Preliminary Proposal

for a Study

EVALUATING THE POTENTIAL OF EAST TEXAS INTERIOR SALT DOMES FOR ISOLATION OF NUCLEAR WASTES

Submitted to

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

by

Bureau of Economic Geology
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University Station, Box X
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I. Executive Summary

The Bureau of Economic Geology proposes to evaluate the suitability of interior salt domes within the East Texas Basin for potential nuclear waste isolation. If, after the first year of investigation, the interior Texas domes appear to exhibit favorable properties, the program may take several years to complete. A summary of the principal budget items for the Fiscal Year 1978 follows:

Administrative	$ 44,496
Salaries	235,018
Fringe, indirect	181,964
Expendables	10,000
Special services	37,600
Special equipment	4,842
Research materials	54,700
Travel/field expenses	17,000
TOTAL	$585,620

The research program consists of five principal research tasks: (1) hydrology/hydrologic integrity; (2) dome geometry and stratigraphic/tectonic framework; (3) tectonic stability; (4) review of previous priority selections; and (5) investigation and continual review of selected domes. Three research groups, each under the direction of a Principal Scientist, will assume responsibility for research tasks 1, 2, and 3, respectively. These three groups will integrate their efforts to accomplish research tasks 4 and 5. A Coordinator (25%) and Principal Investigator will direct the program within the administrative structure of the Bureau of Economic Geology, and The University of Texas at Austin.

Nine critical research elements will be addressed in the program: regional aquifer variations; local hydrologic integrity of domes; geochemistry, petrography and rock physics; regional/local stratigraphy/tectonics; dome geometry; geophysics; remote sensing (fractures, linears); areal geology/geomorphology; and land/human resources. Evaluation of these elements will be based on a residence time of 250,000 years for safe isolation.

The first year of the program (FY 78) is designed to include during the first quarter an intensive review of previous studies and readily available data to confirm, reject or question previous priority selections of host domes. Following this initial review, a prioritized list of domes will be developed and progressively more intensive specific studies will follow. Integrated with specific (and generic) dome studies will be comprehensive analyses of hydrologic systems and tectonic elements within the interior salt dome basin.

Continual review and assessment of the candidate domes will involve specific studies, including initiation of drilling, geophysical monitoring and seismic/gravity analyses during the last half of the year. Continuing regional analyses of hydrologic factors, aquifer variations, and dome piercement histories will supply framework data within which to interpret properly the data derived from specific dome studies.

II. Introduction

At least as early as 1960, the U. S. Atomic Energy Commission was contracting studies of the suitability of salt (halite) as repositories for waste nuclear products. Underground disposal offers the most favorable means of insuring confinement of a growing volume of nuclear waste products. The chemical and physical properties of salt, either in domes or in bedded layers, have focused principal attention on the potential nature of salt repositories.

Bedded salt deposits of various ages occur as strata within numerous sedimentary basins in the United States. In Texas, parts of the Permian Basin, the Palo Duro and Dalhart basins, are currently under investigation to determine waste isolation potential by the Bureau of Economic Geology, The University of Texas at Austin.

Texas also contains at least 78 on-land salt domes that are sufficiently shallow to identify by conventional geophysical and drilling/subsurface mapping methods. Of these 78 domes, 20 domes occur within the interior East Texas Basin. Previous workers have considered coastal domes to be unstable and have also rejected about two-thirds of the Texas interior domes for various reasons (to be discussed later). Consequently, using a variety of criteria and data, approximately a half dozen interior Texas salt domes are currently "unrejected" by studies to date.

At this time, it is necessary to reassess the earlier studies of East Texas interior domes, review the potential of the domes for nuclear waste isolation, and undertake intensive analysis of selected, high-priority candidate domes. This thorough evaluation must precede any decision concerning the actual use of the domes

for nuclear waste disposal. Every conceivable natural factor must be considered and tested if necessary. Principal research effort should be focused very quickly on specific domes. We believe, however, that along with site-specific studies, continuing analysis of regional geohydrologic systems, and salt-basin tectonics should be integrated with site-specific evaluations.

II. 1. Purpose of the study

The Bureau of Economic Geology, The University of Texas at Austin, proposes to undertake a comprehensive analysis of the East Texas interior salt dome basin (Fig. 1) in order to (1) review, verify and select priority salt domes, (2) undertake intensive site-specific analysis (geophysical, stratigraphic, geometric, hydrologic) of selected domes, and (3) undertake and integrate regional evaluation with site-specific studies to insure structural stability and hydrologic integrity for the prescribed 250,000 year nuclear waste residence time. Results of the proposed research will provide the basis for final evaluation of Texas interior salt domes for nuclear waste isolation.

The Bureau of Economic Geology will design and implement a research program that addresses the above listed goals through the analyses of a series of basic research elements integrated into several fundamental research tasks. Research scientists will collect, analyze and evaluate all data required to certify the stability and integrity of candidate salt domes and their bounding structural, stratigraphic and hydrologic systems.

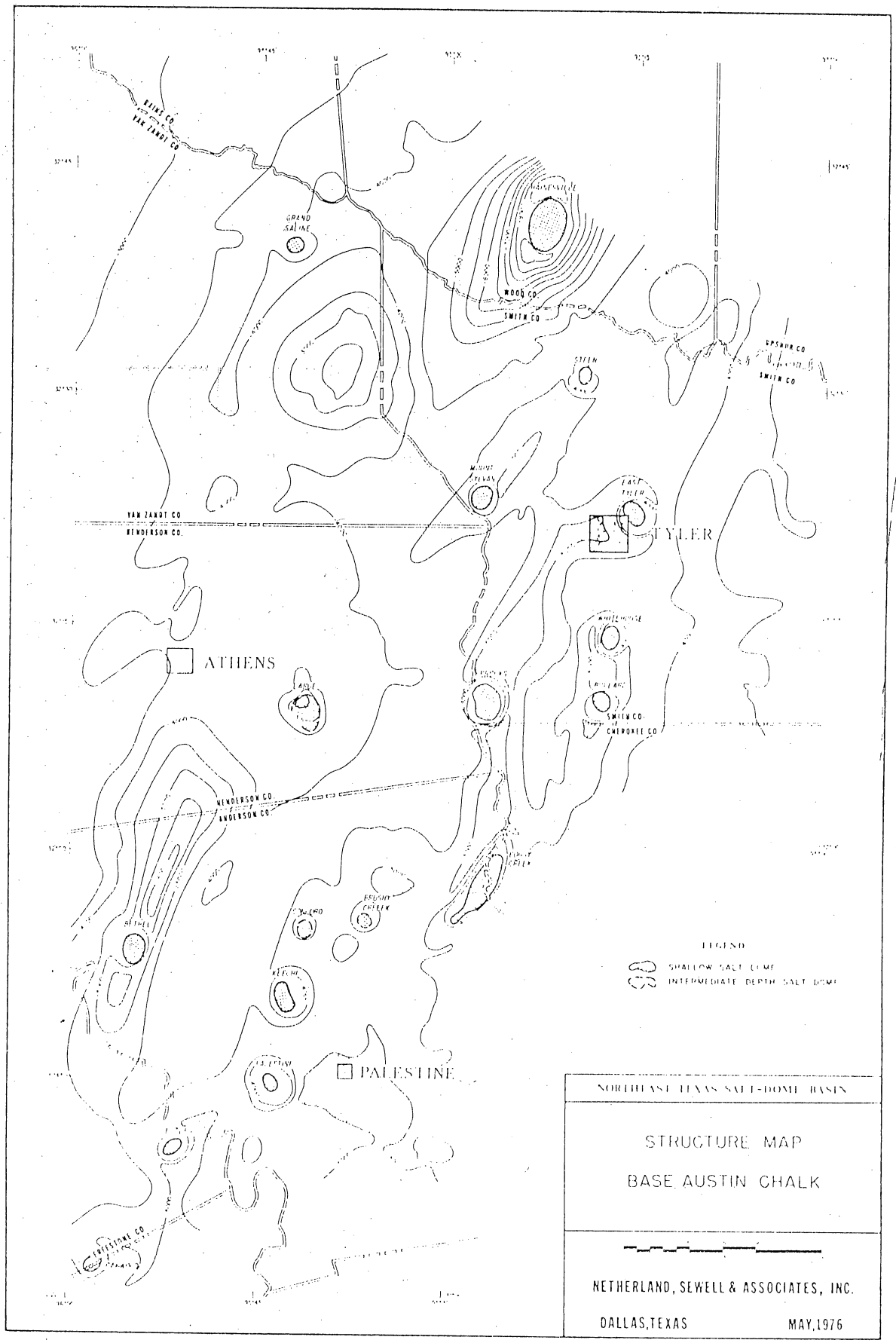

Figure 1. Index and schematic structure map of East Texas interior salt dome basin showing dome locations. After Netherland, Sewell and Associates (1976).

II. 2. Previous studies

The former U. S. Atomic Energy Commission and the present U. S. Energy Research and Development Administrative have been charged with the responsibility for locating safe isolation sites for nuclear wastes. ERDA's Office of Waste Isolation has principal responsibility for the national program.

A great number of contracted studies have been published about the potential of salt as a waste repository. Several recent reports have specifically addressed the potential of the Gulf Coast salt domes: Anderson and others (1973); Ledbetter and others (1975); Martinez and others (1975, 1976); and Netherland, Sewell and Associates (1975, 1976).

Anderson and others (1973) provided an excellent regional summary of the 263 recognized on-shore Gulf Coast salt domes (20 interior Texas domes) and rejected 227 domes as unsuitable for waste emplacement. Of the 36 "unrejected" Gulf Coast domes, 7 occur in the East Texas interior basin; consequently, 13 interior Texas domes were rejected for various reasons.

Ledbetter and others (1975) recommended 5 interior domes, 2 of which occur within the East Texas basin: Whitehouse and Mt. Sylvan.

Martinez and others (1976) selected 3 East Texas interior salt domes for specific review: Keechi, Mt. Sylvan and Palestine. In addition they indicated that 2 domes, Grand Saline and Brooke have no saline ground water plumes. They also detected saline plumes in Wilcox aquifers at 4 domes, Hainesville, Steen, Bullard and Whitehouse, but did not exclude them from further consideration.

Netherland, Sewell and Associates (1975) reviewed the 7

unrejected domes in East Texas (Anderson and others, 1973) and described their oil and gas potential. Keechi dome was selected for a more detailed analysis. Netherland, Sewell and Associates (1976) concluded that 3 interior domes in East Texas, Bullard, Keechi and Whitehouse, exhibit sufficient tectonic and hydrologic stability to warrant further examination.

II. 3. Need for further study

Obvious differences exist in the conclusions of previous workers concerning the priority of various East Texas interior salt domes for waste isolation. The four research groups previously mentioned have generally agreed upon criteria and requirements for safe isolation. In addition, the independent studies have recommended continued interest in the 6 or 7 domes considered "unrejected" by Anderson and others (1973).

At this time, it appears that further meaningful discrimination of domes in East Texas will require the thorough analyses of additional available data, and will require collection of additional site-specific information.

Recommendations by past workers regarding the approach to site-specific studies appear to be quite valid and will constitute the principal part of this proposed research project. An intensive review of the previous studies and data will confirm or question conclusions about specific East Texas domes, as well as verify the type of new information that will be necessary to discriminate further in the selection of highest priority domes. Certainly, primary effort will be focused on final discrimination of candidate domes, including geophysical, coring operations, hydrologic and

hydrochemical analyses, stratigraphic/structural piercement history and rate, and geomorphic/Quaternary analysis.

At the same time, we strongly recommend that complementary studies of the geohydrologic systems, aquifer geometries, regional geochemical patterns, and stratigraphic/salt tectonic framework be maintained. Such regional studies will place the site-specific data into a proper perspective and will provide the necessary background to assess the meaning of dome-to-dome variations. We are not critical of previous and on-going regional studies, but our experience in Texas sedimentary basins convinces us of the importance of integrated site-specific and regional analysis.

II. 4. Natural criteria and information required for dome selection

Excluding the specific properties of salt, which have been studied in considerable detail, a number of generic, as well as specific, criteria are necessary for safe waste isolation in salt domes. These factors have been exhaustively discussed by previous workers. Only the highlights are noted here in order to evaluate the proposed research program.

Dome geometry is a fundamental factor in assessing priority to any dome. Shape, crestal structural, overhangs, internal/boundary relationships, among others, determine its potential as a nuclear waste container. A variety of geophysical and geologic tools and methods are available to evaluate this factor.

Tectonic stability must be verified for any high priority dome. Evidence is required that rates of movement, if any, fall within ranges that are acceptable in view of the residence-time

requirements for nuclear wastes. Methods utilizing geomorphology, remote sensing, stratigraphic piercement analyses, geophysical monitoring, high-order levelling, cap rock development, and regional structure and salt tectonics, among others, provide evidence necessary to evaluate this critical requirement.

Hydrologic integrity insures that any selected dome is isolated from potential salt dissolution during the prescribed life of the repository. When placed against regional hydrologic factors, and aquifer variations, the local geohydrology in the vicinity of a dome can be evaluated for signs of dissolution or potential dissolution. Saline, as well as fresh-water aquifers, must be evaluated to preclude the possibility of salt dissolution. Methods such as aquifer potentiometric and hydrochemical mapping, in addition to detailed stratigraphic mapping of dome perimeters, provide evidence of anomalies resulting from dome effects on regional (background) hydrologic patterns. Cap rock studies and piercement history/rates may provide evidence of paleo-ground-water flow patterns. Computer modelling of the aquifer may be required to analyze available data, both regional and site-specific.

Stratigraphic/tectonic framework is not a primary factor of salt dome suitability for waste isolation but it is a critical factor by which tectonic stability and hydrologic integrity can be analyzed and evaluated. Salt domes do not exist in isolation, but are elements within a sedimentary basin that includes mother-salt, deeply buried salt ridges, fault systems, a complex structural/depositional history, a complex mosaic of aquifer (fresh and saline) and aquiclude facies, and basinal hydrologic systems. Consequently, the common denominator within a sedimentary basin

is the stratigraphic and structural framework on which the many hydrologic and structural elements are superimposed. The framework provides a critical geologic key in discriminating, mapping and interrelating generic basinal features.

Nine research elements are designed to provide the data necessary to evaluate satisfactory dome geometry, tectonic stability, and hydrologic integrity.

II. 5. Significant geologic events and factors

A detailed review of the geology of the East Texas or Tyler Basin is unnecessary at this time, but several specific geologic units and elements that may affect salt dome potential will be noted (Figs. 2, 3).

In the center of the basin at about 15,000 feet, the Jurassic Louann-Werner salt/anhydrite (mother-salt) onlaps the Late Triassic-Early Jurassic (?) Eagle Mills Formation composed of continental red beds of rift-basin origin. One or two kilometers of salt (punching out landward) were probably deposited originally as the Gulf of Mexico was partially restricted from the early proto-Atlantic. Upper Jurassic limestone shelf/shelf-edge deposits (Smockover/Haynesville Formations) accummulated and offlapped or prograded over the salt as the Gulf opened to normal marine salinities and moderate subsidence occurred. Late Jurassic clastic deposits (Cotton Valley/Terryville) of deltaic/barrier origin prograded Gulfward over the limestone shelves. In Mississippi and eastern Louisiana, these Jurassic deltaic deposits probably initiated migration of Louann Salt into growing ridges and diapirs.

ERA	SYSTEM	SERIES	GROUP	FORMATION
CENOZOIC	QUATERNARY	HOLOCENE		
		PLEISTOCENE	Houston	Beaumont Lissie Willis
	TERTIARY	PLIOCENE	Citronelle	
		MIOCENE	Fleming	
			Catahoula	
		OLIGOCENE	Vicksburg	
		EOCENE	Jackson	
			Claiborne	Cockfield - Yegua Cook Mountain Sparta, Zilpha - Winona Weches Queen City > Mt Selman Reklaw Carrizo
			Wilcox	
		PALEOCENE	Midway	
MESOZOIC	CRETACEOUS	UPPER	Navarro	
			Taylor	
			Austin	
			Eagleford	
			Woodbine	
		LOWER	Washita	
			Fredericksburg	
			Trinity	
				Sligo / Hosston
	JURASSIC	UPPER	Cotton Valley	
			Louark	Smackover
		LOWER		Louann
	TRIASSIC	UPPER		Eagle Mills
PALEOZOIC	PERMIAN			

Figure 2. Stratigraphic section in the East Texas Basin. After Ledbetter and others (1975).

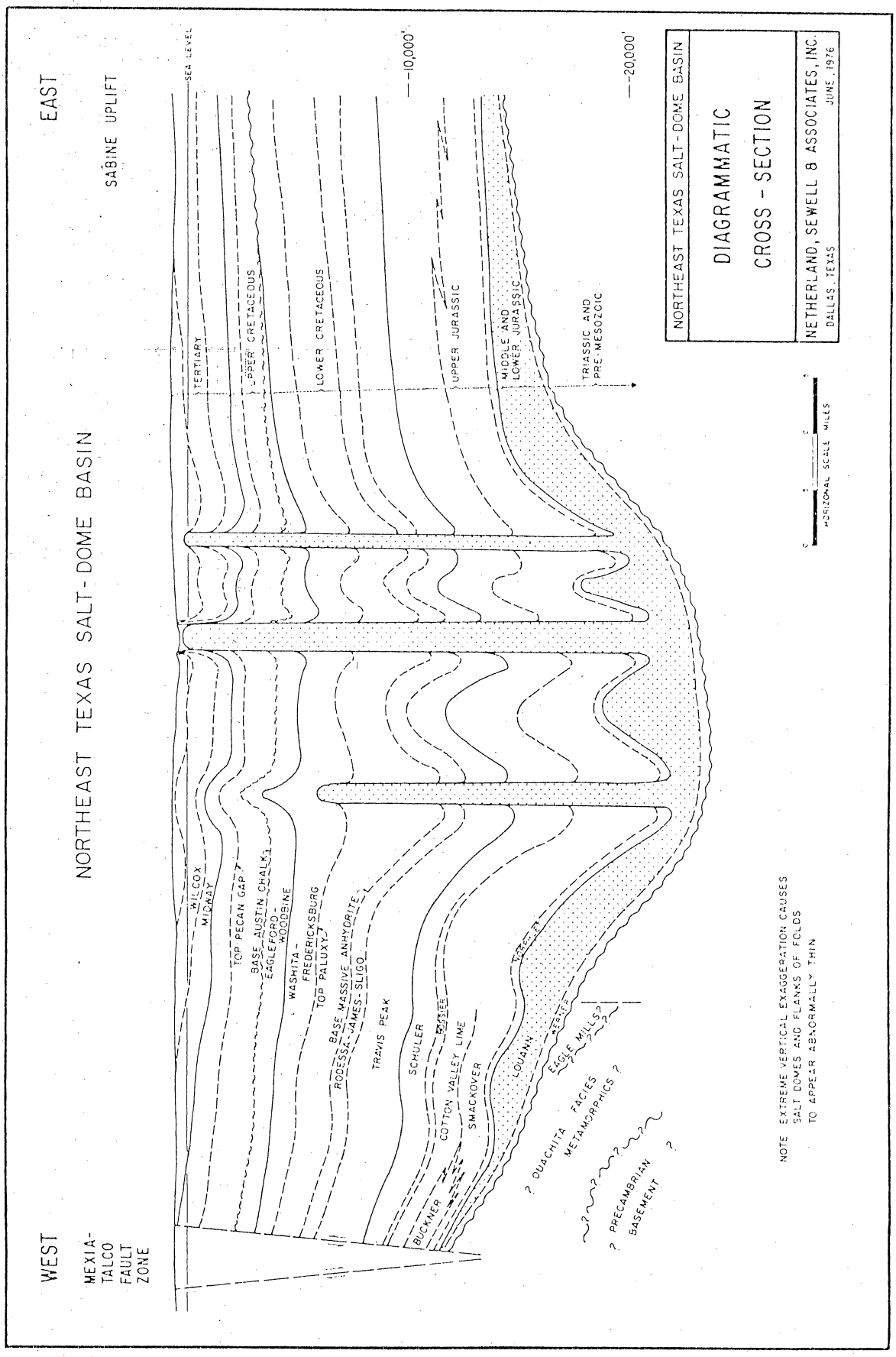

Figure 3. Schematic Cross section of the East Texas Basin showing principal geologic units and structural character. After Netherland, Sewell and Associates (1976).

