A Composite Analysis for Facies Interpretation and Hydrocarbon Identification Using an Advanced Gas Data, A Case Study in Mutiara Field, East Kalimantan, Indonesia

Sinaga, Iranta Bona[1], Robert Nikijuluw[1], Hamjaya Ilham[2] (1) VICO Indonesia, Jakarta, Indonesia (2) Geoservices, Balikpapan, Indonesia

The identification of reservoir formation fluids in the deltaic environment that is influenced by multi layer reservoirs, coal presence in every 100 ft, pressure, mud weight and mud type during drilling operation is often ambiguous. In matters of pay zone recognition, hydrocarbon-bearing reservoir as well as high or low-pressure formation need to be clearly detected. Knowing the composition of the formation fluid while drilling would be obviously one of the most useful data item.

An advanced gas detection system combined with new gas analysis and interpretation services from Geoservices called INFACT has been utilized and evaluated. The fully computerized gas detection system combines total gas and chromatographic measurements and has quicker cycling time for measuring in parts-per-million the concentration of alkane carbon molecules and molecular isomers. This advanced gas detection shows a continuous data stream with far more data points per interval and greater resolution due to a 42 seconds sampling time per complete chromatograph cycle. The method also allows us to evaluate and improve the understanding of reservoir in real time while drilling.

Process analysis and interpretation is started by evaluation of gas quantity based on Total Gas or Methane gas values by taking account the impact of ROP, Mud Weight. Base on this values, potential and interest zone are selected. Next process continued by compositional gas chromatograph analysis from selected zones by using cross plot analysis using N- Dimensional Logarithm.

The method has been applied successfully in Mutiara field, where deltaic environments of ancient Mahakam River tend to have a complexity in determining the hydrocarbon reservoirs. This method could also differentiate gas, oil and water zones, depleted zone, hydrocarbon water contact, and identify hydrocarbon zone with low gas reading.

Formation Evaluation and Permeability Prediction in a Highly Heterogeneous Reservoir – The Kuparuk C-Sand

Klein, Jim D.[1], Mark Scheihing[2], Laird D. Little[3], Dirk Seifert[3] (1) ConocoPhillips, Houston, TX (2) ConocoPhillips, N/A, (3) ConocoPhillips Alaska,

The Kuparuk River Field in Alaska is one of the largest oil accumulations in North America. Approximately one-third of the OOIP is contained in the C-sands, which are shallow marine sandstones characterized by intense bioturbation and complex diagenesis. Siderite content is extremely variable, leading to large variations in permeability, porosity, and capillarity on the sub-foot scale.

Interpretation of mineralogy, porosity, and water saturation from wireline logs is relatively straightforward, provided mineralogy and core heterogeneity are considered. Predicting log permeability is more difficult due to extreme scatter in porosity-permeability cross plots. Deterministic porosity-permeability transforms are poor predictors, since the results do not replicate the scatter present in the core data.

A new method has been developed for the prediction of permeability. This method is based on random selection of values of core bulk density from sub-groups based on log RHOB and petrofacies. For each log depth, selection of core bulk density points is repeated until the density averaged over a sliding window matches the RHOB log. The values of core porosity and permeability that correspond to the selected value of core bulk density are then selected as the final result at each depth point. The method duplicates the statistical distributions of the core porosity and permeability values, with values obtained every half-foot. Upscaled permeability at 1 and 2 ft increments match kH based on core-plug data, on a well-by-well basis. The values are also consistent with kH determined from maximum flow rates observed in a large number of wells.

Interactive Assessment of The Sensitivity of Well Logs to Static and Dynamic Petrophysical Properties of Rock Formations

Ramirez, Thaimar Rocio[1], Carlos Torres-Verdin[2], Hee Jae Lee[3], Gong Li Wang[3] (1) ConocoPhillips, Houston, TX (2) The University of Texas at Austin, Austin, TX (3) The University of Texas at Austin,

Simulation of the process of mud-filtrate invasion considers the interplay of mud properties and petrophysical properties of rock formations. Capillary pressure, relative permeability, porosity, permeability, and salt mixing govern the time evolution of fluid distribution in the near-borehole region. In addition, overbalance pressure and mud properties determine the flow rate of invasion from spurt loss to steady-state imbibition. Mud and petrophysical properties can have a significant impact on well logs acquired with multiple radial zones of investigation. It is difficult to ascertain by visual inspection in what way a given well log is influenced by mud-filtrate invasion.

