Complex problems → Simple solutions

Dr. Mark Deakin

Independent Consultant and Tutor in Petrophysical Data Integration

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Technical Consulting / Complete Petrophysical Training

Public courses held annually in Kuala Lumpur (March), Vienna (May) and Dubai (November)

SHORT CV *Dr Mark Deakin is a consultant, author and tutor in Petrophysical Data Integration. He holds a Ph.D. in 'Integrated Petrophysics' from London's Imperial College, is an ex Amoco petrophysicist, and has 25 years experience, including 12 as a lecturer and Director of his consulting company, Petrophysics Pty Ltd. He has performed over 50 detailed reservoir studies, primarily in Southeast Asia's difficult carbonate and stacked 'low-contrast-pay' reservoirs, keeping abreast of new technologies by technical reading, frequent operations work and lecturing. Deakin's approach is simple and effective, first identifying and ranking reserves uncertainties then guiding the company systematically towards maximum booked reserves via the integration of targeted "data proofs". After his PhD Deakin authored* ***the first public "Integrated Petrophysics" course****. He has evolved this industry benchmark course for over 18 years, through PetroSkills, HOT and independently. Recently Deakin developed* ***PetroDB*** *and his* ***'Carbonates & Fracture Petrophysics'*** *course to promote the efficient development of these complex reservoirs. Deakin is a member of SPWLA and is based in Perth, Australia.*

- ***Experienced:*** *Over 50 integrated reservoir studies for reserves and simulation, deterministic & probabilistic. Countless Peer Reviews. Peer Reviewer. Advisor for Special Core Analysis and Hi-thec Logs*

- ***Reserves Certification:*** *Steer companies toward maximum booked reserves at minimum cost.*

- ***Effective Recommendations:*** *Better, earlier decisions through concise reporting and incisive recommendations. Innovative & critical data acquisition guidance. Project Advisor / Mentor. Corporate Petrophysical Health Checks of small and major operating companies ("Little companies make little mistakes, big companies make big mistakes").*

- ***An Effective Communicator,*** *Acclaimed Trainer:*

- 'Integrated Petrophysics..' industry benchmark training course & manual; 'Carbonate & Fracture Petrophysics' the complete recipe for complex reservoirs. Enthusiastic and motivating instruction!

- On-The-Job Documented Petrophysical Training of local staff.

- Remote mentoring and operations advice. Structured daily emails and phone calls.

- ***S.E. Asia:*** *Wide operations and development project experience in S.E. Asia's problem reservoirs. Robust geo-modeling via innovative integration including facies, cap.pressure, resistivity, sigma, NMR, MDTs, well tests & rel-perms with conventional & special logs (Deakin 1998, 2003).*

- ***PetroDB :*** *A huge, intelligently cross-referenced Petrophysical DataBase: Over 18,000 Routine & Special core plugs cross-referenced to conventional logs and well tests. When used intelligently PetroDB upgrades fast, cheap wells into pseudo cored, tested wells. PetroDB brings clarity to the questions left by inadequate data acquisition.*

- ***200+ key equations*** *collected and created over 25 years of technical reading and innovative petrophysical consulting*

- ***The Vault:*** *a meticulously designed, continuously updated Geolog & IP Evaluation Command File editable for any well or field. After 20 years of evolution the program incorporates core, scal, PetroDB, LWD, NMR, pulsed neutron, all logs, MDT excess pressures, cap.press and permeability models using numerous proprietary and published techniques. The Vault produces Waxman Smits, Dual Water* ***and*** *Capillary pressure Sw's by default, using PetroBD's generic Sw-height and Coates permeability equations. The Vault intelligently cross-references and integrates diverse data sets using PPL's "Data Hierarchy" concept to produce collaborative and uniquely robust answers for Sw, kg, ko, kw and netpay.* ***"The Vault"*** *captures expertise, training courses, equations and the power of PetroDB.*