In East Texas, where Jurassic clastic deposition was restricted, sufficient sedimentary burial to initiate salt movement probably did not begin until after deposition of Lower Cretaceous fluvial/deltaic clastics deposits (Travis Peak Formation, etc.) and reached a climax during Early Tertiary when Wilcox and Claiborne delta systems (Eocene) added thick clastic sections as they filled the northern margin of the Gulf of Mexico. Salt movement declined following delta-building and by Oligocene/Miocene, diapiric activity was greatly reduced. Salt movement continued to decline during Late Tertiary and Quaternary. Careful analysis of piercement history (isopach mapping, seismic reflection studies, structure mapping) will be required to document and graph the piercement rates of domes during Late Cretaceous and Tertiary time.

A critical aspect in evaluating recent salt dome stability is assessment of rates of pirecement during the Quaternary (using terrace analysis and drainage anomalies). Geophysical monitoring will supply short-term evidence of dome stability, but it must be interpreted in the light of long-term geologic evidence of uplift rate vs. time.

Another critical element in dome evaluation is its hydrologic integrity. Principal fresh-water aquifers that overlie or are pierced by the East Texas domes are Eocene fluvial/deltaic facies (Wilcox, Carrizo, Queen City Sparta Formations). Dissolution may occur where these aquifers are in contact with the salt dome above the base of fresh water, or where faults (flanking and radial crestal faults) may interconnect the aquifer and the salt body.

Of less concern but still a viable factor in the hydrologic

integrity of a dome is the potential for dissolution by saline-charged aquifers of Eocene or Cretaceous age below the base of regional fresh water. The potential for deep basin hydrologic circulation should be considered as a possible mechanism for dissolution of the deeper domes and domes flanked by permeable fault zones that could pipe both fresh and saline fluids through impervious shales.

II. 6. Natural resources

Tertiary aquifers supply significant volumes of water in the East Basin. The potential for dissolution of salt domes is a critical factor for insuring safe ground-water supplies for the region.

Although petroleum potential is considered of limited importance in the center of the basin (Netherland, Sewell and Associates, 1975), possibilities for deeper or for marginal gas must be reviewed in light of increasing prices for gas. Current economics may encourage exploration of deep Cretaceous and Jurassic reservoirs that to date have promised to be of marginal potential.

Furthermore, the growing intensity of exploration for uranium and the technology of in situ mining have made all fluvial systems potential targets, even at depths of several hundred feet. Improved technology may extend target depths sufficiently to include Lower Tertiary fluvials facies (Sparta, Queen City, Carrizo/Wilcox).

Weches iron deposits also exist in the region. Currently of limited importance, the future potential is difficult to assess, especially if international problems eliminate imports of foreign ore.

III. Methods of investigation

III. 1. Structure of the program

The Bureau of Economic Geology proposes to accomplish the goals of this complex program by developing an integrated investigation composed of three research groups, each assigned to specific but sometimes overlapping tasks (Fig. 4). Five principal research tasks are apparent at this time: (1) hydrology and hydrologic integrity, (2) dome geometry and stratigraphic/tectonic framework, (3) tectonic stability, (4) review of previous studies and dome evaluations, and (5) investigations of priority domes (regional and site-specific).

Each research task is composed of several elements that constitute the basic research areas of the program. These research elements (Fig. 5) include (1) regional aquifer variations, hydrologic parameters and hydrochemical facies; (2) hydrologic integrity of domes, dissolution, plumes, water chemistry; (3) geochemistry, petrography, rock physics (cores), composition of dome, base-exchange capacities, cap rock and adjacent formations; (4) regional/local stratigraphy, facies, structural elements, salt piercement history, (5) dome geometry, shape, bounding facies, faults; (6) fractures, linears, anomalies; (7) geophysics--dome stability, microseismicity, internal/flank structure; (8) areal geology and geomorphology, erosion, degradation, weathering, stream incision rates, level studies; and (9) land and human resources. These research elements are gouped into three logical research tasks assigned to three individual research groups, each directed by a Principal Research Scientist (Fig. 4).

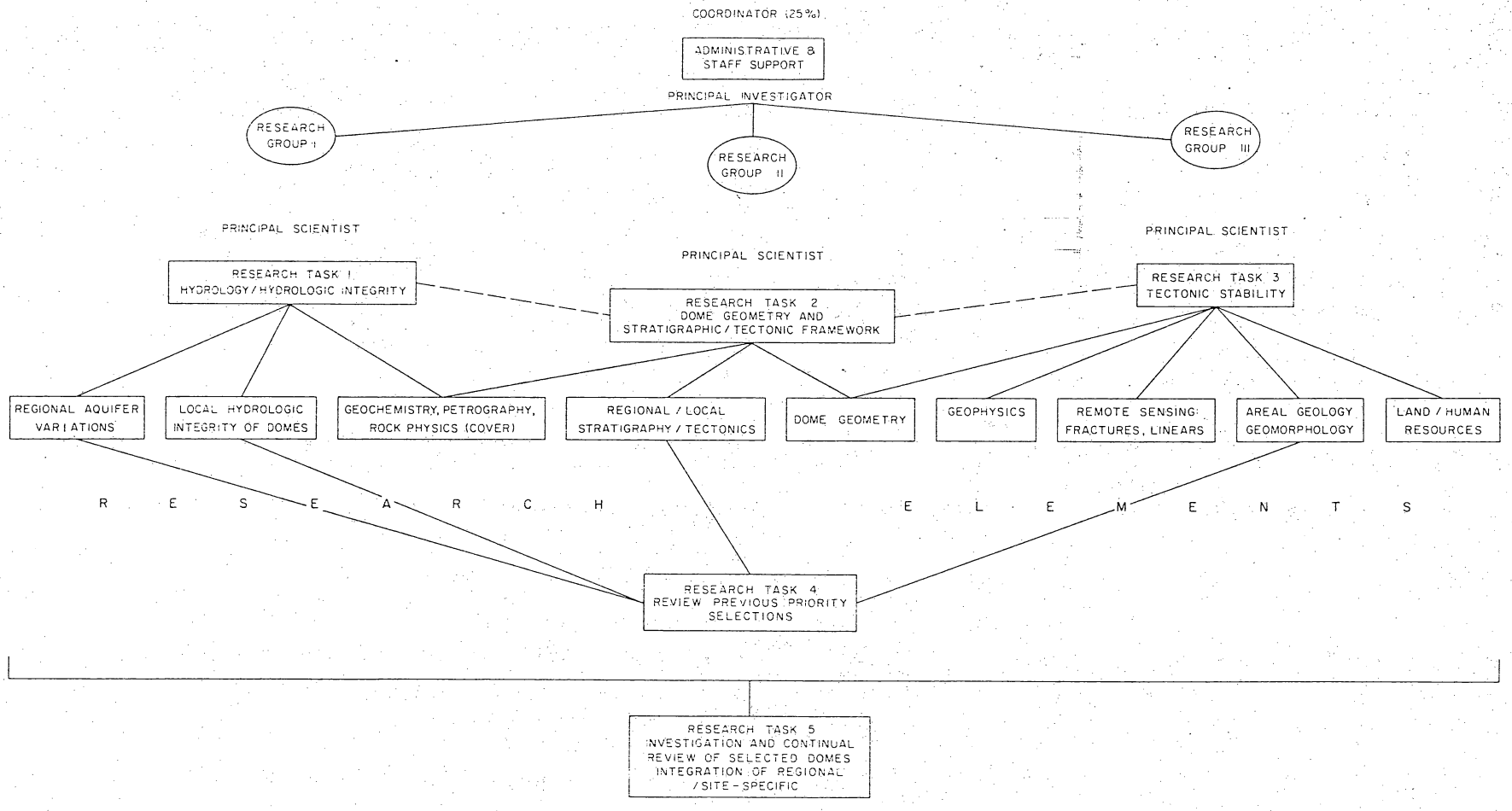

Figure 4. Structure of the proposed East Texas interior salt dome waste isolation program.

RESEARCH TASKS \ RESEARCH ELEMENTS	Regional aquifer variations, hydrologic parameters, hydrochemical facies	Local hydrologic integrity of dome areas, dissolution, water chemistry	Geochemistry, petrography, rock physics (cores), composition of dome, cap and adjacent formations, base-exchange capacities	Regional/local stratigraphy, facies, structural elements, salt history	Dome geometry, shape, bounding facies, faults	Geophysics: stability, microseismicity, internal/flank structure	Remote sensing, fractures, lineations, drainage anomalies, Quaternary stratigraphy	Geomorphology, erosion, degradation, weathering, stream incision rates, level analyses	Land and human resources
I. Hydrology/hydrologic integrity	X	X	X						
II. Dome geometry and stratigraphic/tectonic framework			X	X	X				
III. Tectonic stability					X	X	X	X	X
IV. Review: evaluate priority domes (review previous work)	O	O		O			O		
V. Investigations of priority dome(s): continuous review and selection(s). Integrate site-specific and regional analyses	X	X	X	X	X	X	X	X	X

Figure 5. Relationship of research elements and research tasks in evaluating nuclear waste isolation potential in salt domes of East Texas.

Research task 4 (fig. 6) involves the comprehensive review of previous data and conclusions in order to verify or reject prior evaluations. This review will involve all three research groups during the first three or four months of the program (FY 78). This short-term research task will provide initial conclusions concerning the East Texas domes and will be the basis for focusing site-specific studies and complementary regional analysis during the remainder of the program. It constitute short-lived but critical stage in the program.

Research task 5 (fig. 6) involves the continual integration of data and conclusions derived from each research element to evaluate, prioritize, and select the final recommended dome(s). Although each research group will concentrate on its specific objectives, the results collectively provide the basis for final dome(s) selection and documentation of its (their) stability and integrity for nuclear waste disposal.

III. 2. Hydrology and hydrologic integrity

One of the most critical factors concerning the emplacement of nuclear wastes in a salt dome is hydrogeology. Such studies must concern both the regional hydrologic variations and local hydrologic integrity at each aquifer and salt dome interface. It will be the basin hydrology research which will address the genetic relationships between regional ground-water flow and salt dome dissolution. Site-specific analyses of the hydrologic integrity of selected domes will determine the most suitable dome (from a hydrologic stability point of view), as well as permit a detailed evaluation of the interactions of local ground-water

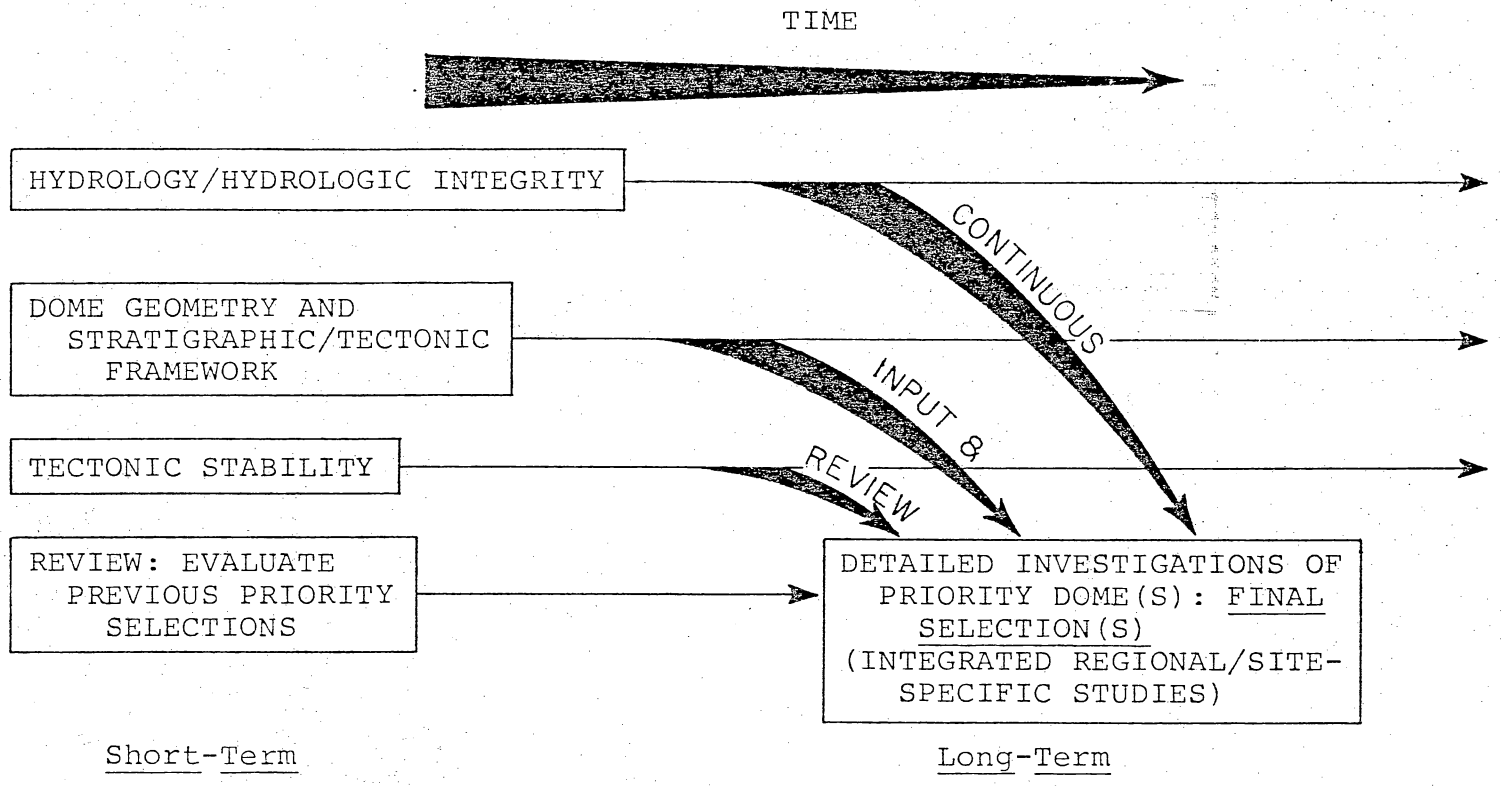

Fig. 6 . Continuous input of data and review of specific domes for safe waste isolation.

flow and the dome itself.

A short-term evaluation of the hydrologic parameters does not suffice to resolve significant questions. For example, there is lack of agreement in hydrologic dome stability as it has resulted from previous brief studies by Martinez and others (1976). The L.S.U. study recommends Keechi, Mt. Sylvan, Brooks and Palestine salt domes. Ledbetter and others (1975) recommend only White house and Mount Sylvan domes. The recent study of Netherland, Sewell and Associates (1976) recommends Bullard, Whitehouse and Keechi. We do not believe that these studies adequately considered the balance among regional and local hydrologic parameters in the determination of a specific recommendation.

III. 2. 1. Regional aquifer variations

A regional hydrologic analysis of the East Texas Basin surrounding selected domes is needed to define the normal hydrologic regimen which is interrupted by salt dome intrusives. From the standpoint of hydrologic control, an ideal dome will occur in sequential layers of essentially impermeable strata, dominantly mudstones. Therefore, the geometry and distribution of the individual sands and muds which make up each aquifer need to be determined and will be delineated in part from the regional stratigraphic studies as discussed later (III. 3. 2.). It is important to understand that most formally defined stratigraphic units in the basin are to varying degrees heterogeneous in composition, physical properties and hydrologic capacities. Within the permeable strata potentiometric surface mapping is a logical sequential step which will illustrate regional flow patterns of fluids.

An additional supplement to understanding direction of ground-water flow and the potential for dissolution of salt will be the mapping of hydrochemical facies.

Records of the Texas Water Board and results of the studies of the U. S. Geological Survey will be integrated toward developing potentiometric surfaces for the aquifers in the region. Also, the same sources will be examined for measurements of transmissivities. It will be especially helpful if there are records of pump tests in these files, as well as drill stem tests in the oil exploration data files. Unfortunately, much of the oil exploration data predates good fluid testing. Hydrochemical facies mapping can be accomplished by gathering older data on ground-water chemistry plus additional sampling where needed and by relating results to modern concepts of aquifer geometry.

A further clue to the geochemistry of the waters will rely on petrographic studies of regionally sampled strata (discussed in III. 3. 1.). The paleohistory of chemical reactions in aquifer beds may be a significant key to predicting future reactions between sediments and fluids.

A regional study of the hydrology of the East Texas area requires an integration of the geologic framework, potentiometric surface elevations and hydrochemical facies evolution. The final product will delineate major flow paths of fresh meteoric water and their downdip interactions with saline formation waters. This information is critical in understanding future salt dome dissolution.

III. 2. 2. Local hydrologic integrity of domes

Ultimately, the local hydrologic integrity must be established for any dome selected for nuclear waste isolation. This integrity will be supported by detailed examination of the local and regional data. We will be asking about the effect of a salt dome piercement and interruption of the regional ground-water flow pattern. Some domes develop surficial salines, whereas other salt domes develop saline plumes. Are these phenomena related to the orientation of the regional potentiometric surface or the local geology or both? Can salines be related to brine discharge from saline aquifers older than Wilcox?

In studies of local hydrogeology, the evolution of cap rocks must be understood (but also understood related to regional paleohydrology). It may be that a matrix approach can yield significant clues to relating dome height, geometry, size and uppermost area with the lithic composition of the pierced sediments and with the paleohydrology. The contact of the cap rock and the salt dome will be especially important in the local hydrologic studies.

Although most of the descriptive data base for regional geohydrologic studies may be available, more detailed and new measurements will be needed for the local geohydrologic studies. Coring of the interface of cap rock/salt and host sediments/salt are needed for hydrochemical, geochemical and petrographic analysis. Wherever fluids are encountered, it will be necessary to measure pressure and temperature of the fluids, as well as to sample the fluids. Observation wells must be drilled peripheral to the salt domes and piezometers installed for monitoring. Detailed

water level and potentiometric surface maps are absolute necessary in the immediate area over and around domes. It will be desirable to run aquifer pump tests for the measure of transmissivities of sediments and of hydrologic boundary conditions of the dome. These detailed studies can also determine the geohydrologic effects caused by the faults that intersect both salt and sediments.