We have developed an interactive, user-friendly PC interface to efficiently assess the influence of mud-filtrate invasion on well logs. The interface allows the user to systematically test the sensitivity of static and dynamic rock formation properties on induction and laterolog measurements acquired in vertical wells. This is achieved by simulating the process of immiscible fluid displacement in permeable formations between water-base mud and in-situ hydrocarbons and connate water. The interface also allows one to ascertain the impact of salt mixing, initial water saturation, and irreducible water saturation on resistivity logs. Moreover, the user may systematically assess the influence of Archie's parameters on well logs, including the possibility of conductivity enhancement due to dispersed clay.

Several examples are shown of the application of the PC interface to quantify the behavior of non-conventional logs, including the cases of tight-gas sands, water-hydrocarbon transition zones, and high contrast of salt concentration between mud filtrate and connate water.

Early Assessment of Reservoir Compartmentalization Using Geochemical Analysis of Wireline Formation Tester Samples

Kaufman, R. L.[1], S. C. Teerman[2], M. E. Cribbs[2] (1) Chevron Energy Technology Company, San Ramon, CA (2) Chevron North America Exploration And Production Co, Houston,

An important issue in field development is the connectivity of the reservoirs to be produced. This impacts both the economics and design of the development plan. The analysis of the reservoir fluids is an important component of this assessment. Oil and gas samples have traditionally been obtained from drill stem tests, but in deepwater settings these are more frequently obtained from pumpout wireline formation testing tools (PWFT). The ability to collect fluid samples using a PWFT in conjunction with pressure tests increases the number of hydrocarbon bearing zones that can be sampled. These discrete single zone samples are also important calibration samples for future reservoir surveillance techniques such as production allocation. Analysis of these samples includes conventional PVT and compositional analyses in conjunction with geochemical techniques such as hydrocarbon and isotope fingerprinting. By combining these datasets with reservoir pressure data, an improved interpretation of reservoir continuity is obtained including communication of gas and oil columns. A related and complimentary analysis is geochemical mud gas logging. This method is an extension of standard mud logging techniques and uses a combination of gas composition and isotopic ratios of the hydrocarbon gases for correlation purposes. In this way it is possible to assess the vertical and lateral connectivity of hydrocarbon zones during or shortly after drilling. By combining all the above data the value of this information is maximized. The success of this methodology will be illustrated using examples from deepwater fields in the Gulf of Mexico and Angola.

Compressional Aanisotropy: Understanding Sonic Logs in Non-vertical Wells

Market, jennifer[1], wyatt Canady[2] (1) Halliburton, Houston, TX (2) halliburton, Houston,

Though shear anisotropy is often measured with wireline dipole sonic tools, compressional anisotropy is seldom addressed and often leads to doubts about log quality. Compressional logs acquired in several wells in a field will generally have the same character and will produce similar slowness profiles for the same formations. This congruence generally holds regardless of the nature of the acoustic tool being used (wireline or LWD). When the results unexpectedly disagree in similar formations the difference is often assumed to be caused by tool or technique failure. Frequently, however, the differences are not due to tool malfunction but to the intrinsic physics encountered during logging. When the logs are acquired over different trajectories, the same formation may be logged at a variety of angles. As the wellbore trajectory varies from vertical, the normal overburden stress begins to exhibit itself to the logging tool as an anisotropy in the surrounding stress field. This anisotropy can lead to (legitimate) differences in the compressional slowness as a function of the angle between the well axis and the formation.

Similar effects in electrical tools are routinely observed and corrected using modelling programmes. While it is not a simple matter to “correct” non-vertical sonic logs using only the sonic data from a single well, it is possible to compute the results if the seismic parameters sigma and epsilon are known or can be estimated. Modelling and field examples will be presented to illustrate the effects of compressional anisotropy and methods of estimating the “corrected” results.

