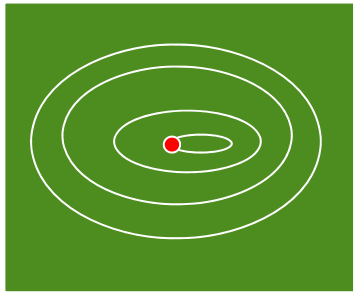
Development / Production



Appraisal / Drilling



Exploration / Prospect Generation



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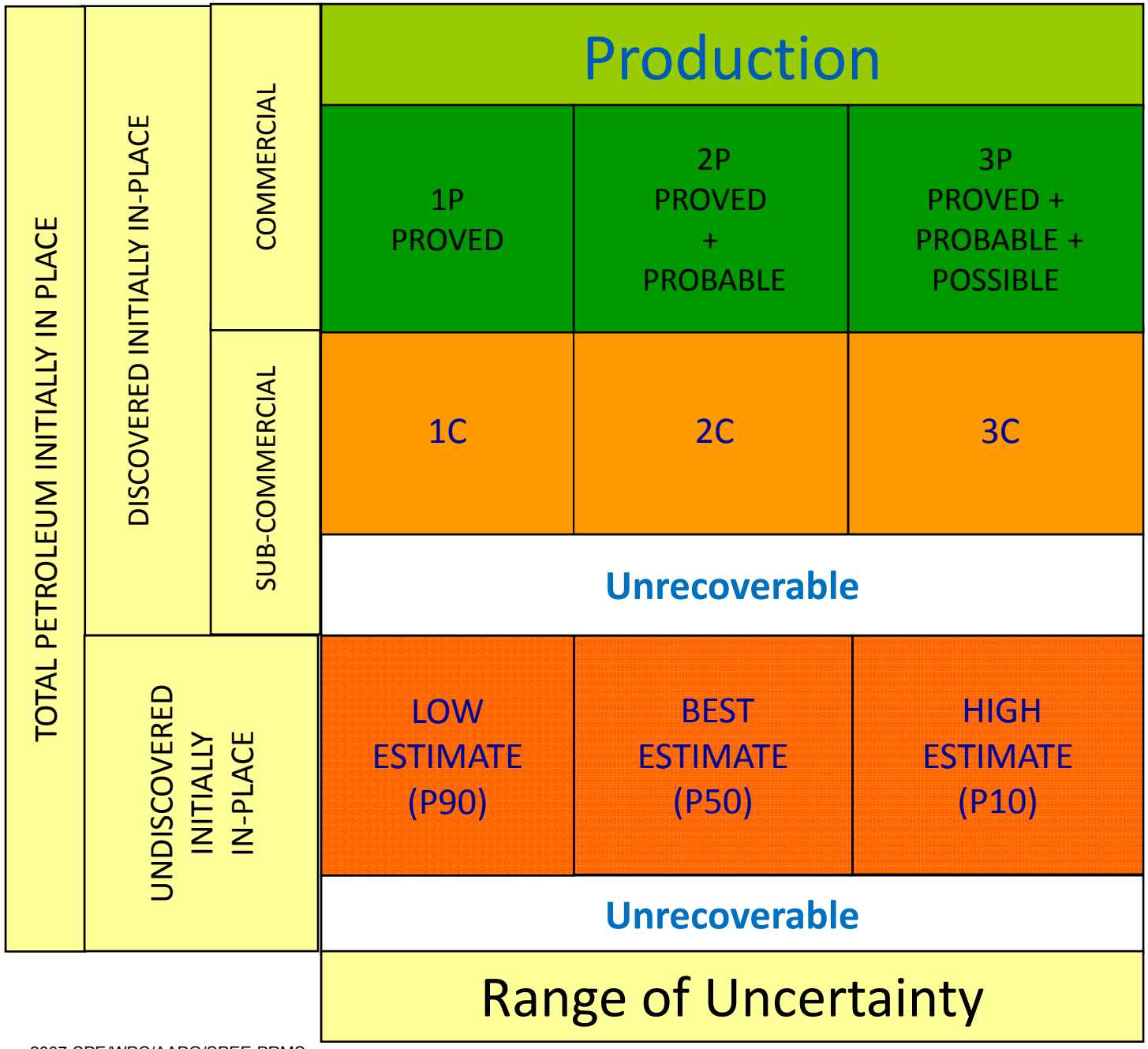