To compliment the proposed studies, a ground-water modelling program should be developed. Rates of salt dissolution will be addressed by solute transport modelling. The effect of aquifer heterogeneities (lithofacies variations, salt domes and faults) on regional hydrology will be addressed by finite element modelling. The amount and the level of model sophistication is dependent on availability of field data.

III. 2. 3. Geochemistry, petrography and rock physics

The final acceptance of a salt host for the isolation of nuclear waste will be based on detailed studies of cores. As indicated from a series of mechanical and geophysical tests, the salt host must prove to be impermeable, and perhaps capable of annealing damages. It must be geochemically pure and not influenced by the surrounding geohydrologic regimen. This purity can be established from chemical and petrographic analysis.

III. 3. Dome geometry and stratigraphic/tectonic framework

This research task involves studies designed to provide (1) the data necessary to determine the geometry of salt domes; (2) the basic regional and local framework by which hydrologic and tectonic data can be assembled, mapped and interpreted; and

(3) the analysis and interpretation of cores which will be utilized also in hydrologic studies. Information supplied by geophysical studies associated with tectonic stability investigations will supplement stratigraphic data based on well logs in order to provide critical information on dome geometry.

The basic products of this task are stratigraphic and structural cross sections and maps of all types (isopacks, isochores, structural configurations, various derivative and/or trend surfaces, net or percent sand, permeability, among others). Data collected can be computerized to permit greater quantification and predictive capability.

III. 3. 1. Geochemistry, petrography and rock physics (cores)

This research element overlaps with the hydrologic task (Group I), which is responsible for evaluating and mapping dissolution, plumes, hydrochemical facies, and potentiometric data.

The role of stratigraphy involves initial description of any cores or any holes drilled as part of the geophysical program. Verification of lithic composition and fabric will aid both hydrologic and stratigraphic analyses. Later rock physics and petrographic analyses may aid interpreting any cap rock or solution zones.

Cores from the flanks of the dome(s) will help verify aquifer composition, base-exchange capacities, and stratigraphic interpretation from down-hole mechanical logs.

III. 3. 2. Regional and local stratigraphy

In order to provide the framework for hydrologic studies

and dome tectonic studies, the subsurface stratigraphic units must be correlated regionally within the East Texas Basin and specifically in the vicinity of candidate salt domes. Principal emphasis will be directed to the upper 2-3,000 feet, but deeper units will also be involved in order to evaluate later the piercement history of the dome(s).

Using available oil well, down-hole logs and seismic data available, a grid of cross sections will be constructed in and around the various domes. Structural elevation maps at various stratigraphic levels and on any major unconformities will provide the basis for isopach/isochore maps that are needed to measure the tectonic development of the basin and its constitutent domes and faults.

Facies interpretation based on logs or cores will provide the basis for interpreting lateral compositional variations in aquifers and aquicludes. Regional sand, sand percent and lithic component maps can be generated in order to provide a regional base with which to predict the stratigraphic sequence adjacent to domes, as well as provide the basis for interpreting and modelling aquifer systems and hydrochemical/hydrologic variations.

Careful analysis of isochore maps (and seismic sections) will provide the basis for tracing the rates of basin subsidence and, near salt domes, the piercement history (rate and variations) can be deciphered from such maps and sections. Graphs of piercement rates vs. time will provide estimates of Late Cretaceous and Tertiary salt movement in order to document any observable piercement rate decline.

III. 3. 3. Salt dome geometry

This research element is shared with research task 3 (tectonic stability) which will provide geophysical information (seismic, gravity and monitoring devices) to supplement conventional sub-surface stratigraphic data.

By constructing detailed isopach, isochore, and structural maps, as well as possible derivative and trend surface maps, the three-dimensional geometry of a dome can be estimated. If supplemented by seismic and gravity data, a very precise model of the dome can be formulated. Core data from the dome and flanks of the dome would permit even greater discrimination of dome geometry.

Studies of dome geometry include cap rock mapping (if any), overhands, marginal and crestal (radial) faults and preserved graben sequences, any dissolution evidence, and the traces of strata that terminate against the falnks of the dome. Ancillary data include fracture/linear traces and geomorphic anomalies.

III. 4. Tectonic stability

The tectonic stability of salt domes is a critical task equal to the significance of hydrologic integrity in most people's assessment of East Texas salt domes as potential hosts for nuclear waste isoltion. As a sidelight, the tectonic stability of interior salt domes is a subject of great interest to all geologists since this subject is a primary factor in all theories of salt dome evolution.

III. 4. 1. Salt dome geometry

One key to tectonic stability is the geometry of the salt

domes. The most obvious departure from regular geometry which suggests instability is a spine. Salt spines may occur on top of domes and intrude the youngest sediments in the area above the dome. In coastal domes, spines exhibit very recent instability (in geologic time). Although not reported for interior domes, the possibility of geometric variances somewhat less spectacular than spines must be tested.

Furthermore, in the final mining engineering of the cavity or burial ground to hold nuclear wastes, the geometry of a host salt dome must be known. The exterior limits of the salt dome as it contacts the pierced sedimentary strata must be delineated in detail to a depth of at least 3000 feet below ground surface. In addition any heterogeneity of the interior framework of the salt dome must be defined. Kupfer (1976) has suggested that the interior of a dome can resemble a bundle of pillars capable of separate movement. A spine would represent one pillar advancing at the expense of the remainder.

The determination of salt dome geometry will come from both concentrated borings and detailed seismic (reflection and refraction) surveys which employ the most modern and sophisticated techniques. Subtle clues to the geometry of salt domes may also occur in the sediments overlying and adjacent to the salt domes in the form of anomalies of facies tracts and tectonic structures.

III. 4. 2. Geophysical monitoring

Because the stability of a host salt dome must be proved without doubt to most critics, the geometry of salt domes is only

one parameter that indicates an acceptable degree of stability. A serious questions is whether an interior salt dome can move in short time periods and can this movement be detected? In this age of sophisticated geophysical instrumentation there is no doubt that dome movement would be detected during geophysical monitoring.

This evaluation will require the deployment of a set of instruments to monitor continuously for possible ongoing dome movement and the development of techniques to process and to assist in the interpretation of the resulting data. The system of instruments will very likely include subsystems to monitor both the transient and quasi-static components of earth movement. The sensing elements of the transient subsystem would consist of geophones, which respond to either the velocity or acceleration of earth motion at the observation point. These would be used to detect seismic waves generated by abrupt movements along pre-existing faults or other planes of weakness. By precisely timing the arrival of these waves at suitable chosen locations and knowing the local elastic wave velocity distribution, it is possible to estimate the location of their source in space and time. Thus, by continuously monitoring seismic radiation in close proximity to a salt dome, it may be possible to establish a history of movements which are occurring along faults or other zones of weakness. The quasi-static subsystem would consist of units to monitor continuously earth strains and tilts. Repeated geodetic levelling and horizontal distance measuring surveys will also supply important data on relative surface movement.

Simple borehold extensometers could be used to sense vertical

earth strains, while biaxial tiltmeters would be utilized to sense rotations in a vertical plane. Horizontal and vertical displacements of the surface of the earth would be detected through repeated horizontal distance-measuring and geodetic levelling surveys. Variations in the local atmospheric pressure, temperature and pore pressure can result in earth strains and tilts that may be large in comparison to deformations resulting from dome movement. Thus, it might be wise to monitor these phenomena in the vicinity of the extensometer and tiltmeter sites.

Data processing procedures should be developed to enhance the detection of the various types of signals. These techniques would be linear operators and could have applications ranging from the suppression of unwanted frequency components to the prediction and rejection of strains and tilts produced by environmental phenomena.

Reliable interpretation of the data will be facilitated through development of methods to simulate numerically any dome movement. Problems of this nature are usually resolved by application of finite element computational procedures and for precise simulation require, among other things, an accurate description of the elastic constants and the geometry of the system whose motion is to be modelled. Thus, supplementary investigations will have to be undertaken to provide this information.

It may be that the selection of sites for instrumentation could be as important as choice of types of instruments. Above a salt dome the most likely locale of initial instability might be a fault. Fortunately, many of special studies of this proposal can be instrumental in locating a fault, and one such study follows.

III. 4. 3. Fractures, lineations

A major concern in the program is the distribution of fracture systems. Their surficial representation will be linear elements interpreted from aerial photography supported by statistical comparison to field measurements of joints and faults. Lineaments on satellite imagery and lineations on aerial photography will be interpreted with reference to fractures. In turn the interpreted fracture zones are expected to be digitized and computations made to relate the abundance and orientation of fracture zones. Expected map products include (1) moving averages of the number, length and intersections per unit area and (2) rose diagrams, weighted arithmetic means and standard deviation in unit areas. Some experimentation with both polymonial surface fitting and fourier filtering is also expected. Fractures will be compared statistically with the location and orientation of surface and subsurface structural features, different ages of structural evolution, near surface and basinal sedimentary facies, and shallow and deep hydrology. In a more specific sense, fracture analyses of the surface and cores will also be related.

There is a potential for discovering three patterns of lineations: (1) a regional fracture pattern, (2) a salt intrusive or piercement pattern, and (3) a pattern of recent instability. The first and second patterns are expected to be clearly established. If the third pattern exists, it will be subtle. It is expected that only sophisticated statistical or filtering computations would reveal recent instabilities.

III. 4. 4. Areal and geomorphology

Very good areal geologic maps are already available for the East Texas basin and occur in publications and files of the Bureau of Economic Geology. Such maps are published in Geologic Atlas of Texas series at a scale of 1:250,000. Most base data for these maps is present on aerial photographs of 1:40,000 and 1:60,000 scale. This mapping negates the need for any regional areal geologic mapping. However, it is possible that very precise areal geologic mapping at scales of 1:24,000 and less will reveal important clues to the recent surficial history overlying interior salt domes. This possibility must be tested.

Areal geologic mapping will be supplemented by geomorphic mapping on both topographic sheets and aerial photographs. Any upward movement of salt must initiate erosion over the dome, perhaps leading to an abnormally entrenched stream. Furthermore, any sediments eroded from a relatively minor movement of salt must be deposited nearby and along a stream. It is expected that drainage pattern anomalies and local depositional surfaces are the primary clues to any recent instability of a salt dome. Drainage anomalies will be partially reflected in the lineation studies. It is known that drainage anomalies and minor depositional surfaces reflect salt dome movement in the coastal province (Tator, 1954). These elements, if present, will be more subtle in interior domes of the East Texas basin and may require precise levelling and age dating.

III. 4. 5. Land and human resources

An auxillary study of surficial and geomorphological mapping includes an inventory of land and human resources in the vicinity of salt domes of interest. The Bureau of Economic Geology has established an international reputation for developing such inventories from environmental geologic mapping. Whatever final decisions are made regarding the use of East Texas salt domes must depend on the impact of such use on local resources. The land and human resources data are derivatives of all the elements of the program described in this entire proposal.

III. 5. Review of previous studies and dome evaluations

During the first three or four months of FY 78 (Fig. 7) an intensive review and evaluation of previous investigations is scheduled. This short-term, but highly important, research task (4) will be undertaken by all research groups and will assess data, interpretations and conclusions contributed by Anderson and others (1973); Ledbetter and others (1975); Martinez and others (1975, 1976); and Netherland, Sewell and Associates (1975, 1976), and any other pertinent reports. This is primarily a review of available data; only selected new data will be reviewed in order to verify or clarify basic assumptions.

Domes considered to be satisfactory (at least on preliminary data) will be reviewed. Rapid review of the 13 "rejected" interior domes in East Texas will be made, followed by more intensive review of the 7 "unrejected" domes (Anderson and others, 1973). From the 20 total domes, a priority list will be prepared and data presented to document recommendations of domes that qualify for

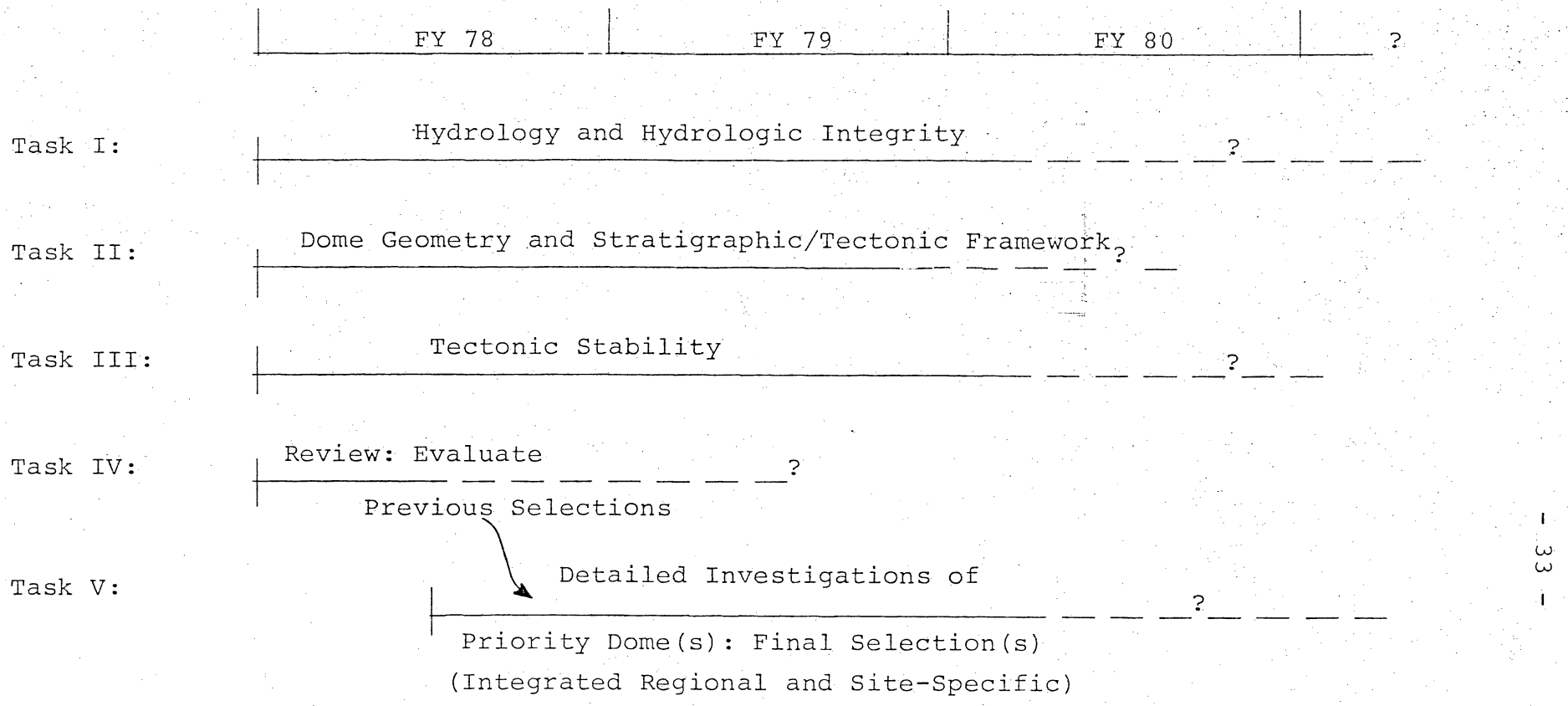

Figure 7. Chron chart showing proposed timing of research tasks in East Texas nuclear waste isolation program.

more intensive, site-specific analysis (Research task 5).

It is anticipated that by January or February 1978, a small number of high priority domes will be selected for further analysis.

III. 6. Investigation of priority dome(s)

Following the screening of East Texas interior salt domes during the first quarter of FY 78 (Fig. 7), more intensive studies will be initiated to reduce the list further or at least permit definite ranking of the remaining domes (Figs. 5, 6).

During this initial phase of task 5, an effort will be made by all research groups to locate, process and interpret additional available data (stratigraphic, hydrologic, structural) in order to discriminate further between domes on the priority list. We believe that, despite the excellent studies to date, considerable improvement in the data base and in operating concepts can be obtained by innovative use of available or extractable surface and subsurface information. Application of regional aquifer, hydrologic, and hydrochemical data using basin analysis and hydrologic systems concepts may permit significant improvement in our ability to predict both limitations and attributes of candidate domes. Maximum use and discrimination of available data should precede final commitment to expensive, site-specific studies, although early site-specific analysis might begin to evaluate various generic questions of East Texas domes. We anticipate that final selection of domes for geophysical and coring operations can be made early in the third quarter of FY 78. We do not, however, believe that such selection relieves us from contemporaneously maintaining intensive regional hydrologic and stratigraphic/

tectonic analyses.

At that time recommendations can be made for coring, geophysical monitoring and acquisition of seismic or gravity records at selected dome(s). More sophisticated analysis of available data, both in the vicinity of priority domes and in the region, should continue and be integrated with the growing volume of new information derived from the special site-specific studies. We believe that this integration is critical if we are to provide maximum documentation of the integrity and stability of a dome. Consequently, maximum work effort should be maintained on each research element, using both new and available data. This effort should continue into FY 79 and perhaps, FY 80, (1) until no doubt exists of the feasibility of one or two domes, (2) until it becomes obvious that none of the domes provide adequate isolation, or (3) until additional types of analyses become necessary to reach a final decision.

IV. Support studies and data collection

To support this proposal certain studies and operations must be performed by subcontractors. It is expected that Law Engineering Testing Company will be the group to contract studies and services which the Bureau of Economic Geology cannot perform. Although more such items can arise in the future, there is immediate concern for the contracting of (1) aerial photographic (remote sensing) collections, (2) geophysical monitoring, (3) a coring program, and (4) seismic and gravity geophysical surveys and/or purchases of available data.

IV. 1. Aerial photography

Initially, it is desired that the region including the salt domes of interest be covered with 1:80,000, quad-centered, high altitude, color infrared, aerial photography. Specifications for the flying and collection of the data must conform to U. S. Geological Survey standards determined in their 1:24,000 ortho-photo mapping program. Specifications for the processing and resulting positive color infrared transparencies must meet standards of the U. S. Department of Agriculture.

It is estimated that this contract will include approximately 800 line miles of data collection and will cost about $24,000.

IV. 2. Geophysical monitoring

The general requirements for geophysical monitoring were described in an earlier section of this proposal (III. 4. 2.). To fulfill these requirements it is necessary to construct and calibrate considerable hardware (e.g. tiltmeters, extensometers, geophones, etc.). It is believed that the same group which constructs the hardware should exercise the monitoring. The Bureau of Economic Geology does not have a capability in these specializations.

BEG would recommend that this phase of the study be subcontracted. BEG would coordinate the results of geophysical monitoring with all other tasks (Fig. 4). In fact, BEG should recommend monitoring sites as result of lineation analyses and areal and geomorphologic mapping.

