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Steve currently manages the geoscience group. At Ryder Scott, Steve works on reserves and resource evaluations worldwide. Additionally, he evaluates exploration portfolios, serves as an expert consultant and witness in litigation cases and trains reserves evaluators.

Steve started out as a field geologist for the United States Geological Survey assisting with evaluation of coal resources in the Green River basin of Wyoming and Utah.

After graduating with a master's degree from the University of Missouri, he joined Standard Oil of California – now Chevron – as an exploration geologist in the Permian basin. During his 17 years with Chevron, he contributed to projects in field development, geophysics, geochemistry and basin modeling.

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The Significance of “Significant” or “*Just Give Me a Number.*”

By Steve Phillips

EXAMPLE 1 - IS IT A DISCOVERY?

- A country with net-gas imports announced a very large gas discovery covering a very large area that could impact energy independence.
- Multiple exploration and appraisal wells were drilled and tested in two formations.
- Tests from one formation had no gas to surface. Extended testing on the other formation yielded small unsteady quantities with high water rates and low pressures.
- The data was indicative of solution gas recovery from an aquifer.
- Declaration of a natural gas discovery was not supported.
- The project is being re-evaluated as a contributor to the vision for energy independence.

EXAMPLE 2 - IS IT A DISCOVERY?

- A country relying totally on petroleum imports encouraged new investment by awarding an exploration license.
- A company initiated a drilling program that resulted in two definitive dry holes.
- At a third location, operations included an original well, a re-drill and a sidetrack.
- After multiple DSTs and acid-frac stimulation, only very small quantities of oil and water were recovered during months of swabbing operations.
- The company could not find investors to fund further drilling and the ministry revoked the license to explore.
- The company claimed oil was discovered and that the revocation was not warranted.

EXAMPLE 3 - IS IT A DISCOVERY?

- A small operating company with a high-profile board of directors was awarded a license to drill several wells in a politically sensitive area without any existing fields.
- A press release “confirmed” a major discovery of oil and gas of “significant” quantities with claims of an astonishing “thickness” of “reserves” that could have a large impact on the country.
- No specifics were released and news about the project went silent.
- With no reputable reserves report and mounting environmental legal challenges, a two year extension was granted, but no wells were drilled.
- About five years following the initial announcement, company disclosed that no traces of oil had been found and operations were discontinued.

EXAMPLE 4 - IS IT A DISCOVERY?

- Two major oil companies partnered to drill a very deep exploration well in a non-productive deepwater area within a known petroleum province.
- Initial press releases indicated “discovery” of an encouraging geological structure and rock type with potential to contain hydrocarbons.
- A comprehensive review of the data from the well preceded drilling of an appraisal well.
- Ultimately, no encouragement was found in the data from the first well and the program was canceled.
- This not so bad. But, the terminology could be misleading.

PRMS DEFINITION OF A DISCOVERY

2.1.1 Determination of Discovery Status

2.1.1.1 A discovered petroleum accumulation is determined to exist when one or more exploratory wells have established through testing, sampling, and/or logging the existence of a significant quantity of potentially recoverable hydrocarbons and thus have established a known accumulation. In the absence of a flow test or sampling, the discovery determination requires confidence in the presence of hydrocarbons and evidence of producibility, which may be supported by suitable producing analogs (see Section 4.1.1, Analogs). In this context, "significant" implies that there is evidence of a sufficient quantity of petroleum to justify estimating the in-place quantity demonstrated by the well(s) and for evaluating the potential for commercial recovery.

2.1.1.2 Where a discovery has identified recoverable hydrocarbons, but is not considered viable to apply a project with established technology or with technology under development, such quantities may be classified as Discovered Unrecoverable with no Contingent Resources. In future evaluations, as appropriate for petroleum resources management purposes, a portion of these unrecoverable quantities may become recoverable resources as either commercial circumstances change or technological developments occur.

OTHER DEFINITIONS*

NONE QUANTIFIED, BUT ALL AIM AT POTENTIAL COMMERCIALITY

- **Discovery well** means the first well capable of producing oil or gas in *commercial quantities* from a pool.
- **Discovery well** means any well capable of producing oil or gas from a single pool in which a well has not been previously produced in *paying quantities* after testing.
- **Discovery well** means the first well completed in a common *source of supply* that is not in communication with any other common source of supply.

**Plus numerous others at https://www.lawinsider.com/dictionary/discovery-well (None are proposed as improvements on PRMS!)*

THE “TEACUP” STANDARD?

