A METHOD FOR PREDICTING FRACTURE-ENHANCED PERMEABILITY IN REGIONS OF "FLAT-LYING" STRATA

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CHAPTER I

INTRODUCTION

The ability to map and predict geologic fractures in the subsurface is of great importance to the world eco-omic community and to understanding the environment. For example, natural fractures are beneficial in the extraction of certain resources because they enhance the permeability of rocks. Fractures are essential to reservoir permeability in oil and gas fields such as the giant Agha Jari field in Iran, and the Spraberry and Sooner Trends in the United States (Nelson, 1985).

Part of the hydrologic cycle includes the storage and flow of water through the upper lithosphere. Except in very simple cases, this part of the cycle is complex and poorly understood. Flow through consolidated and semi-consolidated rocks is commonly affected by natural rock fractures. In some cases, fractures dictate the hydraulic characteristics of rock masses (Witherspoon et al., 1979) and control the migration of fluids through aquifers or reservoirs (Havranek and Smith, 1989). In some fresh water aquifers, high yield water wells are directly related to fracture permeability in the subsurface (Parizek, 1975).

Fracture permeability is not beneficial when a hydrologic confining bed is desired. The United States Environmental Protection Agency is involved with the safe emplacement of liquid wastes in subsurface formations. A major part of the environmental suitability for underground injection is tied to the integrity of confining beds (Pettyjohn, 1987). An important concern is the potential migration of fluids via faults or fractures. Hydraulic conductivities of very low magnitudes can allow transfer of large volumes of liquids across a "confining bed" when calculated over large areas such as square miles (Pettyjohn, 1987). Permeability through confining beds, such as shales, is commonly provided by fractures.

When estimating velocity and direction of contaminant transport in aquifers (non-confining beds), the effect of rock fractures should be considered. For example, the Lockport Dolomite (Middle Silurian) is a pathway for chemical migration to the Niagara River from waste disposal sites in the Niagara Falls area of western New York. Vertical fractures consistent with prominent joint sets appear to control the velocity and migration paths of ground water and chemicals in the Lockport Dolomite (Yager, 1988).

Fluid migration along fractures is also a concern in the unsaturated zone. At the proposed Yucca Mountain nuclear repository in Nevada, the top of groundwater lies

200 to 400 meters (700 to 1,400 feet) below the level of the proposed repository (Monastersky, 1988). This distance to groundwater through relatively low permeability volcanic tuff is considered a safety buffer in the event of a contaminant release. The United States Geological Survey estimates that travel time from the repository to the top of groundwater may take approximately 1,000 years given the current annual average rainfall (Monastersky, 1988). The U. S. Government and others are concerned about fluid migration along fractures and faults (Monastersky, 1988) because they may reduce this travel time by orders of magnitude.

Natural rock fractures can be classified as "tectonic fractures" and "regional fractures" or joints (Nelson, 1985). Regional fractures predominate in areas of flat-lying strata and areas with few if any faults and folds. The ability to predict fracture-enhanced permeability from surface data in areas of "flat-lying strata" is the subject of this investigation.

Attempts to predict regional fracture orientation and density in the subsurface using surface data have yielded mixed results. Uncertainty exists over the depth to which regional fractures (joints) can be projected (Nur, 1982), disagreement whether they can be projected vertically through different rock formations (Hodgson, 1961; Overbey and Rough, 1971; Stearns, 1972; Nelson, 1975, 1985), and disagreement about the extent that they influence surface morphology (Melton, 1959; Maarouf, 1981; Pohn, 1983;

Scheidegger, 1983). The validity of the assumption that high-intensity fracture zones at the surface continue through the geologic section to depth is not completely known at this time (Nelson, 1985).

Rose diagrams of fracture orientations from outcrops do not consistently agree with the frequencies of lineament orientations derived from remote sensing (Nelson, 1975, 1985; Pointe et al., 1985). Discrepancies occur because of preferred fracture orientations induced by the depositional fabric of some formations and by the difference in scale between outcrop measurements and lineaments measured from air photos and satellite data (Nelson, 1975). Error may be introduced by linear sampling bias caused by measurements along "scanlines", such as rock exposures, bore-holes, or tunnels that may be oblique to certain fracture trends (Pointe et al., 1985). In addition, many "flat-land" areas have few rock exposures where fractures can be measured.

A need exists for direct comparisons of remote sensing interpretations with subsurface data. Most studies that have incorporated subsurface data with remote sensing (Berger, 1986, 1988; Maarouf, 1981; Overbey and Rough, 1971) have either used gravity and magnetics as the subsurface source, or have used widely scattered subsurface data points, which are adequate for defining general structures, but do not yield detailed permeability information.

This study uses subsurface data from a heavily drilled area of the Sooner Trend oil and gas field in Oklahoma to infer fracture orientation and areas of relatively high and low fracture permeability in the Mississippian Meramec-Osage reservoir. Subsurface data are systematically compared to surface data from different interpreters and different remote sensing techniques. Surface linear, textural, topographic, and drainage trends are assessed with Landsat MSS (multi-spectral scanner) satellite imagery, air photos, commercial geomorphic maps, and topographic maps. Various computer techniques are used to enhance the satellite images. The goal is to evaluate various types of surface data and interpretation techniques to ascertain if a relationship or correlation exists between surface phenomena (such as topographic, drainage, or textural patterns) and fracture density and orientation in rocks at depths between 2,000 and 2,500 meters (6,500 to 8,000 feet).

The null hypothesis is that no relationship exists between fracture density in the deep subsurface (2,000 m) and surface phenomena in the study area. The null hypothesis may be true because a) of differences in bed thickness, lithology, and depositional fabric between the surficial Permian clastics and the buried Mississippian carbonates; b) of tectonic events that occurred between Mississippian time and the present (such as the formation of the Anadarko Basin) changed stress orientations and fracture patterns; c) of changes in regional orientation resulting from continental drift; d) fracture sets were preferentially "healed" in some formations because of geothermal or hydrodynamic conditions or e) unconformities between the Mississippian and Permian mask older structural fabrics.

The alternative hypothesis is that a relationship does exist between fracture density in the deep subsurface and surface phenomena such as drainage patterns and topography. This relationship may exist because a) regional joint fabrics tend to persist through space and time, perpetuated by minor tectonic adjustments (seismicity); b) surface morphology is influenced by deep structures such as basement knobs or faults despite intervening unconformities and hydrodynamic conditions; or c) current stress conditions affect jointing in rock formations as deep as 2,500 meters.

Attention will be given to fracture orientation, density, and length, all of which may effect fracture porosity or permeability. Where practical, statistical tests such as analysis of variance (ANOVA), linear and polynomial correlation coefficients, and t-tests will be applied. Observations will be deemed significant if the alpha limit for type I error is .01 or less. In other words, if a surface-subsurface relationship is indicated and the appropriate statistical tests indicate 99%

probability or better that the correlation is not caused by random variations, the null hypothesis will be rejected.

CHAPTER II

LITERATURE REVIEW

To predict areas of relatively high and low fracture permeability using remote sensing techniques, one must first identify the elements that control fracture porosity and permeability. Because this study deals with regional fractures, one must ascertain the nature of regional fractures in the crust. Once this has been done, one may investigate the types of phenomena detected by remote sensing and compare these phenomena with surface and subsurface fracture data. This literature review will follow the sequence of classifying fractures, defining fracture porosity and permeability, investigating aspects of regional fractures, defining remote sensing, and reviewing relationships between remote sensing data and subsurface phenomena.

Fractures

Fracture Classification and Origins.

Many classification schemes have been developed for fractures and joints (Nevin, 1949; Billings, 1972; Nelson, 1985). A joint is a type of fracture along which little if any movement has occurred (Nevin, 1949). A joint set consists of a group of more or less parallel joints (Figure 1). A joint system consists of two or more joint sets or of any group of joints with a characteristic pattern (Billings, 1972). Joints may be classed by type of stress, such as tension and shear joints (Nevin, 1949), by genesis, such as extension, exfoliation, release, and shrinkage joints, (Billings, 1972), by regularity, such as systematic and nonsystematic (Nevin, 1949), by geometry, such as ortho-gonal or conjugate (Billings, 1972), by orientation to local strata, such as strike, dip, oblique, and bedding joints (Billings, 1972), or by aerial extent and orientation (Nelson, 1985).

For this study I need a simple classification system that defines fractures by criteria that can, for the most part, be identified using remote sensing techniques. Nelson (1985) proposed classifying natural fractures as tectonic or regional based on aerial extent, orientation, and offset. Tectonic fractures are those whose origin can, on the basis of orientation, distribution, and morphology, be attributed to or associated with a local tectonic event. Tectonic fractures may be fault-related or fold-related.

Regional fractures are those that are developed over large areas of the crust with relatively little change in orientation, show no evidence of offset across the fracture plane, and are always perpendicular to major

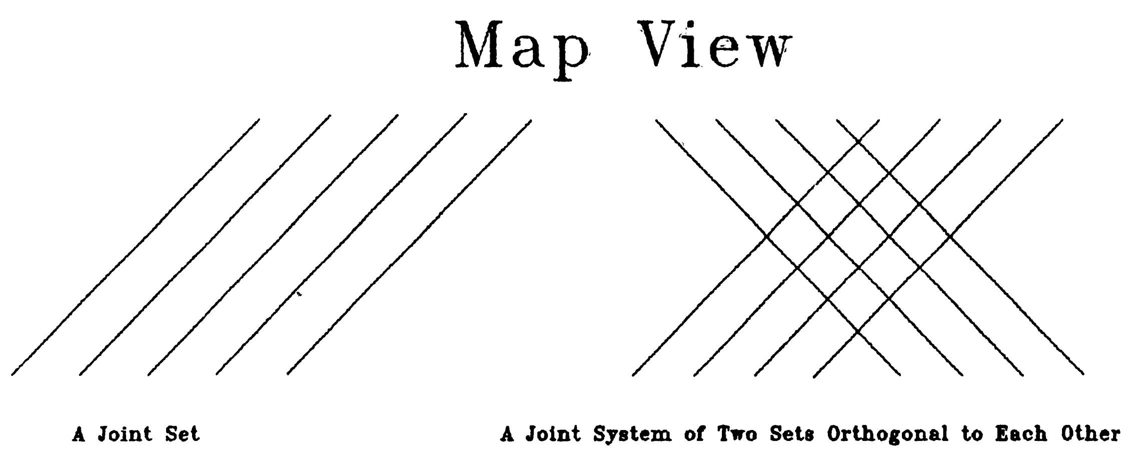


Figure 1. Joint Sets and Joint Systems.

Bedding surfaces. They may be considered as vertical joints. The lack of offset suggests a tensile origin (Billings, 1972; Nelson, 1985). Regional fractures are commonly developed in orthogonal systems (Stearns and Friedman, 1972), i. e., the fracture sets intersect at a 90 degree angle in map view (Figure 1). This study is concerned with regional fractures.

Classification of Fractured Reservoirs.

Fractured reservoirs (and aquifers) may be classified by the effects fractures have on porosity and permeability (Nelson, 1985). Types of reservoirs (or aquifers) in this system are:

TYPE 1: Fractures provide the essential reservoir (aquifer) porosity and permeability.

TYPE 2: Fractures provide the essential reservoir (aquifer) permeability.

TYPE 3: Fractures assist permeability in an already producible reservoir (aquifer).

TYPE 4: Fractures provide no additional porosity or permeability but create significant reservoir (aquifer) anisotropy.

<u>Fracture Porosity and Fracture Permeability</u>.

The effect of fractures on fluid flow through rocks is not uniform everywhere and in all directions. The overall effect may depend on non-fracture porosity and permeability in the host rock and on fracture width, length, density (or spacing), and orientation (Nelson, 1985; Long and Witherspoon, 1985).

Porosity is the pore space , or void space, in rocks and it is expressed as a fraction or percentage (e. g. .23 or 23%) of total volume (Levorsen, 1967). The amount of porosity contributed by fractures depends upon the average fracture width (assuming the fracture is "open") and density (number of fractures per unit area).

The amount of permeability contributed by fractures is more complex. Permeability is the measure of the ease with which fluids may move through the interconnected pores of a rock (Levorsen, 1967) and it is usually measured in units called darcies (one unit being a darcy).

The first quantitative description of fluid flow through porous media was by Darcy (1856). His equation concerned Newtonian flow in a continuous, homogeneous, porous medium and is as follows:

$$Q = K * A * dh/dl \qquad (1)$$

where Q is the flow rate, K is the hydraulic conductivity, A is cross-sectional area, and dh/dl is the head gradient (drop in elevation from point to point in feet per foot or meters per meter). The head gradient provides pressure to the system via gravity.

Hubbert (1940) showed that hydraulic conductivity (K) is a function of permeability (k′) fluid density (P), fluid viscosity (u) and the acceleration of gravity (g) where:

$$K = k'(P * g/u) \qquad (2)$$

and

$$k' = N * d^2 \qquad (3)$$

where N is a dimensionless coefficient characteristic of the medium, and d is the average grain diameter. The dimensions of k′ are length squared, where one micrometer squared equal .968 darcy (Nelson, 1985).

Because $N d^2$ cannot be defined for a fracture (fractures have no grain diameter "d"), the parallel-plate theory of flow was developed (Huitt, 1955; Lamb, 1957; Snow, 1965; Sharp et al., 1972). It is expressed by the equation:

$$Q/A = e^3/12D \ (dh/dl) \ (P * g/u) \qquad (4)$$

where e is the distance between plates (fracture width), and D is fracture spacing (the average distance between parallel regularly spaced fractures).

Parsons (1966) combined the parallel plate equation with Darcy's and Hubbert's equations to determine the total rock permeability:

$$k' = k'' + (e^3 * \cos^2 a)/12D \qquad (5)$$

where k' is the permeability of the fracture plus rock system, k'' is the permeability of the non-fractured host rock, and "a" is the angle between the axis of the pressure gradient (head gradient) and the fracture plane (Figure 2).

It follows that fracture permeability alone is represented by the following equation:

$$\text{Fracture Permeability} = (e^3 * \cos^2 a)/12D \qquad (6)$$

Parson's equation shows that 1) as permeability of the rock matrix (k'') approaches zero, fracture permeability (if present) predominates, and 2) that fracture permeability is dependent on fracture width, fracture spacing (or density), and fracture orientation. Although this equation does not address fracture length, it also plays a part (Long and Witherspoon, 1985).

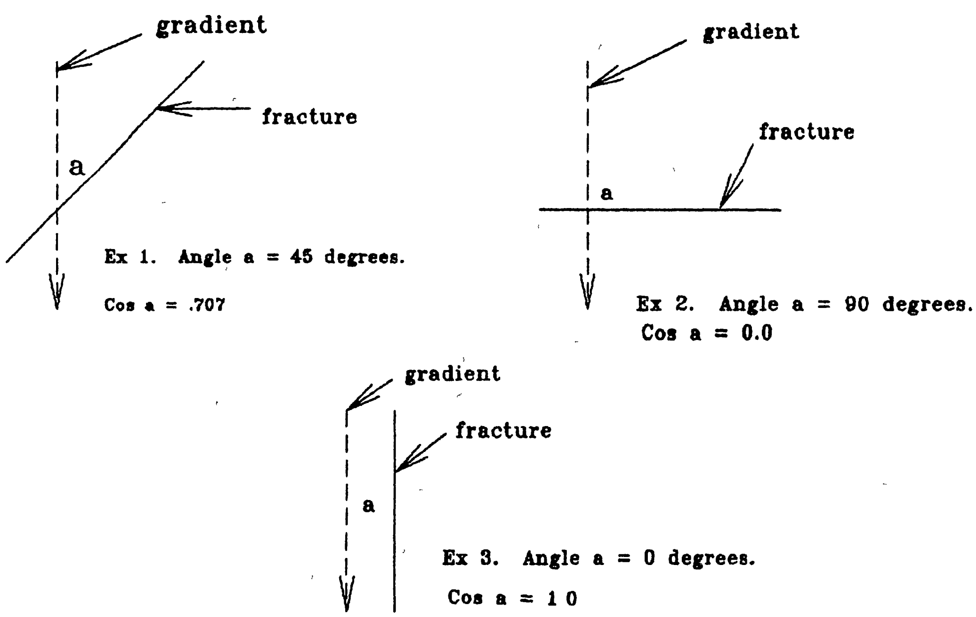


Figure 2. Examples of Angle "a" Between the Gradient and the Fracture Plane.

Long and Witherspoon (1985) showed that interconnection between given fracture sets is a complex function of fracture density, and fracture extent or length. As fracture length increases the degree of interconnection increases.

Direct Measures of Fracture Permeability.

Several methods have been proposed to estimate natural fracture permeability using rock cores (Yale et al., 1989). No method is entirely satisfactory because coring commonly creates artificially induced fractures, release fractures occur soon after coring, and cores yield a limited area of investigation relative to the area of interest such as an oil field or fresh water aquifer. New methods are being proposed simply for accurate prediction of natural fracture direction in cores (Yale et al., 1989).

Fracture identification and determination of oil and gas field "pay" using wireline surveys has been an elusive goal, particularly in carbonate reservoirs (Casarta et al., 1989). Oil detection by well logs in fractured reservoirs is rare (Lau and Bassiouni, 1989).

Nelson (1985) and Harvey (1988) described how electrical and geophysical well logs may be used to detect subsurface fractures using resistivity, caliper, neutron-density, acoustic, and variable intensity logs. These devices may detect the presence of vertical fractures via a particular log signature, but because of variations in down-hole conditions, such as mud resistivity, mud cake, etc., the absence of these log signatures does not define the absence of fractures (Nelson, 1985; Harvey, 1988). Therefore, these methods are qualitative and not quantitative, and commonly cannot be used even to rank areas of greater or lesser fracture density.

Other well-bore fracture detection techniques described by Nelson (1985) include impression packers and down-hole televiewers. These methods also have limitations. In addition to normal photographic problems of light, etc., the down-hole televiewer is limited to gas or clear-liquid filled holes. The presence of residual drilling mud cake on the well wall may impede or eliminate direct photography of the well bore (Nelson, 1985). Although impression packers are useful for delineating artificially induced fractures (Overbey and Rough, 1971), mud cake and relatively small widths of natural fractures severely limit usefulness to detect natural fracture systems (Nelson, 1985).

Field tests have sought fracture networks connecting given wells, but testing for and delineating "in situ" fracture characteristics between wells is a complicated and difficult task (Silliman and Robinson, 1989). Perhaps remote sensing techniques can provide additional insight.

Vertical Continuity of Fractures.

Presently, scientists can not estimate how deep into the subsurface regional tensile fractures may be projected (Nur, 1982). Griggs and Handin (1960) believe that tensile fractures are unlikely to be deeper than just a few hundred meters because pressure from the weight of overlying rocks will tend to close deep fractures. Secor (1965, 1969) and Price (1975) have shown, however, that high hydrostatic pore pressure may actually counteract the overburden effect and permit deep tensile fractures. Secor's fractures do not originate at the surface but at depth from which they may propagate towards the surface (Secor & Pollard, 1975).

Nur (1982) suggested that the penetration depth of tensile fractures that produce lineaments is directly related to length. Long fractures on the surface tend to be those that reach to the greatest depth. Nur's suggestion is based on a mechanical model. He states at present no direct proof exists for the depth distribution of fractures, but he believes that systematic geophysical and borehole investigations may eventually determine the actual depth distribution and thus confirm or disprove his model.

Deep fractures are thought to exist on other planets. Risner (1989) suggests that the subsurface of Mars is fractured to depths up to 10 or 20 Kilometers

(32,000 to 64,000 feet), and that these fractures play an important role in the geohydrology of the planet. These fractures are believed to have been caused by meteor impacts and tectonic extension (Risner, 1989). Because the crust of Mars is not recycled by plate tectonics, the fractures would still be present to serve as reservoirs and conduits (Risner, 1989).

Vertical Propagation of Fractures.

From his study of the Comb Ridge-Navajo Mountain area of Arizona and Utah, Hodgson (1961) proposed that joints form early in the history of a sediment and are produced successively in each new layer of rock as soon as it is capable of fracture. The joint pattern in pre-existing rocks may be reflected upward into new, non-jointed rock and control the joint directions. He noted that in his study area, regional fractures trend across several folds of considerable magnitude but do not swing to keep a set angular relation to a fold axis. He proposed that regional joints are controlled by forces other than those that formed the folds. Lack of offset along the regional fractures suggests a tensile origin.

Stearns (1972) disagreed with Hodgson's vertical propagation (inherited fractures) hypothesis. As evidence he cited the Jurassic beds of the Uncompahgre Plateau, where the underlying Kayenta and overlying Summerville sandstones both contain the same regional orthogonal fracture patterns, but are separated by the 40 m (125 ft) thick Entrada sandstone which has no apparent fractures. Stearns contends that the absence of fractures in the intervening unit argues against vertical propagation. Nelson (1975) suggests that the jointing in the Kayenta and Summerville was caused by the same stress field and that fracturing occurred at the same time without overtly affecting the Entrada.

The Entrada is a calcite cemented sandstone known locally as "slick rock". This descriptive label may be a clue why the Entrada does not display fractures. Calcite is more ductile and less susceptible to fracture than quartz or dolomite (Sinclair, 1980). Calcite cement may also give the Entrada its "slick" appearance. The ductility of the calcite cement may reduce the probability of fracturing, but it does not preclude propagating stress. The question of whether the Kayenta and Summerville were fractured simultaneously by the same stress event (Nelson, 1975), or whether fractures were propagated vertically over time (Hodgson, 1961) is not answered by the lack of fractures in the Entrada. The concept of vertical propagation of joint patterns remains to be proven or disproven.

Aerial Variation of Fracture Sets.

Hodgson (1961) observed the following recognizable variations in the spacing of joints: 1) local departures in the average spacing of joints in a single set, 2) variations in average spacing of joints from set to set in the same area and rock unit, 3) variations in average spacing of joints of the same set in rock units of differing thicknesses and lithologic character in the same area, and 4) irregular areas where systematic jointing is non-existent or poorly developed.

Fracture spacing can be affected by individual variations in lithologic units (Nelson, 1975). This may be explained by differences in ductility and bedding thickness. It is doubtful, however, that all variations in regional fracture spacing are the result of lithologic changes. Hodgson (1961) observed variations in spacing within the same lithologic units in the same area.

Nelson (1975) found regional fractures exceptionally well developed in the Lake Powell area (on the Colorado Plateau). Fracture orientation frequencies (rose diagrams) from outcrops, however, did not agree with rose diagrams of lineaments interpreted from air-photos. Nelson noted that fractures measured at outcrops tended to change strike orientation from formation to formation. This change in orientation was apparently caused by large scale sedimentary structures within the fractured members. These structures create mechanical anisotropies within the formations, which control the orientation of subsequent fractures.

Nelson's regional fracture orientations derived from air-photo interpretation, however, were consistent with the orientation of inferred basement faults beneath Lake Powell measured in a regional geophysical investigation by Case & Joesting (1972). Nelson attributed the difference between ground and air measurements to scale. Ground measurements of a particular fracture tended to emphasize any local variation created by anisotropy (sedimentary structures), whereas the air-photos tended to display major features such as topography, drainage, and tone, and would show the average orientation of regional fracture sets.

Fracture Density.

Natural fracture systems are commonly such a complicated cross-cutting fabric that determination of average spacing is difficult if not impossible to define (Nelson, 1985). Although fracture spacing can be directly observed in outcrop and mines, difficulties exist in quantifying subsurface fracture density because of the small size of most subsurface sampling methods, such as core and wellbore observations (Nelson, 1985).

Nur (1982) suggests from his model that fracture density is inversely proportional to fracture depth. He also suggests that fracture-controlled lineaments at the earth's surface are generally restricted to a small number of sets, with angles ranging from 45-90 degrees between sets. He suggests the opening and subsequent closing of tensile fractures may lead to narrow zones that are relatively high in porosity and permeability, mechanically weak, and liable to erosion. These traits would tend to create topographic or erosional lineaments along long deep fractures.

Remote Sensing

Aerial Photography

The first known aerial photograph was taken in 1858 from a balloon (Newhall, 1969). The use of air-photos, photogrammetry, and remote sensing in geology, however, is relatively recent because the tools needed for these techniques were not available in a practical sense until the twentieth century. The first aerial photographs taken from an airplane for geologic mapping purposes were used to construct a mosaic covering Bengasi, Libya in 1913 (Lillesand and Kiefer, 1987). Some interpretive use of aerial photographs began in the 1920s and air-photos have been used since the early 1930s to facilitate soil mapping (Lillesand and Kiefer, 1987). Prior to World War II, however, aerial photography missions were relatively rare and quite expensive. The weather had to be very clear and air bases had to be close to target areas (Richason, 1983). The use of aerial photos in geologic interpretation was not widespread until the 1940s (Melton, 1959).

Following World War II, science began to adapt wartime techniques to peacetime needs.

Space Imagery

The age of photography in space for geologic interpretation began modestly in the 1960s with sporadic pictures from Hasselblad cameras hand-held by American Gemini astronauts (American Society of Photogrammetry, 1983). In 1972 the Earth Resources Technology Satellite 1 (ERTS-1) was launched. It was designed as an experimental system to test the feasibility of collecting earth resource data from unmanned satellites (Lillesand and Kiefer, 1987). The Earth Resources Experiment Package (EREP) was launched aboard Skylab in 1973. EREP experiments demonstrated the complementary nature of photography, electronic imaging, and multi-spectral scanning from space (NASA, 1977). ERTS was renamed Landsat in 1975 to distinguish it from Seasat, the oceanic satellite program, and it has evolved into a global resource monitoring program (Lillesand and Kiefer, 1987). As of this writing (1989) five Landsat satellites have been launched. Landsat-5 is still operating.

In 1978 the French government undertook the development of the Systeme Pour l'Observation de la Terre (SPOT). From its inception, SPOT was designed as a commercially oriented program, which was to be operational rather than experimental (Lillesand and Kiefer, 1987).

The first SPOT satellite was launched in 1986. SPOT is the first commercial satellite to have pointable optics, and to provide full scene stereoscopic imaging (from two different tracks covering the same area). Detailed descriptions of the capabilities, resolutions, and spectral wavelengths scanned by Landsat and Spot are available in Sabins (1987), Lillesand and Kiefer (1987), and Short & Blair (1986).

The American Landsat and the French SPOT systems operate under an international "open skies" policy which allows nondiscriminatory access to data collected any where in the world. Japan and India are currently developing earth resource satellite systems. Neither country has announced that they will follow the open skies policy.

Although remote sensing in geology may be considered a recent science, the subject is supported by a significant volume of literature. The problem at hand can be narrowed to the discussion of remote sensing in flat land areas, specifically the detection of subsurface fracture trends and fracture density using surface maps and remote sensing.

Lineaments

The term lineament was proposed by Hobbs (1904, 1912). He defined lineaments as "the significant lines of landscape which reveal the hidden architecture of the rock basement... They are character lines of the earth's physiognomy" (Hobbs, 1912, p. 227). Lillesand and Kiefer (1987, p. 130) define lineaments as regional morphological features, such as streams, escarpments and mountain ranges, and tonal features that in many areas are the surface expressions of fractures or fault zones. Sabins (1987, p. 102) defines a lineament as "a mappable simple or composite linear feature of a surface, whose parts are aligned in a straight or slightly curved relationship and which differs distinctly from the patterns of adjacent features and reflect surface phenomena".

Must a phenomenon be "regional" in scale (Lillesand and Kiefer, 1987) to be a lineament, or may it simply be a "mappable linear feature" (Sabins, 1987)? Must features represent "the hidden architecture of the rock basement" (Hobbs, 1912) or be "expressions of fractures or fault zones" (Lillesand and Kiefer, 1987) to be lineaments, or may they simply "reflect surface phenomena which differs distinctly from the patterns of adjacent features" (Sabins, 1987)? Definition is that which refines the pure essence of things from the circumstance (Milton, in Bates and Jackson, 1980). The essence of lineaments is that they are mappable linear features. Sabins (1987) did not assign particular subsurface significance to a given set of lineaments based on remote sensing data alone. No genetic or subsurface connotation should be attached to the term lineament.

To be usable and reproducible, a set of mapped lineaments must be defined by their criteria, which includes the lineament type, minimum or maximum lengths, type of data from which they were mapped, and any other pertinent restrictions for recognition. Sabins (1987) divides lineament types into geomorphic versus tonal, continuous versus discontinuous, and simple versus composite. Geomorphic lineaments are topographic in nature and may include ridges, shorelines, stream valleys, or stream segments. Tonal lineaments involve changes in reflectance and may include changes in soil color or texture, changes in rock color or texture, changes in vegetation type, or changes in vegetation health. For example, a strip of water or drought stressed vegetation in a field of a given crop will tend to have a different reflectance than healthy vegetation. This is commonly apparent in near-infrared wavelengths before it is apparent in visible light (Lillesand and Kiefer, 1987).

Simple lineaments are composed of a single lineament type. Composite lineaments consist of more than one type. A continuous lineament is uninterrupted. A discontinuous lineament is defined by separate features that are relatively closely spaced and aligned in a consistent direction or line.

Surface and Subsurface Relationships

Nelson (1985) showed that fracture trends defined from outcrop measurements emphasized local rock anisotropies, and lineaments from air photo interpretation tended to follow regional basement phenomena. Although lineaments need to be precisely defined for maximum utility, several studies have demonstrated a relationship between lineaments in general and subsurface features.

Lineaments and Near-Surface Fractures.

Peters et al. (1988) correlated lineament analysis with "in-mine" observations at locations in central Utah and northern Alabama. Using a 75 m (250 ft) zone of radius around lineaments, approximately 80% of ground control problems at the Utah sites matched mapped lineaments, and approximately 92% of roof fall problems at the Alabama sites matched mapped lineaments. Surface lineaments matched fractures, fracture zones, paleochannels, and zones of "ground control problems" at the mine level. This research has shown that lineaments in many cases are related to subsurface fractures or paleodrainage patterns that can cause or contribute to ground control problems (Peters, 1988).

Lineaments and Deep Fractures.

One method of indirect detection of natural fractures in the subsurface is via remote sensing (Blanchet, 1957). Certain assumptions are required to apply remote sensing data to the subsurface. They are: 1) high-intensity fracture zones continue with depth (Wheeler, 1980), and 2) features that are long in map view continue deep through the section (Nur, 1982). To what degree these assumptions are valid is not known at this time (Nelson, 1985).

Lineaments and Subsurface Fracture Orientation.

Overbey and Rough (1971) studied the relationship between surface fractures, lineaments, and induced fractures in oil and gas wells in eastern Ohio and found a positive relationship between surface fractures mapped from air photos and induced well-bore fracture orientations. Aerial photographs were interpreted through stream drainage patterns, vegetation, soil distribution, and photographic tones and textures for lineament analyses. Induced well-bore fracture orientations were measured with down-hole impression packers after artificial fracturing. Induced-fracture orientations tended to parallel the dominant fracture orientations measured from air photos. The average depth of wells in the study area is 700 m (2300 ft) (Yates, 1989).

Lineaments and Fracture Permeability.

Parizek (1975) showed that water wells drilled into carbonate aquifers were more highly productive when drilled in areas of fracture concentration defined by surface fracture traces and mapped lineaments. In addition, wells drilled in these areas near a surface fracture trace (lineament) displayed more consistent yield and less variability for the same setting. Cooley (1983) mapped divisions of fracture permeability based on distribution of structures and lineaments in sedimentary rocks of the Rocky Mountains-High Plains region.

Surface Expression of Buried Structures.

Berger (1986) presented a "New Technique" for structural analysis of low-relief basins that integrated Landsat data with other geologic data sets including subsurface and production data. He cited examples from the Powder River Basin and the Central Basin Platform of West Texas. He concluded that surface expression of buried and obscured structures are attributed to differential compaction, loading, structural reactivation, and other processes related to abnormal flows of ground and surface-waters near structures. Okonny (1981) showed a correlation between the sedimentary wedge of the Niger delta and basement controls using Landsat Lineaments.

Topographic Relief Patterns and Geologic Structures.

Eliason (1984) developed a technique for geologic analysis of topography using digital techniques and remote sensing data. His goal was to find a link between topographic relief patterns and geologic structure. These analyses have shown that the last major tectonic event in an area strongly controls the development of the erosional pattern (Eliason, 1984). Natural outcrops are poor areas for locating jointing representative of the most recent major tectonic event. These outcrops tend to develop because of resistance to erosion, which is commonly related to lack of joints. Recent jointing dominates control of erosional topographic forms in many areas and is, therefore, commonly covered by the products of erosional processes (Eliason, 1984).

Subsurface Structure and Sea-Surface.

The expression of subsurface phenomena on remotely sensed data is not limited to lineaments. Bostrom (1989) demonstrated that Seasat imagery can be used as a gravimetric device to display primary crustal structures such as basins and major anticlines or synclines, even in areas where the basement rock is obscured from normal (reflection) seismic data by thick volcanic or carbonate sequences. Simply, sea-surface heights are sensitive to crustal structure, and satellite observations of the sea-surface mirror the basement.

Fractures and Streams

Established evidence proves a link between lineaments and some subsurface phenomena. A systematic procedure is needed that will link specific mappable lineaments, such as stream lineaments, to specific subsurface features, such as fractures. The idea of linking straight line stream segments (as lineaments) with subsurface fractures is not new (Melton, 1959; Ray, 1960), but is still controversial (Scheidegger and Langbein, 1966; Scheidegger, 1983; Pohn, 1983). Conflicting views are given below.

Evidence Against Fracture Influence on Drainage.

Random Processes. The influence of subsurface fractures on drainage patterns has not been universally accepted (Scheidegger and Langbein, 1966; Scheidegger, 1983; Pohn, 1983). Scheidegger and Langbein (1966) applied a mathematical model to rivers and landforms produced by running water and concluded that the processes that are operative represent the cumulative effect of many small-scale events, which are impossible to follow in detail. The primary conclusion was that landforms produced by the action of flowing water are dominated by random processes.

River Trends versus Fractures. Scheidegger (1983) compared joint traces, river-trends and photolinears in

Alberta, Canada and found that river courses in Alberta do not align themselves with joints and are presumably controlled by the general slope of the land towards Hudson's Bay. He concluded that photolineaments are features of uncertain origin and age. Scheidegger's (1983) conclusions may have been affected because his azimuths were averaged for stream segments approximately 1 km in length. No discussion was provided for azimuths of shorter stream segments.

Joint Oblique Valleys. Pohn (1983) studied an area in south-central New York and adjacent northern Pennsylvania that had two sets of joints that meet orthogonally. He hypothesized that the development of most streams parallel to joint directions did not apply in this area. Pohn (1983) studied valley development rather than stream segment or channel morphology. Although some well developed valleys are joint-parallel, most valleys in the Finger Lakes region are joint-oblique. Streams whose courses are oblique to the joint directions (joint-oblique valleys) erode easily because of increased corrasion and subsequent undercutting at the intersection of joints. The removal of joint-bounded blocks in joint-oblique valleys forms cascades that advance headward by apical erosion. Streams whose courses are parallel and perpendicular to the nearly orthogonal joint sets (joint-parallel valleys) erode by waterfall and plunge-pool formation. This is apparently a less efficient mode of valley development than joint-oblique erosion in this area. Where valleys are joint-parallel they are caused by 1) a single deep pervasive joint whose presence acts as a barrier to lateral expansion of the stream, or 2) erosion along joint zones where intense fracturing (high fracture density) produces weak erosional resistance in the rocks.

Evidence For Fracture Influence on Drainage.

Concept of Universal Tectonic Influence. Other researchers have found evidence of fracture influence on streams to be common. In 1959, Frank Melton of the University of Oklahoma proposed the concept of universal tectonic influence on most continental drainage. His primary point was that the last major tectonic event in a region tended to influence the drainage pattern of that region even through or after minor tectonic pulses, inundation, unconformities, etc. The mechanisms by which adjustments to tectonics are reached may be 1) repeated minor uplifts or other movements of buried tectonic features, 2) differential compaction over buried surface topography or tectonic axes, 3) influence on or derangement of groundwater flow because of 1 and 2, and 4) development of joints (fractures) to a degree which will affect weathering and erosion in the overlying rock. Melton asserted that paleotectonic features and even paleogeomorphic features in strata-benchlands (areas of flat lying strata) could be mapped using aerial photographs. Local rills, rivulets, swales, microflexures or microscarps may develop in alignment with tectonic linears and microlinears even on recently exposed strata. In other words, the subsurface fracture pattern should be reflected in the surface drainage pattern (figure 4) and should be persistent in space (vertically) and time.

Fracture Trends and Drainage Maps. Ray (1960) demonstrated how drainage maps may be used to show cross-joint (fracture) trends and to delineate a prominent fracture direction in some areas. He did not project this data into the subsurface, nor did he discuss relative fracture density.

Drainage Line Orientation and Geologic Structure. Weber (1974) prepared a quantitative analysis of the relationship between geologic structure and drainage line orientation in a neotectonic region, the upland Oak Creek watershed area of the Colorado Plateau. He found that drainage line orientations correlate positively with bedrock structural orientations and linear trends defined by remote sensing.

Relation Between Lineaments and Straight Line Stream Segments. In Oklahoma Watts (1977) and Azimi (1978) used remote sensing (Landsat) imagery to study the relationship between lineaments and shallow groundwater aquifers in eastern Oklahoma. Watts (1977) found a positive relationship between lineaments, straight line stream segments, and faults. Some of the lineaments were directly associated with known faults. Others paralleled the structural pattern of the region and correlated well with drainage trends. No statistical measures were listed. Azimi (1978) found similar results.

Correspondence Between Joint Orientation and Stream Networks. Bannister (1980) studied the correspondence between the orientation of joint and stream networks in the mildly folded plateau landscape of southwestern Pennsylvania. He found that joint patterns dominate the trajectories of streams where relative relief and hydrostatic gradient are low. He concluded that joint networks tended to control the directional intensity of stream segments in humid landscapes where structural dips are moderate.

Lineaments, Surface Joint Trends, and Stream Patterns. Heidelberg (1983) noted that rectangular areas, or parallel and equidistant lineaments, are conspicuous on many topographic maps and on views from high flying platforms. Many of the lineaments appeared to be caused by rivers cutting headwards along the most obvious or passable joints. Dimant (1983) showed a significant correlation between subsurface joint trends and surface drainage patterns at an underground storage project in Israel.

Stream Orders and Fracture Domains. Ciccacci et al. (1987) studied the relationship between drainage patterns and fracture trend in the active volcanic area of Monti Sabatini in Northern Latium, Italy. The comparison between the identified drainage network and fracture domains showed that the main orientations are consistent. Their study indicated that certain fracture orientations were more prevalent in certain Strahler stream orders (Strahler, 1954). Ciccacci et al. (1987) speculated that this may be caused by apparently older, higher order stream segments, being associated with older fractures.

Basement Faults and Surface Drainage. Maarouf (1981) used Skylab and Landsat data to determine the relationship between structural and geomorphic features in the Colorado Plateau. He concluded that wind or water gaps are not randomly located. Rather they occur in zones of structural weakness, which have controlled drainage paths. He further concluded that basement faults have influenced the present surface drainage and structures through a sedimentary cover of more than 6 kilometers (nearly 20,000 feet). This same phenomenon can be observed in western Oklahoma over the Aledo gas field. The Aledo field is a faulted structural trap that produces primarily from the Hunton dolomite below a depth of 15,000 feet. A radial drainage anomaly can be observed over Aledo field from Landsat satellite data (Short, 1976; Bruce, 1989).

Stream Patterns and the Mid-Continent Stress Field. Stauffer and Gendzwill (1987) looked at fractures, stream patterns and the midcontinent stress field in the northern plains of North America and found that fractures in Late Cretaceous to Late Pleistocene sediments in Saskatchewan, eastern Montana, and western North Dakota form two vertical, orthogonal sets trending northeast-southwest and northwest-southeast. The pattern is consistent, regardless of rock type or age (except for concretionary sandstone). Modern stream valleys also trend in the same two dominant directions and may be controlled by the underlying fractures.

Linear Stream Segments in Unconsolidated Sediments. Fracture influence on drainage is not limited to areas with near-surface bedrock. Cox and Harrison (1979) demonstrated that fractures significantly influence drainage on recent cover by mapping a (bedrock) fracture-trace influenced stream in glacial drift in northwest Pennsylvania. They discovered that fracture influence did not decrease with increasing thickness of cover, up to the maximum thickness in the study area of 152 meters (500 feet).

Fracture influence on drainage is not always readily apparent or recognized. Whitesell, Vitek, and Butler (1988) studied changes in the planform of the Red River through time before and after installation of a flood control dam upstream. One reason this particular area was selected for study was that the channel lies on thick alluvium and thus is not apparently affected by bedrock patterns such as outcrops or fractures (Vitek, 1989). They found that although the channel pattern had changed substantially over a 46 year period, the channel is inherently asymmetric, and that the asymmetry-index values did not change significantly during the period studied. The dam did not appear to affect channel symmetry or the rate of channel migration. Channel diagrams in the paper displayed consistent linear stream segments oriented NE-SW and NW-SE which are similar to fracture influenced stream segments. Fracture control via groundwater sapping may explain the consistent asymmetry and linear orientation of these stream segments.

Groundwater Sapping. Kochel et al. (1988) demonstrated through model studies that joints can control channel formation in weakly consolidated layered sediments via groundwater sapping. Groundwater sapping is the process of erosion, particularly the headward migration of valleys or stream channels, caused by groundwater movement and the emergence of groundwater onto the surface. Howard et al. (1988), demonstrated the importance of groundwater sapping and piping in channel development on the Colorado Plateau, in Hawaii, and on Mars. Robb (1988) showed that groundwater sapping along joints can be effective even as a submarine process.

Summary. It has been established that fractures influence the ability of some rock formations to transmit fluids in the subsurface, and that fracture density and orientation are two key components in the permeability equation. Evidence has been established to prove that mapped lineaments are indicators of fractures in the near-surface (Peters et al., 1988). However, the validity of projecting near-surface fractures into the deep subsurface is not known (Hodgson, 1961; Stearns, 1972; Nur, 1982; Nelson, 1985; Risner, 1989).

Okonny (1981), Eliason (1984), and Berger (1986) demonstrated that deep geologic structures commonly have surface expression. Melton (1959) hypothesized that most drainage is influenced by deep fractures that project to the surface. Arguments have been given for and against fracture influence on drainage (Weber, 1974; Watts, 1977; Azimi, 1978; Cox and Harrison, 1979; Bannister, 1980; Maarouf, 1981; Heidelberg, 1983; Scheidegger, 1983; Pohn, 1983; Ciccacci et al., 1987; Stauffer and Gendzwill, 1987; Kochel, 1988).

There are many different kinds of lineaments (Sabins, 1987). Lineament mapping can be quite subjective (Podwysocki, 1975). Criteria should be defined for testing individual types of lineaments for geologic or environmental significance. In this study, several different mapping techniques will be tested against an indicator of fracture permeability in the deep subsurface.

CHAPTER III

METHOD

Problem Statement

The problem is to develop a methodology that uses remote sensing and/or surface data to predict areas of relatively high and low fracture-enhanced permeability in the subsurface in regions of flat-lying strata. The assumptions are:

1) Fracture density varies spatially.
2) Relative fracture density influences permeability. {In general, higher fracture density yields higher permeabilities.}
3) Fracture permeability varies with lithology.
4) In a fracture controlled (Type I) oil and gas reservoir production will vary in relation to fracture density. {Higher fracture densities will yield higher cumulative production per well or unit volume of reservoir.}
5) In areas of flat-lying strata, vertical subsurface fracture sets may have surface expression.

Procedure

The procedure for this research will involve the following steps:

1) Select a fracture controlled oil and gas field that produces from the desired depth range (2,000 to 3,000 meters/6,500 to 10,000 feet) to serve as a model for the study. Because bed thickness and lithology may also affect fracture density (Nelson, 1985), it is necessary to locate a target oil and gas reservoir with little apparent variation in these parameters over a given geographic area. Because surficial geology may affect the expression of fractures on the surface, an area with minimum variation in surficial geology is desirable.

2) Make subsurface maps of the field including structure, isopach, and lithofacies maps for control, and production maps to serve as indicators of relative fracture density.

3) Acquire and make a series of lineament maps of the area using different investigators and different methods. Compare the various lineament maps to ascertain which, if any, correlate with subsurface fractures as defined by oil and gas production.

4) Select the best method or methods from above and analyze it (them) in relation to surface and subsurface data to determine if a statistically valid correlation exists between surface phenomena mapped

by a given technique and subsurface fracture density as defined by oil and gas production. Mapping methods will be tested by correlating Meramec-Osage oil and gas production with fracture density or fracture-intersection density. Linear correlation coefficients will be calculated and tested for significance via ANOVA and t-test of correlation. Observations will be deemed significant if the alpha limit for type I error is .01 or less.

5) If a statistically valid correlation is established, define the types of lineaments used, the criteria for their identification, and any additional procedures required to refine the lineament data to create meaningful maps.

CHAPTER IV

STUDY AREA

Location

The Study area (Figure 3) designated as the Southwest Enid Area, consists of Townships 20 North through 22 North and Ranges 7 West through 9 West, Indian Meridian, Oklahoma. It includes parts of Major and Garfield Counties and a small slice of Kingfisher County. The area encompasses 839 square kilometers (324 square miles) and, except for the extreme northeast corner, is primarily farmland with a few villages. The northeast corner of the area includes part of the city of Enid and Vance Air Force Base.

