depth. Up to 34 depth-related markers can be defined for each project-oriented file. In addition, an x-y location is assigned for each well by reading the coordinates from a graph-paper overlay to the user's base map.

One program is used to build and maintain the file with a screen menu of available operations. A screen data form is used to enter and correct the items. Tables of contents of the wells in the file sorted in several different sequences can be listed on the monitor or the printer.

A program to selectively retrieve up to 8 data items per run through the file generates a tabular listing of the wanted items together with the well-identification information. The data items retrieved can be the stored value, the stored value less minus elevation, and the difference between 2 stored values. The retrieved data can be sorted in the same ways as the tables of contents.

The last program creates a printer-posted map of the stored values, or subsea depths, or isopach interval values. Values are normally posted to the right of an asterisk well symbol unless 2 values print in the same position, and then the second value is posted to the left. In places where 3 or more values overprint, the first 2 are posted and the well symbol is changed to a plus sign.

The programs are flexible and easy to run via screen menus. Additions and corrections to the data base are accomplished very quickly.

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Geologic Field Number and Size Assessments of Oil and Gas Plays

Assessments of undiscovered oil and gas potentials for a group of untested but geologically related prospects can be made from an estimate of the possible ranges in number and size of potential fields, assuming the play exists, coupled with an evaluation of geologic risks that it might not exist. Field size distributions can be constructed from known field reserves in geologically similar plays, from assessments of representative prospects in the play, or from simulations of distributions of the play's prospect areas, reservoir parameters and potential hydrocarbon fill. The field size distributions are truncated at both ends, at a practical minimum and at the largest size reasonable expected in the play. The possible range of number of potential fields is estimated from counted and postulated numbers of untested prospects in conjunction with a success ratio, or from look-alike field densities. The chance that the play exists is the chance that there is at least 1 field of at least the minimum size assessed. The final assessment curves, developed by Monte Carlo simulation, portray exceedance probability vs. the range of possible recoverable hydrocarbon potential.

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Production Graphics and Forecast and Evaluation Systems

The production graphics system (PGS) stores historical oil, water, and gas production data, plots these on a screen, automatically fits exponential and/or hyperbolic decline curves to the data, allows the user to alter these curves interactively, and allows transfer of the resulting decline curve information to the property record data base of the forecasting and evaluation system (FES).

The FES maintains a lease or well data base, and uses information on producing rates and prices to calculate before-tax and after-tax economics for oil and gas properties. Both PGS and FES are managed by a color-enhanced, screen-oriented facility, for entering and reviewing pertinent data.

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Geophysical Exploration in Brazilian Continental Margin: History and State of the Art

Geophysical exploration by PETROBRAS started in 1954 in the onshore basins and in 1968 in the offshore basins of the Brazilian continental margin. The major problems that these basins share are: (1) short-range lateral velocity variations; (2) poor seismic data quality in many areas, especially on land, and (3) small traps with some degree of stratigraphic control.

In the search for the solution to these problems, the best techniques available have been tried. CDP was introduced in the early 1960s; digital recording and processing in 1968; bright-spot methodology in 1973; trace inversion in 1976; 3-D migration in 1978; and image-ray depth migration in 1981.

Facilities for computer-generated display for geophysical interpretation were made available in the early 1970s. Presently, an interactive interpretation mapping system with graphic stations is in use.

Examples of techniques applied to exploration and field development activities include time-to-depth conversion, generation of seismic synthetic logs, and porosity prediction.

Geophysics plays an important role in the exploration of the Brazilian continental margin, where recoverable volumes of oil have increased in onshore basins from 86.342 million BOE in 1954 to 2,132.81 million BOE in June 1983, and in offshore basins from 0.069 million BOE in 1968 to 1,626.73 million BOE in June, 1983. These volumes correspond to 246 bbl onshore and 520 bbl offshore per drilled meter for the same periods.