Trends in digital core analysis: treatment of unresolved porosity

Arns, Christoph Hermann[1], Abid Ghous[1], Tim J. Senden[1], Mark Knackstedt[1] (1) Australian National University, Canberra, Australia

Most rocks are inherently heterogeneous having been laid down in a range of depositional environments and possibly having undergone significant diagenesis. Pore sizes can vary over orders of magnitudes and connectivity of pores of different scales can impact greatly on flow properties. Typically, porosity cannot be resolved on all scales.

In this work we describe imaging of a range of core material from outcrops and reservoirs via 3D via micro-CT. We also present methods to quantify the amount of microporosity as well as the flow properties of those microporous regions by differential imaging techniques. High resolution numerical simulations of single phase flow and solute transport are then undertaken. We perform lattice-Boltzmann calculations on the tomographic images, accounting for microporous regions by adding a Darcy-type flow in microporous regions and matching Darcy-like and Stokes like flow regions at the open-space, microporosity interface using Brinkman's equation. These results shows the important role of intermediate pore sizes in dictating the single phase flow properties and the potential for many large pores to act as no or slow flow zones.

For the same samples, we calculate the NMR relaxation response and analyse pore-pore coupling as well as pore-porous background coupling by using a network partitioning technique to label each pore (region) separately.

Blunder Management and Traceability, the Critical Requirements of the Longterm Value of Data

Theys, Philippe Paul[1] (1) Data Quality Expert, Houston, TX

Impeccable data management is understood to be a fundamental ingredient of cost-effective exploration and production of hydrocarbons. What does it mean in practice?

Data management is associated with good connectivity that brings data at the right place in quasi realtime. Is the data fully described, void of ambiguities, useable for important decisions with reasonable risks? In this paper, we will describe the high costs linked to inferior data and the importance to manage metadata at least as well as the data itself.

Data management is also associated with organized databases, emphatically called data powerhouses. Is the data stored there fully traceable? If data has been processed, is there a process track that describes the choices and assumptions made by the analyst. Can improved processes and increased knowledge be derived?

Becoming fashionable is uncertainty management. Random and systematic errors are assessed, sometimes quantified.

What about blunder management, the control of human errors, whose failure converts an almost perfect project in a real disaster?
This paper describes the state of the industry, give guidelines and recommend standards. With these practices, the longterm value of data can be considerably increased. The data becomes a nondisposable product and can be used again and again with maximum confidence. It becomes an important asset that will be negotiated at the best price when the corporation that owns the data contemplates a merger.

An Innovative Fluorescence Spectroscopic Method for Characterisation of Heterogeneous Cores

Liu, Keyu[1], Xiongqi Pang[2], Stephen Fenton[1] (1) CSIRO Petroleum, Bentley, WA, Australia (2) Key Laboratories for Petroleum Formation Mechanics, Chinese Ministry of Education, China University of Petroleum, Beijing, China

Accurate characterisation of heterogeneous reservoir formations is critical to reservoir upscaling and modelling. Petrophysical properties such as porosity and permeability are usually obtained from core plugs of limited sizes of 1 or 2 inches in diameters and 1 or 2 inches in lengths sampled at certain intervals. Extrapolation of the discrete core plug properties to log scale (~0.5-1 ft) can sometimes be difficult in heterogeneous reservoir formations. A relatively rapid method for characterising continuous cores using fluorescence spectrophotometry has been under development at CSIRO Petroleum. The method involves the analysis of fluorescence labelled core slabs using a spectrophotometer and obtains continuous 3D pore volume information at a regular grid of 3.5x3.5 mm from cm to metre scales. This method enables the “missing link” between core plugs and log data to be filled.
Initial laboratory testing and experiments using nano-graded fluorescence dyes and a customised sampling stage enabled us to obtain 3D pore volume information on core slabs of 6x10 cm in dimensions each time. Irregular shaped and large cores can also be measured manually using a fibre optic probe connected to the spectrophotometer. Experiments were carried out on artificial sandstones with known porosities and permeabilities and on a range of reservoir rocks from two petroleum-producing basins in China. Calibrations with a number of techniques including high-resolution optical scanning, UV stereo microscopy and Scanning Electron Microscopy (SEM) imaging, 3D X-ray micro CT scanning and Mercury Injection Capillary Pressure measurements indicate that this method is extremely sensitive and has an excellent reproducibility.