- ***Software Ready:*** *Geolog and IP licensed software. Geoquest certified. Multimin, Landmark, Petcom, Crocker, Shell Logic & multiple other software experience.*

PPL is a pioneer in petrophysical data integration:

1) '84-'89 'Integrated Petrophysics' PhD 2) Jan90 'Integrated Petrophysics' training course 3) Jan90 onwards. Mainstream technical consulting & training 4) Jun05 'Carbonates & Fracture Petrophysics' and 'Quicklook Log Analysis trainingcourses 5) Jan06 ***PetroDB***

If you seek clarity *in developing SE Asia's carbonates, complex or marginal fields then consider PPL's expertise in field development. A PPL review of your existing data will provide an inexpensive, exhaustive and clearly documented basis for your ongoing operational decisions.*

Please make contact early with tentative (no commitment) bookings to facilitate planning

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CLIENT LIST (partial)

Agoco Aramco BP BHP Boral BowValley BritishGas CarigaliTriton Chevron Conoco DiscoveryGeo DNO Esso FletcherChallenge Hardman HLHVJOC HOTEng HOEC Hydro Interoil KNOC MOL NorskHydro PetroSA Petronas PGL Premier RDSHelix ROC Salamander Schlumberger Sphere Statoil TritonEnergy(Hess) Tullow Uzma Woodside

FIELD STUDY LIST (partial)

Amethyst APN Andrew Anoa Armada Belanak Belut Bontang Brae Brent Bualuang Bumi Buntal Cakerawala Ceiba Cliff-Head Cuu-Long-Basin Dai-Hung Drake El-Giza GG Gulf-of-Thailand Hamada Jadotway JDA Kambuna Kapuni Kepodang Kupe L-Field Malay-Basin Mangahewa Matamata McKee North Lobe OO PhuHorm Pornsiri PY1 Rang-Dong Sarir Seruway SK6 SK309 SK312 Sunrise Suriya Te-Giac-Trang(TGT) Thebes Tembang Natuna Vincent

5 Continents: Clastics, Carbonates, Fractured Basement

CURRICULUM VITAE

TECHNICAL CONSULTANT/ADVISOR December 1989 - ongoing

Vietnam Oct08-ongoing: HLJOC. Review & Recommendations then SCAL & Full Petrophysical Integration/Evaluation: Mudlogs, SWC, XRD, Core facies, Image log facies, All logs, RCA, SCAL Pc, Rel-perms, NMR logs, MDT excess pressures & samples. New NMR Sw. Swpc-Swrt-Swnmr & Perm reconciliation, Geo-model inputs. Development well minimum-cost logging tied back to study results.

Indonesia Jan08: Salamander. Technical Consultant/Operations Petrophysics. Stacked shaly sands. Fresh, variable Rw's. [MRIL time domain analysis + standard log + generic PetroDB (RCA,SCAL,Pc) + RDToval] integration for por, Sw, k, kgas, FWL. Results, Recommendations

Thailand Sep07-Ongoing Field Management: Salamander. Heavy oil field appraisal. Investment review & recommendations. Later full petrophysical/geo-modeling integration: LWD, core, wireline, WFT, Tests, Sensitivities, Uncertainties, Petrel geo-modeling. Design detailed SCAL program: wettability, overburden porosity & kbrine, Pc, Kro:Krw, Sorw, Co/Cw, BQv, m*, n*, Interfacial Tension, Contact Angle. Revised simulation input

New Zealand Sep06: Balance. Operations Petrophysics. Technical consultant in tight, stacked shaly sands.

Norway July06: NorskHydro. Clastics and **carbonate**: 'The Petrophysics of Low Permeability Reservoirs' research project. 500+ recent petrophysical papers & articles read. Critique of methods & new evaluation proposed.

Thailand June06: Salamander, Thailand. Fractured **Carbonate** detailed petrophysical integration - 10 wells, ongoing.

Indonesia May06: Salamander, Indonesia. Petrophysical evaluation of **Carbonate** & Clastics variable Rw wells.

