Accumulation generally is considered to be controlled by structure. However, the oil-to-structure relationship is difficult to discern in the original structure contour maps. Evaluation of the geologic maps can be aided by the application of computer enhancement techniques that display the component structures without the distorting effect of regional trends and conflicting small-scale features. A variety of computer techniques display potential prospects, and statistical tests are necessary to determine the optimum enhancement technique for each area. Spatial filtering of the Graham County maps indicates there is better than a 98% probability that the oil is pooled structurally and that the optimum filter displays features with untested locations that have a better than 40% chance of success.

SALGAT, BRENT, R. J. Walker Oil Co., Inc., Oklahoma City, OK

Scully Field—Marion County, Kansas

The Scully field is a multipay new-field discovery located in the southern end of Salina basin, Marion County, Kansas. Since discovery in November of 1981, R. J. Walker Oil Co., Inc., has drilled and completed successfully 15 wells within the field. Productive depths are < 3,300 ft (1,000 m) and production capabilities of individual wells can exceed 300 bbl of oil/day (24 hr gauges). Oil is trapped structurally within the Viola and Simpson units (Ordovician) and trapped by a combination of erosional truncation and structure in the Mississippian units.

The Scully field was discovered using a combination of satellite imagery and subsurface control. Structural lineaments recognized from satellite imagery in conjunction with an understanding of the structural timing and framework of the Salina basin enabled the definition of the structural unit which contains the Scully field. Subsurface control prior to discovery, although relatively sparse, was sufficient in light of these structural elements to define the prospective area of the Scully structure. Subsequent drilling has not altered significantly the potentially productive area.

The overall trapping mechanism at the Scully field is anticlinal closure. Infield drilling has demonstrated, however, that significant stratigraphic variations do exist within the productive area. The stratigraphic variations within the Ordovician reservoirs are controlled strongly by paleostructure.

The Simpson sands have been subdivided in five separate units which range from 4 to 12 ft (1 to 4 m) in thickness. Three of these are of economic importance in the field. In general, the sands with the most economic potential are distributed within relative Ordovician paleolows. Core analysis demonstrates that pay intervals have porosities of 14 to 18% and permeabilities of 200 to 500 md (air) (Whole Core Dean-Stark Analysis).

The Viola has four main lithologic divisions. The uppermost of these is a relatively thin dolomite cap which ranges from 2 to 15 ft (1 to 5 m). This upper dolomite is the primary Viola pay zone. Core analysis indicates that this interval has porosities of 6 to 12% and permeabilities of 30 to 140 md (air) (Whole Core Dean-Stark Analysis). In general, this dolomite is best developed on the Ordovician paleohighs.

The Mississippian section is eroded deeply over the Scully structure and demonstrates about 70 ft (20 m) of thinning. The potential pay interval is chert which has 25 to 30% porosity based on log analysis. The pay interval is absent over the portion of the field that is highest on present-day structure at the Ordovician level. The trapping mechanism is a combination of erosional truncation and structural closure.

In addition to the structural information obtained from satellite imagery, R. J. Walker Oil Co., Inc., evaluated the hydrocarbon potential of T18S, R1E, Marion County, Kansas, which contains the Scully field, using remote sensing technology developed by Earth Reference Systems of Long Beach, California. The technology involves direct detection of hydrocarbons in place, using satellite data, nonlinear mathematics, and the fundamental principles of molecular structure and electromagnetic wave propagation. This analysis was made several months after the discovery well had been drilled in the Scully field. The conformance of these data within the structural and geologic confines of the Scully field after 14 development wells drilled by R. J. Walker Oil Co., Inc., and two recent dry holes drilled by outside operators, provides an interesting glimpse at technology that may revolutionize the way the oil and gas industry searches for new reserves.

STARK, PHILLIP H., Petroleum Information Corp., Littleton, CO

Highlights of 1983 Industry Activity in Mid-Continent—Good Signs in Difficult Times

Drilling activity in the Mid-Continent has suffered from the industry slump. Mid-Continent industry activity, however, remains surprisingly strong when compared to the total United States. In 1982, four Mid-Continent basins ranked in the top ten based on total completions. Two provinces—Anadarko basin and Chautauqua platform—ranked in the top ten based on drilling and completion expenditures. Despite mature development of most Mid-Continent producing provinces, 1982 exploratory drilling continued strong and yielded good success. Seven Mid-Continent provinces ranked in the top ten based on density of wildcat drilling activity. Four provinces ranked in the top ten based on number of wildcats and best success ratios.

