The application of software centers around a unified data management system and is extremely menu oriented, allowing easy use by personnel unfamiliar with computers. Applications software serves to assist in data acquisition, quality control, and computation for both seismic processing and interpretation. These applications include handling of such data as geometry, velocities, and muting, as well as geologic applications such as digitizing horizons, storing and plotting regional data, and digitizing and processing well log data.

HODGSON, ROBERT N., GeoQuest International, Inc., Houston, TX

Future Interpretive Techniques

Over the next few years, interpretive techniques in petroleum exploration will be affected considerably by online graphic methods. A major trend has already started in this area as the industry strives to bring both exploration data bases and applications to the interpretive level. Much of the current work involves the conversion of existing batch applications to online graphic mode, for use in geoseismic modeling, base map generation, mapping and contouring, and selected forms of seismic data analysis.

In the future, it is expected that many new applications will be implemented that greatly expand the interpretive capability of the geologist and geophysicist. Such areas as seismic inversion, migration, well log/seismic trace correlation, seismic stratigraphy, and data integration are all receiving attention and considerable R and D effort.

To implement future systems in these and related areas will require considerable effort in regard to data base and system design, graphic interfaces, and user communications and training.

KLAHN, LOUIS J., JR., Compudyne, Inc., Denver, CO, and JOHN H. DOVETON, Kansas Geol. Survey, Lawrence, KS

Use of Interactive Computer Graphics to Solve Complex Geological Problems—A Case Study

The exact role of the computer in the fields of geology and well log analysis has been the subject of some controversy and a lot of confusion. The computer, when properly implemented and programmed, can assume a different role—that of an analysis partner. In this approach, the user must be able to communicate both freely and naturally with the computer—and vice versa; i.e., the system must be truly interactive. Another key element is graphics, since the geologist's world is usually described using maps, graphs, diagrams, charts, logs, etc. An interactive graphics system has been used to analyze several formations in various parts of the world. The main portion of this paper uses some of these analyses in a "case study" approach to help describe the techniques.

Most of the analyses involve interactive log analysis. The logs were first subjected to a conventional analysis using the computer to help speed up the mathematical computations. The computer also generated all data listings, graphs, plotbacks, and crossplots during this phase.

The next phase was an in-depth detailed analysis to discover more about the key characteristics of the formation. Most of these algorithms are beyond the capability of a handheld calculator, but the interactive nature of the system makes the techniques very easy to use. In addition, several separate models for each well were generated and the results compared statistically in a short span of time.

Results from several formations, including the Mancos "B" in western Colorado, are presented in detail to illustrate the advantage of the use of interactive graphics software. In each formation, an unusual geologic problem was investigated and solved. All formations were determined to be hydrocarbon bearing, and the various zones were identified and analyzed. (The Mancos B is especially interesting in that it is recognized as a tight formation that has resisted some of the more conventional analytic approaches.)

The degree of success achieved in solving these problems indicates that the use of an interactive computer system in this manner is not only valid, but merits more widespread application.

MASLYN, R. MARK, Consultant, Golden, CO

Petroleum Exploration—Real World Examples Using Microcomputers

Several aspects of petroleum exploration are concerned with numerical values, such as the structural elevation of a given formation, net sand thicknesses, water saturations, or interval velocities. Microcomputers provide an interactive way for a geologist or geophysicist to generate on-demand, exploration related values, maps, or other output.

Geologic examples include the use of best-fit trend surfaces for exploration in the Cretaceous of the Denver basin and the use of double Fourier series to model oil-productive paleotopography in the eastern Powder River basin of Wyoming.

Geophysicists are more accustomed to mathematical treatment of their data. In the Michigan basin exploration area, a microcomputer is being used to generate synthetic seismograms from sonic log data. These are then used to model seismic response for differing stratigraphic conditions. Data from the coastal plain area of Alaska have also been input to a microcomputer which then computes and plots several parameters including time, depth, average velocity, and interval velocity as well as subcropping and onlapping intervals at unconformities.

As a result of their versatility, on-demand accessibility, and relative computing power at a small price, microcomputers are being used in expanding applications in petroleum exploration.

MASLYN, R. MARK, Consultant, Golden, CO

Computer Modeling of Minnelusa Formation (Pennsylvanian-Permian) Paleotopography in Eastern Powder River Basin, Wyoming

The great majority of Minnelusa Formation (Pennsylvanian-Permian) oil production in the eastern Powder River basin is derived from various types of stratigraphic traps which resulted from paleotopographic relief developed on the upper Minnelusa. This relief is mirrored by thickness variations in the overlying Opeche Shale (Permian). Construction of isopachous maps of the Opeche is one of the methods used to explore for paleotopographic traps in the Minnelusa.

Hand-contoured Opeche isopachous maps may be subject to ambiguous interpretations in areas where the data points are scattered or nonexistent. This difficulty is partially overcome when the isopachous map is produced by mathematical methods.