Surficial Geology

Approximately 60% of the surface geology consists of Lower Permian age (Cimarronian Series) inter-bedded sandstones, siltstones, and shales of the Cedar Hills and Bison Formations of the El Reno and Hennesey Groups respectively (Figure 4). An outlier of Flowerpot Shale Formation (Permian El Reno Group) touches the northwest corner of the area. The Salt Plains Formation (Permian

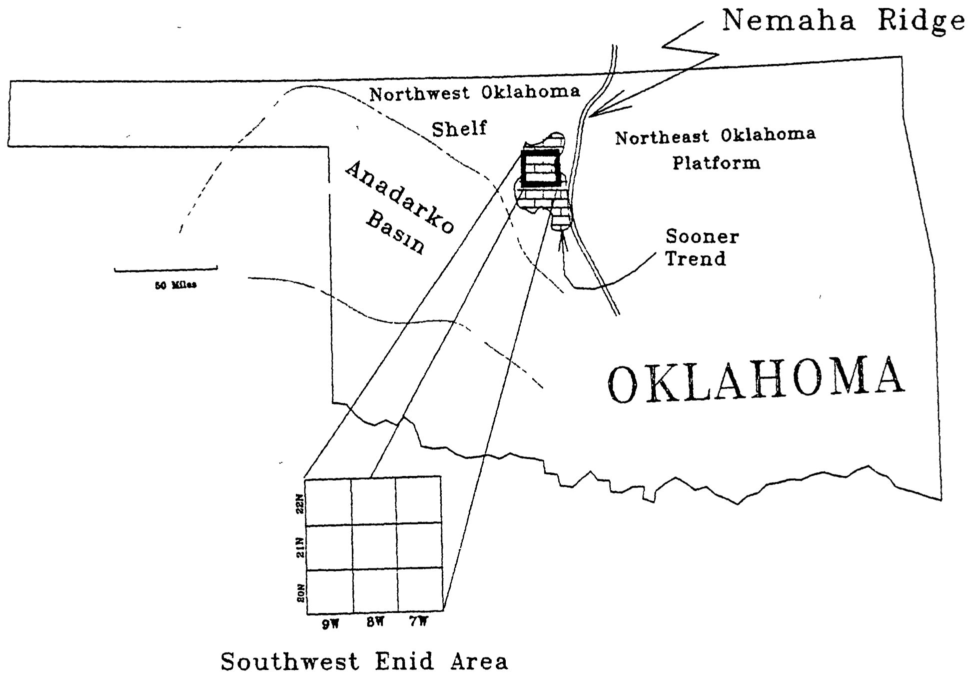


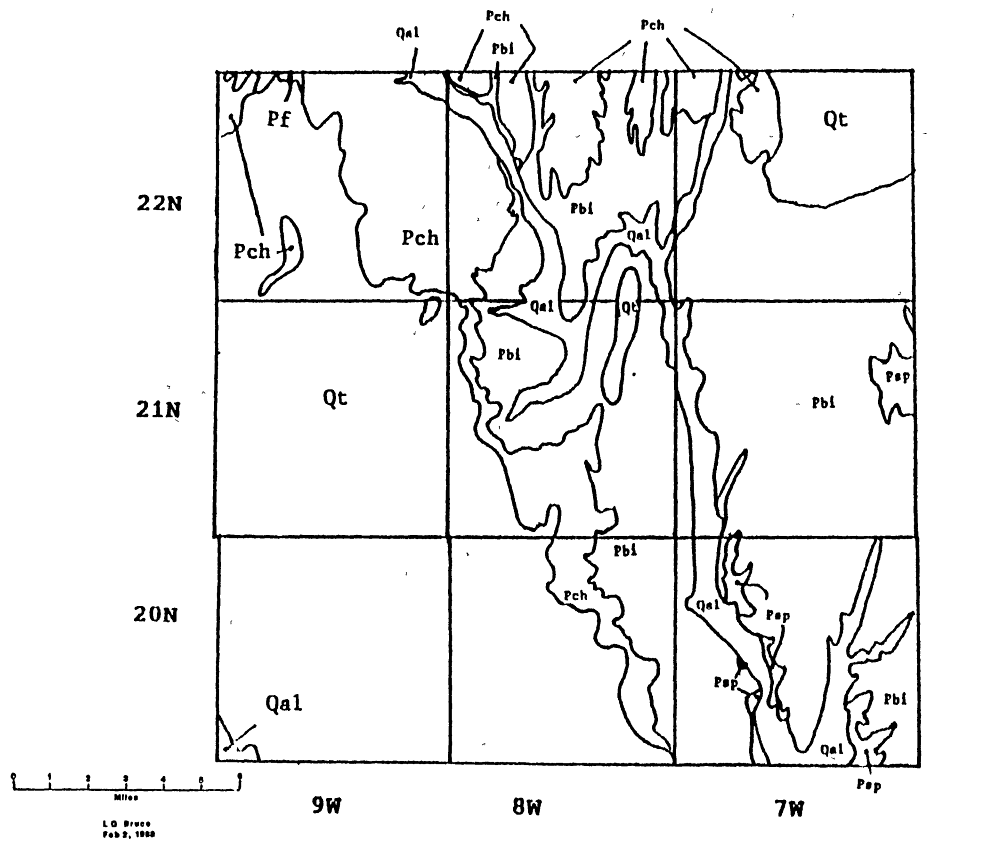
Figure 3. Location Map of Study Area.

Hennesey Group) crops out in places to the southeast where Turkey Creek has cut through the Bison Formation, and to the east where Hackberry Creek (a tributary of Skeleton Creek) has also cut through the Bison Formation. Neither the Flowerpot nor the Salt Plains Formations are important aerially.

The remaining 40% of the surface geology consists of Quaternary alluvium and terrace/aeolian deposits which are essentially flat lying (Morton, 1980). The largest area of Quaternary strata consists of aeolian sand dunes adjacent to Cimarron River alluvium (marked Qt in the southwest portion of Figure 4). A small slice of Cimarron River alluvium touches the southwest corner of the area, and a ribbon of alluvium lies along Turkey Creek. Terrace deposits underlie the city of Enid on the upper reaches of Skeleton Creek drainage basin. A small area west of the village of Drummond was mapped as Quaternary-lacustrine by the U. S. Department of Agriculture, Soil Conservation Service (1967) (Figure 5), but is listed as Quaternary terrace and Permian by Morton (1980).

Structural Geology

The Quaternary strata are flat lying except for depositional dip in alluvial bars and aeolian dunes. The Permian strata are all essentially flat lying with dips averaging 2 to 5 meters per kilometer or 10 to 25 feet per mile (Arbenz, 1956; Morton, 1980). Regional strike is



Qal- Quaternary Alluvium
Qt - Quaternary Terrace
Pf - Permian Flowerpot Sh
Pch- Permian Cedar Hills
Pbi- Permian Bison
Psp- Permian Salt Plains

Figure 4. Surface Geologic Map of the Southwest Enid Area. After Morton (1980) and Bingham et al. (1980)

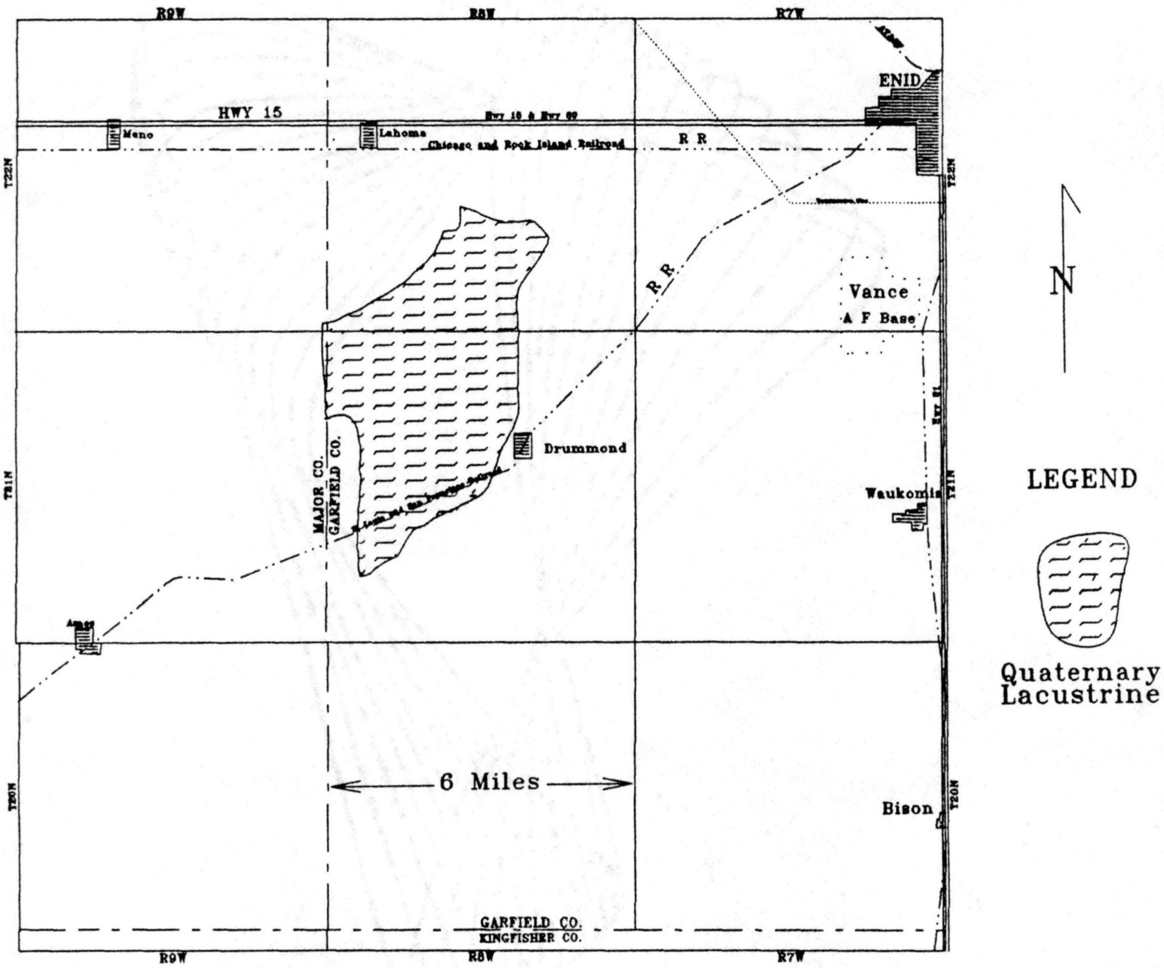


Figure 5. Area of Quaternary Lacustrine Sediments.
(USDA Soil Conservation Service)

approximately west-northwest/east-southeast, and dip is to the south-southwest. No major structural anomalies are known to be present here (Morton, 1980; Evans, 1988).

Outcrops are rare, but when found (Figure 6) display a joint system consisting of four joint sets with the following approximate strike directions; NW-SE, NE-SW, N-S, and E-W. The NW-SE/NE-SW orthogonal pair tends to predominate over the N-S/E-W orthogonal pair.

Topography and Drainage

The Southwest Enid Area is in the Central Lowland and Great Plains Provinces of the Interior Plains (Morton, 1980) and is part of the Cimarron River drainage basin. Hoyle, Turkey, and Skeleton are the principal creeks in the area (Figure 7). Rainfall in the area averages approximately 79cm (31 inches) per year (Pettyjohn, 1983). Topography in the area is the result of erosion and the type of rocks being eroded. Areas underlain by Permian strata display dendritic-like drainage patterns (Figure 8). Areas underlain by Quaternary strata, particularly aeolian deposits, display deranged or centripetal drainage patterns.

The northeastern part of the study area lies within the Skeleton Creek drainage basin. It forms a corridor from Enid and Vance Air Force Base to the village of Waukomis on the east edge of T21N-R7W (Figure 8). The

Figure 6. Orthogonal Joints at Outcrop along Hell-and-Gone Creek, NW/4 Section 8-T20N-R7W. Meter Stick points approximately north-south.

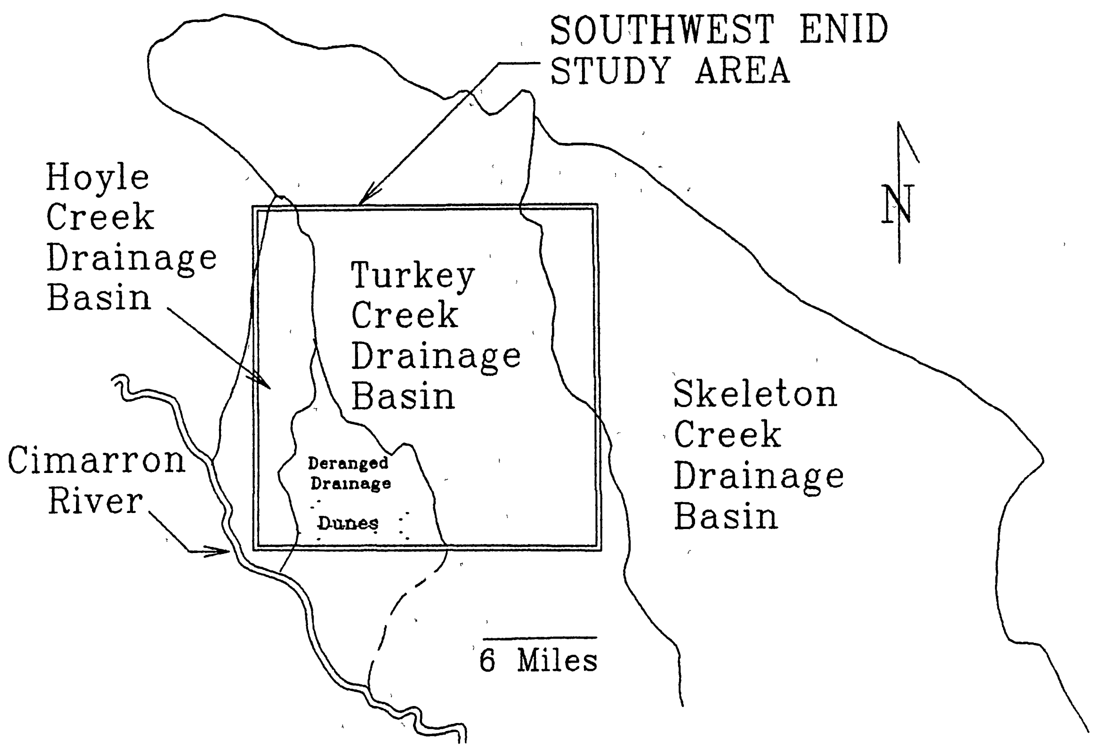


Figure 7. Hoyle, Turkey, and Skeleton Creek Drainage Basins.

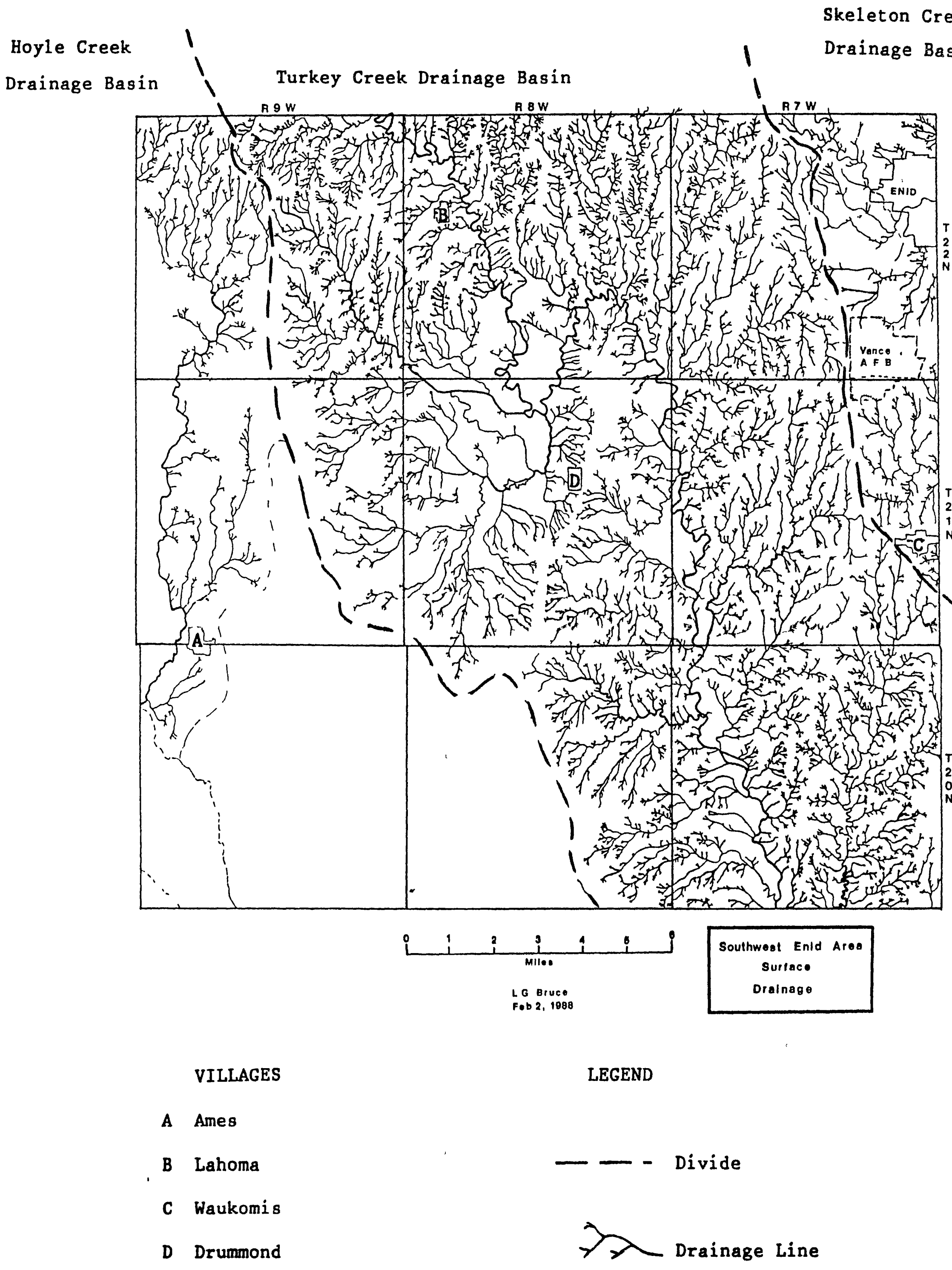


Figure 8. Drainage Map of the Southwest Enid Area.

northern part of the corridor is dominated by urban development. The area is underlain by Quaternary terrace deposits and the Bison and Salt Plains Formations. On the terrace the topography is predominantly flat. The region is underlain by Bison and Salt Plains strata. Incised stream cuts are common.

The central portion of the study area consists of part of the Turkey Creek drainage basin (Figure 8). It runs through the center of the study area aligning from north-northwest to southeast. It is characterized by nearly flat topped hills dissected by Turkey Creek and its incised tributaries. It is underlain primarily by Bison and Cedar Hills Formations. The hilltop areas consist primarily of wheat fields. The vista from the fields gives the impression of uninterrupted gently rolling plains (Figure 9). Stream valleys, particularly tributaries, create an impression of rugged country rather than smooth plains (Figure 10). Straight line stream segments strike parallel to joint sets as measured at outcrops (Figure 10).

Part of the valley of Turkey Creek, however, does not appear rugged. This area, northwest of the village of Drummond, lies in a low flat bowl shaped plain surrounded by hills or higher topography. It has the drainage, soil, and physical characteristics of an ancient lake bed. It is described as deep, nearly level bottom land soils of the Drummond-Miller association by the USDA Soil

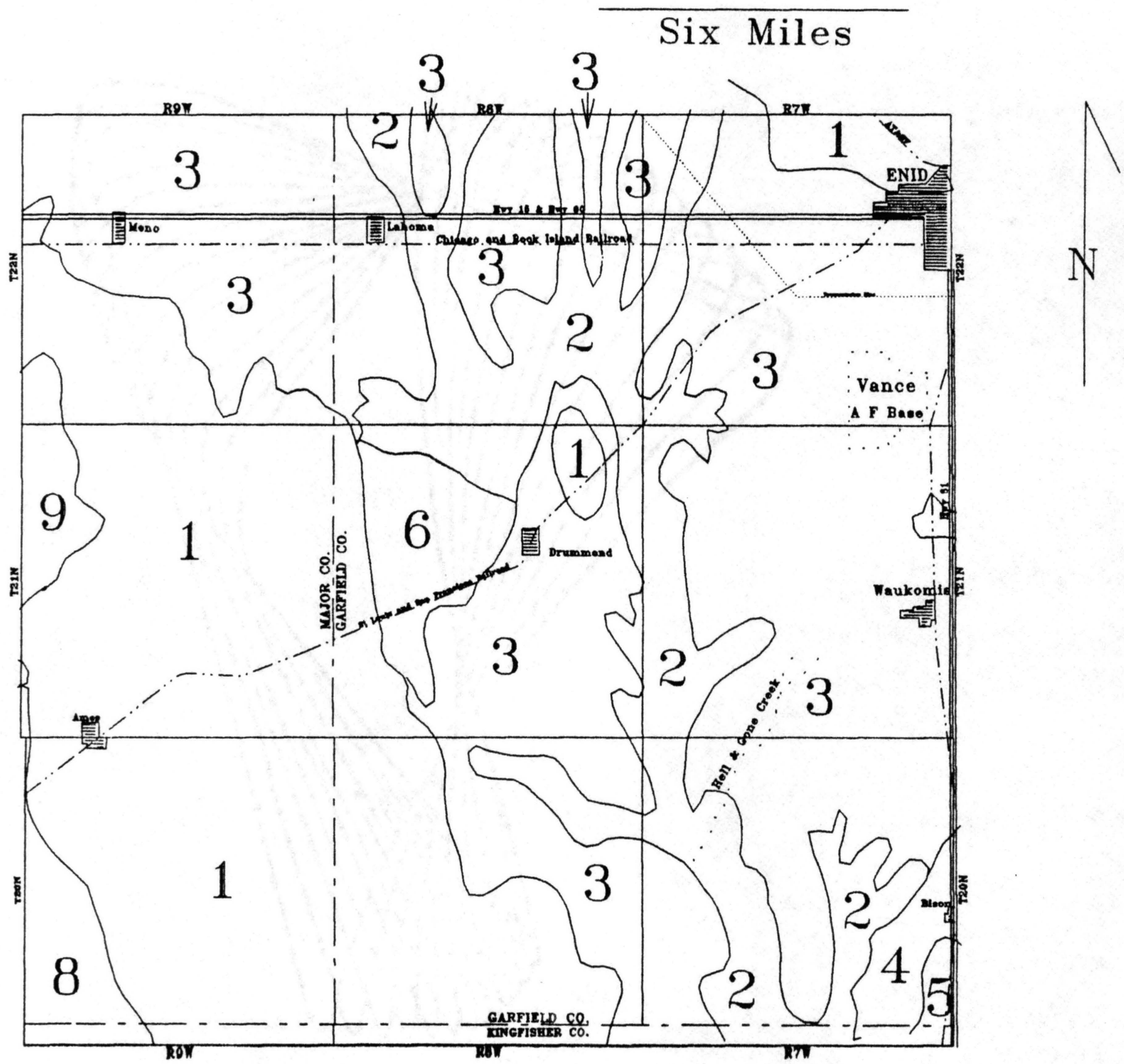
Figure 9. Vista from Wheat Field Gives Impression of Gently Rolling Plains. NW/4 Section 10-T22N-R9W.

Figure 10. Natural Straight Channel along Cut Bank of Hell-and-Gone Creek. Strike S 40 W. Section 8-T20N-R7W.

Conservation Service (1967) (Figure 11). This is the area mapped as Quaternary-lacustrine (Figure 5) by the USDA Soil Conservation Service (1967), but as Quaternary terrace/alluvium and Permian by Morton (1980).

The southwest portion of the study is dominated by stabilized Quaternary aeolian sand dunes. The topography consists of smooth-topped relatively tightly spaced rolling dunes. The southern part of this region has deranged or centripetal drainage and is predominantly pasture land. Part of this region has thicker sand cover, thus allowing subterranean drainage. The lack of field capacity (the ability of soil to hold moisture) is the primary reason this area is in pasture rather than crops. It is described by the USDA Soil Conservation Service (1968) as deep, duned and hummocky, sandy soils of the Tivoli-Pratt association

Northern and western parts of this region (the southwestern portion of the study area) are part of the Hoyle Creek drainage basin. The Hoyle Creek area is a mix of cropland and pastures. One may infer that the sand cover is thinner in the Hoyle creek area, thus allowing a more conventional drainage pattern to develop. The area is described by the USDA Soil Conservation Service (1968) as deep, undulating, sandy and loamy soils of the upland Meno-Shellabarger-Pratt association.



1 Deep sandy, and loamy, level to gently sloping soils of uplands.

2 Deep, nearly level loamy soils of flood plains.

3 Deep, loamy, nearly level to moderately steep soils of of uplands.

4 Deep and shallow, nearly level to gently sloping upland soils with clayey subsoil.

5 Deep, nearly level, loamy soils of uplands.

6 Deep, nearly level soils of bottom lands.

7 Deep and shallow, very gently to steeply sloping soils of uplands.

8 Deep, duned and hummocky, sandy soils of uplands.

9 Deep, undulating to rolling sandy soils of uplands.

Figure 11. Soils Map of the Southwest Enid Area. From USDA SCS (1967 and 1968).

Hydrogeology

Surface water quality in the area is poor with total dissolved solids in Turkey Creek generally exceeding 1,000 mg/l (Bingham et al., 1980; Morton, 1980). Groundwater quality in the area is moderate to poor with total dissolved solids ranging from less than 500 mg/l in the dune sands and the Cedar Hills Aquifer to over 1,000 mg/l in the Turkey Creek and Cimarron River alluvium (Bingham et al., 1980; Morton, 1980).

Minerals

Excluding oil and gas, industrial minerals in the area include sand and gravel along streams, and small deposits of Tertiary and Pleistocene volcanic ash (Johnson, 1969). Sand and gravel is used primarily for building aggregate in concrete and asphalt. Volcanic ash is used as an abrasive, as an admixture in pozzolan cement, and is suitable as an insulating compound (Bates, 1969). In also weathers to bentonite which is used as an adsorbent clay and is valuable for its swelling properties (Bates, 1969; Johnson, 1969).

Subsurface Geology

The geologic column, illustrated in Figure 12, shows the sedimentary section in the study area extends from the surface to a depth of approximately 3,000 meters (+/- 10,000 feet) where Pre-Cambrian igneous/metamorphic "basement" is encountered (Evans, 1988). Of interest in this study is the section down to and including the Meramec-Osage Limestone.

Integrating scout ticket and well log data from the Oklahoma Well Log Library with descriptions of the sedimentary section by Morton (1980) and Bingham et al. (1980) generated the following description. Subsurface Permian rocks include the Garber Sandstone, Wellington Anhydrite, and rocks of the Wolfcampian Series. Of particular note is the Wellington Anhydrite which can be found between the approximate depths of 150 to 600 meters. This thick evaporite section forms a seal between the Permian rocks above, and older rocks below.

Below the Permian lie Pennsylvanian age rocks, which are predominantly shale with interbedded sandstones and siltstones, and occasional limestones such as the Big Lime and Oswego. Pennsylvanian rocks lie unconformably on the Mississippian age (Chesteran) Manning. Below the Manning lies the Meramec-Osage.

The top of the Meramec-Osage Limestone occurs within the depth range of 1,980 to 2,140 meters across the study area. It is between 150 and 200 meters thick and is a thickly bedded calcareous wackestone (using Dunham's classification, 1962) or biomicrite to pelmicrite (using Folk's classification, 1962).

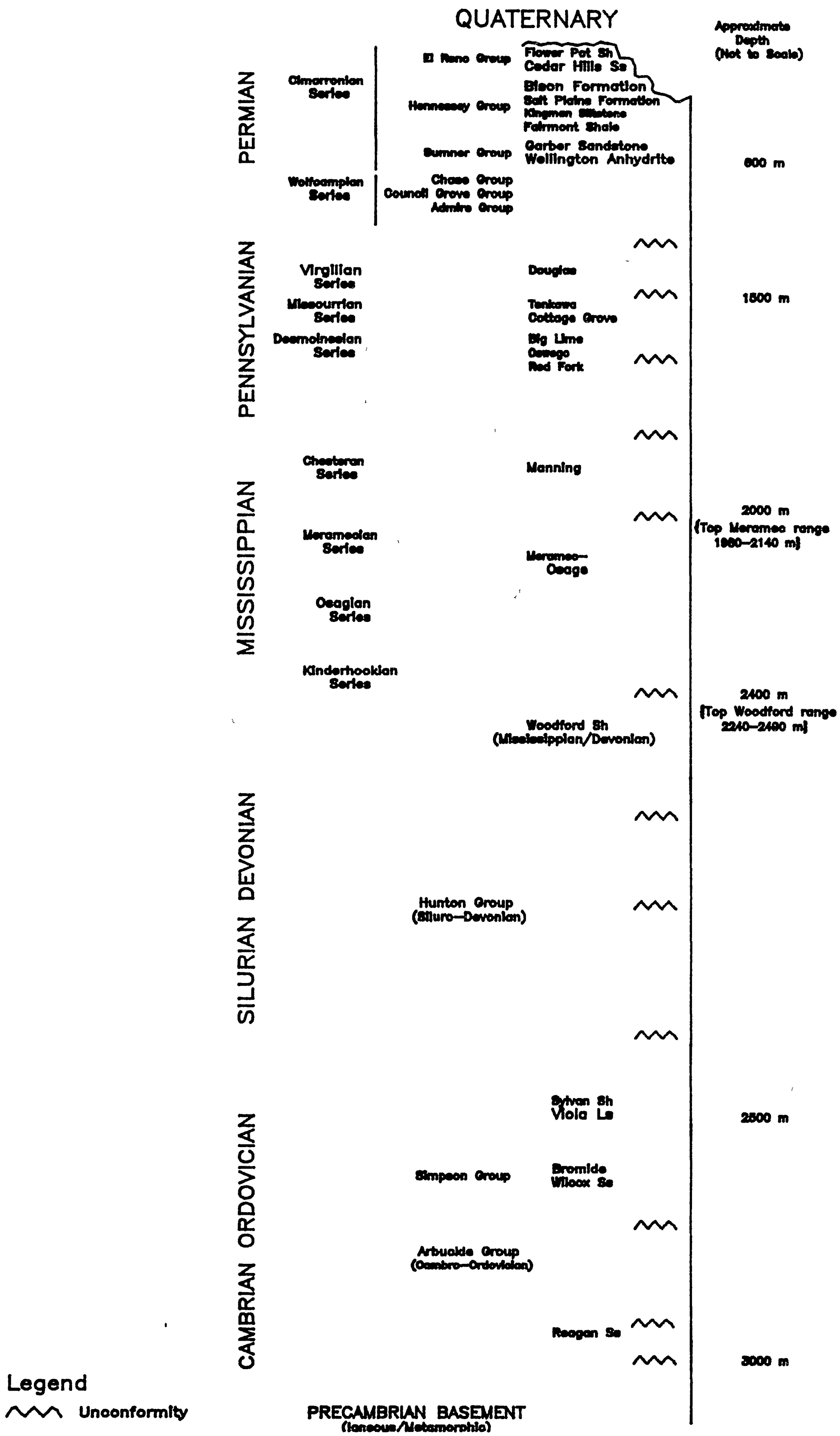


Figure 12. Geologic Column of the Southwest Enid Area.

Four cores of the Meramec-Osage from wells drilled within the study area were examined (Appendix A). Little variation in lithology occurred vertically or horizontally except for some variation in silica (chert) content. None of the cores exhibited visible matrix porosity. Scout ticket data indicated the presence of three feet of "good limestone porosity bleeding oil" in one core, but this core interval was missing. Stylolites were present to abundant in all of the cores.

Vertical fractures were present in some of the cores. These fractures were up to 0.5 mm wide and 70 mm long, with crystal linings. Some fractures were completely "healed" with calcite crystalline cement. Others were open with euhedral quartz crystals lining the fracture walls.

Harris (1975) reported increases in fracture density in conjunction with more siliceous facies in the Meramec-Osage. He postulated that this was because siliceous strata would shatter more readily. It is perhaps as likely that diagenetic chert would occur more readily in areas of higher fracture density because of increased permeability. Which came first, siliceous rocks, or higher fracture density is unresolved.

CHAPTER V

PETROLEUM GEOLOGY

The Sooner Trend

On April 22, 1965, the Oklahoma Nomenclature committee of the Kansas-Oklahoma Division, Mid-Continent Oil and Gas Association consolidated 21 previously separate multi-pay oil and gas fields under the single designation of Sooner Trend (Petroleum Information, 1982). The trend lies on a homoclinal slope on the northeastern edge of the Anadarko basin (Figure 3). It is approximately 20 miles wide and extends over 60 miles NNW-SSE. As of January, 1988, the cumulative production from the Sooner Trend was approximately 300 million barrels of oil and 1.15 trillion cubic feet of gas from approximately 6,000 wells (Petroleum Information, 1982; Oklahoma Geological Survey, 1989). At average 1989 prices, this production would be worth approximately 7.5 billion dollars.

Meramec-Osage in the Sooner Trend

The primary producing formation is the Mississippian age Meramec-Osage Limestone. The Meramec-Osage Limestone in the Sooner Trend is a fracture dominated reservoir (Nelson, 1985). Oil and Gas production within this system is controlled by reservoir characteristics arising from variations in the concentration of fracture permeability (Harris, 1975). The trapping mechanism is the finite nature of permea-bility in a fracture system where it extends laterally through massive beds of low matrix porosity (Harris, 1975). Top and bottom seals are provided by Chesteran and Woodford shales respectively. The study area is near the northern end of this trend.

Southwest Enid Area

Oil and gas are the most important "mineral" resources in the study area. 1,692 wells have been drilled here in the search for commercial quantities of hydrocarbons (Figure 13). This provides an average well density of 2+ per square kilometer (5.2 per square mile). As of January, 1987, over 52 million barrels of oil and 475 billion cubic feet of gas have been produced from these nine townships (Petroleum Information oil data, 1988; and Dwight's Energy Gas Data, 1988). At 1989 prices this production would be worth nearly 1.7 billion dollars.

Petroleum Production History

Production and well history in this area is important because the data show that the Meramec-Osage is the dominant producing reser-voir, and that wells drilled after 1976 were "infill" wells that were predominantly drilled in a partially depleted reservoir. The first recorded test for oil in the area was a shallow dry hole drilled in 1924 (Oklahoma Well Log Library records). At this time most oil and gas production in Oklahoma was limited to the northeastern part of the state. The Oklahoma Geological Survey, as well as most geologists, did not regard the area west of the Nemaha ridge (Figure 4) as having much potential for hydrocarbon production (Petroleum Information, 1982). The area continued to receive little attention in the 1930's because surface mapping of this shelf region failed to define major structural features at a time when most successful exploratory ventures involved structurally entrapped hydrocarbon accumulations (Petroleum Information, 1982).

The first production in the area was established in 1946 from a well completed in the Simpson formation (Section 4-21N-9W). Production was predominantly gas, which was of low commercial value at the time and of less value in this area because of the dearth of gas pipelines nearby. This first producing well was not offset until 1948 (Oklahoma Well Log Library records, 1988). The offset was dry.

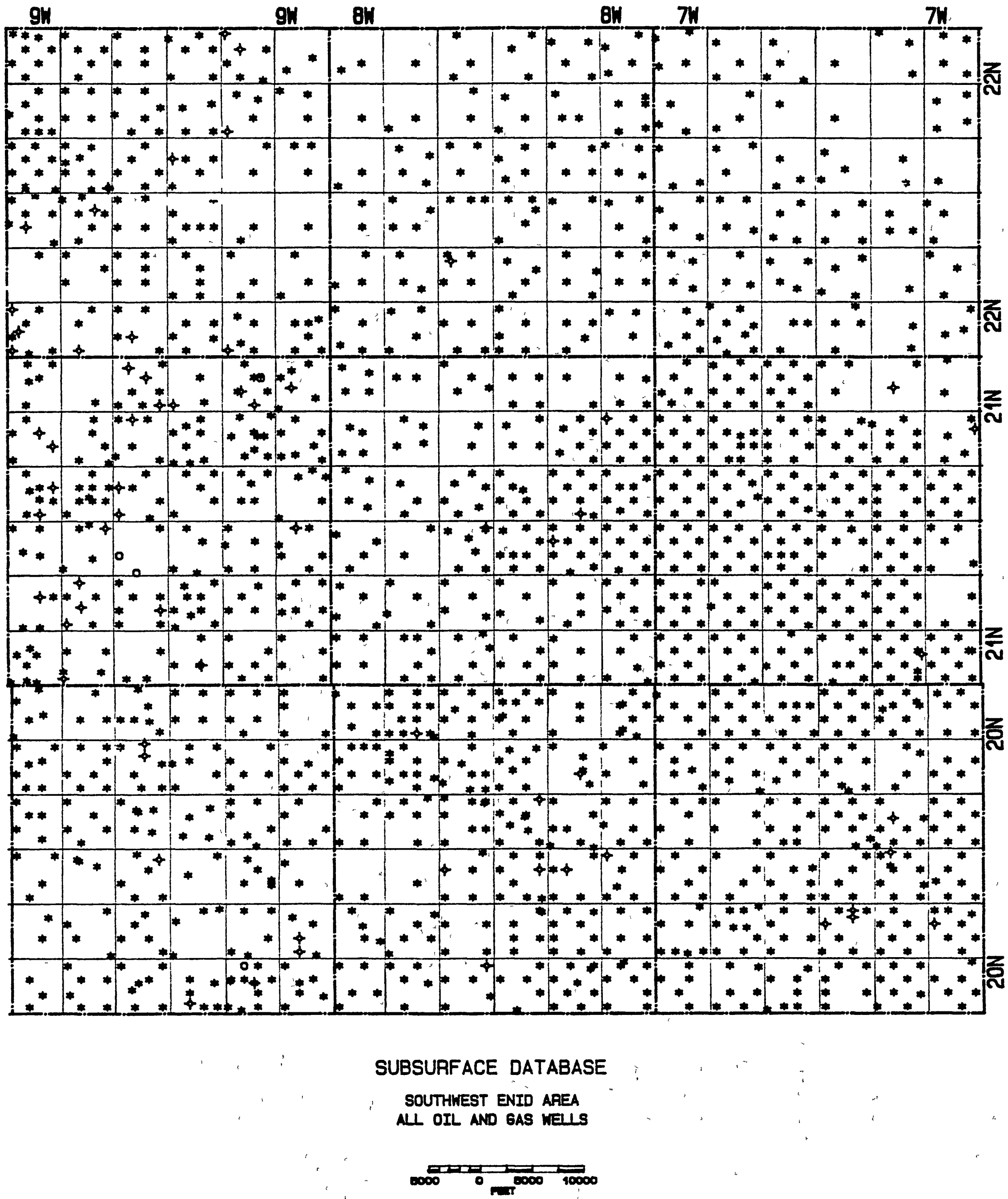


Figure 13. Oil and Gas Well Control in the Southwest Enid Area.

Only five additional producing wells were drilled in this area between 1948 and 1961. They produced from the Red Fork and Manning formations. In 1961 oil and gas was discovered in the Meramec-Osage. This discovery was made commercial by artificial fracture treatments. From 1961 to 1977, 852 additional producers were added to the Southwest Enid area, 95% of which (809 wells) were completed in the Meramec-Osage. These 809 wells have accounted for 81% of the total gas and 86.5% of the total oil produced from the area to 1988.

The rapid rise in oil and gas prices of the late 1970s and early 1980s, coupled with industry tax incentives and large volumes of "Fund" drilling capital, caused another 784 tests to be drilled between 1977 and 1988, bringing the total number of wells drilled to 1,692. Most of these wells were unnecessary for the economic recovery of existing reserves. Post-1976 wells do not yield production representative of reservoir quality or fracture density.

Oil and gas have been produced in the study area from the Hunton, Inola, Manning, Meramec-Osage, Oswego, Red Fork/Skinner, Simpson, and Viola Formations. Of all oil and gas wells completed in the study area to date, 88% have been completed in the Meramec-Osage, accounting for 91.5% of the gas, and 88.5% of the oil recovered. Over 71 percent of the Meramec-Osage wells were single zone completions (i. e. no other formations contributed to the production).

Inspection of the data shows that of the remaining 29 percent of the Meramec-Osage wells (those that are multi-zone completions), only those wells dually completed with the Hunton yielded above average production rates. These Hunton-Meramec wells are associated with isolated areas of single zone Hunton wells along the Hunton subcrop trend. It is not unusual for some Meramec-Osage production to be associated with Hunton production in the study area. The reverse, however, is not true. Meramec-Osage production in conjunction with Hunton fields may be caused by fracturing associated with relatively small localized flexures which either influenced the location of the Hunton subcrop via preservation of the Hunton in depressions, or were caused by drape over "paleo-cuestas" formed by the Hunton (Withrow, 1972). Meramec-Osage production in the heart of the Sooner Trend portion of the study area, however, appears to be controlled by variations in regional fracture density (Harris, 1975).

Production from single zone wells other than Meramec-Osage has come from completions in the Manning and Simpson. These are all located in the western portion of the study area and are easily separated from Meramec-Osage wells. Production from all other zones is relatively insignificant.

Summary

Because a large number of wells in the Sooner trend have been completed from more than one zone, and because wells drilled late in the development of the trend suffer from depletion affects, cumulative production maps have not been considered a reliable indicator of trends within any given zone. Production from one formation would interfere with mappable patterns of production from another. Evidence has been established to prove that in the study area, the Meramec-Osage is the dominant oil and gas producing formation and that most Meramec-Osage production is from single-zone wells. It has also been established that wells completed before 1977 will yield reliable individual well production without interference from depletion. It follows that in this part of the Sooner trend, features delineated by mapping single-zone Meramec-Osage production (by unit area, or by individual wells completed before 1977) will be reliable indicators of Meramec-Osage production trends.

CHAPTER VI

SUBSURFACE ANALYSIS

Subsurface analysis focused on the Meramec-Osage limestone. The primary goals were to map Meramec-Osage oil and gas production distribution, and to ascertain if conventional geologic mapping such as structure or porosity isopachs could explain this distribution. Well density was sufficient to produce detailed structure, isopach, and production maps.

Data

Scout tickets, geophysical well logs, cores, and petroleum production records were the framework for the study. The Oklahoma Well Log Library in Tulsa, and the Oklahoma Geological Survey in Norman provided most of the necessary information. Data were gathered on all 1,692 oil and gas tests drilled (Appendix B). Geophysical well logs were available at the Oklahoma Well Log Library on 1,100 (68%)(Figure 14). Data included were:

TABLE I

INFORMATION GATHERED FOR EACH WELL

1) Well location to an accuracy of 50 meters/165 feet(i.e. to 1/4 1/4 1/4 1/4 Section).
2) Well status; oil/gas/dry.
3) Year completed.
4) Datum elevation (usually kelly bushing elevation).
5) Depth to top of Mississippian Meramec.
6) Depth to top of Woodford Shale (base Meramec-Osage).
7) Total thickness in feet of Meramec-Osage log-porosity greater than 6%, and porosity log type (e.g. sonic, density, etc.).
8) Pay zone (or zones) in each well.
9) Cumulative oil production per well to Jan. 1, 1987.
10) Cumulative gas production per well to Jan. 1, 1987.
11) Calculated oil equivalent per well in KBOEQ (barrels of oil equivalent in thousands). [Oil and Gas production were combined by equating one billion cubic feet of gas to 176,000 barrels of oil (U. S. Dept. of Energy, 1988)].
12) Whether or not the well was fracture treated.
13) If logs were available at the Oklahoma Well Log Library.
14) Whether or not "fracture signatures" were present on logs for each well logs were available.
15) Meramec-Osage core descriptions.

Subsurface Mapping.

Well data were processed in a Lotus(tm) spread-sheet computer program. Repetitive mathematical functions such as oil equivalent calculations were performed in Lotus. To avoid "interpretive prejudice" in the early stages of the subsurface evaluation, Lotus files were entered into a Jupiter(tm) mapping program, a commercially available geologic contouring program which uses a "neighborhood-based" algorithm (Watson, 1987). This algorithm constructed a grid over the map area and weighted values were calculated for grid intersections based upon values of and distances to surrounding wells. In the Jupiter system, each individual well value is also honored as long as well density does not exceed one per grid. The optional grid size was kept small enough to avoid multiple wells per grid. The program, therefore, mathematically contoured data based upon grid and well values. Each computer map had over 20,000 calculated grid data points(approximately one every 200 meters/660 feet) derived from and in addition to well values.

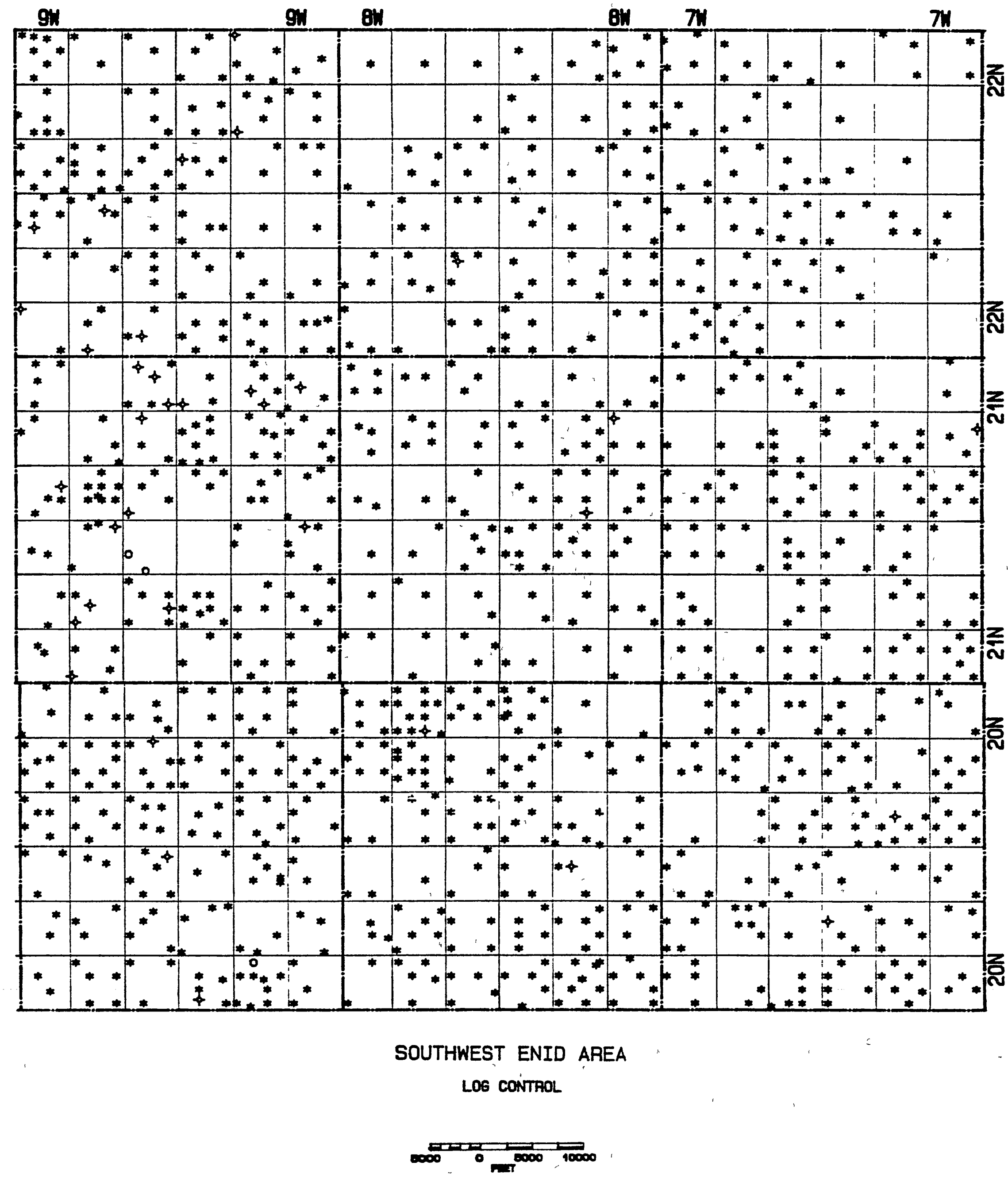


Figure 14. Map of Wells That Had Geophysical Well Logs Available at the Oklahoma Well Log Library. (Log Control)

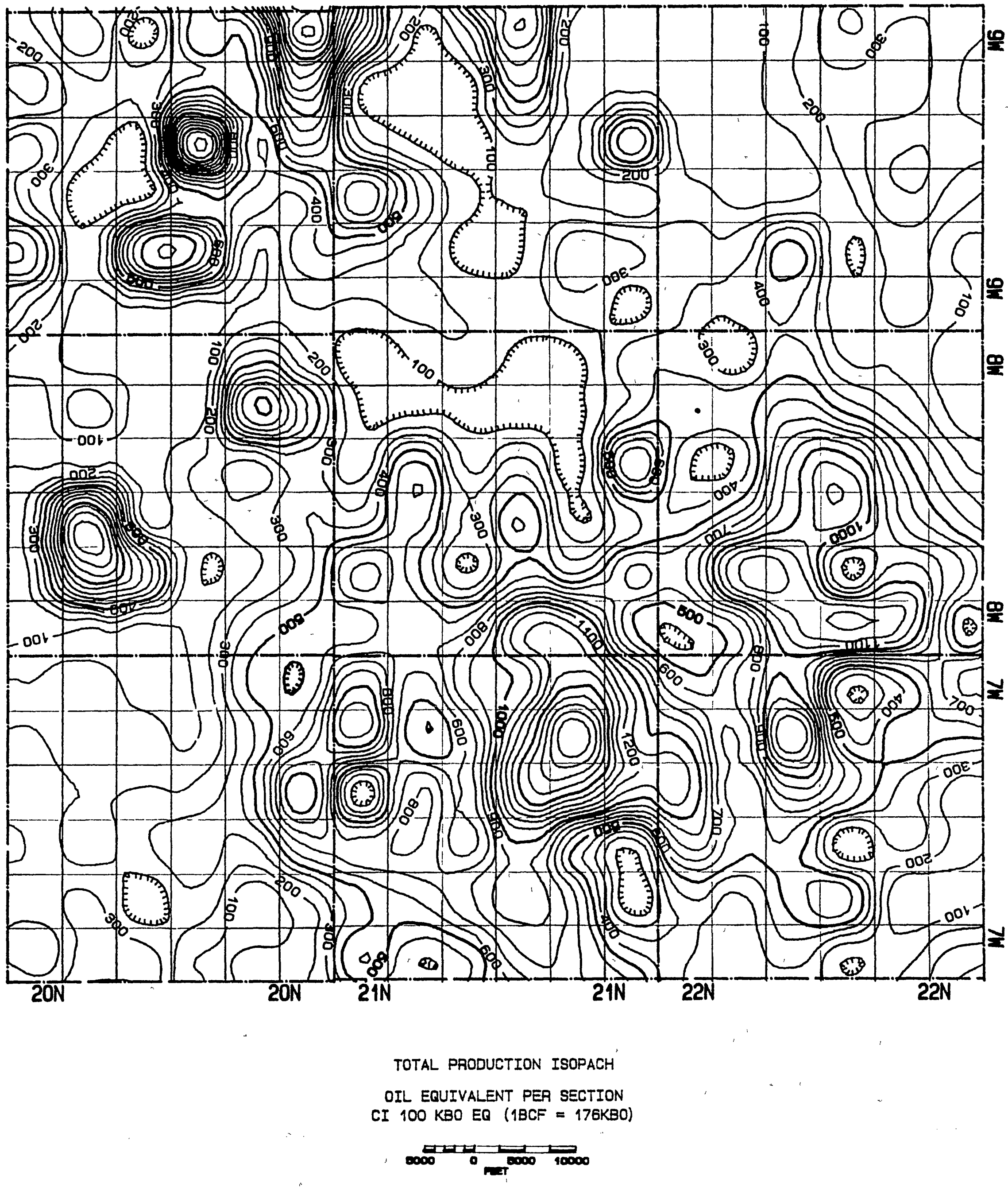


Figure 15. Isopach of Total Oil and Gas Production Per Section (all zones).