Coupled with active exploratory drilling both Oklahoma (+2.8%) and Kansas (+3.8%) increased their annual crude-oil production. Average 1982 oil well initial potentials increased by 30% to 30 bbl/day in Kansas and by 9% to 58 bbl/day in Oklahoma. The increased productive potential coupled with lower drilling costs indicates the potential for improved investment return for Mid-Continent wells.

The 1983 drilling and exploratory activity are reviewed to highlight positive factors and trends that support continued healthy industry activity in the Mid-Continent.

STEWART, HARRY E., Sun Exploration & Production Co., Dallas, TX

Integration of Remote Sensing Data into the Exploration Effort

Soon after the launch of the initial ERTS satellite in 1972 several facts became evident. (1) The multispectral scanner, which takes data and processes it in digital form, was a powerful new reconnaissance tool added to the geologist's list for evaluating prospective hydrocarbon and mineral producing areas. (2) Based on NASA laboratory and field experiments, if additional spatial resolution (from 80 to 30 m pixels) and additional spectral resolution (more bands in the near infrared and infrared) were added, the tool would be more valuable for the geologist. (3) There were inherent errors in the system affecting both geometric and radiometric accuracy.

During the 10 years following the 1972 initial launch, three more Landsat-type satellites were launched with the latest, Landsat 4, incorporating many of the changes requested by geologists. The new multispectral scanner has seven spectral bands covering portions of the visible, near infrared, and infrared. The ground resolution now is about 30 m (100 ft).

The purpose of this presentation is to introduce some processed images from the Landsat 4 thematic mapper, compare these images in terms of quality and information content to Landsat MSS, and to discuss methods of integrating these data into an exploration program. Methods of calibrating the images as well as methods of combining multiple diverse data sets also will be covered.

Examples of several geologic areas will be shown where multiple types of digital processing provide different types of information of the areas. Methods for extracting lithologic, structural, and vegetation cover information also are covered.

SUHM, RAYMOND W., Texas Gas Exploration Corp., Oklahoma City, OK

"Simpson" Reservoirs in Arkoma Basin and Ouachita Mountains, Oklahoma and Arkansas

The Simpson Group and its equivalents are shown to have reservoir potential in the Arkoma basin and Ouachita overthrust region of Oklahoma and Arkansas.

The Simpson in Oklahoma, the Everton/St. Peter in Arkansas, and the Crystal Mountain/Mazarn/Blakely of the Ouachitas were studied in outcrop, and from well cuttings and logs to derive an understanding of (1) their stratigraphic relationships, (2) the nature and distribution of "Simpson" reservoir sands, (3) depositional and source environments, and (4) geologic history.

It was determined that sandstones of the Calico Rock, Newton, and St. Peter of Arkansas are equivalent to the Oil Creek, McLish (Burgen), and Bromide sandstones of Oklahoma, respectively. Further, the Crystal

Mountain, lower Blakely, and upper Blakely sandstones of the Ouachitas are stratigraphically equivalent to the Oil Creek (Calico Rock), McLish (Newton), and Bromide (St. Peter), respectively.

The Everton/St. Peter is a mixed sandstone-carbonate association throughout most of the Arkoma but changes facies to carbonates in the eastern Arkoma basin and Mississippi embayment and is dominantly sandstone and shale in the southern and southwestern portions of the Arkoma basin in Arkansas. Similarly, the Simpson is a mixed sandstone-carbonate association in the Arkoma basin of Oklahoma, but is dominantly shale in the southern and southwestern portions of Oklahoma.

Sandstones of the Simpson and Everton/St. Peter were derived from a source to the north and were deposited in shifting strandline and shelf environments. Crystal Mountain and Blakely sands also were derived probably from the north but were deposited in deeper water fanlike environments via chutes on the downthrown sides of growth faults at the Arkoma basin (shelf) geosyncline transition. Substantial amounts of clay, however, were derived from a source to the south.

Regional cross sections, sand distribution maps, and paleogeographic maps are used to illustrate these ideas and to point out areas favorable for oil and gas exploration.