Reserves

Contingent Resources

Prospective Resources

Source: 2007 SPE/WPC/AAPG/SPEE PRMS

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The Highway……

Prospective Resources – Exploration Potential

Exploration Discovery

Contingent Resources – Sub-Commercial

Commercialised

Reserves – Commercial

Developed

Production – Sales

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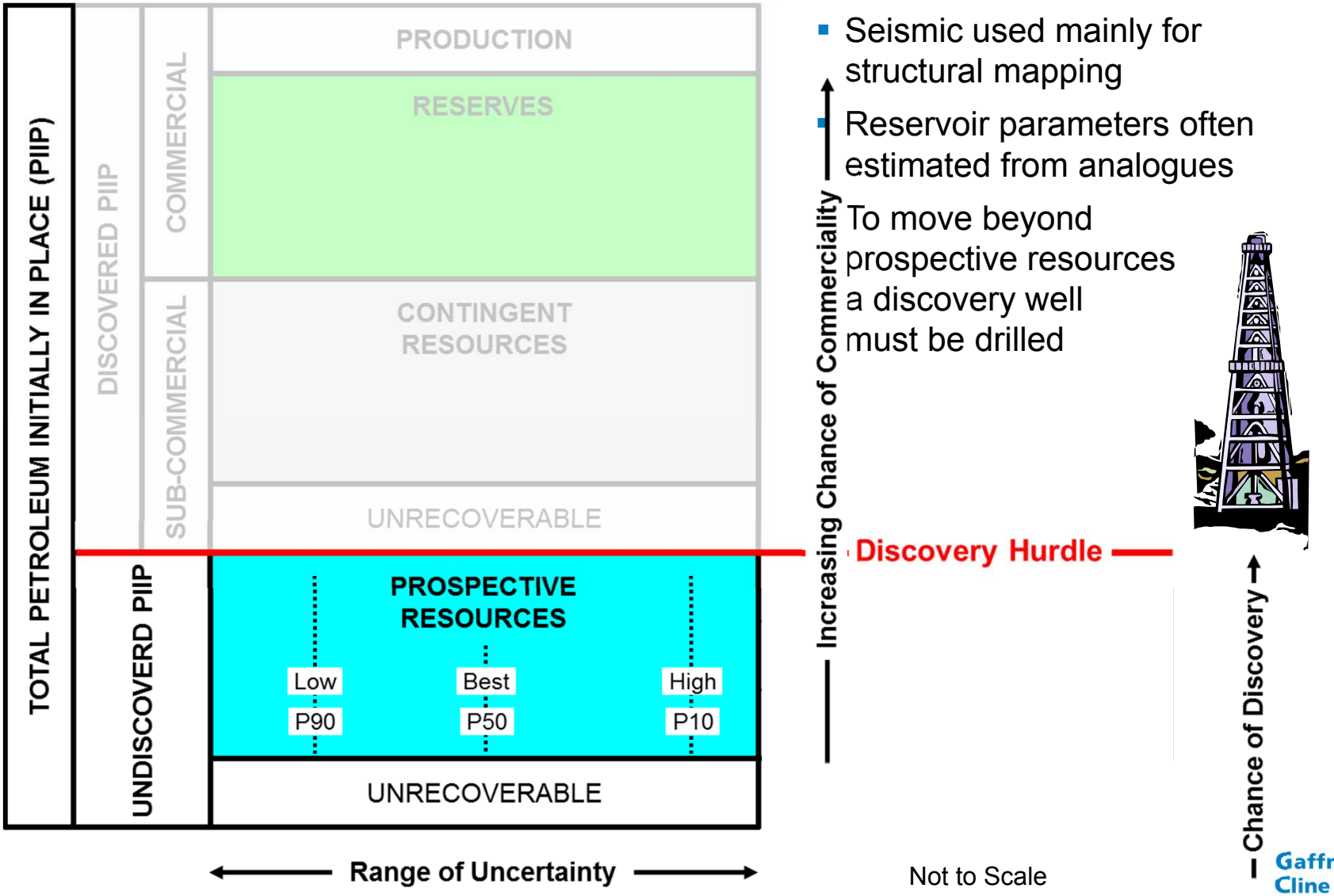
Exploration

The Journey Begins



- Focus of work is to define an economically viable prospect
- Seismic used mainly for structural mapping
- Reservoir parameters often estimated from analogues
- To move beyond prospective resources a discovery well must be drilled

Not to Scale

Modified from 2007 SPE/WPC/AAPG/SPEE PRMS

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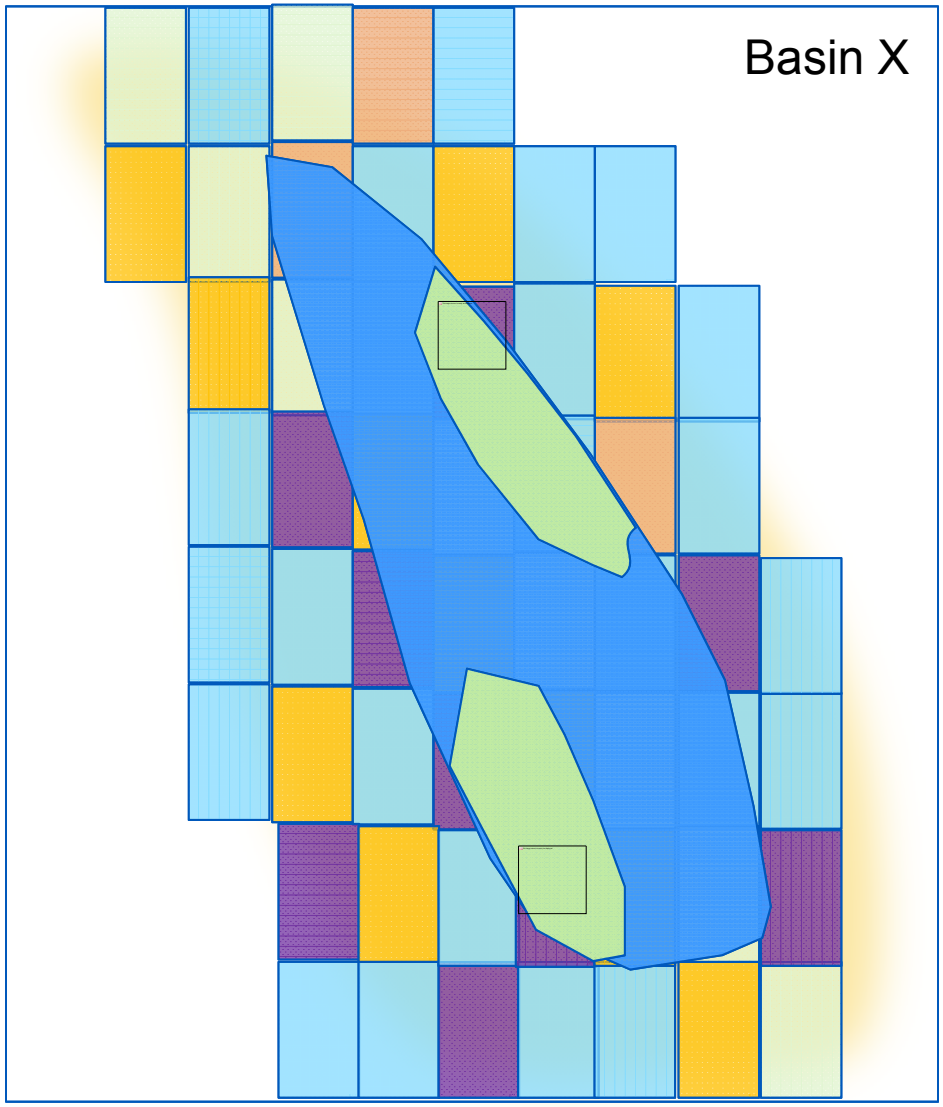
Exploration Phase (Prospective Resources)