Based on other bids for geophysical monitoring, an investment of $250,000 per year 1 and $60,000 per year thereafter is good

estimate of costs.

IV. 3. Coring program

A coring program herein includes all boreholes because, in addition to cores of salt, numerous shallow borings may be drilled into the cap rock and top of the salt and into neighboring sediments. The purposes of these borings have been defined in the technical proposal under hydrology and dome geometry. Recommendations of what domes will be initially cored will be determined three to six months after start-up. A good estimate seems to be at least two core holes in FY 78.

The Bureau of Economic Geology recommends that an East Texas firm be employed in all land acquisition and drilling and that drilling be contracted on a turnkey basis. Many difficult political problems are solved in this way, resulting in an expeditious program overall.

It is estimated that two core holes may cost as much as $1,000,000 and supplementary borings may approach $300,000.

IV. 4. Seismic and gravity geophysical surveys

In the technical discussions the value of seismic, reflection and refraction, as well as pravity geophysical surveys are suggested. These techniques will contribute to outlining salt dome geometry. Sophisticated digital processing of seismic data may even locate areas of salt dissolution. Since the East Texas basin is an old petroliferous province, modern seismic records are probably not available. Therefore, new lines will be recommended following an initial technical evaluation which may take up to

six months. Costs in this area are not known at this time.

V. Chronology

A chronology, which has been estimated to complete the principal research tasks, is shown in Figure 7. Estimates for completions of tasks are conservative, because the Bureau of Economic Geology is directly responsible to the Governor and people of Texas to ascertain without question the ultimate safety for planning isolation of nuclear wastes in East Texas salt domes.

One strength of Bureau investigations has resulted from their charter to map a very large state, approaching 270,000 square miles. That strength is a clear understanding of the need for a regional perspective before finally accepting site-specific studies. This has best been proved in Bureau land, water, mineral and energy resource studies over many years.

As shown in the chronology chart (Fig. 7) Tasks I to III reflect the above precepts. Both regional and site-specific studies of hydrology, dome geometry, and tectonic stability will proceed contemporaneously for an estimated two plus years. An initial review of all previously published data will be included in the first three or four months. Thereafter, supplementary coring, drilling and geophysical surveys will proceed. From mid-FY 78 until project termination, a regular review and evaluation of the most appropriate salt domes for isolation of nuclear wastes will continue.

BUDGET

FY 78: October 1, 1977 - September 30, 1978

SALARIES

Administration

Directoral		$ 2500
* Principal Investigator	(25%)	6250
Purchasing Officer	(25%)	2600
Editor II	(50%)	7686
Cartographer I	(50%)	5694
Tech Staff Assistant	(50%)	6230
Mag Keyboard Operator	(50%)	5508
Senior Secretary	(80%)	8028

Research Group I: Hydrology/hydrologic integrity

* Principal Scientist	(25%)	6250
Research Scientist	(60%)	22,000
Research Scientist Associate	(100%)	16,400
2 Graduate Research Assistants	(50%)	10,560
Senior Clerk Typist	(50%)	4896

Research Group II: Dome geometry and stratigraphic/tectonic framework

Principal Scientist	(100%)	23,000
2 Research Scientists	(100%)	36,000
1 Research Scientist Associate	(100%)	13,000
2 Graduate Research Assistants	(50%)	10,560
Senior Clerk Typist	(50%)	4896

Research Group III: Tectonic stability

Principal Scientist	(100%)	23,000
2 Research Scientists	(100%)	36,000
Research Scientist Associate	(100%)	13,000
2 Graduate Research Assistants	(50%)	10,560
Senior Clerk Typist	(50%)	4896

	$ 279,514
VACATION AND SICK LEAVE (0.6% of salaries)	1677
FRINGE BENEFITS (8.5% salaries)	23,759
INDIRECT COSTS	156,528
	$ 461,478

BUDGET (Continued)

EXPENDABLE SUPPLIES		$ 10,000
SPECIAL SERVICES		
Printing		3000
Computer (20 hrs. @ $260/hr.)		5200
Digitizing		2400
Core handling		4000
Radiometric dating		3000
Porosity/permeability analyses		4500
Water analyses		2000
Chemical analyses		3000
Programmer		1500
Well data surveys		9000
	Services subtotal	$ 37,600
SPECIAL EQUIPMENT		
Integrated depth sampler		800
Zoom transfer scope accessories		1220
Richards manual "T" bracket		220
Coulter counter accessories		2500
Stephens staff gauges		102
	Equipment subtotal	$ 4,842
RESEARCH MATERIALS		
Sequential aerial photography		10,000
Sample logs		24,300
Oil/gas well maps		2400
Electric logs		9000
Scout tickets		9000
	Materials subtotal	$ 54,700
TRAVEL		
Fieldwork and sample collection		
Per diem - 140 days @ $30/day		4200
Mileage - 40,000 miles - $.18/mile		7200
Technical presentation		
8 trips @ $300/trip		2400
Liaison with Oak Ridge and Washington		
8 trips @ $400/trip		3200
	Travel subtotal	$ 17,000
	OTHER THAN SALARIES SUBTOTAL	$124,142
	GRAND TOTAL	$585,620

SELECTED REFERENCES

Anderson, R. E., Eargle, D. H., and Davis, B. O., 1973, Geologic and hydrologic summary of salt domes in Gulf Coast region of Texas, Louisiana, Mississippi and Alabama: U. S. Geological Survey Open File Report, USGS 4339-2, 294 p.

Kupfer, D. H., 1976, Shear Zones inside Gulf Coast salt stocks help to delineate spines of movement: Amer. Assoc. Petroleum Geol. Bull., V. 60, p. 1434-1447.

Ledbetter, J. O., Kaiser, W. R., and Ripperger, E. A., 1975, Radioactive waste management by burial in salt domes: Engineering Mechanics Research Laboratory, The University of Texas at Austin, Contract AEC AT-(40-1)-4639.

Martinez, J. D., Kupfer, D. H., Thomas, R. L., Smith, C. G., Kolb, C. R., 1975, An investigation of the utility of Gulf Coast salt domes for the storage or disposal of radioactive wastes: Report No. ORNL-Sub-4112-10, Institute for Environmental Studies, Louisiana State University, Baton Rouge, Louisiana, 204 p.

Martinez, J. D., Thomas, R. L., Kupfer, D. H., Smith, C. G., Jr., Kolb, C. R., Newchurch, E. J., Wilcox, R. E., Manning, T. A., Jr., Romberg, M., Lewis, A. J., and Rovik, J. E., 1976, An investigation of the utility of Gulf Coast salt domes for the storage or disposal of radioactive wastes: Report No. ORNL-Sub-4112-25, Institute for Environmental Studies, Louisiana State University, Baton Rouge, Louisiana, 329 p.

Netherland, Sewell and Associates, 1975, Preliminary study of the present and possible future oil and gas development of areas immediately surrounding the interior salt domes, upper Gulf Coast salt dome basins of east Texas, north Louisiana, and Mississippi as of December 1975: Dallas, Texas. Unpublished report for Holifield (Oak Ridge) National Laboratory; purchase Order No. 78X-87988V (Union Carbide Corp.)

Netherland, Sewell and Associates, 1976, Geologic study of the interior salt domes of northeast Texas salt-dome basin to investigate their suitability for possible storage of radioactive waste materials as of May, 1976: Dallas, Texas. Unpublished report for Holifield (Oak Ridge) National Laboratory, Purchase Order No. 78X-99939 V. (Union Carbide Corp.)

Tator, B. A., 1954, Drainage anomalies in coastal plains region: Photogrammetric Eng. V. 20, p. 412-217.

VIII. CAPABILITY OF THE BUREAU OF ECONOMIC GEOLOGY

VIII. 1. Introduction

The Bureau of Economic Geology was established, in the words of the Board of Regents, realizing

> "the necessity of keeping the University in close touch with the affairs of the State, the importance in multiplying the bonds of mutual interest that connect the University with the citizens of the State, and the significance of furthering the utilization of the State's natural and mineral resources."

This statement reflects the purpose of the Bureau as well today as it did in 1909 when the Bureau was created. The types of programs that accomplish these ends have changed over the years; however, the fundamental purpose of making geologic research serve the needs of the State and its citizens, both professionals and laymen, has not.

The Bureau of Economic Geology maintains State-wide programs in basic and applied research, systematic mapping, and public service in the areas of geology, environmental problems, mineral and natural resources, earth materials and processes, and resource use and statistics. The Bureau serves Texas as its state geological survey; however, it has no regulatory responsibility but maintains strong ties with all State governmental agencies concerned with natural resources. It conducts cooperative programs and projects with numerous State and federal agencies. The Bureau is a member of the Interagency Council on Natural Resources and Environment, the Texas Mapping Advisory Committee and many other standing

committees and boards. The Bureau has had a significant role in the Coastal Management Program of Texas.

Results of Bureau research are disseminated principally through reports issued as part of its own publication series and through numerous national and international journals. Research colloquia on current research are presented annually and scores of invited papers are presented throughout the United States each year by Bureau research scientists. The Bureau has a scientific staff of approximately 35 full-time professionals, including 16 doctorate-level scientists. A supporting staff includes cartographic, administrative, clerical, technical and editorial personnel. Approximately 60 graduate students are employed annually in research support positions. The Bureau maintains a Mineral Studies Laboratory and Well Sample and Core Library at Balcones Research Center which provide support for Bureau research programs and a service to Texas residents.

HISTORY

VIII. 2. History

The Bureau of Economic Geology was established in 1909 by the Board of Regents as an organized research unit of The University of Texas. It became the successor to several short-lived State geological surveys created and terminated by Texas legislatures during the latter half of the 1800's. Although a research unit of The University of Texas, the Bureau has, since 1909, been recognized as the equivalent of other state geological surveys and is a member of the Association of American State Geologists. Its Director serves as the State Geologist of

Texas. Hence, the Bureau functions dually as an organized research component of The University of Texas at Austin and as a quasi-State agency, the Texas Geological Survey. Since its founding, the Bureau has provided many of the basic ideas, concepts and data that have aroused interest in and led to the discovery of many major mineral and energy resources by private industry in the State. Not only has the Bureau of Economic Geology provided the principal source of geological expertise on Texas for the public sector, many of the ideas and techniques have spread nationally and internationally through 68 years of scientific publications. In addition Bureau scientists have formally and informally contributed to the academic program of The University of Texas at Austin throughout its history.

VIII. 3. Current Activities

The Bureau's 1976 annual report (enclosed) summarizes current activities in research, teaching and public service. A list of projects currently underway is presented here.

Research

Energy and Mineral Resources

Resource Assessment of the Geopressured Geothermal Resources of the Texas Gulf Coast

In Situ Gasification of Texas Lignite

Uranium Potential and Genetic Stratigraphy of the Triassic Dockum Group of the Texas Panhandle

Uranium Potential of the Catahoula Formation, Texas Coastal Plain -- A Stratigraphic, Depositional and Geochemical Evaluation

Uranium in Volcanic Terranes, Trans-Pecos Texas

Earth Science Education -- Curriculum Materials on Energy Resources of Texas

Texas Mineral Atlas

Sand and Gravel Resources of Texas

Index of Texas Mineral Producers (Exclusive of Oil and Gas Producers)

Texas Carbonate Materials: Suitability for Sulfur Dioxide Removal

Mineral Production in Texas

Depositional Systems in the Ogallala Formation of the Llano Estacado and the Occurrence of Ground Water

Reconnaissance Geothermal Resource Assessment of the Rio Grande Valley, Trans-Pecos Texas

Selection of a Geopressured-Geothermal Test Well Site, Texas Gulf Coast

Land Resources and Environmental Geology

Land Resources of Texas: Mapping and Classification

Statewide Land Use Map

Landslide Incidence and Susceptibility in Texas

Environmental Geologic Atlas of the Texas Coastal Zone

The Guadalupe-San Antonio-Nueces River Basins Regional Study

Land Resources and Environmental Impact, East Texas Lignite Belt

Reactor Siting Hazards: Faulting and Fault Activation in the Texas Coastal Zone

Criteria for Coastal Zone Management (Methodology to

Evaluate Impacts of Alternative Policy Decisions: Applications in the Texas Coastal Zone)

Urban Geology of the Greater San Antonio Area

Environmental Aspects of Geothermal Energy Production

Coastal Geology

Historical Monitoring of the Texas Gulf Coast Shoreline

LANDSAT Investigation for the Texas Coastal Zone

Sediment Budget of Galveston Island

Geology of Padre Island National Seashore

Geology of State-Owned Submerged Lands, Gulf of Mexico

Geologic Mapping

Geologic Atlas of Texas

Geologic Quadrangle Mapping in Central Texas

Other Research Projects

Virgil-Wolfcamp Facies, Eastern Shelf, North-Central Texas

Carbonate Facies and Porosity Distribution of the Subsurface Sligo Formation, South Texas

Comparative Sedimentology of Modern and Ancient Coarse-Grained Terrigenous Clastics

Nitrogen Isotopes of Nitrate and Ammonium in Natural Waters, Texas

Composition and Origin of Tektites

VIII. 4. Public Service and Support Facilities

In addition to conducting basic and applied research programs, the Bureau of Economic Geology provides a variety of advisory, technical, and information services relative to the geological, mineral and land resources of the State. These services are available to individuals, companies, and govern-

mental bodies and agencies.

Principal dissemination of information is through the publication of reports and maps; these are sold as a price designed to recover the cost of printing. All materials developed as part of ongoing research programs are available for examination and study at the Bureau offices.

Staff members respond to individual requests for information that are received daily by letter, by telephone, and from visitors. The Bureau maintains cooperative programs with several State and federal agencies and local units of government. A variety of information is made available through research colloquia and workshops, continuing education, public lectures, and invited legislative testimony.

The Bureau maintains a Mineral Studies Laboratory at Balcones Research Center. This lab supports research programs of the Bureau and makes tests and evaluations of rock and mineral samples submitted by Texas residents. The Bureau also maintains a Well Sample and Core Library, established by the Texas Legislature in 1937. This library, housed at Balcones Research Center, is the public repository for cores and samples from a large number of wells drilled in Texas. Facilities are provided at the library so that any interested person may examine and study these materials.

The Bureau of Economic Geology maintains a Reading Room located on the fifth floor of the Geology Building on the main campus of The University of Texas at Austin. This facility is open to the public and houses publications pertaining to Texas geology and natural resources.

VIII. 5. Personnel

Perhaps the best reflection of the capability of the Bureau of Economic Geology is its people. The vitae of those professionals who are expected to contribute to the program outlined in this proposal follow this page.

PROFESSIONAL SUMMARY

LEONARD FRANKLIN BROWN, JR.

PERSONAL VITA

Business Address

The University of Texas at Austin
University Station, Box X
Austin, Texas 78712
(512) 471-1534

Home Address

4127 Honeycomb Rock Circle
Austin, Texas 78731
(512) 345-0412

Current Positions

Associate Director, Bureau of Economic Geology *and* Professor, Department of Geological Sciences, The University of Texas at Austin

Private Consultant: Geologic Education and Industrial Consulting (outside of Texas)

Area Specialties

Basin analysis (including seismic stratigraphy), facies interpretation, mineral/energy exploration, land and environmental resources, geologic education, geologic mapping, and field studies

Personal

Born June 1, 1928, Seminole, Oklahoma
Married: Mettie L. Roots, December, 1956; one daughter, March, 1960
Social Security: 440-28-6348

Academic Background

1953-55	University of Wisconsin Geology; Soil Science Minor Dissertation: A Paleoecologic Study of Foraminifera in Selected Pennsylvanian Cyclothems	Ph.D. (1955)
1951-53	University of Wisconsin Geology Thesis: Description and Stratigraphic Relationship of a Carboniferous Cephalopod Fauna, Confusion Range, Utah	M. S. (1953)
1948-51	Baylor University Geology; Chemistry Minor	B. S. *cum laude*
1946-48	Oklahoma State University Zoology and Chemistry	

Drumright High School, Drumright, Oklahoma, graduated valedictorian, 1946

PROFESSIONAL EXPERIENCE

Administrative Positions and Experience

Associate Director of Research, Texas Bureau of Economic Geology since 1971; directing a variety of research projects funded by federal, state, and regional governments. Operation involves a staff of 35 senior scientists, 30 research assistants, and 30 support personnel. Responsible (since 1977) for mineral-energy research program. Principal Investigator on government research grants. Interaction with state, federal, regional, industrial groups, and environmental agencies.

Research Positions and Experience

1971- Associate Director, Bureau of Economic Geology, The University of Texas at Austin

1966-71 Research Scientist, Bureau of Economic Geology, The University of Texas at Austin

Summers 1961, 1962,1963 Research Scientist, Bureau of Economic Geology, The University of Texas at Austin

1957-60 Research Scientist V, Bureau of Economic Geology, The University of Texas at Austin

1951-55 Wisconsin Alumni Research Assistant, research on x-ray diffraction of clay minerals

Personal research has principally involved (1) comprehensive depositional systems analysis of Upper Paleozoic basins in Texas including surface and subsurface facies analyses, mapping, paleogeographic reconstruction, and mineral/energy potential; (2) Pleistocene and Holocene depositional systems analysis of the Texas Coastal Zone, including processes, environments, and facies; (3) interpretation of terrigenous clastic facies (outcrops, cores, E-logs and seismic data) and development of interpretive depositional models and criteria; (4) innovating environmental geologic (land resource) analysis with special consideration of coastal zone problems. See publications and lectures; (5) seismic-stratigraphic analysis concepts in petroleum exploration.

Current research projects include both individual research studies and team programs.

(1) Environmental Geologic Atlas of the Texas Coastal Zone. With W. L. Fisher, C. G. Groat, and J. H. McGowen. Comprehensive environmental inventory of 20,000 square miles of the coastal zone. Published in 7 individual atlases with 63 multicolored maps, text, and statistics.

(2) Depositional systems analyses of Upper Pennsylvanian and Lower Permian strata on the eastern flank of the West Texas Basin. With many students. Comprehensive surface and subsurface analysis of fluvial, deltaic, shelf and slope depositional systems. Several aspects in preparation for publication. Application to mineral/energy resources and the environment.

(3) Terrigenous clastic depositional systems: A genetic approach to stratigraphy. With W. L. Fisher. Text on principal depositional systems, modern models, and ancient process related analogs.

(4) Pleistocene geology of the Texas Coastal Region (including map).

(5) Texas statewide geologic map (1:500,000).

(6) Systematic analysis of Texas basins: A geology of Texas series (in planning).

(7) Resume of Brazilian offshore basins involving seismic-stratigraphic methods. With W. L. Fisher. Awaiting Petrobras release. Based on 4-year study.

Industrial Positions and Experience

Exploration Geologist, Standard Oil Company of Texas (Chevron), 1955-57. Short-term consulting: Petroleo Brasileiro—Petrobras (1973-); Chevron (1974-); Amoco (1975-); Anaconda (1974-); Mobil (1973-); Instituto Mexicano del Petroleo (1974-); Kerr-McGee (1975-); Shell (1977-); Gulf (1977-); Home Oil, Ltd. (1976-).

