Geophysical Applications – Using Geophysics for Reserves and Resources Classification and Assessment

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The reserves sub-committee of the Chief Geophysicists Forum (CGF) has compiled a document entitled "Geophysical Applications – Using Geophysics for Reserves and Resources Classification and Assessment". This document outlines some principles for the use of geophysics for reserves and resource classification and assessment and reservoir modeling.

The goal of this document is to form a recommendation for an update to COGEH, a primary document referenced by APEGGA and NI 51-101 for the booking of resources and reserves.
This has been done in coordination with the SEG working document for the updated PRMS AD(used in the US and globally).

The CGF is a subset of the CSEG and is comprised of Chief Geophysicists, Sr. Geophysicists and Managers of Geophysics that have a passion for technical excellence, a desire to make a difference and that have internal corporate support.

Geophysical methods, principally seismic surveys, are some of the many tools used by the petroleum industry to assess the quantity of oil and gas available for production from a field or to assess the potential of an undeveloped resource. Geophysical data are integrated with well logs, pressure tests, cores, and other information from the exploration and appraisal wells to determine if a known accumulation is commercial and to formulate an initial field development plan. Figure 1 compares the resolution of the scientific tools used to measure rock and fluid properties for the determination of petroleum reserves. Historically, seismic data were used in reserves documentation to map the areal extent of the reservoir formation and the geometry and nature of the trap. However, in some cases, by matching seismic elastic properties to reservoir rock and fluid properties from well data, a meaningful interpolation and extrapolation of these properties allows us to determine reserve/resource volumes with greater confidence. This integration of geologic data, geophysical data, and engineering data is imperative to achieving a fully comprehensive reserve assessment with increased certainty.

The application of geophysics to reserve and resource estimation can be usefully divided into geophysics for conventional plays, where reservoir quality is fair to good; and geophysics for resource plays, where it is poor. In conventional plays, formation mapping plays a major role. In international work, where the existence and quality of source rock is often the limiting factor in hydrocarbon accumulation, the use of geophysical mapping for reserves extends beyond the bounds of individual pools to include source basins and migration pathways. In conjunction with geochemical modelling, geophysics can provide estimates of total hydrocarbons generated, timing of generation relative to key structural events, probable migration pathways, and possibility of refill of traps after fault-induced leakage. In the Western Canada Basin, the abundance of source often allows source and migration path to be assumed; the geophysical effort is concentrated on trap geometry, reservoir quality and heterogeneity, and fluid type. Elastic inversion and seismic attributes can be valuable here, along with 4-D seismic as reserves are produced. In resource plays, by contrast, there may be no geometric traps to map. Mapping is still useful to determine gross rock volume and stratigraphic subdivisions, to aid in bit steering, and to map faults which may be an unwelcome source of water. But the principal value of geophysics is in predicting resource content, natural fractures, fracability, and stimulated rock volume (or increasingly, stimulated surface area). 3D seismic and microseismic are of critical importance to such work.

The CGF sub-committee developed and followed some certain 'philosophies'. Although engineers would much like a 'checklist' for this document, that's not what we've delivered; rather we focused on different 'workflows'. The authors tried to acknowledge:

- -uncertainty in predictions, and the impact on 'reliability'
- -the integration of geophysical data with other EGG data, improving 'reliability'
- -no one/single prescriptive workflow exists; this depends on your geophysical data, your other project data and what prediction is desired
- -Any reservoir characterization with geophysics is significantly better than that characterization without geophysics

The authors also felt that examples are good, Canadian examples are better and pictures are best; all three are help to illustrate the technical applications!

Geophysical techniques have routinely proven helpful, and sometimes fundamental, in reducing the uncertainty in this integrated process involving the geological, geophysical, and reservoir engineering disciplines. Therefore, reserves or resource estimations not grounded in geophysics are inherently at higher risk than those with geophysics (see Figure 2). The future of geophysics especially in unconventional plays is driven to integrate all data for prediction of geomechanical properties.

This presentation will walk through some of the highlighted workflows and case histories included in the document.

