



Reserves and Resources Estimation

**Gaffney,
Cline &
Associates**

Gaffney, Cline & Associates

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 is well known as one of the leading suppliers of Reserves and Resources assessments, which are required for many purposes including statutory reporting, stock exchange listing, development planning, project finance, and asset valuation. In addition, GCA offers a full range of upstream, midstream and downstream consultancy services. These include seismic interpretation, static and dynamic reservoir modelling, field development planning, facilities and pipeline engineering, gas monetisation, LNG/GTL, mergers and acquisitions, economics and project finance, unitisation and redetermination, and expert witness work. GCA operates worldwide from three main offices in London, Houston and Singapore, supported by regional offices in Buenos Aires, Sydney and elsewhere.

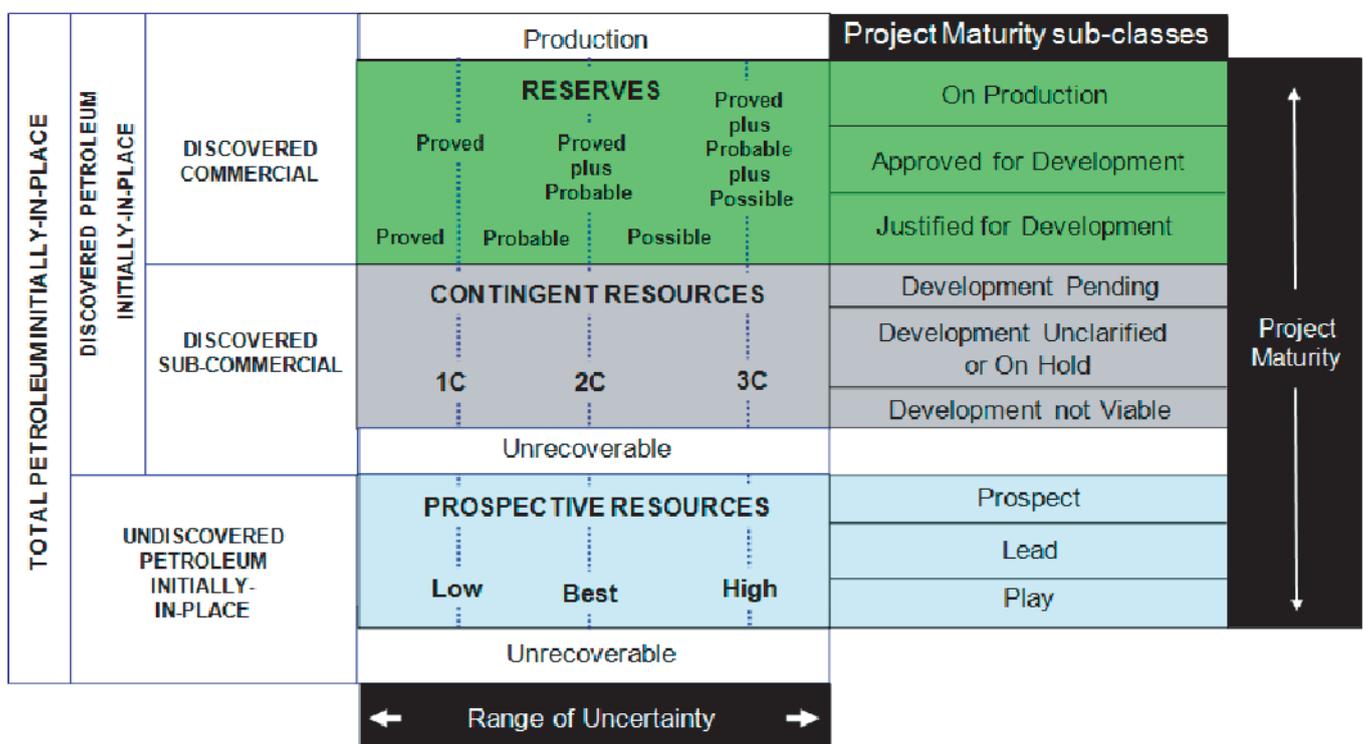
Reserves & Resources Classification Systems

