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Integrated Trap Analysis - Best Practices and Workflows for Evaluating Potential Fault Traps and Closures

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SUMMARY

ExxonMobil's Integrated Trap Analysis (ITA) is a set of best practices and technical workflows for evaluating trap and seal in specific business environments. The ITA workflows contain recommendations for the application of appropriate tools and technologies in fault interpretation, bed and fault seal evaluation, and volumetric assessment of potential traps and closures for all upstream business stages.

ITA best practice workflows differentiate between time scales (exploration vs. production) and the technical workflow is adjusted to reflect the time scale being analyzed. As well, rather than forcing an improbable solution using a single technology (e.g., capillary seal analysis), ITA workflows require the analyst to integrate multiple approaches to seal evaluation, which allows solutions that incorporate multiple seal mechanisms.

Application of ITA workflows and associated technologies has impacted business decisions ranging from frontier and mature basin exploration, to development plans in new fields, to infill and near-field wildcat drilling in and around mature fields. Implementation of the ITA best practices has improved efficiency and quality in fault interpretation and structural mapping, promoted consistent application of appropriate technologies for trap and seal definition, and improved linkage of trap and seal analysis with volumetric assessment.

ExxonMobil's Integrated Trap Analysis (ITA) is a set of best practices and technical workflows for evaluating trap and seal in specific business environments (i.e., play analysis, lead seriatim, prospect analysis, new field definition, and mature field compartmentalization). The ITA workflows contain recommendations for the application of appropriate tools and technologies in fault interpretation, bed and fault seal evaluation, and volumetric assessment of potential traps and closures for all upstream business stages.

The ITA best practices consist of three major steps that then define the technical workflows to be implemented: 1) Project Scoping; 2) Trap Definition and Evaluation; and 3) Input to Volumetric Assessment (Fig. 1). Project scoping is the initial project planning phase where business objective is defined and work effort is designed in order to maximize the potential impact on assessed volumes. Business objective is a combination of the work goal and business phase. Workflows describe an increasing work effort as the business phase becomes more mature in an environment with more and better data. Work effort analysis for a trap or closure comprises a series of critical questions about available data, required data, and project timing constraints.

Trap definition and evaluation is subdivided into structural interpretation and mapping and trap and seal evaluation. Structural interpretation and mapping consists of reconnaissance, interpretation and time mapping, and depth mapping. Each of these tasks involve several work steps; these work steps constitute a work flow for a given business objective. High quality structural maps are essential for accurate trap and seal analyses and geologic modeling. Moreover, small errors or uncertainty in structural maps may have large impact on predicted chance of success, column heights, and trap size. In general, recommended volume-based interpretation and faulted framework model construction lead to improved efficiency and quality in fault interpretation and structural mapping.

Trap and seal evaluation includes seal definition, trap definition, evaluation of top seal controls on hydrocarbon distribution, juxtaposition analysis, other controls on seal, and compartmentalization. All steps within this work flow need to be completed in order to evaluate seal integrity and adequacy (i.e., both top seal and fault seal analyses are required and the results integrated). Juxtaposition is thought to be the dominant control over geologic time on hydrocarbon distribution in most faulted traps, and should be considered as the base case for exploration fault seal analysis. Exception to this base case do occur, and valid local calibration is required to call upon other sealing mechanisms (e.g., fault gouge, shale smear, cementation, etc.) as a possible scenario for increased chance of fault seal and trap fill.

Integrated Trap Analysis inputs to volumetric assessment are utilized for play assessment and probabilistic and deterministic assessments. Play assessments are used to evaluate the undiscovered hydrocarbon resources when the business objective is a play analysis. Probabilistic assessments are used for sizing leads, prospects, and in determining the probable total volume in a new field development program. Deterministic assessments may be used in development of a mature field, or in a new field where compartments have known fluid contacts, and can be used to support history-matching reservoir simulations or volume calculations.

It is important to note that ITA best practice workflows differentiate between time scales (exploration vs. production) and the technical workflow is adjusted to reflect the time scale being analyzed. For example, industry approaches to fault seal analysis at both the exploration and production fluid flow time scales commonly use the same technology to predict the existence of fault zone materials and to assign capillary (seal) and transmissibility (flow) properties to them. The ITA fault seal workflow explicitly recognizes the fundamental difference in time scale, thus recommends two distinctly different approaches. For exploration time scale fault seal analysis ITA recognizes that fault juxtapositions are the primary control on static hydrocarbon distributions, whereas at the production time scale fault zone materials play a significant role in fault transmissibility and dynamic hydrocarbon behavior.

