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An Extended Example of Microcomputer-Aided Interpretation

Computers are useful to the explorationist not only because they can easily perform computations too lengthy to be performed routinely "by hand" (e.g., forming a synthetic seismic section for a moderately complex earth model), but also because they can reduce the tedium, time, and error rate of tasks the interpreter now performs (e.g., interpolating and rescaling displays). This paper presents a single example of computer-aided interpretation that illustrates the versatility, speed, and operational simplicity of a stand-alone microcomputer work station. Seiscom Delta's "Microseis" system performs various tasks required to go from a seismic time section to a final depth map.

The system permits picking the section at irregular intervals; thus the user can space data points widely in uninteresting areas, and closely in complex areas. Comments, for example, noting surface features or subtle changes in the character of data, can be entered along with numeric data. The data need not be seismic; the system works equally well with well depths, geochemical data, and radiometric readings. Line tying, isovalue generation, and conversion routines can be used for both seismic and nonseismic data. Data can be entered from displays having various scales and can be easily corrected or supplemented. The user has a wide variety of display options in data selection and format, display scales, and presence of supplemental information.

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Order and Randomness in Sedimentary Sequences

Sedimentary sequences show statistical evidence of dependence between successive lithologies; no truly random sequence has been reported. Explicit, although idealized, models were examined to determine the sensitivity of chi-squared tests to both random and dependent components of a depositional system. A series of simple models with the following characteristics were tested.

P is the probability of transiting from one state to the next in an ideal system, q is the probability of returning (feedback) to an initiating state, and r is the probability of a random transition to any state (including that just exited). $P + q + r = 1.0$. While varying P, q, and r, I simulated the performance of the system and tested the resulting frequency matrix against random models. P, that part attributed to a "cyclic" process, can be very small (about 0.1 or 0.2) and still result in significant differences from the random model. Even small contributions from a dependent process, superimposed on a largely random process, can cause the appearance of great order.

Permian Salado Formation beds exhibit values for P in the general range of 0.1-0.3 and, both visually and statistically, attain considerable order.

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Should a Microcomputer Be Used to Make a Geologic Contour Map?

Four hurdles common to successful computer contouring of geologic data are: (1) gathering and entering the data, (2) retrieving and correcting it, (3) properly interpreting the computer-contoured surface, and (4) biasing the control on the contoured surface to support a working hypotheses. An interactive microcomputer system is used to solve these 4 problems; in this presentation, the various components of this system are illustrated by a series of pictorial or schematic diagrams.

Well data from scout tickets are entered by use of a full cathode ray tube (CRT) screen. Prompting is provided for entry of well location or x-y status, elevation, total depth, and stratigraphic correlations—the measured depths of a predetermined series of formation tops. The system provides the option of entering initial production (IP) data or shows of oil and/or gas for each formation of interest. All data may be corrected and fine-tuned by the use of the full screen editor.

Contoured surfaces or isopachs are generated from the system's data base, and may be either displayed on the CRT screen or plotted as a map on appropriate plotter equipment. Automatic background section lines for reference are a significant feature of this system.

Fault traces with fault throws are also entered on the CRT map data. Direction of trend of the contours and rate of dip can be further controlled by entry of dip and strike data. The interactive analysis and utilization of all this information allow a rapid geologic interpretation of an area. The completed microcomputer-generated map may be adequate for a final map or may be used as a work map and guide for manual contouring that best fits an interpretation of the geologic features in the area.

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Application of Computer-Processed Well Log Data for Geologic Evaluation of Green River Basin, Wyoming

As part of ongoing regional evaluation of tight gas sand resources, computer processing of well log data was used as a tool for revealing gross trends in stratigraphic and diagenetic characteristics. Log data for 20 wells in the northern Green River basin were processed using a DEC LSI-11/23 microprocessor.

The processing technique involved the application of single or multiple logic tests for lithology discrimination and elimination of "bad hole" data. Resulting data for the entire length of the well are plotted vs. depth as x-y plots, thereby displaying large-scale trends that may be present. Cross sections constructed using these crossplots aid in regional evaluation.

This technique has proven to be particularly useful for identifying the regional Cretaceous-Tertiary unconformity, which in many wells shows up as a dramatic shift in gamma-ray response across the boundary from low (Cretaceous) to high (Tertiary). Possible zones of overpressuring are identified by means of shale conductivity crossplots. Porosity reduction trends as well as gas zones are revealed through plots of sandstone sonic travel time.

The primary advantages of this method are that it (1) reduces the sampling bias that can occur with manual plotting and reduces the sensitivity of data trends to discriminator values due the large sample population; (2) reveals data trends that may not be apparent from viewing analog well log prints or that may be masked by the log response due to the presence of other lithologic characteristics; and (3) provides additional insight into problems related to stratigraphy, overpressuring, and porosity, for which other kinds of data are incomplete or absent.

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Selected Upper Cretaceous and Paleocene Reservoirs in Hanna Basin, Carbon County, Wyoming

The central Hanna basin offers multiple hydrocarbon targets in the Mesaverde Group (Campanian Stage), Lewis, Medicine Bow, and Ferris formations (Upper Campanian, Maestrichtian, and Danian Stages). Reservoirs within these formations are found in siltstone, sandstone, coal, and lignitic facies. Permeability is associated with intergranular porosity, microporosity in clays, cleating in coal and lignite, and fracture fields which may be independent of stratigraphic boundaries.

The quality of reservoirs, as determined by logs, is similar to known gas and condensate producing areas of the Red Desert, Washakie, and Wind River basins, in Mesaverde, Lewis, and Medicine Bow (Lance) formations.

Mature oil source is indicated in Medicine Bow and Ferris transitional marine and lacustrine facies (Lance and Fort Union time equivalents). Oil source and sandstone depositional style may be similar to oil productive Fort Union strata in the Wind River and southern Powder River basins.

Source rock studies and time vs. temperature relationships of the Upper Cretaceous lithologic package suggest an area of over 250 mi^2 (650 km^2) prospective for "tight sands" gas in Mesaverde and Lewis formations to 15,000 ft (4,570 m) and deeper. Lithologic studies of clay and matrix chemistry suggest that specific drilling and treatment fluids are necessary to minimize damage and achieve commercial recovery of gas and condensate.

Recent drilling and modern logging in the Seminoe Unit, T24N, R83-84W, have revealed anomalous gas saturation in Lewis and Mesaverde reservoirs. Numerous reservoirs containing hydrocarbons in the Upper Cretaceous section remain to be evaluated, and the volume of hydrocarbons to be recovered provides reason to proceed.