Production Maps

The following contour maps were made in Jupiter(tm):

1) Total Production Isopach in KBOEQ-thousands of barrels of oil equivalent-(Figure 15). This map is representative of economically recoverable reserves per Section from all zones. It was compiled using all recorded oil and gas production from all wells. KBOEQ were totaled for each Section and plotted as one data point in the center of the Section.

2) Single Zone Meramec-Osage Cumulative Production Isopach in KBOEQ (Figure 16). This map is representative of economically recoverable reserves per well from the Meramec-Osage. It included only single zone Meramec-Osage wells completed before January 1, 1977, but totaled production from these wells to January 1, 1987. This procedure filtered and enhanced the Meramec-Osage data by eliminating production from other zones and by eliminating "in-fill" wells drilled after 1976 that distorted well production figures by tapping a partially depleted reservoir (see discussion of Southwest Enid Petroleum Production History).

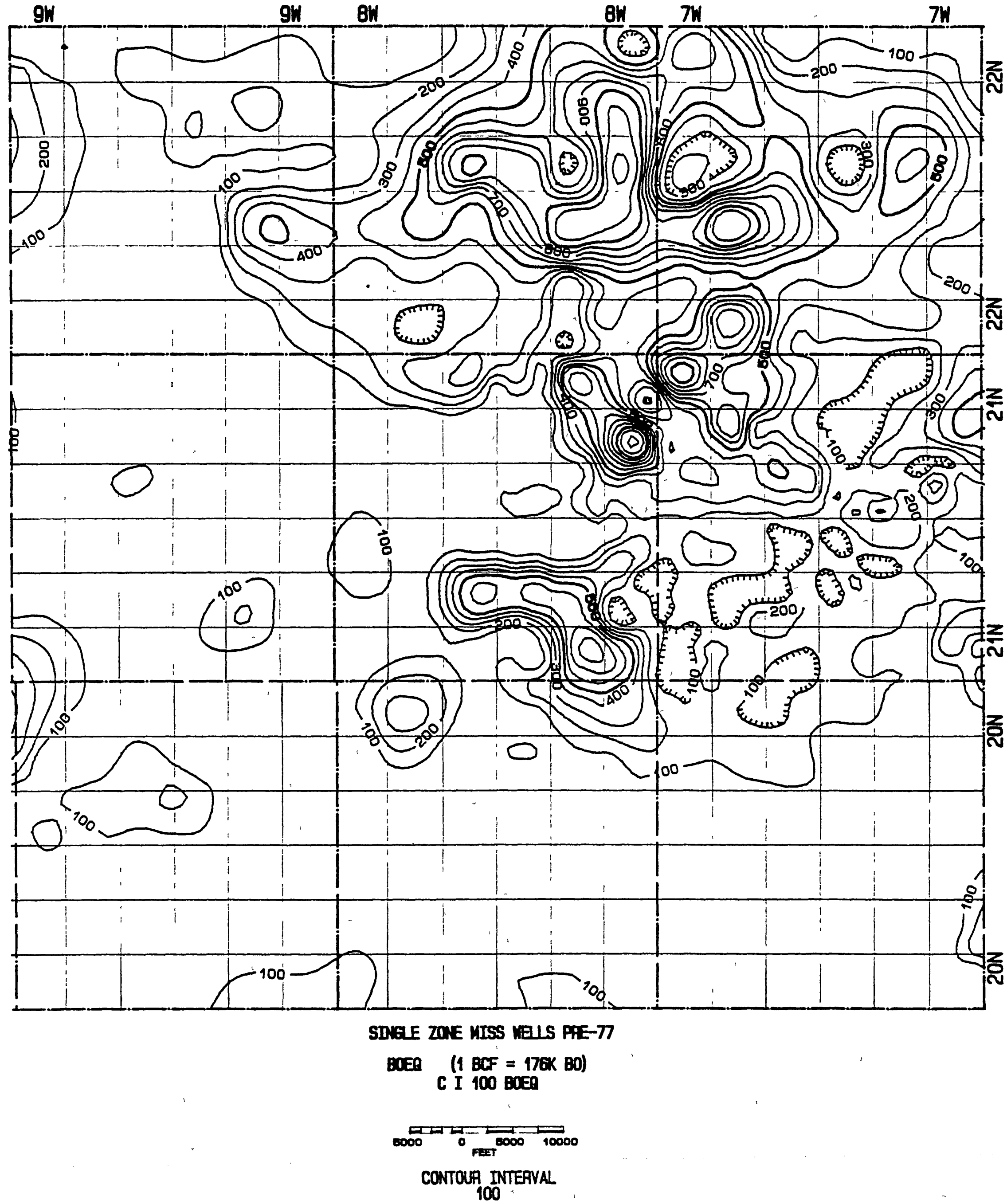
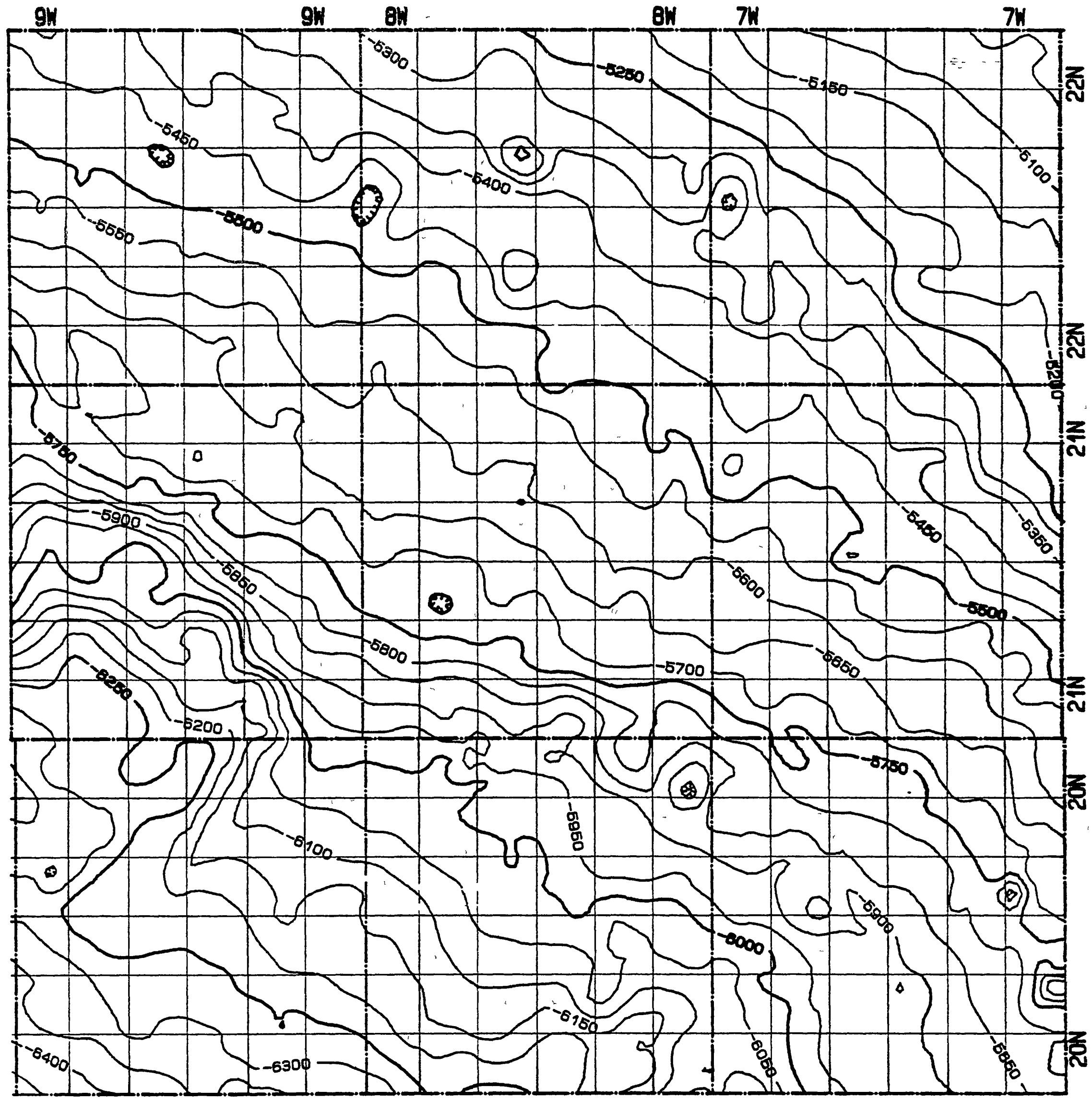


Figure 16. Isopach of Cumulative Oil and Gas Production from Single-Zone Meramec-Osage Wells Completed before 1977.



STRUCTURE TOP MERAMEC-OSAGE

SOUTHWEST ENID AREA
CONTOUR INTERVAL 50 FEET

5000 0 5000 10000
FEET

Figure 17. Structure Top Meramec.

General Geologic Maps

The following contour maps were made in Jupiter(tm):

3) Structure Top Meramec Limestone (Figure 17). Verified formation tops from log data only were used.

4) Structure Top Woodford Shale/Base Osage (Figure 18). Verified formation tops from log data only were used.

5) Meramec-Osage Isopach (Figure 19). This map was made from well log data and by subtracting the Woodford Structure Map from the Meramec-Osage Structure Map at each grid point. This type of map is commonly called a convergence map (Krumbein and Sloss, 1953).

6) Meramec-Osage Porosity Isopach (Figure 20). This map was made by contouring the total feet of Meramec-Osage log porosity greater than 6 percent.

Analysis of Production Maps

Total Production Isopach

Inspection of the Total Production Isopach (Figure 15) shows that oil and gas production is not distributed uniformly over the study area, but is concentrated in localized tracts. If one were to visualize the tracts of higher production as "strings of beads", subtle linear trends can be discerned. Although this map includes production from all zones, most of the production in this

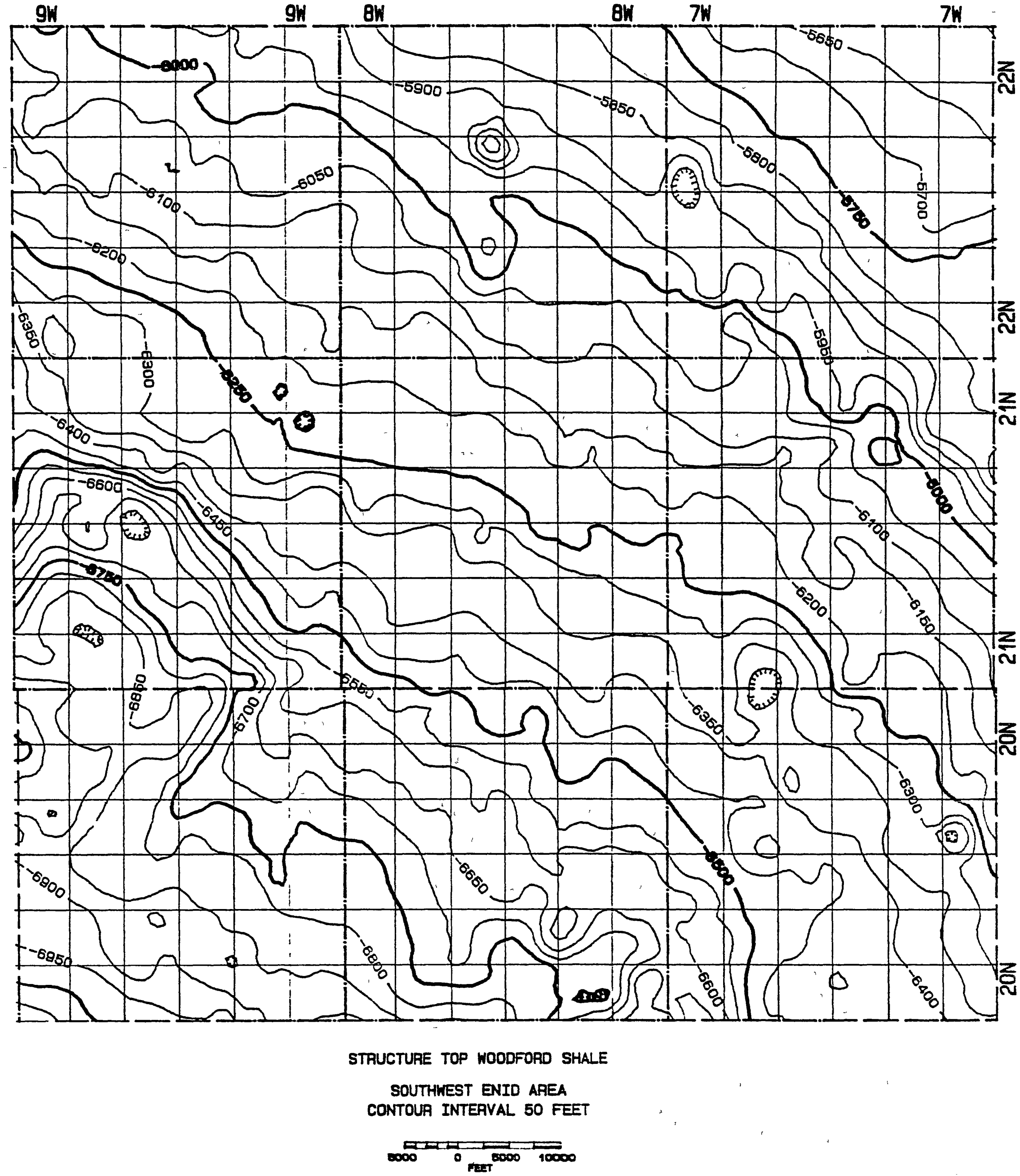


Figure 18. Structure Top of Woodford Shale.

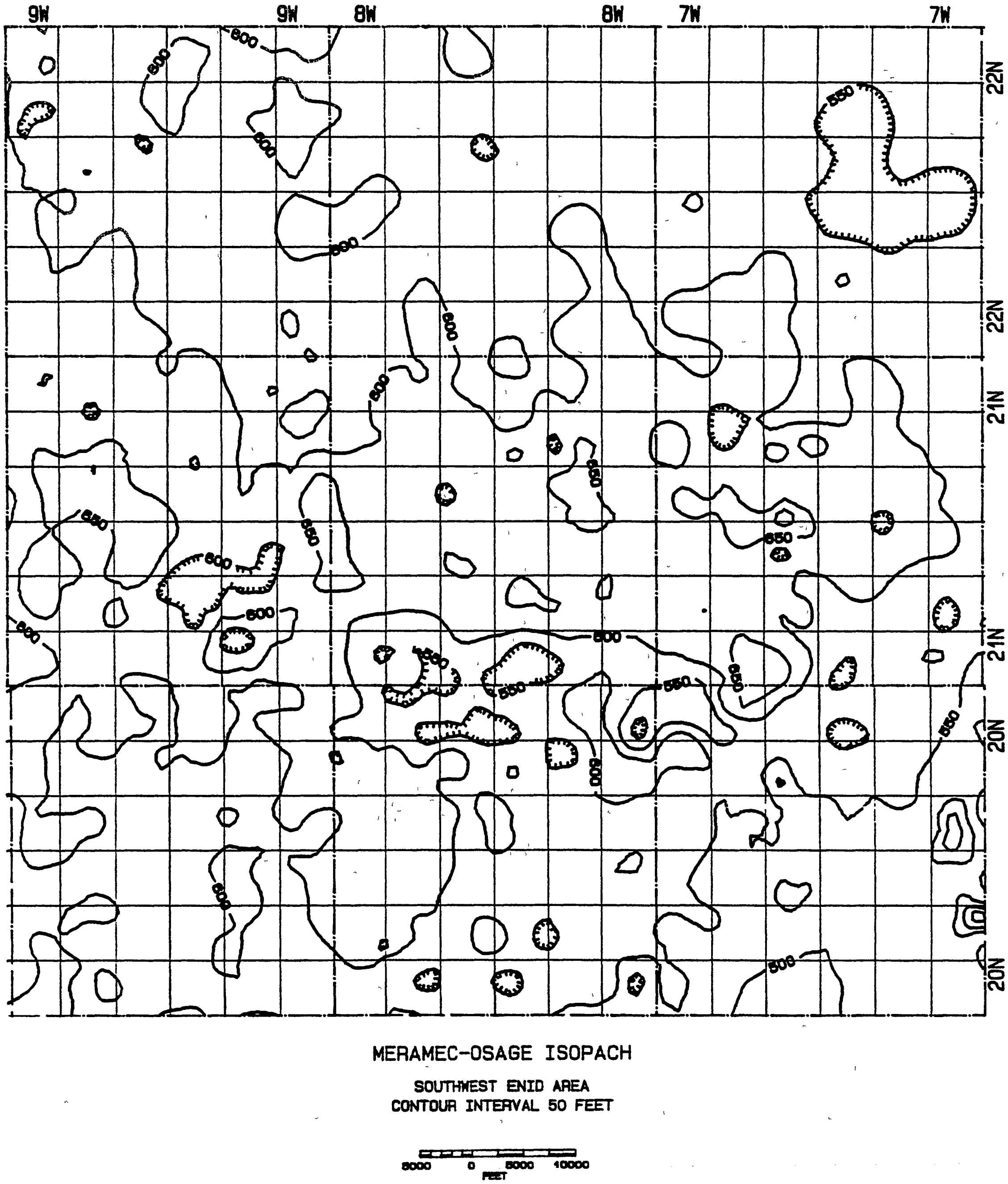


Figure 19. Meramec-Osage Isopach.

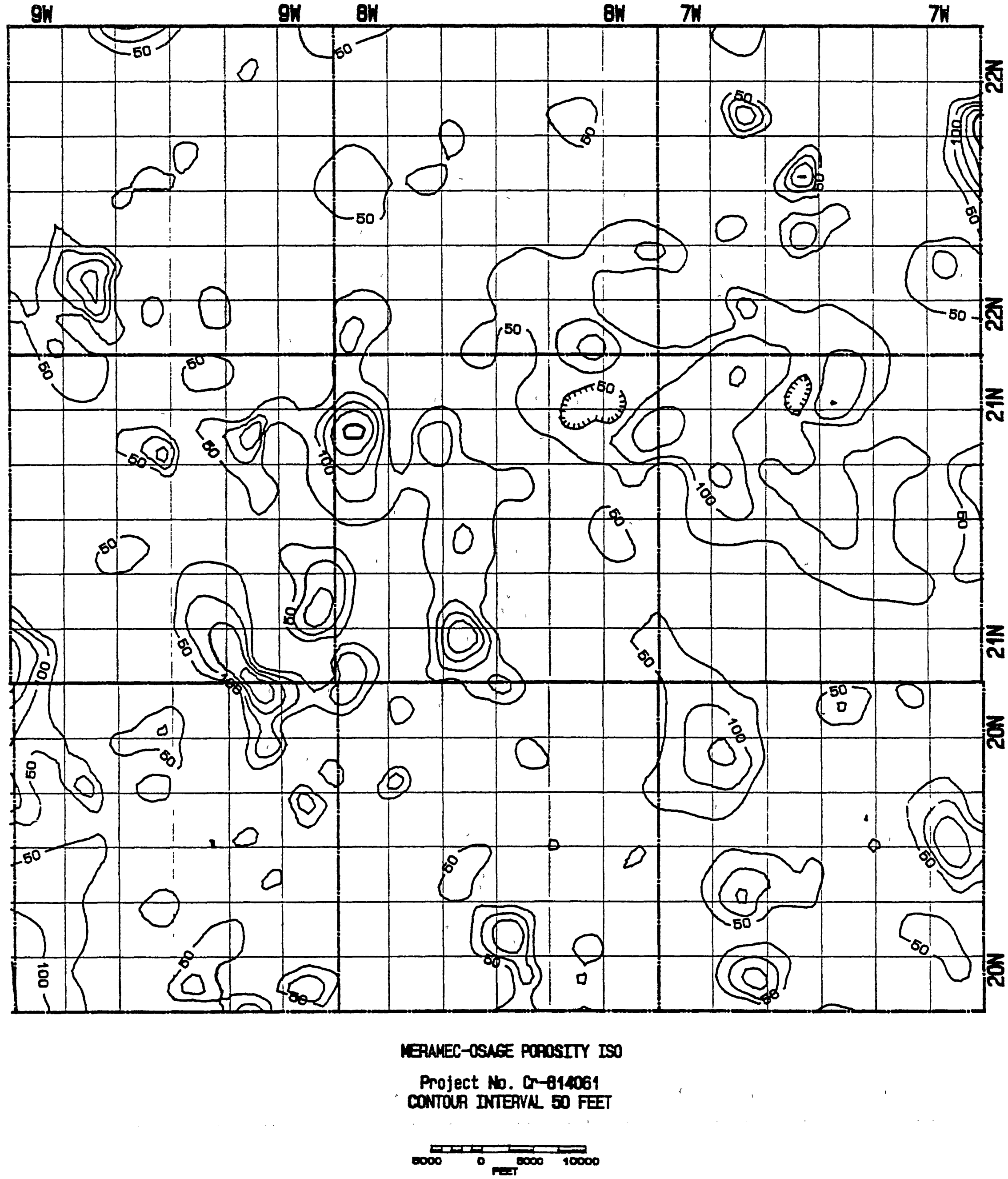


Figure 20. Meramec-Osage Porosity Isopach.

area is from carbonate rocks (Meramec-Osage, Manning, or Hunton) which in the Mid-Continent are commonly thought to be fracture influenced.

Meramec-Osage Production Isopach

The single-zone Meramec-Osage cumulative production isopach was derived from wells completed before January 1, 1977 (Figure 16) and displays well-defined areas of prolific oil and gas production. Production distribution is different from that shown on the Figure 15. The dominance of Meramec-Osage on total production is obvious when Figure 15 and Figure 16 are compared. On Figure 16 the "string-of-beads" visualization yields several distinct and a few subtle linear trends, some of which are marked on Figure 21. The dominant linear trends are north-south, east-west, northwest-southeast, and southwest-northeast. These are by inference the dominant strike directions of fractures in the Meramec-Osage. Areas with the most prolific Meramec-Osage oil and gas production occur at the intersections of the more distinct linear trends. This map will be used as an indicator of relative fracture density in the subsurface.

Analysis of General Geologic Maps

Neither the Meramec nor the Woodford structure maps (Figures 17 and 18) show features that would explain the distribution of oil and gas production. Several small

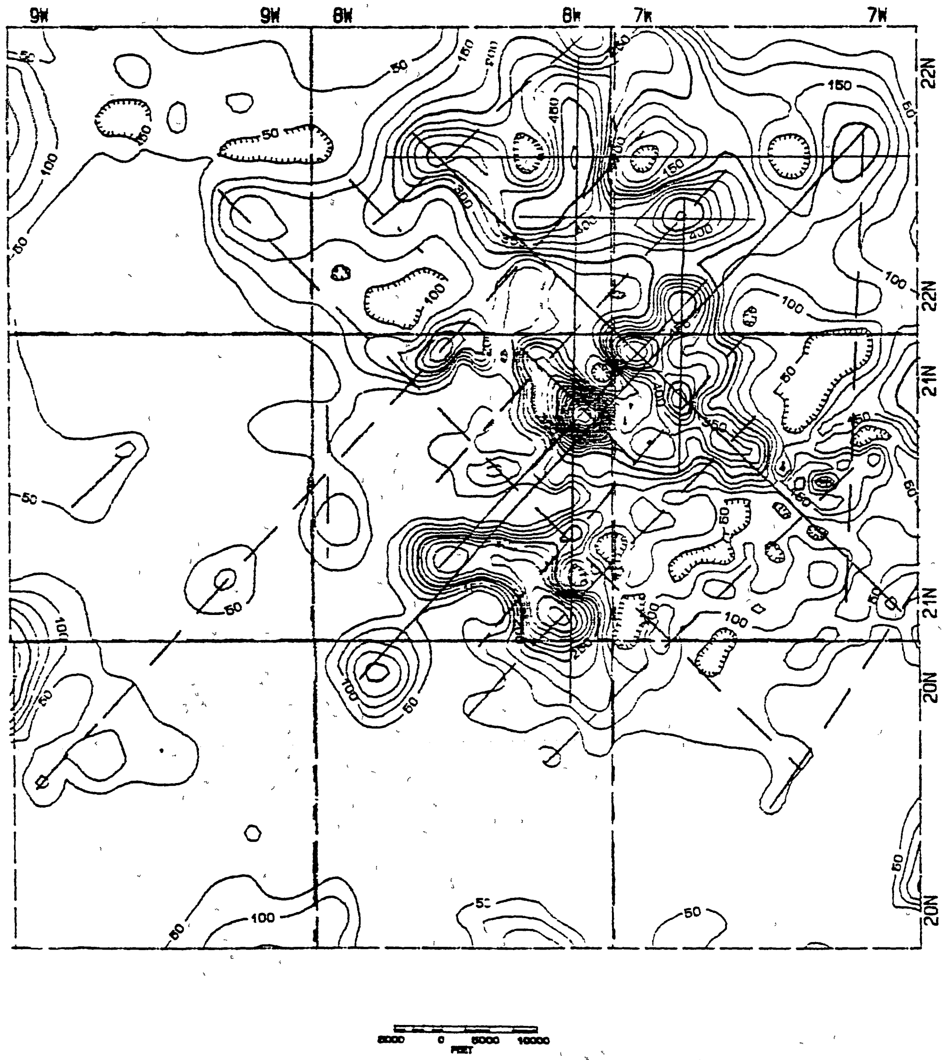


Figure 21. "String-of-Beads" Linear Trends from Meramec-Osage Single-Zone Cumulative Production Map.

anomalies such as closures are present on the maps, and one relatively large linear trough is present in the southwest portion of both maps. However, no apparent closures, depressions, or linear trends outline or align with the production.

Linear trends may be indicative of faulting or fracturing in the subsurface. They can be interpreted from the structure maps if one were to align small flexures with a straight edge. In this context a flexure is a structural hinge or line defined by a sudden change in structural strike or dip. It may be represented by small noses, depressions, closures, or monoclines. These alignments may be highly interpretive without some additional data to give guidance in orientation and grouping.

Neither the Meramec-Osage isopach (convergence) map (Figure 19), nor the Meramec-Osage porosity isopach (Figure 20) show trends that coincide with Meramec-Osage (single zone) production distribution. The Meramec-Osage porosity isopach does, however, show linear trends that are similar in orientation to the production trends but these do not overlay each other.

Assuming the Woodford Shale was flat at time of deposition and during Meramec-Osage time, the Meramec-Osage Isopach would represent the paleo-surface on top of the Meramec unconformity. The surface is karst-like in appearance. Karst tends to develop along fracture trends

(Jennings, 1985; Bogli, 1980). High porosity zones in a karstified limestone should develop along linear trends coincident with fracture trends. The Meramec-Osage porosity isopach (Figure 20) does show linear trends north-south, east-west, northwest-southeast, and northeast-southwest. Some areas of thick porosity are coincident with good Meramec-Osage production, but most are not. Many areas of good production are not associated with thick areas of Meramec-Osage porosity. This information in conjunction with the lack of evidence of karst in the Meramec-Osage cores indicates that the Meramec-Osage production in this area is not dependent on or a result of karstification.

Overlaying porosity and structure maps and plotting available scout ticket and production test data show that production distribution is not explained by typical updip porosity pinchouts. In short, Meramec-Osage production distribution in the study area cannot be explained by "conventional" petroleum geologic mapping techniques.

CHAPTER VII

SURFACE ANALYSIS-REMOTE SENSING

Meramec-Osage oil and gas production in the study area cannot be explained or predicted by the usual subsurface structure and isopach maps. The Meramec-Osage in the Sooner Trend is a fracture-controlled reservoir (Harris, 1975; Nelson, 1985). One of the assumptions in this study is that in a fractured controlled reservoir, oil and gas production will vary in relation to fracture density. It follows that for a map or mapping technique to be a predictor of relative fracture density in the study area, mapped phenomena (or some aspect of the map) should yield a good correlation with oil and gas production from the Meramec-Osage.

The question is what remote sensing mapping technique(s), if any, will provide a reliable (statistically significant and reproducible) map of some phenomenon that correlates with (and therefore may be a predictor of) relative fracture density in the subsurface. To answer this question, different types of remote sensing maps that included the study area were obtained or made. Not all of these maps were made for fracture analysis, but they were examined nevertheless to determine if the mapped phenomenon related to fractures at the Meramec-Osage level. Specific areas of interest were the effects of map scale, and the types of phenomena mapped, such as indiscriminate composite lineaments, geomorphic anomalies, or lineaments with special criteria.

Remote Sensing Data.

Six remote sensing maps of the study area were obtained or made for comparison with subsurface data. Four of the maps are "regional" in the sense that they cover a much larger area than the Southwest Enid Study Area. Three of the "regional" maps were made for purposes other than fracture analysis. Two of the maps were made exclusively of the study area. One was made as a general lineament map, and one was made specifically for fracture analysis. The six maps are listed below with their pertinent characteristics.

1. Lineament Map of Northcentral Oklahoma, (Figures 22 and 23) by Shoup (1980). This map is in Shoup's Masters Thesis (University of Oklahoma) titled: Correlation of Landsat Lineaments with Geologic Structures, Northcentral Oklahoma. The map is regional in extent and was not intended for use in fracture analysis other than faults. Printed scale is approximately 1:500,000 (1 inch = 8 miles/10.5 kilometers).

2. Lineament Map of the Nemaha Uplift Region, (Figures 24 and 25) by Burchett, et al. (1985). This map was published in Oklahoma Geological Survey Special Publication 85-2, Seismicity and Tectonic Relationships of the Nemaha Uplift and Midcontinent Geophysical Anomaly. The map is regional in extent and was not intended for use in fracture analysis. Printed map scale is approximately 1:2,660,000 (1 inch = 68 kilometers/42 miles).

3. Regional lineament map, (Figures 26 and 27) by the author. This map was constructed from a band-7 Landsat image dated 15 December, 1982. Approximate scale of working image was 1:500,000 (1 inch = 8 miles/13 kilometers). This map was made for use in this fracture study.

4. Photogeologic-Geomorphic Evaluation Map of the Anadarko Basin and Northern Shelf Area of Oklahoma and Texas, (Figures 28, 29, and 30) by TGA (1988). A map of the study area only was provided courtesy of TGA, a commercial geologic mapping company. Maps were provided at a scale of 1:96,000 (1 inch = 8,000 ft/2,438 meters). TGA's study area was regional, covering the Anadarko Basin and Northern shelf areas. The map was intended for subsurface correlation, but not specifically in fracture analysis.

5. Lineament map of the study area interpreted from computer enhanced Multi-Spectral-Scanner Landsat Data, (Figure 31) constructed for the author by Gregory (1988). Working scale on screen was approximately 1:60,000 (1 inch = 5000 ft/1500 meters). Data were analyzed at Oklahoma State University's Center for Applications in Remote Sensing. Image date was August 9, 1985. Although made for this study, this is a general lineament map without filtering or manipulation for fracture analysis.

6. Drainage-lineament Intersection maps (Figure 32) constructed by the author. These maps were derived from detailed drainage maps, which were made from 15 minute quadrangle topographic maps. Topographic map scale was 1:62,500 (1 inch = 1 mile/1.6 kilometers). Working drainage map scale was 1:120,000 (1 inch = 10,000 feet/3,048 meters). The maps were made specifically for fracture analysis.

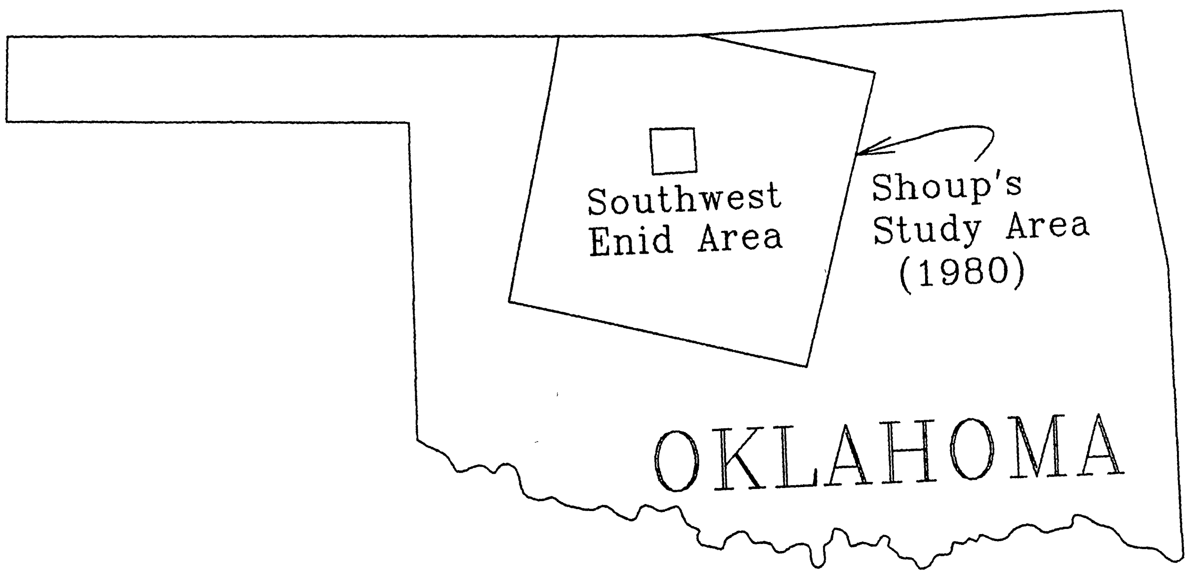
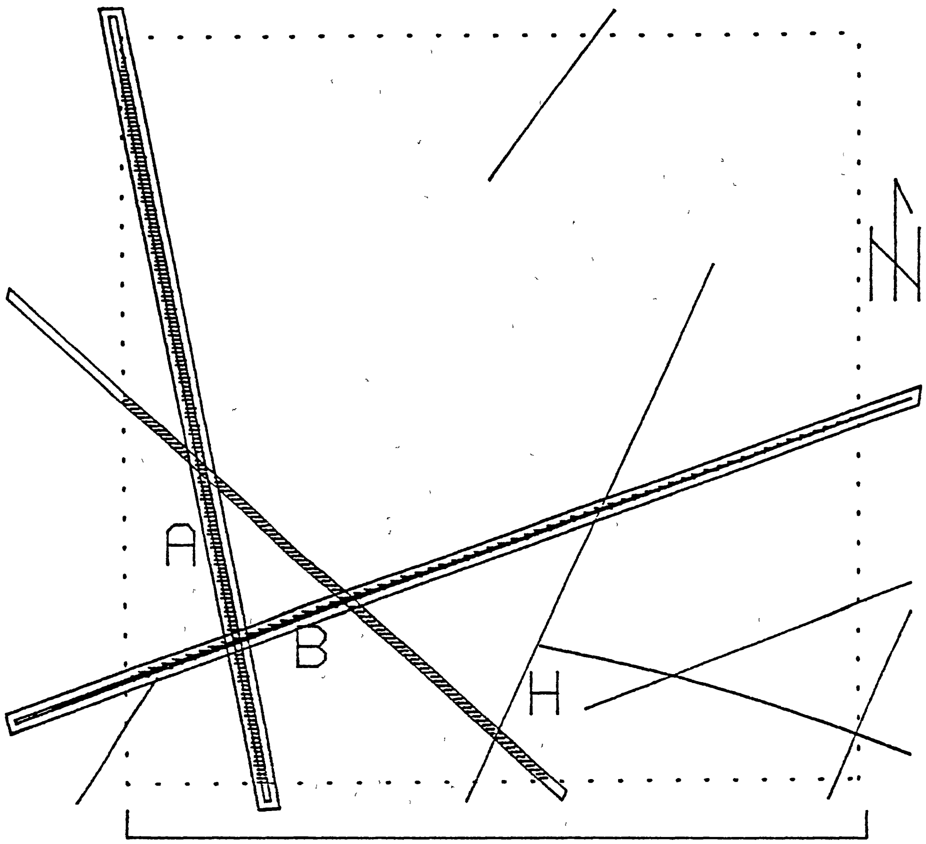


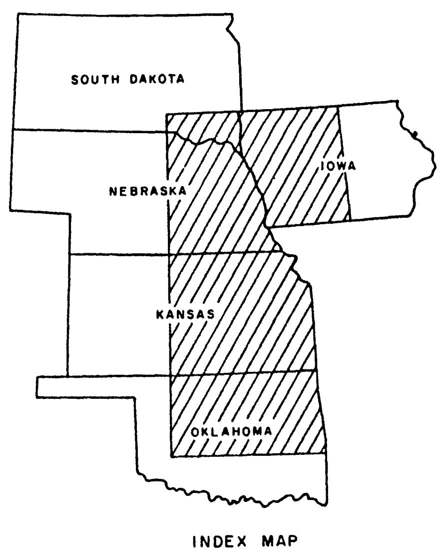
Figure 22. Area Covered by Lineament Map of Northwest Oklahoma by Shoup (1980)



Southwest Enid portion of Shoup's (1980) map enlarged.

Broader lines denote higher "confidence".

Figure 23. Shoup's (1980) Lineaments in Southwest Enid Area.



THE NEMAHA UPLIFT REGION

Figure 24. Area Covered by Burchett et al. (1985), (hatched). Southwest Enid Area (Shaded).

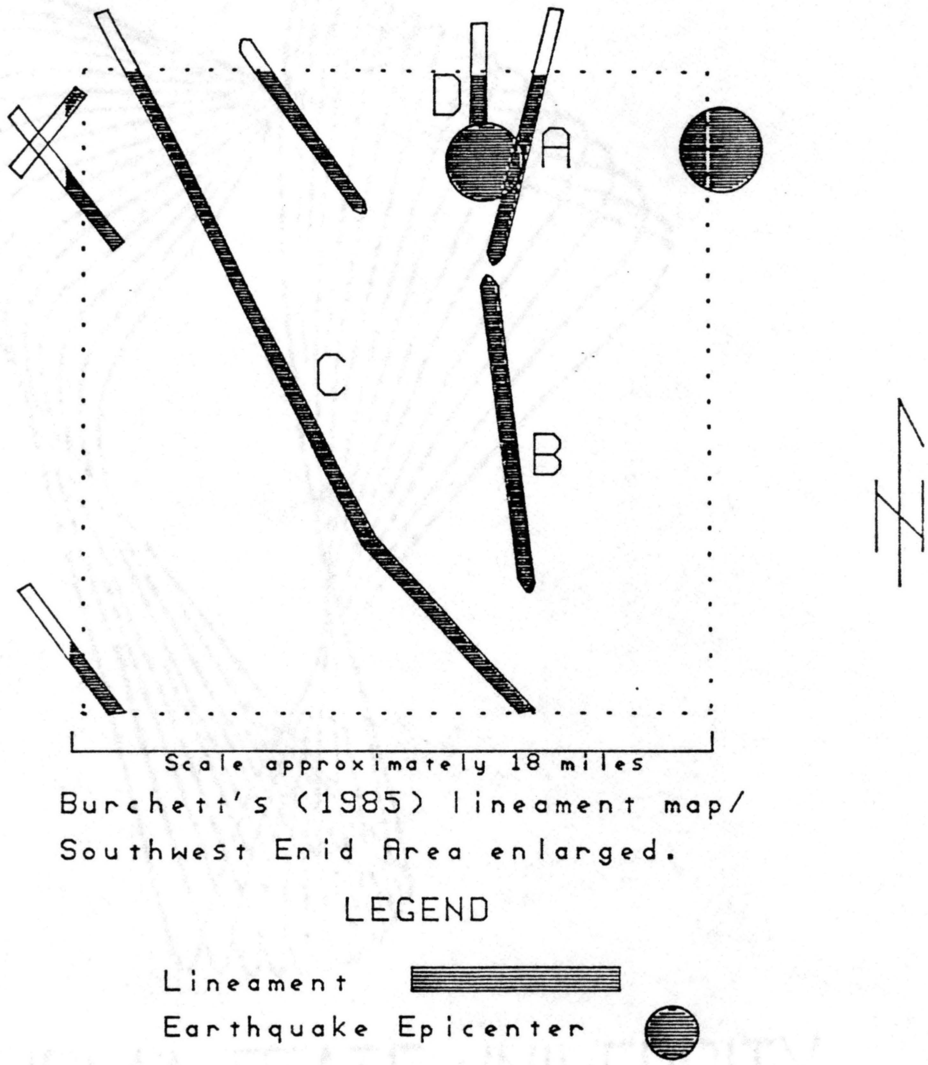


Figure 25. Lineaments by Burchett et al. (1985) in Southwest Enid Area.

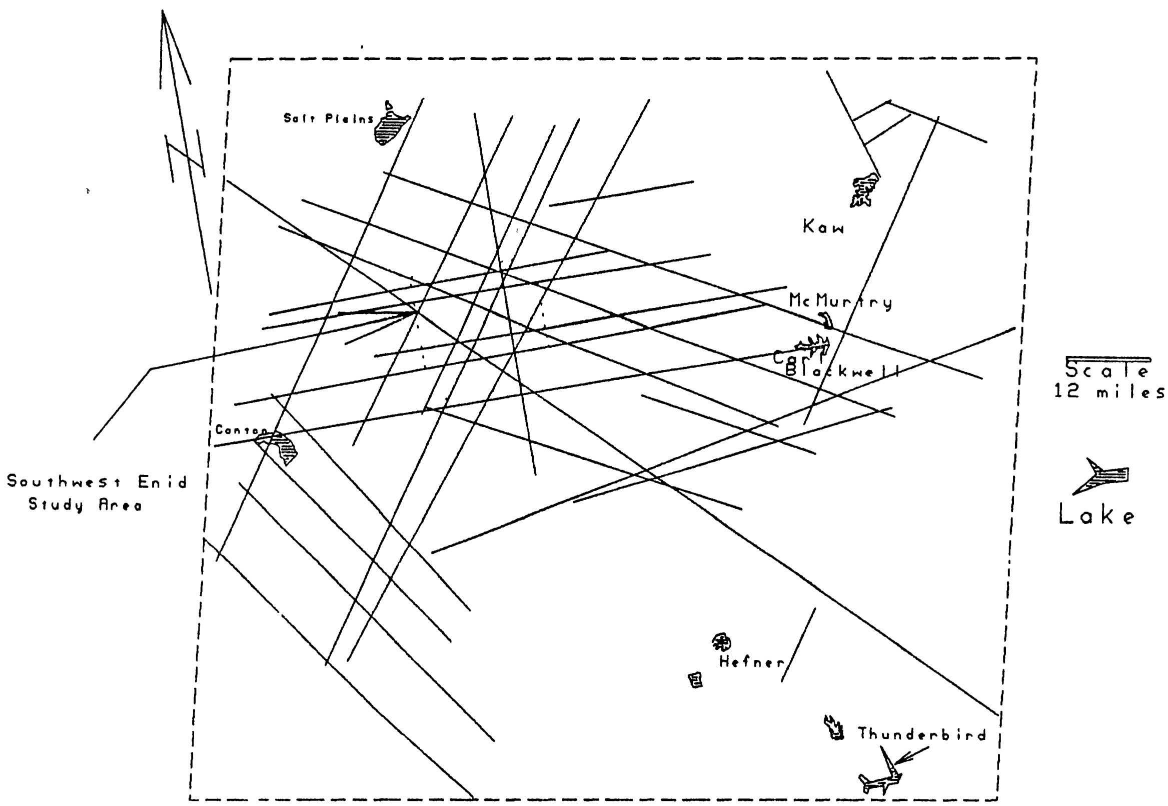
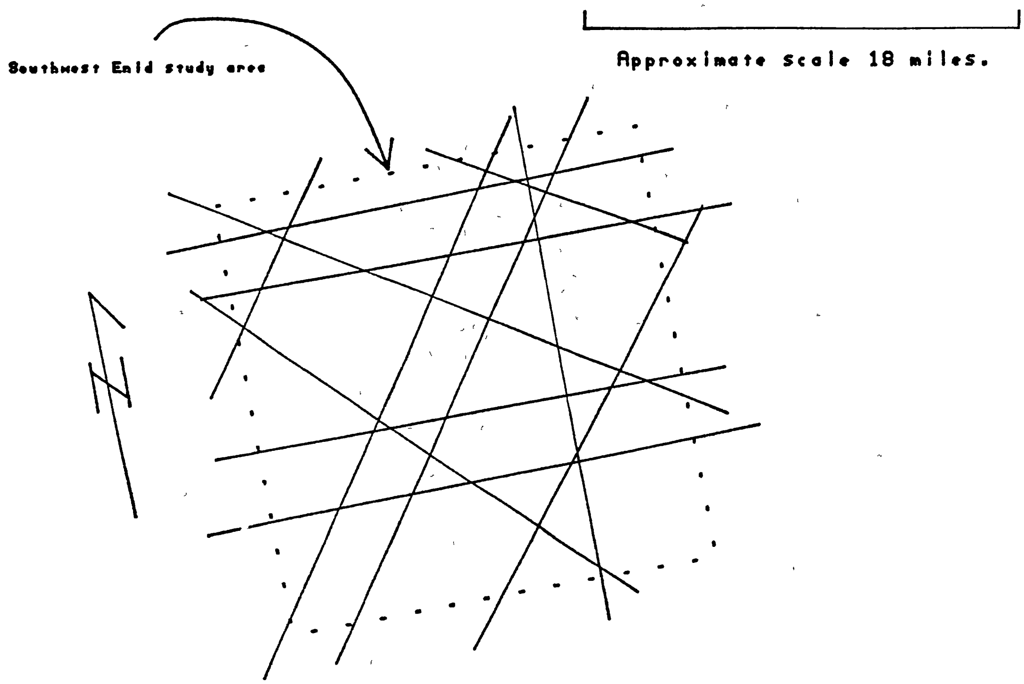


Figure 26. Regional Lineament Map by Author.