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Thermal Stabilization of Kerogen Maturation Over a Finite Reaction Duration

If a first order reaction can be assumed for kerogen maturation during burial diagenesis, then its reaction rate constant is $k = -\ln(f)/t$, where f is the fraction of kerogen transformable to hydrocarbon remaining after some functional reaction duration, t. The fraction of reactive kerogen is estimated from Tissot and Espitalie's model of vitrinite reflectance (R_o) evolution. A method for calculating the functional reaction duration is suggested by kerogen maturation experiments that show hydrocarbon generation proceeds by concurrent reactions with successively higher activation energies (E_a), which at a given temperature: (1) are already complete and not generating products; (2) are generating significant products; or (3) are slow and will not generate significant products in geologic time. The general correlation of R_o with maximum temperature suggests that at a given temperature, only a limited suite of reactions control hydrocarbon generation, and increased time at that temperature will not make the slower (high E_a) reactions geologically significant. Thus, the functional reaction duration cannot exceed the time necessary for the controlling reactions to essentially complete hydrocarbon generation (to the 99% level). Geologic field data, and kerogen maturation experiments extrapolated to geologic time and temperature ranges, suggest this occurs in 10^6-10^7 years.

When plotted on an Arrhenius diagram (ln k versus 1/T), reaction rate constants calculated for 80 cases of kerogen maturation at maximum temperature show a strong linear relationship ($r = 0.77$). The pseudo E_a of the overall kerogen maturation reaction is about 9 kcal/mole, and its frequency factor is 10^{11} sec^{-1}. This curve provides a method of assessing maximum paleotemperature from R_o if the kerogen has had sufficient time to stabilize.

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Distribution of Oil and Gas on Active Continental Margins

Accumulation of oil and gas in an area depends on amount and type of organic matter, adequate temperatures for generation, suitable trapping configuration, and correct timing of events. All these factors can vary considerably across active margins of both island arc and continental (Andean) type.

Forearc areas are characterized by low geothermal gradient owing to subduction, poor reservoirs derived from volcaniclastics, and relatively low organic carbon content. Although tectonic complexity may offer a wide variety of trapping configurations, overall petroleum potential is low. Gas is present in some commercial (and many noncommercial) accumulations and is in part biogenic. What little oil is present is usually paraffinic with a low sulfur content ($\approx 0.1\%$) and an API gravity in the range 30°-35°. These facts suggest a major role for land-derived organic matter, an idea supported by the available geochemical data.

Back arc areas are characterized by higher geothermal gradients and

larger basins. These may show evidence of extension with the development of organic-rich lakes or marine embayments in the downthrown area. Here source rocks are shales with above average organic carbon content. They have generated high pour-point waxy crude oils with low sulfur content and API gravities around 35°. Again, these characteristics suggest an important role for land-derived organic materials and this is supported by geochemical data for biomarker distributions, pristane/phytane ratios, etc. The simpler structural setting in back arc basins favors the development of larger fields, and several giants occur in this setting, for example, Minas in Sumatra.

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Seabed Morphology of George V Continental Shelf, Antarctica

Seabed processes at high latitudes are known to involve ice and ice-related processes. Antarctic sedimentologic studies have outlined the glacial domination of major modern sedimentary processes and topographic features of the Antarctic shelf. The troughs, basins, and shoals of the shelf exhibit glacial and slump deposits, turbidites, and preglacial outcrops. The bed forms associated with the glacial and ice-related processes, as well as with the slumping and current-related processes, have not yet been defined. This study investigates the smaller scale bed forms and their relation to seabed processes.

The outcome of a cruise during January 1984 to the George V continental shelf is expected to show the major influence of icebergs in determining the modern morphology of the shoals and bank tops. The bed forms related to grounding of such iceblocks will help define the nature of ice/sea-floor interactions. We postulate that significant oceanic energy is expended on the sea floor through grounding of ice on the banks during the winter when wave and current activity under the ice is minimized. The depth of these shoals may be controlled in part by the maximum dominant keel depths of the ice shelf and of glacially calved iceblocks. On the basin slopes and floors, glacial, mass-failure, and current-related morphologies are expected to dominate.

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Trapper Canyon Tar Sand Deposit Revisited

In 1981, the Trapper Canyon tar sand deposit, Big Horn basin, Wyoming, was selected for investigation by the Bureau of Land Management (BLM) because the deposit was threatened by immediate trespass. The purpose of the investigation was to resolve conflicts between mining and leasing interests and to pave the way for commercialization of the deposit. The Combined Hydrocarbon Leasing Act of 1981 was of little use in the immediate development of the deposit; it did not "grandfather in" existing oil and gas leases. Conditions governing development of the deposit were a 1965 Interior Department Solicitor's opinion based on the 1960 amendments to the Mineral Leasing Act of 1920, as reinterpreted by the BLM. The lessee must demonstrate that hydrocarbons can flow "naturally" by primary or secondary methods; tertiary recovery methods, are specifically excluded.