Teaching Positions and Experience

1971- Professor of Geological Sciences, The University of Texas at Austin

1966-71 Lecturer, Department of Geological Sciences, The University of Texas at Austin

1963-66 Associate Professor, Baylor University

1960-63 Assistant Professor, Baylor University

1953 Instructor, University of Wisconsin summer field course

1949-51 Instructor, Baylor University

Teaching experience involves undergraduate, graduate, and industrial/professional education. At Baylor University (1960-66), taught a variety of undergraduate and graduate courses including physical geology, historical geology, paleontology, and stratigraphy; supervised 6 master's theses and served on 6 master's committees. Obtained several research grants from government and industry for student research. At The University of Texas at Austin (1966-), taught Terrigenous Depositional Systems (1969-); supervised 4 Ph.D. students and 4 master's students; served on numerous Ph.D. and M.S. examination and theses committees.

Originated and/or participated in many continuing education courses, symposia and lecture series.

(a) Delta Systems in the Exploration for Oil, Gas, and Other Minerals (sponsored by Texas Bureau of Economic Geology): Austin (1969), Midland (1970). Shreveport (1970), New Orleans (1971), Lafayette (1971), Houston (1972), San Antonio (1972), Corpus Christi (1972), Casper (1973), Midland (1973)

(b) Environmental Geology and Land Resources Management Symposia: Milwaukee (AGI:GSA) (1970), New Orleans (1971), Houston (AGI:AAPG) (1971), Austin (1972), Anchorage (1973), Stillwater (1974), Austin (1974)

(c) American Association of Petroleum Geologists Continuing Education Courses (1974-): Billings (1975), Bogota (1975), Caracas (1975), Lexington, U.S.G.S. (1975), Oklahoma City, Kerr-McGee (1975), Dallas, Soc. Econ. Geophysicists (1976); Vail (1976); Houston (1977); Calgary (1977); Monterrey (1977); Casper (1977)

(d) Short Courses on Basin Analysis and/or Seismic Stratigraphy (continuing basis): Instituto Petroleo del Mexicano (1974-), Chevron (1974-), Amoco (1975-), Anaconda (1974-76), Petrobras (1973-); University of Houston short course in geophysics

(e) American Association of Petroleum Geologists Distinguished Lecturer (1972-73): Presented lectures to 60 associations and universities

(f) More than 50 lectures and talks to state, federal, and science groups on Environmental Geology (1970-)

(g) More than 25 talks or field conferences to geological groups on depositional systems analysis

(h) Five-month Petrobras training/research program in basin analysis/seismic stratigraphy (1973-74; 1974-75; 1975-76): With W. L. Fisher and E. G. Wermund. Involves training two geologists and two geophysicists in Austin each year; 1976-1977 Evaluation of Foz do Amazonas Exploration Program

MEMBERSHIP IN PROFESSIONAL OR LEARNED SOCIETIES

Phi Eta Sigma (Freshman Honorary Society), 1947

Phi Kappa Phi (Honorary Scholastic and Leadership Society), 1954

Sigma Xi (Scientific Research Society), 1955

National Association of Geology Teachers, 1956

Member, Geological Society of America, 1957

Fellow, Texas Academy of Science, 1962

American Men and Women of Science, (1965-)

Fellow, Geological Society of America, 1966

Society of Economic Paleontologists and Mineralogists, 1967

Permian Basin Society of Paleontologists and Mineralogists, 1969

Who's Who in the South and Southwest (1972-)

Who's Who in America (1977-)

Who's Who in American Government (1977-)

HONORS AND AWARDS

Honors and Awards Received

Wisconsin Alumni Research Foundation Fellow, 1952-55

1st Honorary Life Member, Permian Basin Section, Economic Paleontologists and Mineralogists, 1960

American Geological Institute Visiting Geoscientist, 1965

Ranked 8th out of 240 faculty members, Baylor University student evaluation, teaching effectiveness, 1965-66

Best Paper Award, Gulf Coast Association of Geological Societies, Miami, 1969

American Geological Institute Visiting Geoscientist, 1971

American Association of Petroleum Geologists Distinguished Lecturer (60 lectures), 1972-73

American Association of Petroleum Geologists Continuing Education (lecturer, 1974-)

LEADER OF PROFESSIONAL FIELD CONFERENCES

Leader, Geological Field Conference, Permian Basin Section, Society of Economic Paleontologists and Mineralogists, North-Central Texas, 1960

Leader, Geological Field Conference, Southwest Section, American Association of Petroleum Geologists, North-Central Texas, 1960

Co-leader (with E. G. Wermund) of Field Conference on Shelf Deposition in North-Central Texas for annual meeting of American Association of Petroleum Geologists, Dallas, 1969

Leader, Field Trip for Coal Division, Annual Geological Society of America Meeting, Dallas, 1973

Leader (with E. G. Wermund) of Permian Basin S.E.P.M. Conference on Clastic and Carbonate Depositional Systems in North-Central Texas, 1976

EDITORSHIPS OR ORIGINATOR OF GEOLOGIC PUBLICATIONS

Originated and edited *Baylor Geological Studies* Bulletins, 1960-66

Supervised and edited a series of geological field guidebooks as sponsor of Baylor Geological Society, 1960-66

Regional editor and contributor to *Comanchean Symposium*, Permian Basin Society of Economic Paleontologists and Mineralogists, 1965-66

Editor, 4th Forum on Industrial Minerals, 1968

Continuing editorial duties, Bureau of Economic Geology. Evaluation of submitted manuscripts (about 30 per year)

SCIENTIFIC PUBLICATIONS

Reports

Stratigraphy of the Blach Ranch–Crystal Falls section (Upper Pennsylvanian), northern Stephens County, Texas. The University of Texas, Bureau of Economic Geology Report of Investigations No. 41, 1960, 3 pls., 1 table, 6 figs., 41 p.

A stratigraphic datum, Cisco Group (Upper Pennsylvanian), Brazos and Trinity Valleys, North-Central Texas. The University of Texas, Bureau of Economic Geology Report of Investigations No. 46, 8 pls., 3 figs., 2 tables, 35 p., 1962.

(With J. H. McGowen, C. G. Groat, W. L. Fisher, and A. J. Scott). *Effects of Hurricane Celia–A focus on environmental geologic problems of the Texas coastal zone*. The University of Texas at Austin, Bureau of Economic Geology, Geological Circular 70-3, 39 p., 1970.

(With W. L. Fisher, A. W. Erxleben, and J. H. McGowen). *Resource capability units, their utility in land and water-use management with examples from the Texas coastal zone*. The University of Texas at Austin, Bureau of Economic Geology, Geological Circular No. 71-1, 22 p., 4 figs., 1971.

(With W. L. Fisher, J. H. McGowen, and C. G. Groat). *Environmental geologic atlas of the Texas coastal zone–Galveston-Houston area*. L. F. Brown, Jr., Project Coordinator. The University of Texas at Austin, Bureau of Economic Geology, 9 colored maps, 22 figs., 7 tables, 91 p., 1972.

(With W. E. Galloway). *Depositional systems and shelf-slope relationships in Upper Pennsylvanian rocks, North-Central Texas*. The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 75, 4 pls., 31 figs., 3 tables, 40 p., 1972.

(With W. L. Fisher and J. J. Malina). *Evaluation of sanitary landfill sites, Texas coastal zone—Geologic and engineering criteria*. The University of Texas at Austin, Bureau of Economic Geology, Geological Circular 72-3, 18 p., 3 figs., 4 tables, 1972.

(With W. L. Fisher, J. H. McGowen, and C. G. Groat). *Environmental geologic atlas of the Texas coastal zone—Beaumont-Port Arthur area*. L. F. Brown, Jr. Project Coordinator. The University of Texas at Austin, Bureau of Economic Geology, 9 colored maps, 20 figs., 7 tables, 93 p., 1973.

(With R. A. Morton, J. H. McGowen, C. W. Kreitler, and W. L. Fisher). *Natural hazards of the Texas Coastal Zone (atlas)*. The University of Texas at Austin, Bureau of Economic Geology, 18 figs., 6 tables, 7 maps, 13 folio p., 1974.

(With J. H. McGowen, C. V. Proctor, Jr., T. J. Evans, W. L. Fisher, and C. G. Groat). *Environmental geologic atlas of the Texas coastal zone—Port Lavaca area*. L. F. Brown, Jr., Project Coordinator. The University of Texas at Austin, Bureau of Economic Geology, 9 colored maps, 33 figs., 13 tables, 107 p., 1976.

(With J. H. McGowen, T. J. Evans, C. G. Groat, and W. L. Fisher). *Environmental geologic atlas of the Texas coastal zone—Kingsville area*. L. F. Brown, Jr., Project Coordinator. The University of Texas at Austin, Bureau of Economic Geology, 9 colored maps, text in press, 1976.

(With J. H. McGowen, T. J. Evans, W. L. Fisher and C. G. Groat). *Environmental geologic atlas of the Texas coastal zone—Bay City-Freeport area*. L. F. Brown, Jr., Project Coordinator. The University of Texas at Austin, Bureau of Economic Geology, 9 colored maps, 29 figs., 13 tables, 98 p., 1976.

(With J. L. Brewton, J. H. McGowen, T. J. Evans, W. L. Fisher and C. G. Groat). *Environmental geologic atlas of the Texas coastal zone—Corpus Christi area*. L. F. Brown, Jr., Project Coordinator. The University of Texas at Austin, Bureau of Economic Geology, 9 colored maps, 32 figs., 13 tables, 123 p., 1976.

(With C. G. Groat, J. L. Brewton, T. J. Evans, J. H. McGowen and W. L. Fisher). *Environmental geologic atlas of the Texas coastal zone—Brownsville-Harlingen area*. L. F. Brown, Jr., Project Coordinator. The University of Texas at Austin, Bureau of Economic Geology, 9 colored maps, text in press, 1976.

(With R. S. Kier and L. E. Garner). *Land Resources of Texas*. The University of Texas at Austin, Bureau of Economic Geology, in press, 1977.

Articles

Problems of stratigraphic nomenclature and classification, Upper Pennsylvanian, North-Central Texas. American Association of Petroleum Geologists Bulletin, v. 43, no. 12, 1959, p. 2866-2871.

Geometry and distribution of fluvial and deltaic sandstones (Pennsylvanian and Permian), North-Central Texas. Transactions of the Gulf Coast Association of Geological Societies, XIX, (1969), p. 23-47. (Reprinted by The University of Texas at Austin, Bureau of Economic Geology, Geological Circular 69-4, 1969.)

(With P. T. Flawn and W. L. Fisher). *Environmental geology and the coast—rationale for land-use planning*. Journal of Geological Education, v. XVIII, p. 85-86, 1970.

(With W. E. Galloway). *Depositional systems and shelf-slope relations on cratonic basin margin, uppermost Pennsylvanian of North-Central Texas*. American Association of Petroleum Geologists Bulletin, v. 57, 1973, p. 1185-1218.

(With W. L. Fisher). *Environmental geologic atlas, Texas Coastal Zone--the role of geology in land use planning*. Gulf Coast Association of Geological Societies, Transactions, v. 24, p. 4-24, 1974.

(With W. L. Fisher). *Environmental atlas of the Texas Coastal Zone and its role in land use planning*. Proceedings, 25th Annual Highway Geology Symposium (May 23, 24), Raleigh, N. C., 13 figs., 4 tables, p. 94-120, 1974.

Critical role for geologists in resource and environmental management. American Association of Petroleum Geologists, Bulletin, v. 58, no. 9, p. 1771-1780, 1974.

(With R. S. Kier and L. E. Garner). *Application of Texas land resources map*. Gulf Coast Association of Geological Societies, Transactions, v. 27 (in press), 1977.

(With W. L. Fisher). *Seismic-stratigraphic interpretation of depositional systems: Examples from Brazilian rift and pull-apart basins*. American Association of Petroleum Geologists Memoir 26 on Seismic Stratigraphy, (in press), 1977.

(With J. U. Ricoy). *Depositional systems in the Sparta Formation (Eocene), Gulf Coast of Texas*. Gulf Coast Association of Geological Societies, Transactions, v. 17 (in press), 1977.

(With S. W. Bailey, L. M. Cline, and J. S. Lister). *Clay mineralogy in relation to deltaic sedimentation patterns of Desmoinesian cyclothems in Iowa-Missouri*. Clays and Clay Minerals, (in press), 1977.

Books and Manuals

(With W. L. Fisher, A. J. Scott, and J. H. McGowen). *Delta Systems in the exploration for oil and gas: A research colloquium*. Austin: The University of Texas at Austin, Bureau of Economic Geology, 1969, 212 p.

(With W. L. Fisher). *Clastic depositional systems--A genetic analysis: Annotated outline and bibliography*. The University of Texas at Austin, Bureau of Economic Geology, 1972, 211 p.

(With A. W. Cleaves and A. W. Erxleben). *Pennsylvanian depositional systems in North-Central Texas: A guide for interpreting terrigenous clastic facies in a cratonic basin*. Bureau of Economic Geology, The University of Texas at Austin, 1973, 122 p.

Abstracts

Problems of stratigraphic nomenclature and classification, Upper Pennsylvanian, North-Central Texas. Southwestern Federation of Geological Societies, Lubbock, Texas, 1960. *Program abstracts.*

Urban geology of Waco: A project sponsored by Baylor University and Cooper Foundation. Texas Journal of Science, v. XVI, no. 4, 1964, p. 456-466.

The stratigraphic framework of surface and near-surface Upper Pennsylvanian and Lower Permian rocks, North-Central Texas. Southwestern Federation of Geological Societies, Austin, Texas, 1965. *Program abstracts.*

(With J. H. McGowen, M. J. Seals, T. H. Waller, and J. R. Ray). *Role of compaction in development of geometry of superposed elongate sandstone bodies*. American Association of Petroleum Geologists Bulletin, v. 51, no. 3, p. 455-456, 1967.

Shelf model for Late Pennsylvanian and Early Permian deposition in North-Central Texas. South-Central Section, Geological Society of America (Printed Program) (1968), p. 12-13.

(With J. L. Goodson). *Sedimentary versus contemporaneous tectonic control of fluvial-deltaic deposition*. Geological Society of America, Abstracts with Program (1969) Part 2, 4.

Virgil and Wolfcamp fluvial, deltaic, and interdeltaic embayment depositional systems in North and West-Central Texas. American Association of Petroleum Geologists Bulletin, v. 55, no. 1, p. 151-152, 1971.

(With W. E. Galloway). *Recognition of fluvial and deltaic sandstones of Pennsylvanian and Permian ages in North-Central Texas*. American Association of Petroleum Geologists Bulletin, v. 55, no. 2, p. 332, 1971.

South Texas eolian system—A model of coastal eolian processes. Transactions, Gulf Coast Association of Geological Societies, v. 22, p. 58, 1973.

Environmental geology and land management. Abstracts with Program, Southeastern Geological Society of America, no. 5, p. 381, 1972.

(With A. W. Cleaves and A. W. Erxleben). *Deltaic systems within evolving forcland and cratonic basins, North-Central Texas*. American Association of Petroleum Geologists and Society of Economic Paleontologists and Mineralogists, Annual Meeting Abstracts, v. 1, p. 12-13, 1974.

Chapters

"A Review of Pennsylvanian clay mineral industries, North-Central Texas." In *A Guide to the Strawn and Canyon Series of the Pennsylvanian System in Palo Pinto County, Texas*, W. C. Hamilton, Jr., (ed.). Texas Geological Society, 1958. (Reprinted 1959 by Bureau of Economic Geology, Mineral Resource Circular No. 39.)

"Traverse of post-Cisco rocks, Brazos Valley, North-Central Texas." In *Field trip guidebook, Permian Basin Section, Society of Economic Paleontologists and Mineralogists*, 1 pl., 1 table, 16 figs., 46 p. (Field Trip Leader), 1960.

(With O. T. Hayward). "Comanchean (Cretaceous) rocks of Central Texas." In *Comanchean (Lower Cretaceous) stratigraphy and paleontology of Texas*, Leo Hendricks (ed.). Midland: Permian Basin Section, Society of Economic Paleontologists and Mineralogists, 1967, p. 31-48.

"Virgil and Lower Wolfcamp repetitive environments and the depositional model, North-Central Texas." In *Symposium on cyclic sedimentation in the Permian Basin*, Jack G. Elam and Stewart Chuber (eds.). Midland: West Texas Geological Society, 1969, p. 115-134. (Reprinted by Bureau of Economic Geology, The University of Texas at Austin, Geological Circular 69-3, 1969).

"Late Pennsylvanian paralic sediments." In *A guidebook to the Late Pennsylvanian shelf sediments*, North-Central Texas, L. F. Brown, Jr., and E. G. Wermund (eds.). Dallas: Dallas Geological Society, 1969, p. 21-33.

(With W. L. Fisher). "An approach to environmental geology with examples from the Texas coastal zone." In *American Geological Institute, Short course lecture notes*, Milwaukee, 1970. (In conjunction with the Geological Society of America annual meetings.)

(With C. G. Groat). "Environmental Geologic Atlas of the Texas Coast: Basic data for coastal zone management." In *Proceedings, Conference on tools for coastal zone management*, Marine Technology Society, Washington, D. C., 1972, p. 1-15.

"Environmental inventory: Innovation in geology and geologic presentation." In *Approaches to environmental geology* (E. G. Wermund, ed.). The University of Texas at Austin, Bureau of Economic Geology, Rept. Inv. 81, p. 3-11, 1974.

(With W. L. Fisher). "Environmental Geologic Atlas of the Texas Coastal Zone." In *Approaches to environmental geology* (E. G. Wermund, ed.). The University of Texas at Austin, Bureau of Economic Geology, Rept. Inv. 81, p. 25-51, 1974.

"Role of sediment compaction in determining geometry and distribution of fluvial and deltaic sandstones." In *Compaction of coarse-grained sediments, I: Developments in sedimentology*, ISA (G. V. Chilingarian and K. H. Wolf, eds.) Elsevier Scientific Publishing Co., Amsterdam, 1975, p. 247-292.

Books Edited

(Co-editor with E. G. Wermund). *A Guidebook to the Late Pennsylvanian shelf sediments*, North-Central Texas. Dallas: Dallas Geological Society, 1969, 69 p.

Proceedings Edited

(Editor-in-Chief). *Proceedings, Fourth forum on geology of industrial minerals*. Austin: Bureau of Economic Geology, The University of Texas at Austin, 1968, 174 p.

Maps

"Abilene Sheet." In *Geological atlas of Texas*, Virgil E. Barnes, Director. Bureau of Economic Geology, The University of Texas at Austin. Multicolored map and accompanying text.

Unpublished Industrial Reports

(With C. S. Baumgarten, J. A. Estrela Braga, and W. L. Fisher). Depositional systems and petroleum potential, Foz do Amazonas area, Brasil. Petroleo Brasileiro S. A., Dexpro-Divex, 23 figs., 54 p., 1974.

(With M. V. Dauzacker, M. Saito, and W. L. Fisher). Depositional systems and petroleum potential, Santos Basin, Brasil. Petroleo Brasileiro S. A., Dexpro-Divex 25 figs., 53 p., 1975.