Reporting of Prospective Resources varies from Country to Country. Some of the reporting 'grey' areas include:

- Technical maturity of a play or lead included in reported volumes may vary from company to company.
- Reported volumes may be risked or unrisked.
- Risk associated with reported volumes may or may not be reported.
- Arithmetic or probabilistic addition of Prospective Resources.
- Prospective Resources may be reported as working interest or net entitlement.
- Definition of 'geological risk' and methodology used to estimate it may vary from company to company.
- Unconventional Resources further complicate the picture…….

Note: Individual stock exchanges may set reporting standards for Reserve and Resource reporting beyond those provided in the SPE PRMS, e.g. SGX requires disclosure of "relevant risk factors" and volumes should be unrisked. The SEC mandates that only Reserves should be reported and that Contingent and Prospective Resources should be excluded etc.

How to define a Prospect in a continuous unconventional accumulation?



By Basin

- Basins can cover 100s sq. km?
- Basin Resource Potential?
- Should clearly identify maturity (Play / Lead / Prospect), Use Sub-classes!
- Same risk for all?

By Licence Block / Tenement / Sub-Block

- Provides granularity and is often level at which development decisions are made.
- How big is a block?

By Geological "Domain"

- Various combinations e.g. depth, thickness, gas content, mineralogy, facies, thermal maturity, structural style, stress regime, elastic properties etc.

By Concentric Well Spacing

- i.e. same methodology as used for Reserves ?

By Combinations / Others

- Combinations of the above

Source: Unconventional Reserves and Resources - A Square Peg in a Round Hole? – APPEA April 2014

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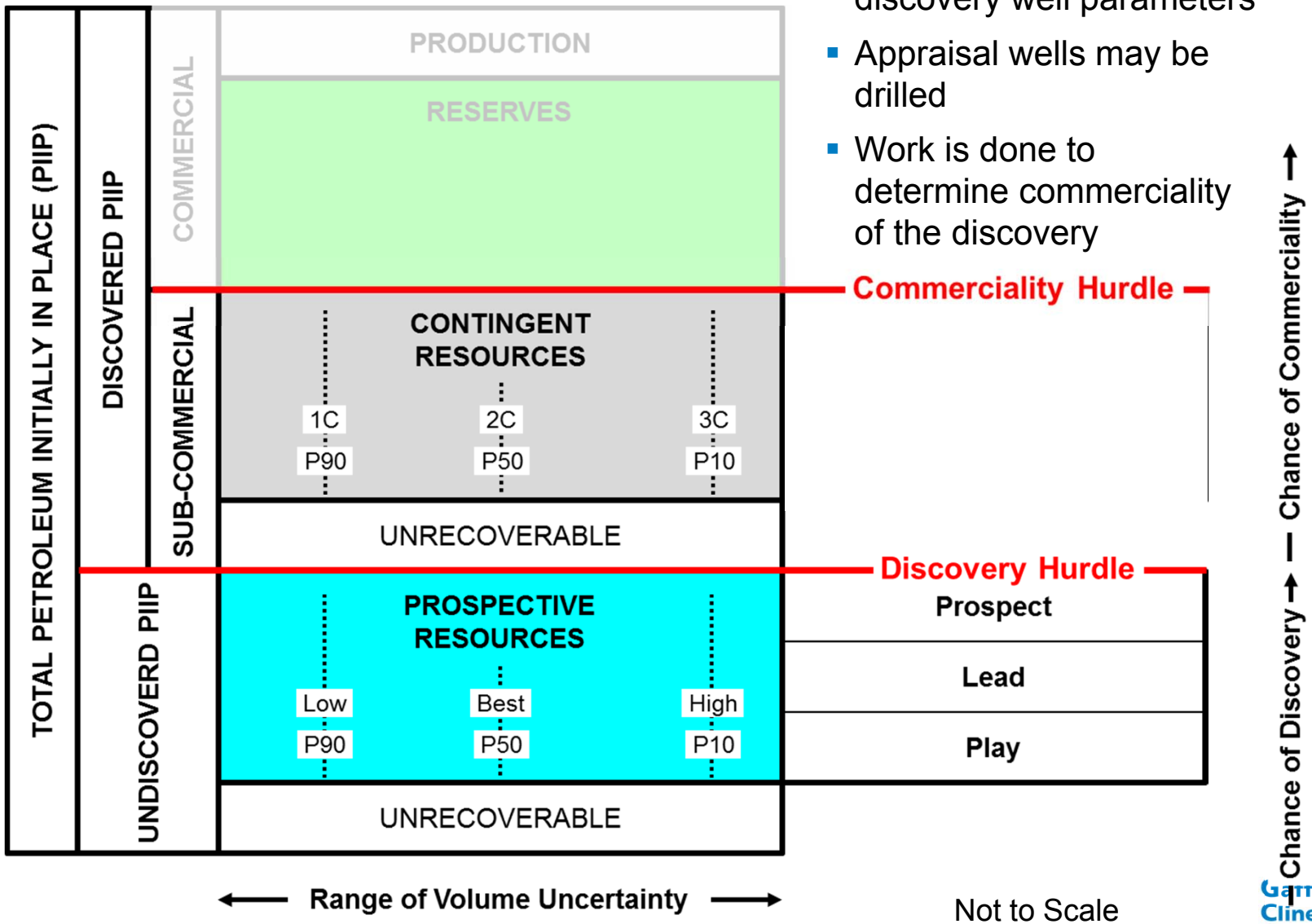
Geological Chance of Success / Discovery Test in Unconventional Resources