Landsat lineament map (Bruce, 1989) enlarged.

Figure 27. Southwest Enid Portion of Regional Map.

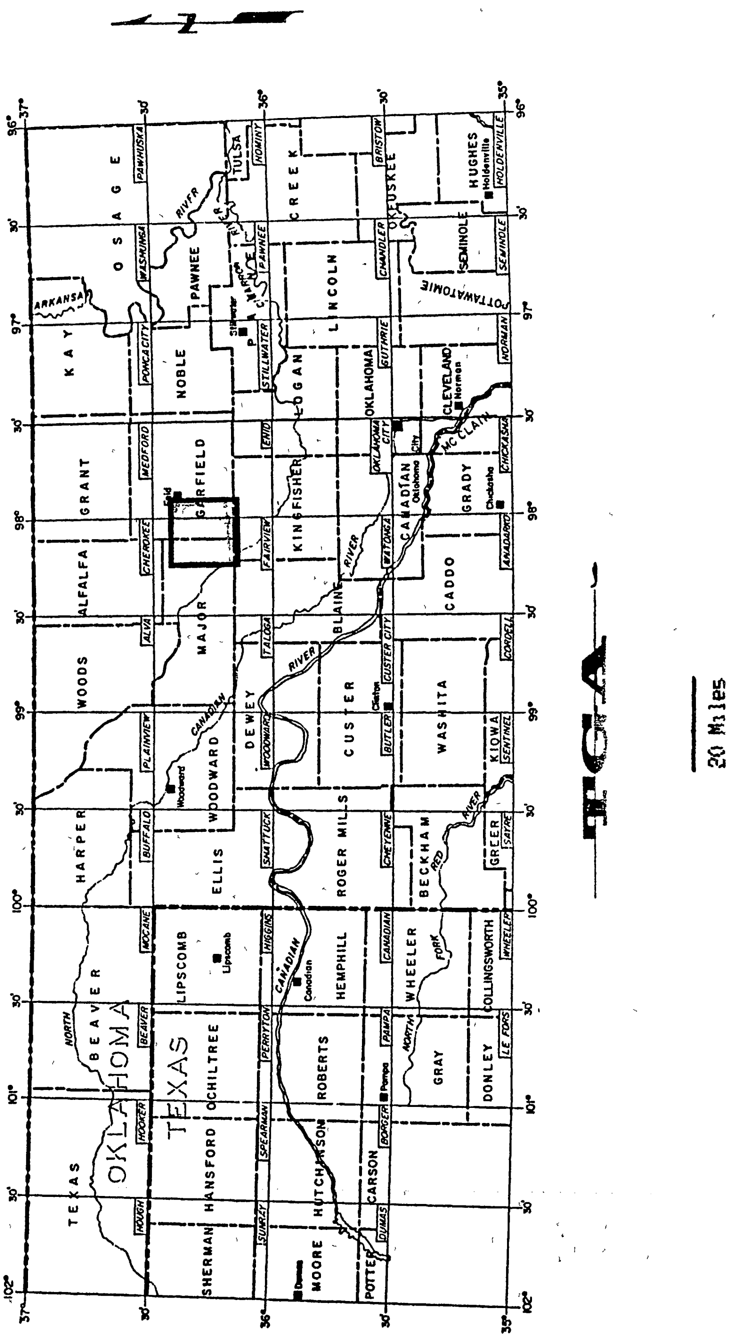


Figure 28. Area Covered by Regional TGA Study (1988).
Southwest Enid Area Shaded.

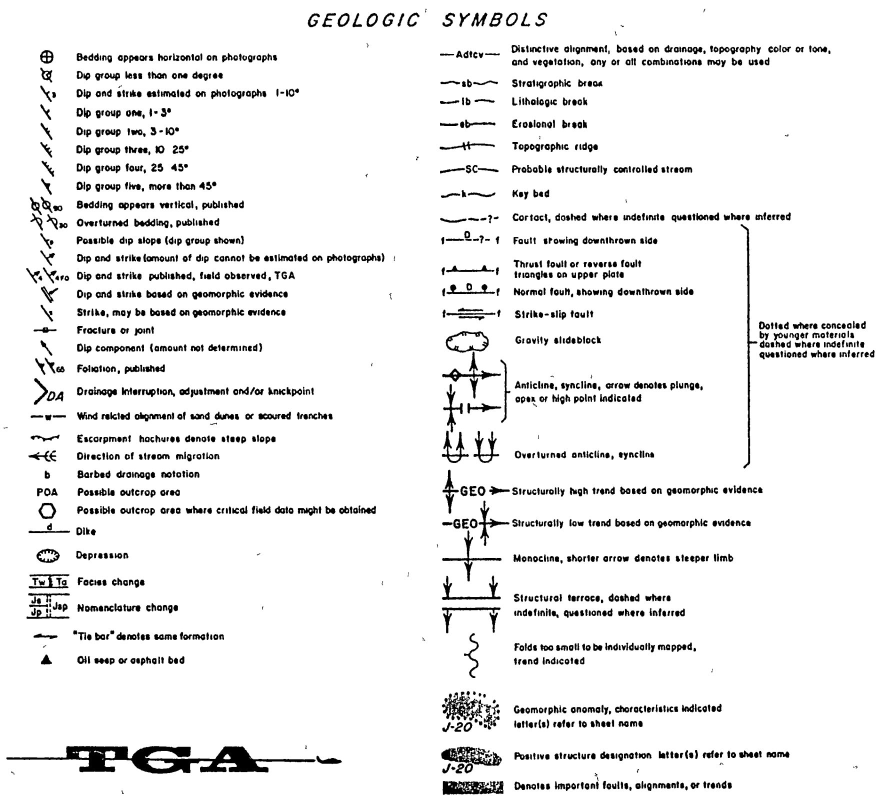


Figure 29. Legend for TGA Map (1988).

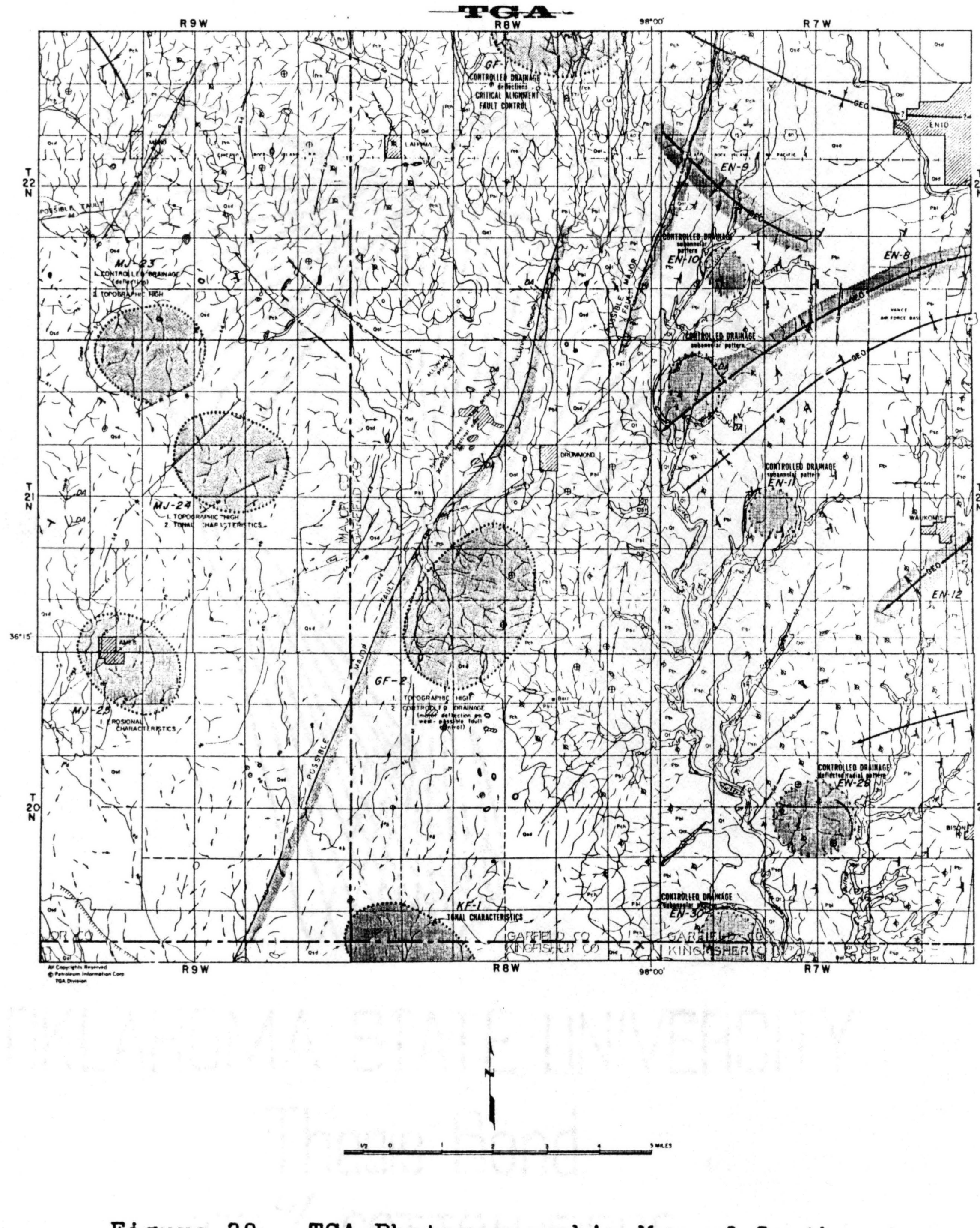


Figure 30. TGA Photogeomorphic Map of Southwest Enid Area.

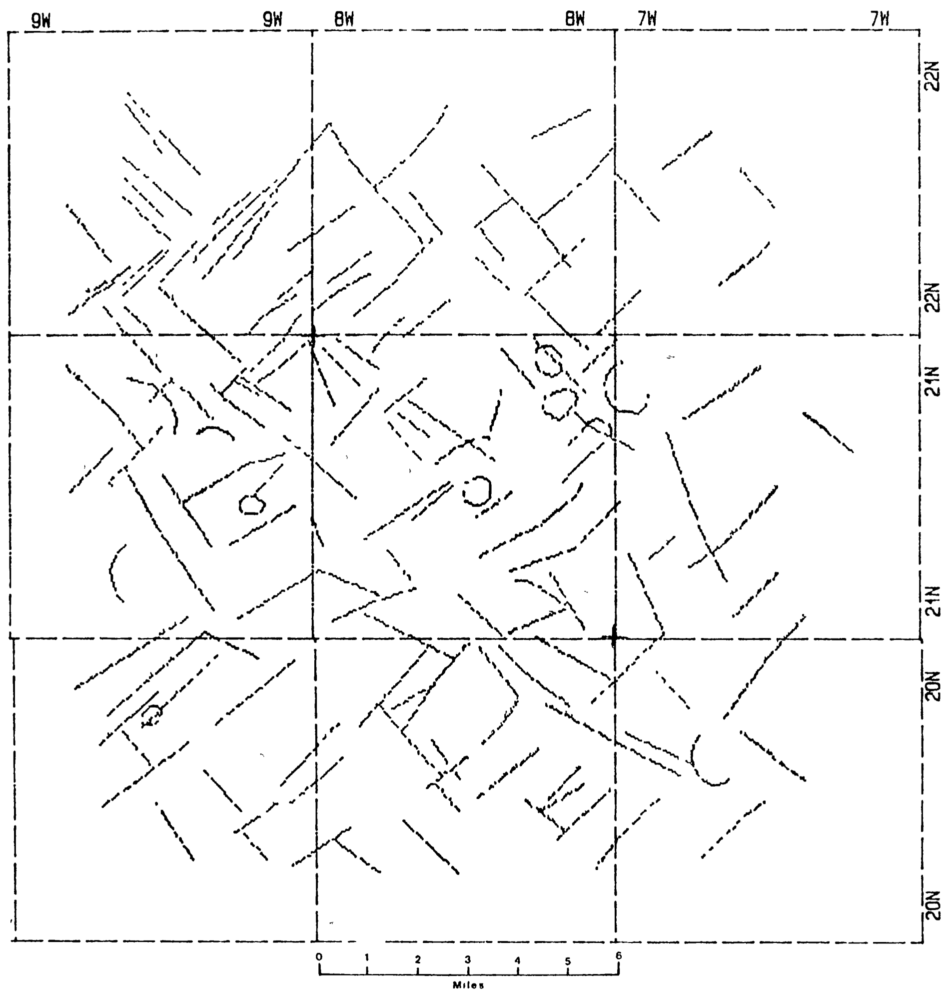


Figure 31. Lineament Map by Gregory (made for this study).

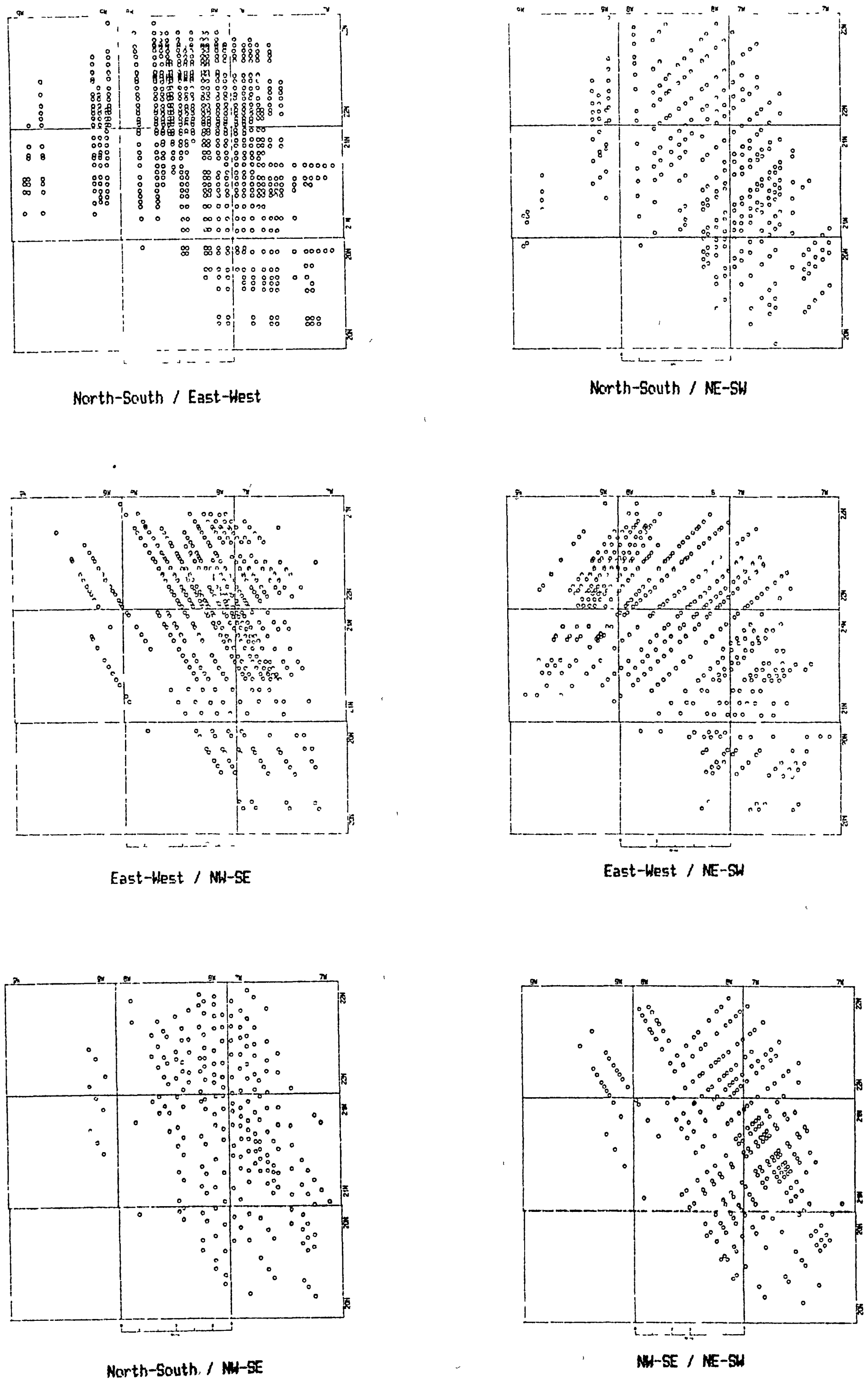


Figure 32. Drainage Lineament Intersection Maps.

Analysis of Remote Sensing Data

General Geologic Comparison

A comparison of each map was made with Meramec-Osage general geologic maps to determine if any relationship exists between remote sensing phenomena and any obvious structural or isopachous variations of the target zone. These data were used in a purely qualitative sense to get an impression of whether or not an association exists. No statistical analyses were made from these comparisons.

Comparison with Production Data

A comparison was made with the production maps specifically to see if a statistical analysis could be made. Where sufficient data were available, a statistical parameter such as analysis of variance, linear correlation coefficient or t-test was calculated. If the alpha limit for type I error was .01 or less, the correlation was deemed significant.

Analysis of Shoup's Lineament Map (1980)

Shoup's (1980) lineament map (Figure 22) was derived from several Landsat MSS images of the same area (in central Oklahoma) and it covers over 44,000 square kilometers (17,000 square miles). For lineament criteria he chose composite lineaments and followed Colwell's (1973) "multi-concept" (of multi-band, multi-date, and multi-station) by analyzing two MSS bands (5 and 7) from two different seasons (winter and summer) and by analyzing different scale images such as air-photos in conjunction with satellite data. He down-graded lineaments that were not present on multiple images and up-graded lineaments that were discernible on more than one type of image calling these features "high confidence" lineaments. Shoup found that many lineaments recognizable on satellite images could not be recognized on air-photos.

He compared four of his "high confidence" lineaments to subsurface maps made for his study and found that three of the four were correlative with apparent subsurface geologic features such as flexures and fault zones. He did not make a direct comparison of the all of his lineaments to his subsurface maps apparently because most of the rest of his lineaments were not "high confidence" by the criteria he set forth.

Nine of Shoup's (1980) lineaments intersect the Southwest Enid study area. The large difference in map scales makes direct comparison difficult, but enlargement of a portion of Shoup's (1980) map (Figure 23) allowed a general comparison. The enlargement was made using a digitizer and computer-aided drafting software.

Most of Shoup's (1980) lineaments were located in the southwest corner of the study area and tended to loosely correspond with flexures. Conversely, most obvious structural and isopachous trends on the subsurface maps were not represented by lineaments, probably because of the dearth of lineaments intersecting the study area.

None of Shoup's lineaments correspond with prolific single zone Meramec-Osage oil and gas producing areas. The intersection of lineaments marked "A" and "B" and the area marked "H" (which is bounded by lineaments and their intersections, Figure 23), directly overlie prolific Hunton/Meramec-Osage oil and gas fields (Figure 15). As stated in Chapter V, it is not unusual for some Meramec-Osage production to be associated with excellent Hunton production because of concomitant localized structures or flexures, but the reverse is not true. In the study area, Shoup's (1980) lineaments tended to correlate with those flexures associated with the Hunton production, but not with single zone Meramec-Osage oil and gas production that is indicative of regional fracture porosity.

Analysis of Burchett et al. (1985) Map

The purpose for this map was to help in the study of earthquakes along the tectonically active Nemaha Ridge. The lineament map, the area of which is shown in Figure 24, includes parts of Iowa, South Dakota, Nebraska, Kansas, and Oklahoma. It covers thousands of square miles and, therefore, shows very little local detail. It was made from the interpretation of Landsat MSS (Multi-Spectral-Scanner) band-5 and band-7 near-infrared images. Lineament criteria were not listed in the text or on the map. Only eight lineaments from this study intersect the Southwest Enid study area. All but two of these trend northwest-southeast, which is the orientation of the Cimarron River and other streams in the area that are visible on satellite imagery.

Correlation of these lineaments with Southwest Enid data is very tenuous because of the large difference in map scales. However, a general comparison can be made by enlarging a portion of Burchett et al.'s (1985) map (Figure 25). This "enlargement" was made by outlining the Southwest Enid study area on Burchett et al.'s (1985) map and digitizing the area outline and the lineaments using a Calcomp 9100(tm) digitizer and a DesignCad(tm) computer aided drafting program. The output could be made to whatever scale was convenient for overlay or comparison with other maps. Because of the small scale of the original map, lines representing lineaments were close to one kilometer wide at map scale (i. e., if the published map were photographically enlarged, thin lines on the original map became lines with measurable widths on the reproduction). This was a function of drafting technique, not geologic interpretation. Any bold inked line at this scale became a two dimensional figure when enlarged. To allow for variations in line location caused by scale changes, digitized lineaments were made as elongated rectangles or polygons of approximately the same scale width as the original.

Comparing these lineaments with the general geologic maps of the subsurface showed that two of the lineaments (marked "A" and "B" on Figure 25) align along a series of small structural flexures displayed on the Meramec and Woodford structure maps (Figures 17 and 18). The flexures that lineaments "A and "B" overlie tend to be "lows". An earthquake epicenter adjacent to lineament "A" lies nearly on top of a positive flexure ("high" or small closure) shown on both the Meramec and Woodford structure maps.

The lineament marked "C" on Figure 25 can loosely be correlated with a series of "low" flexures. It also very nearly defines the boundary between Region II (Turkey Creek drainage basin) and Region III (Hoyle Creek drainage basin, Figure 8) of the study area. In a broad sense it separates the more prolific (Meramec-Osage) oil and gas producing northeastern 60 percent of the study area from the less prolific southwestern 40 percent (Figure 16). In general, few lineaments intersected the study area. Most structural and isopachous phenomena appearing on the Meramec-Osage and Woodford maps were not represented by a corresponding lineament.

Two earthquake epicenters from Burchett et al.'s (1985) map are in the Southwest Enid area, indicating that at least some tectonic activity is still occurring in and near the Sooner Trend. The epicenter near lineament "A" (and lineament "D" associated with the epicenter) lie more or less atop an area of prolific Meramec-Osage oil and gas production.

Of importance to this study is whether or not mapped lineaments correlate to Meramec-Osage oil and gas production, thus representing fracture porosity and permeability. Except for lineament "D" (Figure 25), no other lineaments from Burchett et al.'s (1985) analysis correspond directly with Meramec-Osage oil and gas production. Although lineaments "A", "B", and "C" correspond negatively (tend to lie in areas of low production between areas of higher production), data are too sparse to make a statistical analysis.

Analysis of TGA's (1988) Photogeologic-Geomorphic Map

Using special purpose air photos with a high ratio of vertical exaggeration, TGA (1988) mapped the entire Anadarko Basin and "Northern Shelf" area of Oklahoma and the Texas Panhandle on a scale of 1 inch equal 8,000 feet (Figure 28). This mapping was based on techniques developed by W. V. Trollinger (1971). TGA's study area covered from 35 degrees north latitude to 37 degrees north latitude and from 96 degrees west longitude to 102 degrees west longitude, which is approximately 120,000 square kilometers (46,300 square miles). The maps were geomorphic in nature and emphasized drainage, tone, vegetation, outcrop patterns, and topography rather than lineaments alone. Much of the data on the map were used to establish basic geologic and geomorphic relationships. "Interruptions" to the regional "norm", such as changes in dip or drainage anomalies, were interpreted as diagnostic clues to anomalous subsurface geologic conditions. The goal was to use geomorphic features to help define and predict "deep seated" geologic structure. TGA's (1988) mapping criteria is exemplified in the legend of geologic symbols (Figure 29). The maps were not necessarily designed nor intended for fracture analysis, but the volume of data presented made the study a candidate for analysis.

The TGA map of the Southwest Enid study area is shown in Figure 30. Features or anomalies TGA deemed important (interruptions to trend) are clearly marked via shading. The map is literally full of additional symbols denoting dip, surface geology, drainage, etc. which represent the basis for establishing regional trends and anomalies.

Overlaying TGA's (1988) map with Meramec and Woodford structure maps and Meramec-Osage total and porosity isopachs yielded numerous places where flexures or isopachous thicks and thins coincided with TGA (1988) anomalies or linear trends. The correlation was not 1:1, but a large number of features were correlative. As with Burchett et al.'s (1985) and Shoup's (1980) maps, not all structural or isopachous features on the subsurface maps had a corresponding TGA anomaly. Geologic analyses of why one feature coincided and another did not is beyond the scope of this study, and is best left to the individual researcher. Of greater importance to this study is the correlation of anomalies to indicators of fracture porosity in the subsurface.

TGA's (1988) map was overlain on to the single zone Meramec-Osage production map and the total production isopach (Figures 16 and 15 respectively). Little or no correlation was observed with either map. Statistical analysis was not necessary to show no relationship between the TGA (1988) anomalies and apparent fracture porosity and permeability.

An attempt was made to use the background data on the map to determine areas of relatively high and low fracture density. The attempt was difficult because of the volume of background data on the map; it appeared "busy" and unfocused. TGA may have some of the data divided into a series of separate theme maps for exclusive use by their clients, but that is unknown to the author at this time.

The most prominent background feature was drainage. Drainage displayed on this map, apparently derived from air-photos, is entirely local and does not reflect drainage networks or detailed drainage patterns from topographic map analysis such as would be made for a Strahler (1954) drainage map (see Figure 8). Although this allows localized interpretations, such as radial drainage anomalies, it limits the usefulness of the drainage data. I was unable to make a fracture interpretation from it. No meaningful maps related to fracture porosity or permeability were derived from the background data.

Analysis of Regional Lineament Map; the author

This map was constructed from a Landsat Band-7 (near infra-red) image dated 15 December, 1982. The analysis was made from a photographic paper print of the image at a scale of approximately 1:500,000. Lineament criteria included composite, continuous, or discontinuous lineaments of any length. The goal was to pick lineaments of any type that were obvious to the author, with emphasis on the western portion of the image, which contained the study area. Because of the scale of the image, only relatively large features were mapped. Figure 26 is the lineament map of the entire satellite image, which includes an area approximately 185 kilometers (115 miles) to a side. Figure 27 is the Southwest Enid portion of this map enlarged.

Overlaying this map with Meramec-Osage general geologic maps yielded tenuous correlation with structural and isopachous trends. The least interpretive correspondence was between lineament "A" (Figure 27) and a northwest southeast porosity trend centered in the northwest of T21N-R9W (Figure 20). Porosity in the Meramec-Osage (Figure 20) was also more abundant in the area marked "B" on Figure 27 where three lineaments intersect Overall, however, little direct correlation exists between the general geologic maps and this set of lineaments

Overlaying this map on the production maps yielded even less correspondence than with the maps above The area marked "C" on Figure 27 outlined a single zone Meramec-Osage producing area, which is slightly offset from a Hunton/Meramec-Osage Field, but none of the other lineaments or their intersections displayed any apparent correlation with oil and gas production No statistical parameters were calculated from this data

Analysis of Lineament Map Interpreted from Computer Enhanced Multi-Spectral-Scanner Landsat Data (Gregory, 1988)

This map was made for this study in Oklahoma State University's Center for Applications in Remote Sensing Gregory (1988) limited his study to the Southwest Enid area, and used techniques described by Walsh (1985) to enhance multi-spectral digital satellite data Enhancement techniques included principal component analysis, edge enhancement, and false-color imaging Data were from an August 9, 1985 satellite pass-over Lineaments were mapped on a high-resolution color computer monitor with the image at an approximate working scale of 1 60,000 on screen The final map (Figure 31) was of lineaments compiled from all three enhancement techniques To minimize the edge effect (Davis, 1986), lineaments were not drawn in the outer most ring of Sections in the study area, thus reducing the actual map area from 18 miles square to 16 miles square Lineament criteria called for composite (any type or combination) continuous lineaments This was meant to be a general lineament map, without special consideration given to fractures

Lineaments on this map were abundant, and appeared uniformly distributed Comparison with the structure maps showed numerous correlation between lineaments and flexures Most of the lineaments were associated with some form of flexure, but not all flexures were associated with lineaments Little correlation occurred with either of the isopach maps (Figure 19 and Figure 20)

Comparing these lineaments with the production maps also failed to show any apparent relationship Although the principle areas of oil and gas production (total and single zone Meramec-Osage) did have associated lineaments, a large number of lineaments were not associated with production Lineaments from this map were as abundant away from prolific producing areas as they were in prolific producing areas No statistical analysis was deemed necessary

Analysis of Drainage Lineament Maps

Map Development

Basic Drainage Map This analysis is based on derivatives of a detailed drainage map (Figure 8) which is a basic map suggested by Strahler (1954) for geomorphic analysis A fifteen-minute quadrangle at a scale of 1 62,500 was used as the topographic base The map was made by tracing streams and drainage lines as far upstream or uphill as the slightest detectable topographic crenulation indicated a "V" in a contour line This technique usually projected streams and tributaries nearly to the top of hills and ridges thus showing gullies and sometimes rills in detail It also showed drainage lines in nearly flat areas that were visible but subtle upon ground inspection (Figure 9) The working scale of the drainage map, 1 120,000, was obtained by photographically reducing the original 1 62,500 map

USGS fifteen-minute quadrangle maps were chosen for several reasons The scale was convenient Topographic detail was sufficient to provide a detailed drainage map Finally, topography was mapped from aerial photographs taken in 1954, and field checked in 1956 The maps pre-dated oil field activity, eliminating the possibility that service roads, pipelines, or other activity associated with oil and gas production would influence the drainage map

Because a) numerous stream segments showed angular bends and sequential straight line segments and b) some of the streams displayed a "stair-step" pattern in aerial view as they progressed downgradient, a stream lineament map seemed appropriate Marking each short segment, however, would only outline part of a given stream Marking any and all apparent alignments regardless of distance between features was not discriminating enough Criteria were needed to define stream lineaments

Drainage Lineament Criteria Although the options were numerous, the following criteria yielded a workable set of lineament maps

1 A lineament was mappable if at least three "linear drainage features" occurred in a straight line within a 10 kilometer (6 2 mile) distance "Linear drainage features" are defined as straight line stream segments with the same approximate azimuth as the potential lineament being considered, or angular bends in drainage alignment that occur along the line of the potential lineament

2 Lineament length was defined by "anchoring" each end of a lineament on a "linear drainage feature" Lineament lengths may be less than 10 kilometers, or may be greater than 10 kilometers as long as at least three "linear drainage features" occur within any 10 kilometer segment of the lineament

Mapping Procedure. The drainage map was inspected for dominant linear trends by aligning a straight edge with straight stream segments that appeared to be in line or en echelon. This was a procedure suggested by Pettyjohn (1988), and resulted in Figure 33. Figure 33 is designated the "long form" lineament map because alignments were drawn regardless of the distance between the linear drainage features. The dominant azimuths were 1) north-south, 2) east-west, 3) northwest-southeast, and 4) northeast-southwest. Dominant drainage features, and selected lineaments were field checked to eliminate human induced drainage or linear trends.

A lineament map was then made for each dominant trend (Figures 34) using the 10 kilometer lineament criteria listed above. To clarify the picture, and make interpretations and calculations easier, the intersection of each set of lineaments was mapped (Figure 32). The number of intersections per Section were entered in to a Lotus(tm) spreadsheet, and the data were entered into the Jupiter(tm) mapping system. An isopach of total lineament intersections per Section (Figure 35) was generated in Jupiter(tm). Overlaying this map with the Total Production Isopach (Figure 15), and the Single Zone Meramec-Osage Cumulative Production Isopach (Figure 16), showed an apparent relationship with each map, but not a perfect one. To test the significance of this relationship, ANOVA (analysis of variance), linear correlation coefficients, and t-tests for significance were calculated.

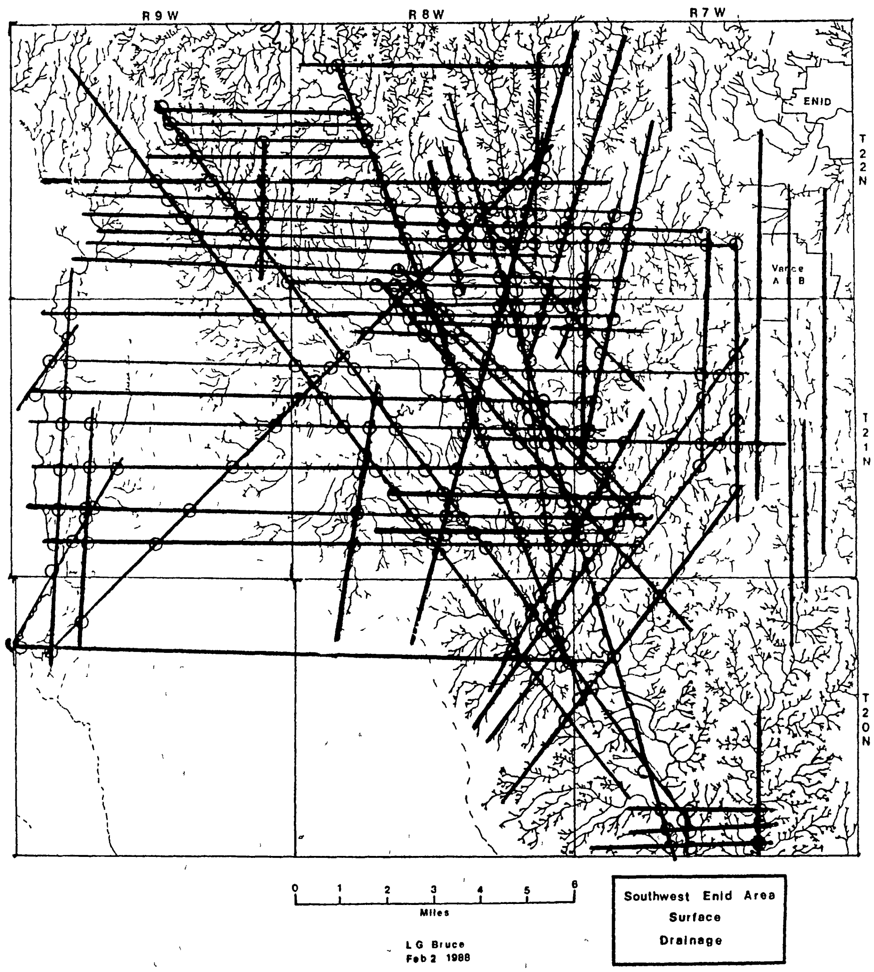


Figure 33. Generalized "Unrestricted" Stream Lineaments ("Long Form").

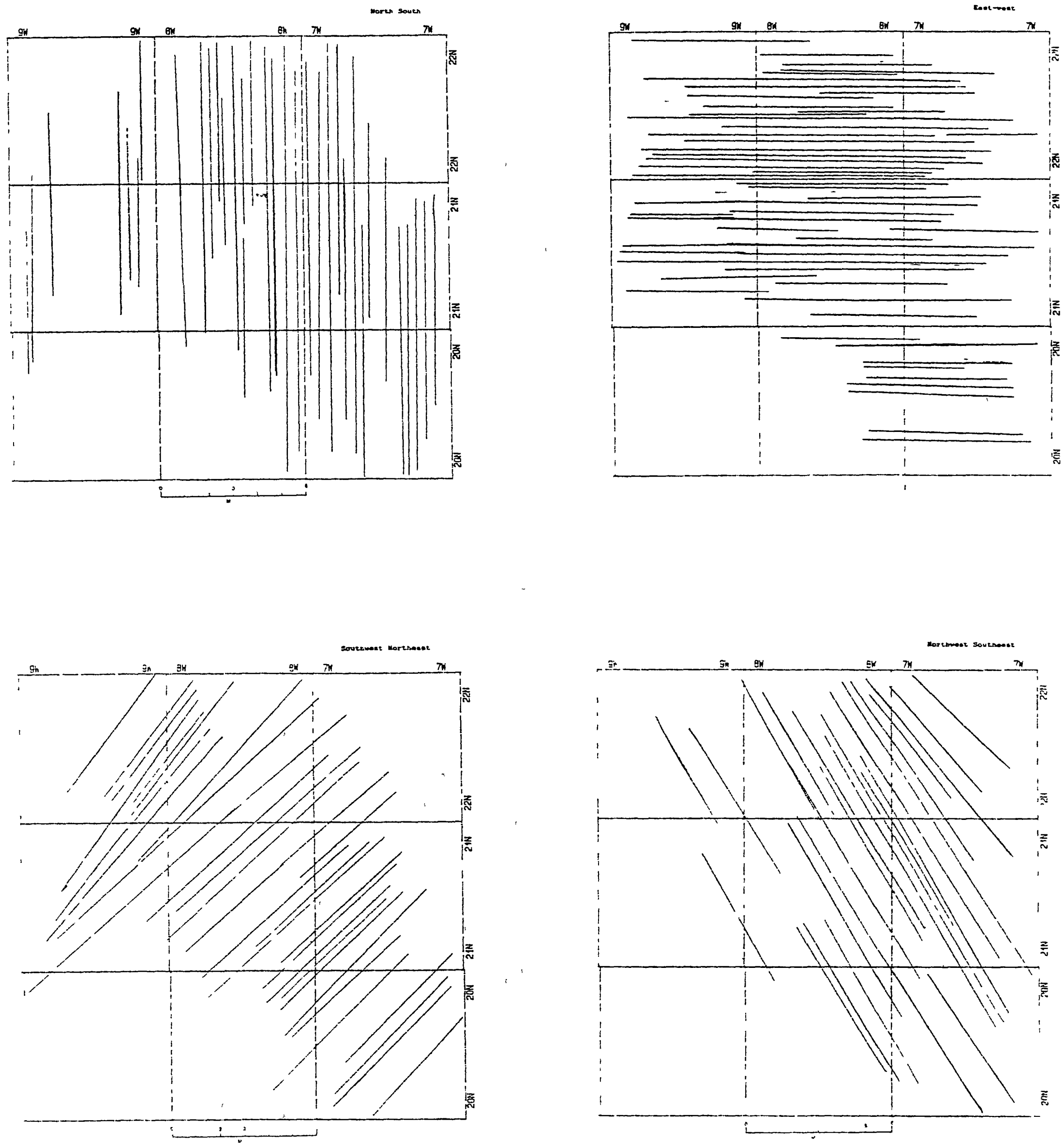


Figure 34. "6-Mile" (10 Kilometer) Lineament Maps.

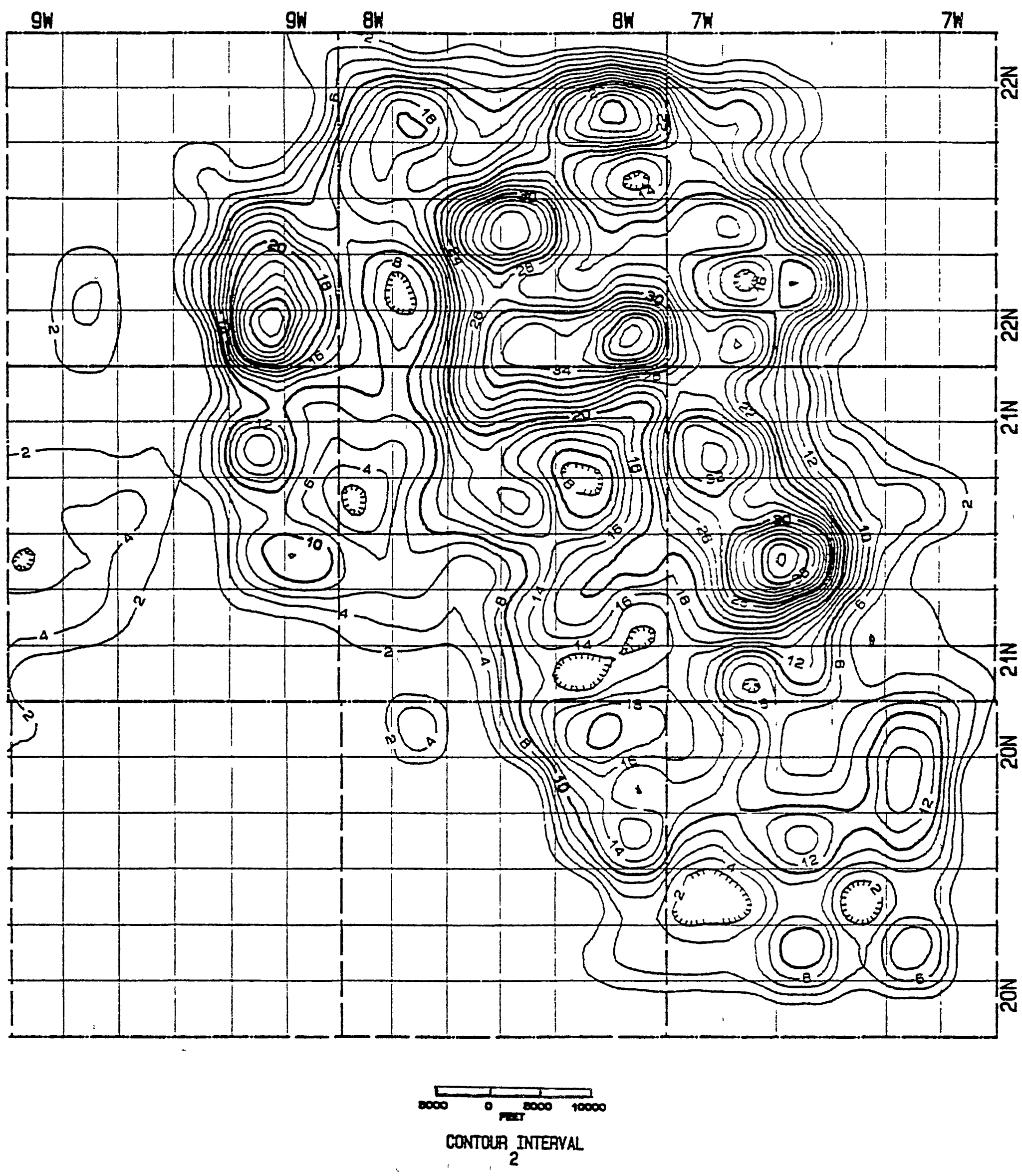


Figure 35. Isopach of Drainage Lineament Intersections.

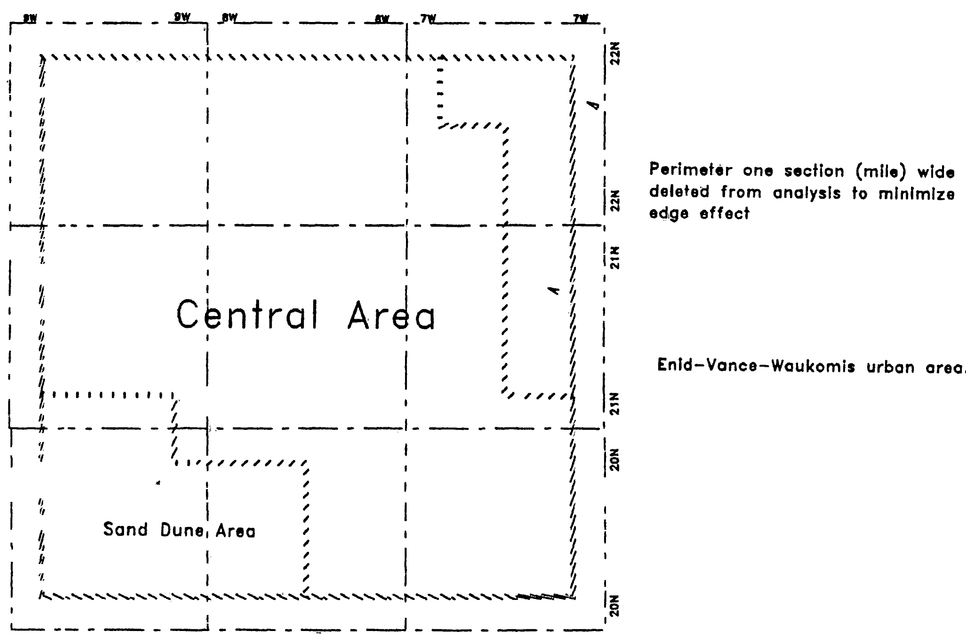


Figure 36. Quadrat Areas

Statistical Analysis.

For more meaningful comparison of data sets, the study area was divided (Figure 36) using the following criteria:

1. Perimeter Sections were deleted from the analyzed area to minimize "edge effect" (Davis, 1986). This reduced the area to 16 Sections north-south by 16 Sections east-west instead of 18 by 18.

2. The resulting area was divided into two-Section square (four square mile) quadrats.

3. Quadrats were grouped into an "urban dominated" region located in the northeast along the Enid-Vance-Waukomis corridor (9.4% of the area analyzed), a Quaternary sand dune region located in the southwest near the Cimarron River (15.6% of the area analyzed), and a central region consisting of the rest of the Southwest Enid area (75% of the area analyzed).

Linear Correlation Coefficient

Total lineament-intersections per quadrat were compared with single-zone Meramec-Osage production per quadrat and cumulative total production per quadrat. A linear correlation coefficient was calculated for each comparison. Statistical equations are listed in Appendix C. A data table for the quadrats is given in Appendix D.

Calculations of linear correlation coefficients and sums of squares were made in STAT, a PC-computer program (Davis, 1986) and corroborated in POLY (Rohlf, 1981) and LOTUS(tm). Figure 37 consists of scatter diagrams of the comparisons.

