boniferous and to *Schwagerina* and related forms in the Early Permian.

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Eastern Gas Shales Project (EGSP) Data System: Useful Exploration and Research Tool

The U.S. Department of Energy in Morgantown, West Virginia, and the U.S. Geological Survey and Petroleum Information Corp. in Denver, Colorado, have created two large data files for the Eastern Gas Shales Project (EGSP). All computer-compatible well, outcrop, and sample data generated by EGSP contractors from Devonian shales throughout the Appalachian basin are being edited, converted to a data base, and accessed by Department of Energy contractors to produce digital printouts, charts, and maps.

The EGSP Well Data File was developed as an extension of the Petroleum Information Well History Control System (WHCS) and contains geologic, engineering, and production test data for more than 6,000 wells. The EGSP Sample Data File contains geochemical, lithologic, and physical characterization data on more than 50,000 samples from 17 EGSP cored wells, and 140 additional wells and outcrops.

Well and sample data can be retrieved to produce (1) production test summaries by formation and location; (2) contoured isopach, structure, and trend surface maps of Devonian shale units; (3) sample summary reports by location, well, contractor, and sample number; (4) cross sections displaying digitized log traces and geochemical and lithologic data by depth for wells; and (5) frequency distributions and bivariate plots.

EGSP Data System products are being used by EGSP contractors to help solve Devonian shale exploration and research problems in the Appalachian basin. Although part of the EGSP Well Date File is proprietary, and distribution of complete well histories is prohibited by contract, maps and aggregated well data listings can be made available to the public through published reports.

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Overview of Seals for Hydrocarbons

Seals for hydrocarbons need to be analyzed and described at two differing scales. A micro view of the rock matrix, pore structure, and fluid content of the seal surface provides quantitative information about the capacity of the seal to impede hydrocarbon movement at a specific measured point. Such micro information often can be accurately measured, but can rarely be extrapolated to describe the overall (mega) sealing capacity of a large hydrocarbon trap.

Efforts have been made over the years to describe the lateral variability of seals for hydrocarbon accumulations. One of the best features of the simple anticlinal structure is that it generally provides sequential sealing surfaces. Top-seal surfaces may be expected to have relatively little lateral variability (at least on the scale of an individual anticline). Faulted structures, in contrast, require not only a top seal, stable in lithology over the trap area, but require juxtaposition of the hydrocarbon-bearing interval against a sealing lithology at the fault plane surface. Large hydrocarbon columns become almost impossible to seal if the trapping configuration requires multiple faults with throws that vary along the individual faults.

Stratigraphic traps for hydrocarbons typically require a top seal, bottom seal, and an updip lateral seal. In addition, the transition from reservoir to seal must be very rapid or the hydrocarbon accumulation will largely occupy a "waste-zone"—not quite a reservoir, hardly a seal.

Regionally, it can be shown that hydrocarbons are preferentially distributed under major roofing seals. These major sealing units are characterized by broad extent, by laterally stable character, and commonly by ductile lithologies. Where these regional seals are above significant source rocks and reservoirs, they largely control the emplacement of hydrocarbon accumulations.

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Morphology of Continental Shelf-Slope Break

The continental shelf-slope break has been defined as the point of first change in gradient at the outermost edge of the continental shelf, fundamental boundary of the earth's crust. Through the projection of its strike must pass all materials carried from the continents to the ocean basins. Although morphology of the shelf-slope break commonly depends on the crustal change between continents and ocean basins, it is a reflection of tectonics and structure, lithology, age of the margin, sea level, deposition, erosion, reworking, and diagenesis. Many details of specific physical factors and processes influencing morphology of the break remain to be discovered. Therefore, analysis of the resultant of all these factors, the morphology of the break itself, will be useful in understanding the components which formed it. As many of the factors which affect the transition from shelf to slope are dynamic, continental shelf-slope break morphology is not static but changes through time. Changes in morphology must commonly interact in a feedback loop to alter the processes contributing to that morphology. If the elements of formation were to remain constant, the shelf-slope break would go through a regular morphologic evolution as it ages. Variation in the processes involved, such as sea-level state, most commonly interrupt the cycle.

Because the shelf-slope break represents the upper boundary of the continental slope, it is convenient to discuss the interplay of the various factors involved as extensions of the 6 types of continental slopes. The resulting framework for shelf-slope breaks is: folded or faulted, stepped breaks; progradational transitions; pull-apart transitions; sharp, steep shelf-slope breaks resulting from crustal convergence; breaks associated with reefal dams; and breaks associated with diapir dams. A shelf-break classification emphasizing shelf-to-slope morphology, based on comparison of different world margins, is proposed.

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Data Enhancement from 500-Channel Streamer

Seismic reflection data obtained with a 500-channel, digital streamer cable can be processed by array-forming techniques that include optimal weighting and time-shifting of individual channels. Such processing can improve the vertical resolution of horizons at early and intermediate times as well as enhance the continuity and clarity of later reflections. In addition to the recording of individual channels, a separate recording can be made aboard ship with the individual channels array formed to simulate data obtainable with any of a wide variety of conventional streamers.