(With A. Fugita and K. Tsubone). Depositional systems and petroleum potential, Barreirinhas Basin, Brasil. Petroleo Brasileiro, S. A., Dexpro-Divex, 1976.

Evaluation of the oil and gas potential of the Late Tertiary reservoirs, Foz do Amazonas area, Brasil. Petroleo Brasileiro S. A., Dexpro-Divex, 40 figs., 163 p., 1977.

(With W. L. Fisher). Fluvial and deltaic systems in the exploration for oil, gas and other minerals. Home Oil Company, Ltd., manual, Calgary, 160 p., 1976.

TESTIMONY AND COMMITTEE SERVICE

Chairman, Society Econ. Paleontologists and Mineralogists. Shelf Symposium, Annual Meeting, American Association of Petroleum Geologists, Dallas, 1969.

Testimony, U. S. Corp of Engineers Public Hearings, shell dredging permits for Matagorda Bay, Port Lavaca, Texas.

Testimony (written) to Texas Senate Committee on pipelines and beaches, Austin, Texas, 1971.

Testimony (with W. L. Fisher), Texas Water Development Board Coastal Environmental Hearings, Port Aransas, 1971.

Panelist, Coal Policy, Forum on Energy Resources and Mineral Plant Food, National Materials Policy Commission and The University of Texas, 1972.

Testimony on Land Use, Texas Legislature Committee on Land Use, 1973.

National Environmental Committee, American Association of Petroleum Geologists (1973-).

Member of Texas Land Use Committee, Interagency Council on Resources and Environment, Office of the Governor, 1973.

Program Committee, Annual Meeting, American Association of Petroleum Geologists, San Antonio, 1974.

Review Environmental Impact Statements for Division of Planning Coordination, Office of the Governor (1974-).

Chairman, Sedimentology Session, Annual Meeting, American Association of Petroleum Geologists, Dallas, 1975.

Seagrants Advisory Council, Texas A and M University (1975-77).

Associate editor, the American Association of Petroleum Geologists, Tulsa, Oklahoma (1976-).

INVITED LECTURES (1970-)

Texas Christian University, Fort Worth, Texas, 1970.
North Texas Geological Society, Wichita Falls, Texas, 1970.
KLRN Radio Program on Coastal Environmental Geology, 1971.
Louisiana Technical University, Ruston, 1971.
Northeastern Louisiana State University, Monroe, 1971.
Pick and Hammer Club, USGS, Denver (with W. L. Fisher), 1972.
Alamo Council of Governments, San Antonio (with W. L. Fisher), 1972.
Coastal Environmental Conference, Austin, 1972.
Oklahoma Environmental Institute, Oklahoma State University, Stillwater, 1972.
Association of Engineering Geologists, Arlington, Texas, 1972.
Symposium on Environmental Geology, Texas Academy of Science, San Marcos, 1972.
Symposium on Solid Waste Disposal, American Association for the Advancement of Science, Philadelphia, 1972
American Association of Petroleum Geologists Distinguished Lecture Series (1972-73)

Dallas Geological Society
Houston Geological Society
Mississippi Geological Society
Oklahoma City Geological Society
Kansas Geological Society
University of Kansas
University of Iowa
Iowa State University
University of Nebraska
Liberal Geological Society
Panhandle Geological Society
West Texas Geological Society
Abilene Geological Society
Corpus Christi Geological Society
South Texas Geological Society
Austin Geological Society

Texas Tech University
Alaska Geological Society
Alberta Geological Society
Amherst (4-college Lecture Series)
Arizona State University
Colorado School of Mines
Duke University
Edmonton Geological Society
Four-Corners Geological Society
Grand Valley State College
Los Angeles Geological Society
McMaster's University
Memphis State University
Michigan Basin Geological Society
Montana Geological Society
North Carolina State University
Northern Arizona State University
Northern California Geological Society
Northern Illinois University
Northern Ohio Geological Society
Northwest (Seattle) Geological Society
Pennsylvania State University
Philadelphia Geological Society
Rocky Mountain Geological Society
Roswell Geological Society
Shreveport Geological Society
State University of New York-Binghampton
University of Alabama
University of Cincinnati
University of Illinois
University of Michigan
University of Notre Dame
University of Rochester
University of Tennessee
Wayne University
West Virginia University
Wyoming Geological Society
University of Texas

National Sigma Gamma Epsilon Annual Meeting, Arlington, Texas, 1973 (Banquet speaker).
Governor's Planning Office and University of Mississippi, Jackson, 1973.
Organization for Preservation of Unblemished Shorelines, Corpus Christi, Texas, 1973.
Southeastern Section, Geological Society of America, Knoxville, Tennessee, 1973 (Keynote address).
University of Texas at El Paso, 1974.
Mobil Research Labs, Dallas, 1974.
Fort Worth Geological Society, 1974.
Petrobras: Petroleo Brasileiro, Rio de Janeiro, 1974, 1975, 1976, 1977.
Closed-Circuit T. V., Oklahoma Education: Environmental Management, Stillwater, Oklahoma, 1974.
Coastal Zone Management Conference, General Land Office of Texas, 1974.
Earth-Resources Section, NASA, Johnson Space Center, 1974.
Permian Basin Society of Economic Paleontologists and Mineralogists, 1975, 1976.
Texas A and M University, Coastal Zone Management Seminar, 1976.
Penrose Conference, Geological Society of America, Austin, 1976.
Texas Christian University, 1977.

RESUME FOR EDMUND GERALD WERMUND, JR.

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Austin, Texas 78712
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PLACE OF BIRTH: Arlington, New Jersey, USA April 15, 1926

EDUCATION:

Franklin and Marshall College, B. S. in Geology, 1948
Washington University, 1948-1950
Louisiana State University, Ph.D. in Geology, 1961

PROFESSIONAL EXPERIENCE:

October 1971 - Present: Associate Director, Bureau of Economic Geology, The University of Texas at Austin. Responsible for administering personnel and research contracts, liaison with Texas agencies, and directing research on land resource inventories, remote sensing and coastal studies.

May - June 1971: Consultant to United Nations. Responsible for contract specifications in remote sensing and geological engineering on the Trans-Saharan Highway; primarily the location of water. Worked with a team of three technologists and government officials of Algeria, Mali and Niger.

January 1970 - April 1971: Technical Manager with Remote Sensing, Inc., Houston, Texas. Responsible for developing remote sensing applications and markets. Developed remote sensing technology to map earth fractures, to explore for ground water, and to measure oil spills. Published two papers on this technology; wrote RSI brochure.

June 1957 - January 1970: Research Associate with Mobil Research and Development Corporation, Dallas, Texas. Responsible for initiating, completing, and reporting research on petroleum and mineral exploration problems; liaison and consultation with operating company; and part-time management of a geology section. In the forefront of modern geology including computer mapping of facies, statistics, remote sensing, and operations research, as well as fundamental stratigraphic-sedimentologic studies.

September 1952 - June 1957: Instructor in Department of Geology, Louisiana State University, Baton Rouge, Louisiana. Responsible for teaching Physical Geology, Historical Geology, Rocks and Minerals, Sedimentation, Geomorphology, Seminars, and Summer Field Camp.

PROFESSIONAL EXPERIENCE (Cont'd):

Other: Party Chief for three exploring lignite deposits in North Louisiana. Consultant to two companies on Louisiana lignite deposits. Summer experience as a junior mining engineer evaluating silver-lead deposits. Summer experience in surface geologic mapping in Alaska.

PROFESSIONAL SOCIETIES:

Geological Society of America, Fellow
American Association of Petroleum Geologists
Society of Economic Paleontologists and Mineralogists
American Association for the Advancement of Science
American Society of Photogrammetry
Austin Geological Society
Sigma Xi

AWARDS AND HONORARY SOCIETIES:

1950	Elected Associate Member of Sigma Xi
1954	Honorable Mention, National Science Foundation
1954-56	Magnolia Oil Company Fellow
1965	Elected Fellow in Geological Society of America

PUBLICATIONS - See attached list

PUBLICATIONS

Brooks, J. E., Wermund, E. G., and Williams, T. E. (1969) Shallow shelf sedimentation in rock record: Introduction to symposium (abst.): Bull. Amer. Assoc. Petrol. Geol., vol. 53, p. 709.

Brown, L. F., Jr., and Wermund, E. G. (1969) Guidebook to Late Pennsylvania Shelf Sediments, North Central Texas: Dallas Geol. Soc., 73 p.

Harvey, J. R., Foster, M. R., and Wermund, E. G. (1966) Preferred alignments of salt domes in southern Louisiana, in Second symposium of salt, Rau, J. L., Ed.: No. Ohio Geol. Soc., pp. 85-94.

Selig, Franz, and Wermund, E. G. (1966) Families of salt domes in the Gulf Coastal Province: Geophysics, vol. 31, pp. 726-740.

Wermund, E. G. (1955) Fracture patterns in northwest Louisiana: Bull. Amer. Assoc. Petrol. Geol., vol. 39, pp. 2329-2336.

(1961) Glauconite in early Tertiary sediments of Gulf Coastal Province: Bull. Amer. Assoc. Petrol. Geol., vol. 45, pp. 1667-1696.

(1964) Geologic significance of fluviodetrital glauconite: Jour. Geol. vol. 72, pp. 470-476.

(1965) Cross-bedding in the Meridian Sand: Sedimentology, vol. 5, pp. 69-79.

(1965) Extrapolated settling velocity of muscovite -- an unsatisfactory basis for geologic inference (abst.): Geol. Soc. Amer. Spec. Paper 82, p. 313.

_____, and Jenkins, W. A. (1965) Late Missourian tilting of the Eastern Shelf of the West Texas Basin (abst.): Geol. Soc. Amer. Spec. Paper 82, pp. 220-221.

_____, and _____ (1965) Missourian shelf of West Texas Basin (abst.): Permian Basin Sect., Soc. Econ. Paleont. Mineral., Midland, Texas.

_____ (1966) Missourian facies in the Possum Kingdom Vicinity, Palo Pinto County, Texas: Jour. Grad. Res. Center, vol. 35, pp. 143-167.

_____, Kenny, G. S., and Burke, W. H. (1966) K-Ar ages of detrital muscovite in the Meridian Sand of Alabama and Mississippi: Bull. Geol. Soc. Amer., vol. 77, pp. 319-322.

_____, and Moiola, R. J. (1966) Opal, zeolites, and clays in an Eocene neritic bar sand: Jour. Sed. Petrology, vol. 36, pp. 248-253.

_____, and Jenkins, W. A. (1968) Late Pennsylvanian sand deposi-

tion in north-central Texas (abst.): South-Central Sect., Geol. Soc. Amer., p. 40.

_____, and _____ (1969) Late Pennsylvanian shelf of north-central Texas (abst.): Bull. Amer. Assoc. Petrol. Geol., vol. 53, p. 749.

_____, and Hile, B. D. (1970) Oil pollution monitoring with remote sensors: 9th Texas Water Pollution Control Assoc. Conf., p. 10.

_____, and Jenkins, W. A. (1970) Recognition of deltas by fitting trend-surfaces to Upper Pennsylvanian sandstones in north-central Texas, in Deltaic sedimentation, Morgan, J. P., Ed.: Soc. Econ. Paleont. Mineral. Spec. Publ. No. 15, pp. 256-269.

_____ (1971) Hydrogeologic prospecting with remote sensors in arid terrains: Trans. of IEEE in Geoscience Electronics, vol. GE 9, pp. 120-131.

Kennedy, J. M. and _____ (1971) Oil spills, IR and microwave; Photogrammetric Engineering, vol. 37, p. 1235-1242.

_____ and True, C. (1972) Determining the significant environmental units in a thick carbonate terrane (abst.): Program annual meetings Geolo. Soc. Amer., p. 704.

_____ (1973) Conduits in the Edwards limestone recharge and aquifer beds (abst.): Program annual meetings, Geol. Soc. Amer., p. 860.

_____ (1974) A review of the symposium, geology and management in the coastal zone: institutional perspectives, area perspectives; Geology, vol. 2, p. 135.

_____, Joseph C. Cepeda and Ann E. Bell (1974) Fracture patterns in the southern Edwards Plateau, Texas (abst.), Geol. Soc. America Abstracts, p. 129.

_____, R. A. Morton, P. J. Cannon, C. M. Woodruff and D. E. Deal, (1974) Test of environmental geologic mapping, southern Edwards Plateau, southwest Texas; Geol. Soc. America Bull., vol. 85, p. 423-432.

_____ (1974) Economic applications from environmental geologic mapping, southern Edwards Plateau, Texas (abst.); Amer. Assoc. Petrol. Geologists, Annual Meeting Abstracts, p. 98 and Austin Geological Society.

_____ (1974) Environmental units in carbonate terranes as developed from a case study of the southern Edwards Plateau and adjacent coastal plain; in Approaches to Environmental Geology, E. G. Wermund, ed., Univ. Texas, Austin, Bur. Econ. Geology Rept. Inves. 81, p. 52-78.

_____ and C. T. Waddell (1974) Adapting biologic assemblages data for environmental needs; in Approaches to Environmental Geology, E. G. Wermund, ed., Univ. Texas, Austin, Bur. Econ. Geology Rept. Inves. 81, p. 236-246.

_____ and C. A. Caughey (1974) A numeric code for describing rocks in sedimentary basins; Univ. Texas, Austin, Bur. Econ. Geology Circ. 74-3, 28 p.

_____ (1975) Upper Pennsylvanian limestone banks, north central Texas; Univ. Texas, Austin, Bur. Econ. Geol. Circ. 75-3, 34 p.

_____, L. F. Brown, Jr. and W. L. Fisher (1975) Regional inventories and mapping of land resources and environmental geology using remotely sensed data (abst.); NASA Earth Resources Survey Symposium, Houston, Texas, p. 152.

_____(1975) Land resource units for planning in carbonate terranes (abst.); Inf. Assoc. Hydrologists, 12 Int. Congress - Karst Hydrogeology, p. 88.

_____(1975) Relation of fracture zones to the Edwards limestone aquifer (abst.); Int. Assoc. Hydrologists, 12th Int. Congress - Karst Hydrogeology, p. 89.

_____, L. F. Brown, Jr. and W. L. Fisher, 1975, Regional inventories and mapping of land resources and environmental geology using remotely sensed data, in Semistad, Olar (Coord.), Proceedings of NASA Earth Resources Survey Symposium: NASA TMX-58168, JSC-09930, p. 1029-1058.

_____, and Cepeda, J. C., 1976, Toward solving regional movement of ground water through fractured limestones in the Edwards aquifer (Abst.); Geol. Soc. America Abstracts with Programs, vol. 8, no. 6, p. 1164-1165.

_____, (1976), Remote sensing in Texas agencies: past and present; Proceedings of Remote Sensing for Land and Management in the South and Southwest, Texas A&M University, College Station, Texas, p. 52-64.

_____,and Cepeda, J. C., 1977, Regional relation of fracture zones to the Edwards Limestone Aquifer, Texas, in J. S. Tolson and F. L. Doyle (eds.); Karst Hydrogeology, Internat. Assoc. Hydrogeologists, Proc. 12th Internat. Corp., Mem. V. XII, p. 239-253.

_____,and Woodruff, C. M., Jr., 1977, Land resource units for planning in carbonate terranes, in J. S. Tolson and F. L. Doyle (eds.) Karst Hydrogeology: Internat. Assoc. Hydrogeologists, Proc. 12th Internat. Corp., Mem. V. XII, p. 339-353.

UNPUBLISHED PAPERS, REPORTS, PROPOSALS PREPARED AS COMPANY REPORTS:

Columbia Southern Chemical Corporation

1955 Lignite reserves in northwest Louisiana

Mobil Research and Development Corporation

1958 Opportunity for Submarine Mining of Precious Stones and Metalliferous Ores; 12 pp.

1959 Structure and Isopach of the Missourian and Virgilian Series in North-Central Texas; folio of 9 pp. with maps and text, coauthor.

1959 Limestone Stratigraphic Traps; typed report of 60 pp., coauthor.

1960 Geology of the Possum Kingdom Vicinity -- Sedimentary Facies Relationships; 100 pp. with 11 illustrations, 1 map.

1960 Surface Texture classification of Sand and Silt Particles from the Winchell Formation; 15 pp. coauthor.

1962 The Distribution of Sedimentary Facies on a Model Shelf, Upper Pennsylvanian of North-Central Texas; 26 maps and text in folio.

1962 Submarine Economic Deposits Other than Fuels; 8 pp.

1963 Salt Dome Dynamics, Part IV: Salt Domes in the Coastal Region; 30 pp. text, 11 figures, coauthor.

1963 Code for Digitizing Lithologic Data; 5 pp., coauthor.

1964 Extrapolated Settling Velocity of Muscovite -- An Unsatisfactory Basis for Geologic Inference; 30 pp.

1964 Potential of Airborne Sensors in Geologic Exploration; 20 pp., 16 illustrations, coauthor.

1965 Temperature Distribution in Salt Domes and Surrounding Sediments; 30 pp. 10 figures, coauthor.

1965 A Statistical Test for Preferred Alignments of Points; 20 pp. 8 illustrations, coauthor.

1965 Thermal Anomalies over Ore Bodies; 18 pp., 12 illustrations, coauthor.

1965 Preferred Alignments of Salt Domes in Southern Iran; 8 pp.

1966 Prospective Infrared Anomalies in Disseminated Copper Mining Areas of Arizona and New Mexico; 75 pp., coauthor.

1966 An Exploration System; 30 pp.

UNPUBLISHED PAPERS, REPORTS, PROPOSALS PREPARED AS COMPANY REPORTS (Continued):

Mobil Research and Development Corporation (Continued)

1967 Examples of Trend Surface Analyses of Facies Data; 10 pp.

1967 Late Pennsylvanian Terrigenous Sand Deposition in North-Central Texas; 50 pp.

1969 A Statistical Evaluation of Geological Contoured Prospecting Methods; 50 pp.; coauthor.

Remote Sensing, Inc.

1970 Remote Sensing Application in the Petroleum and Natural Gas Business

1970 Remote Sensors for Hydrogeologic Prospecting in Arid Terrains

1970 Proposal to Prospect for Ground Water in Saudi Arabia

1971 A Proposal to Prospect for Water and Minerals in Muscat-Oman

1971 A Proposal to Prospect for Water and Minerals in Jordan

1971 A Proposal for Hydrothermal Prospecting in Ethopia Using Infrared Line Scanning

1971 Proposal: Airborne Survey in Lesotho for Kimberlites

1971 Remote Sensing in Mineral Exploration Programs

United Nations

1971 Areas of Potential Water Supplies for Construction of Trans-Sahara Highway

Petrobras

1976 Depositional Systems in Tuscano Basin - Relation to Oil and Gas

Governor's Office

1977 A Multiple Land-Use Plan for Camp Swift Military Reservation, Texas

University of California
Department of Geology and Geophysics

R E S U M E

Richard L. Andersen
621 Hillsborough St.
Oakland, California, 94606
(415) 893-3247

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GRADUATE STUDIES

Fields of Concentration: Urban Geology, Environmental Impact Analysis

M. S. Thesis Topic: Geology and Slope Stability Analysis of the Mitchell Canyon Landslide, Mt. Diablo, Calif. [This is a case study evaluating the feasility of urban development in landslide areas, using computer analysis, airphoto interpretation, infrared photogeology, and field mapping and soil strength testing.] June, 1974.