- Unconventional accumulations haven't undergone source-migration-trap history, so conventional risking doesn't apply.
- PRMS does not provide detailed guidance (even for conventional).
- Risk factors are different e.g.
  - CSG: Coal Thickness, Gas Content, Permeability, Gas Saturation, Cleating, Stress Regime,
  - Shale Gas: Basin character, burial history, organic content, geochemical (kerogen type, TOC), mechanical (brittleness).
  - Conventional: Usually include Source, Migration, Reservoir and Seal.

Contingent Resources

The Second Leg of the Journey



- Resource estimates are revised based on discovery well parameters
- Appraisal wells may be drilled
- Work is done to determine commerciality of the discovery

Not to Scale

Modified from 2007 SPE/WPC/AAPG/SPEE PRMS

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Discovery Status

The First Stop

- "A discovery is one petroleum accumulation, or several petroleum accumulations collectively, for which one or several exploratory wells have established through testing, sampling, and/or logging the existence of a significant quantity of potentially moveable hydrocarbons"
  - The PRMS intentionally does not require a flow test in order to establish a discovery
  - In some instances it may nevertheless be considered that logging alone would not be considered sufficient to identify a discovery since some indication of fluid type and producibility will normally be required to comply with the following requirement
- "In this context, "significant" implies that there is evidence of a sufficient quantity of petroleum to justify estimating the in-place volume demonstrated by the well(s) and for evaluating the potential for economic recovery"

Source: 2007 SPE/WPC/AAPG/SPEE PRMS

Appraisal Phase (Contingent Resources)

Some of the reporting ‘grey’ areas include:

- Understanding of the discovery definition:
  - Has sufficient information been acquired to meet the discovery requirements?
  - How far from the ‘discovery’ well(s) can the discovery be reasonably extended?
  - Vertical limits of the discovery?
  - What does “evaluating the potential for economic recovery” really mean?
- Should the ‘commercialisation risk’ be reported for Contingent Resources?
- Contingent Resource subclasses are generally not reported hence reported volumes include the two extremes of “non viable” and “development pending” resources – does it make sense to combine such diverse groups – could this be misleading?

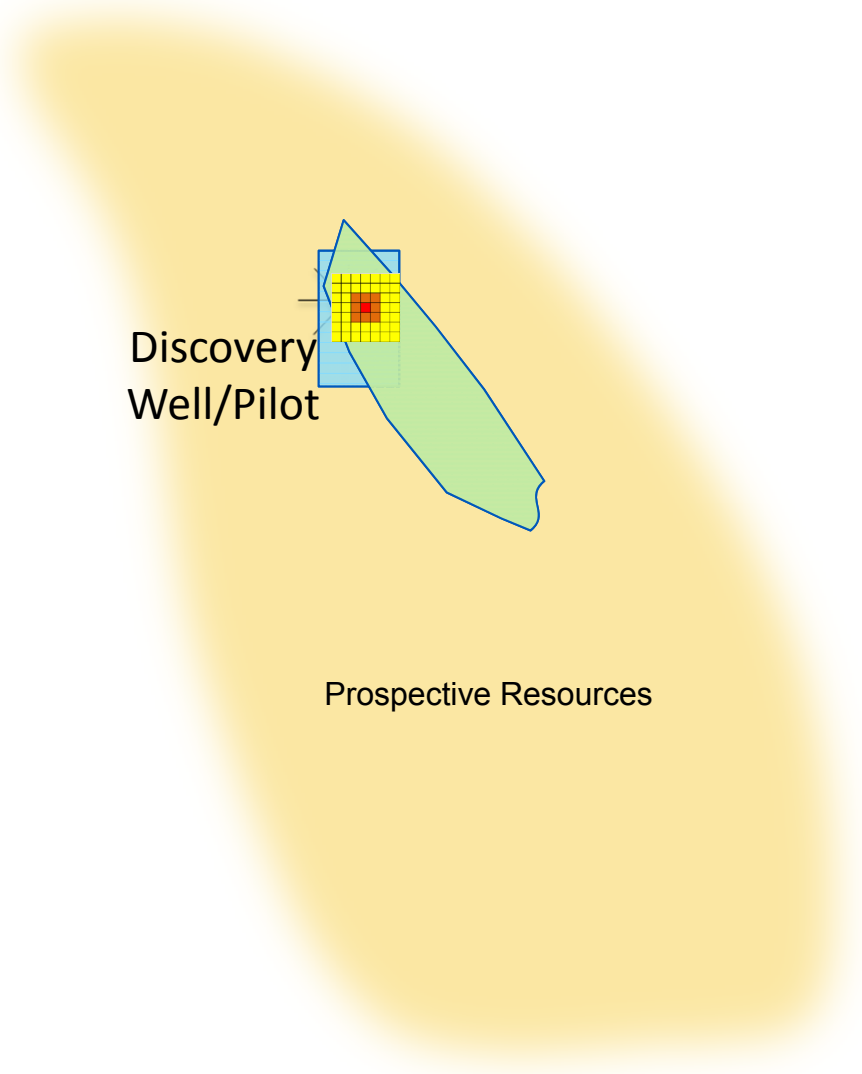
Appraisal Phase (Contingent Resources)

Has sufficient information been acquired to meet the discovery requirements?

