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

the support systems in place with the technology make it abundantly clear that graphics has arrived as a prime tool for the explorationist.

Today we will examine factors associated with the use of graphics and graphics technology. First, we will review the technology evolving in computer graphics and comment on what impact and value technology has on the graphics products of today and what future trends can be projected. Second, we will discuss the techniques and philosophy of the software support systems. We will look at some of the earlier frustrations of graphics systems and examine the easier-to-use systems available today. Third, we will examine some of the economics associated with graphics systems and discuss trade-offs and alternatives available to the industry. Fourth, we will discuss some of the personal and personnel factors associated with the use of graphics and graphics technology.

The summary will bring together the four points mentioned above to show that it has taken an evolution and a change in all of these factors to provide the current environment where graphics can provide a really productive tool for the progressive explorationist.

ROSS, CHARLES G., Kansas Geol. Survey, Lawrence, KS

GIMMAP—An Interactive Computer Cartography System

Computer-produced contour maps with postings of data points and optional perspective views for surface representation are widely recognized as valuable tools in oil exploration, seismic studies, ground-water modeling, and other geologic applications. Few, in any, of the myriad contouring packages are designed to provide an accurate background of cartographic information to help the scientist, engineer, or politician relate contoured information to the real world of political boundaries, highways, and river beds. Additionally, there is much information of interest (e.g., geologic contacts) which cannot be contoured, but which must be treated as pure cartographic information. The GIMMAP (Geodata Interactive Management Map Analysis and Production) system, developed jointly by the Kansas Geological Survey and the Bureau de Recherches Geologiques et Minieres (France), is being used to produce such background maps as well as traditional multicolor geologic maps. The U.S. Geological Survey 7.5-minute topographic series is used as the primary input source for construction of a cartographic data base consisting of political boundaries, surface hydrology, the transportation network, and U.S. Land Survey information (township-range-section). Additional features may be digitized or projected from latitude-longitude coordinates as required for special projects. GIMMAP employs interactive techniques to assist graphical editing of linework; relative definition, editing, and coloring of areal features; placement and editing of symbology; and versatile, user-specified retrieval for producing plots or high-quality scribes for color separation. The modular FORTRAN package relies on physical and logical data segmentation and extensive use of random-access files to operate on a (64 K byte) minicomputer.

SCHETTER, W. C., and R. A. BASSE, Exxon Co., USA, Denver, CO

Normalization of Well Log Data for Regional Stratigraphic Analysis

The normalization of well logs is a recognized technique for the removal of instrument and sensitivity errors. This paper describes a project which used logs from 240 wells that penetrated Upper Cretaceous rocks in the Powder River basin of Wyoming. Normalization of the gamma ray, density, and conductivity curves was accomplished by adjusting each curve to a trend surface for the project area. Examples before and after normalization will be shown and alternate methods are discussed. Processing and problems, data flow, and tabular results of discriminant analysis of the normalized log digits are discussed. The discriminant analysis relates to the evaluation of geologic models established for the Sussex and Shannon formations.

SPERLING, TEDD F., Consultant, Lansing, MI

Seismic Modeling with an Apple

Seismic stratigraphy is one of the most fascinating and complex aspects of geoscience. The complexity arises from the profound formulas and numerous variables used to model earth algorithms. In this aspect the microcomputer, when equipped with appropriate seismic modeling software, has proven itself, in the Michigan basin, as an extremely useful tool to discern and depict seismic response.

STARK, P. H., JIM FITZGERALD, and LARRY WILCOX, Petroleum Information Corp., Denver, CO

Interactive Synthesis of Geological Data for Exploration in Frontier Provinces

The successful integration of interactive graphics systems with data base management and application systems is a major challenge for the 1980s. In the past ten years, developers of computer systems have introduced stand alone systems for seismic processing, petrophysical analysis, and interactive drafting/mapping and graphic display systems. Separate data base management systems with applications for large industry files such as well and production data have evolved. The integration of multiple large data files with user friendly data base management systems has received great attention, but has not been solved. The challenge can be met through the cooperative effort of data base specialists, interactive graphics specialists, and users.

This paper describes a data management system that was developed to provide interactive applications using geological and geophysical data to evaluate the National Petroleum Reserve, Alaska. The system permits interactive online retrieval from multiple data files and interface to application programs that feature graphic displays. Examples show the results of integrating multiple data files with graphics output. Included are: (1) seismic combined with well data and digital base map for subsurface geological mapping; (2) geochemistry combined with bore hole logs, a stratigraphic section, and lithology; and (3) paleontology combined with lithology and a stratigraphic section.

The system also accommodates other geological data such as surface geology and petrographic analysis. This system supports the user by featuring geological data management and applications with graphic displays using electrostatic plotters. The user will be additionally rewarded when this capability is merged with interactive CRT graphics systems.