Malaysia April06: Murphy Sarawak. Operations Petrophysics: LWD/PEX/MDT Dual Packer. Developed a generic system for permeability prediction from standard LWD data, local and PetroDB data. Uses a hierarchical, robust bound fluid prediction with a near universal Coates based Permeability Model. Reduced uncertainty of uncored pay and reserves. Provided clarity in uncored rocktypes. Reduced coring costs.

Perth, WA Apr05: Woodside. Seismic petrophysics. Full petrophysical resistivity/cap.press evaluation followed by seismic integration. Edited rhob, dtc, dts; fluid substitutions (Gassman) virgin and brine; virgin and brine synthetics. Various attributes aimed at wellbore calibration of subtle seismic character with excellent petrophysical and seismic data sets. Integration of resistivity with cap.press and permeability for a base case saturation.

Malaysia/Thailand November04: Carigali-Triton OpCo. Return to update 1997 "Facies Based Petrophysics". The JDA Petrophysical Model derives multiple Sws, continuously selects the least compromised result at each interval and calculates a foot by foot uncertainty curve. The "Sw Decision Tree" calculates, ranks and integrates any and all available sources of Sw: oil mud core, resistivity, cap.press, magnetic resonance, production logs etc within an agreed, transparent and fully flexible

framework. A robust permeability output is an integral part of this process, allowing the estimation of undrilled contacts. The upscaled geo.model is checked against well results. See also Malaysia/Thailand Sep95

Malaysia August04: Petronas Agent. **Carbonate** and typical Stacked shaly sands pre-FDP appraisals.

Perth, WA Apr04 - ongoing: Woodside. Assurance Check3. Detailed review and independent critique of core-log, facies based geo-modeling. Porosity, Permeability, Sw-Height and Upscaling issues. Impact on reserves/plateau. Miscellaneous other tasks.

Brazil Feb04: Hardman Resources. Matamata field appraisal.

India NW Oct03 - Mar04: HOEC. Fractured Basement Gas Field appraisal (hydrothermally altered gniess). Complex, staged, innovative integration of core, logs & tests for reserves certification & development scenarios in an extremely problematic reservoir. Staff training.

Indonesia Dec01 - Dec02: BP Indonesia. BP's 'Define' stage for Field Development Plan, complex poregeometry **carbonate**, detailed core-log integration, capillary pressure Skelt Sw functions, peer reviews. ALSO: Marginal conglomerates feasibility study / Detailed Geolog Multimin studies / Probabilistic vs Deterministic comparisons

Indonesia Apr01 - Dec01: BP Indonesia. Gas field appraisal. Full spec low invasion water mud coring, high porosity soft sands, LRLC pay, NMR, RDT(Halliburton) wellsite supervision. General and specific operational and evaluation recommendations, integration for reserves certification. Staff training.

Indonesia Jan00 – Feb01: Premier: Stacked shaly sands. Petrophysical Health Check. Re-evaluation of typical log analysis using all available data plus analogs towards reduced reserves uncertainty, reserves certification and focused data acquisition. Operational recommendations and evaluation: OBM, CMR, AIT, RCST, MDT for certifiable Netpay. Effective on-the-job staff training.

Dallas, Texas Jun99-Jul01 ongoing: Hess (Triton Energy). Research, update and advise on low invasion OBM coring for direct reservoir Sw: mud specs, coring, core analysis, NMR logging and MDTs. Operations: data acquisition of Core, Platform Express, AIT, CMR(NMR), UBI, MDT, CST. Work closely with a first class, experienced team (The A Team), world class specialist consultants and effective management to forge a systematic integration of ALL data for robust, minimum error reserves, testing, prediction of undrilled contacts and seismic integration. This thorough, comprehensive and effective petrophysical data acquisition, and its proper integration, is key to booking maximum early reserves for this project's fast track development. Triton Do Things Properly!