Moreover, because ITA workflows require the analyst to integrate multiple approaches to seal evaluation, solutions tend to be more robust than the more common single analysis approach. Every ITA includes evaluation of both bed seal and fault seal, which allows solutions that incorporate multiple seal mechanisms. For example, in a single hydrocarbon accumulation a gas-oil contact may be controlled by capillary entry pressure while the oil-water contact may be controlled by fault juxtaposition or synclinal spill. Rather than force an improbable solution using a single technology (e.g., capillary seal analysis), or resort to a generally untestable hypotheses such as charge limitation, ITA allows the user to build a consistent and testable solution.

Implementation of the ITA best practices has: 1) improved efficiency and quality in fault interpretation and structural mapping with emphasis on faulted framework model construction; 2) promoted consistent application of appropriate technologies for trap and seal definition, analysis of historical drilling results, fault juxtaposition analysis (includes both deterministic and probabilistic analyses), examination of other controls on seal (e.g., fault zone materials), and reservoir connectivity and compartmentalization analysis; and 3) improved linkage of trap and seal analysis with volumetric assessment (i.e., prospect sizing, risking, and uncertainty analysis).

Our integrated approach to trap and seal analysis has impacted business decisions throughout the exploration, development, and production cycle. Workflows have been applied to frontier and mature basin exploration, to development plans in new fields, and to infill and near-field wildcat drilling in and around mature fields. ITA has allow consistency throughout the upstream and business units worldwide of trap mapping and evaluation, prospect sizing and risking, determining controls on trap fill and reservoir connectivity, and evaluating fault-zone effects on fluid flow. Examples and applications of ITA workflows and technologies are presented.

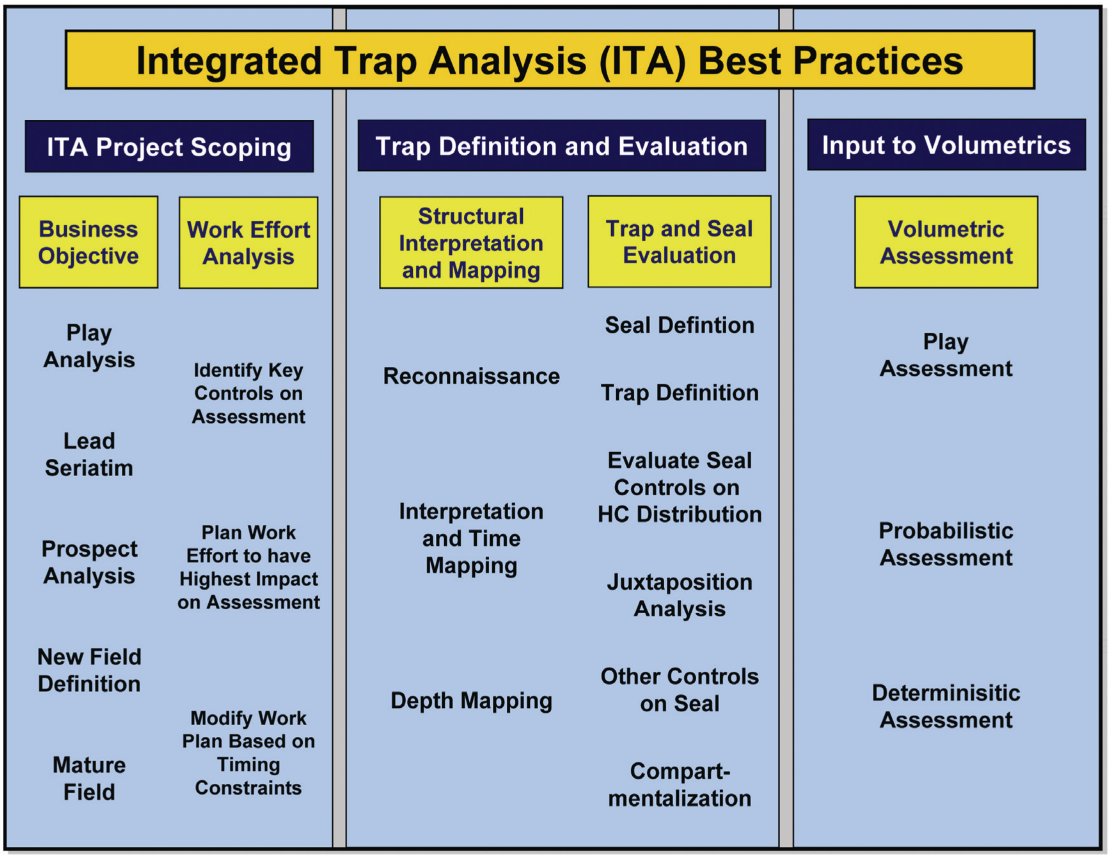

Figure 1 *Conceptual diagram showing ExxonMobil's Integrated Trap Analysis best practices consisting of three major steps and five business objectives that define the technical tasks and workflows to be implemented for evaluating traps and closures for all upstream business stages and cycle.*