All discoveries are not equal:

- Discovery Test - more problematic for unconventionals?
  - Different for different types?
    - CSG: Dewatering? How much?
    - Shale Gas/Tight Gas: Need fraccing?
- Near field discovery versus wild cat.
- New play type versus existing.
- Unclear versus clear log response.
- Poor seismic versus good seismic.
- Complex faulted/stratigraphic trap versus simple structure.

Unconventional Resources - once made, how far does a discovery extend?



Can now classify as Contingent Resources, but still have similar issues as for "what is a Prospect"

- In a single unit, formation?
- Limited by what?
  - Geology, size, lease, depth, thickness, gas content, development criteria, distance……
- Maximum Size?
- How to define 1C, 2C, 3C?
- Does concentric rings incremental method predetermine 1C, 2C, 3C ratios?
- Tendency to develop only sweet spots?
- Combinations are likely appropriate depending on local circumstances

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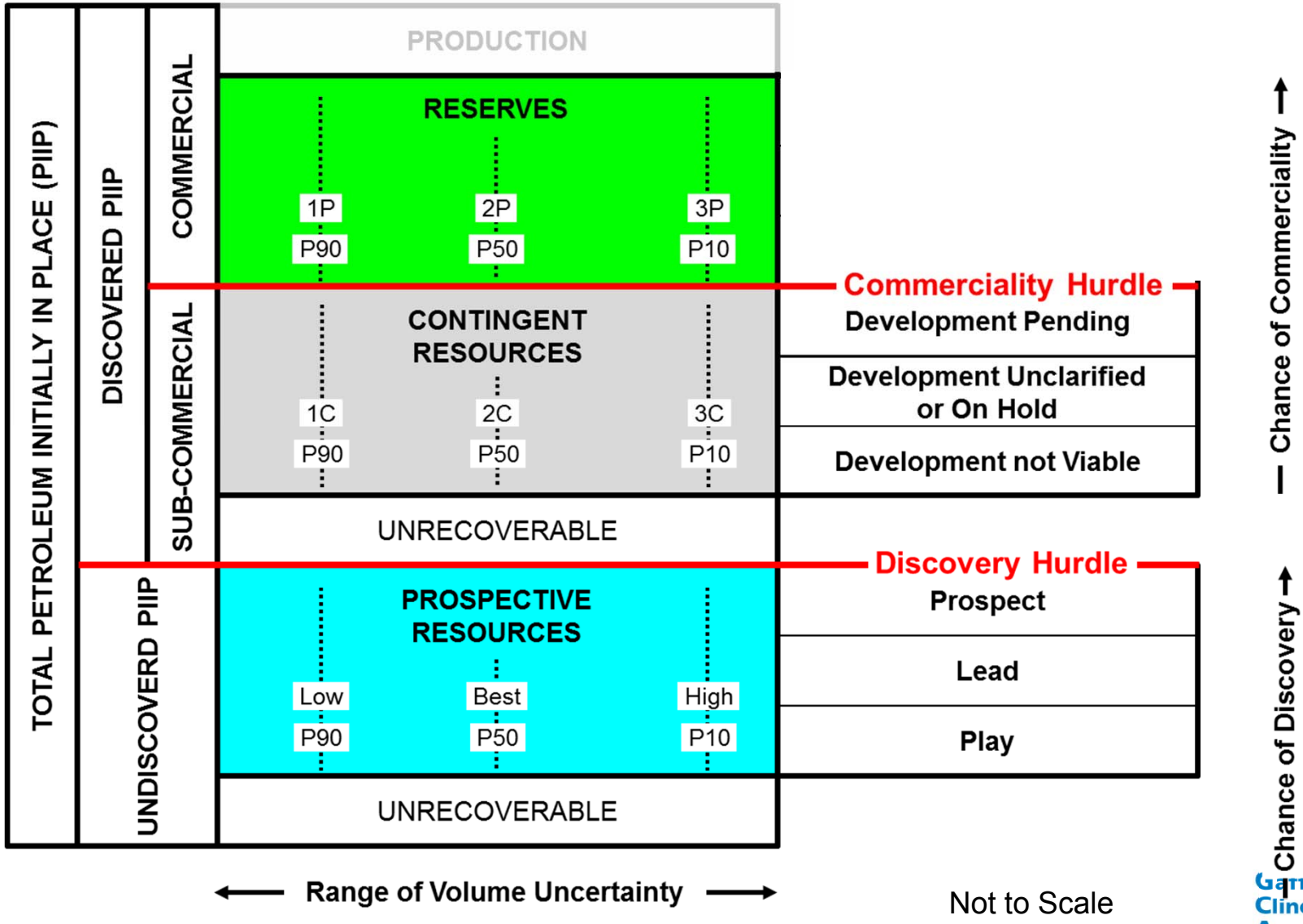
Source: Unconventional Reserves and Resources - A Square Peg in a Round Hole? – APPEA April 2014

Reserves

The Third Leg of the Journey



Modified from 2007 SPE/WPC/AAPG/SPEE PRMS

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What are Reserves?

- "… quantities of petroleum anticipated to be commercially recoverable by application of development projects to known accumulations from a given date forward under defined conditions."