Indonesia Aug99 - Aug00: Premier: reserves upgrade. Review of existing log analysis including recommendations for data acquisition and evaluation. The close implementation of these recommendations contributed to a 70% reserves upgrade.

Indonesia Dec98 - Aug99: Conoco: low resistivity low contrast pay (LRLC pay). Integrated petrophysical evaluation of varied brackish water reservoirs using all available data and disciplines: geophysical, geological, petrophysical and engineering, resulting in a significant reserves increase. Log-independent saturation reference. Data acquisition and evaluation templates. On-the-job staff training.

Egypt Jan99. Tullow: Operations, 15000ft Fractured **Carbonate**s. Operations, log integration, testing recommendations.

Thailand Nov97: Thaipo. Petrophysical Health Check: Critique and recommendations for cost-effective petrophysical data acquisition and evaluation. Data acquisition and evaluation templates.

New Zealand Dec97 - ongoing: Fletcher Challenge: Tight, high-pressure fresh water gas field appraisal. High Pc transition zones, complex pore geometries, fractures, nmr, mwd, innovative data acquistion, prediction of undrilled contacts via Reservoir Master Equation (see course summary).

New Zealand Mar-May98: Fletcher Challenge: Reserves, simulation model. Wet-gas development feasibility study, complex diagenesis. The study replaced and clarified numerous previous studies its thorough and systematic data integration. Pc rocktype calibrations etc, ko, predicted FWLs

China Jan-Aug97: Schlumberger Wireline & Testing. Technical author and editor, China WEC.

New Zealand Apr-Aug97: Fletcher Challenge: Mature field, reserves & simulation input, mixed-oil wettability, complex paleo and production related fluid zones.

Malaysia/Thailand Sep95 - ongoing. Petronas: Carigali-Triton Operating Company (CTOC). WaxmanSmits Sw. Low contrast pay (LRLC pay), freshwater stacked shaly sands, variable Rw. Design complex SCAL program re "Facies Based Petrophysics": integration of core-FMI facies, core capillary pressures, MDT pressures, pump-out samples and hi-tech logs (nmr, fmi, ari, iplt, mwd) per facies (SPE 39761) for reserves study. The resulting 23% reserves upgrade **was vigorously challenged by a rival major operator (BP)**, but successfully defeated due to this **well documented and technically sound, core based evaluation.**

"Whilst the changes in reserves implied by this study are large an alternative technique equally founded on direct core observations is difficult to envisage" (May97 FBP report summary)

Malaysia/Thailand May95-Sep95. Petronas: Carigali-Triton Operating Company (CTOC). Operations. Gas-condensate freshwater stacked shaly sands. Optimised mud systems, innovative mdt programs, hi-tech logs, mwd, uncored Waxman Smits BQv, k and testing programs for shaly sand, very low contrast pay (LRLC pay). Data acquisition planned for Facies Based Petrophysics study (above). Petrophysical-seismic attribute integration for interwell HC column. Staff training.

Vietnam Exploration. Jan-Feb95. PEDCO. Typical S.E.Asia freshwater, stacked shaly sands. Sw, Netpay, testing-perforating recs. RCI, CBIL Image Log, innovative WS derived Sw

Vietnam Dai Hung Formation Evaluation: Field Study. July94-Nov94 BHP Petroleum. Integrated Petrophysical Field Study: Complex mixed lithology **carbonate**s and dislocated stacked shaly sands. (WS Sw) What is Netpay? The criteria and delineation of Netpay and Netrock in cored, complex lithology, complex fluid zone, multiple oil reservoirs.

Vietnam Dai Hung Formation Evaluation: Operations. July93-May94. BHPPetroleum (Dual Water Sw). Sw, Netpay, testing recs. Integration of conventional & hi-tech logs with core & RFTs in dislocated, stacked, shaly, sideritic sands. Provided earliest recognition, later proved correct, of the truely problematic nature of this development.

North Sea LWD - Horizontal Wells - Unconsolidated Sands. Oct-Nov93. Bow Valley (UK) Ltd. Integration of MWD, conventional logs and core, from horizontal + vertical wells to plan for an Extended Well Test.