WATNEY, W. LYNN, and FRANK W. WILSON, Kansas Geol. Survey, Lawrence, KS

Relationship of Epeirogeny and Sedimentation in Kansas

Regional subsurface and lithofacies mapping has revealed that epeirogenic movement, particularly involving subtle, periodic reactivation of preexisting structural weaknesses has affected sedimentation through time in the Mid-Continent. Similarly, regional outcrop studies have provided many examples where paleostructures have influenced sedimentation. Detailed measurements of the earth's gravity and magnetic field intensity, remote sensing, and geomorphologic analysis also have identified surface and subsurface features which can be used to infer discontinuities in the composition and structure of basement rocks. Faults, folds, and possible fracture systems have propagated up through the sedimentary section, are expressed in the topography of the present land surface, and control stream and river drainage patterns. Structural elements, large and small, appear to have influenced regional and local sedimentation, erosion, and diagenetic patterns through long periods of time, as suggested by the geologic record in Kansas.

In some situations, bathymetric and topographic highs related to preexisting structural elements have affected markedly the distribution of petroleum reservoir-quality carbonates and sandstones from the Cambrian through the Cretaceous. A review of four, vertically stacked carbonate-dominated cyclothems from the Upper Pennsylvanian Kansas City Group in central and western Kansas reveals an evolving display of time and location dependent features caused by the combined effects of epeirogenic and recurrent structural movement, sedimentologic controls such as clastic influx, and eustatic changes in sea level. Favorable reservoir facies trends of the carbonates and early freshwater diagenetic patterns can be explained, in part, by variations in the configuration of the Pennsylvanian epeiric shelf.

In addition to trap formation, subtle structural development also may affect indirectly the reservoir distribution by influencing markedly the processes of sedimentation and diagenesis. Inasmuch as the subtle expression of deep structure usually can be detected in shallow and surface records, it follows that remote sensing and geomorphologic analysis can assist conventional geophysics and subsurface geology in the development of new energy and mineral prospects.

WHITING, PHILIP H., and STEVEN D. LEVINE, Tenneco Exploration & Production Co., Denver, CO

Red Fork Sandstones (Lower Pennsylvanian) in Deeper Parts of Anadarko Basin, Oklahoma

Red Fork sandstones in the deeper part of the Anadarko basin are the downdip equivalents of fluvial and deltaic sandstones in the Cherokee Group. The sandstones have repetitive, ordered sequences of sedimentary structures in vertical section. Individual bedsets display sharp basal contacts, gradational tops, and contorted bedding. The characteristics indicate these basinal sandstones were deposited by turbidity currents.

The sandstones occur as narrow, linear constructional channels that are dip-trending. The lateral change from channel-fill to overbank facies takes place abruptly. Channel sandstones display incomplete "AE" bedsets up to 12 ft (3.6 m) thick. Overbank deposits have thin "BE," "BCE," and "CE" Bouma sequences and generally are dominated by shale.

The sandstones are very fine-grained litharenites with an average composition of 58% quartz, 8% feldspar, 17% rock fragments, 5% other grains, and 12% matrix. Cement consists mainly of calcite ranging from 2 to 40% of the bulk volume. Quartz content tends to decrease upward and matrix increases upward within bedsets. The compositional grading is accompanied by a decrease in grain size upward within bedsets, indicating deposition during a decreasing flow-regime.

Red Fork sandstones are low-permeability reservoirs with an average porosity and permeability of 7.8% and 0.1 md, respectively. Natural gas reservoirs occur mainly in the thicker, channel sequences.

The bedding character of the channel and overbank facies is reflected in gamma-ray log responses. Log characters of the two facies are used to interpret turbidite sections of uncored areas. The interpretations are adapted to the East Clinton field for prediction of constructional channel reservoirs. The interpretation of dip-trending turbidite deposits may aid in exploration and development of the Red Fork sandstones.

WONCIK, JOHN, Consultant, Tulsa, OK

Shallow Gas in Arkoma Basin—Pine Hollow and South Ashland Fields

The Pine Hollow and South Ashland fields located in Pittsburg and Coal Counties, Oklahoma, established a combined reserve exceeding 200 bcf of gas. The Hartshorne Sandstone of early Desmoinesian (Pennsylvanian) age is the producing zone at a depth of 4,000 ft (1,200 m). Gas, probably of biogenic origin, migrated into the reservoir shortly after deposition. Subsequent folding and faulting of the Ashland anticline resulted in repositioning of the gas in a downthrown fault trap. The upthrown anticline portion of the Hartshorne is water-bearing. Moderate well costs and high individual reserves have resulted in excellent economics. Competitive bidding on federal leases has resulted in a high bid exceeding $1 million for one tract in the South Ashland field.