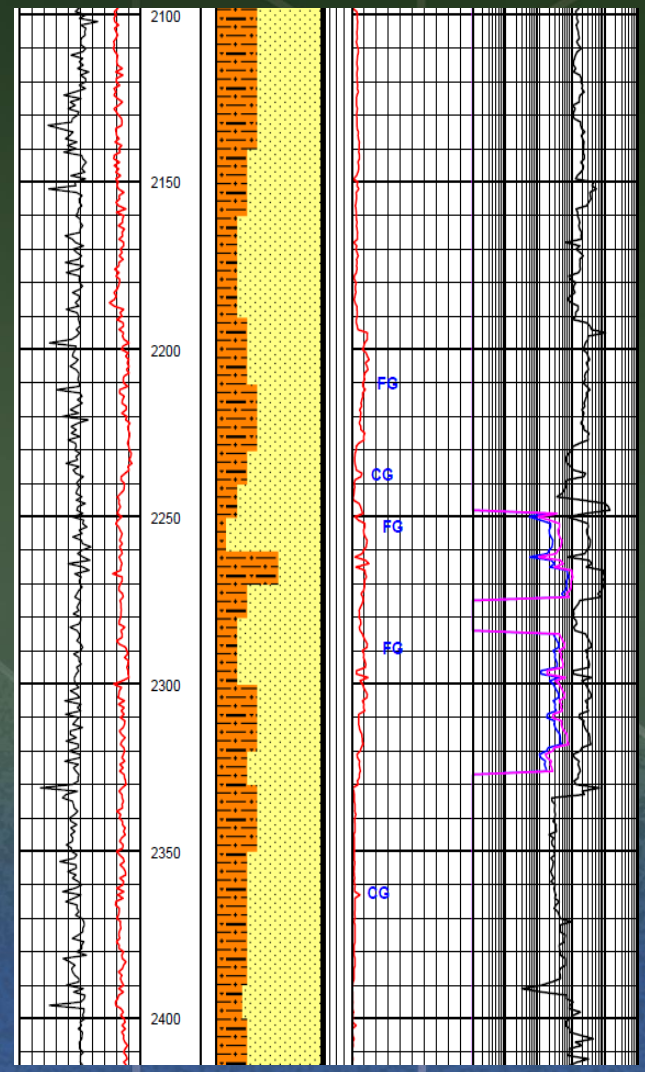
2.1.3 Project Status and Chance of Commerciality (*Pc*)

A. The chance that the potential accumulation will result in the discovery of a significant quantity of petroleum, which is called the “chance of geologic discovery,” P_g.

B. Once discovered, the chance that the known accumulation will be commercially developed is called the “chance of development,” P_d.

WHY WE CAN FOOL OURSELVES

- In many sedimentary basins, some detectable level of hydrocarbon concentration can be widespread (e.g. C1 occurrence in mud logs, surface geochemical prospecting).
- Thermal and biological generation and migration processes can be active over large areas in the past and present.
- However - Concentration of hydrocarbons into conventional and unconventional reservoirs with commercial potential require favorable and relatively localized conditions.

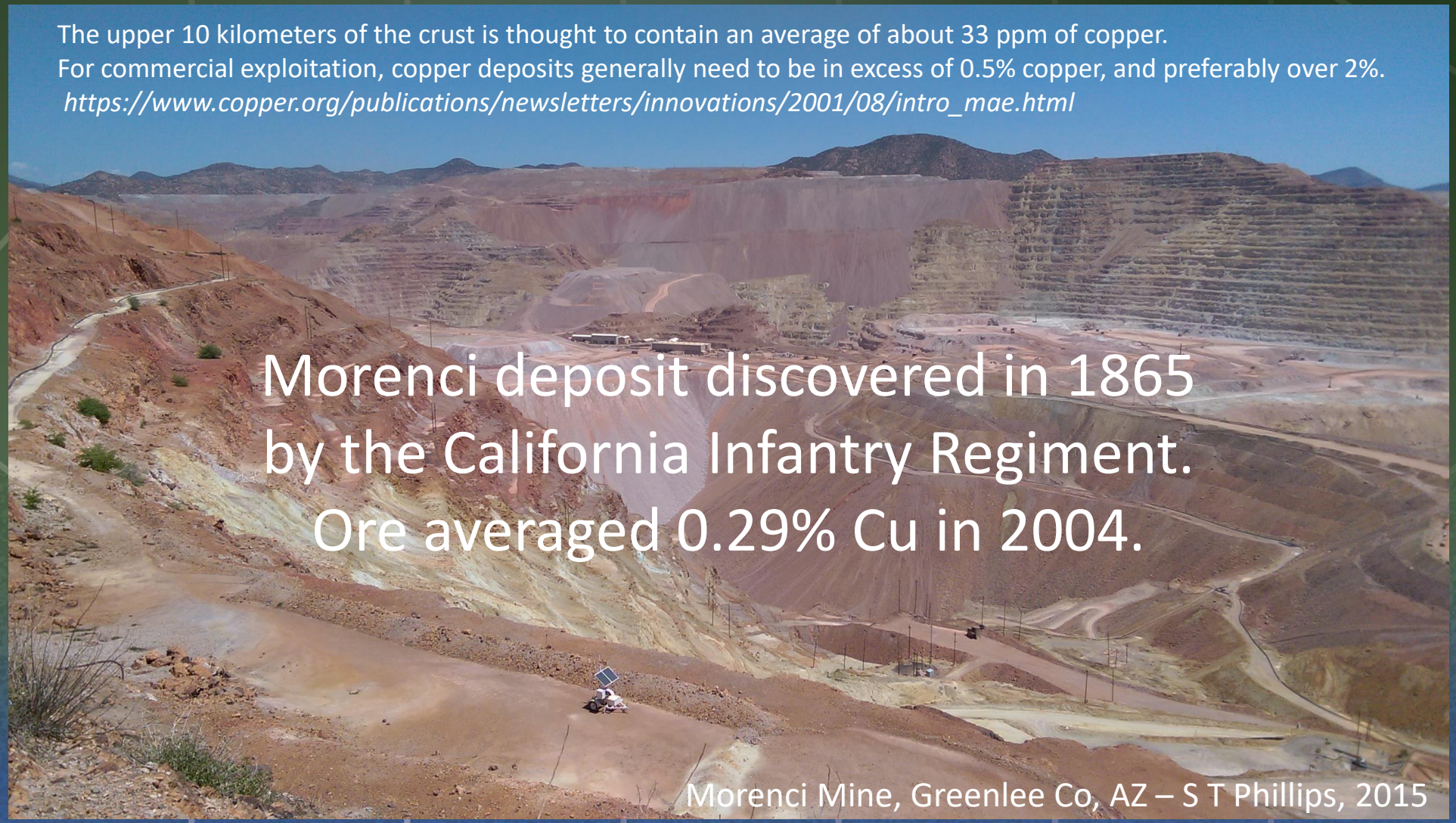


DETERMINING DISCOVERY STATUS

- Evaluators are responsible for sound application of Discovery Status.
- Requires experienced judgement to discriminate between minor or background hydrocarbon occurrences and deposits with commercial potential that are *SIGNIFICANT*.
- Let’s consider some practical approaches that assist with compliant application of PRMS discovery status.