The upper Minnelusa paleotopography is believed by the author to reflect eolian sand dunes encased by the red shale of the Opeche. Observations from oil tests in the area indicates that this paleotopography has a cyclicity, with a crest wavelength of approximately 3 mi (5 km). Double Fourier transforms are most appropriately used in modeling where such a cyclicity exists.

The resulting double Fourier transform-generated computer model of the upper Minnelusa paleotopography shows a good correlation between the observed data points and the calculated best-fit surface. Additionally, the computer generated surface suggests areas away from present production and drilling which may warrant further exploration.

The computer generated surface data must, however, be integrated with other known geologic data and examined closely in areas where the control point spacing exceeds either the x or y direction fundamental wavelengths.

MCCALLUM, ROBERT, Arco Oil and Gas Co., Dallas, TX, and DOUGLAS L. BREMNER, Arco Exploration Co., Denver, CO

Distributed Exploration Data Processing

Distributed Data Processing is becoming an increasingly significant part of the petroleum explorationist's computing environment. At Arco, hardware, software, and personnel of both central and remote computing sites have been linked to establish a computing resource network.

By separating those network components which can be practically and economically implemented at remote computing centers from those more suited to a central site, the explorationist is being given immediate local access to a great deal more computing resources. Because of this distribution of computing resources, considerable gains have been realized by the exploration community in terms of increased exploration efficiency, improved information transfer, and greater technical integrity.

This paper describes Arco's Computing Resource Network, some of its more elaborate capabilities, some of the currently active distributed applications, and some of the reasons for its success in an exploration environment.

ORTEL, WALTER H., Consultant, Marble Falls, TX

Oil and Gas Exploration Using a Microcomputer

A contouring program has been developed in Pascal for the Apple II computer using irregularly spaced data. The program plots contours and data points on the CRT and dumps the resulting map with headings on a 440 IDS printer. The contouring package is the main program of a larger system being developed to explore for oil in mature areas. The package will include a file management program for well data files, trend surface and residual surface mapping, log evaluation and mapping of log parameters, and a program to evaluate drilling deals using probabilities.

PARADIS, ARTHUR R., and JEFFREY W. SCHWALM, Dynamic Graphics, Inc., Berkeley, CA

Interactive Surface Modeling and Display for Oil Industry

As the cost of data acquisition increases, there is a corresponding increasing need to maximize the usefulness of the data at hand and to find quick cost-effective methods of data analysis.

Computers and computer graphics techniques have been used effectively to display and help analyze geophysical data. The characteristics of such data analysis (to date) are typically (1) mountains of data (i.e., numbers), and (2) little control from the user during the analysis process.

Analysis of geologic data by computer has been less successful owing to the data's qualitative nature (i.e., location of formation or geologic, province, the existence or absence of a particular rock type, etc). Here, not only is the amount of data orders of magnitude less (typically), but the data often do not have the same kind of precision as its geophysical counterpart. Further, the automatic analysis of geologic data needs a fair amount of guidance from the geologist who is familiar with the region.

Interactive computing and interactive computer graphics allow the user to see results more quickly and help to involve him in the analysis process. A methodology involving this technology is presented which will take advantage of the qualitative nature of geological data and the quantitative nature of geophysical data. This technique will allow the user to combine, correlate, modify, display, and analyze both kinds of data together.

Through such analysis of both geologic and geophysical data for both known and prospective sites, decisions can be made as to where to look for oil, or, at least, where to look for data which will, in turn, indicate where to look for oil.

PAYNE, THOMAS G., U.S. Geol. Survey, Fort Collins, CO

Use of Apple II in Mapping Geology of Coastal Plain of NPR Alaska

REGIONAL MAPPER is a menu-driven system in BASIC for computing and plotting (1) time, depth, and average velocity to geologic horizons; (2) interval time, thickness, and interval velocity of formations; and (3) subcropping and onlapping intervals at unconformities. The system consists of FILER, TRAVERSER, REFILER, and PLOTTER. A control point (sequential file) is a shot point with velocity analysis or a well with velocity check shot survey. Reflection time to and code number of seismic horizons are filed by digitizing table from record sections. TRAVERSER starts at a point of geologic control and, in traversing to another, parallels seismic events, records loss of horizons by onlap and truncation, and stores reflection time for geologic horizons at traversed points. REFILER reads sequential files and writes a random-access file for PLOTTER.

Permafrost and buried canyons cause velocity anomalies that complicate depth mapping. At a control point, depth (Z) is from seismically derived velocity (Z_S) and from velocity interpolated between wells (Z_W). The depth difference (D) has a non-random component (D_{nr}) and an areally random component (D_r). A plot of D for a base horizon below the velocity anomalies is contoured with smoothing to form a D_{nr} surface showing the effect of permafrost and paleocanyons. Estimated depth to base horizon is the sum of Z_W and D_{nr}. For deeper horizons, depth is that of the base horizon plus a thickness derived by the "layer cake" method.

ROBERTSON, JOHN, IMB Corp., Houston, TX

Trends in Graphics and Graphics Technology

Graphics technology has been evolving for at least 15 years. There have been false starts and diverse paths that have been followed. Now, however, the present state of technology and