PRE-GRADUATE EDUCATION

Military: U.S. Army Signal School, Fort Monmouth, New Jersey. Honor Graduate of Microwave Communication Course, 1969.

College: Bachelor of Science Degree, Utah State University, Department of Geology, Logan, Utah, 1968.

EMPLOYMENT AND EXPERIENCE

1972-1973: National Oceanic and Atmospheric Administration Sea Grant Internship, University of California, Berkeley. Compiled and organized a computer inventory of probable geological and other environmental impacts resulting from resource development projects.

1968-1971: Microwave Radio Crewchief and Repairman. Maintained and repaired a variety of microwave and undersea cable communication equipment.

1967-1969: Collected native plant materials for the Albert Einstein Medical Research Center in Philadelphia, Pennsylvania.

1966-1968: Laboratory Assistant, Department of Physics, Utah State University. Responsible for student laboratory equipment.

SPECIAL INTERESTS

Photography, experimental electronics, botany, astronomy, mechanics

-continued-

REFERENCES

Professor Clyde Wahrhaftig, Department of Geology and Geophysics, University of California, Berkeley, California, 94720

Mr. Jens C. Sorensen, Institute of Urban and Regional Development, University of California, Berkeley, California, 94720

Professor Arthur H. Holmgren, Herbarium, Department of Botany, Utah State University, Logan, Utah, 84321

Professor William R. Houston, Department of Geotechnical Engineering, University of California, Berkeley, California, 94720

RESUME

Graham E. Fogg, Jr.
Dept. of Hydrology and Water Resources
Old Psychology Building
University of Arizona
Tucson, Arizona 85713
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HOME ADDRESS:
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PERSONAL DATA: Age: 23
Marital Status: Married
Health: Excellent

EDUCATION: University of New Hampshire
Degree: Bachelor of Science, '75
Major: Hydrology

University of Arizona
Degree: M.S. Candidate, '77
Major: Hydrology

MAJOR INTERESTS: Geology; Water quality problems; Tracer methods in ground-water hydrology; The use of digital and mathematical models in solving ground-water problems.

SCIENTIFIC SOCIETY MEMBERSHIPS: American Water Resources Association
National Water Well Association

PROFESSIONAL EXPERIENCE:

July 1, 1976 - present
Research Assistant, Dept. of Hydrology, University of Arizona
Digital ground-water modeling study with Professors S. P. Neuman and E. S. Simpson. Responsibilities: research the hydrogeology of the Tucson Basin, direct model input data acquisition, test three of today's most advanced ground-water flow models on their advantages and disadvantages, use one of the models to solve an unsaturated flow problem, analyze all aspects of the results, and compose a thesis based on some of the findings.

November 1, 1975 - June 15, 1976
Research Assistant, Dept. of Hydrology, University of Arizona
Unsaturated flow study with Professor S. P. Neuman.
Responsibilities: learn the theory of the unsaturated flow of water in porous media, and perform research on the hysteresis phenomenon.

May, 1975 - August, 1975
Engineering Aid II, Hydraulics Sect., Design Div., N.H. Highway Dept.
Studied and compiled information on rainfall-runoff relationships for small watersheds of different characteristics in New Hampshire. The job included both field and office work.

May, 1974 - August, 1974
Engineering Aid II, Hydraulics Sect., Design Div., N.H. Highway Dept.
Researched and compiled information on erosion and sedimentation control; and participated in flood routing procedures in the design of highway drainage systems. The job included both field and office work.

REFERENCES:

Dr. John W. Harshbarger
Dr. Stanley N. Davis
Dr. Shlomo P. Neuman
Professors of Hydrology
Dept. of Hydrol. & Water Resources
University of Arizona
Tucson, Arizona 85713

Mr. Joseph I. Grady
Head, Hydraulics Section
Design Division
N. H. State Highway Department
John O. Morton Building
Loudon Road
Concord, New Hampshire 03301

RESUME

PERSONAL:

Name: Edgar Humberto Guevara-Sanchez
Place of birth: San Cristobal, Tachira, Venezuela, So. America
Nationality: Venezuelan
Date of birth: 18 July 1942
Social Security Number: 457-06-1597
Current Address: Apdo. 829, Caracas 101 Venezuela

DEGREES:

Ph.D. (Geology), The University of Texas at Austin, 18 May 1974
M.A. (Geology), The University of Texas at Austin, 20 May 1972
Geologo, Univ. Central de Venezuela, Caracas, 5 February 1965

NON-ACADEMIC COURSES:

Stratigraphic Interpretation of Seismic Data, AAPG, Houston, September 1976 (40 hours)
Exploration Geology, Shell Training Centre, The Hague, Holland, November 1967-June 1968
Counseling Techniques, Caracas, 1976 (40 hours)
Managerial Grid, Caracas, 1974 (40 hours)
Effective Writing, Caracas, 1969 (20 hours)

PROFESSIONAL ASSOCIATIONS:

Colegio de Ingenieros de Venezuela
Sociedad Venezolana de Geologos
Associacion Venezolana de Geologia, Mineria y Petroleo
American Association of Petroleum Geologists
International Association of Sedimentologists

PROFESSIONAL EXPERIENCE:

Head of Stratigraphic Section, Exploration Dept., Comp. Shell Venezuela (Maraven S. A. as of 1 January 1976), Caracas, December 1975-
Assistant Professor (part-time), Univ. Central Venezuela, Caracas, September 1975-August 1976 (Historical Geology)
Geologist, Evaluation Section, Creole Petr. Corp., Caracas, June-November 1975 (Regional Geology/Stratigraphy)
Research Scientist Associate V, Bureau of Economic Geology, The University of Texas at Austin, Oct. 1974-June 1975
Assistant Professor (part-time), Univ. Central Venezuela, Caracas, January-Aug. 1974 (Stratigraphy, Historical Geology)
Exploration and Production Geologist, Comp. Shell Venezuela, Caracas, December 1973-September 1974 (Subsurface Geology, Reservoir Geology/Sedimentology)
Research Scientist Assistant II, Bureau of Economic Geology, The University of Texas at Austin, 1972
Exploration Geologist, Compania Shell Venezuela, Caracas, January 1965-August 1970

PROFESSIONAL EXPERIENCE (continued):

Teaching Assistant, Paleontology, Univ. Central de Venezuela, Caracas, 1964
Teaching Assistant, Physical Geology, Univ. Central de Venezuela, Caracas, 1963

PUBLICATIONS:

Guevara, E. H., 1967, Contributions of the AVGMP Eocene Nomenclature Committee, The Santa Rita, Jarillal and La Victoria Formations: AVGMP Bull., v. 10, p. 51-69 (Translated into Spanish and included in: "La Estratigrafia del Eoceno en la Cuenca de Maracaibo" AVGMP Sp. Publ. 1)

(Collaborator), 1970, Stratigraphical Lexicon of Venezuela, 2nd Ed.

Guevara, E. H., and Garcia, Roberto, 1972, Depositional Systems and Oil-Gas Reservoirs in the Queen City Formation (Eocene), Texas, AAPG Bull., v. 56, p. 1898 (abstr.)

Guevara, E. H., and Garcia, Roberto, 1972, Depositional Systems in the Queen City Formation (Eocene), Texas: GCAGS Transactions, v. 22, p. 1-22. Reprinted by Univ. Texas Bur. Econ. Geology, GC 72-4.

Guevara, E. H., 1974, Pleistocene Facies in the subsurface of the southeast Texas coastal plain: Dissertation Abstracts

Key, C., Munoz, N. G., and Guevara, E. H., 1977, Glosario de Facies Sedimentarias (pre-print): III Congr. Geol. Latinoamericano, Mexico City, Mexico.

Kreitler, C. W., Guevara, E. H., Granata, G., and McKalips, D. G., 1977, Geometry of Gulf Coast Aquifers, Houston-Galveston, Texas: to be presented at the 1977 GCAGS meeting, Austin, Texas.

SELECTED PRIVATE REPORTS (unpublished, proprietary):

Bowen, J. M., and Guevara, E. H., 1965, Tertiary Sediments of the Guajira Peninsula (Comp. Shell Venezuela/Maraven S.A.)

Guevara, E. H., 1965, Notes on the Photogeology of southeast Falcon, W. Venezuela (Comp. Shell Venezuela/Maraven S.A.)

(coauthor), 1968, Petroleum/Geological Atlas, Western Venezuela (C.S.V./Maraven S.A.)

SELECTED PRIVATE REPORTS (unpublished, proprietary):

(collaborator), 1969, Geological Evaluation of the Gulf of Venezuela (CSV/Maraven S.A.)

Guevara, E. H., 1970, Sampling for Oil Source Rock Studies, NW Falcon (CSV/Maraven S.A.)

Guevara, E. H., 1970, Well Summary VLA-515 (CSV/Maraven S.A.)

Ochoa, R. E., and Guevara, E. H., 1974, Sedimentology of Well VLE-677 cores (CSV/Maraven S.A.)

Guevara, E. H., 1975, Stratigraphy and hydrocarbon occurrences, NW Falcon--A Revision (manuscript) (Creole Petroleum Corp./Lagoven)

Guevara, E. H. (coordinator et al., 1977, Geological Evaluation of a portion of the Venezuela continental shelf: in preparation.

PROFESSIONAL SUMMARY

William R. Kaiser

Research Scientist Associate IV

Bureau of Economic Geology

University of Texas at Austin

Austin, Texas 78712

(512) 471-1534 GEO 509

Born: August 15, 1937, Racine, Wisconsin

Married: one daughter

EDUCATION

1968 - 1972 The Johns Hopkins University, Baltimore, Maryland 21218
Ph.D. 1972 - Geology

1959 - 1962 University of Wisconsin-Madison, Madison, Wisconsin 53706
M.S. 1962 - Geology

1955 - 1959 University of Wisconsin-Madison
B.A. 1959 - Geology major

HONORS, AWARDS, and FELLOWSHIPS

Western Foundation (of Racine, Wisc.) Scholarship (1955 - 59)

Wisconsin Fellowship (Univ. Wisc. 1959 - 60)

Phi Beta Kappa (Alpha Chapter, Univ. Wisc., May 7, 1959)

Gilman Fellowship (Johns Hopkins Univ. 1968 - 72)

Balk Summer Fellowship (1970)

NSF Summer Traineeship (1971)

EXPERIENCE

10/72 - Bureau of Economic Geology, University of Texas, Austin, Texas.
Energy resources, radioactive waste management.

9/68 - 5/72 The Johns Hopkins University, Baltimore, Maryland.
Teaching and research assistant at undergraduate level.

4/65 - 8/68 Exxon Company, U.S.A., P. O. Box 2180, Houston, Texas.
Production and exploration geology (subsurface), South Texas Tertiary.

5/63 - 2/65 Ghana Geological Survey, Accra, Ghana, W. Africa.
Igneous and metamorphic petrography, x-ray diffraction work.
U.S. Peace Corps Volunteer.

6/62 - 2/63 Exxon Company, U.S.A.
Micropaleontology, South Texas Tertiary.

9/60 - 6/62 University of Wisconsin - Madison
Teaching assistant at undergraduate level

Summer 1961 Exxon Company, U.S.A.
Surface mapping, Tertiary on Olympic Peninsula of Washington

RESEARCH

Interests:

clastic sedimentation

lignite geology

geohydrology

radioactive waste management

sedimentary petrography

sedimentary iron ore

carbonate geochemistry

Projects:

In situ gasification of Texas lignite: geology of deep-basin lignite and an environmental assessment of gasification, in progress.

Ogallala Formation (Southern High Plains of Texas): depositional systems and the occurrence of ground water, in progress.

Salt domes for radioactive waste disposal: long-term tectonic stability and hydrologic integrity of domes and the implications for waste management, 1974.

Ph.D. dissertation: Delta cycles in the Middle Devonian of central Pennsylvania, 183 p. 1972.

> The study documents a style of sedimentation that has been rarely recognized and little studied in the central Appalachians. The unit studied is probably the finest ancient example of deltaic sedimentation in the central Appalachians (see Dissert. Abs., May 1973, v. 33, no. 11, p. 5349B).

Synthesis and solubility of two high-Mg calcites: (31 and 41 mole percent $MgCO_3$ respectively) were synthesized from brines at 1 atm. and 40°C, ion activity products were measured ($10^{-8.25}$ and $10^{-8.11}$), and lattice constants calculated. Experimental evidence suggests that static conditions (restricted environments) favor inorganic precipitation of Mg-calcites, 1969.

Eocene sedimentation: environments of deposition, Wilcox and Yegua-Jackson of South Texas, 1967-68.

Pegmatite petrogenesis: sequence of crystallization, lithium pegmatites, southern Ghana, 1964.

M.S. thesis: The Late Mesozoic geology of the Pearse Peak Diorite - southwest Oregon, 75 p., 1962.

> Study of one of the few plutons on the west coast that can be fixed rather precisely as intra-Late Jurassic or classic "Nevadan".

Publications:

Radioactive waste management by burial in salt domes: Univ. Texas, Austin, Engr. Mechanics Res. Lab., EMRL 1112, 82 p., 1975. (with E. A. Ripperger and J. O. Ledbetter).

Texas lignite: near-surface and deep-basin resources: Univ. Texas, Austin, Bur. Econ. Geology Rept. Inv. 79, 70 p., 1974.

Lignite: the other fuel of Texas: Univ. Texas, Austin, Bur. Business Res., Texas Business Rev., v. 48, no. 4, p. 86-91, 1974 (with W. L. Fisher).

East Texas iron ore and lignite, Society of Economic Geologists Guide Book, Arkansas - Texas economic geology field trip: Little Rock, Ark., Ark. Geological Comm., p. 19-47, 1974.

Lignite geology, mining, and reclamation at Big Brown steam plant near Fairfield, Texas: Univ. Texas, Austin, Bur. Econ. Geol., Field Trip Guidebook, Geol. Soc. Am. Ann. Mtg., Dallas, Texas, 24 p., 1973 (with C. G. Groat).

Cyclic sedimentation in the Middle Devonian of south-central Pennsylvania (abst.): Geol. Soc. Am. Absts. with Programs, v. 3, no. 7, p. 616, 1971.

Geology of the Humbug Mountain State Park area: Ore. Dept. Geol. and Min. Ind., The Ore.-Bin, v. 23, no. 3, p. 23-30, 1961, (with J. G. Koch and R. H. Dott, Jr.).

Grants and Contracts:

In situ gasification of Texas lignite to synthetic fuel: from NSF, funded Nov. 1974, $59,800 budget, extended Nov. 1975, $230,900 budget; total $290,700, co-principal investigator.

Use of salt domes for radioactive waste disposal: from AEC, funded May 1974, $48,000 budget, co-principal investigator.

Cyclic sedimentation in the Middle Devonian of south-central Pennsylvania: Penrose Research Grt. (no. 1484-71), from Geol. Soc. Am., funded Mar. 1971, $600 budget, principal investigator.

PROFESSIONAL ACTIVITIES

Field Trips:

Co-leader; Soc. Econ. Geologists, Arkansas - Texas economic geology field trip, Feb. 23-24, 1974, pre-convention trip, Ann. Mtg. AIME, Dallas, Texas.

Co-leader; Lignite strip mining and reclamation at Big Brown electric power plant, Fairfield, Texas, Nov. 15, 1973, post-convention trip, Geol. Soc. Am., Ann. Mtg., Dallas, Texas.

Talks:

Site selection factors for in situ gasifiers in the Texas Coastal Plain: presented at 1st Ann. Underground Coal Gasification Symposium, sponsored by ERDA, Laramie Energy Research Center, Laramie, WY., July 31, 1975.

Sedimentology of Texas lignite: presented to Corpus Christi Geol. Soc., Sept. 18, 1974.

Cyclic sedimentation in the Middle Devonian of south-central Pennsylvania: presented at Geol. Soc. Am. Ann. Mtg., Washington D.C., Nov. 3, 1971.

Other:

Program Chairman; conference titled Gulf Coast lignite: geology, utilization, environmental aspects, June 2, 3, and 4, 1976, Austin, Texas, sponsored by Bur. Econ. Geology and ERDA.

Co-Chairman; SEPM Sedimentation session (IIgeneral), April 3, 1974, AAPG-SEPM Ann. Convention, San Antonio, Texas.

PROFESSIONAL SUMMARY

Robert S. Kier

BUSINESS ADDRESS
The University of Texas at Austin
University Station, Box X
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HOME ADDRESS
Route 1, Box 31
Manor, Texas 78653
(512) 272-5019

PRESENT POSITION
Research Scientist Associate
Bureau of Economic Geology
The University of Texas at Austin

AREA SPECIALTIES
Multidisciplinary research involving natural resources; environmental geology; resource use and management; carboniferous stratigraphy, Central Texas

PERSONAL
Born April 21, 1943, Pittsburgh, Pennsylvania
Married, no children

ACADEMIC BACKGROUND
Shaler High School, Glenshaw, Pennsylvania, graduate 1961
B. A. degree, Geology, Franklin and Marshall College, Lancaster, Pennsylvania, 1965
M. S. degree, Geology, Franklin and Marshall College, Lancaster, Pennsylvania, 1967
Ph.D. degree, Geology, The University of Texas at Austin, Austin, Texas, 1972

PROFESSIONAL EXPERIENCE
Administrative Experience
Project Coordinator: Establishment of Operational Guidelines for Texas Coastal Zone Management, now called Methodology to evaluate alternative Coastal Zone Management Policies: Application in the Texas Coastal Zone, research contracts with the Research Applied to National Needs Program, National Science Foundation, and the Division of Planning Coordination, Office of the Governor of Texas, 1974-1976; annual budget approximately $330,000, staff comprised of faculty, research scientists, research associates, and graduate students.

Project Director: Land Resources of Texas, contract with the Texas Water Development Board and the Office of the Governor, 1972-1974

Assistant Project Director: Analysis of Resource Capability of the Corpus Christi Area and the Coastal Bend COG, research contract with NSF-RANN, 1972-1974

Research Experience

Current Research

Establishment of Operational Guidelines for Texas Coastal Zone Management. Coordination of researchers and consultants and heading of data gathering for multidisciplinary effort to develop a methodology that aids in predicting environmental and economic impacts of alternative public policies concerning land use.

Resource capability of Texas. Inventory of natural land resources of the state on a single map at a scale of 1:500,000. Eighty different capability units classified according to geohydrology, mineral resources, physical properties, geomorphic and structural features, physical processes, biology, subaqueous environmental characteristics, and man-made and modified attributes.

Detailed study of regional and local stratigraphy and depositional systems of Carboniferous rocks in Central Texas: their genetic interpretation in relation to modern systems and their relevance to petroleum exploration.