WHAT ABOUT MINING?

The upper 10 kilometers of the crust is thought to contain an average of about 33 ppm of copper.
For commercial exploitation, copper deposits generally need to be in excess of 0.5% copper, and preferably over 2%.
https://www.copper.org/publications/newsletters/innovations/2001/08/intro_mae.html



MINING: ECONOMIC GRADE EXAMPLES

Metal	Typical Background Level	Typical Economic Grade*	Concentration Factor
Copper	40 ppm	10,000 ppm (1%)	250 times
Gold	0.003 ppm	6 ppm (0.006%)	2,000 times
Lead	10 ppm	50,000 ppm (5%	5,000 times
Molybdenum	1 ppm	1,000 ppm (0.1%)	1,000 times
Nickel	25 ppm	20,000 ppm (2%)	800 times
Silver	0.1 ppm	1,000 ppm (0.1%)	10,000 times
Uranium	2 ppm	10,000 ppm (1%)	5,000 times
Zinc	50 ppm	50,000 ppm (5%)	1,000 times

*It's important to note that the economic viability of any deposit depends on a wide range of factors including its grade, size, shape, depth below the surface, and proximity to infrastructure, the current price of the metal, the labour and environmental regulations in the area, and many other factors.

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https://opentextbc.ca/geology/part/chapter-20-geological-resources/

Physical Geology by Steven Earle was created as part of the B.C. Open Textbook Project.

MINING: SERIOUS INVESTMENTS

How many loads would be significant enough to justify purchase of this new ore hauler?

Eureka Co, NV – S T Phillips, 2021

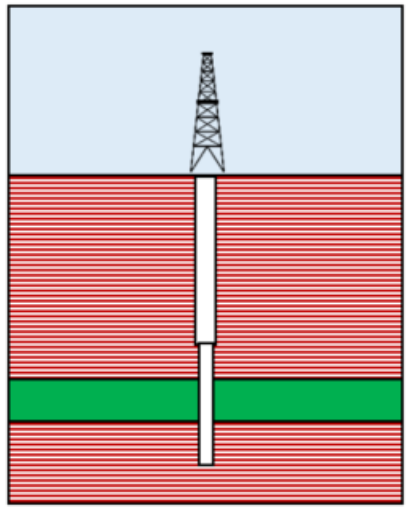
QUALITY? CAN WE USE *UNIT* PIIP?

- Instead of total discovered volume, is unit volume (barrels or mcf) per acre-foot a potential metric?
- For oil: 7758 x porosity x oil saturation x 1/Bo = barrels/acre-foot
- RSC internal database: Average Unit PIIP ~ 920 bbl/ac-ft

Examples	Central Asia	Algeria	GOM Shelf	North Sea UK
Unit PIIP (oil)	127	729	1092	1982
Avg Porosity %	4.8	15.1	28.3	32.5
Avg So %	72.0	76.9	68.4	89.0
Avg Bo dec.	2.17	1.24	1.42	1.13
	One field, Paleozoic, Carbonate	One field, Mesozoic, Sandstone	Multiple fields, Tertiary, Sandstone	Three Fields, Balder Fm, Tertiary SS

- So, no – not a good metric.