TABLE II

LINEAR CORRELATION COEFFICIENTS

Independent variable	Dependent variable	"r"
	Central Area	
Lineament-Intersections	Single-zone Miss	.807168
Lineament-Intersections	Total Production	.667945
	Urban Area	
Lineament-Intersections	Single-zone Miss	.836268
Lineament-Intersections	Total Production	.813439
	Sand Dune Area	
Lineament-Intersections	Single-zone Miss	0
Lineament-Intersections	Total Production	0

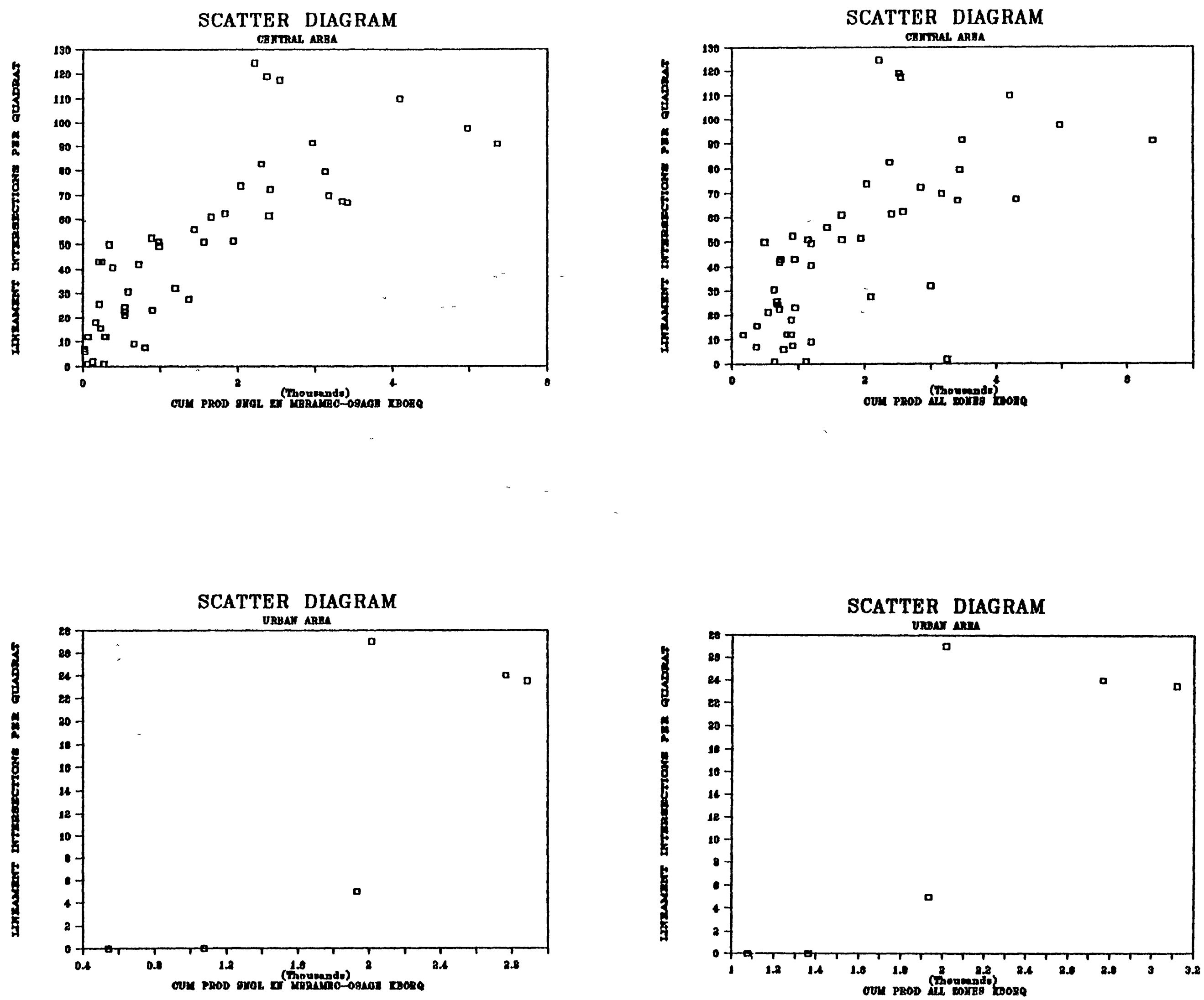


Figure 37. Scatter Diagrams.

ANOVA

Comparisons that yielded a linear correlation coefficient of .6 or greater were tested for validity of correlation by analysis of variance (ANOVA) and by "t" test of correlation (Davis, 1986). ANOVA tested the affect of scatter or variance in the data. The ANOVA test follows:

Ho (Null Hypothesis): The line projected through the data via linear regression analysis is the result of scatter (variance) in the data, and therefore the correlation coefficient is not significant.

Ha (Alternate Hypothesis): The line projected through the data via linear regression analysis is not the result of scatter (variance) in the data, and therefore the correlation coefficient is significant.

The test statistic is the "F" parameter calculated in the ANOVA tables (F = Mean Squares Regression / Mean Squares Deviation). The following ANOVA tables were analyzed:

Central Area:

Lineament-intersections versus Single-zone Meramec-Osage Production.

N (number of pairs) = 48 "r" = .807168

Critical Region: If alpha limit of error is .01, with 1 and 46 degrees of freedom, then F must be greater than 7.31 to reject the null hypothesis (critical F values from table in Steel and Torie, 1980).

TABLE III

ANOVA FOR CENTRAL AREA SINGLE-ZONE MERAMEC-OSAGE

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F
Regression	55,656,320	1	55,656,320	MSR/MSD
Deviation	29,769,100	46	647,154	86.00
Total	85,425,420	47		

F (86) > 7.31, the null hypothesis is rejected, the correlation is significant.

Lineament-intersections versus Total Production.

N (number of pairs) = 48 "r" = .667945

Critical Region: If alpha limit of error is .01, with 1 and 46 degrees of freedom, then F must be greater than 7.31 to reject the null hypothesis (critical F values from table in Steel and Torie, 1980).

TABLE IV

ANOVA FOR CENTRAL AREA TOTAL PRODUCTION

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F
Regression	39,292,880	1	39,292,880	MSR/MSD
Deviation	48,778,060	46	1,060,393	37.05
Total	88,070,940	47		

F (37.05) > 7.31, the null hypothesis is rejected, the correlation is significant.

Urban Area:

Lineament-intersections versus Single-zone Meramec-Osage Production.

N (number of pairs) = 6 "r" = .836268

Critical Region: If alpha limit of error is .01, with 1 and 4 degrees of freedom, then F must be greater than 21.20 to reject the null hypothesis (critical F values from table in Steel and Torie, 1980).

TABLE V

ANOVA FOR URBAN AREA SINGLE-ZONE MERAMEC-OSAGE

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F
Regression	2,976,006	1	2,976,006	MSR/MSD
Deviation	1,279,418	4	319,855	9.3
Total	4,255,424	5		

F (9.3) < 21.20 the null hypothesis is not rejected, the correlation is not significant.

Lineament-intersections versus Total Production.

N (number of pairs) = 6 "r" = .813439

Critical Region: If alpha limit of error is .01, with 1 and 4 degrees of freedom, then F must be greater than 21.20 to reject the null hypothesis (critical F values from table in Steel and Torie, 1980).

TABLE VI

ANOVA FOR URBAN AREA TOTAL PRODUCTION

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F
Regression	2,044,805	1	2,044,805	MSR/MSD
Deviation	1,045,502	4	261,376	7.8
Total	3,090,307	5		

F (7.8) < 21.20 the null hypothesis is not rejected, the correlation is not significant.

<u>"t" test of correlation</u>

The "t" test of correlation tested the validity of the sample versus random values. It is dependent upon the number of sample pairs versus the correlation coeffi- ient. The following hypotheses were tested:

Ho (Null Hypothesis): The two variables are independent and any non-zero value of "r" has arisen because of the vagaries of random sampling.

Ha (Alternate Hypothesis): The two variables are dependent and a non-zero value of "r" indicates a valid correlation.

Test Statistic is "t" where:

$$t = \frac{"r" \; (N - 2)^{1/2}}{[\,1 - ("r")^{2}\,]^{1/2}} \qquad (7)$$

Central Area.

Lineament-intersections versus Single-zone Meramec-Osage Production.

N (number of pairs) = 48 "r" = .807168 df = N - 2 (46)

Critical Region: If alpha limit of error is .01 (alpha/2 or .005 for this two tailed test), with 46 degrees of freedom, then absolute value of "t" must be greater than 2.75 to reject the null hypothesis (critical "t" values from table in Steel and Torie, 1980).

"t" = 9.27

¦9.27¦ > 2.75, therefore the null hypothesis is rejected and the correlation is significant.

Lineament-intersections versus Total Production.

N (number of pairs) = 48 "r" = .667945 df = N - 2 (46)

Critical Region: If alpha limit of error is .01 (alpha/2 or .005 for this two tailed test), with 46 degrees of freedom, then absolute value of "t" must be greater than 2.75 to reject the null hypothesis (critical "t" values from table in Steel and Torie, 1980).

"t" = 6.09

¦6.09¦ > 2.75, therefore the null hypothesis is rejected and the correlation is significant.

Urban Area.

Lineament-intersections versus Single-zone Meramec-Osage Production.

N (number of pairs) = 6 "r" = .836268 df = N - 2 (4)

Critical Region: If alpha limit of error is .01 (alpha/2 or .005 for this two tailed test), with 4 degrees of freedom, then absolute value of "t" must be greater than 4.60 to reject the null hypothesis (critical "t" values from table in Steel and Torie, 1980).

"t" = 3.05

|3.05| < 4.60, therefore the null hypothesis is not rejected and the correlation is not significant.

Lineament-intersections versus Total Production.

N (number of pairs) = 6 "r" = .813439 df = N-2 (4)

Critical Region: If alpha limit of error is .01 (alpha/2 or .005 for this two tailed test), with 4 degrees of freedom, then absolute value of "t" must be greater than 4.60 to reject the null hypothesis (critical "t" values from table in Steel and Torie, 1980).

"t" = 2.80

|2.80| < 4.60, therefore the null hypothesis is not rejected and the correlation is not significant.

Summary of Statistical Analysis.

Linear correlation coefficients exceeding the designated critical range of .6 (Table II) were obtained from the central and urban regions of the study area. Only the sand dune region failed to yield a correlation between oil and gas production and the density of lineament-intersections.

The central area, which included most of the study area, had linear correlation coefficients that exceeded the designated critical value of .6. These data sets passed ANOVA and "t-test" of correlation statistical analyses. Therefore, the correlations are statistically significant at the designated alpha limit of error of .01. This means that there is less than one percent probability that these correlations are caused by variance or scatter in the data (ANOVA) or by random values (t-test). Statistically significant correlations do not imply cause and effect. They do state a valid correlation exists regardless of the cause.

The highest correlation coefficients occurred in the urban region. These data sets, however, failed to pass ANOVA and "t-test" of correlation analyses using an alpha limit of error of .01. Therefore, data from the urban area can not be judged as statistically significant.

In the urban case, small sample size is the primary reason for failure to pass the significance tests. The lack of significance appears to be quite valid, despite the small sample size, because the urban environment has created quadrats containing no lineament intersections (because of buildings and pavement) and little or no oil and gas production; and quadrats containing a small number of lineament intersections and some oil and gas production. This combination has created a correlation between lineament intersections and oil and gas production that is apparently a function of building density and not necessarily fracture density. A larger sample population may or may not yield a different correlation, which may or may not be statistically valid. In any event, the correlations from the urban area in this study are not valid.

Urban areas in future studies should be considered problem interpretation areas, and a positive correlation should not be confused with cause and effect. The influence of fractures on drainage may affect urban building density, which in turn may affect the location of oil and gas tests, but these are topics for other studies.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

Correlation Between Deep Subsurface Fractures and Drainage

The ability to map and predict geologic fractures in the subsurface is important to the world economic community and to understanding the environment. It is of particular importance when interests focus on hydrologic confining beds, fracture controlled aquifers, or fracture dominated oil and gas reservoirs. The validity of projecting near surface fracture zones into the deep subsurface through unconformities and "unfractured seals" is not known. In an effort to correlate surface phenomena with subsurface fractures, six remote sensing maps were reviewed in relation to oil and gas production data from part of the Sooner trend in Oklahoma. Five of the six maps did not show any general correlation. However, a map of lineament-intersections derived from drainage lineaments did show a statistically significant correlation with Meramec-Osage single-zone production. This relationship has a linear correlation coefficient in excess of .8 with ANOVA and "t" test-of-correlation alpha-limit-of-error less than .01.

A significant correlation with total production from all zones was also made. Because most production in the area is from the Meramec-Osage, the correlation with total production appears to be a result of this dominance. The linear correlation coefficient between drainage lineament intersections and total production (.667) was less than that for single-zone Meramec-Osage (.807), indicating that adding production from other zones caused scatter in the data, and did not help in focusing the correlation. This may indicate that permeabilities in other zones are not dominated by fractures to the same degree as the Meramec-Osage.

Based on evidence provided in this paper, the following statements can be made: 1) some surface drainage is influenced by fractures; 2) oil and gas production from the Meramec-Osage Limestone (which exists at depths up to 2500 meters in the study area) is fracture controlled; 3) areas of prolific production from the Meramec-Osage should be areas of high fracture permeability, and by extension, areas of relatively high fracture density; 4) therefore, a statistically significant correlation between a remote sensing phenomena (drainage lineaments) and this production is a correlation between a surface phenomena and fracture density at depths up to 2,500 meters.

This does not imply that a given fracture may be projected over 2,000 meters into the subsurface. No vertical fractures exceeding 150 mm (6+ inches) were observed in the Meramec-Osage cores. This implies that there are linear zones with high fracture density in the subsurface that correlate with linear zones of high fracture density at the surface, but there is no evidence to suggest that single fractures at depth project in a contiguous manner to the surface.

Causes for the Correlation

Statistically significant correlations do not imply cause and effect. They do state a valid correlation exists regardless of the cause. Possible causes for a correlation between subsurface and surface phenomena were hypothesized by Hodgson (1957), Melton (1959), Nelson (1975), Maarouf (1981), Nur (1982), Eliason (1984), and Berger (1986). All of these involved some sort of a past or present stress field applied to the crust, or diferential compaction at a geologic unconformity. Other causes for surface/subsurface correlations may be the result of human activity. In urban areas, buildings are commonly located on flat, dry places, away from active streams, leaving space in drainage valleys (where drainage lineaments are more likely to be interpreted) to drill oil and gas tests (discussed in Chapter VII). Also, pipelines and oil field service roads may be mistakenly marked as natural lineaments. These features will commonly have a positive correlation with oil and gas production.

Restrictions and Pitfalls

This method has only been tested in one area. To be proven as a viable tool, it should be tested in other areas such as the rest of the Sooner trend in Oklahoma, the Spraberry trend of west Texas, or other fracture dominated oil and gas fields (several of which are listed by Nelson, 1985). The method should also be tested in areas where an accurate deter-mination of relative fracture density in the subsurface can be made without using fracture dominated oil and gas production. Fracture dominated fresh water aquifers such as carbonate aquifers in the midwestern U.S., or igneous aquifers in the Rocky Mountains, or the northeastern U.S. would be likely candidates.

Lateral changes in surficial geology and geomorph-ology may affect drainage response. These changes may affect the expression of fractures at the surface. Although the central portion of this study area yielded a valid correlation despite mixed substratum of Permian and Quaternary deposits, some surficial deposits may yield pinnate drainage or other patterns characteristic of the surface medium and not fractures. Sedimentary structures in bedrock, such as crossbedding, may also affect surficial fracture or drainage trends by locally altering fracture azimuths (Nelson, 1985). The geomorphic setting as well as the geologic setting should always be accounted. Additional study in other geographic areas is required to ascertain how much surficial variation is required to change the drainage-lineament response.

Other factors that affect drainage should always be considered. Human constructions such as roads, railroads, pipelines, drainage ditches, and channelized streams should always be considered. Presence of these features, however, does not preclude a valid drainage-lineament interpretation if topography has not been altered to the extent that natural drainage paths cannot be inferred. In essence, this study correlated linear topographic trends in a "flat land area" with oil and gas production from a fracture dominated reservoir. Where a valid correlation was found (in the central portion of the study area), there was very little urban development, and little change in topography caused by service roads, pipelines, or culture other than farming. Topographic data used in this study pre-dated oil field activity. Historic topographic data may be useful in future drainage-lineament analyses.

This method was tested in an area of flat lying strata. Areas with pronounced geologic structures may alter drainage. Hodgson (1961) observed that regional fractures did not change strike when crossing local structures in the Comb Ridge-Navajo Mountain area, but the affect these fractures have on drainage segments in structured areas is unknown.

Lithologic changes in the target formation may affect fracture density. In general, more brittle rocks will have greater fracture densities than less brittle rocks. Use of this correlation tool may require that the subsurface target formation be relatively free of lateral lithologic variations. Fracture controlled permeability in the subsurface is an integral of fracture density, open fracture width, fracture orientation, fracture length, lithology, and pressure on the rock formation. Based on examination of cores, the target formation (Meramec-Osage) in the study area had little lateral or vertical variation in lithology. Drill stem and production test data showed there was little change in pressure gradient in the Meramec-Osage in the area. Changes in permeability in this zone, therefore, are related to changes in fracture density, width, orientation, and length. These parameters are probably interrelated.

Pressure will affect fracture density. Pressure effects will vary with lithology. A brittle shale near the surface (less than 200 meters depth) may be susceptible to fracturing. The same shale at depth may be more plastic, and may be less susceptible to fracturing. At sufficient depth or pressure, most shales will probably be "seals" or confining zones, such as the Chester age shales (1,700 to 2,000 meters deep) in the study area. At shallower depths (less than 200 meters), in areas of relatively high fracture density, these shales may display substantial fracture permeability and may not be reliable confining beds. The depth at which a given shale may be affected or not affected by fracture density will depend on the lithology and degree of induration.

Applications

The ability to predict relative fracture density and dominant fracture orientations in the subsurface would be useful in estimating confining bed integrity in hydrologic investigations, estimating migration paths of groundwater pollutants in fractured aquifers, locating high-flow well locations for ground water resources, locating zones of probable ore concentration in Mississippi-Valley type metal deposits, locating fracture dominated oil and gas fields, more efficient extraction of oil and gas from existing fields, and locating and extracting coal-gas deposits. Other potential applications may lie in locating regional fracture swarms which may be related to plate tectonic, global tectonic (tidal), or past tectonic stresses. Areas of high fracture density may also be related to zones of earthquake tectonic activity.

Advantages

This method has several advantages over subsurface methods of investigation. It is relatively inexpensive. The only tools required are topographic and geologic maps, tracing paper or film, and a straight edge. (Soil maps and a light table are also helpful.) The area of investigation is not limited to the area around a bore hole, but may be quadrangle size or larger. The time of investigation may be less than that required for a detailed bore hole or geophysical survey. Finally, in the study area, it gave a more accurate prediction of fracture density than geophysical porosity measurements (Figure 20), or fracture indicators on logs (see Appendix B).

Possible Improvements

The mapping method used to derive drainage-lineament intersection data may be improved by integrating U.S. Geological Survey Digital Terrain Model (DTM) computer data with an algorithm that will draw a detailed drainage map based on topography. If accurate topographically-derived drainage maps can be drawn with speed and accuracy by a computer, larger areas may be investigated in less time. The primary limitation on this data is the resolution, or scale of each digital "pixel". At this time, most of the U.S. is available at a geographic scale of 1:250,000, and a "pixel" resolution measured in acres.

Another improvement via computers would be an algorithm that will define drainage lineaments from a drainage map. These lineaments should be delineated according to specific criteria based on a minimum number linear drainage features per specified length. Criteria may then be adjusted or "fine tuned" with a minimum of effort to derive maximum utility from the data. Use of computer generated maps may also reduce interpretive bias by drawing all lineaments that meet the given criteria. Development of such a system would not be easy, and may involve a large amount of fine tuning, but the results may be quite rewarding. The mathematics and programming sophistication for these tasks are available with current technology, but are beyond the scope of this discussion. A negative aspect of computer mapping is that historical topographic data may not be available in the USGS DTM database.

Additional Research

The validity of this method should be tested in other geographic areas. The depth at which shales can be considered reliable confining beds regardless of fracture density needs to be investigated.

Additional research on fracture permeability and the extent of fractures at depth may be accomplished by studying vertical and lateral variations in temperature and salinity. Temperature and water salinity data is available through geophysical well logs via direct measurements, or through "log" calculations. The Southwest Enid area provides an excellent data base for initiating a study of this type.

Remote Sensing and Subsurface Structure

The six remote sensing maps and mapping methods were also reviewed in relation to subsurface structural and isopachous phenomena. All six maps showed some relationship with subsurface structure or isopachous features. These relationships were not uniform, and no simple statistical correlation appeared feasible.

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APPENDIXES

APPENDIX A

CORE DESCRIPTIONS

TEXAS EASTERN No. 1 ANDERSON
SE NW Section 26-T21N-R7W

Completed:	6-10-65.
Producing Zone:	Meramec-Osage.
Interval:	Open Hole from 6,910´ to 7,370´.
Frac:	22,868 barrels of fresh water.
Initial Prod:	120 barrels oil; 140 barrels load water per day.
Cumulative Production:	104,000 barrels of oil 400,000 mcfg (.4 billion cubic feet of gas).

CORE DESCRIPTION:

Interval	Description
6925-6953	Core was shattered, probably because of natural fractures: Limestone, calcareous mudstone, gray (2.5Y 5/0 on Munsel chart), slightly silty, slightly dolomitic, heavily burrowed, chert nodule , gray, 2" by 1" at 6927, no visible matrix porosity under binocular microscope (25X).
6953-6970	Whole core, not shattered: Limestone, calcareous mudstone, gray, slightly brownish (2.5Y 5/2), abundant stylolites with organic tarry lining, paper thin argillaceous laminae. Visible vertical fractures, some open with crystal (predominantely quartz) lining, open fractures up to 0.5 mm wide, length of fractures up to 70mm, some fractures end in stylolites, others taper out or bifurcate and taper. No visible matrix porosity under binocular microscope (25X).
6970-7010	Core missing.
7010-7030	Limestone, calcareous mudstone, olive gray (5Y 5/2), trace of pyrite, rock becoming siliceous to very cherty. No visible matrix porosity under binocular microscope (25X).
7030-7150	Core missing.

7150-7174 Limestone, siliceous to cherty, dark gray (2.5Y 4/0), grading to near black (2.5Y 3/0) near base of interval, some black chert, stylolitic, burrowed. Visible vertical fractures, mineralized in part with calcite crystals, some fractures open up to .2mm. No visible matrix porosity under binocular microscope (25X).

TEXAS EASTERN No. GOFF
SE SW Section 14-T20N-R8W

Completed: 10-20-60
Producing Zone: Manning Limestone (Mississippian).
Interval: 6920-6934
Initial Prod: 15 Barrels of Oil, 5 Barrels salt water per day.
Cumulative Production: N/A (none listed).

SCOUT TICKET CORE INFORMATION:

Cored 7234-7260,	Recovered 16′ limestone, 3′ limestone with good porosity bleeding oil, 2′ limy "silt" bleeding oil, 1′ silty limestone with now show, 4′ limy silt bleeding oil.
Cored 7260-7265,	Recovered 5′ limestone.
Cored 7267-7287,	Recovered 9′ limestone, 11′ shaly limestone.

SCOUT TICKET DRILL STEM TEST INFORMATION:
DST Meramec-Osage 7236-7287.
Open 6 hours, gas in 20 minutes, too small to measure, Recovered 564′ gas cut mud and 540′ slightly oil cut mud.
Initial Shut In Pressure 2400 psi/30 min
Flow Pressure 270 to 440 psi/240 min
Final Shut In Pressure 1785 psi/30 min.

Lost Circulation at 7460. (Possibly indicative of fractures).

Perforated 7436-56, swabbed mud.
Perforated 7420-46, swabbed mud.

Did not frac Meramec-Osage.

Completed in Manning.

CORE DESCRIPTION:

Meramec-Osage Core available from 7275-7287:

Limestone, calcareous mudstone to wackestone, olive gray (5Y 4/2) to dark grayish brown (2.5Y 4/2), paper thin argillaceous laminae, siliceous in part with lighter gray chert, burrowed, fossiliferous with crinoids, gastropods, pelecypods, and brachiopods. Some vertical fractures, most mineralized closed, one open vertical fracture, 150 mm long, mineralized, apparent mineral zoning. No visible matrix porosity under binocular microscope (25X).

CRAWFORD No. 1 LAMUNYON
SW SE Section 7-T22N-R7W

Completed: 10-18-62
Producing Zone: Meramec-Osage.
Interval: Perforated 6520-6528
Open Hole 6528-7059
Frac: Sand Frac (30# X 60 & 2000# mothballs).
Initial Prod: Four Point Calculated Open Flow 6,000 mcf/day + 15 barrels "distillate" per 1,000 mcf.
Cumulative Production: 1,890,000 mcf (1.89 billion cubic feet of gas) + 11,000 barrels of oil.

CORE DESCRIPTION:

Interval	Description
6570-6583	Limestone, calcareous mudstone, siliceous, dark gray (2.5Y 4/0) to light olive brown (2.5Y 4/2) to light olive gray (5Y 4/1), paper thin argillaceous laminae, stylolitic in part, heavily burrowed, gray to white chert nodules in part, trace pyrite, fossiliferous with gastropods, come coarse crystal calcite in molds. Visible vertical fractures, mineralized with calcite and quartz. No visible matrix porosity under binocular microscope (25X).

SHELL No. 1 RHODES
SE SW Section 18-T22N-R7W

Completed:	7-25-63
Producing Zone:	Meramec-Osage
Interval:	Open Hole 6673-7310
Frac:	Sand frac 15# X 30
Initial Prod:	4,050 mcf/day, no reported fluid (except load water).
Cumulative Production:	980,000 mcd (.98 billion cubic feet of gas).

Scout Ticket Tests:

Drill Stem Test 7027 to 7347, open 1 hour, Recovered 540′ mud, Initial Shut In Pressure 2811 psi/30 min, Flow Pressure 127 psi to 178 psi/60 min, Final Shut In Pressure 2585 psi/60 min.

Drill Stem Test 6650-6985, open 2.5 hours, Recovered 50′ slightly gas cut mud, 240′ mud, Initial Shut In Pressure 260 psi/80 minutes, Flow Pressure 219 to 219 psi/150 minutes, Final Shut In Pressure 260 psi/80 minutes.

Meramec Osage Core (hole was deviated by 39 degrees)

CORE DESCRIPTION:

Interval	Description
6982-7200	Limestone, calcareous mudstone to wackestone, olive gray (5Y 4/2) to dark olive gray (5Y 3/2), slightly siliceous in part, trace pyrite, paper thin argillaceous laminae, heavily burrowed, fossiliferous with crinoids, brachiopods, and gastropods, a few incipient stylolites (none well developed). Some visible vertical fractures (6982, 7077, 7142, 7182) mineralized with calcite and quartz. Shell Oil marked one vertical fracture where the core was split with little or no mineralization. The core was broken in several places at 39 degrees from apparent vertical which would have been in actual vertical orientation because of hole deviation. This core is less siliceous than the Crawford No. 1 Lamunyon.

APPENDIX B

SOUTHWEST ENID AREA WELL DATA

ABBREVIATIONS

SEC: Section
TWP: Township
RGE: Range
S1 S2 S3 S4: 1/4 1/4 1/4 1/4 Section
ST: Status (oil, gas, dry, oil&gas, location)
YR: Year Completed
ELEV: Elevation of measuring point above sea level
MISSP: Meramec-Osage Structure Top
WDFRD: Woodford Structure Top
MSISO!: Total Meramec-Osage isopach value.
CUOIL!: Cumulative oil production per well.
CUGAS!: Cumulative Gas Production per well.
EQOIL!: Oil equivalent per well.
LOGGD!: 1 = logs available at OWLL
$PAY1 $PAY2 $PAY3 $PAY4: Primary Pay formation,
Secondary Pay formation, etc.

- MISSP = Meramec-Osage
- HUNTN = Hunton
- RDFRK = Red Fork
- MANNG = Manning
- OSWGO = Oswego
- VIOLA = Viola
- SKINR = Skinner
- INOLA = Inola

MSPOR!: Number of feet of Meramec-Osage log porosity greater than 6%.

LTYPE!: Porosity log type.
- 1 = Density
- 2 = Sonic/Acoustic
- 3 = Neutron/compensated neutron
- 4 = other

FINDR!: Fracture indicator present on logs.
- 1 = Shallow Resistivity inside deep resistivity.
- 2 = Cycle skipping on sonic
- 3 = Caliper
- 4 = Spikes on Density

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
1	20N	7W			SE	NE	O&G	66	1248	6828			5	0.25	49	2	MISSP	SKINR			4	2	5
1	20N	7W			SE	NW	O&G	66	1232	6847	7400	553	30	0.01	32	1	MISSP						
1	20N	7W			NW	NE	O&G	81	1240	6828	7379	551	3	0.25	47	2	MISSP	HUNTN					
1	20N	7W			SE	SE	O&G	67	1251	6840	7390	550	16		16	1	MISSP				139	1	
1	20N	7W			SE	SW	O&G	66	1224	6840	7392	552	16	0.00	16	2	MISSP						
1	20N	7W	N2	SE	NW	NW	O&G	83	1247	6880	7440	560			0	1	MISSP				8	1	
2	20N	7W			NW	NW	O&G	76	1226	6890	7464	574	29		29	1	OSWGO						
2	20N	7W			SE	NW	O&G	66	1217	6888			35		35	2	MISSP						
2	20N	7W		SE	SW	NW	O&G	82	1227	6875	7450	575	2	0.03	7	2	SKINR						
2	20N	7W		NW	SE	NE	O&G	80	1210	6870	7430	560	1		1	1	MISSP	RDFRK	VIOLA		55	1	
2	20N	7W			SE	NE	O&G	66	1197	6866			11		11	2	MISSP						
2	20N	7W			NW	NE	O&G	76	1223	6872	7490	618	22	0.29	73	2	MISSP						
2	20N	7W			SE	SW	O&G	66	1197	6908			18		18	2	MISSP						
2	20N	7W			NW	SW	O&G	82	1222	6890	7462	572	2	0.02	6	1	MISSP	SKINR			20	1	
2	20N	7W			NW	SE	O&G	77	1204	6884			5		5	2	MISSP						
2	20N	7W			SE	SE	O&G	66	1218	6902			5		5	2	MISSP						
3	20N	7W			NW	NW	O&G	77	1230				35	0.20	70	2	MISSP						
3	20N	7W			SE	NW	O&G	67	1222	6952	7526	574	158	0.40	228	1	MISSP	OSWGO			102	2	4
3	20N	7W			NW	NE	O&G	78	1239	6913						2	MISSP						
3	20N	7W			SE	NE	O&G	66	1228	6938			62	0.60	168	2	MISSP						
3	20N	7W			NW	SE	O&G	79	1245	6960						2	MISSP						
3	20N	7W			SE	SE	O&G	66	1231	6950			13	0.32	69	1	MISSP	OSWGO			110	2	2
3	20N	7W			NW	SW	O&G	67	1209	6975	7540	565	30	0.60	136	1	MISSP	OSWGO			65	2	2
3	20N	7W			SE	SW	O&G	79	1203	6996	7508	512	4	0.14	29	1	MISSP				32	1	
4	20N	7W			SE	NW	O&G	66	1222	6980	7564	584	109	1.00	285	1	MISSP	OSWGO				2	
4	20N	7W			SE	NE	O&G	78	1244	6966	7568	602	5	0.50	93	2	MISSP						
4	20N	7W			SW	NE	O&G	65	1226	6974	7560	586	77	0.20	112	1	MISSP				22	2	1
4	20N	7W			SE	SW	O&G	78	1206	6972	7560	588				2	MISSP						
4	20N	7W			NW	SW	O&G	66	1208	6970	7546	576	152	0.51	242	2	MISSP	OSWGO					
4	20N	7W		E2	SE	SE	O&G	82	1235	7000	7570	570		0.17	30	1	MISSP				19	1	
4	20N	7W			NW	SE	O&G	66	1220	6980	7563	583	103	1.10	297	2	MISSP	OSWGO					
5	20N	7W			NW	NW	O&G	78	1155	6902	7500	598				1	MISSP	OSWGO					
5	20N	7W			SE	NW	O&G	67	1183	6924			140	0.20	175	1	MISSP	OSWGO					
5	20N	7W			NW	NE	O&G	81	1195	6950	7610	660	23	0.25	67	1	MISSP	OSWGO			46	1	1
5	20N	7W			SE	NE	O&G	66	1183	6937			31	0.10	49	2	MISSP						
5	20N	7W			SE	SW	O&G	66	1179	6970	7511	541	111	0.68	231	1	MISSP	OSWGO					
5	20N	7W			NW	SW	O&G	77	1183	6937	7566	629				2	MISSP						
5	20N	7W			SE	SE	O&G	66	1206	6988			89	0.50	177	1	MISSP	OSWGO					
5	20N	7W			NW	SE	O&G	78	1166	6933						2	MISSP						
6	20N	7W			SE	NE	O&G	66	1150	6968			65		65	1	MISSP	OSWGO					
6	20N	7W			SE	SE	O&G	66	1159	6988			95	0.10	113	1	MISSP						
6	20N	7W			NW	SE	O&G	78	1159	6959						2	MISSP						
6	20N	7W			SE	NW	O&G	66	1163	6950	7568	618	65	0.25	109	2	MISSP						
6	20N	7W		SW	NW	NW	O&G	82	1180				5		5	2	OSWGO						
6	20N	7W			NW	SW	O&G	66	1166	6986	7598	612	92	0.75	224	2	MISSP	OSWGO					
7	20N	7W			SE	NW	O&G	81	1161	7006	7597	591	9	0.10	27	2	MISSP						
7	20N	7W			NW	NW	O&G	66	1160	6980	7588	608	89	0.60	195	1	MISSP				52	1	1
7	20N	7W			NW	NE	O&G	67	1149	6960	7588	628	55	0.52	147	1	MISSP				28	1	
7	20N	7W			NE	SW	O&G	66	1150	7000	7590	590	59	0.21	96	1	MISSP						
7	20N	7W		NE	NW	SE	O&G	84	1152	7000	7596	596	4	0.02	8	1	MISSP	OSWGO	MANNG	HUNTN			
7	20N	7W			SE	SE	O&G	67	1144	7002	7592	590	43	0.05	52	2	MISSP						
8	20N	7W			SE	NW	O&G	84	1145	6970	7554	584	15	0.17	45	1	MISSP	BGLIM	MANNG		153	1	5
8	20N	7W			NW	NW	O&G	66	1166	6963	7517	554	78		78	2	MISSP	OSWGO					
8	20N	7W			NW	NE	O&G	67	1156	6957	7551	594	32	0.58	134	1	MISSP				92	2	5
8	20N	7W			E2	SW	O&G	78	1144	7023			8	0.09	24	1	MISSP						
8	20N	7W			NW	SW	O&G	66	1147	6994	7579	585				1	MISSP				61	2	1

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
8	20N	7W			NE	SE	O&G	69	1190	7026			47	0.35	109	2	MISSP	OSWGO	MANNG				
8	20N	7W		SE	SE	SE	O&G	81	1175	7025	7600	575				1	MISSP	OSWGO	MANNG		17	1	
9	20N	7W			NW	NW	O&G	68	1193	6990			55		55	1	MISSP	OSWGO			254	1	
9	20N	7W			SE	NW	O&G	82	1200	7010			7	0.04	14	1	MISSP	OSWGO					
9	20N	7W			NW	NE	O&G	67	1217	7006			42		42	2	MISSP	OSWGO					
9	20N	7W			SE	NE	O&G	81	1221				21	0.10	39	2	OSWGO						
9	20N	7W				SW	O&G	68	1196	7040	7536	496	128	0.43	204	1	MISSP	OSWGO			4	1	1
9	20N	7W			NW	SE	O&G	67	1209	7030	7600	570	67	0.31	122	1	MISSP				15	1	
10	20N	7W			NW	NW	O&G	82	1242	7028	7596	568	2		2	1	MISSP	SKINR			4	1	
10	20N	7W			NW	NE	O&G	67	1230	6982			25		25	1	MISSP						
10	20N	7W			SE	NE	O&G	78	1218	6971	7532	561	27	0.19	60	1	MISSP	HUNTN					
10	20N	7W	S2	NE	SE	SW	O&G	81	1210					0.06	11	2	OSWGO						
10	20N	7W			NW	SW	O&G	66	1230	7040			100	0.25	144	1	MISSP	OSWGO					
10	20N	7W		SW	SW	SE	O&G	81	1217	7035	7592	557	14		14	1	MISSP	OSWGO					
10	20N	7W			SE	NW	O&G	66	1224	7000			10		10	1	MISSP						
10	20N	7W			SE	SE	O&G	67	1193	6988	7540	552	17		17	1	MISSP				21	1	
11	20N	7W			NW	NE	O&G	65	1130	6904	7482	578	10		10	2	MISSP						
11	20N	7W			E2	NE	O&G	78	1220	6920	7476	556	4		4	1	MISSP				5	1	
11	20N	7W	W2	E2	SE	SW	O&G	79	1189	6936	7494		8	0.08	22	1	MISSP				79	2	
11	20N	7W			NW	SE	O&G	61	1183	6902			1		1	2	MISSP						
12	20N	7W			SE	NW	O&G	66	1254	6832	7430	538	8		8	1	MISSP				97	2	
12	20N	7W			SE	NE	O&G	66	1235	6862	7404	542	27		27	1	MISSP	SKINR			10	1	1
12	20N	7W			NW	SW	O&G	82	1218	6910	7445	535	6	0.06	17	1	MISSP	RDFRK	MANNG		42	1	
12	20N	7W			SE	SW	O&G	67	1234	6935			13		13	1	MISSP						
12	20N	7W			NW	SE	O&G	78	1238	6918	7452	534	7	0.23	47	1	MISSP	SKINR			32	1	
13	20N	7W			SE	NW	O&G	67	1207	6922			5		5	1	MISSP	SKINR					
13	20N	7W			NW	NW	O&G	80	1228	6958	7498	540	9	0.16	37	1	MISSP	SKINR	RDFRK		122	1	
13	20N	7W			NW	NE	O&G	66	1214	6920			10	0.17	40	2	MISSP	SKINR					
13	20N	7W			SE	NE	O&G	82	1222	6900	7400	500	3		3	1	MISSP	SKINR			17	1	
13	20N	7W			SE	SW	O&G	67	1204	6940			11		11	1	MISSP				182	2	
13	20N	7W			NW	SW	O&G	81	1212	7078	7622	544	1		1	1	MISSP	SKINR	MANNG				1
13	20N	7W			NW	SE	O&G	66	1210	6902			8		8	1	MISSP	SKINR					
13	20N	7W			SE	SE	O&G	82	1219	6910	7450	540				1	MISSP	SKINR			127	1	
14	20N	7W			NW	NW	O&G	68	1185	6968	7540	572	44		44	2	MISSP						
14	20N	7W		S2	SE	NW	D&A	85	1176	6960	7506	546				1					32	2	
14	20N	7W		SE	SE	NE	O&G	79	1213	6974	7506		8		8	1	MISSP				18	1	
14	20N	7W		SW	SW	SW	O&G	82	1173	6976	7512	536	83	0.14	108	1	VIOLA				51	1	
14	20N	7W			NW	SW	O&G	68	1166	6960	7496	536	5		5	1	MISSP				30	2	1
14	20N	7W			SE	SW	O&G	81	1182	6982	7522	540	17	0.08	31	1	MISSP				22	1	
14	20N	7W			NW	SE	O&G	60	1187	6956			54		54	1	MANNG						
14	20N	7W			SE	SE	O&G	68	1200	6970	7512		17		17	1	MISSP	MANNG			180	2	
15	20N	7W			SE	NW	O&G	81	1213							2	MISSP	OSWGO	HUNTN				
15	20N	7W			NW	NW	O&G	66	1222	7058			170		170	1	MISSP	OSWGO					
15	20N	7W			NW	NE	O&G	66	1211	7028			68		68	1	MISSP						
15	20N	7W	N2	SW	SE	NE	O&G	82	1196	7032	7570	538	5	0.05	14	1	MISSP	VIOLA			50	1	
15	20N	7W			NW	SW	O&G	67	1200	7060	7600	540	29		29	1	MISSP	OSWGO					
15	20N	7W			NW	SE	O&G	67	1185	7026						1	MISSP						
15	20N	7W		SE	SW	SE	O&G	82	1185	7032	7570	538	1		1	1	OSWGO	BGLIM					
15	20N	7W		NE	SE	SE	O&G	81	1160	6974			78		78	2	VIOLA						
16	20N	7W			NW	NW	O&G	66	1195	7054			107		107	1	MISSP	OSWGO					
16	20N	7W			NW	NE	O&G	67	1239	7104			50		50	2	MISSP	OSWGO					
16	20N	7W			SE	NE	O&G	82	1236	7070	7615	545	5	0.05	14	1	MISSP				7	1	1
16	20N	7W			NW	SW	O&G	77	1181	7070	7624		17	0.05	26	1	MISSP				53	1	
16	20N	7W			SE	SW	O&G	82					6		6	1	MISSP						
16	20N	7W			SW	SE	O&G	77	1221	7126	7660	534	19		19	1	MISSP				19	1	1
16	20N	7W			NW	SE	O&G	66	1238	7132			7		7	1	MISSP						

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
17	20N	7W			NW	NW	O&G	66	1140	7010			33	0.06	44	2	MISSP	OSWGO					
17	20N	7W			SE	NE	O&G	66	1173	7059			24	0.05	33	1	MISSP				140	1	
17	20N	7W	E2	W2	NW	SW	O&G	81	1136	7065			3		3	2	MISSP	MANNG	OSWGO				
17	20N	7W			SE	SE	O&G	82	1190	7028	7577	549	12	0.05	21	1	MISSP	SKINR	OSWGO		30	1	1
18	20N	7W			NW	SW	O&G	68					29	0.20	64	2	MISSP						
18	20N	7W			SW	SE	O&G	65	1160	7100	7664	564	28		28	1	MISSP				29	2	2
18	20N	7W			NE	NW	O&G	66	1172	7045			16		16	2	MISSP						
18	20N	7W			SW	NE	O&G	78					5		5	2	MISSP						
18	20N	7W			NE	NE	O&G	68					10		10	2	MISSP	OSWGO					
19	20N	7W			NE	NW	O&G	82	1170	7120	7690	570	2		2	1	MISSP				14	1	1
19	20N	7W			SW	NW	O&G	66	1180	7186	7746	560	5		5	1	MISSP				4	1	1
19	20N	7W			SE	NE	O&G	80	1144	7105	7700	595	7		7	2	MISSP						
19	20N	7W			SE	SW	O&G	83	1172	7226	7782	556	30		30	1	MISSP				15	1	
19	20N	7W			SE	SE	O&G	81	1162	7178	7718	540	14		14	1	MISSP	OSWGO	MANNG	HUNTN			
19	20N	7W			NW	SE	O&G	81	1167	7170			15		15	2	MISSP	OSWGO	MANNG	HUNTN			
20	20N	7W			NW	NW	O&G	75					13		13	2	MISSP						
20	20N	7W			SE	NE	O&G	67	1143	7070	7613	543	25	0.06	36	2	MISSP	OSWGO					
20	20N	7W			SE	SW	O&G	67	1139	7086	7630	544	23	0.05	32	2	MISSP						
20	20N	7W			NW	SE	O&G	66	1130	7072			44	0.08	58	1	MISSP	OSWGO					
21	20N	7W			NW	NW	O&G	66	1173	7087			69		69	2	MISSP	OSWGO					
21	20N	7W	SW	NE	SE	NE	O&G	82	1222	7134	7680	546	3		3	1	MISSP	OSWGO			64	1	
21	20N	7W		W2	SW	NE	O&G	66	1187	7088	7626	538	58		58	1	MISSP	OSWGO			42	2	5
21	20N	7W			NW	SW	O&G	81	1127	7070	7616	546	4	0.04	11	1	MISSP	OSWGO			96	1	
21	20N	7W			SE	SW	O&G	66	1161	7082			33		33	1	MISSP						
21	20N	7W			SE	SE	O&G	66	1199	7096			20		20	2	MISSP						
21	20N	7W			NE	SE	O&G	77	1212	7137			12		12	2	MISSP						
22	20N	7W			NW	NW	O&G	65	1208	7096	7640	544	60		60	1	MISSP				10	2	5
22	20N	7W			NE	NE	O&G	78					7		7	2	MISSP						
22	20N	7W			SW	NE	O&G	68	1166	7027	7594	567	12		12	2	MISSP						
22	20N	7W			NE	SW	O&G	82	1176	7068	7616	548	6	0.03	11	1	MISSP	OSWGO			16	1	
22	20N	7W			SW	SW	O&G	66	1193	7100			40	0.10	58	2	MISSP	OSWGO					
22	20N	7W			SW	SE	O&G	66	1168	7076			136		136	2	MISSP	OSWGO					
23	20N	7W		NW	NE	NW	D&A																
23	20N	7W			NW	NW	O&G	80	1163	6971	7525	554	68		68	2	VIOLA						
23	20N	7W		NW	SE	NW	O&G	80	1187	7000			2		2	2	MISSP						
23	20N	7W			SE	NW	O&G	61	1194	7012			21		21	1	MISSP						
23	20N	7W			NW	NE	O&G	82	1167	6963			13	0.04	20	2	MISSP	MANNG	HUNTN	VIOLA			
23	20N	7W			SE	NE	O&G	67	1201	6980	7524	544	5		5	1	MISSP	SKINR			22	2	5
23	20N	7W			NW	SW	O&G	82					5		5	2	MISSP	MANNG					
23	20N	7W			SE	SW	O&G	67	1185	7032			9		9	2	MISSP						
23	20N	7W	N2	SE	NE	SE	O&G	80	1200	7007	7537	530	4		4	2	MISSP	SKINR	MANNG				
23	20N	7W			SE	SE	O&G	67	1199	7020			6		6	2	MISSP						
24	20N	7W			SE	NW	O&G	67	1219	6982	7514	532	31	1.20	242	1	MISSP	MANNG	SKINR		140	1	
24	20N	7W			NW	NE	O&G	78	1212	6938	7480	542	8	0.42	82	2	MISSP	SKINR					
24	20N	7W	SW	NE	NW	SW	O&G	82	1213	7016	7555	539	2		2	1	MISSP	SKINR	MANNG		18	1	
24	20N	7W			SE	SW	O&G	67	1209	6990			6		6	2	MISSP	SKINR					
24	20N	7W			NW	SE	O&G	68	1247	7008			2		2	2	SKINR						
24	20N	7W			SE	SE	O&G	82	1250	7007	7536	529	1		1	1	MISSP	SKINR			16	1	
25	20N	7W			SW	NW	D&A	78															
25	20N	7W			NW	NW	O&G	80	1195	6995	7532	537	1		1	2	MISSP	MANNG	HUNTN				
25	20N	7W			NE	NW	O&G	67	1214	7002	7536	534	22		22	1	MISSP	MANNG			38	2	5
25	20N	7W			SW	NE	O&G	66	1232	7020			14	0.65	128	2	MISSP	SKINR					
25	20N	7W		SW	NE	NE	O&G	84	1250	6875			1		1	1	SKINR				24	1	
25	20N	7W			NE	SW	O&G	68	1215	7020			28		28	2	MISSP						
25	20N	7W			NE	SE	O&G	82	1233	7004	7520	516				1	VIOLA						
25	20N	7W			SW	SE	O&G	65	1222	7023	7538	515	87	0.40	157	2	MISSP						