This administrative position has resulted in several expensive recovery projects for a relatively uncomplicated deposit.

There is no question that hydrocarbons underlie the area and that the most economical method of developing them would be to mine rather than pump the reservoir. There are serious questions as to whether the hydrocarbons of this deposit (2-5° API, 30,000 cp) can be induced to flow naturally. A water-injection, reverse circulation test was conducted on the Tensleep Sandstone reservoir of Pennsylvanian age in June 1983. Hydrocarbons were recovered at injection water temperature of 160-165° F (71-74°C) but not at the lower temperatures (reservoir temperature of 50-60°F, 10-16°C) requisite under the governing interpretation. The lessee has been authorized by the BLM to conduct an additional recovery project, injecting propane at reservoir temperature. On April 1, 1984, the lease expires automatically returning the Trapper Canyon deposit to the simultaneous oil and gas system or the competitive lease system.

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Macroborings and Epizoans on Late Cretaceous Rudists from West Coast Active-Margin Environments

Rudists are a major component of Cretaceous carbonate strata. Studies of rudists from these strata have demonstrated that epizoans are sparse but macroborings are relatively common. Previous studies have not been made of macroborings and epizoans on rudists from nearshore, clastic, active-margin environments.

Beds of the Rosario Formation lower sandstone containing the late Campanian rudist *Coralliochama orcutti* crop out along the northern coast of Punta Banda on the Pacific coast of Baja California, Mexico. Serial sections of rudist skeletons from this area show that borings include *Entobia* and varying forms of *Trypanites,* while epizoans include serpulid worms, the bivalve *Acila* and juvenile *Coralliochama.* Macroborings occur on 30% of examined specimens, primarily on the upper portion of the attached valve and on the free valve, while epizoans are found on 10% of examined specimens, typically from the middle third to the commissure of the attached valve and on the free valve. Only a small portion of the skeleton may be covered by epizoans, and some boring and encrusting appears to have occurred during life. Inhibition by rudists of epizonas, a concept proposed by Kauffman and Sohl, probably was not as effective in *Coralliochama* as in rudists from Antillean reefs. In addition, *Coralliochama* appears to be more heavily bored than Antillean reef rudists.

These results aid in understanding the broad environmental range of Late Cretaceous rudists and the adaptive response to this range. Rudists of clastic environments may have been more susceptible to boring and encrustation than those from reef associations.

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Dolomitization Stages in a Regressive Sequence of Hunton Group, Anadarko Basin, Oklahoma

The Upper Silurian Henryhouse Formation, of the Hunton Group (Upper Ordovician–Lower Devonian), is a major hydrocarbon reservoir in the Anadarko basin. Detailed examination of Henryhouse cores were conducted at many localities in the basin, west of T10 W. Sedimentary structures, lithology, fossil content, and fabric relationships were used as criteria to recognize various depositional facies. Subtidal, intertidal, and supratidal facies can be distinguished readily, and their spatial relationships consistently indicate a shallowing-upward sequence. Previously unreported nodular anhydrite (replaced and unreplaced) occurs at the top of the sequence, suggesting that hypersaline conditions developed in supratidal environments.

Three stages of dolomitization were documented in the Henryhouse Formation. Petrographic, cathodoluminescent, and isotopic techniques were used to investigate the genesis and textural relationships of various dolomite types. The following paragenetic sequence was discerned: (1) penecontemporaneous hypersaline dolomite occurring as brownish, hypidiotopic, 60-80 μm rhombs concentrated in the supratidal and intertidal facies; (2) marine water–fresh water mixing dolomite occurring as white rims around preexisting hypersaline dolomite and as anhedral, white rhombs in vugs and molds; (3) deep burial vug, mold, and fracture-filling baroque dolomite.

Cathodoluminescence reveals that typical Henryhouse dolomite exhibits dully luminescing cores with outer bright rims corresponding to the dark core and light rim seen in plane light. This zonation represents two stages of dolomitization.

Oxygen isotope ratios range from -2.2 to -9.9 (mean -4.6) ‰ vs. PDB, whereas the carbon isotope ratios range from 0 to +3.3 (mean + 1.4) ‰ vs. PDB. The considerably light $\delta^{18}O$ reflects a fresh water influence. Values of $\delta^{13}C$ may represent initial composition because of their resistance to alteration.