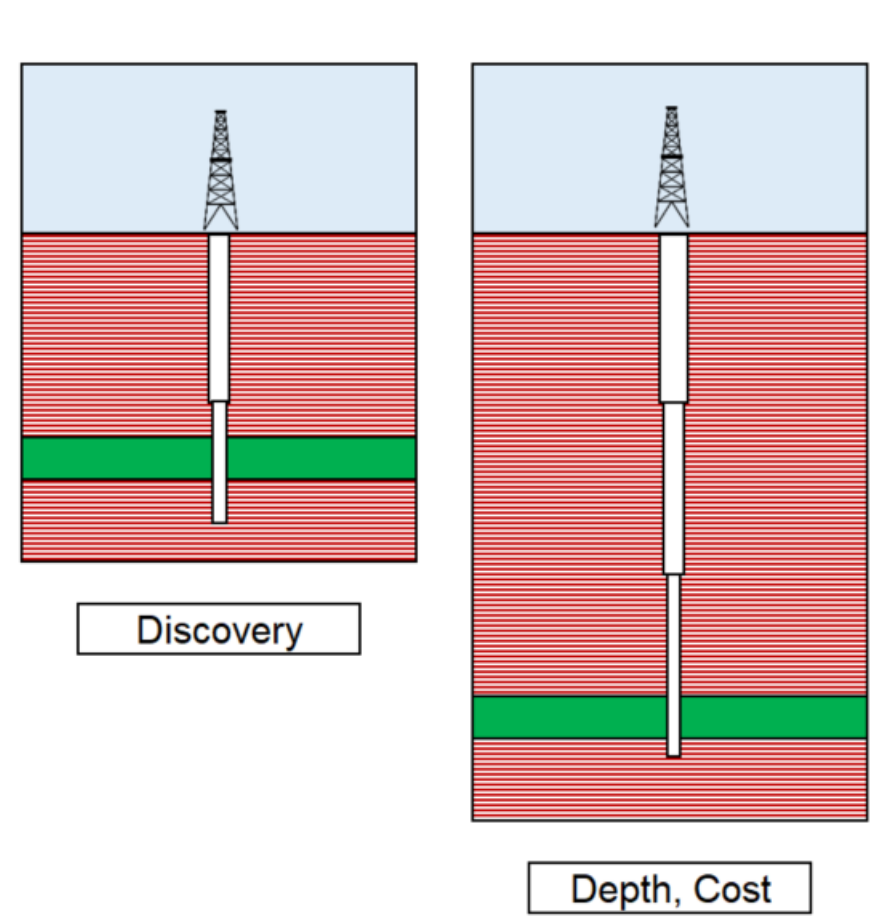
ECONOMIC VIABILITY OF X BARRELS



Discovery

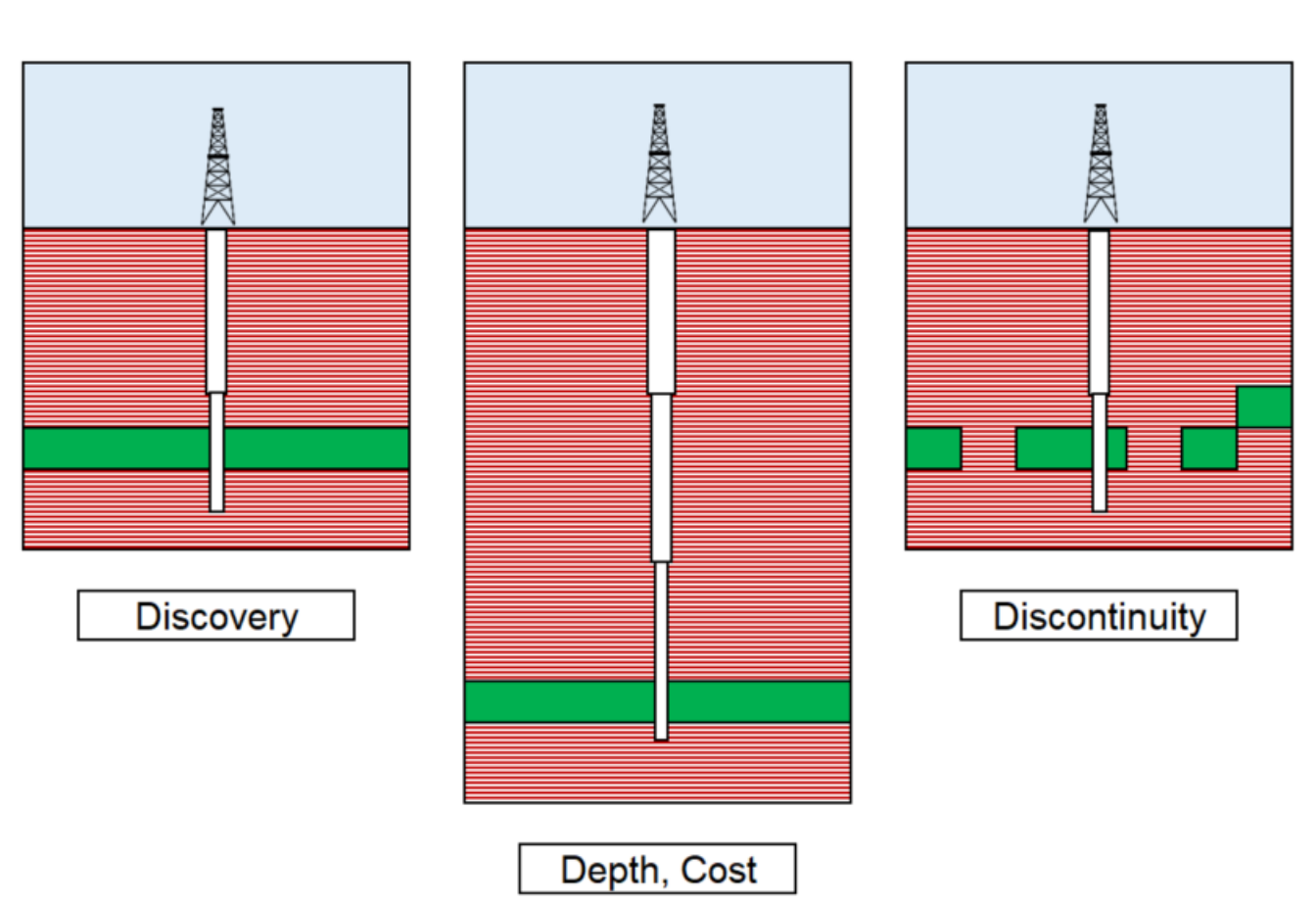
- Discovery Status Conditions are met:
  - Significant quantity
  - Sufficient to justify estimating the in-place quantity
  - potential for commercial recovery
- In other words – Project Maturity Sub-class of Development Pending is a reasonable expectation.