- Must be
  - Discovered
  - Recoverable
  - Remaining (as of the evaluation date)
  - Commercial
    - Based on the development project(s) applied

Source: 2007 SPE/WPC/AAPG/SPEE PRMS

Requirements for Commerciality

The Second Stop

- "Discovered recoverable volumes (Contingent Resources) may be considered commercially producible, and thus Reserves, if the entity claiming commerciality has demonstrated firm intention to proceed with development and such intention is based upon all of the following criteria:
  - Evidence to support a reasonable **timetable** for development
  - A reasonable assessment of the future **economics** of such development projects meeting defined investment and operating criteria
  - A reasonable expectation that there will be a **market** for all or at least the expected sales quantities of production required to justify development
  - Evidence that the necessary production and transportation **facilities** are available or can be made available
  - Evidence that legal, contractual, environmental and other social and economic concerns will allow for the actual implementation of the recovery project being evaluated"

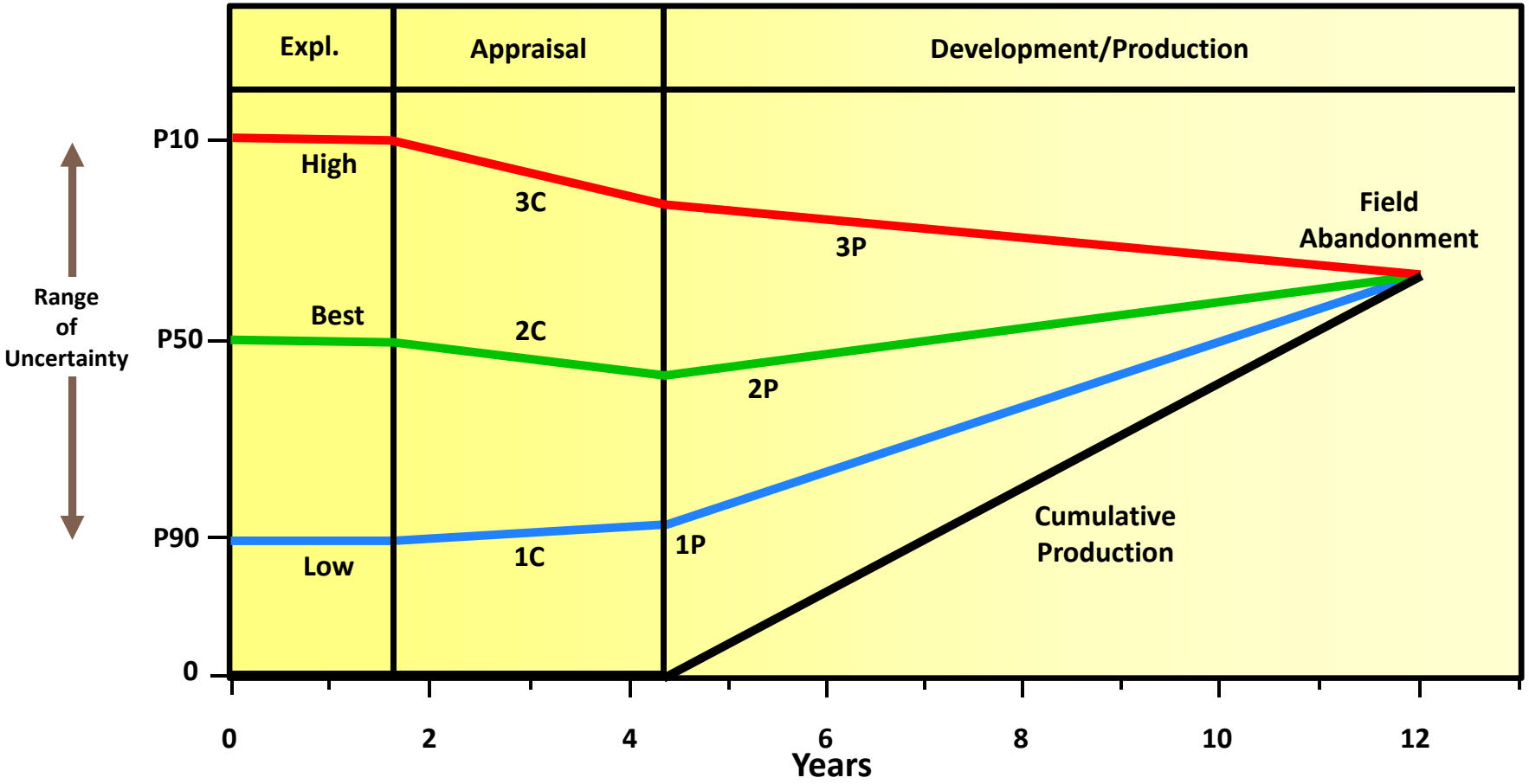
Source: 2007 SPE/WPC/AAPG/SPEE PRMS

Development Phase (Reserves)

Some of the reporting ‘grey’ areas include:

- Understanding of the ‘Commerciality’ definition – the transition between Contingent Resources and Reserves:
  - What is required to demonstrate ‘firm intention to proceed’?
  - When and how much can be booked for gas reservoirs?
  - Gas used as fuel – should it be included or not?
  - Project sanctioned on 2P reserves but 1P volumes not economic – can the 1P be booked as reserves?
  - Confusion between ‘Possible Reserves’ and Contingent Resources.
  - Booking of volumes beyond license or contract expiry.

