pretation. It incorporates the inference and knowledge of human dipmeter experts. The first prototype system, which was completed in December 1980, consisted of interpretation in marine environments, but recently the system has been extended to continental and transitional environments as well.

The Dipmeter Advisor system has a highly interactive graphics user interface. During the interpretation, the user has access to the arrow plot data and other related well data through a graphics display screen. The interpretation is made in a sequence of passes over the data, each pass arriving at some conclusions based on user input, combined with applications of the rules of dipmeter interpretation and of pattern recognition algorithms in previous passes. The partial results are displayed on the graphics screen for user verification and the user can, with graphics interaction devices, make any additions, deletions, and modifications of the results in each pass. The final output of the system consists of a log annotated much in the same way as dipmeter logs are currently annotated by human experts.

Several aspects of the Dipmeter Advisor system will be described: the system organization, the graphics interface, and the general form of the rules and the inference structure. The operation of the Dipmeter Advisor system will be demonstrated with an example of dipmeter interpretation.

CRANE, DAVID C., Consultant, Dallas, TX

Microcomputers in Exploration—A Survey

The author has contacted about 50 geoscientists who are using "personal" microcomputers (micros) in their profession. They include respondents to notes in the *AAPG Explorer*, people referred by members of the AAPG Committee on Computer Applications to Geology, and numerous other members of the AAPG and SEG whose assistance is gratefully acknowledged.

Microcomputers have been widely available for only about five years. Software sophisticated enough to realize their potential has been slow to appear, but a surprising number of geoscientists, including independents and consultants, now wonder how they ever survived without computers. Reported applications areas range from word-processing, production accounting, and financial analysis of prospects to log analysis and creation of synthetic seismograms. System costs range from under $2,000 to over $30,000 *plus* software.

Explorationists involved in the rapidly growing use of micros are invited to submit their names, addresses, applications, system descriptions, and interests to the Committee on Computer Applications to Geology for inclusion in the next survey mailing. The first survey and mailing list are being made available as part of this paper.

DOWNING, JAMES A., ZYCOR, Inc., Austin, TX

Interactive Gridding

Gridding of geologic or geophysical data is at the foundation of most computerized mapping and modeling operations. Surface display techniques such as contouring, fish-net isometrics, and cross sections are usually derived from gridded surface models. Processing and analysis techniques such as surface filtering, trend analysis, Fourier transforms, and simple algebraic combinations of surfaces use gridded models in intermediate steps.

A combination of conventional gridding techniques with interactive control for manual interpretation of data hold the potential for dramatically improving results and expanding acceptance of the technology. Several conventional algorithms are reviewed and two new gridding techniques are introduced. Procedures for interactively controlling gridding techniques and adapting the techniques to respond to manual interpretations of the data will be discussed. Also, procedures for intractively adjusting gridded surfaces to conform to manually input contour curves will be described and demonstrated.

DUDA, RICHARD, Fairchild Laboratory for Artificial Intelligence, Palo Alto, CA

An Overview of Rule-Based Expert Systems

One of the more successful applications of artificial intelligence techniques has been the development of programs that have come to be known as rule-based expert systems. These programs encode knowledge about specialized problem areas in the form of sets of if-then rules, typically obtained by interviewing people who are specialists or experts in those problems. The rules can then be used by the program to solve similar problems. The modular structure that results allows incremental development, leading to performance that continually improves as the rule base is expanded.

Most of the rule-based expert systems that have been developed to date have been designed for problems in medical diagnoses. However, among several efforts that are relevant to the petroleum industry, a program called Prospector has been developed for the U.S. Geological Survey for certain problems in hard-rock mineral exploration, and a program called the Dipmeter Adviser has been developed by Schlumberger for the geological interpretation of dipmeter data. This presentation will describe the basic principles behind all such systems and will summarize the current state of the art.

DUPREE, R. L., Amoco Production Co., Tulsa, OK

Highly Interactive Contouring Systems

Computer contour systems are intended to aid in the interpretation of geologic data as well as to prepare drafted quality displays. To accomplish this, completely automated (batch) contour systems require complex algorithms and a significant amount of computer resources. Multiple submissions are also usually required to obtain a finished display.

A highly interactive contour system, however, relies much more heavily on the interpreters and the graphical functions of an automated drafting system to prepare a finished display. This approach uses simpler algorithms, less computer resource, and more interpretative interaction from the end user. Examples of the two approaches include the use of color schemes for displaying results.

HILDEBRAND, H. A., CYBERAN Corp., Houston, TX

A Microcomputer Workstation for Interactive Geology and Geophysics

The capabilities of a new microcomputer system are reviewed. This system allows easy data management for both geologists and processing geophysicists. Currently available peripherals include a digitizer, pen plotter, raster graphics printer, and graphics video. Communications allow hardwired or modern access to other computers.

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