SAME X BARRELS, BUT COST PROHIBITIVE

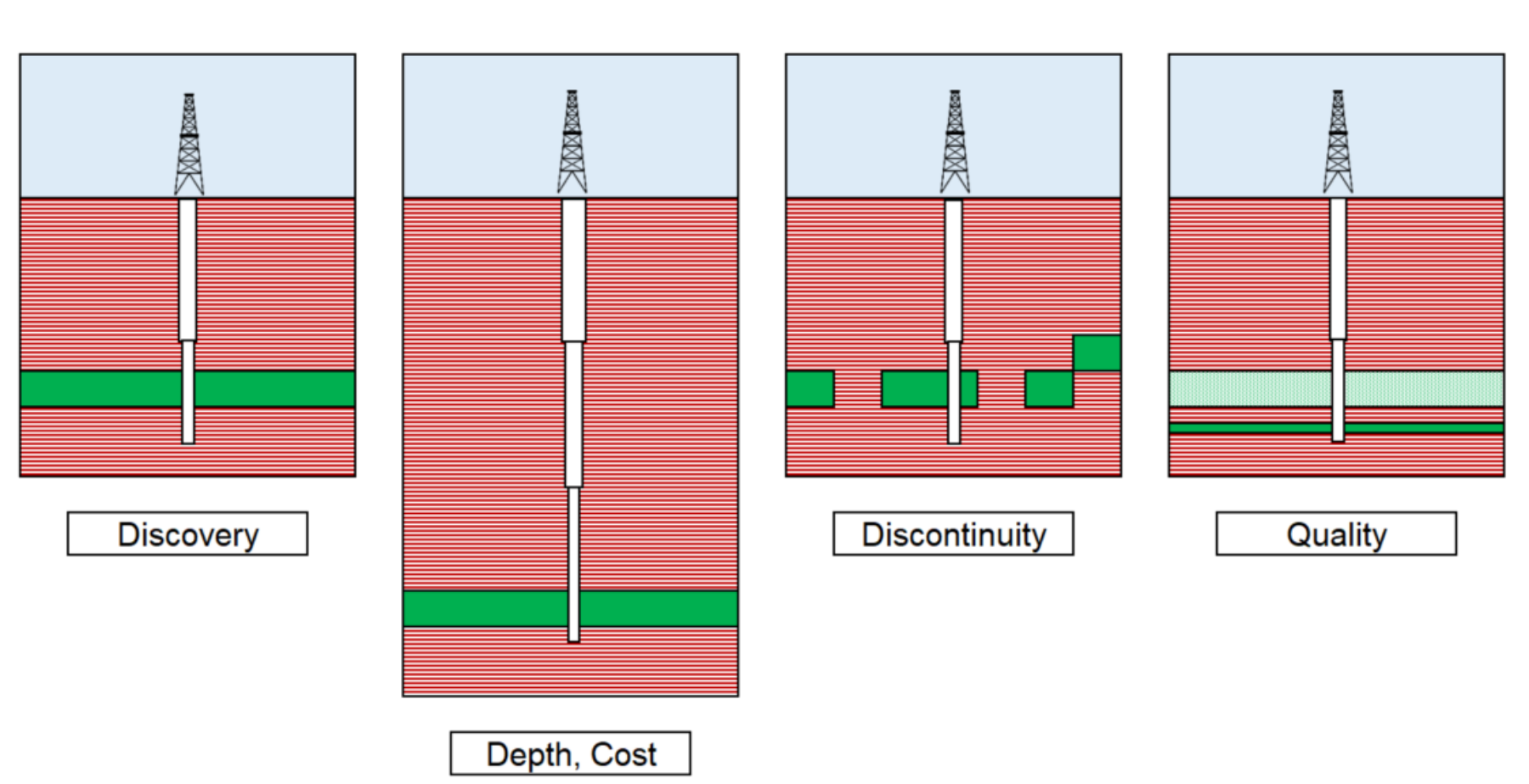


- Discovery Status Conditions are questionable:
- Project Maturity Sub-class of
  - Development On Hold?
  - Development Unclarified?
  - Development Not Viable?