A Grassroots Search for Practical Standards in Petrophysics

Storey, Martin C.[1] (1) Formation Evaluation Society of Western Australia (FESWA), Perth, Australia

A bane of the petrophysical profession is that a workable “preliminary evaluation” of a data set can often be produced in less than an hour, whereas it can take weeks, sometimes more, to issue a first version of the “final evaluation”. Most of the intervening time has to be spent on thoroughly checking all the data, and gathering and conditioning ancillary data to support the interpretation. Petrophysicists have an efficiency problem, and this situation may not be improving. Data sets are increasing in variety, complexity, and size, and with time lacking, interpreting a data set is often reduced to a matter of understanding what it is, rather than what it means. There seem to be no widely accepted guidelines on, for instance, how to fill in a log header, to check a digital tape, to record a durable audit trail, or to present results, all of which would assist future users of the data.
Early in 2006, some concerned members of FESWA formed a working group to review chronic bottlenecks and other vexing problems facing petrophysicists. It adopted principles of independence and openness, and declared its interest in real-world issues and long- term value. It set itself to work on simple questions first, reviewing existing practices and methods, and offering practical recommendations which it posted on its public website. Nearly a year later, the presenter will review the challenges faced and the results achieved so far, together with the perceived impact of this initiative on peers, companies, and the authorities.

Hydrocarbon Characterization in Jatibarang Volcanic Fracture Reservoirs

Benyamin, Benyamin[1], M. I. Tachjudin Taib[1], E. Suparka[1], P. Permadi[2] (1) BPMIGAS, N/A, Indonesia (2) Bandung Institute of Technology (ITB), N/A, Indonesia

Research of hydrocarbon reservoir rock of fracture volcanic in the world still rare because of the limited invention of hydrocarbon at that reservoir. Geophysical well log until now where made for the sake of interpretation of carbonate and sandstone reservoir in consequences if it is used or utilized for interpretation fracture volcanic rocks will give very unique response .
This research aim to develop a method for the hydrocarbon characterization in volcanic fracture reservoir with area research of Jatibarang Field ,West Jawa ,Indonesia which covering the prediction of the volcanic , which determining the value of property of the porosity, exponent of saturation (n), exponent of cementation (m) , formation factor (F) and tortuosity (a) use log data , which is validation with core data, and production data. Besides that This research also conducted a determination of hydrocarbon zone with qualitative and also quantitative method with the calculation methods of new saturation which represented of saturation equation modification of Archie which is usually used in carbonate and sandstone.
In this research also made the correlations of corrective saturation which yielded to nature of rock physical like Poison Ratio, Sigma, Shear Modulus, Lame Constanta, Bulk Modulus, Young Modulus and Acoustic Impedance which is entirely alighted from Compression Wave Velocity (P) and Shear Wave (S), based on the nature of physical of litology and fluid which is record at log response and also quickly creep measurement both wave in each rock type of reservoir in laboratory .

Advanced down Hole Fluid Analysis

Weston, Stuart[1] (1) Crocker Research, N/A, Australia

The key aim of this research is to design and commercially operate a down-hole sampling tool that could perform a range of fluid analyses. The tool's main functionality will be to rapidly and accurately perform molecular analysis and fluid characterisation at reservoir conditions. Sampling can thus occur over the productive interval to clearly define compositional distribution in a manner that is currently not available.

Operating the analysis equipment down-hole provides the ability to determine molecular composition at reservoir conditions before the fluid leaves the vicinity of the producing interval. The tool's ability to obtain samples repeatedly while in position, precludes the need for further wire line runs to obtain more fluid samples.

Modern methods of fluid sampling and recovery do not allow for the detection of minor components such as mercury that may have a profound effect upon materials used for production and process equipment. Some reservoir fluid components such as hydrogen sulphide are absorbed by the steel tubulars and fittings used down hole and are thus poorly identified at the surface. The down-hole analyses methods should avoid these problems and give a greatly improved accuracy with a faster and cheaper service that will result in improved production and process design.

This research has potential to provide a major contribution in the understanding of vertical fluid distributions within the reservoir and the way we operate formation testing tools.