To demonstrate data enhancement obtained by these techniques, a line was surveyed in the Gulf of Mexico, first with the 500-channel system and then with a conventional 48-channel streamer. When the 500-channel data were processed to duplicate the conventional streamer data, the larger system yielded better results for late as well as early times; this improvement may be attributed partly to reduced cable noise. Comparisons made with record sections and stacked sections show that: (1) long, beam-steered arrays can enhance deeper events while retaining the high-frequency content of shallow data, and (2) short arrays at small group intervals allow fine resolution of shallow events.

The ultimate approach to preserving broadband information is full 500-channel processing of individually recorded channels. With such processing, individual hydrophone groups can be considered essentially as points. When the Gulf of Mexico data are processed in this way, signal continuity persists to frequencies above 125 Hz, and lateral changes are observed to the limit of resolution provided by the 3-m spacing of the output stacked traces.

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Porosity Evolution in Upper Cretaceous Austin Chalk Formation, South-Central Texas

Austin Chalk in south-central Texas was deposited in an unique environment that consisted of a relatively shallow-water platform and adjacent deeper water. Shallow water promoted deposition of highly fossiliferous chalks that contained appreciable quantities of aragonitic constituents. These anomalous sediments periodically were transported into the adjacent basin, a site of more typical chalk deposition.

Porosity and geochemical trends support petrographic evidence that the Austin Chalk underwent a greater degree of diagenesis than did European and North Sea chalks of similar age. Porosity reduction occurred more quickly and earlier in the Austin Chalk's burial history, and at shallower burial depths than in these other chalk sequences.

Exposed, relatively shallow-water Austin Chalk sediments now average 20% porosity but were never deeply buried. Porosity reduction resulted from early physical compaction followed by freshwater dissolution of aragonitic grains and associated cementation by non-ferroan calcite. Relatively low bulk iron and strontium concentrations resulted from this diagenesis.

More basinal and oil-productive Austin Chalk averages 5% porosity. After early physical compaction, most porosity loss resulted from pervasive pressure solution and concomitant cementation. Some cementation occurred when aragonite (where present) was stabilized under higher burial temperatures prior to pressure solution. Cements are mostly ferroan calcite. Progressive burial diagenesis further obliterated primary matrix fabrics and gradually depleted bulk oxygen-18. Relatively higher bulk iron and strontium concentrations reflect this diagenetic history.

Austin Chalk is capable of producing solely from its preserved matrix porosities and permeabilities although late-stage fracturing does enhance production.

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Association of Stylolitic Carbonates and Organic Matter: Implications for Temperature Control on Stylolite Formation

Petrographic and geochemical examination of carbonate-rock samples collected from three cores penetrating the Slave Point Formation (Middle Devonian, northwestern Alberta, T96–R4W6) have demonstrated a local association between high concentrations of organic matter, the presence of ferroan calcite and ferroan dolomite, and significant stylolite development. The stratigraphic succession of stylolitic and nonstylolitic rocks indicates that overburden pressure alone was not the main control on stylolite formation. Light-colored, pelletal/skeletal grainstones contain fewest stylolites and lowest concentrations of organic content (TOC 0.2%). In contrast, dark-brown lime wackestones and mudstones contain abundant stylolites and contain organic carbon contents as high as 1.0% and extractable organic matter (EOM) contents as high as 1,600 ppm. Organic matter is concentrated as an insoluble residue along stylolites; concentration developed during diagenesis as a result of selective solution of soluble carbonate-rock matrix. However, the greater abundance of stylolites in mudstones relative to grainstones suggests that factors inherited from original depositional environments have affected the tendency for later stylolite formation.

We suggest that acidic species, principally CO_2, released by catagenetic alteration of autochthonous organic matter, can dissolve sufficient carbonate to initiate stylolite formation prior to significant pressure solution. Solution of carbonate in the reducing environment of organic diagenesis also had led to the precipitation of ferroan calcite and ferroan dolomite along stylolites. These minerals are notably absent from non-stylolitic intervals.

Stylolite formation in carbonate rocks may be related to type and distribution of autochthonous organic matter, which then is related to depositional environment. In addition, thermal history (rank level) of the section will also effect the depth at which stylolites form. Thus, in some carbonate rocks, subsurface temperature rather than pressure may be a more significant factor in determining the depth of stylolite formation. It is proposed that carbonate solution by organic-derived acidic species may act as an important mechanism by which carbonate rocks may locally concentrate organic matter, and produce conduits along which generated hydrocarbons may be expelled.

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Pennsylvanian Fan-Delta Deposition, Mobeetie Field, Texas Panhandle

A prism of Pennsylvanian and Lower Permian arkosic sandstone and conglomerate (granite wash) was deposited in alluvial fans and fan deltas north of the Amarillo uplift in the Anadarko basin. Deposits adjacent to the main bounding fault are as much as 1,500 m thick but thin to 30 m within approximately 60 km of the uplift. Mobeetie field, in northwest Wheeler County, is located 16 km north of the basement uplift, at the northern limit of upper Missourian granite-wash sedimentation. Oil and gas are produced from a sequence of Missourian granite wash and interbedded carbonate rocks.

The oldest Missourian carbonate unit and the overlying classic unit form a representative depositional cycle. In the carbonate unit, a series of elongate, phylloid-algal mounds composed of algae-foram wackestones and packstones developed along strike and separated the open shelf from a more restricted lagoonal environment. Progradation of coarse-grained clastics onto the carbonate shelf halted carbonate pro-