North Sea Development feasibility study. N.Lobe Brae conglomerates. Dec92-May93. Bow Valley (UK) Ltd. What is Netpay? A quantitative synthesis of all relevant data including water encroachment, depletion and core relative permeabilities to define Netpay, and the impact of conglomerate clasts on volumetrics and simulation. This bottom up, core-log detailed geological integration enabled the first successful history match, radically revised HCPV distribution and a 25% reserves upgrade for client's asset.

Malaysia Fresh water shaly sands Nov91. British Gas. Independent evaluations of problem wells including recommendations for improved drilling and targeted data acquisition.

North Africa Fresh water shaly sands and **carbonate**s, mature reservoir. May92-Jan93 HOT Eng. (Dual Water Sw) HCFT (EHC), permeability and facies evaluated from open and cased hole logs, core, test and production data. Rationale for data extraction and reserves in capillary transition zone through careful, multidiscipline, concept and data integration.

North Africa Giant, mature oil field. Jan90 with ongoing updates. HOT Eng. (Dual Water Sw). A two year, integrated, full scale geological-reservoir engineering study of a mature, braided fluvial reservoir with secondary recovery problems. The study involved 300 wells, 10,000 feet of core, open hole & production logs. Ø, Sw, k, initial and residual oil saturation, heavy oil zones and logfacies were quantified and mapped. The petrophysical evaluation resulted from the systematic, detailed integration of core, production logs, RFTs, well tests and 25 years of production history and formed the cornerstone of the geological model. Following initial conditions mapping, utilising pre and post production wells, and predicting residual oil saturation the model was used as 'hard' input for simulation. Effective presentations were a key component of this study.

Russia Fresh water stacked reservoirs. Oct-Nov91. Quad Eng. A log analysis study of key wells with limited data utilising classic pre-porosity log analysis techniques.

North Africa Capillary Transition Zone **Carbonate**s July92 May93. Evaluation of HCIIP and producibility in variable transition zone producing **carbonate**s: pore-typing, fracture ID for What is Netpay? Capillary pressure and relative perm. modelling in transition zone. Innovative transition zone klog from Sw and J Functions.

North Sea Netpay criteria re dynamic data. Oct-Nov90. Ireland Dept. of Energy. **What is Netpay?** Establishing key log parameters including permeability for Netpay by reference to production data and tests. Full re-calculation sensitivity studies to determine impact on GIIP.

North Sea Permeability prediction. Jan90-Jun92. Esso. Predicting permeability from logs in facies with dissimilar pore geometries but apparently identical bulk volumes.

PROFESSIONAL LECTURER (Course Instructor) March 1991 - ongoing

1. **Integrated Petrophysics for Reservoir Characterization**
2. **Carbonate and Fracture Petrophysics - A Roadmap**
3. **Actual Well/Field Evaluation - Computer**
4. **Parallel Petrophysical Training**

These popular, industry benchmark 3-5 day courses cover the full spectrum of petrophysical training needs and are delivered by an reputable, PhD qualified, mainstream petrophysical consultant.

AMOCO PETROPHYSICIST 1988 - 1990

Worked as a qualified petrophysicist in a field development teams consisting of managers, geophysicists, geologists and reservoir engineers. Work embraced reservoir engineering and the economics of field development. Projects included a Department of Energy gas/condensate Annex B, equity re-determinations and in-house sensitivity studies. Represented Amoco at equity meetings and vetted equity agreements. Role required knowledge of evolving petrophysical techniques and spanned exploration, reservoir geology, and reservoir engineering. Resigned (that means not laid-off!) following repeated offers for consulting projects and a contract with TerraSciences to supply a PC and TerraStation software in exchange for developing "Integrated Petrophysics" Ph.D (see below).

Often neglected, inter-departmental skills reduce risk and enhance oil company profits. Since my PhD in 1985 my career has focused on filling this then neglected, but now established approach to reservoir problem solving.