GCA has a comprehensive knowledge of all internationally recognised Reserves and Resources classification systems and considerable experience in the independent assessment of Reserves and Resources. GCA has a long standing commitment to the development and use of industry standard procedures, through direct involvement in major professional bodies. Indeed GCA currently has two members (including a past Chairman) on the Oil and Gas Reserves Committee (OGRC) of the Society of Petroleum Engineers (SPE), which is tasked with drafting revisions to the SPE Petroleum Resource Management System (PRMS) framework (Figure 1). Utilizing its expertise, GCA regularly provides independent Reserves and Resources reports in line with the SPE PRMS, which is accepted by many Stock Exchanges including London (Main Board and AIM), Australia (ASX) and Singapore (SGX), the requirements of the US Securities and Exchange Commission (SEC), or Canadian National Instrument (NI) 51-101 as required for the Alberta and Toronto Stock Exchanges. GCA also has extensive experience of the former Soviet Union system and its various successors.

Reserves & Resources Estimation and/or Audit Projects

Over more than 50 years, Gaffney, Cline & Associates (GCA) has undertaken many thousands of Reserves and Resources assessments covering all types of reservoirs and hydrocarbons and all the world's major petroleum basins. An assessment may take the form of an audit, which involves a review of estimates of Reserves and Resources proposed by the client in order to form an opinion on the adequacy of the data relied upon and the methods used, and ultimately on the reasonableness of the resulting estimates. Alternatively, GCA may undertake an independent estimation of Reserves and Resources based on the data supplied by the client. In addition to assessments and reporting, GCA provides training courses and workshops in the application of the above standards. GCA's experience is too extensive to provide in detail here, but Figure 2 provides a colour-coded map summarising GCA's Reserve and Resource experience since 2000, which illustrates the truly global coverage. As most of GCA's work is confidential, it is not possible in many instances to name clients and specific fields. However, to illustrate further the breadth and depth of GCA's work, brief summaries of some projects recently undertaken by GCA have been provided on the following pages.

Figure 1: PRMS Framework



GCA Reserves & Resources Experience Examples

Annual Assessments, Angola: For many years GCA has provided year end Reserves and Contingent Resources reports for both Sonangol DPRO (the Concessionaire) and P&P (the Operating company). This has involved the independent assessment of oil and gas fields and discoveries; both onshore and offshore in the Lower Congo Kwanza basins of Angola. The Reserves and Contingent Resources reporting is in accordance with SPE PRMS. In addition to annual reporting, GCA has supported Sonangol DPRO and P&P with training and workshops in the audit and independent assessment of Reserves and Resources.

Independent Assessments, Turkmenistan: GCA has been regularly retained by the Turkmen State Corporation, Turkmengeologiya and State Concern Turkmen gas to provide independent assessments of the Gas in Place, Reserves and Contingent Resources for the super giant onshore Galkynysh gas field as well as other fields in Turkmenistan. These projects have involved comprehensive subsurface evaluations including geophysical and petrophysical interpretations which were integrated into detailed static and dynamic reservoir models combining all available geoscience and engineering data.

Reserves and Resources Audit, Middle East: For a Middle Eastern Wealth Fund, and for four consecutive years, GCA audited the client's Reserves and Contingent Resources estimates in a large, undeveloped, fractured carbonate oil reservoir in Iraq, for year end reporting purposes. In the most recent case, additional wells and a significant volume of production testing had been performed since the previous audit. The new work integrated static and dynamic reservoir models which were used to estimate STOIP and production profiles. GCA audited the models and the resulting estimates, as well as costs and economic limit calculations. Reserves and Contingent Resources were reported in accordance with the definitions and guidelines of SPE PRMS.

