



Integrated Reservoir Modelling

**Gaffney,
Cline &
Associates**

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Gaffney, Cline & Associates (GCA) is a global consultancy that has been offering technical, commercial, and strategic advice to the oil and gas sector for more than 50 years. GCA has developed an enviable reputation within the industry for the quality, insightfulness, impartiality and independence of that advice. GCA offers a full range of upstream, midstream and downstream consultancy services. These include seismic interpretation, petrophysical analysis, static and dynamic reservoir modelling, field development planning, facilities and pipeline engineering, gas monetisation, LNG/GTL, mergers and acquisitions, asset evaluations, project finance, reserves and resources assessments, unitisation and redetermination, and expert witness work. GCA operates worldwide from three main offices in London, Houston and Singapore, supported by regional offices in Argentina, Australia and elsewhere.

Integrated Reservoir Modelling

Integrated reservoir modelling is a key component of field development planning and GCA has extensive experience in building reservoir models for this purpose. While the benefits of an integrated approach to subsurface modelling are widely recognized within the industry, some companies still struggle to achieve true integration. GCA's project teams include all the necessary technical disciplines, usually in a single location, and are led by an experienced project manager. Further, GCA can include facilities engineers, petroleum economists and monetization experts in the team to offer a truly comprehensive, integrated solution to all field development challenges.

A key aspect of integrated reservoir modelling is accounting for uncertainty, particularly prior to project sanction or whenever other large investment decisions need to be made. While detailed analysis of the data by experienced professionals can reduce uncertainty, it will never be eliminated. Development plans must be optimized taking account of the uncertainties, and this must be borne in mind from the start of the project to ensure that the reservoir models built are fit for purpose, achieving a balance between detailed representation of the geology and flexibility to address the uncertainties in a reasonable time frame.

While sub-surface uncertainties are sometimes the most significant, project execution risk and commodity price uncertainty can be equally or more important and should not be overlooked. GCA's fully integrated approach allows all these risks to be evaluated and mitigations plans prepared.

GCA's approach is a pragmatic one, based on its long experience in all aspects of the oil and gas industry. GCA understands the importance of timely delivery of results, and the need to avoid lengthy study of aspects that ultimately have little impact on the final decisions to be taken.

While field development planning is the principal application of integrated reservoir modelling, GCA also has experience of its application in unitisation and redetermination disputes. These often require only static reservoir modelling, to determine hydrocarbons initially in place but some require production data analysis and dynamic modelling as well.

In addition to fully integrated reservoir modelling, GCA can undertake any aspect of the reservoir modelling chain on a stand-alone basis if required. GCA can provide a Peer Review of in-house work, or work in conjunction with the Client's own asset team. GCA regularly reviews models on behalf of non-operating partners or financing institutions, whose priorities or emphasis may differ from those of the Operator.

Ultimately, GCA will always provide independent, unbiased advice and recommendations, giving the Client greater confidence in business and investment decisions through a better understanding of reservoir performance.

Software

GCA staff are familiar with most of the standard industry software relevant to integrated reservoir modelling, covering all of the following aspects:

- Seismic interpretation and reservoir characterisation
- Well log correlation
- Petrophysical interpretation
- Static (geological) reservoir modelling, including geostatistical methods
- Well test and production data analysis
- PVT analysis and modelling
- Dynamic reservoir simulation, including specialist applications such as EOR
- Well performance and network modelling

GCA retains licences for the most commonly used packages, and rents others as required.