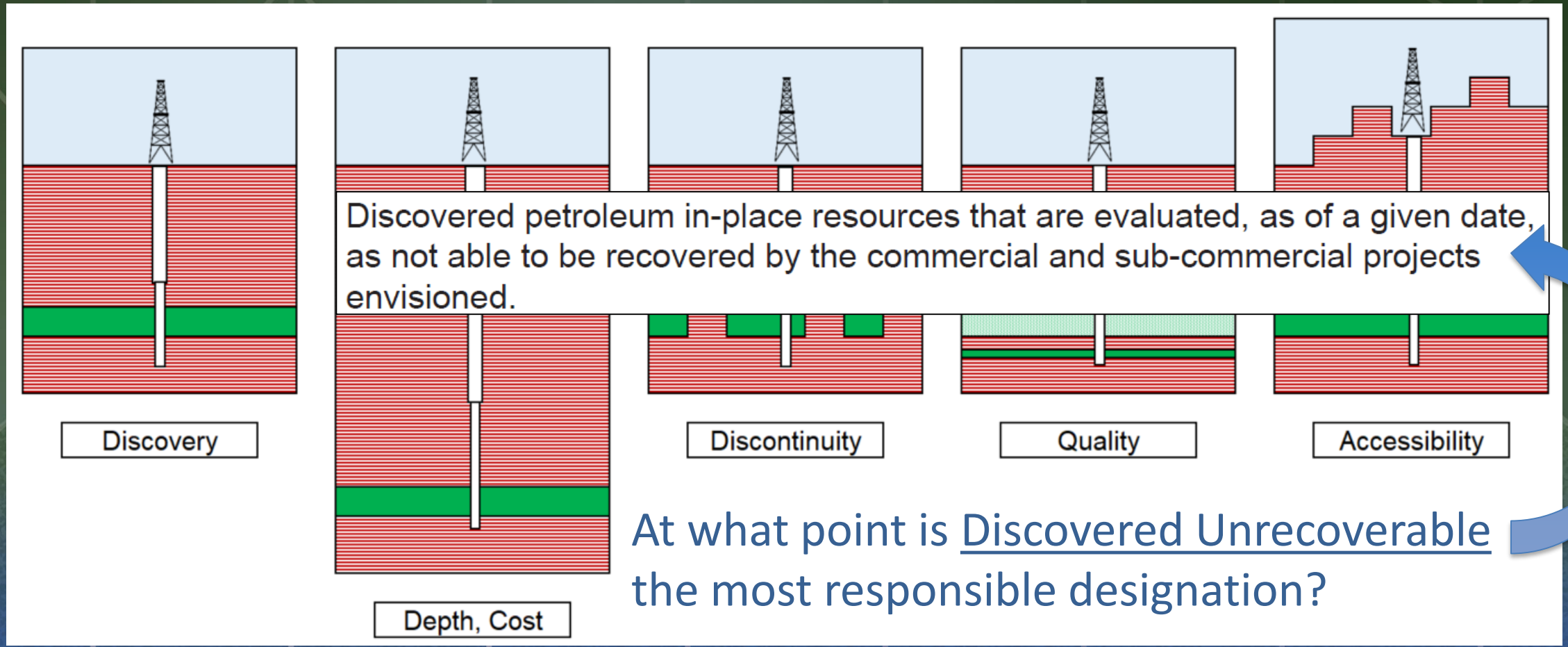
SAME X BARRELS, BUT COMPARTMENTALIZED



SAME X BARRELS, BUT TIGHT, THIN OR WRONG FLUID



SAME X BARRELS, BUT INACCESSIBLE



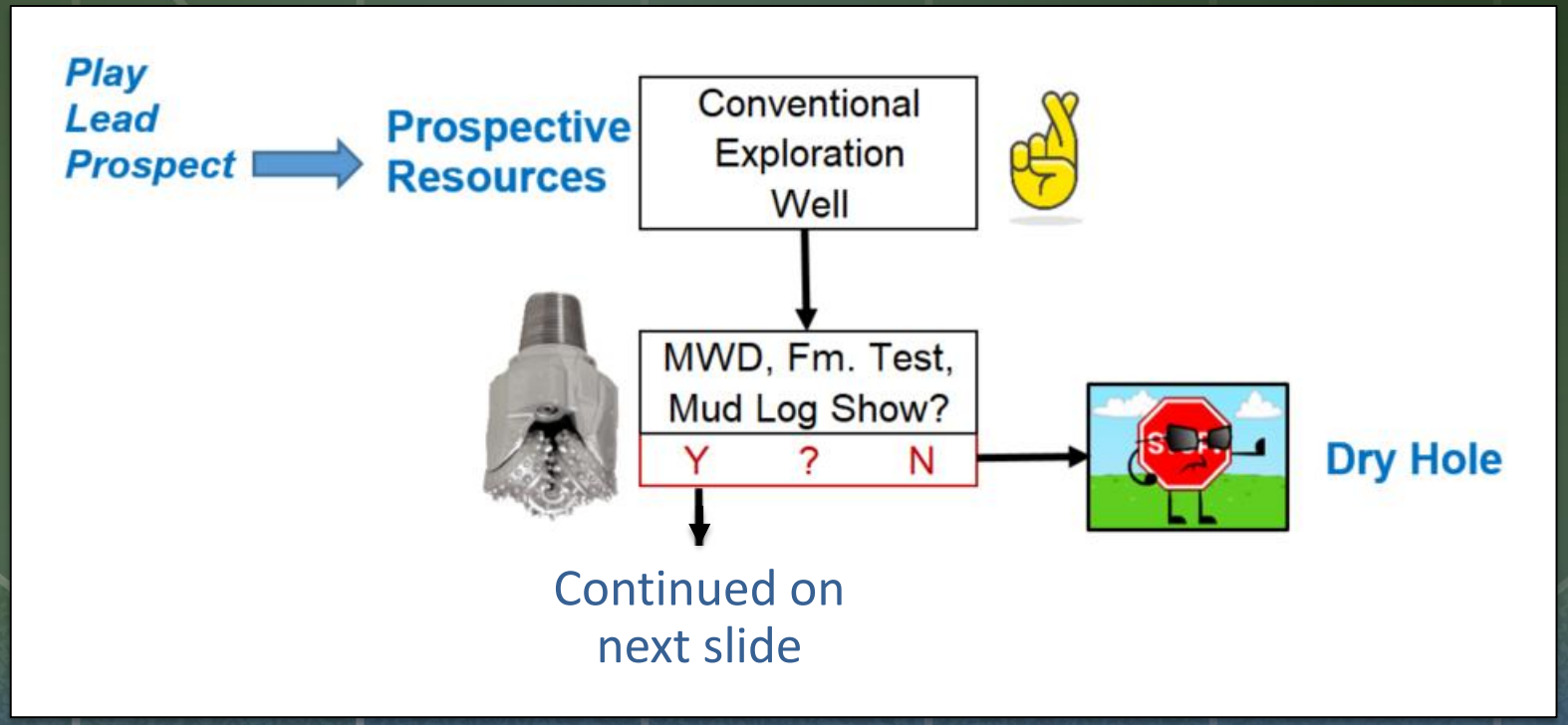
PROJECT MATURITY SUBCLASSES: A REVIEW

Maturity Subclass – Contingent Resources	A discovered accumulation where…	Guidelines
Development Pending	…project activities are ongoing to justify commercial development in the foreseeable future.	…further data acquisition (e.g., drilling, seismic data) and/or evaluations are currently ongoing…
Development on Hold	…project activities are on hold and/or where justification as a commercial development may be subject to significant delay.	…may be subject to a significant time delay…
Development Unclarified	...project activities are under evaluation and where justification as a commercial development is unknown based on available information.	…further appraisal/evaluation activities are ongoing to clarify the potential for eventual commercial development.
