detail for the particular stage of exploration and production. The type and amount of data required for a proper reservoir description are diverse, from several disciplines, and depend upon the stage of the reservoir's exploration and production cycle. The cycle is viewed as a continuous series of overlapping stages from discovery, through appraisal, planning, development, and reservoir management. The concepts and data needed to define and exploit reservoirs become more complex and quantitative as the production becomes more mature. Concepts, data, and models developed during the production phases, when reapplied to exploration, provide important guides to the explorationists for evaluating trapping elements, seals, reservoir quality, and risks in basin and wildcard evaluation.

When one looks at the question "When is a reservoir description needed?" the answer is simple. The need starts once a discovery is made and the discovery is being appraised as to the best estimates of hydrocarbon in place, recoverable reserves, and production rates. As a field or reservoir goes through its typical cycle of discovery, appraisal, planning, development, and reservoir management, a more complete description is both necessary and possible.

A critical first step in the reservoir description process is recognizing any correlative reservoir subzones or layers and any intervening dense, impermeable, or low-permeability strata. Knowledge of the depositional/diagenetic processes controlling reservoir and nonreservoir rocks is fundamental to determine one's ability and degree of confidence in correlating these units. Seismic sequence, lithologic, and fluid analyses, and well-documented outcrop studies can add significantly in establishing interwell correlations. Recognizing and mapping all vertical or horizontal fluid-flow barriers, as well as their zones or zones of unusual permeability contrast and faults, are critically important to all recovery processes. Flow-test data, detailed with knowledge of the reservoir and nonreservoir framework based on geology/geophysics, provide the best reservoir description of continuity/discontinuity.

Structural and stratigraphic maps, cross sections, and fence-and-block diagrams convey the three-dimensional geometry, distribution, and continuity of the reservoir, nonreservoir, and aquifer. A variety of computer programs aid in preparing these illustrations. Isopach maps without the accompanying detail correlation sections have been the pitfall of many projects. Net-pay isopach maps drawn to provide the basis for determining hydrocarbons in place have tricked many petroleum engineers into believing a reservoir is more continuous, more homogeneous, and less stratified than it actually is.

The importance of discontinuous shale barriers of limited areal extent on coming and the drainage of oil from a gas-inved area illustrate the need to include shale dimensions in many types of recovery calculations and predictions.

The recognition, selection, and description of reservoir units or layers, and the communication of this picture to the petroleum engineers are fundamental contributions and responsibilities of the geologists/geophysicists. A coordinated data-acquisition program can greatly improve the probabilities of correct assessments in discovery, appraisal, planning, development, and reservoir management.

A good reservoir description designed to answer key reservoir performance questions is a fundamental tool. The incremental well costs to obtain adequate data for a reservoir description are very small compared with its value in improved recovery. The time to complete a reservoir description is before significant expenditures are planned and spent. Mathematical models and simulation of reservoir performance that do not have a realistic reservoir rock-fluid description are interesting, but are expensive exercises that potentially lead to inappropriate or incorrect management decisions.

In exploration ventures, detailed reservoir-description studies made during exploration stages provide the critical data needed by the explorationist to estimate reservoir quality from seismic, well logs, and samples.

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Laramide Basin Subsidence and Basement Uplift in Rocky Mountain Foreland of Wyoming

The basin analysis approach to modeling sedimentary basins affords the opportunity to view ore deposits or accumulations of fossil fuels in the context of the evolution of a single basin. Integration of data from diverse specialties is now widely practiced, and the multidisciplinary approach to the study of basins has greatly enhanced our ability to understand and to predict the occurrence and distribution of economically important commodities. A significant outgrowth of the basin analysis technique is a more rigorous testing of scientific paradigms. Feedback from diverse specialties provides numerous constraints so that no conclusion can be drawn about one aspect of a basin's history without affecting the interpretation of other aspects. Thus, when a conclusion from one line of evidence is at variance with a conclusion drawn from several other lines of evidence, it is necessary to challenge the assumptions that led to the different conclusions. Challenging such assumptions usually involves examining cherished theories or paradigms. Our general reluctance to discard prevailing theories reflects our heavy reliance on useful rules of thumb; without them we could not begin to interpret the geologic past. This reluctance to relinquish useful theories is more easily overcome when several lines of evidence point us toward new concepts that have exciting implications of their own. Basin analysis, by its very nature, pushes us toward new perspectives and thus serves to promote new discoveries in geoscience.

A case study in the San Juan basin of New Mexico serves as an example of the basin analysis approach to a geologic problem and serves to illustrate that sometimes answers to questions that were never posed are the most significant (and surprising) outcome of the basin-analysis approach. The original goal of the San Juan basin study was to develop a genetic model for sandstone-type uranium deposits in the Jurassic Morrison Formation. Tectonic, geophysical, sedimentologic, petro-
graphic, hydrologic, and geochemical (organic and inorganic) studies were drawn together so that mineralization could be evaluated as one diagenetic event in the context of the entire depositional, structural, and diagenetic framework. The result was not only a model for uraniu- 
mum mineralization but also the development of several new concepts, many of them unrelated to the original problem. Spin-offs from the 
original study include significant advances in fields as diverse as hydro-
lurgy, coal geology, saline, alkaline-lake geochemistry, and clay mineral-
ogy. It was possible to document, for instance, that authigenic illite 
formed at near-surface conditions in the absence of the elevated tem-
peratures commonly thought to be required. This finding limits the use 
of illite as a geothermometer and makes it of considerable interest in petroleum geology.