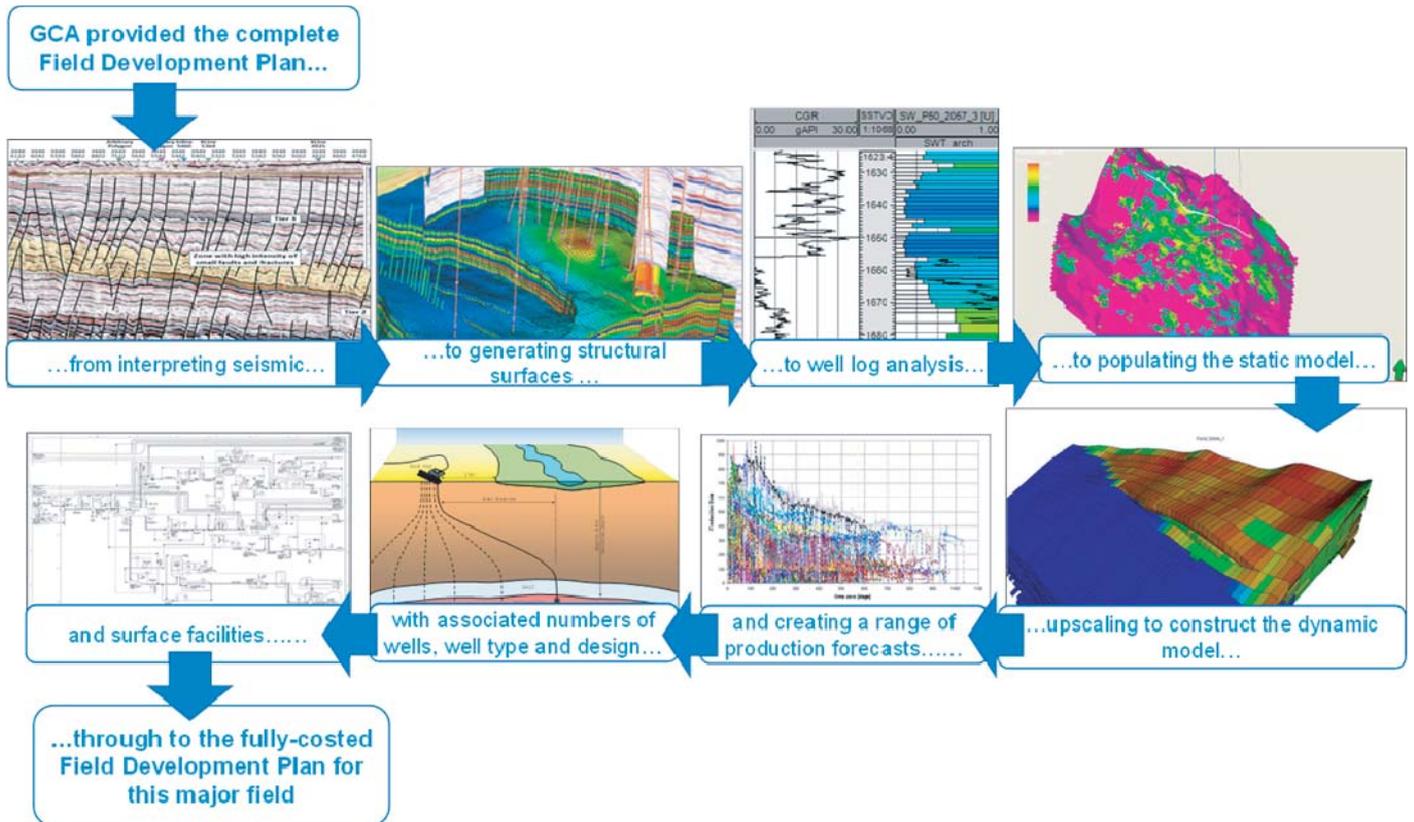
Experience

GCA's experience encompasses conventional and unconventional oil, gas and gas condensate fields of all types in all of the world's major hydrocarbon provinces, both onshore and offshore. It includes clastic, carbonate, shale and basement formations, with and without natural fractures, initial ("green") field developments, mature ("brown") field redevelopments, incremental developments and field optimisation, water injection, immiscible and miscible gas injection, steam injection and other EOR projects.

A small subset of selected examples of GCA projects involving integrated reservoir modelling are summarised overleaf. For reasons of confidentiality, specific client and field names are not disclosed except where they are public knowledge.

Giant Gas Field in Turkmenistan:

GCA was engaged to assess the resource potential of and to prepare a full field development plan for the giant Galkynysh gas field in Turkmenistan. GCA constructed static and dynamic reservoir models to achieve this following the workflow outlined below.



GCA has subsequently provided regular updates to this analysis based on new data and alternative gas sales scenarios.

Heavy Oil Field in Timan-Pechora, Russia: For a Russian operator, GCA developed static and dynamic models for a giant heavy oil field in Timan-Pechora, and applied bespoke development concepts, which were required due to the substantial reservoir depth and the prevailing surface temperatures. GCA used the models to prepare a full field development plan and also undertook comprehensive facilities planning along with cost estimation.

Gas Condensate Discovery in India: GCA was engaged by a leading Indian oil company to develop static and dynamic reservoir models for a deep-water gas condensate discovery, offshore India. GCA conducted its own interpretation of the 3D seismic data, which revealed the structure to be highly faulted. Seismic data quality was insufficient for reservoir characterisation. GCA also analysed the log, well test and PVT data, and constructed a range of scenario-based static and dynamic models. These were used to investigate alternative development scenarios and key uncertainties. Two technically attractive development options were identified for further study and recommendations for appraisal of the field were made.