Estimated Ultimate Recovery - Conventional Resources



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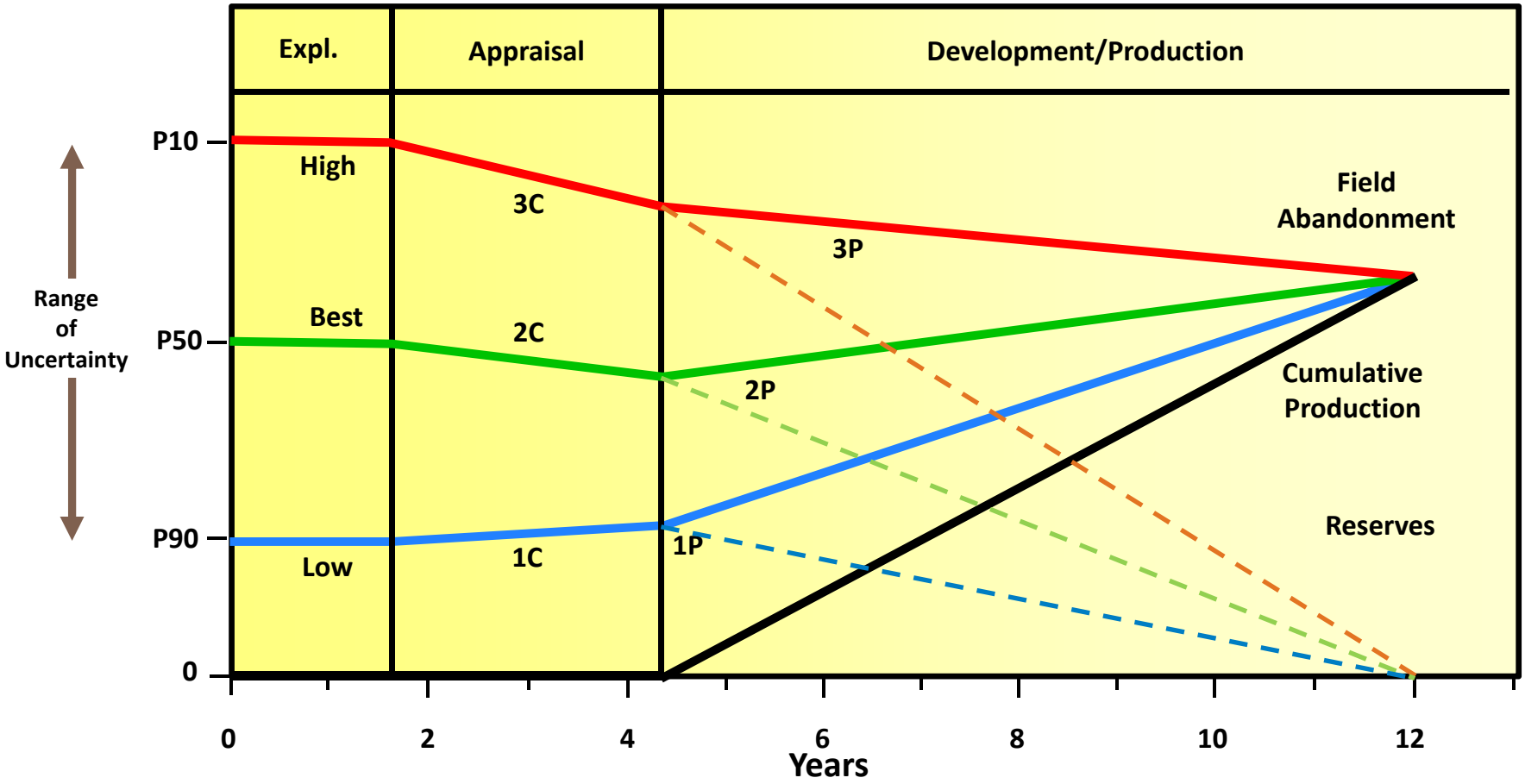
Estimated Ultimate Recovery/Reserves - Conventional Resources



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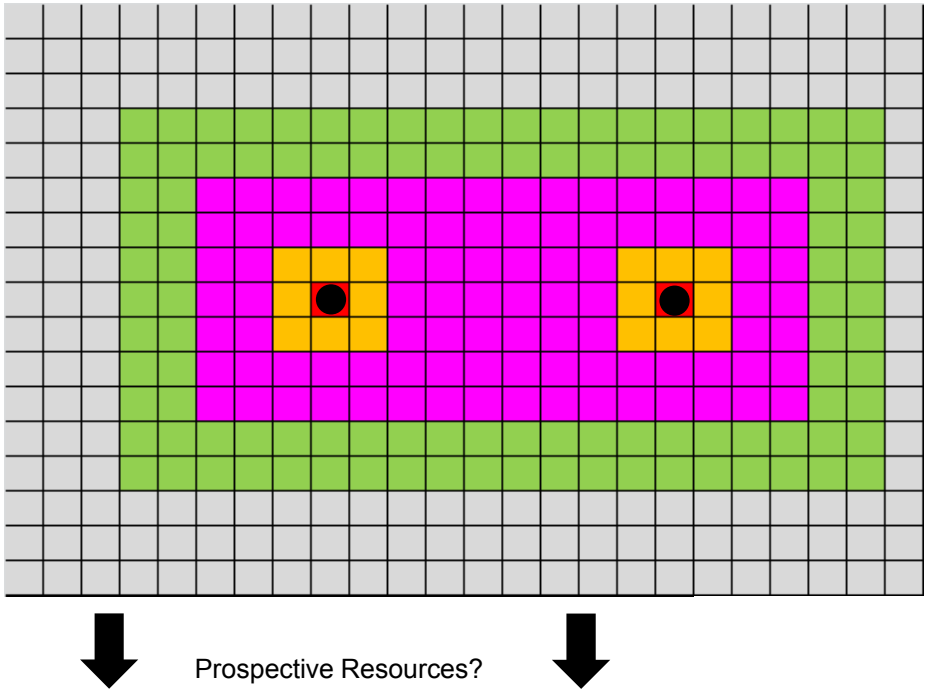
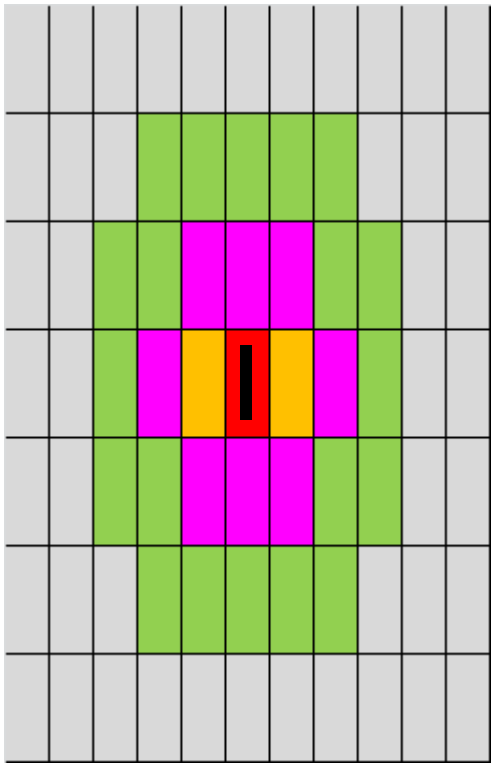
Unconventional Resource - Traditional Incremental Method