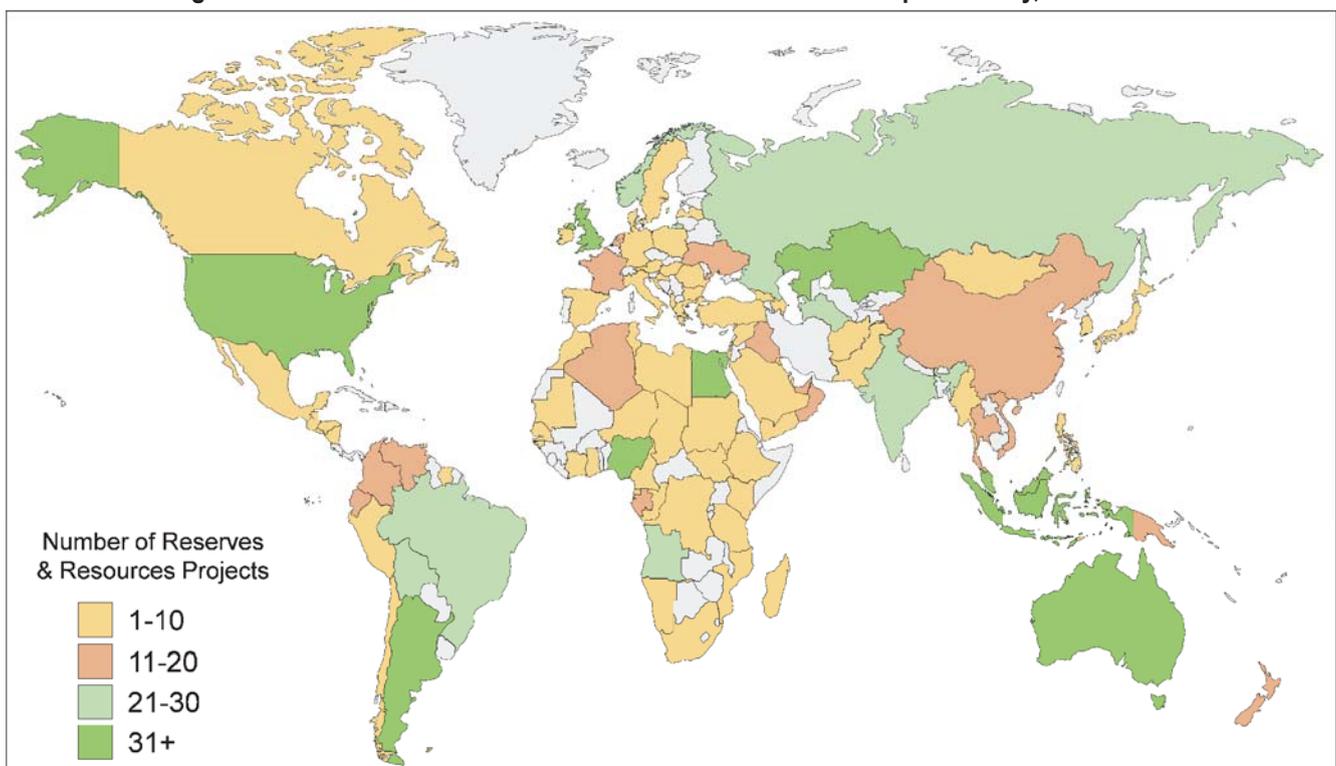
Independent Assessment, India: For a major Indian operator, GCA undertook a detailed analysis and independent assessment of the Reserves for a major development offshore Eastern India. GCA's Reserves opinion was based on all available geoscience, reservoir engineering and production data. This analysis confirmed a reduction in ultimate recoverable volumes of gas, and highlighted the importance of onshore gas compression to continued field life. Following this assessment, GCA evaluated other nearby gas discoveries that the client is considering for tie back to the field infrastructure. GCA estimated In Place volumes and Contingent Resources for these discoveries.

Technical Specialist Report (CBM), Australia: For an independent operator, GCA prepared a Technical Specialist Report for a Target Statement to shareholders, following an acquisition of shares. The report included an assessment of the Reserves and exploration potential in and around Coalbed Methane assets in Queensland, Australia.

Reserves Evaluation, China: GCA evaluated the Reserves for an onshore Chinese oil development. A comprehensive analysis of the development plan was undertaken, including steam injection plans and associated capital and operating costs. The certified Reserves were input into a Competent Person's Report which was used for a stock exchange listing. The field is analogous to a deep (more than 3,200 m) heavy oil reservoir which was previously assessed for Reserves by GCA for a national oil company.

Year End Reserves Update, North Sea: GCA recently prepared a comprehensive year end Reserves update for a portfolio of fields in the UK North Sea operated by the client, a mid sized independent company with a strong UKCS focus. This assessment led to an overall increase in Reserves.

Figure 2: Number of GCA Reserves and Resources Evaluations per country, since 2000



Reserves and Resources Report, Middle East: On behalf of an independent Middle Eastern oil company GCA prepared a report on the Reserves and Contingent Resources of an Egyptian onshore Eastern Desert asset which contained several producing oil fields. The majority of the fields are very mature; however opportunities for infill drilling and water injection were identified. Production profiles were estimated predominantly through decline curve analysis and the Operator's reservoir models were used to underpin the estimates for the water injection project. Reserves and Contingent Resources were estimated in line with the SPE PRMS and GCA prepared cash flows and Net Present Values for each Reserves case.