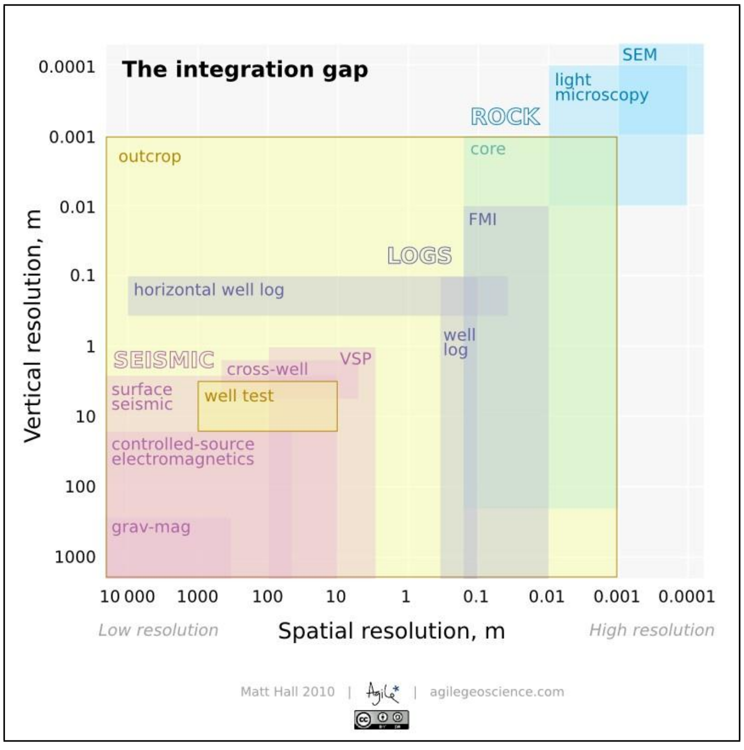

Figure 1. Vertical and spatial resolution of various geophysical and geological data. Geophysics, particularly seismic, allows interpolation between wells with greater confidence because it has good areal coverage; however, in its most commonly used form, its vertical resolution is restricted by the bandwidth of the seismic wave. All-in-all, geophysical data can provide a huge improvement over maps made with wells only, thereby decreasing the uncertainty. Newer methods, such as stochastic inversion and spectral decomposition attempt to redress the vertical resolution of seismic methods. Note how the poor areal coverage of well data is complemented by the larger areal sampling of the geophysical methods.

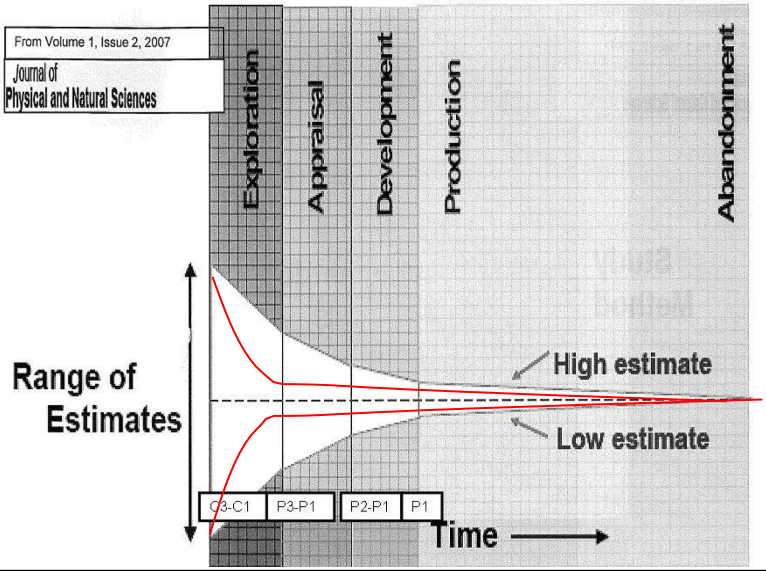

Figure 2. Temporal trends in reserves estimates. As more data (primarily production data) is collected over time, the range of uncertainty in reserves diminishes; an estimate incorporating geophysical data (red lines in figure) reduces the uncertainty of the estimate in the life of a hydrocarbon Pool/Field.