Regional stratigraphy of North Texas, Wichita Falls and Lawton (Tx) 1° x 2° sheets, Geologic Atlas Project.

Completed Research

Resource capability of the Corpus Christi area and the 13 county Coastal Bend COG (with W. L. Fisher, director). Preparation of maps depicting natural land and water resources at scales of 1:125,000 and 1:250,000. Quantification of physically defined units, hydrogeology, documentation of the kinds and rates of shoreline changes, and analysis of the environmental effects of man's activities in the Texas Coastal Zone.

Stratigraphic studies in eastern Pennsylvania and in Central Texas in conjunction with M.S. and Ph.D. degree work, respectively.

Regional mapping (with Peggy Harwood) for the Brownwood Geologic Atlas.

Teaching Experience

Graduate teaching assistant, Franklin and Marshall College, 1965-1966
Graduate teaching assistant, the University of Texas at Austin, 1966-1968, 1969, 1970

Graduate committee member, The University of Texas at Austin, (1973 -); currently participating on one M. S. committee
Lecturer, summer course, Coastal Resources Management, Division of Comparative Studies, the University of Texas at Austin, 1974

COMMITTEE RESPONSIBILITIES AND SPECIAL ASSIGNMENTS

Governmental Committees

Land Resource Management Advisory Committee, Flood Control and Flood Plain Management Subcommittee

INVITED PROFESSIONAL LECTURES

Texas Academy of Science, 1972
South-central Section of Geological Society of America, 1973
Southwest Section, American Association of Petroleum Geologists, 1973
Environmental Protection Agency (Houston), 1973
Conference on Coastal Zone Management, Gulf States Organization, 1974
American Association of Petroleum Geologists Annual Meeting, 1974
Approaches to Environmental Geology, Workshop and Colloquium, Bureau of Economic Geology, 1974
Special Topics in Coastal Zone Management, Texas A & M University, 1974
Southern Environmental Resources Conference (Austin), 1975
Workshop on Coastal Sedimentology, Engineering Geology, and related Environmental Studies, Marine Science Institute at Port Aransas, 1975

SCIENTIFIC PUBLICATIONS

Published

Kier, R. S., 1972, Carboniferous Stratigraphy of Eastern San Saba County and Western Lampasas County, Texas: Ph.D. Dissertation, Univ. Texas, 437 pp., 13 figs., 14 pls.; Reproduced by Univ. Microfilms, Inc., Ann Arbor, Mich.

Kier, R. S., and Zachry, D. L., 1973, Platform Carbonate Deposition of the Lower Marble Falls Formation, Central Texas (abs): Southwest Section, AAPG.

Zachry, D. L., and Kier, R. S., 1973, Carbonate Deposition of the Lower Part of the Marble Falls Formation, Central Texas (abs): South-Central Section, Geol. Soc. America Abstracts with Programs for 7th Annual Meeting, p. 290.

Fruh, E. G., and others, 1973, Establishment of Operational Guidelines for Texas Coastal Zone Management--Interim Report Summary, Chapter 5.

Fisher, W. L., Kier, R. S., Bell, D., Dildine, M., and Woodman, J. T., 1973, Resource Capability, Interim Report, Establishment of Operational Guidelines for Texas Coastal Zone Management, Prepared for Research Applied to National Needs Program, National Science Foundation, and Division of Planning Coordination, Office of the Governor of Texas, Coordinated through Division of Natural Resources and Environment, The University of Texas, Austin, 249 pp.

Kier, R. S., 1974, Land Resources of Texas - A Statewide Inventory of Natural Capability (abs): American Association of Petroleum Geologists and Society of Economic Paleontologists and Mineralogists, Annual Meeting Abstracts, V. 1, 53-54.

Kier, R. S., 1974, Texas Statewide Resource Capability Mapping and Inventory in Approaches to Environmental Geology: E. G. Wermund, ed., Univ. of Texas, Austin, Bur. Econ. Geol., Rept. Inv. No. 80, pp. 12-24.

Kier, R. S., and Bell, D. L., 1974, Quantification of Resource Capability Units, Corpus Christi Area in Approaches to Environmental Geology: E. G. Wermund, ed., Univ. of Texas, Austin, Bur. Econ. Geol., Rept. Inv. No. 80, pp. 152-183.

Kier, R. S., White, W. A., Fisher, W. L., Bell, D., Patton, P. C., and Woodman, J. T., 1974, Resource Capability Units II, Land Resources of the Coastal Bend Region, Texas, Final Report, Establishment of Operational Guidelines for Texas Coastal Zone Management, Prepared for Research Applied to National Needs Program, National Science Foundation, and Division of Planning Coordination, Office of the Governor of Texas, Coordinated through Division of Natural Resources and Environment, The University of Texas at Austin, 226 pp.

Kier, R. S., White, W. A., Fisher, W. L., and Bell, D., 1974, Resource Capability Units I: Assessment of Locational Effects of Residential, Commercial and Industrial Expansion in the Corpus Christi Area, Texas--Methodology, Final Report, Establishment of Operational Guidelines for Texas Coastal Zone Management, Prepared for Research Applied to National Needs Program, National Science Foundation, and Division of Planning Coordination, Office of the Governor of Texas, Coordinated through Division of Natural Resources and Environment, The University of Texas at Austin, 152 pp.

Kier, R. S., (ed.), 1974, Environmental and Economic Impacts of Recreational Community and Parks Development on Texas Barrier Islands, Progress Report, Establishment of Operational Guidelines for Texas Coastal Zone Management, progress report, Prepared for Research Applied to National

Needs Program, National Science Foundation, and Division of Planning Coordination, Office of the Governor of Texas, Coordinated through Division of Natural Resources and Environment, The University of Texas at Austin, 55 pp.

In final preparation

Fruh, E. G. and others, in preparation, Evaluation of Regional Environmental Policies Affecting Texas Bays and Estuaries, Example Application II, Methodology to Evaluate Alternative Coastal Zone Management Policies: Application in the Texas Coastal Zone, Prepared for Research Applied to National Needs Program, National Science Foundation, and Division of Planning Coordination, Office of the Governor of Texas, Coordinated through Division of Natural Resources and Environment, The University of Texas at Austin.

Kier, R. S. and others, in preparation, Evaluation of Development Policies for a Texas Barrier Island, Mustang Island-North Padre Island Area, Example Application III, Methodology to Evaluate Alternative Coastal Zone Management Policies: Application in the Texas Coastal Zone, Prepared for Research Applied to National Needs Program, National Science Foundation, and Division of Planning Coordination, Office of the Governor of Texas, Coordinated through Division of Natural Resources and Environment, The University of Texas at Austin, 3 vols.

Kier, R. S. and others, in preparation, Evaluation of Transferability in Texas of the Methodology to Assess Alternative Management Policies, Example Application IV Methodology to Evaluate Alternative Coastal Zone Management Policies: Application in the Texas Coastal Zone, Prepared for Research Applied to National Needs Program, National Science Foundation, and Division of Planning Coordination, Office of the Governor of Texas, Coordinated through Division of Natural Resources and Environment, The University of Texas at Austin.

Fruh, E. G., and others, in preparation, Final Report, Methodology to Evaluate Alternative Coastal Zone Management Policies: Application in the Texas Coastal Zone, Prepared for Research Applied to National Needs Program, National Science Foundation, and Division of Planning Coordination, Office of the Governor of Texas, Coordinated through Division of Natural Resources and Environment, The University of Texas at Austin, 2 vols.

PROFESSIONAL SOCIETIES

Society of Economic Paleontologists and Mineralogists
Austin Geological Society
American Association for the Advancement of Science

AWARDS AND HONORARY SOCIETIES

Phi Kappa Phi
Sigma Gamma Epsilon
Guy E. Green Scholarship, spring 1970
Pan American Petroleum Foundation Faculty Doctoral Fellowship in Geology, 1968-1969
National Science Foundation Summer Traineeship for Teaching Assistants, summer 1968

RESUME of Charles W. Kreitler
Bureau of Economic Geology
University of Texas at Austin
Austin, Texas 78712
512 471-1534

Biographical Data

Home address: 8 N. Peak Road
Austin, Texas 78746

Birth: October 31, 1947

Marital Status: Married; no children

Health: excellent

Education

St. Lawrence University, Canton, New York — B.S. Geology (1969) Honors in Geology

The University of Texas at Austin
Austin, Texas — M.A. Geology (1972)

The Universityof Texas at Austin
Austin, Texas — Ph.D. Geology (1974)

Doctoral Dissertation: Determining the source of nitrate in groundwater by using nitrogen isotope studies, L. Jan Turk (supervisor)

Professional Experience

Research Scientist Associate IV, Bureau of Economic Geology, University of Texas at Austin, September 1973 to present.
Panelist for U.S. Congress, Office of Technology Assessment, August 4-August 15, 1975.
Research Associate, Juneau Icefield Research Project, July-August 1972.
Engineer-Scientist, Radian Corporation, June-August 1970; June 1971-July 1972.
Teaching Assistant, The University of Texas at Austin, Fall 1969; Spring 1970; Spring 1971; Geology 320 Field Course, May 1971.
Participant in the Juneau Icefield Research Project (N.S.F. sponsorship), Juneau, Alaska, Summer 1969.
Teaching Assistant, St. Lawrence University, Canton, New York, Fall 1968; Spring 1969.
Field Assistant with the U.S. Geologic Survey in the Alaska Range, Alaska, Summer 1968.

Research Interests

1. Methods of fault activation in the Texas Coastal Zone: There is a complex interrelationship between recent fault movements, hydrocarbon and ground-water withdrawal, and land subsidence.

2. Ground-water flow through Texas Coastal Zone sediments: Lithofacies mapping of the aquifers of the Houston area show major dip-oreinted stacked sand trends. An understanding of mechanisms of recharge and flow in these aquifers is important in evaluating available water resources in the Texas Coastal Zone.

3. Evaluation of potential for land subsidence and fault activation from the ground-water production of geopressured aquifers in the Texas Gulf Coast for geothermal energy.

4. Geochemistry and isotope chemistry of geopressured waters from Gulf Coast Tertiary sediments.

5. Nitrogen isotopes of nitrogen species in natural waters: Natural nitrogen isotope ratios can be used to identify sources of nitrate contaiminants in ground water. The technique is also being used for studying nitrogen transformation in surface waters.

6. Hydrogeology of the Edwards aquifer in Travis County, Texas.

Research Grants

1. Principal investigator of Reactor Siting Hazards: Faulting and Fault Activation in the Texas Coastal Zone (Year I) October, 1974-October, 1975, U.S. Geological Survey Grant No. 14-08-001-G-144, $74,500.

2. Principal investigator of continuation of Reactor Siting Hazards: Faulting and Fault Activation in the Texas Coastal Zone: April 15, 1976 to June 30, 1976. U.S. Geological Survey Grant No. 14-08-001-G-144, $10,000.

3. Co-principal investigator with Dr. Lynton S. Land, Associate Professor, Department of Geological Sciences, University of Texas at Austin, of Nitrogen Isotopes in Surface Waters and Ground Waters of Central Texas, National Science Foundation, Grant No. DES74-13560, October 1974 to April 1977, $49,600.

4. Principal investigator of Nitrogen Isotopes of Nitrate Contamination. Radian Corporation, February, 1977 to February, 1978, $10,175.

Publications

(with L. J. Turk, R. J. Heil, and D. C. Jones), Nitrate contamination of ground water in Runnels County, Texas: Proc. Fifth Ann. Conf. on Trace Substances in Environmental Health, Univ. Missouri at Columbia, p. 153-166, June 1971.

Nitrogen isotope ratios, a new technique for determining the source of nitrate in ground water (abs.), Geological Society of America, v. 5, no. 7, p. 699, 1973.

(with L. F. Brown, Jr., R. A. Morton, J. H. McGowen, and W. L. Fisher), Natural hazards of the Texas Coastal Zone, 13 p., 7 maps, 1974.

Natural soil nitrate: the cause of the nitrate contamination of ground water in Runnels County, Texas: Ground Water, v. 13, no. 1, p. 53-62, 1975.

Lineations and active faulting in the Houston-Galveston area of subsidence (abs.), Geological Society of America, v. 7, no. 2, p. 180, 1975.

Determining the source of nitrate in ground water by nitrogen isotope studies: Bureau of Economic Geology, Report of Investigations No. 83, 57 p., 1975.

(with H. B. H. Cooper, B. L. Foote, C. G. Groat, J. O. Ledbetter, J. A. Lopez-Gonzales, D. R. Starr, and B. R. Weise), Texas nuclear power policies: a study of alternatives, Vol. 4: Environmental Effects Center for Energy Studies, Univ. Texas-Austin, 70 p., 1975.

(with C. L.Lewis and D. McKalips), Geologic control of land subsidence, Houston-Galveston, Texas (abs.): Geological Society of America, v. 7, no. 7, p. 1154, 1975.

(with A. E. St. Clair, C. V. Proctor, Jr., W. L. Fisher, and J. H. McGowen), Land and water resources Houston-Galveston Countil of Governments, Land-Resources Laboratory Map, 1975.

Lineations and Faults in the Texas Coastal Zone: Bureau of Economic Geology, Report of Investigations No. 85, 32 p., 1976.

Fault control of land subsidence, Houston-Galveston, Texas: Bureau of Economic Geology, University of Texas at Austin, Research Note 5, 17 p., 1976.
also to be published in Geoscience and Man, Proceedings of the William R. Russel Memorial Symposium, 1977 (in press)
and in Ground Water, April-May, 1977 (in Press)

Lineations and active faulting in the Houston-Galveston area of subsidence (abs.) Geol. Soc. Amer., v. 7, no. 2, p. 180, 1976.

(with T. C. Gustavson), Geothermal resources of the Texas Gulf Coast -- environmental concerns arising from the production and disposal of geothermal waters: Bureau of Economic Geology Geological Circular 1976.
also to be published in Energy resources of Texas: Houston Geological Society, Special Publication, 1977 (in press),

Faulting and land subsidence from ground water and hydrocarbon production, Houston-Galveston, Texas in Proceedings of Second International Symposium on Land Subsidence (in press)

(with McKalips, D. and Mueller, D.), Horizontal resistivity profiles across surface faults (abs.), Geological Society of America South Central Meeting, 1977.

(with Ragone, S. and Katz, B.), Nitrogen isotopes of ground-water nitrate, Long Island, New York (in preparation)

(with McKalips, D.), Horizontal resistivity profiles across surface faults and lineations, Texas Coastal Zone: Bureau of Economic Geology Circular (in preparation)

Nitrogen isotopes of ground-water nitrate, Central Texas (in preparation)

VITA

MARK W. PRESLEY

Birthdate: October 24, 1946
Family: Married, with 4 children, ages 1 to 8
Parent: Ione Presley, presently of Midland, Michigan
Health: Excellent

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PRESENT POSITION

Research Associate, West Virginia University; principal investigator on research funded by the State of West Virginia, for the further development of direct applications of geology and sedimentology to coal resource evaluation, and to the evaluation of geologic factors which have a direct bearing on coal mine safety, coal production, and coal quality.

AREAS OF SPECIALIZATION

Major:
1. Sedimentation and stratigraphy
2. Sedimentation as applied to problems encountered in the oil and coal industries (applied sedimentation)
3. Pennsylvanian stratigraphy in the eastern U.S.A.

Minor:
1. Petrographic interpretation of clastic and carbonate rocks, especially in interpreting the formation and preservation of porosity
2. Geomorphology as applied to the understanding of processes acting on sediments in modern coastal and alluvial environments

ACADEMIC HISTORY

West Virginia University: 1973 - , Ph.D. in geology expected 1977
University of Montana: 1968 - 1970, M.S. in geology 1971
Franklin and Marshall College: 1964 - 1968, A.B. in geology 1968
Atlantic City High School, Atlantic City, NJ: 1960 - 1964

PROFESSIONAL EXPERIENCE

Research and Field Experience

September, 1976 - present: Research Associate, West Va. University; see above
Summer, 1975: Consultant with Drs. Donaldson and Heald of West Virginia University; petrographic interpretations in natural gas-bearing Devonian sands and shales of West Virginia, based on subsurface data and petrographic work on cores
Summer, 1974: Mapping for dissertation in northern West Virginia
Summer, 1971: Geologist (Asst. Party Chief), Quebec Dept. of Mines, PQ, Canada; mapping in iron-bearing pillow lavas and greywackes in Quebec
Summer, 1970: Lindgren Exploration Company, Wayzata, MN; mapping in copper exploration program in quartzites of the Belt Series in Montana
Summer, 1969: With Dr. D.W. Hyndman of the University of Montana; mapping for thesis, and sampling in the Flint Creek Mountains of Montana
Summer, 1968: Summer Geologist, Shell Oil Company, Midland, TX; subsurface mapping in New Mexico

Summer, 1967: With Dr. J. Moss and Dr. D. Ritter, then of Franklin & Marshall College; mapping Pleistocene gravel terraces in Montana (Dr. Ritter now at Southern Illinois University)

Teaching Experience

August, 1973 - May, 1976: Instructor, Part-Time (Teaching Fellow), West Virginia University
January - August, 1973: Instructor, Tidewater Community College, Virginia Beach, Virginia
1971 - 1973: Teacher, Virginia Beach City Public Schools, Virginia Beach, Virginia; teaching earth science in an experimental school program
1968 - 1970: Graduate Assistant, University of Montana

THESES AND PUBLICATIONS

1976, A Sense of the Earth's Past: A Laboratory Manual for Historical Geology, published privately by the Department of Geology, West Virginia University.
1972, Metamorphism in the Sapphire Mountains, Montana: Northwest Geology, v. 2, p. 36-41.
1971, Igneous and Metamorphic Petrology of the Willow Creek Drainage Basin, S. Sapphire Mtns., Montana: unpublished M.S. Thesis, University of Montana.
1968, Geology of the Mill Creek School Area, Lancaster Co., PA: unpublished Undergraduate Thesis, Franklin and Marshall College.

RECENT AWARDS AND PROFESSIONAL ACTIVITIES

April, 1976: Initiated into the Honor Society of Phi Kappa Phi
April, 1976: Chosen Graduate Student of the Year (Fridley Award), by the Geology faculty of West Virginia University
October, 1975: WVU delegate to Sigma Gamma Epsilon Convention in Las Vegas
April, 1975: Chosen Graduate Assistant of the Year (Tarr Award) by Geology students of West Virginia University
March, 1975: Participant in West Virginia Geol. Survey Short Course, "Fundamentals of Coal for the Energy Explorationist"

MEMBERSHIPS IN PROFESSIONAL ORGANIZATIONS

Geological Society of America, Society of Economic Paleontologists and Mineralogists, West Virginia Academy of Sciences, Sigma Gamma Epsilon

REFERENCES

The following faculty members of the Department of Geology of West Virginia University will be happy to provide letters of reference:

Dr. Alan C. Donaldson, Chairman of the Department, sedimentologist, and my dissertation advisor

Dr. Robert C. Shumaker, Professor, petroleum geologist, and a member of my dissertation committee

Dr. Robert E. Behling, Assistant Professor, geomorphologist, and my direct teaching supervisor