Petrophysical Consultant, N. Sea conglomerates Dec'87-Mar'88 Occidental Petroleum.

Integration of all geological and engineering data from three N.Sea appraisal wells. Core-log-test integration, and a hierarchical (ranked) flow of conclusions solved a four year interpretation problem and provided the only credible explanation of extremely confusing data. This rigorous approach provided a general evaluation template which set the style of my career direction for thoroughness, attention to detail, and the careful, logical, piecing together of information.

Consultant Wellsite Geologist / Log Analyst 1976 - 1987

11 years field experience combined with PhD studies of a real petrophysical problem encouraged the following skills:

- control of mud properties for optimum logs, minimum formation damage, and preservation of "native state" core
- recommendations for cost effective logging programs in wildcat wells. 500+ hrs spent in wireline units
- real time RFT supervision and interpretation addressing Operator key objectives
- Quick Look Analysis for Øt, Øe, Sw, k, contacts. Reservoir zonation for testing
- on-site well test recommendations based upon core and lithlogs, combined with log analysis and RFTs, not just logs

EDUCATION and RESEARCH

1973 - 1976. University of Reading: B.Sc. Honours Degree in Geology.

1984 - 1988. Imperial College, London. Ph.D. thesis. Sponsor: Occidental Petroleum.

The Ph.D. research program outlined below was the response to a survey sent to 15 operating oil companies. The survey enquired of major shortcomings in formation evaluation.

Ph.D: 'Integration of Core, Log and Drill Stem Test Data for the Petrophysical Analysis of Brae Conglomerates, North Sea'

The PhD thesis provides a generalized method for the quantitative integration of cores, logs, RFTs, DSTs, SCAL, petrography, X-Ray diffraction, and SEM's. The method creates Non-log-inputs from these data to integrate with the continuous log data. The resulting hybrid parameters enable high confidence lithology and fluids analysis from their rich information content, and a prediction of kcore and DST kh values. The need to reconcile apparently contradictory data provided the impetus for this research. The integration is based upon sound petrophysical theory, and **provided a prototype for solving a wide variety of formation evaluation problems,** from the identification of Netpay in exploration wells, to the optimum exploitation of reservoirs with complex lithologies, pore geometry's or other unusual features. All MSc Petroleum Engineering and Petroleum Geology courses were completed during Ph.D. studies.

The approach developed by this PhD formed the cornerstone of Deakin's long career in integrating petrophysical data and began the movement away from 80's stand-alone log analysis to quantitative petrophysical integration of diverse data. It has since been adopted by countless other companies, large and small, and has evolved into the industries standard for petrophysics, in part due to the 18 years and 1,000+ students of the IPRC training course

Professional Courses and Affiliations Numerous SPWLA & SPE Annual Conventions / seminars. Numerous Amoco in-house lecture courses on Formation Evaluation and Development Geology. Schlumberger Basic and Advanced Log Interpretation. Member SPE, SPWLA. Bali SPE Forum 1998. Technical articles and lectures are occasionally given, time permitting.

PUBLICATIONS

'The Petrophysical Integration of Four Volumetric End Points Applied to an Indonesian **Carbonate**' Indonesian Petroleum Association (IPA) paper G-151, Jakarta October 2003. Deakin, M.J.W and Smith, D.R.

'Petrophysical Data Integration Increases Reserves In S.E. Asia's Stacked Shaly Sands' IPA Conference, Jakarta, May98

'The Integration of Petrophysical Data for the Evaluation of Low Contrast Pay' SPE 39761, Asia-Pac.Conf., Kuala Lumpur, Mar98

'Wettability, Formation Resistivity Factor and Excess Conductivity' SPE 16518, 1987

Unpublished: 'Low invasion core and integration with the reservoir master equation for the prediction of undrilled contacts' June99

Unpublished: 'Earthtides: Their Power during Petrophysical Integration' presented at SPE Forum, Bali May98

REFEREES

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