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
26	20N	7W			SW	S:	O&G	77	1163	7002			3		3	2	MISSP						
26	20N	7W			NE	SE	O&G	68	1187	7018	7546	528	10		10	1	MISSP	MANNG			57	2	
26	20N	7W			NE	NW	O&G	78	1174	7050	7604	554	44	0.27	92	2	MISSP	MANNG					
26	20N	7W			SW	NW	O&G	66	1164	7034	7564	530	34	0.25	78	1	MISSP	HUNTN			18	2	1
26	20N	7W			SW	NE	O&G	67	1169	7006	7544	538	126		126	1	MISSP	MANNG			56		1
26	20N	7W			SW	SW	O&G	66	1153	7030	7556	526	6		6	1	MISSP	MANNG			40	2	1
26	20N	7W	E2	W2	NE	SW	O&G	76	1162	7015			4		4	2	MISSP	MANNG					
27	20N	7W			NE	NW	O&G	66	1179	7090			94		94	2	MISSP	OSWGO					
27	20N	7W			NE	NE	O&G	66	1150	7040	7568	528	25		25	1	MISSP				49	1	
27	20N	7W			W2	NE	D&A		1139	7030	7558	528				2							
27	20N	7W			NW	NE	D&A									1							
27	20N	7W			SW	NW	D&A	82	1190	7092	7604	512				1	MISSP				46	1	
27	20N	7W			NE	SW	O&G	67	1173	7083	7594	511	14		14	1	MISSP				30	2	1
27	20N	7W		W2	SW	SW	O&G	81					11		11	2	MISSP	OSWGO	MANNG				
27	20N	7W			SW	SE	O&G	65	1154	7053	7578	525	9		9	1	MISSP				26	2	
28	20N	7W			NE	NW	O&G	81	1122	7074	7600	526	2		2	2	MISSP	MANNG	HUNTN				
28	20N	7W			SW	NW	O&G	67	1155	7087			21		21	2	MISSP						
28	20N	7W			NE	NE	O&G	66	1197	7123	7650	527	110	0.10	128	2	MISSP	OSWGO					
28	20N	7W			SW	SW	O&G	80	1122	7074	7600	526	14		14	2	MISSP	OSWGO	MANNG	HUNTN			
28	20N	7W			NE	SW	O&G	67	1173	7103	7630	527	22		22	1	MISSP				36	1	
28	20N	7W			NE	SE	O&G	67	1187	7114	7620	506	11		11	2	MISSP						
29	20N	7W		SE	SE	NW	O&G	81	1140	7126	7660	534	8		8	1	MISSP	MANNG	HUNTN		53	1	
29	20N	7W			NE	NW	O&G	67	1131	7098			14		14	1	MISSP						
29	20N	7W			SW	NW	O&G	81					6		6	2	MISSP	OSWGO	MANNG	HUNTN			
29	20N	7W		SE	SW	NE	O&G	82	1124	7072	7596	524	14		14	1	MISSP	OSWGO	MANNG	HUNTN	36	1	
29	20N	7W			NW	NE	O&G	66	1124	7080	7594	514	22		22	1	MISSP				142	2	1
29	20N	7W	W2	NE	NE	NE	O&G	82	1127	7068	7588	520	1		1	1	MISSP				72	1	1
29	20N	7W			SW	SW	O&G	68	1131	7157			47		47	2	MISSP	MANNG					
29	20N	7W			SW	SE	O&G	78	1119	7070			7		7	2	MISSP	OSWGO					
29	20N	7W			NE	SE	O&G	67	1122	7070			14		14	1	MISSP						
30	20N	7W			SW	NW	O&G	67	1193	7251	7794	543	29		29	1	MISSP				22	1	
30	20N	7W			SW	NE	O&G	67	1169	7209	7756	547	21		21	1	MISSP	MANNG			16	1	
30	20N	7W		NW	NE	NE	O&G	79	1164	7160	7718	558	7		7	1	MISSP						
30	20N	7W			SW	SW	O&G	85	1186	7268	7820	552	1	0.20	36	1	MISSP				46	1	
30	20N	7W			SF	SW	O&G	68	1176	7238	7780	542	12		12	1	MISSP	MANNG			7	1	1
30	20N	7W	NE	SW	SW	SE	O&G	82	1169	7182			1		1	2	MISSP						
30	20N	7W			SE	SE	O&G	66	1148	7182			31		31	2	MISSP						
31	20N	7W		E2	NE	SW	O&G	81					3		3	2	RDFRK						
31	20N	7W			NW	NE	O&G	67	1164	7219	7761	542	15		15	1	MISSP	HUNTN			10	1	
31	20N	7W			SW	NE	O&G	77	1177	7250	7798	548	12		12	1	MISSP				54	1	1
31	20N	7W			SW	NW	O&G	80	1194	7272	7826	554	40	0.07	52	1	HUNTN				112	1	
31	20N	7W			SW	SE	O&G	81	1175	7295	7834	539	20		20	1	RDFRK				8	1	1
32	20N	7W			NE	NW	O&G	66	1144	7128	7650	522	12		12	2	MISSP	RDFRK					
32	20N	7W	NW	SC	NE	NC	O&G	78	1121	7070	7560	490	5	0.05	14	2	MISSP						
32	20N	7W			NE	SW	O&G	78	1151	7160	7674	514	14	0.12	35	2	MISSP						
32	20N	7W			SW	SW	O&G	68	1162	7225			52	0.12	73	2	MISSP						
32	20N	7W			NE	SE	O&G	66	1121	7074	7560	486	50	0.15	76	1	MISSP				148	1	1
32	20N	7W			SW	SE	O&G	70	1128	7114	7599	485				1	MISSP	HUNTN			6	1	
33	20N	7W			SW	SE	O&G	63	1112	7056						1	MISSP						
33	20N	7W			NW	SE	O&G	77	1117	7060	7532	472	27	0.40	97	1	MISSP	MANNG	HUNTN		2	1	1
33	20N	7W			SE	SW	O&G	78	1116	7052	7528	476		0.24	42	1	MISSP	MANNG	HUNTN		5	1	1
33	20N	7W		SW	SW	SW	O&G	70	1122	7092	7572	480	6	0.40	76	1	MISSP				1	3	
33	20N	7W			SW	NW	O&G	78					4	0.05	13	2	MISSP	SKINR					
33	20N	7W		SW	NE	NE	O&G	79	1168	7103	7612	509	4		4	2	MISSP	MANNG	HUNTN				
33	20N	7W			SW	NE	O&G	62	1160	7101						1	MISSP						
34	20N	7W			SW	NW	O&G	81	1160	7072	7556	484	55	0.15	81	1	MISSP	HUNTN			27	1	

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EOOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
34	20N	7W			NE	NW	O&G	65	1153	7058	7570	512	20		20	1	MISSP	MANNG					
34	20N	7W			NE	NE	O&G	67	1131	7026	7551	525	57	0.20	92	2	MISSP	HUNTN					
35	20N	7W			NE	NW	O&G	81	1163	7038			5		5	1	MISSP						
35	20N	7W			NE	NE	O&G	81	1176	7020	7552	532				1	MISSP	MANNG	HUNTN				
35	20N	7W			SW	NE	O&G	65	1151	7010	7548	538	10		10	1	MISSP				10	2	1
35	20N	7W		W2	SW	SW	O&G	81	1130	7015	7555	540	20		20	2	MISSP	MANNG	HUNTN				
34	20N	7W			SW	SW	O&G	66	1150	7090	7578	488	43		43	1	MISSP	MANNG			50	2	1
34	20N	7W			NW	SW	O&G	82	1159	7093	7580	487	2		2	1	MISSP	MANNG	HUNTN	VIOLA	10	1	
34	20N	7W			NE	SE	O&G	66	1121	7018	7548	530	41		41	1	MISSP				16	2	1
35	20N	7W			SW	NW	O&G	65	1142	7035	7570	535	140		140	1	MISSP	HUNTN			22	3	
35	20N	7W			NE	SW	O&G	67	1129	7010	7557	547	31		31	1	MISSP						
35	20N	7W			SW	SE	O&G	65	1152	7034	7574	540	38		38	1	MISSP						
35	20N	7W	N2	S2	NE	SE	O&G	80	1188	7058	7591	533	8		8	1	MISSP				16	1	
36	20N	7W			SW	NW	O&G	65	1193	7018	7558	540	15		15	2	MISSP						
36	20N	7W		NW	NE	NE	O&G	82	1217	6956			11	0.19	44	2	SKINR						
36	20N	7W			SW	NE	O&G	64	1222	7039	7560	521	9		9	1	MISSP				53	2	1
36	20N	7W			NE	SW	O&G	65	1213	7047	7565	518	34		34	1	MISSP						
36	20N	7W			NE	SE	O&G	82	1205	7000	7525	525	2		2	1	MISSP	SKINR			17	1	
36	20N	7W			SW	SE	O&G	66	1205	7035	7556	521	23		23	2	MISSP	MANNG					
1	20N	8W			SE	NW	O&G	66	1204	7095	7687	592	118	1.50	382		MISSP						
1	20N	8W			NW	NE	O&G	80	1185	7022							MISSP						
1	20N	8W			SE	SW	O&G	76	1202	7000							MISSP						
1	20N	8W		SE	SW	SE	O&G	68	1192	7147	7644	497				1	MISSP				20	2	
1	20N	8W	S2	NE	SE	NW	O&G	81	1201				14		14		OSWGO						
1	20N	8W		NE	SE	SW	O&G	84	1201				14		14		OSWGO						
1	20N	8W			NW	SE	O&G	77	1181				92	0.16	120	1	OSWGO						
1	20N	8W			SE	NE	O&G	78	1185								OSWGO						
2	20N	8W			NW	NW	O&G	76	1230	7088							MISSP						
2	20N	8W			SW	NE	O&G	67	1231	7020	7640	620	85	1.58	363	1	MISSP						
2	20N	8W			SW	SW	O&G	68	1216	7122	7684	562				1	MISSP				8	2	
2	20N	8W			NW	SE	O&G	79	1215	7026							MISSP						
3	20N	8W		NE	SW	NW	O&G	82	1259	7155			23	0.23	69	1	MISSP						
3	20N	8W		NE	SE	NW	O&G	81	1240	7152	7740	588	10	0.10	28		MISSP						
3	20N	8W			NW	NW	O&G	69	1268	7200	7740	540				1	MISSP				110	1	1
3	20N	8W		N2	SE	NE	O&G	82	1220	7100			2		2	1	MISSP						
3	20N	8W			NW	NE	O&G	64	1224	7121			61	0.85	211	1	MISSP						
3	20N	8W		NE	NW	SW	O&G	82	1259	7200	7752	552	2		2	1	MISSP				10	1	
3	20N	8W			NW	SW	O&G	64	1230	7180	7722	542	11		11	1	MISSP				17		2
3	20N	8W			SE	SW	O&G	69	1250	7208	7752	544	17	0.20	52	1	MISSP						
3	20N	8W			NW	SE	O&G	63	1215	7146	7726	580	25		25	1	MISSP				11	2	5
4	20N	8W			NW	NW	O&G	68	1262	7222	7765	543	28	0.80	169	1	MISSP				11	1	1
4	20N	8W		SW	SE	NW	O&G	81	1270	7202			11	0.12	32	1	MISSP						
4	20N	8W			NW	NE	O&G	69	1265	7177	7740	563	18		18	1	MISSP				71	1	1
4	20N	8W			SE	NE	O&G	80	1260	7194	7750	556	35	0.06	46	1	MISSP	OSWGO	HUNTN		34	1	
4	20N	8W			NW	SW	O&G	69	1269	7256	7810	554	51		51	1	MISSP	HUNTN			44	1	1
4	20N	8W	N2	S2	SW	SE	O&G	80	1266	7233			4	0.06	15		MISSP						
4	20N	8W			NW	SE	O&G	64	1254	7210	7747	537	19		19	1	MISSP				3	2	1
5	20N	8W			NW	NW	O&G	69	1267	7257	7804	547	46		46	1	MISSP	HUNTN			19	1	
5	20N	8W			SW	NW	O&G	70	1263	7256	7810	554	88		88	1	HUNTN				75	1	
5	20N	8W			SW	NE	O&G	70	1267	7258	7818	560	6		6	1	HUNTN				36	1	1
5	20N	8W			SE	NE	O&G	80	1269	7206	7800	534	2		2	1	MISSP	HUNTN			13	1	
5	20N	8W			NW	NE	O&G	69	1261	7220	7762	542	84		84	1	MISSP	HUNTN			5	1	
5	20N	8W	E2	W2	NE	SW	O&G	71	1268	7279	7850	571				1	HUNTN				7	1	
5	20N	8W			SW	SW	O&G	69	1280	7285	7874	589				1	HUNTN				8	2	
5	20N	8W			SE	SW	O&G	66	1272	7278	7850	572	182	0.70	305	1	MISSP				12	1	
5	20N	8W			SW	SE	DRY	70	1269	7284	7829	545				1					3	3	

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EOOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
5	20N	8W			NW	SE	O&G	69	1272	7250	7807					1	MISSP	HUNTN					
5	20N	8W		SE	SE	SE	O&G	80	1268	7270	7809	539	1		1	1	MISSP				12	1	
5	20N	8W			SE	SE	O&G	68					66		66		HUNTN						
6	20N	8W			SE	NW	O&G	69	1274	7260	7870	610	9		9	1	MISSP	OSWGO	MANNG				
6	20N	8W	N2	SW	NW	NW	O&G	79	1280	7260			4		4	1	MISSP				130	1	
6	20N	8W			SE	NE	O&G	69	1275	7258	7824	566	52		52	1	MISSP	OSWGO	HUNTN		8	1	
6	20N	8W			E2	SW	O&G	78	1277	7312	7901	589	1		1	1	MISSP				15	1	
6	20N	8W			SE	SE	O&G	68	1274	7296	7884	588	164		164	1	MISSP	HUNTN					
7	20N	8W			SW	NW	O&G	81	1283	7314	7913	599	1		1	1	MISSP				22	1	
7	20N	8W			NE	NW	O&G	69	1285	7300	7912	612	20		20	1	MISSP				8	1	
7	20N	8W			NW	NE	O&G	81	1281	7322	7897	575	1		1		MISSP	OSWGO					
7	20N	8W			NE	NE	O&G	69	1263	7288	7886	598	417		417	1	MISSP	HUNTN					
7	20N	8W			SW	SW	O&G	81	1274	7359	7969	610	10		10		MISSP						
7	20N	8W			NE	SW	O&G	69	1275	7330	7944	614	1		1	1	MISSP				2	1	1
7	20N	8W			NE	SE	O&G	68	1279	7318	7924	606	5		5	1	MISSP	HUNTN			9	2	
8	20N	8W			SW	NW	O&G	69	1273	7290	7902	612	253		253	1	MISSP	HUNTN			8	1	1
8	20N	8W			NE	NW	O&G	71	1272	7274	7864	530				1	MISSP	HUNTN					
8	20N	8W			W2	NW	O&G	76	1276	7285	7894	609	3		3	1	MISSP	HUNTN			30	1	1
8	20N	8W			SW	NE	O&G	69	1275	7280	7870	590	375	0.60	481	1	MISSP	HUNTN					
8	20N	8W			NE	SW	O&G	68	1275	7282	7900	618	212		212	1	MISSP	HUNTN			6	1	
8	20N	8W			W2	SW	O&G	82	1277	7310	7928	618	2		2	1	MISSP				121	1	
8	20N	8W			NW	SE	O&G	79	1266	7290	7900	610				1	MISSP	MANNG			2	1	
8	20N	8W		SE	NE	SE	O&G	80	1270	7311			2		2		MISSP	OSWGO	HUNTN				
8	20N	8W			SW	SE	O&G	69	1275	7298	7912	614	25		25	1	HUNTN				22	1	
9	20N	8W			SW	NW	O&G	69	1272	7236	7864	628	10		10	1	MISSP				9	1	
9	20N	8W		SE	SE	NW	O&G	80	1215	7272	7827	555	11		11		MISSP	HUNTN	VIOLA				
9	20N	8W			NW	NE	O&G	74					11		11		MISSP						
9	20N	8W	N2	S2	SE	SE	O&G	79	1276				105		105		HUNTN						
9	20N	8W	NE	NW	SW	SW	O&G	80	1269	7298	7832	594	16		16	1	MISSP						
9	20N	8W			NW	SE	O&G	80	1275	7265	7838	573	9		9		MISSP						
9	20N	8W	NE	SW	SW	SE	O&G	80	1278	7272	7827	555	1		1		HUNTN						
9	20N	8W			NE	SE	O&G	68	1271	7268	7844	576	7		7	1	MISSP				12	1	
10	20N	8W		SW	NE	NW	O&G	81	1249	7234			5		5		MISSP	HUNTN					
10	20N	8W			SW	NW	O&G	68	1267	7234	7817	583	46	0.25	90	1	MISSP				10	1	1
10	20N	8W	N2	SW	NE	NE	O&G	81	1223	7160	7724	564	2		2	1	MISSP	HUNTN			52	1	1
10	20N	8W			SW	NE	O&G	68	1231	7180	7755	575	86	0.10	104	1	MISSP				72	1	1
10	20N	8W		N2	NE	SW	O&G	79	1234	7193	7796	603	7	0.10	25	1	MISSP	HUNTN			26	1	
10	20N	8W			SW	SW	O&G	69	1272	7268	7858	590	3		3	1	MISSP				11	1	1
10	20N	8W			SW	SE	O&G	68	1248	7204	7782	578	20		20	1	MISSP				4	1	1
11	20N	8W			NW	NW	O&G	68	1203	7140	7680	540	78		78	1	MISSP						
11	20N	8W		NE	SW	NE	O&G	67	1197	7126			95		95	1	MISSP						
11	20N	8W		NE	NW	SE	O&G	79	1228	7104	7706	602	9		9		MISSP						
11	20N	8W		NW	SE	SE	O&G	79	1174	7134	7728	594	4		4		MISSP						
11	20N	8W			NW	SE	DRY	25															
12	20N	8W		W2	NW	NW	O&G	68	1194	7062	7680	618	42	0.30	200	1	MISSP	HUNTN			22	1	
12	20N	8W			SW	NE	O&G	66	1169	7038	7646	608	128	0.25	172	1	MISSP				19	1	
12	20N	8W			NW	SW	O&G	69	1163	7064	7680	616	33		33	1	MISSP				50	1	
12	20N	8W		NW	SE	SE	O&G	78	1160	7092			5		5		MISSP						
13	20N	8W			NW	NW	O&G	68	1188	7118	7714	596	27		27		MISSP						
13	20N	8W			NW	NE	O&G	69	1171	7108	7705	537	56	0.04	63	1	MISSP				47	1	1
13	20N	8W		NW	NW	SW	O&G	69	1196	7172	7780	608	15		15		MISSP						
13	20N	8W			SE	SW	O&G	82	1200	7214	7786	572	1		1	1	MISSP				17	1	
13	20N	8W			SE	SE	O&G	78					5	0.04	12		MISSP						
13	20N	8W			NW	SE	O&G	68	1184	7146	7734	588	24		24	1	MISSP				74	2	
14	20N	8W			NW	NW	O&G	68	1233	7160	7758	598	16		16	1	MISSP	MANNG			16	1	
14	20N	8W			SE	NE	O&G	68	1205	7151	7738	587	42	0.22	81	1	MISSP				14	1	

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
14	20N	8W			NW	SW	O&G	81	1243	7228	7796	568	1		1	1	MISSP				17	1	1
14	20N	8W			NE	SW	O&G	69	1235	7228	7808	580	10		10	1	MISSP				11	1	
14	20N	8W		SW	SW	SW	O&G	81	1242	7274	7846	572	2		2	1	MISSP	HUNTN			54	1	1
14	20N	8W	S2	S2	SE	SE	O&G	81	1213	7232	7824	592	3		3	1	MISSP					3	
14	20N	8W			SW	SE	O&G	60	1218	7234	7808	574				1	MANNG				38	2	1
15	20N	8W			NE	NW	O&G	69	1272	7250	7842	592	3		3	1	HUNTN				42	1	
15	20N	8W	S2	N2	SW	NW	O&G	79	1264	7270	7850	580	5		5		MISSP	HUNTN					
15	20N	8W	NE	SW	SW	NE	O&G	82	1270	7259	7848	589	2		2		HUNTN						
15	20N	8W			SW	NE	O&G	69	1269	7262	7856	594	18		18	1	MISSP	HUNTN			32	1	1
15	20N	8W	S2	N2	NE	NE	DRY	80	1238	7182	7765	583											
15	20N	8W			SW	SW	O&G	68	1274	7296	7900	604	46		46	1	MISSP				9	1	1
15	20N	8W		NW	NE	SW	O&G	85	1275	7270	7870	600	2		2	1	MISSP	MANNG			34	1	
15	20N	8W			SE	SE	O&G	81	1263	7254	7834	580	62		62	1	HUNTN				25	1	1
15	20N	8W	NW	SE	NW	SE	O&G	81	1270	7232	7795	563	33		33		HUNTN						
16	20N	8W			NE	NE	O&G	80	1270	7294	7906	612	6		6	1	MISSP						
16	20N	8W			SW	NW	O&G	69	1270	7303	7913	610	2		2	1	MISSP				15	1	
16	20N	8W		N2	NW	NW	O&G	79	1272				11		11		MISSP						
16	20N	8W	NE	SW	NE	NE	O&G	80	1276	7294	7901	607	6		6		MISSP	HUNTN					
16	20N	8W			NW	NE	O&G	79	1274	7270	7867	597	68	0.20	103	1	HUNTN				45	1	
16	20N	8W			SW	SW	O&G	68	1269	7306	7910	604	23	0.20	58	1	MISSP				74	1	1
16	20N	8W			NW	SE	O&G	82	1276	7316	7900	584	5		5	1	MISSP	MANNG			4	1	
16	20N	8W			NE	SE	O&G	69	1274	7286	7890	604	3		3	1	MISSP	MANNG			1	1	
17	20N	8W			SW	NW	O&G	82					10		10	1	MISSP				19	1	
17	20N	8W			NE	NW	O&G	69	1278	7322	7929	607	1		1	1	MISSP				11	1	1
17	20N	8W			SW	NE	O&G	69	1275	7324	7931	607	1		1	1	MISSP	MANNG			19	1	
17	20N	8W		NW	NE	NE	O&G	81	1272	7304	7918	614	1		1	1	MISSP				132	1	
17	20N	8W			SW	SE	O&G	82	1266	7334	7950	616	1		1	1	MISSP				13	1	
18	20N	8W			SW	NE	O&G	80	1264	7360	7953	593	1		1		MISSP						
18	20N	8W			NE	NE	O&G	69	1267	7332	7946	614				1	MISSP				112	1	
18	20N	8W			SW	SW	O&G	69	1258	7390	8013	623	2		2	1	MISSP	MANNG			16	1	
18	20N	8W			SW	SE	O&G	69	1257	7390	8000	610	1		1	1	MISSP				22	1	
19	20N	8W			SW	SW	O&G	68	1245	7420	8033	613	16	0.10	34	1	MISSP	HUNTN			1	1	
19	20N	8W			SW	SE	O&G	69	1241	7398	8008	610	16		16	1	MISSP				1	1	1
20	20N	8W			NW	SE	O&G	77	1259	7350	7962	612	4	0.20	39	1	MISSP	HUNTN			17	1	
21	20N	8W			SW	NW	DRY																
21	20N	8W			SW	NE	O&G	69	1276	7324	7918	594	3		3	1	MISSP						1
21	20N	8W		NW	NE	NE	O&G	81	1275	7310	7908	598	8	0.02	12	1	MISSP				58	1	
21	20N	8W			SW	SW	O&G	62	1258	7340	7936	596	23		23	1	MISSP				58	2	
21	20N	8W			SW	SE	O&G	69	1256	7323	7897	574	8		8		MISSP	HUNTN					
22	20N	8W			SW	NW	O&G	68	1283	7328	7916	588	3		3	1	MISSP				5	1	1
22	20N	8W			NE	NW	O&G	83	1287	7300			5		5		MISSP	HUNTN					
22	20N	8W			SE	NE	DRY	69	1276	7318	7884	566											
22	20N	8W			NE	NE	O&G	81	1276	7297	7878	581	65		65		MISSP	HUNTN					
22	20N	8W			SW	SW	O&G	81	1281	7350	7932	582	1		1	1	SMPSN				6	1	
22	20N	8W			NE	SW	O&G	68	1280	7332	7906	574	5		5		MISSP						
22	20N	8W	NW	SE	SE	SE	O&G	76	1270	7321	7871	550					MISSP	HUNTN					
22	20N	8W			SW	SE	O&G	68	1280	7360	7954	594	10		10	1	MISSP				8	1	1
23	20N	8W			SW	NW	O&G	68	1272	7302	7874	572	19		19	1	MISSP	HUNTN					
23	20N	8W			SE	NW	DRY	77	1238	7300	7882	582				1					5	1	
23	20N	8W			NE	NE	O&G	61	1217	7253			20		20		MISSP						
23	20N	8W			SW	SW	O&G	67	1262	7306	7860	554	515	1.24	733		MISSP	HUNTN					
23	20N	8W			SW	SE	O&G	68	1266	7320	7890	570	13		13	1	MISSP				3	1	
24	20N	8W			NW	NW	DRY	80	1209	7244	7814	570											
24	20N	8W	W2	E2	SE	NW	O&G	79	1218	7270	7824	554					MISSP	OSWGO					
24	20N	8W			NW	NE	O&G	69	1202	7210	7814	604	11		11	1	MISSP				54	2	
24	20N	8W		SW	NE	SW	O&G	80	1232	7290	7898	608	7		7		MISSP	RDFRK	MANNG	HUNTN			

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
24	20N	8W			SW	SW	O&G	67	1232	7300	7862	562	49		49		MISSP	OSWGO					
24	20N	8W			SW	SE	O&G	81	1201	7250	7830		5		5	1	MISSP	MANNG			18	1	
25	20N	8W			NE	NW	O&G	67	1212	7290	7854	564	14		14	1	MISSP				9	1	
25	20N	8W			NE	NE	O&G	68	1188	7251	7820	569	25		25	1	MISSP	MANNG			9	1	
25	20N	8W			NE	SW	O&G	67	1211	7341	7918	577	14		14	1	MISSP				8	1	
25	20N	8W			SW	SW	O&G	80					4		4		MISSP	OSWGO	HUNTN				
25	20N	8W			NE	SE	O&G	67	1190	7276	7816	540	47		47		MISSP						
26	20N	8W			SW	NW	O&G	67	1278	7318	7870	552	834	0.86	985	1	HUNTN				2	1	
26	20N	8W			NE	NW	O&G	78	1274	7331	7890	559	1		1		MISSP	HUNTN					
26	20N	8W	N2	S2	NE	NE	O&G	81	1247	7338	7916	578	5	0.10	23	1	MISSP	HUNTN			28	1	1
26	20N	8W			SW	NE	O&G	67	1251	7346	7918	572	45		45	1	MISSP				6	1	1
26	20N	8W			NW	SW	O&G	87	1272	7365	7888	523					HUNTN						
26	20N	8W			SW	SW	O&G	67	1268	7398	7924	526					MISSP	HUNTN					
26	20N	8W			NE	SE	O&G	67	1241	7387	7956	569	40		40	1	MISSP	MANNG			28	2	1
26	20N	8W			SW	SE	O&G	78	1263	7430	7996	566	5		5	1	MISSP	HUNTN			85	1	1
27	20N	8W			SE	NW	O&G	68	1286	7412	8000	588	8		8	1	MISSP				48	2	
27	20N	8W	NW	SE	NE	NE	O&G	81									MISSP	HUNTN					
27	20N	8W			NE	NE	O&G	68	1278	7335	7894	559	637	0.24	679	1	MISSP	HUNTN			35	1	
27	20N	8W			SE	SW	O&G	68	1266	7452	8031	579	9		9	1	MISSP				62	1	
27	20N	8W			NE	SW	O&G	81	1274	7425	8014	589	13		13	1	MISSP				178	1	
27	20N	8W			NE	SE	O&G	68	1276	7366	7906	540	569		569	1	HUNTN				6	1	1
28	20N	8W			SW	NW	O&G	82	1243	7351	7933	582	15	0.15	41	1	SMPSN				7	1	
28	20N	8W			SE	NE	O&G	69	1259	7380	7984	604	11		11	1	MISSP				54	2	
28	20N	8W			SW	SW	O&G	69	1237	7366	7930	564	18		18	1	MISSP				34	2	
28	20N	8W			SE	SE	O&G	68	1248	7408	8008	600	4		4	1	MISSP					4	
29	20N	8W			NW	NW	O&G	69	1248	7392	8000	608	36		36	1	MISSP				19	1	1
29	20N	8W			SW	[illegible]	O&G	69	1256	7380	7976	596	9		9	1	MISSP				10	1	
29	20N	8W		SE	NE	NE	O&G	81	1249	7351	7948	597	4	0.40	74	1	MISSP	HUNTN			14	1	
29	20N	8W			NE	SW	O&G	69	1243	7386	7990		1		1	1	MISSP				8	1	
29	20N	8W	NE	SW	SW	SW	O&G	81	1242	7401	8002	601	16	0.20	51	1	MISSP	MANNG	HUNTN		34	1	
29	20N	8W			NE	SE	O&G	69	1241	7362	7954	592	21	0.25	65	1	MISSP				3	1	
30	20N	8W			NE	NW	O&G	80	1249	7426	8046	620	6		6		MISSP						
30	20N	8W	NE	SW	SW	NE	O&G	82	1246	7416	8026	610	11		11	1	MISSP	MANNG			34	1	
30	20N	8W		SE	NE	SE	O&G	81	1260	7424	8023	599	16		16	1	MISSP				14	1	
30	20N	8W			NW	SE	O&G	69	1247	7430	8036	606	18		18	1	MISSP	HUNTN			10	1	
31	20N	8W			NW	NW	O&G	79					14	0.01	16		MISSP	HUNTN					
31	20N	8W			NW	NE	O&G	69	1244	7452	8052	600	88	0.10	106	1	MISSP				4	1	
31	20N	8W			NE	SW	O&G	80	1236	7530			3		3		MISSP	OSWGO					
31	20N	8W			SW	SW	O&G	74	1220	7544	8116	572	6		6	1	MISSP	OSWGO			4	1	1
31	20N	8W			NE	SE	O&G	80	1233	7500	8045	545	11		11		MISSP	HUNTN					
32	20N	8W			NW	NW	O&G	69	1236	7420	8004	584	1		1	1	MISSP				6	1	
32	20N	8W			SE	NW	O&G	81	1247	7445	8004	559	1		1	1	MISSP	OSWGO			42	1	
32	20N	8W			NW	NE	O&G	68	1233	7410	7970	560	14		14	1	MISSP				28	1	
32	20N	8W		SW	SE	NE	O&G	81	1225	7442	7986	544	2		2	1	MISSP				26	1	
32	20N	8W			SE	SW	O&G	64	1225	7450			12		12	1	MISSP						
33	20N	8W			SW	NW	O&G	79	1239	7427	7987	560	1		1	1	MISSP	MANNG			17	1	
33	20N	8W			SW	NE	O&G	69	1240	7432	7996	564	8		8	1	MISSP	MANNG			26	2	1
33	20N	8W			SW	SW	O&G	71	1234	7486	8066	580	41		41	1	MISSP	MANNG	HUNTN		16	1	
33	20N	8W		SE	NE	SE	O&G	72	1243	7476	8050	574	38		38	1	MISSP				25	1	
33	20N	8W			NE	NE	DRY	81	1241	7440	7992	552											
34	20N	8W			SW	NW	O&G	68	1246	7470	8009	539	81		81	1	MISSP				2	1	
34	20N	8W			NE	NE	O&G	68	1279	7472	8044	572	125		125	1	MISSP	HUNTN			20	1	
34	20N	8W			SW	NE	O&G	81	1252	7476	8032	556	2		2	1	MISSP	HUNTN			116	1	
34	20N	8W		SE	SE	SW	O&G	71	1232	7450	8012	562	42		42	1	MISSP	HUNTN			70	2	1
34	20N	8W			NE	SE	O&G	69	1255	7450	8026	576	67		67	1	MISSP	HUNTN			20	1	1
35	20N	8W		E2	NE	NW	O&G	67	1265	7428	8000	572	54		54	1	MISSP				20	1	1

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
35	20N	8W			SW	NW	O&G	82	1265	7418	7976	558	12		12	1	MISSP	HUNTN			17	1	
35	20N	8W		SW	SW	NE	O&G	81	1257	7432	8000	568	11	0.10	29	1	MISSP	MANNG	HUNTN		54	1	
35	20N	8W		SW	NE	NE	O&G	82	1251	7396	7952	556	8		8	1	MISSP	HUNTN			40	1	
35	20N	8W			NE	NE	O&G	67	1250	7408	7968	560	16		16	1	MISSP						1
35	20N	8W			SW	SW	O&G	81	1255	7422	7977	555	3		3	1	MISSP				29	1	
35	20N	8W			NE	SW	O&G	68	1258	7448	8012	564	147		147	1	MISSP				18	1	1
35	20N	8W			NE	SE	O&G	68	1253	7426	8004	578				1	MISSP				16	1	
35	20N	8W			SW	SE	O&G	82	1255	7410	7950	540	4		4	1	MISSP	RDFRK	HUNTN		46	1	
36	20N	8W			NE	NW	O&G	68	1220	7336	7890	554	19		19		MISSP						
36	20N	8W			SW	NW	O&G	77	1237	7372	7944	572	8		8	1	MISSP				30	1	1
36	20N	8W		NE	NE	NW	O&G	82	1219	7324	7866	542	5		5	1	MISSP	HUNTN			8	1	
36	20N	8W			SW	NE	O&G	80	1236	7295	7787	492	5		5	1	MISSP	HUNTN			5	1	
36	20N	8W			NE	NE	O&G	68	1201	7308			32		32		MISSP						
36	20N	8W			SW	SW	O&G	79	1255	7366	7832	526	5		5	1	MISSP	MANNG				1	
36	20N	8W			NE	SE	O&G	81	1196	7296	7824	528	23		23	1	HUNTN				19	1	
36	20N	8W			SE	SE	O&G	67	1216	7272	7806	534	25		25	1	MISSP				55	2	2
1	20N	9W			NW	NW	O&G	69	1283	7280	7862	582	4		4	1	MISSP	MANNG			138	2	
1	20N	9W			SW	NW	O&G	75	1276	7274	7870	596	3	0.16	31	1	MISSP				40	1	
1	20N	9W			SW	SW	O&G	76	1270	7294	7924	630	14	0.85	164	1	MISSP	MANNG			12	1	
1	20N	9W			SE	SE	O&G	69	1280	7312	7914	602	1		1	1	MISSP	OSWGO			1	1	1
2	20N	9W			NW	NW	O&G	71	1257	7388	7987	599	9		9	1	MISSP				18	1	
2	20N	9W			NW	NE	O&G	69	1275	7336	7920	584	24		24	1	MISSP	MANNG			226	1	1
2	20N	9W			SE	SW	O&G	85	1264	7336	7922	586	2	0.09	18	1	MISSP				48	1	
2	20N	9W			NW	SW	O&G	75	1249	7346	7950	604	5	0.88	160	1	MISSP	MANNG			218	1	
2	20N	9W			NW	SE	O&G	75	1267	7294	7896	602	15	0.85	165	1	MISSP	MANNG			12	1	
3	20N	9W			NW	NW	O&G	75	1233	7492	8094	602	5	0.38	72	1	MISSP				26	1	
3	20N	9W			NW	NE	O&G	70	1247	7474	8032	618	7		7	1	MISSP	MANNG			13	1	
3	20N	9W			NW	SW	O&G	70	1233	7510	8074	564	36		36		MISSP						
3	20N	9W			NW	SE	O&G	75	1244	7428	8046	618	22	1.05	207	1	MISSP	MANNG			62	1	
4	20N	9W		NE	NE	NW	O&G	78	1241	7468			3	0.07	15		MISSP						
4	20N	9W			SW	NE	O&G	69	1228	7468	8064	596	64		64	1	MISSP	MANNG			22	1	
4	20N	9W			NW	SW	O&G	69	1225	7466	8074	608	76	2.08	442	1	HUNTN				9	1	1
4	20N	9W			NE	SW	O&G	80	1235				22	0.20	57		HUNTN						
4	20N	9W	NW	SE	NW	SE	O&G	77	1231	7488	8030	602	29	0.68	149	1	MISSP	HUNTN			20	1	
4	20N	9W	SE	NW	SE	SE	O&G	82	1232	7518	8114	596	44	0.25	88	1	HUNTN				102	1	
5	20N	9W	W2	E2	NW	NE	O&G	69	1231	7512	8120	608	43	0.16	71	1	MISSP				25	1	1
5	20N	9W			NE	SW	O&G	70	1204	7484	8076	592	6	2.09	374	1	MISSP	HUNTN			18	1	1
5	20N	9W			NE	SE	O&G	69	1232	7483	8108	625	164	3.44	769	1	MISSP	HUNTN					
6	20N	9W	N2	N2	SW	NW	O&G	71	1193	7508	8157	649	28	0.45	107		MISSP	HUNTN					
6	20N	9W		NW	NW	NE	O&G	73	1198	7506	8122	616	36	3.22	603	1	HUNTN				19	1	
6	20N	9W		SW	SW	SW	O&G	82	1185	7556	8182	626	29	0.36	92	1	MISSP	INOLA	MANNG		98	1	
6	20N	9W			NE	SW	O&G	70	1180	7506	8136	630	54	0.02	58		MISSP	MANNG					
6	20N	9W	NW	NE	NW	SE	O&G	70	1189	7477	8036	619	330	3.48	942	1	HUNTN				21	1	
7	20N	9W		S2	SE	NW	O&G	81	1172	7516	8126	610	4		4	1	MISSP				43	1	1
7	20N	9W			NW	NW	O&G	70	1183	7565	8198	632	186	0.72	313	1	MISSP						
7	20N	9W			SW	NE	O&G	69	1180	7500	8106	606	17		17	1	MISSP						
7	20N	9W			NE	NE	O&G	72	1184	7506	8100	594	61	0.32	117	1	MISSP	MANNG			58	2	
7	20N	9W			NW	SW	O&G	71	1172	7436	8116	620	13		13	1	MISSP	HUNTN			22	1	1
7	20N	9W		W2	SE	SW	O&G	81					6		6		MISSP						
7	20N	9W			SW	SE	O&G	69	1185	7514	8122	608	92	0.15	118	1	HUNTN				30	1	1
8	20N	9W			NE	NW	O&G	71	1202	7503	8104	601	38	0.06	49	1	MISSP				32	1	
8	20N	9W			NE	NE	O&G	70	1221	7508	8118	610	129		129	1	MISSP	HUNTN			61	1	
8	20N	9W			SE	NE	O&G	79	1214	7498	8094	596	11	0.07	23	1	MISSP	MANNG			46	1	
8	20N	9W			NW	SW	O&G	70	1187	7528	8104	576	24		24	1	MISSP				70	1	
8	20N	9W			SE	SW	O&G	79	1205	7512	8102	590	27	0.23	67	1	MISSP				132	1	
8	20N	9W			NW	SE	O&G	65	1209	7530	8112	582	80		80	1	MISSP				26	2	2

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
8	20N	9W			SE	SE	O&G	78	1215	7471	8052	581	31	0.33	89	1	MISSP				12	1	
9	20N	9W			NW	NW	O&G	71	1218	7497	8035	598	36	0.63	147	1	HUNTN				70	1	1
9	20N	9W	N2	NW	SW	NE	DRY	70	1221	7490	8086	596											
9	20N	9W		S2	SE	NE	O&G	86	1229	7452	8054	602	4		4	1	MISSP				16	1	
9	20N	9W		NW	NW	NE	DRY	72	1221	7490	8088	598				1							
9	20N	9W			NE	SW	O&G	65	1219	7450	8026	576				1	MISSP				4	1	
9	20N	9W			S2	S2	O&G	68	1225	7468	8058	590	13	0.91	173	1	MISSP				92	1	1
9	20N	9W			SE	SE	O&G	85	1224	7400	7988	588	10	0.58	112	1	MISSP	HUNTN			66	1	
10	20N	9W			SE	NW	O&G	63	1233	7380	7980	600	1		1	1	MISSP				18	2	
10	20N	9W			NE	NW	O&G	77	1243	7428	8030	602	6	0.35	68	1	MISSP	MANNG			11	1	
10	20N	9W		SW	SW	NW	O&G	86	1224	7433	8030	597	2	0.02	6	1	MISSP				62	1	
10	20N	9W			NE	NE	O&G	79	1237	7336	7940	604	3	0.45	82	1	MISSP				20	1	
10	20N	9W			SW	SW	O&G	69	1230	7381	7961	580	6	1.00	182	1	MISSP				8	1	
10	20N	9W			NE	SE	O&G	76	1241	7350	7944	594	8	0.17	38	1	MISSP	MANNG			1	1	
11	20N	9W			SW	NW	O&G	77	1243	7340	7934	594	8		8	1	MISSP				78	1	
11	20N	9W			NE	NE	O&G	76	1266	7322	7912	590	4		4	1	MISSP				138	1	
11	20N	9W			SW	SW	O&G	77	1249	7378	7960	582	4	0.42	78	1	MISSP	MANNG			26	1	
11	20N	9W			NE	SW	O&G	62	1247	7356			5		5	1	MISSP	MANNG					
11	20N	9W	E2	W2	NE	SE	O&G	77	1265	7360	7944	584	4	0.14	29	1	MISSP	MANNG			24	1	
12	20N	9W			SW	NW	O&G	76	1269	7340	7932	592	9	0.19	42	1	MISSP	MANNG			2	1	
12	20N	9W		SW	SW	NE	O&G	77	1274	7338	7954	616	2	0.01	4	1	MISSP	MANNG			17	1	
12	20N	9W			NE	NE	O&G	70					2		2		MISSP						
12	20N	9W			NE	SW	O&G	69	1274	7364	7992	628	2		2	1	MISSP				38	1	
12	20N	9W			SW	SW	O&G	78	1269	7367	7972	605	4	0.12	25	1	MISSP	MANNG			3	1	
12	20N	9W			NE	SE	O&G	69	1273	7336	7950	614	3		3	1	MISSP				87	1	
12	20N	9W			SW	SE	O&G	80	1282	7368	7990	622	4	0.19	37	1	MISSP				14	1	1
13	20N	9W			SW	NW	O&G	81	1259	7386	8004	618	5		5	1	OSWGO				20	1	
13	20N	9W			NE	NW	O&G	69	1261	7370	7980	610	3	0.03	8	1	MISSP				126	1	1
13	20N	9W	W2	E2	SW	SW	O&G	80	1253	7430	8022	592	2		2	1	MISSP				36	1	1
13	20N	9W			SW	SE	O&G	81	1259	7431	8005	574	1		1		MISSP	HUNTN					
13	20N	9W			NE	SE	O&G	80	1257	7412	8000	588	2	0.10	20	1	MISSP				16	1	1
14	20N	9W			NW	NW	O&G	78	1245	7390	7980	590	34	0.25	78	1	MISSP	MANIG					
14	20N	9W			SW	NW	O&G	68	1236	7398	8003	605	12		12	1	MISSP				2	1	
14	20N	9W			NW	NE	O&G	78	1258	7375	7964	589	8	0.14	33	1	MISSP	MANNG					
14	20N	9W		E2	E2	SW	O&G	81	1247	7406	7986	580	31	2.13	406	1	HUNTN				58	1	
14	20N	9W			SW	SW	O&G	73	1241	7410			3		3		MISSP						
14	20N	9W	E2	SW	SW	SE	O&G	80	1242	7380	7980	600	34	2.20	421	1	HUNTN				39	1	
14	20N	9W			NE	SE	O&G	69	1240	7376	7960	584	17		17	1	MISSP				11	1	1
15	20N	9W	N2	S2	SE	NW	O&G	70	1231	7410	8000	590	19	0.77	155	1	MISSP				26	1	
15	20N	9W				NE	O&G	78	1235	7408	8004	596	4	0.25	48	1	MISSP				11	1	
15	20N	9W				SW	O&G	82	1230	7448	8039	591	13	1.24	231	1	HUNTN				44	1	
15	20N	9W	NE	NE	SW	SE	O&G	83	1234	7436	8022	586	1	0.03	6	1	MISSP				48	1	
16	20N	9W	NW	NE	SE	NW	O&G	76	1221	7458	8042	584	80	0.73	208	1	HUNTN				21	1	1
16	20N	9W		NE	SE	NW	O&G	84									INOLA						
16	20N	9W			NW	NW	O&G	62	1228	7450	8034	584		0.86	151	1	MISSP	HUNTN			6	4	1
16	20N	9W	NE	NE	SW	NE	O&G	80	1235	7420	8002	582	43	0.09	59	1	HUNTN				28	1	
16	20N	9W			NE	SW	O&G	65	1222	7450	8028	578	271	5.34	1211	1	MISSP	HUNTN			14	2	2
16	20N	9W		SE	NW	SE	O&G	81	1244	7450	8024	574	8	0.48	92	1	MISSP					1	1
17	20N	9W			SE	SW	O&G	67	1201	7414	8012	598	35	0.22	74	1	MISSP						
17	20N	9W			NW	NW	O&G	67	1195	7518	8102	584	78	0.26	124	1	MISSP				19	2	2
17	20N	9W			SW	NE	O&G	64	1205	7442	8046	604	118	0.25	162	1	MISSP						
17	20N	9W			NW	SW	O&G	72	1200	7452	8075	623	41	0.14	66	1	MISSP						
17	20N	9W			NE	SE	O&G	70	1210	7450	8046	596	15	0.35	77	1	MISSP	MANNG			42	1	
18	20N	9W			SE	NW	O&G	82	1208	7510	8112	602	5		5	1	MISSP				84	2	
18	20N	9W			NW	NW	O&G	69	1193	7526	8122	596	31		31	1	MISSP				102	2	1
18	20N	9W			SW	NE	O&G	68	1198	7545	8145	600	73		73	1	MISSP				24	4	1