Development Not Viable	…there are no current plans to develop or to acquire additional data at the time because of limited production potential.	…the theoretically recoverable quantities are recorded so that the potential opportunity will be recognized in the event of a major change in technology or commercial conditions.

AN INTERNAL STANDARD?

- Minimum thresholds for:
  - Continuous pay thickness?
  - Mean in-place or technically recoverable volume?
  - Test rate, water cut?
  - Fluid characteristics (Phase, API, GOR, Viscosity, H_2S, CO_2, etc.)
  - Area or offset locations?
- How often are these defined in advance of an exploration project?

ACTIONS AT THE WELL SITE?



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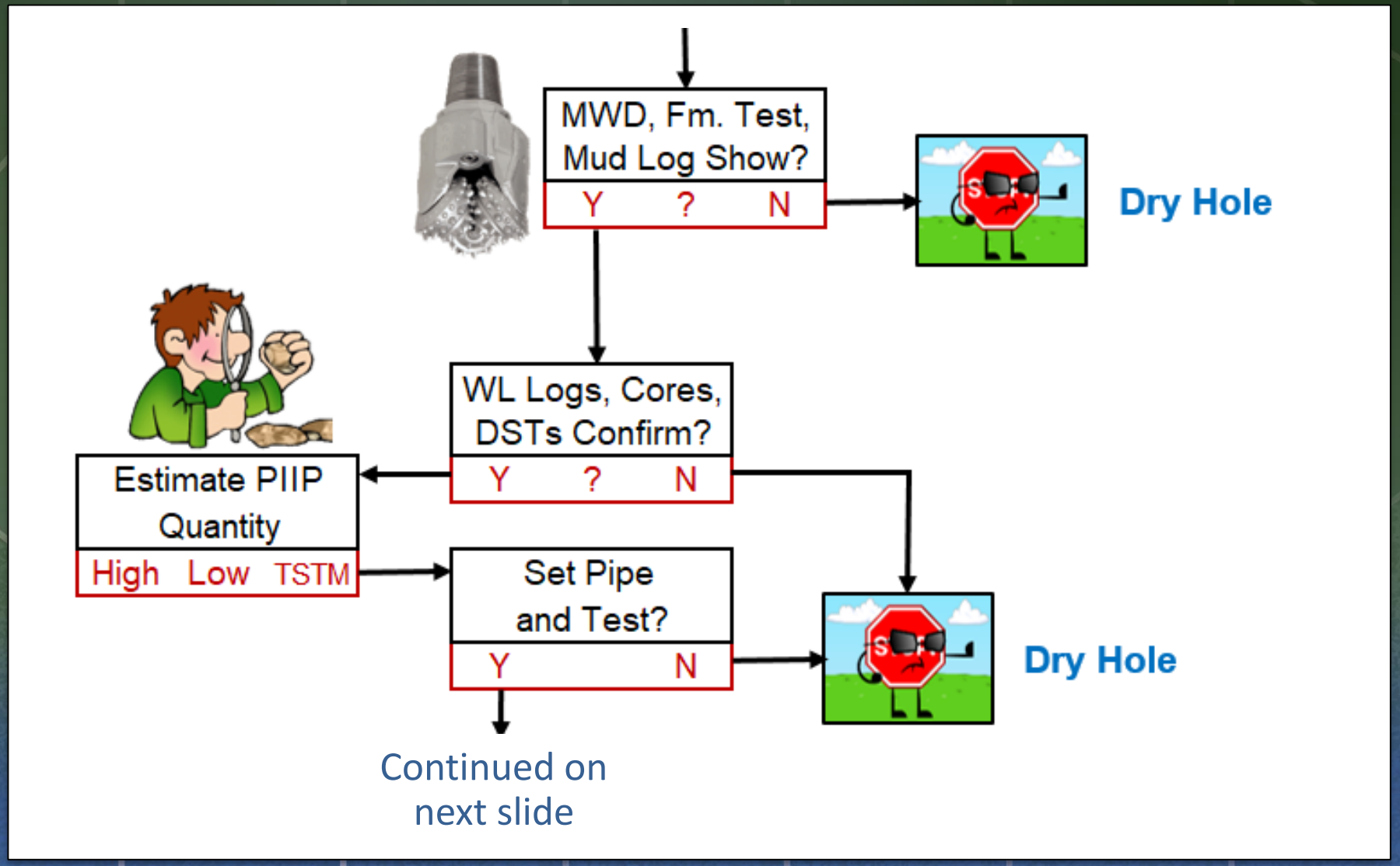