Reserves Assessment Update, Far East: As part of its ongoing role as the Lender's Technical Consultants for a major LNG project in the Far East, GCA conducted a Reserves Assessment Update for the three major oil and gas fields that supply the LNG plant. GCA had previously conducted a full independent assessment of Reserves in the three fields; in this update GCA commented upon the changes since its previous assessment and audited the updated Reserves estimates made by the Operator. Proved (1P) Reserves were assessed in accordance with the SEC rules, while the Proved plus Probable (2P) and Proved plus Probable plus Possible (3P) Reserves were assessed according to the SPE PRMS. GCA's work involved a review of the static and dynamic models used as the basis for the Reserves estimates in one of the fields, plus decline curve analysis for the other two fields. Finally, GCA reviewed the development plans and gas utilization forecasts.

Reserves Report, USA: On behalf of a mid sized international independent oil company GCA was engaged to provide a detailed written report estimating proved and probable Reserves in addition to future revenue for a number of tight oil and shale gas properties located in the Barnett Shale in North Texas.

Technical Review, Bolivia: GCA undertook a technical review in support of a Reserves statement for two fields in the sub Andean Tarija Province of southern Bolivia. The sandstones which comprise the reservoirs of both fields have low matrix porosity, typically less than 4% 5%, and fracturing provides the main permeability conduits for hydrocarbon production.

Reserves and Resources Audit, Vietnam: GCA audited Reserves, Contingent and Prospective Resources for two fields in the Cuu Long Basin, offshore Vietnam, for a company listed on the London Stock Exchange, using the SPE PRMS guidelines. The larger of the two fields had been in production for four years and comprised more than 100 separate oil accumulations in stacked reservoir sands, deposited in fluvio-lacustrine environments, in a series of adjacent fault blocks. Extensive good quality seismic, log and production/pressure data were available permitting detailed modelling of the field; all of which was reviewed and cross checked by GCA during its audit. The principal reservoir in the smaller field, which had been producing oil for more than six years, was in fractured zones in the pre Tertiary igneous basement. Reserves and Resources were assessed on the basis of reservoir modeling, decline curve analysis and analogue field information.

GCA has 50+ years of consulting experience across the breadth of the energy industry in every major sedimentary basin worldwide. Reserve and Resource audit and assessment is the foundation from which GCA has built a truly comprehensive oil and gas consultancy. As it moves towards its 60th year, GCA continues to support its clients by providing unparalleled and independent technical and commercial advice.

Additional Information

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

Europe, Africa & Russia Caspian

United Kingdom
Bentley Hall, Blacknest,
Alton, Hampshire
GU34 4PU, United Kingdom
Tel: +44 (0)1420 525366
+44 (0)1420 526700
GCA.BD.London@gaffney-cline.com

Americas

Houston
5555 San Felipe Street
Suite 550
Houston, TX 77056
USA
Tel: +1 713 850 9955
GCA.BD.Houston@gaffney-cline.com

Asia Pacific

Singapore
80 Anson Road, #31-01C
Fuji Xerox Towers
Singapore 079907
Tel: +65 6225 6951
GCA.BD.Singapore@gaffney-cline.com

Argentina
Edificio Puerto León
Juana Manso 205, piso 3
Dique 4, Puerto Madero
C1007CBE
Buenos Aires,
Argentina
Tel: +54 11 4378 6497
GCA.BD.BuenosAires@gaffney-cline.com

**Gaffney,
Cline &
Associates**

www.gaffney-cline.com

Terms and conditions of use: by accepting this document, the recipient agrees that the document together with all information included therein is the confidential and proprietary property of Gaffney, Cline & Associates and includes valuable trade secrets and/or proprietary information of Gaffney, Cline & Associates (collectively "information"). Gaffney, Cline & Associates retains all rights under copyright laws and trade secret laws of the United States of America and other countries. The recipient further agrees that the document may not be distributed, transmitted, copied or reproduced in whole or in part by any means, electronic, mechanical, or otherwise, without the express prior written consent of Gaffney, Cline & Associates, and may not be used directly or indirectly in any way detrimental to Gaffney, Cline & Associates' interest.

© 2016 Gaffney, Cline & Associates. All rights reserved.