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
18	20N	9W			NW	SW	O&G	69	1207	7464	8060	596	109	1.25	329	1	MISSP	HUNTN			42	1	1
18	20N	9W		S2	W2	SE	O&G	68	1210	7476	8092	616	80	0.30	133	1	MISSP				10	4	
19	20N	9W			NW	NW	O&G	70	1206	7508	8106	598	12		12	1	MISSP						
19	20N	9W			NF	NE	O&G	82	1210	7468	8072	604	3	0.07	15	1	MISSP	HUNTN			68	1	
19	20N	9W			SE	SW	O&G	81	1212	7550	8138	588	7	0.05	16	1	MISSP				81	1	
19	20N	9W			NW	SE	O&G	67	1201	7519			10		10		MISSP						
20	20N	9W	SE	SW	NE	NW	O&G	76	1241	7476	8072	596	5		5	1	MISSP				60	1	
20	20N	9W		SW	NE	NW	O&G	81						1.21	213		RDFRK						
20	20N	9W		NE	SW	NE	O&G	70	1207	7444	8038	594	14		14	1	MANNG				8	1	1
21	20N	9W	SW	NE	NE	NW	O&G	69	1218	7440	8024	584	13	0.08	27	1	MISSP				4	1	1
21	20N	9W			SW	NE	O&G	66	1219	7450	8036	586	25		25	1	MISSP				24	1	
21	20N	9W		SW	NE	NE	DRY	67	1232	7450	8038	588				1						2	1
21	20N	9W			NW	SW	O&G	83	1207	7454	8044	590				1	MISSP	MANNG			34	1	
21	20N	9W			SE	SW	O&G	79	1216	7476	8071	595	3	0.02	7	1	MISSP	MANNG	OSWGO		24	1	
21	20N	9W			SE	SE	O&G	80	1215	7491	8091	600	2		2	1	MISSP				12	1	
22	20N	9W	SE	SW	SE	NW	O&G	77	1223	7450	8038	588	8	0.34	68	1	MISSP				21	1	
22	20N	9W			NE	NE	O&G	78	1231	7438	8040	602	4		4	1	MISSP				91	1	
23	20N	9W		SE	NE	NW	O&G	78	1228	7401	8014	613	50	1.68	346	1	HUNTN				30	1	1
23	20N	9W			SW	NE	O&G	78	1233	7406	7984	578	65	1.47	324	1	HUNTN				34	1	1
23	20N	9W			NE	SW	O&G	80	1234	7434	8054	620	4	0.67	122	1	MISSP				43	1	
23	20N	9W	N2	S2	NE	SE	O&G	69	1225	7405	7986	581	45	0.07	57	1	MISSP				51	2	1
23	20N	9W		N2	NE	SE	O&G	82	1240	7420	7990	570	16	0.86	167	1	HUNTN				59	1	
24	20N	9W			W2	NW	O&G	82	1231	7400	7993	599	1		1	1	MISSP				34	1	
24	20N	9W			NE	SW	O&G	77	1239	7424	8020	596	12	0.46	93	1	MISSP	HUNTN			3	1	
25	20N	9W				NW	O&G	78	1226	7440	8032	592	19		19	1	HUNTN				22	1	
25	20N	9W			SW	NE	O&G	69	1240	7446	8046	600	5		5	1	MISSP				1	1	
25	20N	9W			NE	SW	DRY	69	1225	7452	8064	612											
25	20N	9W			SE	SW	DRY	75	1228							1							
25	20N	9W		SE	SW	SE	O&G	82	1233	7484	8074	590	19		19	1	MISSP	HUNTN			18	1	
26	20N	9W			NE	NW	O&G	79	1231				13	0.18	45	1	MISSP				62	1	
26	20N	9W			NE	NE	O&G	79	1223	7431	8032	601	4		4		MISSP						
26	20N	9W			SW	SW	O&G	84	1220	7508	8116	608	8		8	1	MISSP	MANNG			58	1	
26	20N	9W		SE	SE	SW	O&G	84	1224	7478	8068	590	49	0.11	68	1	HUNTN				20	1	1
26	20N	9W		W2	NE	SE	O&G	77	1223	7474	8058	584	5	0.01	7	1	MISSP	MANNG			2	1	
27	20N	9W			NW	NE	O&G	81	1217	7484	8074	590	3		3	1	MISSP	OSWGO			32	1	
27	20N	9W		N2	SW	NW	O&G	85	1218	7481	8070	589	4		4	1	MISSP	OSWGO			40	1	
27	20N	9W	SW	NE	NE	NE	O&G	79	1229	7460	8050	590	2		2	1	MISSP	MANNG			42	1	1
27	20N	9W		SW	SW	SW	O&G	75	1202	7513	8092	579	6		6	1	MISSP	OSWGO			29	1	
28	20N	9W			SE	NW	O&G	75	1212	7430	8086	596	13		13	1	MISSP	OSWGO	MANNG		18	1	
28	20N	9W		SW	NW	NE	O&G	81	1210	7464	8054	590	5	0.03	10	1	MISSP				86	1	
28	20N	9W			NW	SW	O&G	79	1197	7488	8076	588	14	0.13	37	1	MISSP	OSWGO	MANNG		24	1	
28	20N	9W			SE	SE	O&G	81	1211	7523	8114	591	2	0.06	13	1	MISSP	OSWGO			4	1	
28	20N	9W			NW	SE	O&G	80	1210	7488	8104	616	4	0.41	76		MISSP	OSWGO	MANNG				
29	20N	9W			SW	NW	O&G	81	1204	7540	8144	604	3	0.46	84	1	MISSP	INOLA			72	1	
29	20N	9W			NE	NE	O&G	73	1201	7470	8072	602	46	0.33	104	1	MISSP	MANNG			6	1	1
29	20N	9W	W2	W2	NF	SW	O&G	78	1200	7528	8118	590	4	0.40	74	1	MISSP	OSWGO	MANNG		68	1	
29	20N	9W		SE	SL	SE	O&G	84	1191				1	0.01	3		MISSP	MANNG					
30	20N	9W				NE	O&G	82	1199	7546	8134	588	6	0.03	11	1	MISSP	MANNG			80	1	
30	20N	9W			NW	SE	O&G	75	1185	7515	8118	603	15	2.44	444	1	MISSP	OSWGO	MANNG	HUNTN	98	2	1
31	20N	9W			SE	NW	O&G	72	1134	7541	8134	593	24		24	1	MISSP	OSWGO	MANNG				
31	20N	9W			SE	SW	O&G	73	1128				19		19		OSWGO						
31	20N	9W	N2	S2	NW	SE	O&G	72	1133	7548	8164	616	63	0.90	221	1	OSWGO						
32	20N	9W			NW	NW	O&G	81	1187	7542	8150	608	7	0.08	21	1	MISSP	MANNG			52	1	
32	20N	9W			SE	NW	O&G	81	1164	7546	8140	594	4		4	1	MISSP	HUNTN			44	1	
32	20N	9W			SE	NE	O&G	81	1189	7528	8134	606	8	0.05	17	1	MISSP	MANNG			26	1	
32	20N	9W	NW	SE	NW	SW	O&G	73	1153								OSWGO						

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
32	20N	9W			SE	SW	O&G	81	1146	7548	8144	596	4	0.02	8	1	MISSP				50	1	
32	20N	9W			SE	SE	O&G	74	1171	7558	8154	596	5		5	1	MISSP	OSWGO	RDFRK	MANNG	5	1	
33	20N	9W			NW	NW	O&G	81	1194	7498	8084	586	17	0.96	186	1	HUNTN				12	1	
33	20N	9W		SE	SE	NW	O&G	73	1176								OSWGO						
33	20N	9W			SW	NE	O&G	72	1190				1	0.12	22		OSWGO						
33	20N	9W			NE	NE	O&G	69	1193	7506	8100	594	2		2	1	MISSP	HUNTN			2	1	
33	20N	9W		NW	NE	SW	O&G	82					1		1	1	MISSP	MANNG	HUNTN				
33	20N	9W			SE	SW	O&G	73	1178	7557	8150	593	7	0.55	104	1	OSWGO				12	1	
33	20N	9W			SE	SE	O&G	73	1177	7552	8136	584	4	0.61	111		OSWGO						
34	20N	9W			SE	NW	O&G	77	1204	7522	8108	586	10	0.14	35	1	MISSP	MANNG	HUNTN		34	1	
34	20N	9W		SW	SE	NE	O&G	85	1198	7504	8096	592	3	0.04	10	1	HUNTN				48	1	
34	20N	9W		N2	SE	SW	DRY	85	1197	7530	8128	598				1					27	1	
34	20N	9W			NE	SW	O&G	73	1203	7536	8120	584	15	0.15	41	1	MISSP	OSWGO			116	2	
34	20N	9W			SW	SE	O&G	73	1202	7563	8146	583					HUNTN						
34	20N	9W			SE	SE	O&G	74	1181	7556	8142	586	149	0.20	184	1	MANNG	HUNTN			51	1	
35	20N	9W	NE	SW	SW	NW	O&G	75	1206				1	0.42	75		OSWGO						
35	20N	9W			SW	NW	O&G	69	1205	7488	8084	596	1		1	1	MISSP	MANNG			28	1	
35	20N	9W			SE	NW	O&G	86	1216	7502	8100	598				1	MISSP				16	1	
35	20N	9W		SW	SW	NE	DRY	74	1210	7506													
35	20N	9W			NW	NE	O&G	84	1216	7472	8063	591	3	0.06	14		MISSP	MANNG	HUNTN				
35	20N	9W		SW	SW	NE	O&G	83	1214	7506	8084	578	18	0.30	71	1	VIOLA	SMPSN			12	1	
35	20N	9W			SE	NE	O&G	79	1218	7510	8100	590	7	0.04	14	1	MISSP				17	1	
35	20N	9W		W2	SW	SW	O&G	73	1198	7546	8116	570	201		201	1	HUNTN				68	1	1
35	20N	9W		SW	SE	SW	O&G	75	1205	7562	8116	554	203	0.11	222	1	HUNTN				128	1	
35	20N	9W			NW	SE	O&G	84	1225	7539	8118	579	1	0.12	22	1	SMPSN				26	1	
35	20N	9W			SW	SE	O&G	74	1206	7543	8100	557	5		5	1	MISSP	MANNG			80	1	1
36	20N	9W			NW	NW	O&G	84	1229	7498	8074	576	6	0.05	15	1	MISSP	OSWGO	MANNG		19	1	
36	20N	9W		S2	SE	NW	O&G	72	1212				5		5		OSWGO						
36	20N	9W			SW	NE	O&G	73	1229				1	0.54	96	1	OSWGO						
36	20N	9W			NE	SW	O&G	71	1218	7530	8094	564	10	0.81	153	1	OSWGO				134	2	
36	20N	9W			SW	SW	O&G	81	1221	7546	8104	558	2		2	1	MISSP	OSWGO	MANNG		2	1	
36	20N	9W		SW	NE	SE	O&G	80	1221	7510	8085	575					MISSP	HUNTN					
35	20N	9W			NE	NW	LOC	86	1215	7430	8082	592				1	MISSP				6	1	
1	21N	7W		NE	NE	NW	O&G	65	1288	6522	7093	571	28	1.38	271	1	MISSP				10	2	
1	21N	7W	N2	S2	NE	SW	O&G	78	1263	6518	7074	556		0.82	144	1	MISSP				13	3	
2	21N	7W			NE	NE	O&G	68	1301	7042	7674	632	5	0.08	19	2	MISSP						
2	21N	7W		NE	NE	SW	DRY	24															
3	21N	7W			NW	NW	O&G	77	1136	6678	7268	590				2	MISSP						
3	21N	7W			NW	NE	O&G	77	1304	6654	7283	629				2	MISSP						
3	21N	7W			NE	SW	O&G	66	1300	6662			39	0.52	131	1	MISSP					3	
4	21N	7W			SE	NW	O&G	65	1281	6692	7312	620	185	1.10	379	1	MISSP				104	1	
4	21N	7W			NW	NW	O&G	75	1277	6708	7384	676				2	MISSP						
4	21N	7W			SE	NE	O&G	66	1285	6668			90	0.70	213	2	MISSP						
4	21N	7W			NW	NE	O&G	76	1296	6677	7279	602				1	MISSP				78	1	
4	21N	7W		E2	NW	SW	O&G	78	1264	6734			56	0.58	158	2	MISSP						
4	21N	7W			SE	SW	O&G	66	1257	6701	7296	595	56	0.20	91	2	MISSP	HUNTN					
4	21N	7W			SE	SE	O&G	66	1274	6696	7270	574				1	MISSP				19	1	
4	21N	7W	E2	W2	NW	SE	O&G	76	1272	6678	7272	594	121	0.80	262	1	MISSP				24	1	
5	21N	7W			SE	NW	O&G	67	1239	6682	7298	616	194	2.10	564	1	MISSP				36	2	
5	21N	7W	N2	S2	NW	NW	O&G	77	1214	6645						2	MISSP						
5	21N	7W			SE	NE	O&G	67	1267	6714	7348	634				1	MISSP				78	1	
5	21N	7W	S2	N2	NW	NE	O&G	77	1240	6686	7324	638				1	MISSP				80	1	
5	21N	7W			NW	SW	O&G	77	1220	6671	7276	605				1	MISSP					3	
5	21N	7W			SE	SW	O&G	76	1220	6705	7341	636				2	MISSP						
5	21N	7W			SE	SE	O&G	66	1252	6712	7332	620	303	1.40	549	2	MISSP						
5	21N	7W			NW	SE	O&G	76									MISSP						

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
6	21N	7W			SE	NW	O&G	66	1200	6644	7252	608	325	4.10	1047	1	MISSP				9	1	
6	21N	7W	S2	N2	NW	NE	O&G	79	1216							2	MISSP						
6	21N	7W	SE	NW	SE	SW	O&G	76	1208	6679	7285	606				2	MISSP						
6	21N	7W	NW	SE	NW	SW	O&G	77	1186	6663	7269	606				2	MISSP						
6	21N	7W			SE	SE	O&G	76	1215	6693	7356	663				2	MISSP						
6	21N	7W	W2	E2	NW	SE	O&G	77	1207							2	MISSP						
7	21N	7W			SE	NW	O&G	74	1197	6680			238	0.86	389	2	MISSP						
7	21N	7W			NW	NW	O&G	66	1182	6664						2	MISSP						
7	21N	7W			SE	NE	O&G	75	1213	6732	7294	562				2	MISSP						
7	21N	7W			NW	NE	O&G	67	1201	6691	7274	583	172	1.16	376	2	MISSP						
7	21N	7W			SE	SW	O&G	75	1171							2	MISSP						
7	21N	7W			NW	SW	O&G	65	1168	6630	7312	682	264	0.48	348	1	MISSP				154	2	
7	21N	7W			NW	SE	O&G	65	1182	6696	7342	646	250	0.58	352	2	MISSP						
7	21N	7W			SE	SE	O&G	74									MISSP						
8	21N	7W			NE	SE	O&G	66	1250	6739	7368	629	300	0.64	413	1	MISSP	HUNTN			18	2	2
8	21N	7W			SW	SE	O&G	75	1250	6752	7376	624	54		54	2	MISSP	HUNTN					
8	21N	7W			NW	SE	O&G	87					7		7		MISSP						
8	21N	7W		S2	SW	NE	O&G	74								2	MISSP						
8	21N	7W			SE	NE	O&G	66	1219	6699	7360	661	248	0.10	266	2	MISSP						
8	21N	7W			NW	SW	O&G	65	1225	6726	7325	599	337	0.70	460	1	MISSP				114	1	
8	21N	7W	W2	E2	SE	SW	O&G	74	1240	6744						2	MISSP						
8	21N	7W			NW	NW	O&G	66	1225	6706	7288	582				2	MISSP	OSWGO					
8	21N	7W			SE	NW	O&G	74	1232	6733	7362	629	422	2.00	774	2	MISSP						
9	21N	7W			SW	NW	O&G	65	1250	6727	7330	603	462	0.60	568	1	MISSP	HUNTN			165	1	
9	21N	7W			NE	NW	O&G	73	1258	6704						2	MISSP	OSWGO					
9	21N	7W			NW	SW	O&G	66	1246	6739	7398	659	253	0.84	407	1	MISSP				57	2	2
9	21N	7W			SW	SW	O&G	75	1270	6775						1	MISSP						
9	21N	7W			SW	SE	O&G	66	1242	6710	7349	639	214	0.86	365	1	MISSP				88	1	
9	21N	7W	W2	E2	NE	SE	O&G	75								2	MISSP						
9	21N	7W			SW	NE	O&G	66	1249	6711	7310	599	106	0.42	180	2	MISSP						
9	21N	7W			NE	NE	O&G	81	1265	6770			12		12	2	MISSP						
10	21N	7W			SW	NE	O&G	66	1266	6648	7266	618		0.23	40	2	MISSP						
10	21N	7W	NE	SW	NE	NE	O&G	77	1284	6652			47	0.76	181	2	MISSP						
10	21N	7W			NW	NW	O&G	76	1285	6690	7272	582	39	0.24	81	1	MISSP				116	1	
10	21N	7W			SW	NW	O&G	67	1259	6686			41		41	1	MISSP				6	1	
10	21N	7W			SW	NW	O&G	66	1257	6706	7340	634	78	0.13	101	1	MISSP				8	2	
10	21N	7W			NE	SW	O&G	81	1264	6748			4		4	2	MISSP						
10	21N	7W			SW	SE	O&G	66	1253	6667	7274	607	40		40	1	MISSP				56	1	
10	21N	7W			NE	SE	O&G	75	1272	6650	7260	610	8		8	1	MISSP				42	1	
11	21N	7W			NW	NE	O&G	66	1236	6622	7082	460	28	1.14	229	2	MISSP	HUNTN					
11	21N	7W			SE	NE	O&G	81	1240	6512	7086	574	6	0.17	36	1	MISSP				35	1	1
11	21N	7W			SE	NW	O&G	81	1290	6635	7241	606	3		3	2	MISSP						
11	21N	7W	SW	SW	NW	NW	O&G	82	1284	6684	7302	618	1		1	1	MISSP	RDFRK			37	1	
11	21N	7W			SW	SW	O&G	66	1278	6662	7274	612	90	1.04	273	1	MISSP				52	2	
11	21N	7W			NE	SW	O&G	76	1276	6652	7272	620				1	MISSP				60	1	
11	21N	7W			SW	SE	O&G	65	1237	6604	7234	630	95	0.32	151	1	MISSP				74	2	1
11	21N	7W			NE	SE	O&G	76	1240	6550	7148	598				1	MISSP				42	1	
12	21N	7W		NE	SE	NE	DRY	55	1236	6465	7052	587				1					23	4	1
12	21N	7W			NE	NE	O&G	79	1247	6494			23	0.60	129	2	MISSP						
12	21N	7W				SE	O&G	85	1209	6473			1	0.04	8	1	MISSP					1	
12	21N	7W		SE	SE	NW	O&G	65	1219	6478	7046	568	41	2.47	476	1	MISSP				12	2	
12	21N	7W			SE	SW	O&G	75	1220	6514	7064	550	15	0.48	99	2	MISSP						
13	21N	7W			NE	NE	O&G	65	1206	6459	7020	561	104	0.50	192	1	MISSP				25	2	
13	21N	7W			SW	NE	O&G	75	1220	6544	7130	586	13	0.27	61	1	MISSP				102	1	
13	21N	7W			SW	NW	O&G	65	1233	6614	7224	610	128	1.16	332	1	MISSP				40	2	2
13	21N	7W	E2	W2	NE	NW	O&G	76	1204	6537	7098	561				2	MISSP						

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EGOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
13	21N	7W			NE	SE	O&G	65	1213	6534	7112	578	23		23	1	MISSP				50	1	
13	21N	7W			SW	SE	O&G	77	1229	6607			14	0.18	46	2	MISSP						
13	21N	7W			NE	SW	O&G	65	1222	6594	7186	592	122	0.20	157	1	MISSP				12	2	
13	21N	7W			SW	SW	O&G	75	1247	6644						1	MISSP						
14	21N	7W			SW	NW	O&G	65	1258	6678	7292	614	113		113	2	MISSP						
14	21N	7W			NE	NW	O&G	76	1261	6670				0.70	123	2	MISSP						
14	21N	7W			SW	NE	O&G	65	1248	6646	7275	629	176		176	1	MISSP				46	2	
14	21N	7W			NE	NE	O&G	75	1230	6612	7225	613		0.23	40	1	MISSP				3	2	
14	21N	7W			NW	SW	O&G	65	1239	6650	7268	618	234		234	2	MISSP						
14	21N	7W			SW	SW	O&G	75	1236	6692	7290	598		0.46	81	1	MISSP				62	2	
14	21N	7W			NE	SE	O&G	65	1232	6630	7245	615	134	0.26	180	1	MISSP				53	1	
14	21N	7W			SW	SE	O&G	76	1242	6666						2	MISSP						
15	21N	7W			SW	NW	O&G	66	1225	6702			165	0.40	235	2	MISSP						
15	21N	7W	NE	SW	NE	NW	O&G	75	1243	6698	7315	617				2	MISSP						
15	21N	7W			SW	NE	O&G	66	1243	6700	7318	618	137	0.23	177	1	MISSP				28	2	
15	21N	7W			NE	NE	O&G	75	1246	6743						2	MISSP						
15	21N	7W			SW	SW	O&G	66	1223	6714	7346	632	178		178	1	MISSP				11	2	
15	21N	7W			NE	SW	O&G	75	1231	6811				0.50	88	2	MISSP						
15	21N	7W			SW	SE	O&G	65	1227	6696	7327	631	234	0.40	304	1	MISSP				33	1	
15	21N	7W			NE	SE	O&G	75	1227	6710	7334	624				2	MISSP						
16	21N	7W			NW	NW	O&G	66	1263	6775	7410	635	375	0.75	507	1	MISSP				32	2	
16	21N	7W			SE	NW	O&G	75	1248	6750	7368	618				2	MISSP						
16	21N	7W			SE	NE	O&G	66	1243	6718	7336	618	324	0.70	447	1	MISSP				9	2	
16	21N	7W	N2	S2	NW	NE	O&G	76	1239	6726	7357	631				1	MISSP						
16	21N	7W			SE	SW	O&G	66	1234	6682	7396	714	203	0.30	256	1	MISSP				62	1	
16	21N	7W			NW	SW	O&G	75	1227	6758	7378	620				1	MISSP				66	1	
16	21N	7W			NW	SE	O&G	66	1217	6714			249	0.40	319	1	MISSP						
16	21N	7W	N2	N2	SE	SE	O&G	75	1221	6736						2	MISSP						
17	21N	7W			SE	NW	O&G	65	1238	6776	7426	650	298	0.40	368	1	MISSP				143	1	
17	21N	7W			NW	NW	O&G	75	1221	6760	7400	640				1	MISSP				156	1	1
17	21N	7W	E2	NW	SE	NE	O&G	75	1235	6754	7376	622				2	MISSP						
17	21N	7W			NW	NE	O&G	66	1236	6757	7404	647	253	0.40	323	2	MISSP						
17	21N	7W			NW	SW	O&G	66	1219	6771			254	0.50	342	1	MISSP				8	2	
17	21N	7W			SE	SW	O&G	75	1216	6778	7402	624				2	MISSP						
17	21N	7W		NE	NE	SE	O&G	66	1219	6760	7365	605	97	1.30	326	2	MISSP						
17	21N	7W		S2	NW	SE	O&G	75	1220	6766	7392	626				2	MISSP						
18	21N	7W			NW	NW	O&G	64	1166	6632	7324	632				1	MISSP				11	2	
18	21N	7W			SE	NW	O&G	75	1169	6772						2	MISSP						
18	21N	7W			SE	SW	O&G	76	1162	6742	7392	650				2	MISSP						
18	21N	7W			NW	SW	O&G	65	1164	6712	7353	641	145	1.00	321	1	MISSP				12	2	2
18	21N	7W			NW	NE	O&G	64	1211	6762	7396	634	373	0.30	426	2	MISSP						
18	21N	7W			SE	NE	O&G	75	1208	6756	7393	637				1	MISSP				29	2	
18	21N	7W			NW	SE	O&G	65	1222	6778	7438	660	227	0.40	297	1	MISSP				121	1	
18	21N	7W			SE	SE	O&G	75	1232	6800	7440	640				2	MISSP						
19	21N	7W			NW	NW	O&G	66	1158	6778	7403	625	111	0.24	153	1	MISSP				13	2	2
19	21N	7W			SE	NW	O&G	76	1148	6748	7383	635				2	MISSP						
19	21N	7W			NW	SW	O&G	67	1169	6790	7422	632	120		120	1	MISSP				25	2	2
19	21N	7W			SE	SW	O&G	75	1163	6908						2	MISSP						
19	21N	7W			NW	SE	O&G	66	1155	6760			142	0.50	230	1	MISSP						
19	21N	7W			SE	SE	O&G	77	1185	6820	7423	603				2	MISSP						
19	21N	7W			NW	NE	O&G	65	1217	6804	7444	640	110	1.60	392	1	MISSP	OSWGO			67	1	
19	21N	7W	E2	W2	SE	NE	O&G	75	1222	6810	7449	633				2	MISSP						
20	21N	7W	S2	N2	SE	NW	O&G	76	1214	6787	7430	643				2	MISSP						
20	21N	7W			NW	NW	O&G	65	1219	6784	7426	642	74	0.25	118	1	MISSP						
20	21N	7W			SE	NE	O&G	65	1211	6761	7400	639	110	0.25	154	2	MISSP						
20	21N	7W	E2	W2	NW	NE	O&G	76	1209	6752	7420	668				1	MISSP				57	2	

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSIGO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
20	21N	7W			NW	SW	O&G	66	1183	6778	7405	627	102	0.75	234	1	MISSP				9	2	2
20	21N	7W			SE	SW	O&G	76	1172	6648						2	MISSP						
20	21N	7W			SE	SE	O&G	66	1197	6793	7416	623	72	0.40	142	1	MISSP				9	2	2
20	21N	7W			NW	SE	O&G	76	1184	6662						2	MISSP						
21	21N	7W			NW	NW	O&G	66	1227	6769	7408	639	63	0.20	98	2	MISSP						
21	21N	7W			SE	NW	O&G	76	1221	6768	7392	624	14	0.14	39	1	MISSP						
21	21N	7W			SE	NE	O&G	65	1219	6759	7388	629	59	0.25	103	2	MISSP						
21	21N	7W	W2	E2	NW	NE	O&G	76	1210	6732	7362	630	32	0.60	138	2	MISSP						
21	21N	7W			NF	SW	O&G	62	1211	6790			4		4	1	MISSP						
21	21N	7W			NW	SW	O&G	66	1209	6778	7401	623	47	0.50	135	2	MISSP						
21	21N	7W	S2	N2	SE	SW	O&G	81	1212	6772	7392	620	3		3	1	MISSP				20	1	
21	21N	7W			SE	SE	O&G	66	1225	6782	7413	631	47	0.40	117	2	MISSP						
21	21N	7W			NW	SE	O&G	81	1210	6733	7348	615	5		5	1	MISSP				74	1	
22	21N	7W	NW	SE	NW	NE	O&G	76	1228	6704	7357	653				2	MISSP						
22	21N	7W			SE	NE	O&G	66	1235	6735			127	0.50	215	2	MISSP						
22	21N	7W			SE	NW	O&G	65	1226	6744	7380	636	42		42	1	MISSP				46	2	
22	21N	7W			NW	NW	O&G	74	1213	6714			61	0.32	117	2	MISSP						
22	21N	7W			NW	SW	O&G	66	1242	6760	7386		72	0.30	125	1	MISSP				35	2	
22	21N	7W			SE	SE	O&G	67	1254	6778			27	0.25	71	1	MISSP				8	2	2
23	21N	7W			NW	NW	O&G	66	1244	6723	7320		170	0.50	258	1	MISSP				67	1	
23	21N	7W			SE	NW	O&G	75	1252	6728						2	MISSP						
23	21N	7W			NW	NE	O&G	66	1253	6684	7299	615	136	0.80	277	1	MISSP				44	2	
23	21N	7W			SE	NE	O&G	76	1285	6708	7342	634				2	MISSP						
23	21N	7W			SE	SE	O&G	76	1251	6622						2	MISSP						
23	21N	7W			NW	SE	O&G	66	1256	6732	7347	618	66	0.60	172	1	MISSP				26	2	2
23	21N	7W			SE	SW	O&G	65	1260	6772	7330	618	42	0.20	77	1	MISSP				3	2	2
23	21N	7W			NW	SW	O&G	00	1251	6758	7374	616				2	MISSP						
24	21N	7W			NW	NW	O&G	66	1257	6662	7282	620	94		94	1	MISSP				23	2	2
24	21N	7W			SF	NW	O&G	76	1242	6653	7265	612	50	0.40	120	2	MISSP						
24	21N	7W			NW	NE	O&G	66	1242	6640			67		67	2	MISSP						
24	21N	7W			SW	SW	O&G	66	1254	6720			13		13	2	MISSP						
24	21N	7W	NW	NE	SF	SE	O&G	76	1228	6654			4	0.80	145	2	MISSP						
25	21N	7W			SE	SW	O&G	66	1251	6819	7356	537	1	0.10	19	1	MISSP	HUNTN			35	1	
25	21N	7W			SE	NE	O&G	65	1256	6743	7318	575	27		27	1	MISSP				53	2	
25	21N	7W			SE	SE	O&G	68	1242	6732	7326	594	24	1.50	288	1	MISSP				28	2	
26	21N	7W			SE	NW	O&G	65	1248	6820			104	0.40	174	1	MISSP						
26	21N	7W			NW	NW	O&G	78					11	0.20	46	2	MISSP						
26	21N	7W			SE	NE	O&G	66	1247	6790			25	0.70	148	1	MISSP				52	1	
26	21N	7W			NW	NE	O&G	77	1239	6805						1	MISSP					1	
26	21N	7W			SE	SW	O&G	65	1234	6947			144		144	2	MISSP						
26	21N	7W			NW	SW	O&G	77					24	0.30	77	2	MISSP						
26	21N	7W			SE	SE	O&G	66	1241	6804	7374	570	10		10	1	MISSP				54	2	
26	21N	7W			NW	SE	O&G	79	1239	6821			2		2	2	MISSP						
27	21N	7W			NW	NW	O&G	66	1245	6796			25	0.25	69	1	MISSP						
27	21N	7W			SE	NW	O&G	76	1244	6865			31	0.20	66	2	MISSP						
27	21N	7W			NW	NE	O&G	65	1257	6806	7424	618	73	0.80	214	2	MISSP						
27	21N	7W	SW	NE	SE	NE	O&G	77	1264	6842	7479	637				2	MISSP						
27	21N	7W			NW	SW	O&G	65	1244	6846			67	0.24	109	1	MISSP				18	1	
27	21N	7W			SE	SW	O&G	78	1228				18	0.10	36	2	MISSP						
27	21N	7W			NW	SE	O&G	65	1243	6855			99	0.35	161	2	MISSP						
27	21N	7W			SE	SE	O&G	78	1238	6888	7444	556	17	0.80	158	2	MISSP						
28	21N	7W			SE	NW	O&G	75	1213	6812	7426	614	28	0.14	53	2	MISSP						
28	21N	7W		S2	NW	NW	O&G	80	1192	6772	7396	624	4	0.10	22	2	MISSP						
28	21N	7W			NW	NE	O&G	66	1217	6792			66	0.50	154	1	MISSP						
28	21N	7W			SE	NE	O&G	77	1233	6822						2	MISSP						
28	21N	7W			SE	SW	O&G	61	1222	6892			48	0.38	115	1	MISSP	OSWGO				1	

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
28	21N	7W			NW	SW	O&G	79	1243	6870			13	0.60	119	2	MISSP						
28	21N	7W	N2	S2	SE	SE	O&G	76	1224	6890			53	0.30	106	2	MISSP						
28	21N	7W			NW	SE	O&G	66	1236	6836			73	0.80	214	1	MISSP				21	1	
29	21N	7W			SE	NW	O&G	65	1199	6816			45		45	2	MISSP						
29	21N	7W			NW	NW	O&G	79	1198	6810			5	0.10	23	2	MISSP						
29	21N	7W			SE	NE	O&G	67	1187				41		41	2	MISSP						
29	21N	7W		NW	NW	SW	O&G	78	1174	6830				0.17	30	2	MISSP	OSWGO					
29	21N	7W			SE	SW	O&G	67	1193	6862			43	0.16	71	2	MISSP						
29	21N	7W			SE	SE	O&G	67	1221	6880			96	0.80	237	2	MISSP						
29	21N	7W			NW	SE	O&G	77	1204							2	MISSP						
30	21N	7W			NE	NE	O&G	66					72	0.30	125	2	MISSP						
30	21N	7W			SW	NE	O&G	00									OSWGO						
30	21N	7W			NW	NW	O&G	76	1168	6876	7454	578	5		5	2	MISSP						
30	21N	7W			SE	NW	O&G	64	1188	6812	7450	638	105	0.30	158	1	MISSP				9	2	2
30	21N	7W	E2	W2	NW	SE	O&G	76	1168	6850	7460	610				1	MISSP				15	1	
30	21N	7W			SE	SE	O&G	66	1166	6850	7455	605	62	0.30	115	1	MISSP				178	1	
30	21N	7W			NW	SW	O&G	76	1160	6882			29		29	2	MISSP						
30	21N	7W			SE	SW	O&G	66	1162	6860			98	0.24	140	1	MISSP						
31	21N	7W			SE	NW	O&G	66	1166	6836			125	1.00	301	1	MISSP	OSWGO					
31	21N	7W			NW	NW	O&G	76	1180	6952			31	0.38	98	2	MISSP						
31	21N	7W			SE	NE	O&G	66	1160	6850			111	0.50	199	1	MISSP				6	2	
31	21N	7W			NW	NE	O&G	76	1160	6995			43		43	2	MISSP						
31	21N	7W			NW	SW	O&G	75	1181	6990			39	0.10	57	2	MISSP						
31	21N	7W			SE	SW	O&G	67	1162	6936			16		16	1	MISSP				3	2	
31	21N	7W			SE	SE	O&G	67	1155	6914			156	0.35	218	1	MISSP				23	2	2
31	21N	7W			NW	SE	O&G	76	1159	7015			33	0.10	51	2	MISSP						
32	21N	7W			SE	NW	O&G	65	1207	6892			95	0.32	151	2	MISSP	OSWGO					
32	21N	7W			NW	NW	O&G	77					16		16	2	MISSP						
32	21N	7W			SE	NE	O&G	67	1229	6930			66	0.50	154	1	MISSP				47	2	2
32	21N	7W			NW	NE	O&G	77	1206	6940						2	MISSP						
32	21N	7W			SE	SW	O&G	76	1158	6912			44	0.38	111	1	MISSP				37	2	2
32	21N	7W			SE	SW	O&G	67	1158	6878			50	0.60	156	2	MISSP						
32	21N	7W		S2	SE	SE	O&G	78	1200	6953			4		4	2	MISSP						
32	21N	7W		S2	NW	SE	O&G	77	1198	6950			19		19	2	MISSP						
33	21N	7W			SE	NW	O&G	67	1212	6894			40	0.82	184	1	MISSP	OSWGO					
33	21N	7W			SE	NE	O&G	67	1219	6874			56	1.30	285	1	MISSP				16	2	
33	21N	7W		NW	NW	NE	O&G	79	1226	6876			22		22	2	MISSP						
33	21N	7W			SE	SW	O&G	67	1208	6904			37	0.10	55	1	MISSP				6	2	2
33	21N	7W	NE	SW	NW	SW	O&G	80	1210							2	MISSP						
33	21N	7W			SE	SE	O&G	68	1225	6918	7508	590	87		87	1	MISSP				20	2	
33	21N	7W			NW	SE	O&G	78	1210	6910						2	MISSP						
34	21N	7W			NW	NW	O&G	68	1229	6858			99	0.18	131	1	MISSP				1	2	2
34	21N	7W			NW	NE	O&G	79	1241	6854			6	0.10	24	2	MISSP						
34	21N	7W			SE	NE	O&G	65	1232	6868			88		88	1	MISSP				55	1	
34	21N	7W		SW	SE	SW	O&G	68	1236	6894	7440	546	61	0.40	131	1	MISSP				14	2	
34	21N	7W			NE	SW	O&G	64	1223					1.40	246	1	OSWGO						
34	21N	7W			SE	SE	O&G	65	1237	6885			95		95	1	MISSP				18	1	
34	21N	7W			NW	SE	O&G	79	1241				16		16	2	MISSP						
35	21N	7W			SE	NW	O&G	65	1235	6860			51		51	1	MISSP						
35	21N	7W			NW	NW	O&G	78	1247	6860	7444	584	14	0.20	49	2	MISSP						
35	21N	7W			SE	NE	O&G	66	1231	6818	7416	598	16		16	1	MISSP				35	1	
35	21N	7W			NW	NE	O&G	79	1233	6850	7410	560	8		8	1	MISSP				28	1	
35	21N	7W		SE	SE	NE	DRY	80	1237	6809	7410	601											
35	21N	7W			NW	SW	O&G	78	1227	6830	7445	555	26	0.36	89	2	MISSP						
35	21N	7W			SE	SW	O&G	65	1239	6868			104		104	1	MISSP						
35	21N	7W			SE	SE	O&G	65	1218	6846	7424	578	79		79	1	MISSP				60	1	

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
35	21N	7W			E2	SE	O&G	80	1226	6832	7413	581	6	0.40	76	2	MISSP						
35	21N	7W			NW	SE	O&G	85								2	SKINR						
36	21N	7W			SE	NW	O&G	66	1228	6775			71	1.00	247	1	MISSP						
36	21N	7W			NW	NW	O&G	77	1245							2	MISSP						
36	21N	7W			NW	NE	O&G	80	1231	6747	7340	593	3		3	1	MISSP						1
36	21N	7W		W2	SE	NE	O&G	81	1243	6792	7351	559	6		6	1	SKINR						
36	21N	7W			SE	NE	O&G	65	1243	6809			71		71	2	MISSP						
36	21N	7W			SE	SW	O&G	66	1231	6840	7403	563	8		8	1	MISSP				20	2	2
36	21N	7W			NW	SW	O&G	78	1236	6837						2	MISSP						
36	21N	7W			NW	SE	O&G	83	1241	6818			3	0.30	56	1	SKINR						
36	21N	7W			SE	SE	O&G	66	1250	6816	7358	542	26	1.00	202	1	MISSP				45	1	
1	21N	8W			SE	NW	O&G	64	1201	6700	7332	632	10	2.09	378		MISSP						
1	21N	8W	N2	S2	SE	NE	O&G	77	1189	6664	7282	618	6		6	1	MISSP				46	1	
1	21N	8W	S2	N2	SE	SW	O&G	77	1185	6686	7300	614	33	0.09	49	1	MISSP				29	1	
1	21N	8W			SE	SE	O&G	76	1177	6662	7275	613	67	0.15	93	1	MISSP				24	1	
2	21N	8W			SE	NW	O&G	64	1245	6766	7356	590	40	3.73	696	1	MISSP						
2	21N	8W			SE	SE	O&G	79	1220	6720	7332	612	5	0.10	23	1	MISSP						
3	21N	8W			SE	NW	O&G	64					252		252		MISSP						
3	21N	8W			SE	NE	O&G	65					21	0.29	72		MISSP						
3	21N	8W			SE	SW	O&G	78	1200	6780	7360	580	29		29	1	MISSP				71	1	
3	21N	8W			SE	SE	O&G	79	1212	6750	7355	605	18			1	MISSP				70	1	
4	21N	8W			NW	NW	O&G	65	1202	6771	7382	611	25	1.78	338	1	MISSP						
4	21N	8W			SW	NE	O&G	65	1205	6769	7352	583	361	0.32	417	1	MISSP						
4	21N	8W			NE	SW	O&G	81	1202	6774	7372	598	15	0.03	20	1	MISSP				32	1	
4	21N	8W		NE	NE	SE	O&G	73	1197	6765	7349	584	47	0.25	91		MISSP						
5	21N	8W			S2	NW	O&G	83	1218	6798	7404	606	3		3	1	MISSP				34	1	
5	21N	8W			SW	NE	O&G	66	1205	6774	7372	598	85	1.48	345	1	MISSP						
6	21N	8W		S2	N2	NW	O&G	85	1226	6833	7410	577	35	0.21	72	1	MISSP				82	1	
6	21N	8W	N2	N2	S2	NE	O&G	81	1222	6816	7408	592	60	0.25	104	1	MISSP				8	1	
6	21N	8W		W2	NE	SW	O&G	65	1229	6854	7438	584	6	0.83	152	1	RDFRK						
6	21N	8W			N2	SE	O&G	84	1216	6832	7432	600	4	0.04	11	1	MISSP	RDFRK	HUNTN		58	1	
7	21N	8W	NW	NE	SE	NW	O&G	81	1217	6850	7446	596	12	0.05	21	1	MISSP				250	1	
7	21N	8W			SW	NE	O&G	75	1218	6854			54		54	1	MISSP						
7	21N	8W				SW	O&G	81	1227	6884			4		4		MISSP						
7	21N	8W			W2	SE	O&G	81	1209	6848	7452	604	2		2	1	MISSP				168	1	1
8	21N	8W			NE	NW	O&G	75	1206	6816	7436	620	36	0.10	54	1	MISSP				9	1	1
8	21N	8W				NE	O&G	82	1205	6800	7422	622	6		6	1	MISSP				92	1	
8	21N	8W			N2	SW	O&G	82	1202	6815	7432	617	5		5	1	MISSP				18	1	1
8	21N	8W		N2	N'	SE	O&G	81	1200	6804	7432	628	5		5	1	MISSP				146	1	
9	21N	8W				NE	O&G	76	1200	6796	7418	622	13	0.15	39	1	MISSP				37		
9	21N	8W			NW	SE	O&G	65	1203	6814	7438	624	8		8	1	MISSP				9	2	1
10	21N	8W			NE	NE	O&G	64	1208	6756	7360	604	28		28	1	MISSP						
10	21N	8W			NE	SW	O&G	64	1200	6782	7430	648	69		69	1	MISSP						
10	21N	8W				NW	O&G	77	1195	6788	7374	586				1	MISSP						
10	21N	8W			NE	SE	O&G	00									MISSP						
11	21N	8W		NW	SE	NW	O&G	77					51	0.25	95		MISSP						
11	21N	8W			SE	SE	O&G	78	1234	6770	7412	642	16	0.15	42	1	MISSP				45	1	
11	21N	8W			NW	SE	O&G	64	1217	6756	7418	662				1	MISSP					2	2
11	21N	8W			SE	NE	O&G	78	1215	6732	7351	619	24	0.48	108	1	MISSP				88	1	
11	21N	8W			NW	NE	O&G	65	1213	6730	7340	610				1	MISSP				20	2	4
11	21N	8W				SW	O&G	64	1255	6814	7416	602	98	0.32	154	1	MISSP				78	1	
12	21N	8W			NW	NW	DRY	59	1201	6700	7310	610				1					26	2	2
12	21N	8W			NW	SE	O&G	64	1170	6712	7320	608	746	2.60	1204	1	MISSP				154	2	2
12	21N	8W			SE	SE	O&G	75	1170	6692							MISSP						
12	21N	8W			NW	NE	O&G	00									MISSP						
12	21N	8W			SE	NE	O&G	00									MISSP						

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
12	21N	8W			NW	SW	O&G	66	1196	6736	7376	640				1	MISSP				90	2	2
12	21N	8W			SE	SW	O&G	00									MISSP						
12	21N	8W			SE	NW	O&G	00									MISSP						
13	21N	8W			NW	NW	O&G	66	1209	6764	7392	628	292	1.20	503	1	MISSP				41	2	2
13	21N	8W			SE	NW	O&G	76	1196	6768							MISSP						
13	21N	8W			SW	NE	O&G	63	1180	6740	7378	638	184	0.40	254	1	MISSP				55	2	1
13	21N	8W	S2	S2	NE	NE	O&G	75	1166	6840							MISSP						
13	21N	8W			NW	SW	O&G	64	1235	6804	7462	658	155	0.32	211		MISSP						
13	21N	8W		N2	SE	SW	O&G	76	1205	6786	7432	646				1	MISSP				58	1	
13	21N	8W			NW	SE	O&G	64	1187	6770			187	0.60	293	1	MISSP				10	2	2
13	21N	8W			SE	SC	O&G	75	1161								MISSP						
14	21N	8W			NW	NW	O&G	65	1242	6812	7460	648	19		19	1	MISSP				32	2	2
14	21N	8W			SE	NW	O&G	75	1231	6838	7451	613	23	0.40	93		MISSP	HUNTN					
14	21N	8W			NW	NE	O&G	64	1247	6806	7468	662	85	0.13	108	1	MISSP					2	4
14	21N	8W			SE	NE	O&G	76	1225	6800							MISSP						
14	21N	8W			NW	SW	O&G	66	1247	6844			105		105	1	MISSP				127	1	
14	21N	8W			SW	SE	DRY	51	1219	6810	7460	650				1						4	1
14	21N	8W			NW	SE	O&G	65	1208	6796	7449	653				1	MISSP				32	2	1
14	21N	8W	N2	S2	SE	SE	O&G	76	1192	6776			134	0.60	240		MISSP						
15	21N	8W			SE	NW	O&G	65	1201	6818	7434	616	54		54	1	MISSP				57	2	4
15	21N	8W			NW	NW	O&G	79	1204	6821			16	0.12	37		MISSP						
15	21N	8W		SW	SW	NE	O&G	67	1226				86		86		MISSP						
15	21N	8W			NW	SW	O&G	66	1205	6844			105		105		MISSP						
15	21N	8W			SE	SW	O&G	78					29	0.15	55		MISSP						
15	21N	8W			NW	SE	O&G	65	1223	6835	7466	631	144	0.25	188	1	MISSP				50	1	
15	21N	8W			SF	SE	O&G	77					35	0.20	70		MISSP						
16	21N	8W		NW	SL	NW	O&G	77					23	0.61	130		KISSP	HUNIN					
16	21N	8W			NW	NE	O&G	66	1200	6806	7444	638	43	0.26	89	1	MISSP				72	1	1
16	21N	8W			SF	NE	O&G	78					9	0.07	21		MISSP						
16	21N	8W			SE	SW	O&G	78	1203	6882	7514	632	7	0.15	33	1	MISSP				130	1	
16	21N	8W			NW	SW	O&G	78	1199	6884	7478	594	6	0.07	18	1	MISSP	MANNG	HUNTN		74	1	
16	21N	8W				SE	O&G	67					46		46		MISSP						
17	21N	8W		NW	SE	NW	O&G	80	1205	6854	7517	663	8		8		MISSP						
17	21N	8W			SE	SW	O&G	80	1221	6920	7566	646	8		8		MISSP						
17	21N	8W			NW	SE	O&G	67	1204	6874	7500	626	19		19	1	MISSP				48	4	
18	21N	8W		NW	NE	NW	O&G	81	1229	7056			5		5		MISSP						
18	21N	8W				NE	O&G	76					32	0.07	44		MISSP						
18	21N	8W			NE	SW	O&G	81	1238	6902	7520	618	5	0.02	9	1	MISSP				106	1	
18	21N	8W	E2	E2	W2	SE	O&G	81	1218	6914	7540	626	11	0.03	16	1	MISSP						
19	21N	8W			W2	NW	O&G	82	1248	7014	7625	611					MISSP						
19	21N	8W			SE	NE	O&G	80	1219	6958							MISSP						
19	21N	8W			SE	SW	O&G	82	1248	7010	7650	640					MISSP						
19	21N	8W			NW	SE	O&G	67	1232	6965	7602	637	104	0.40	174	1	MISSP				10	2	2
20	21N	8W			NF	NE	O&G	80	1204	6913	7559	646	31	0.15	57	1	MISSP	OSWGO			98	1	
20	21N	8W			NE	SW	O&G	67	1208	6960			20		20	1	MISSP						
21	21N	8W		SE	NW	NW	O&G	81	1205				15	0.01	17		MISSP						
21	21N	8W			NE	NE	DRY	75	1210	6904	7527	623											
21	21N	8W	N2	S2	NE	NE	O&G	76	1213	6888	7516	628	49	0.01	51	1	MISSP				90	1	
21	21N	8W		NW	SW	NE	O&G	81	1219	6890	7514	624	9	0.03	14	1	MISSP				100	1	
21	21N	8W			SE	SW	O&G	81	1239	6946			6	0.12	27	1	MISSP						
21	21N	8W		NE	NW	SE	O&G	66	1242	6940	7582	642	5	0.33	64	1	MISSP				8	2	2
21	21N	8W			SE	SE	O&G	80	1252				4	0.05	13		MISSP						
22	21N	8W		SE	NW	NW	O&G	79	1215	6880	7510	630	19	0.01	21	1	MISSP				22	1	
22	21N	8W			NW	NE	O&G	65	1256	6886	7498	612	57		57	1	MISSP				111	1	
22	21N	8W			SE	NE	O&G	78					1	0.14	26		MISSP						
22	21N	8W			NE	SW	O&G	65	1258	6932	7576	644	12	0.26	58	1	MISSP					4	