CSG



Shale Gas



- Producing Well
- Proved Undeveloped
- Probable
- Possible
- Contingent Resources

Number of well spacings can be increased if confidence is high

2P areas can be joined up if high confidence of coal continuity (rubber banding)

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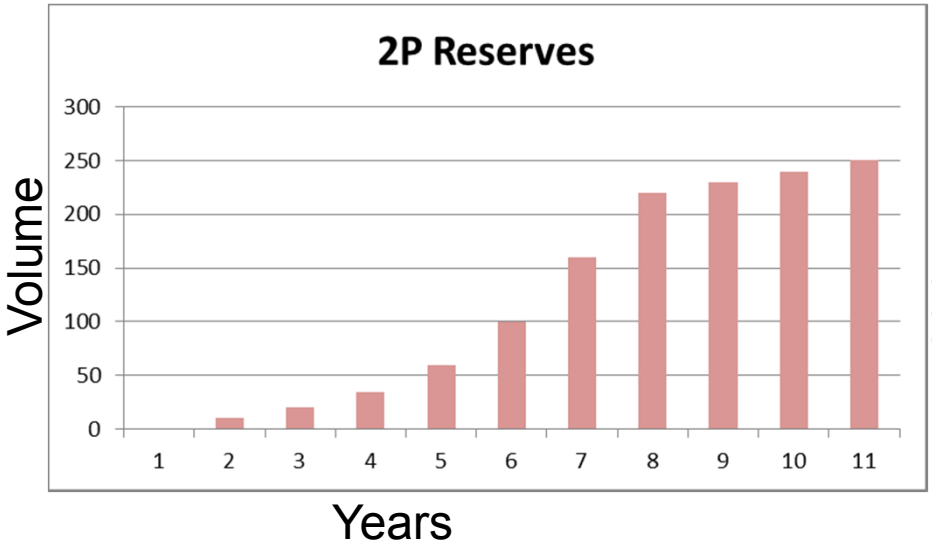
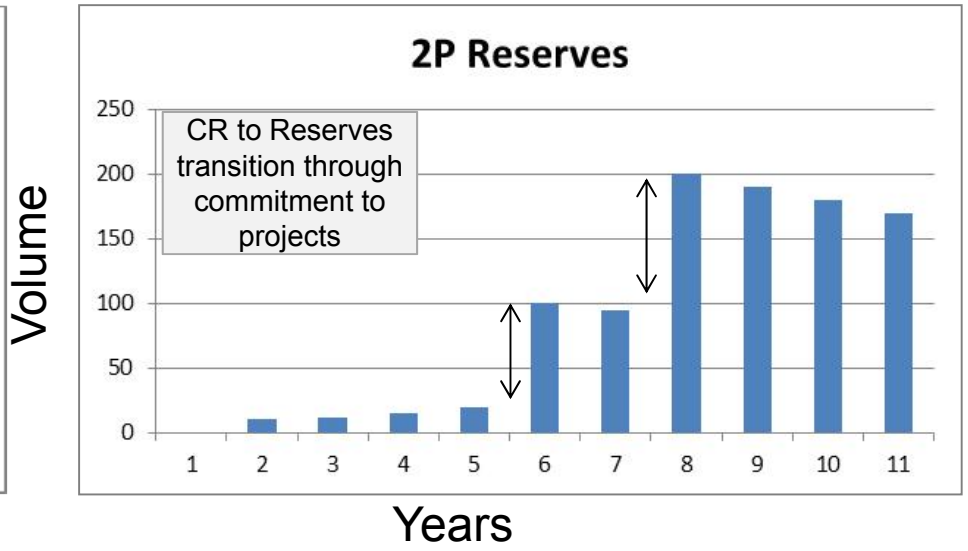
Reserves Maturation – Unconventional Resources





- Reserves keep going up as more wells are drilled and larger areas are joined up as 2P.
- What is linkage to development plans and decisions, FID, GSA, LNG contracts etc. ?
- What is uncertainty range based on?

- Reserves jump up (conversion from CR) as "firm intent to proceed" is achieved when all criteria or contingencies for Reserves are met.
- For large projects e.g. CSG-LNG, should this happen in phases?
- Appropriate definition of a Project? Sub-Projects, Phase
  - Depends on decision making?

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Conclusions

- Objective of the resource maturation process (monetization highway) is to provide management and investors with:
  - A set of resource estimates that reflect the stage of maturation.
  - A method for companies to track and measure the resource maturation process.
  - Resource estimates that can reliably be compared between companies.
- However, maturation of resources along the ‘highway’ is not straight forward and different interpretations of the ‘rules’ are possible.
- The major move toward unconventional resources has further complicated the process.
- The SPE Oil & Gas Reserves Committee is currently reviewing a number of the issues raised in this presentation.

Thank you!

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Associates

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