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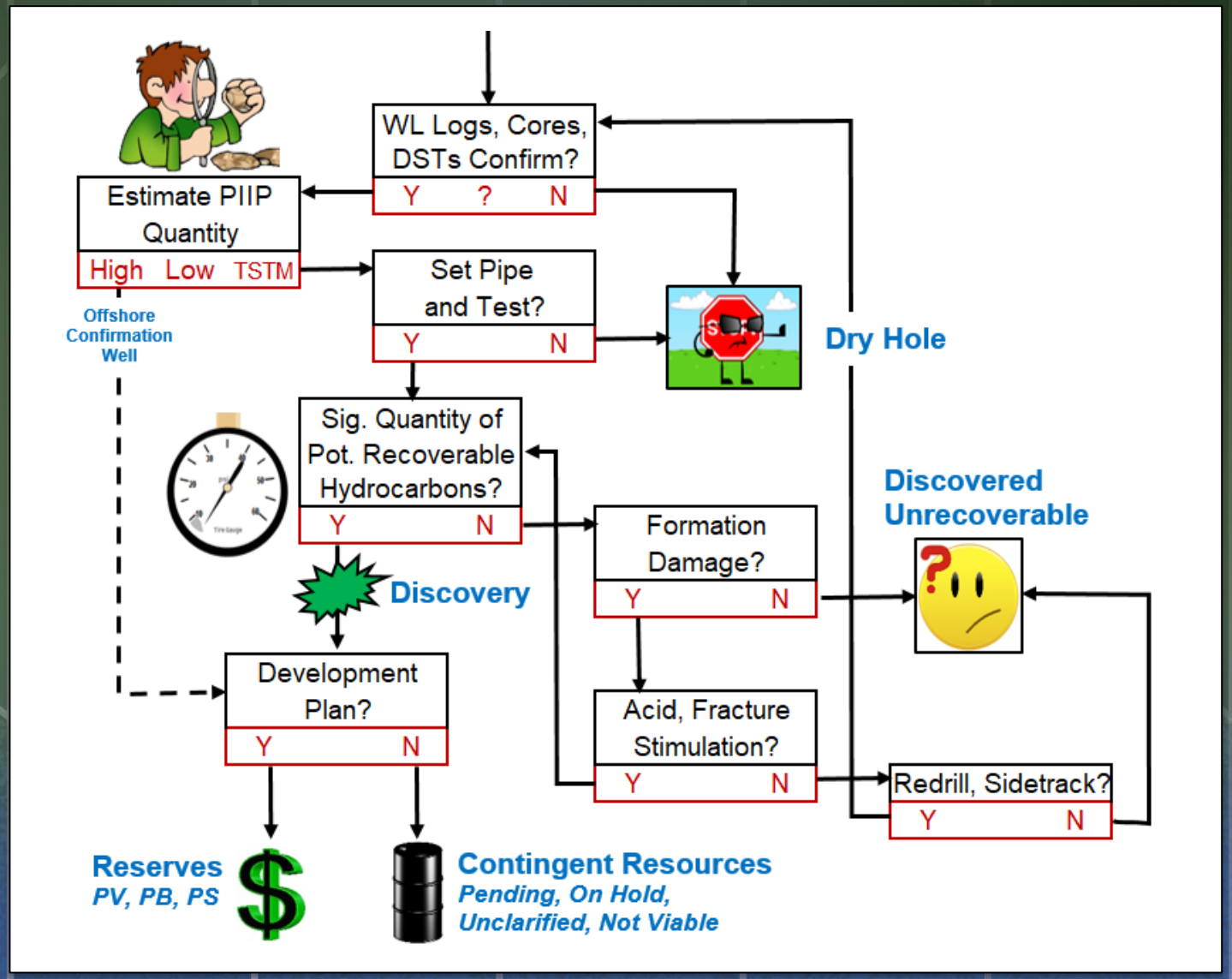

WHAT ARE WE LOOKING FOR?

- Do logs and cores discriminate pay from non-pay?
- Does testing confirm petrophysical analyses?
- Do FT pressure data points define gradient(s) that are indicative of a continuous hydrocarbon column within one or more flow units?
- Are reservoir fluids producible with established technology or technology under development?
- Can trap boundaries and seals be observed and mapped with seismic data?
- If LKO/G, how far above mapped spill point?
- Did well test P90, P50 or P10 case?
- Were internal standards achieved?

DISCLOSURE OF WELL-FLOW TEST RESULTS

- **Canadian Securities Administrators Staff Notice 51-327 (Dec 2014)**
  - Disclosure of well-flow test results can have a significant effect on the market price or value of an Oil and Gas Issuer.
  - Additional information is often necessary in order to avoid misleading readers with such disclosure.
  - Disclosing the results of short-term tests, “rates up to”, or short-term peak rates as daily rates, for example, would be misleading without additional explanation.

Disclosures should include:

-Geological formation

-Type of test -Average rate during test -Recovered fluid types and volumes

-Significant production or pressure decline during the test

-Tests are preliminary, if no Pressure Transient Analysis or Test Interpretation

-Cautionary statement: results not necessarily indicative of long-term performance or ultimate recovery.

CONCLUSIONS

- It is bad business to exaggerate Discovery Status.
- PRMS and other definitions of Discovery are justifiably non-quantitative but can serve to guide honest reporting of exploration project results.
- The range of potentially commercial reservoir characteristics is very wide and careful technical analysis must be combined with thoughtful application of resource definitions.
- This is one area where our ongoing commitment to ETHICS must lead the way for the technical work and public disclosures.
- THANK YOU – KEEP EXPLORING!