Major Gas Field in Asia: On behalf of an Asian NOC, GCA performed detailed analysis of log, core, fluid and well test data, constructed a reservoir simulation model and used it to prepare optimum development and production plans under various scenarios. GCA additionally prepared a reserves report, and made recommendations for stimulation of the various reservoir zones.

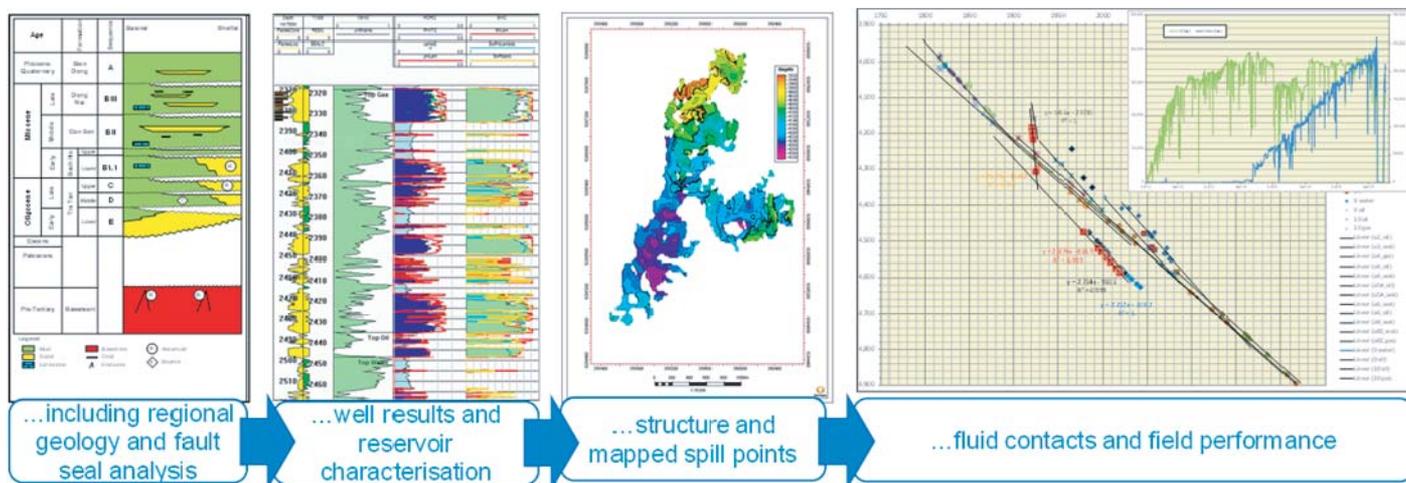
Marginal Offshore Field in Nigeria: GCA was engaged by an independent Nigerian operator to perform an integrated study of a marginal field producing oil, gas and condensate from stacked sandstone reservoirs. GCA's work included structural interpretation of the 3D seismic dataset, attribute analysis, depth conversion, evaluation of log data, construction of static (Petrel) and dynamic (Eclipse) models of the reservoirs, history matching, forecasting future production both for a "do nothing" case and for an optimized drainage plan, economic assessment and estimation of the reserves. As a result, GCA identified a number of opportunities, including an additional well and recompletions of existing wells, and made recommendations for better reservoir monitoring.



Carbonate Oil Reservoir in the Middle East: On behalf of a major NOC, GCA analysed all the available data for an undeveloped carbonate reservoir in a large offshore oil field. GCA reviewed the existing petrophysical interpretations and geological model, and consequently modified the existing static model before up-scaling it for dynamic reservoir simulation. However, it proved impossible to reconcile the simulation model with the well test results, and GCA concluded that the reservoir was naturally fractured. Dual porosity sector models were used to prepare a range of indicative production forecasts, which were iterated with preliminary assessments of the likely facilities requirements, in order to scope out a potential development plan. Recommendations for further data acquisition were made.

Oil Field in Norway: GCA developed a detailed sedimentological model for a Norwegian reservoir and interpreted the 3D seismic survey, undertook a petrophysical analysis to establish the reservoir zonation, carried out stochastic modelling to provide an insight into alternative reservoir facies distributions and an appropriate understanding of the range of hydrocarbons in place. GCA established a new structural and sedimentological model to improve understanding of the complexity and fluid flow characteristics of the reservoir.

Offshore Oil Field in Vietnam: GCA was engaged to provide a reserves audit for a complex oil field, offshore Vietnam. GCA audited the static and dynamic reservoir models provided by the Client, which under-pinned the reserves estimates, and highlighted a number of inconsistencies in the models. The Client accepted GCA's recommendations for improving the models, and re-engaged GCA the following year to confirm the Reserves, even though the volumes were significantly reduced.



Additional Information

For more information about GCA's integrated services, please contact your local GCA office.

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