The integrative nature of the basin analysis approach allows a synop-
tic rather than a myopic view of specific geology problems. The 
approach can be applied to any geologic problem and will continue to 
lead us away from current paradigms as multiple lines of evidence force 
us to question our most cherished beliefs. Most certainly we will con-
tinue to learn surprising answers to questions we forgot to ask.

AAPG RESEARCH CONFERENCE
Petroleum Potential of Sedimentary Basins—
Methods, Techniques, and Approaches
Leesburg, Virginia
April 26-29, 1988

NAHUM SCHNEIDERMANN and CHARLES MASTERS
Co-Conveners

The conference, held at the Xerox training center, was 
convened with the idea of bringing together workers in basin assessment through geological analogy, workers doing computer modeling by deterministic approaches, geologic statisticians, and representatives of exploration management. The conference was attended by 103 invited participants, 40 of whom represented 17 coun-
tries outside the United States. This international group represented 14 major oil companies, nine national oil 
companies, five national geological surveys and labora-
tories, and 13 research institutes and laboratories.

The conference was based on topical keynote addresses covering (1) basin development, classification, 
and play identification, (2) source rock occurrence and maturation, (3) oil generation, migration, and retention, 
(4) deterministic modeling of basin processes, and (5) statistical and analog methods of assessing petroleum occurrence by prospect, by play, and by basin. Free-form discussion was planned for and successfully encouraged both in conference and leisure time. In the program con-
clusion, three senior exploration management officials expressed their perspectives on the conference develop-
ments followed by spirited discussion from the conference audience. Details of some of the conference topics are as follows.

Source Rock Occurrence and Maturation. Various 
speakers clearly brought out the importance of recognizing 
and quantifying the geologic, biologic, and chemical 
controls on the occurrence of petroleum and its precursor 
rocks. Prolific source rocks were demonstrated to be 
unevenly distributed around the world and through geo-
graphic time; methods were presented to qualify the source

rock potential by basin, considering richness, thickness, 
and stratigraphic distribution, to arrive at measured evalu-
ations of the possible basin charge. These kinds of 
regional understandings are extremely important to 
basin petroleum evaluations and provide the context for 
play and prospect assessment.

Oil Generation, Migration, and Retention. Although much is now understood about these three essential ele-
ments in oil occurrence equations, clearly much remains to 
be learned. In general, the geochemists confirm an oil 
generating ability in nature far in excess of our ability to 
map its path or place limits to its migration. Continued 
efforts to quantify the physico-chemical aspects of oil 
maturity and expulsion are necessary to improve our 
deterministic predictions of fluid amounts and composi-
tion and of the timing of migration. Possible mechanisms 
of primary migration are generally known, but we do not 
understand which of these mechanisms was dominant in 
a particular geologic environment. We know the broad 
geochemical parameters that control the secondary migra-
tion and sealing of the fluid flow. Random fracturing 
and other hydrodynamic windows in seals, however, 
introduce unpredictable avenues of vertical migration 
that can be recognized by biomarker determinations 
and/or pressure anomalies; the modeling of such migra-
tion pathways is not now possible. Migration losses are 
also beyond the realm of direct deterministic quantifica-
tion.

Deterministic Modeling of Basin Processes. The 
physico-chemical modeling of certain basin processes 
was shown to be satisfactorily conducted in either two or 
three dimensions over time. The exercise is valuable in 
forcing rigor of data development but it suffers from the 
axiom, first expressed by G. K. Gilbert, that a given geo-
logic configuration can be achieved by more than one 
sequence of processes. Furthermore, and more impor-
tantly, as an assessment procedure, modeling is limited 
by our inability to physically control the migration and 
reservoir/entrapment variables. Statistical means were 
demonstrated to circumvent the random character of 
migration paths and character of reservoir development 
in order to predict charge volume in undrilled prospects.

Statistical and Analog Methods of Assessing Petro-
leum Occurrence by Prospect, by Play, and by Basin. The 
varied presentations suggest that there is no unique way 
to conduct the exercises. Rather, there are many ways 
depending on the purpose and data available to the asses-
sor. In all modes of assessment, the investigator is trying 
to use, statistically, the experience gained under analog 
conditions to demonstrate the probability of petroleum 
occurrence. The exercise is valid to the extent that the 
analogs are rational. Some highly sophisticated systems 
of assessment develop statistical measures of analog ele-
ment validity. Though the basic exploration/assessment 
element in everyone's mind is the play, there is little in the 
way of systematic understanding of what is meant by a 
play nor little actually published in the way of play 
models. The significance of precision in play understand-
ing lies in assigning risks to elements of the proposed play 
extensions. The assignment of risk, a major part of 
assessment methodology, remains difficult. Because no

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