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
22	21N	8W			SE	SW	O&G	79	1266	6960				0.19	33	1	MISSP				18	1	
22	21N	8W			NW	SW	O&G	82	1257	6960			1		1	1	MISSP						
22	21N	8W			NW	SE	O&G	78					2	0.08	16		MISSP						
22	21N	8W			SE	SE	O&G	78	1243	6922	7560	638	2	0.44	79	1	MISSP				7	1	
23	21N	8W			SE	NW	O&G	76	1237	6848	7476	628	2		2	1	MISSP						
23	21N	8W			NW	NW	O&G	64	1247	6856	7436	640	13		13	1	MISSP				6	2	2
23	21N	8W			SW	NW	DRY	82															
23	21N	8W			NW	NE	O&G	65	1223	6824	7476	652	14		14	1	MISSP				20	1	
23	21N	8W			SE	NE	O&G	79	1213	6823			5	0.13	28		MISSP						
23	21N	8W		SE	SE	SW	O&G	77					42	0.24	84		MISSP						
23	21N	8W			NW	SW	O&G	66	1243	6876	7520	644	12		12	1	MISSP				24	1	
23	21N	8W			NW	SE	O&G	66	1218	6880	7500	620	49		49	1	MISSP				32	2	2
23	21N	8W	S2	N2	SE	SE	O&G	78	1210	6998							MISSP						
24	21N	8W			NW	NW	O&G	65	1201	6797	7446	649	14		14	1	MISSP				70	1	
24	21N	8W			SE	NW	O&G	77	1190	6794	7440	646	11	0.12	32	1	MISSP				40	1	
24	21N	8W			SE	NE	O&G	76	1160	6760							MISSP						
24	21N	8W			NW	NE	O&G	66	1164	6746							MISSP						
24	21N	8W			NW	SE	O&G	66	1178	6790			103	1.00	279		MISSP						
24	21N	8W	E2	W2	SE	SE	O&G	76	1162	6816							MISSP						
24	21N	8W			NW	SW	O&G	66	1210	6836	7480	644				1	MISSP						
24	21N	8W	NE	SW	SE	SW	O&G	76	1186	6828	7460	632	186	1.00	362		MISSP						
25	21N	8W			NW	NW	O&G	66	1208	6848			182	0.70	305		MISSP						
25	21N	8W			SE	NW	O&G	77	1187	6858			27	0.08	41		MISSP	OSWGO					
25	21N	8W			NW	NE	O&G	67	1174	6850			61	0.03	66		MISSP						
25	21N	8W			NW	SW	O&G	67	1230	6914			39	0.14	64	1	MISSP				13	2	2
25	21N	8W			SE	SW	O&G	75	1203	6950			19	0.03	24		MISSP						
25	21N	8W			NW	SE	O&G	66	1206	6895	7524	629	146	0.26	192	1	MISSP				44	1	
25	21N	8W			SE	SE	O&G	75	1180	6885	7515	630				1	MISSP	OSWGO			41	1	
26	21N	8W			NW	NW	O&G	74	1237	6948	7610	662					MISSP						
26	21N	8W			SW	NE	O&G	67	1227	6898			210	1.84	534	1	MISSP				6	2	2
26	21N	8W			SE	SW	O&G	68	1208	6918	7548	630				1	MISSP						
26	21N	8W		S2	NW	SE	O&G	79	1216								MISSP						
27	21N	8W			NW	NW	O&G	75	1260	6978							MISSP						
27	21N	8W			SW	NE	O&G	67	1243	6938			235	2.25	631	1	MISSP				15	2	2
27	21N	8W		S2	NW	SW	O&G	78	1274								MISSP						
27	21N	8W		N2	SE	SE	O&G	68	1227	6950	7580	630				1	MISSP				36	2	
28	21N	8W			NW	NW	O&G	76	1232								MISSP						
28	21N	8W			SW	NE	O&G	67	1261	7016			291	1.88	622	1	MISSP				72	4	
28	21N	8W			NW	SW	O&G	78	1245	7028							MISSP						
28	21N	8W			E2	SE	O&G	68	1263	7010	7645	635				1	MISSP				14	2	2
29	21N	8W			NW	NW	O&G	64	1218	6962	7594	632				1	MISSP				28	2	2
29	21N	8W			SW	NE	O&G	67	1223	6980	7603	623	67	0.04	74	1	MISSP				33	2	2
29	21N	8W		SW	NW	SW	O&G	78	1236								MISSP						
29	21N	8W			SE	SE	O&G	69	1234	7038							MISSP						
30	21N	8W		SE	NW	NW	O&G	80	1254	7034							MISSP						
30	21N	8W			SW	NE	O&G	67	1243	7016	7654	638	47	0.35	109	1	MISSP				13	2	2
30	21N	8W			W2	SW	O&G	82	1263	7122							MISSP						
30	21N	8W	N2	S2	SE	SE	O&G	78	1241								MISSP						
31	21N	8W			NW	NW	O&G	82	1268	7148	7763	615	1	0.05	10	1	MISSP				46	1	1
31	21N	8W			NW	NE	O&G	69	1272	7138	7704	566	8		8	1	MISSP				9	1	1
31	21N	8W			NW	SW	O&G	82					9		9	1	MISSP				124	1	
31	21N	8W			NW	SE	O&G	80	1263	7181	7778	597	1		1		MISSP	HUNTN					
32	21N	8W			NE	NW	O&G	69	1236	7040			14		14		MISSP	HUNTN					
32	21N	8W			NW	NE	O&G	68	1235	7104	7660	556	41		41	1	MISSP				24	1	1
32	21N	8W			SE	NE	O&G	76	1245	7118	7696	578	8	0.10	26		MISSP	HUNTN					
32	21N	8W			SE	SW	O&G	78	1254	7174			2		2	1	MISSP				41	1	1

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
32	21N	8W			NW	SE	O&G	69	1255				12		12	1	MISSP	HUNTN			27	1	
32	21N	8W			SE	SE	O&G	81	1261				2		2	1	MISSP	HUNTN	VIOLA		72	1	
33	21N	8W			NE	NW	O&G	68	1256	7086	7692	606	33	0.35	95	1	MISSP	HUNTN			135	1	
33	21N	8W		NE	SE	NE	O&G	68	1281	7116	7692	576	18		18	1	MISSP				25	1	
33	21N	8W		NW	NE	NE	O&G	83					5	0.03	10	1	MISSP						
33	21N	8W			SE	SW	O&G	68	1264	7196	7740	544					MISSP						
33	21N	8W			NW	SE	O&G	68	1270	7140	7700	560	18	0.06	29	1	MISSP				108	1	
34	21N	8W			NE	NW	O&G	68	1243	7063	7631	568	12	0.06	23		MISSP						
34	21N	8W			SE	NE	O&G	68					28	0.60	134	1	MISSP				8	1	1
34	21N	8W			NW	SW	O&G	65	1274	7152			24	0.50	112	1	MISSP				53	2	2
34	21N	8W			SE	SE	O&G	79	1238	7110	7630	520	14	0.15	40		MISSP						
34	21N	8W			NW	SE	O&G	64	1237	7140			43		43	1	MISSP				17	2	2
35	21N	8W	N2	S2	NW	NW	O&G	78	1213	6975							MISSP						
35	21N	8W			SW	NE	O&G	67	1213	7000			318	2.90	828	1	MISSP				16	1	
35	21N	8W			NW	SW	O&G	77	1245	7100							MISSP						
35	21N	8W			SW	SE	O&G	68								1	MISSP				36	2	
36	21N	8W			SE	NW	O&G	66	1189	6988	7560	572	318	1.30	547	1	MISSP				42	1	
36	21N	8W			NW	NE	O&G	75	1196	6974							MISSP						
36	21N	8W			SW	SW	O&G	68	1222	7028	7628	600				1	MISSP				2	2	
36	21N	8W		SE	NW	SE	O&G	79	1179	6970							MISSP						
36	21N	8W		S2	SE	SE	O&G	81	1180				4		4		OSWGO						
1	21N	9W			SW	NW	O&G	68	1272	6910	7508	598				1	SMPSN				7	1	
1	21N	9W		W2	E2	NW	O&G	87	1239	6891							MISSP						
1	21N	9W			NW	NE	O&G	85	1245	6850			15	0.50	103		MISSP						
1	21N	9W		NW	NE	SW	DRY	84	1281	6320	7496	576				1					14	1	
1	21N	9W		SW	SW	SW	O&G	84	1277	6918	7510	592	5	0.26	51	1	MISSP				82	1	
1	21N	9W				SE	O&G	76	1242	6853	7458	605	10		10	1	MISSP				25	1	
2	21N	9W		E2	NE	NW	O&G	81	1291	6926	7501	575	17	0.20	52	1	VIOLA				27	1	
2	21N	9W			SW	NE	O&G	67	1282	6930	7504	574	208	0.09	224	1	SMPSN				5	1	
2	21N	9W			NE	SW	DRY	68	1306	6954	7546	592				1							
2	21N	9W			S2	NE	SWD	73	1284							1					2	1	
2	21N	9W		W2	NE	SW	O&G	74	1311					0.18	32	1	RDFRK						
2	21N	9W			NE	SE	O&G	69	1285	6938	7540	602	3		3	1	RDFRK				9	1	
2	21N	9W			SW	SE	DRY	48	1293	6945	7530	585				1							
3	21N	9W			SW	NE	O&G	79	1325	6984	7598	614	15	0.03	20	1	MISSP	OSWGO			94	1	
3	21N	9W			SW	SW	DRY	49	1329	6998	7606	608				1							
3	21N	9W		NE	SW	SE	O&G	81	1332	6996	7602	606	1		1	1	RDFRK				18	1	
4	21N	9W		SW	NE	NW	DRY	82	1329	7030	7640	610				1					30	1	1
4	21N	9W		E2	NE	NE	O&G	81	1327	6982	7580	598	2		2	1	MISSP				2	1	
4	21N	9W			SW	NE	DRY	63	1331	7020	7628	608				1					9	1	1
4	21N	9W			SW	SW	O&G	54	1330	7015	7648	633		0.16	28	1	RDFRK						
4	21N	9W			NE	SW	O&G	80	1331								OSWGO						
4	21N	9W			SE	SE	DRY	78	1332	6994	7604	610				1					5	1	
4	21N	9W			NE	SE	O&G	80	1317								OSWGO						
4	21N	9W		W2	SW	SE	O&G	46	1310	6990	7602	612	39	3.30	620	1	SMPSN						
5	21N	9W		NE	SW	SE	O&G	54	1316					0.38	67	1	RDFRK						
6	21N	9W		SE	SE	NW	O&G	59	1340	7080			1		1	1	MANNG						
6	21N	9W	W2	F2	NE	NW	O&G	81	1343	7100	7720	620	8	0.07	20	1	MISSP	MANNG	INOLA	OSWGO	9	1	
6	21N	9W			SW	NE	O&G	82					11	0.10	23		MISSP	MANNG	INOLA	OSWGO			
6	21N	9W			NE	NE	O&G	81	1361	7048	7694	646	5		5	1	MISSP	MANNG	OSWGO		42	1	
6	21N	9W			SE	SW	O&G	69	1313	7080	7711	631	2		2	1	MANNG	OSWGO			5	1	1
7	21N	9W			NE	NW	O&G	81	1297	7090	7726	636	3		3	1	MISSP	MANNG					
7	21N	9W			SW	NW	O&G	81	1283	7090	7730	640	13	0.02	17	1	SMPSN				9	1	
7	21N	9W			SW	NE	DRY	80	1294														
7	21N	9W			SW	SW	O&G	77	1275				4		4		MISSP						
7	21N	9W			NE	SE	DRY	80	1273														

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
8	21N	9W	W2	E2	NW	NE	O&G	79	1332	7050	7650	600	10		10	1	MISSP						
8	21N	9W			SW	NE	O&G	80									MISSP	RDFRK					
8	21N	9W			SE	SW	O&G	70	1282	7108	7764	656	1		1	1	MISSP	MANNG			20	1	1
8	21N	9W			NE	SE	O&G	69	1302	7048	7706	658	4		4	1	MISSP	HUNTN			41	1	
8	21N	9W		SE	SE	SE	O&G	79	1301	7030	7750	660	2		2	1	MISSP	OSWGO					
9	21N	9W			NE	NW	DRY	81	1325	7012	7632	620				1					22	1	1
9	21N	9W			NW	NW	O&G	80	1339	6950			1	0.14	26		MISSP	OSWGO					
9	21N	9W	W2	E2	NW	NE	O&G	79	1330	7050	7620	570					MISSP						
9	21N	9W			NE	SW	O&G	64	1318	7074	7710	636	1		1	1	MISSP				87	2	2
9	21N	9W		NW	SW	SW	O&G	81					45	0.03	50		MISSP						
9	21N	9W			SE	SE	O&G	69	1298	7048	7676	628	3		3	1	MISSP				168	1	
10	21N	9W			E2	NW	O&G	80	1330	6982	7588	606	24	0.10	42	1	MISSP	VIOLA			2	1	
10	21N	9W			SW	NW	O&G	69	1316	6978	7600	622	1		1	1	MISSP	MANNG			7	1	
10	21N	9W			SW	NE	O&G	84	1320	7000	7616	616	2		2	1	MISSP	VIOLA			78	1	
10	21N	9W			NW	NE	O&G	69	1331	7000	7624	624	3		3	1	MISSP					4	
10	21N	9W		S2	SW	SW	O&G	81	1314	7084	7720	636	2		2	1	MISSP				52	1	
10	21N	9W			NE	SW	O&G	69	1319	7014	7638	624	7		7	1	MISSP				4	1	
10	21N	9W		SE	SE	SW	O&G	81	1321	7090			2		2	1	MISSP						
10	21N	9W		E2	SW	SE	O&G	81	1324	7050	7666	616	5		5	1	MISSP				27	1	1
11	21N	9W	SE	NW	NE	NW	O&G	79	1310	6980	7580	600	3		3	1	MISSP				16	1	
11	21N	9W		SE	SW	NW	O&G	81	1316	6930			2		2		MISSP						
11	21N	9W		NE	NE	NE	O&G	84	1290	6944	7538	594	1		1	1	SMPSN				83	1	
11	21N	9W			SW	NE	O&G	64	1298	6962	7556	594				1	MISSP	HUNTN			190	2	
11	21N	9W		SW	SE	NE	O&G	81	1299	6956	7556	600	3		3	1	MISSP				5	1	1
11	21N	9W		SE	SW	NE	O&G	80	1278	7010			2		2		MISSP						
11	21N	9W		NE	SE	SW	O&G	80	1306	6930			43	0.20	78	1	MISSP					1	1
11	21N	9W		S2	NW	SE	O&G	80	1291	6948			39	0.10	57		MISSP						
11	21N	9W		N2	SE	SE	O&G	79	1282	6962			219		219	1	MISSP					4	
12	21N	9W			SW	NW	O&G	78	1282	6930	7526	596	6		6	1	MISSP				44	1	1
12	21N	9W			NE	NW	O&G	82	1270	6904	7529	625	5		5	1	MISSP	MANNG			55	1	
12	21N	9W			SE	NE	O&G	80	1255	6875	7470	595	10	0.04	17	1	MISSP						
12	21N	9W		N2	SW	SW	O&G	81					5		5		MISSP						
12	21N	9W	N2	N2	SE	SW	O&G	81									MISSP						
12	21N	9W	E2	E2	NW	SE	O&G	76	1253	6894			58	0.14	83	1	MISSP					1	1
12	21N	9W			SE	SE	O&G	78	1250	6900			35	0.35	147	1	MISSP					4	
13	21N	9W		SE	NE	NW	O&G	77	1287	6994			8		8	1	MISSP					1	
13	21N	9W		NE	NW	NE	O&G	81	1261	6920						1	MISSP					1	
13	21N	9W		SE	NE	NE	O&G	77	1259	6934			44	0.26	90		MISSP						
13	21N	9W		SW	SW	SW	O&G	77	1295	7052	7668	616	9	0.10	27	1	MISSP				10	1	
13	21N	9W			NE	SE	O&G	77	1259	6952	7632	680	10	0.02	14	1	MISSP				72	1	
14	21N	9W			NE	NW	O&G	75	1312	7022							MISSP	MANNG	VIOLA				
14	21N	9W		NW	SW	NE	O&G	82	1315	7020	7620	600	5	0.01	7	1	MISSP	HUNTN					
14	21N	9W			NE	NE	O&G	69	1299	6975	7590	615	37	0.14	62	1	MISSP						
14	21N	9W			NE	SW	O&G	80	1316	7078	7679	601	6	0.10	24	1	MISSP				32	1	
14	21N	9W			NW	SE	O&G	81	1318	7080	7687	607	5		5	1	MISSP	HUNTN			81	1	
15	21N	9W			NE	NW	O&G	69	1313	7070	7696	626	37		37	1	MISSP				12	1	1
15	21N	9W			SW	NE	O&G	80	1320	7070	7692	622	18	0.03	23	1	MISSP				2	1	
15	21N	9W			NE	NE	O&G	80	1329	7050	7670	620	19	0.05	28	1	MISSP				2	1	
15	21N	9W			SW	SW	O&G	80	1307				7	0.05	16		MISSP						
15	21N	9W			NE	SE	O&G	80	1318	7074			6	0.02	10		MISSP						
16	21N	9W			SW	NW	DRY	70	1298	7214	7884	670											
16	21N	9W			SE	NW	O&G	81	1301	7204	7856	652	15	0.50	103	1	MISSP				19	1	
16	21N	9W			NW	NE	O&G	69	1302	7032	7716	624	61	0.17	91	1	MISSP				8	1	
16	21N	9W			SW	SW	DRY	70	1269	7296	7980	684				1					3	1	
16	21N	9W			NE	SE	O&G	69	1308	7220	7870	650	2		2	1	MISSP				6	1	
16	21N	9W		SE	SW	SE	O&G	79	1289	7240			8	0.02	12		MISSP						

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EGOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
17	21N	9W			SE	NW	O&G	70	1277	7224	7898	674	151		151	1	MISSP	MANNG	HUNTN		9	1	
17	21N	9W		E2	SE	NE	O&G	80	1285	7233	7900	667	2		2	1	MISSP	MANNG			1	1	
17	21N	9W			SW	NE	O&G	70	1283	7226	7894	668	1		1	1	HUNTN				1	1	
17	21N	9W			NW	NE	O&G	69	1291	7194	7844	650	6		6	1	MISSP	HUNTN			23	1	
17	21N	9W			NE	SW	O&G	70	1266	7244	7906	662	185	0.25	223	1	MISSP	HUNTN			9	1	
17	21N	9W			SW	SW	O&G	74	1274	7252	7931	679					MISSP	HUNTN					
17	21N	9W			NE	SE	O&G	69	1272	7240	7904	664	186		186	1	MISSP	MANNG	HUNTN		4	1	
17	21N	9W		NW	NW	SE	O&G	80	1271	7230	7886	656	8	0.02	12	1	MISSP				68	1	
17	21N	9W			NW	SE	O&G	70	1277	7232	7892	660				1	HUNTN				2	1	
18	21N	9W			NE	NW	O&G	81					5	0.02	9		MISSP	MANNG	INOLA	VRDGR			
18	21N	9W		SE	SE	NW	O&G	71	1267	7210			29		29		MISSP	HUNTN					
18	21N	9W			SE	NE	DRY	70	1262	7226	7896	670				1					1	1	
18	21N	9W			SW	NE	O&G	72	1268	7216	7884	668	2		2		HUNTN						
18	21N	9W			SE	SW	O&G	70	1269	7242	7858	616	387	0.50	475	1	HUNTN				15	1	
18	21N	9W			NE	SE	O&G	70	1283	7265	7938	673	235	0.16	263	1	MISSP	HUNTN			28	1	
18	21N	9W			SW	SE	DRY	71	1251	7246	7931	685											
18	21N	9W	S2	N2	NW	SE	O&G	82	1247	7234	7872	638	19	0.49	105	1	HUNTN				39	1	
19	21N	9W			NW	NW	O&G	70	1260	7258			95	0.60	201		HUNTN						
19	21N	9W			NW	NE	O&G	71	1250	7260	7910	650	59	0.15	85		MISSP						
19	21N	9W		NW	NE	SW	O&G	81	1251	7275	7919	644	3		3	1	MISSP				2	1	
19	21N	9W			NW	SE	O&G	70	1248	7318	7980	662	1		1	1	MISSP				4	3	
20	21N	9W			NE	NW	O&G	70	1262	7235	7860	625	10		10	1	MISSP	MANNG			12	2	
20	21N	9W			NE	NE	DRY	69	1267	7294	7936	642				1					6	1	
20	21N	9W		NW	NW	NE	O&G	80	1273	7270	7910	640	4	0.04	11	1	MISSP	OSWGO					
20	21N	9W		W2	SW	SW	O&G	79	1268	7395	8058	663	10	0.05	19	1	MISSP						
20	21N	9W		S2	NW	SE	O&G	79	1256	7326			3		3		MISSP						
21	21N	9W		SE	SE	SW	LOC	81	1260	7288	7360	672				1					31	1	
21	21N	9W			NE	NE	O&G	80	1289	7235	7914	679	6	0.03	11		MISSP						
21	21N	9W			NW	SW	LOC	81	1250	7272	7930	658			0	1					84	1	
22	21N	9W			NE	NW	O&G	78	1307				6		6		MISSP						
22	21N	9W	W2	E2	SW	NE	O&G	78	1301	7248	7905	657	4	0.14	29		MISSP						
22	21N	9W			SW	SW	O&G	73	1286	7308	7960	652	18	0.03	23		MISSP						
22	21N	9W		SW	SW	S-	O&G	73	1289	7343	7999	656	42	0.14	67		MISSP	MANNG	HUNTN				
23	21N	9W		SW	SW	NW	O&G	78	1320	7180	7738	618	2	0.09	18	1	MISSP				86	1	
23	21N	9W			NW	NW	O&G	69	1318	7120	7740	620	2		2	1	MISSP				15	1	1
23	21N	9W			SW	NE	O&G	79	1302	7086	7708	622	3	0.05	12		MISSP						
23	21N	9W			SW	SW	O&G	73	1299	7248	7830	582	4		4		MISSP						
23	21N	9W			SW	SE	O&G	77	1300	7134	7730	596	6	0.09	22		MISSP						
24	21N	9W		SW	SW	NW	O&G	78	1292	7070	7670	600	13	0.11	32	1	MISSP				42	1	
24	21N	9W			NE	NW	DRY	81	1290	7049						1					20	1	1
24	21N	9W			NW	NE	O&G	69	1271	7006	7660	654	16	0.12	37	1	MISSP				8	1	1
24	21N	9W			NW	SW	O&G	69	1288	7090	7692	602	15		15	1	MISSP				56	1	
24	21N	9W			NE	SE	O&G	77	1254	7138	7682	544	21	0.21	58		MISSP						
24	21N	9W			SW	SE	O&G	80	1264	7036	7666	630	27	0.05	36	1	MISSP				7	1	
25	21N	9W			SW	NW	O&G	69	1287	7128	7738	610	145		145	1	MISSP	HUNTN			24	1	
25	21N	9W			NE	NW	O&G	78	1268	7080	7680	600	9		9		MISSP						
25	21N	9W			NE	NE	O&G	77	1266	7050	7710	660	66		66	1	MISSP				140	1	
25	21N	9W	N2	S2	NW	SW	O&G	71	1287		7796		1		1		MISSP						
25	21N	9W			NE	SW	O&G	78	1284	7144	7744	600				1	MISSP				7	1	
25	21N	9W			SW	SE	O&G	69	1277	7158	7780	622	7		7	1	MISSP				164	1	1
25	21N	9W			NE	SE	O&G	78	1267	7122	7727	605				1	MISSP				153	1	
26	21N	9W			SE	NW	O&G	81	1306	7290			2		2		MISSP	MANNG					
26	21N	9W		SE	NW	NE	O&G	78	1297	7178	7774	596	1	0.12	22	1	MISSP	MANNG			13	1	
26	21N	9W			NW	SW	O&G	79	1297	7270	7880	610	11	0.05	20	1	MISSP	MANNG	HUNTN				
26	21N	9W			NW	SE	O&G	63	1293	7193			24	0.90	182	1	MISSP					2	
27	21N	9W			SE	NW	O&G	61	1274	7390			54		54	1	MANNG					1	

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
27	21N	9W		SW	NE	NW	O&G	79	1276	7338	8006	668	4	0.01	6		MISSP	MANNG					
27	21N	9W			NE	NE	O&G	73	1294	7324	7980	656	14		14		MISSP	MANNG	HUNTN				
27	21N	9W			SW	NE	O&G	61	1282	7378			111		111	1	MISSP	MANNG					
27	21N	9W	W2	SE	SW	SW	O&G	76	1255	7375	7982	607	5	0.22	44	1	MISSP	MANNG			33	1	
27	21N	9W			NW	SW	O&G	62	1260	7362			39	0.03	44	1	MANNG					3	
27	21N	9W	S2	SE	NE	SW	O&G	84	1258	7405	7984	579	1	0.04	8	1	MISSP	MANNG			113	1	
27	21N	9W			SE	SE	O&G	61	1280	7340			21		21	1	MISSP	MANNG				2	
27	21N	9W			NW	SE	O&G	61	1274	7373			118		118	1	MISSP	MANNG				2	
28	21N	9W			SE	NW	O&G	82	1250	7342	7982	640	1	0.02	5	1	MISSP				14	1	
28	21N	9W			NW	NW	O&G	82	1250	7348	7998	650	1		1	1	MISSP				28	1	
28	21N	9W			SE	NE	O&G	63	1264	7361			24	0.15	50	1	MISSP	MANNG				2	
28	21N	9W			NW	SW	O&G	81	1262	7280	7950	670	5		5		MISSP						
28	21N	9W			SW	SW	O&G	79	1245	7440	8030	650	1	0.19	34	1	MISSP	MANNG			3	1	
28	21N	9W			NE	SE	DRY	82	1271	7360	7986	626				1					16	1	
28	21N	9W			SE	SE	O&G	63	1246	7372						1	MANNG					2	
29	21N	9W			NE	NW	DRY	81	1291	7442	8100	658											
29	21N	9W			SW	NW	O&G	82	1257	7482	8120	638	3	0.01	5	1	MISSP				21	1	
29	21N	9W		E2	SW	NE	O&G	78	1252	7450	8044	594	6	0.06	17		MISSP						
29	21N	9W	W2	NE	NE	SW	DRY	83	1245	7468	8108	640				1					10	1	
29	21N	9W			SW	SW	DRY	77	1220	7488	8120	632				1							
29	21N	9W			SW	SE	O&G	80	1234	7476			2		2		MISSP						
30	21N	9W			SW	NE	DRY	73															
30	21N	9W			SE	NE	O&G	80	1239	7432	8096	664	8	0.02	12	1	MISSP	MANNG	HUNTN		4	1	
30	21N	9W		SW	SE	SW	O&G	82					3	0.04	10		HUNTN						
30	21N	9W		S2	SW	SE	O&G	73	1221	7454	8090	636	7	0.42	81	1	HUNTN				7	1	
31	21N	9W		NE	SE	NW	O&G	73	1215	7485	8062	577		0.22	39	1	MISSP	OSWGO	MANNG		146	1	
31	21N	9W		SE	SW	NW	O&G	73	1210	7426			2	0.08	16		HUNTN						
31	21N	9W		SW	SW	NE	O&G	73	1212	7488	8052	564	6	0.72	133	1	MISSP	MANNG	HUNTN		145	1	
31	21N	9W		SW	SW	SW	O&G	71	1204	7483	8133	650	112	0.75	244		MISSP	MANNG	HUNTN				
31	21N	9W			NE	SW	O&G	80	1200	7440			2		2		MISSP						
31	21N	9W	N2	S2	SE	SW	O&G	76	1191				12		12		HUNTN						
31	21N	9W		SW	SW	SE	O&G	72	1193	7478			78	1.55	351		MISSP	MANNG	HUNTN				
32	21N	9W			SW	NW	O&G	81	1210	7470	8086	616	7	0.15	33	1	MISSP	MANNG			10	1	
32	21N	9W			SE	NE	O&G	70	1246	7512	8134	622	26	0.05	35	1	MISSP	MANNG			6	1	
32	21N	9W		W2	SW	SW	DRY	73	1206	7500	8104	604				1					17	1	
32	21N	9W		W2	W2	SW	O&G	82									MISSP						
32	21N	9W	W2	W2	E2	SE	O&G	82	1236	7516	8120	604	17	0.05	26	1	MISSP				1	1	
33	21N	9W			SE	NE	O&G	77					18		18		MISSP	MANNG					
33	21N	9W			S2	SW	O&G	76	1236	7486	8098	612	29	0.28	78		MISSP	MANNG					
33	21N	9W			SW	SE	O&G	77	1232	7458	8050	592	19	0.79	158		MISSP	MANNG					
34	21N	9W			NW	NE	O&G	63	1276	7391			60	1.32	292	1	MISSP	MANNG				2	
34	21N	9W			NW	SW	O&G	63	1243	7407	8010	603	49	2.34	461	1	MISSP	MANNG			31	2	
34	21N	9W	E2	W2	NW	SE	O&G	79	1260	7426	8052	626	2	0.61	109		MISSP						
34	21N	9W			NW	SE	DRY	78	1248														
35	21N	9W			NW	NW	O&G	75	1294	7421			13	0.94	178	1	MISSP	MANNG			200	1	
35	21N	9W			SE	NE	O&G	70	1234				3		3		MISSP	MANNG					
35	21N	9W			SE	SW	O&G	85	1287	7440	8054	614	3	0.02	7	1	MISSP	MANNG			230	1	
35	21N	9W			NW	SW	O&G	75	1292	7431	8022	591	11	0.92	173	1	MISSP	MANNG			176	1	
35	21N	9W			SE	SE	O&G	71	1281				7		7		MISSP						
35	21N	9W			NW	SE	O&G	82	1300	7350	7948	598	9		9	1	MISSP	MANNG			25	1	
36	21N	9W			NW	NW	O&G	75	1235	7221	7817		13	0.20	48	1	MISSP	MANNG			94	1	
36	21N	9W			SE	NE	O&G	70	1267	7176	7785	609	1		1	1	MISSP	MANNG			3	1	
36	21N	9W			NW	SW	O&G	68	1288	7258	7904	646	13		13	1	MISSP	MANNG			10	1	1
36	21N	9W			SE	SE	O&G	69	1286	7236	7858	622	31	0.50	119	1	MISSP	MANNG	HUNTN		14	1	1
1	22N	7W			NE	NW	O&G	67	1284	6318	6889	571	16	0.80	157	2	MISSP	SKINR					
1	22N	7W		SW	NE	NE	O&G	67	1275	6318	6892	574	21	0.10	39	1	MISSP				7	1	

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
1	22N	7W			NE	SW	O&G	68	1280	6328	6894	566	13	0.60	119	2	MISSP						
1	22N	7W		NW	SE	SE	O&G	68	1279	6320	6890	570	3		3	1	MISSP				16	1	
2	22N	7W		NE	NW	NW	O&G	68	1312	6375	6944	569	17		17	1	MISSP				47	1	
2	22N	7W				NE	O&G	68	1301	6350	6919	569	8		8	1	MISSP						
2	22N	7W		NW	SE	SE	O&G	85	1234	6363	6927	564	1		1	1	MISSP				26	1	
3	22N	7W			NE	SW	O&G	66	1324	6420	6983	563	23	0.90	181	1	MISSP				18	2	2
4	22N	7W				NW	O&G	75	1335				4		4	2	MISSP						
4	22N	7W			NE	SW	O&G	66	1331	6454	7024	570	9	0.60	115	1	MISSP				6	2	2
4	22N	7W			SW	SW	O&G	84	1327	6470	7048	578	1	0.10	19	1	MISSP				2	1	
4	22N	7W		SW	SE	SE	O&G	84	1325	6463	7025	562	2	0.16	30	1	MISSP				12	1	
5	22N	7W		E2	W2	NW	O&G	84	1285	6410	6970	560	1		1	1	MISSP				62	1	
5	22N	7W		E2	SW	SW	O&G	84	1262	6420	6990	570	1		1	1	MISSP				2	1	
5	22N	7W			NW	SE	O&G	66	1309	6450	7023	573	16	2.80	509	1	MISSP				43	2	2
6	22N	7W		SW	NW	NW	O&G	84	1322	6500	7074	574	3	0.10	21	1	MISSP				35	1	
6	22N	7W		NE	NW	NE	O&G	84	1324	6460	7028	568	5	0.10	23	1	MISSP				3	1	
6	22N	7W		S2	NW	SW	O&G	84	1307	6500	7076	576		0.01	2	1	MISSP				23	1	
6	22N	7W			NW	SE	O&G	65	1317	6480	7054	574	27	4.05	740	1	MISSP				10	2	
7	22N	7W	E2	W2	SE	NW	O&G	84	1295	6521	7090	569		0.01	2	1	MISSP				2	1	
7	22N	7W			W2	SW	O&G	84	1274	6542			1	0.45	80	1	MISSP				12	1	
7	22N	7W			SW	SE	O&G	62	1239	6501			11	1.89	344	1	MISSP				29	2	
8	22N	7W		SW	NE	NE	O&G	84	1325	6490	7056	566	1	0.12	22	1	MISSP				6	1	
8	22N	7W		NE	SW	SW	O&G	84	1295	6527	7090	563	1	0.17	31	1	MISSP				8	1	1
8	22N	7W			NW	SE	O&G	66	1311	6505	7065	560	21	2.83	519	1	MISSP				177	2	
9	22N	7W			SE	NW	O&G	66	1323	6488	7054	566	15	2.04	374	1	MISSP					4	
10	22N	7W			NE	SW	O&G	66	1294	6456	7002	546	22	1.73	326	1	MISSP				1	1	
12	22N	7W		N2	S2	NW	O&G	85					2	0.20	37	1	MISSP						
12	22N	7W		SW	NE	NE	O&G	85					2	0.20	37	1	MISSP				7	1	
12	22N	7W		N2	S2	SW	O&G	85					2	0.20	37	1	MISSP				21	1	
12	22N	7W		SW	NE	SE	O&G	85					2	0.20	37	1	MISSP				224	1	
13	22N	7W	NW	NW	SE	SW	O&G	82	1282				2	0.76	136	1	MISSP						
14	22N	7W			SW	NE	O&G	65	1273	6412	6968	556	27	3.27	603	1	MISSP				16	2	1
14	22N	7W		NE	SW	SE	O&G	85						0.13	23	2	MISSP						
15	22N	7W		E2	W2	NW	O&G	87	1287	6458						2	MISSP						
15	22N	7W			W2	SW	O&G	86	1286	6480	7030	550				1	MISSP				1	1	
15	22N	7W		NW	NW	SE	O&G	66	1281	6452	7000	548	2	0.70	125	1	MISSP				6	2	
16	22N	7W			SE	NW	O&G	67	1309	6515	7077	562	18	3.00	546	1	MISSP				11	2	2
16	22N	7W		W2	SE	SW	O&G	84	1291	6540			1	0.58	103	1	MISSP						
16	22N	7W				SE	O&G	86	1291	6501	7056	555		0.02	4	1	MISSP				202	1	
17	22N	7W		SE	NW	NW	O&G	84	1274	6516	7080	564	1	0.50	89	1	MISSP				2	1	
17	22N	7W			NE	NE	O&G	84	1304	6510	7066	556		0.06	11	1	MISSP				2	1	
17	22N	7W			NE	SW	O&G	65	1280	6550	7106	556	10	1.75	318	1	MISSP				23	2	
18	22N	7W		S2	NW	NW	O&G	84					1	0.34	61	1	MISSP				2	1	
18	22N	7W			SE	SW	O&G	63	1226	6632	7212	580	3	0.98	175	1	MISSP				24	2	2
18	22N	7W		N2	SE	SE	O&G	84	1264	6560	7120	560		0.10	18	1	MISSP					3	
19	22N	7W		N2	SW	NW	O&G	84	1221	6580	7148	568	1	0.15	27	1	MISSP						
19	22N	7W			NE	NE	O&G	84	1274	6578			1	0.24	43	1	MISSP				1	1	
19	22N	7W			NE	SW	O&G	65	1240	6583	7159	576	28	4.65	846	1	MISSP				31	2	2
19	22N	7W		N2	SE	SE	O&G	85	1274				1	0.37	66	1	MISSP						
20	22N	7W			N2	NW	O&G	84	1275	6584	7154	570		0.11	19	1	MISSP				4	1	3
20	22N	7W			N2	NE	O&G	84	1283	6566	7146	580	3	0.87	156	1	MISSP				30	1	1
20	22N	7W			NE	SW	O&G	66	1254	6591	7156	565	71	6.40	1197	1	MISSP				60	2	2
20	22N	7W		S2	NE	SE	O&G	84	1275	6572	7152	580	1	0.10	19	1	MISSP				44	1	
21	22N	7W			SE	NW	O&G	66	1283	6560	7125	565	30	4.30	787	1	MISSP				41	2	
21	22N	7W		S2	N2	NE	O&G	87	1281	6518	7070	552				1	MISSP				37	1	
21	22N	7W		N2	S2	SW	O&G	84	1279	6570	7148	578	4	0.56	103	1	MISSP				43	1	
21	22N	7W		E2	SW	SE	O&G	84	1287	6576	7156	580				1	MISSP				142	1	4

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EOOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
22	22N	7W			SE	NW	O&G	66	1280	6494	7033	539	14	2.40	436	1	MISSP				59	2	2
22	22N	7W		S2	NE	NE	O&G	84	1205	6484	7014	530		0.10	18	1	MISSP				15	1	1
22	22N	7W		E2	SW	SW	O&G	84	1278	6528	7082	554	2	0.46	83	1	MISSP				47	1	
22	22N	7W			SE	SE	O&G	84	1280				1	0.12	22	1	MISSP						
23	22N	7W			SE	NW	O&G	65	1278	6469	7014	545	16	2.78	505	1	MISSP				28	2	2
23	22N	7W		S2	NE	SW	O&G	84	1284	6480	7014	534	1	0.10	19	1	MISSP				2	1	
23	22N	7W		SW	NE	SE	O&G	84	1305	6465	7004	539		0.10	18	1	MISSP				3	1	2
24	22N	7W			SE	NW	O&G	65	1265	6418				1.72	303	1	MISSP				13	1	1
24	22N	7W		SW	NW	NW	O&G	85	1285	6446	6984	538		0.16	28	2	MISSP	RDFRK					
24	22N	7W		E2	SW	SW	O&G	86	1274	6458	7010	552	3	0.19	36	1	MISSP	RDFRK			38	1	
25	22N	7W			NW	NW	O&G	66	1277	6459	7024	565	7	1.00	183	1	MISSP				98	1	1
25	22N	7W			SW	NE	O&G	85	1273	6448	7038	590	2	0.14	27	2	MISSP						
25	22N	7W			SE	SW	O&G	85	1282	6470	7060	590	3	0.15	29	2	MISSP						
26	22N	7W				SE	O&G	69	1280				17	1.53	286	2	MISSP						
27	22N	7W			SE	NW	O&G	66	1282	6501	7096	595	22	2.39	443	1	MISSP				13	2	
27	22N	7W		S2	NE	NE	O&G	84	1282				1	0.10	19	2	MISSP						
27	22N	7W		N2	SW	SW	O&G	84	1274				4	0.30	57	2	MISSP						
27	22N	7W			S2	SE	O&G	84	1285	6525	7110	585	2	0.10	20	1	MISSP				9	1	
28	22N	7W		E2	W2	NW	O&G	84	1264	6570	7180	610	9	0.34	69	1	MISSP				10	1	
28	22N	7W			E2	NE	O&G	84	1265	6550	7112	562	1		1	1	MISSP				20	1	
28	22N	7W			NE	SW	O&G	66	1230	6544			36	2.23	428	1	MISSP					3	
28	22N	7W		E2	W2	SE	O&G	85	1277	6610	7204	594	5	0.16	33	1	MISSP				22	1	1
29	22N	7W			NW	NE	O&G	84	1264	6600	7186	586	4	0.67	122	1	MISSP				18	1	1
29	22N	7W			NE	SW	O&G	66	1255	6630	7236	606	98	2.06	461	1	MISSP					3	
29	22N	7W		SW	NE	SE	O&G	84	1235	6576	7182	606	8	0.10	26	1	MISSP				12	1	3
30	22N	7W	E2	W2	NE	NW	O&G	84	1238				1	0.42	75	2	MISSP						
30	22N	7W				NE	O&G	78	1238	6585	7168	583	13	1.07	201	1	MISSP					3	
30	22N	7W			NE	SW	O&G	65	1219	6610	7200	590	108	1.63	395	1	MISSP				44	1	2
30	22N	7W				SE	O&G	84	1278	6588	7186	598	11	0.22	50	1	MISSP				14	1	
31	22N	7W			SE	NE	O&G	79	1200	6617	7233	616				1	MISSP					3	
31	22N	7W	N2	S2	NW	NE	O&G	80	1200	6606	7232	626	13	0.16	41	1	MISSP						
31	22N	7W	NW	NW	SE	SW	O&G	83	1181	6620	7216	596	8		8	1	MISSP				47	1	
31	22N	7W			NW	SE	O&G	66	1192	6626	7226	600	50	2.63	513	1	MISSP				27	2	2
31	22N	7W			SE	SE	O&G	79	1187	6630			1		1	2	MISSP						
32	22N	7W			SE	NW	O&G	66	1213	6654	7299	645	231	4.20	970	1	MISSP				34	2	2
32	22N	7W		NW	NW	NW	O&G	84	1230	6610	7230	620				1	MISSP						
32	22N	7W			NW	NE	O&G	78	1247	6592	7210	618				1	MISSP				121	1	1
32	22N	7W		S2	SE	NE	O&G	84	1266	6642	7262	620				1	MISSP				85	1	
32	22N	7W		SE	NW	SW	O&G	79	1220	6650	7260	610				1	MISSP					3	
32	22N	7W		S2	SE	SW	O&G	85	1237	6650	7260	610				1	MISSP				130	1	
32	22N	7W			SE	SE	O&G	76	1250	6671	7304	633				1	MISSP				111	1	
32	22N	7W	SE	NE	NW	SE	O&G	84	1235							2	MISSP						
33	22N	7W			SW	NE	O&G	66	1273	6634	7230	596	226	3.66	870	1	MISSP	RDFRK			59	2	2
33	22N	7W			SE	NE	O&G	83					17		17	2	MISSP						
33	22N	7W			SE	SW	O&G	76	1287	6681			3	1.33	237	2	MISSP						
34	22N	7W			SE	NW	O&G	66	1288	6606	7187	581	77	4.22	820	1	MISSP	RDFRK			68	1	2
34	22N	7W	E2	W2	SE	NE	O&G	84								2	MISSP						
34	22N	7W		N2	N2	NE	O&G	84	1305							2	MISSP						
34	22N	7W			SE	SW	O&G	77	1296	6652	7240	588				2	MISSP						
35	22N	7W		SW	SE	NE	O&G	68	1284	6471			69	1.54	340	2	MISSP						
35	22N	7W	SW	NW	SE	SE	O&G	78	1318				8	0.26	54	2	MISSP						
36	22N	7W				E2	O&G	68	1284	6480	7080	600	28	1.29	255	2	MISSP						
36	22N	7W			NE	NE	O&G	78					9	0.15	35	2	MISSP						
36	22N	7W	SW	NE	NE	SW	O&G	78					4	0.12	25	2	MISSP						
1	22N	8W	S2	N2	SW	NW	O&G	85	1298	6502	7082	580	1	0.01	3	1	MISSP				1	1	
1	22N	8W			N2	NE	O&G	84	1304	6482	7062	580	2		2	1	MISSP				1	1	1

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINOR'
1	22N	8W		NE	SW	SW	O&G	84	1285	6520	7098	578		0.04	7	1	MISSP				1	1	1
1	22N	8W			NW	SE	O&G	65	1294	6496	7070	574	19	2.49	457	1	MISSP				15	1	1
2	22N	8W			W2	NW	O&G	84					2		2		MISSP						
2	22N	8W		W2	E2	NE	O&G	84	1301	6522	7100	578	1	0.07	13	1	MISSP				5	1	
2	22N	8W			SE	SE	O&G	84	1295	6551	7120	569	1	0.23	41	1	MISSP						
2	22N	8W			NE	SW	O&G	65	1253	6500	7079	579	28	3.71	681	1	MISSP				22	2	2
3	22N	8W			SE	NW	O&G	66	1307	6546	7133	587	19	2.15	397	1	MISSP				23	2	2
3	22N	8W			N2	NE	O&G	84					5	0.05	14		MISSP						
3	22N	8W		E2	SW	SE	O&G	84	1279	6550	7125	575	3	0.15	29	1	MISSP				4	1	
4	22N	8W			NE	NW	O&G	84					1		1		MISSP						
4	22N	8W		W2	SE	SW	O&G	84					2	0.22	41		MISSP						
4	22N	8W			NW	SE	O&G	66	1286	6602	7138	536	11	1.10	205	1	MISSP				39	1	
5	22N	8W			NW	SE	O&G	67	1308	6593	7162	569	7	0.30	60	1	MISSP				26	2	2
6	22N	8W				SW	O&G	80					3	0.01	5		MISSP	HUNTN					
6	22N	8W			NW	SE	O&G	68	1242	6550	7126	576		0.01	2	1	MISSP				34	2	2
7	22N	8W			NW	SE	O&G	67	1261	6628			4	-0.98	176		MISSP						
8	22N	8W		N2	SW	SW	O&G	84	1244					0.03	5	1	MISSP						
8	22N	8W			NW	SE	O&G	66	1259	6600	7178	578	8	1.61	291		MISSP						
9	22N	8W		E2	NW	NE	O&G	84					1	0.09	17		MISSP						
9	22N	8W			NW	SE	O&G	66	1263	6592	7180	588	16	3.01	546	1	MISSP				18	1	1
10	22N	8W				NW	O&G	78	1289	6592	7163	571		0.37	65	1	MISSP				25	1	
10	22N	8W	S2	N2	SW	SW	O&G	84	1297	6638	7208	570		0.34	60	1	MISSP				1	1	1
10	22N	8W			NW	SE	O&G	65	1291	6608			24	3.09	568	1	MISSP				39	2	2
11	22N	8W		SE	NW	NW	O&G	84	1275				2	0.12	23	1	MISSP						
11	22N	8W		W2	NE	SW	O&G	84						0.01	2		MISSP						
11	22N	8W			NW	SE	O&G	66	1272	6560	7138	578	33	5.05	922	1	MISSP				56	2	2
12	22N	8W			SE	NW	O&G	65	1271	6537	7114	577	48	5.75	1060	1	MISSP				34	2	
12	22N	8W			E2	NE	O&G	83						0.03	5		MISSP						
12	22N	8W			SE	NE	O&G	82	1283	6530	7106	576		0.01	2	1	MISSP						
12	22N	8W			SE	SW	O&G	84	1261	6555	7129	574	1	0.63	112	1	MISSP				19	1	1
12	22N	8W		N2	SE	E2	O&G	87	1283	6552	7120	568		0.02	4	1	MISSP				7	1	
13	22N	8W			NW	NW	O&G	87	1253	6552	7130	578		0.06	11	1	MISSP				8	1	
13	22N	8W		S2	N2	NE	O&G	86	1274	6570	7138	568		0.10	18	1	MISSP				41	1	
13	22N	8W			NE	SW	O&G	65	1247	6565	7130	565	44	6.71	1225	1	MISSP				5	1	2
13	22N	8W		SW	NE	SE	O&G	84	1269	6568	7146	578		0.34	60	1	MISSP				1	1	
14	22N	8W			NW	NW	O&G	84					2	0.43	78		MISSP						
14	22N	8W		S2	NE	NE	O&G	87	1267	6574	7149	575		0.10	18	1	MISSP				42	1	
14	22N	8W			NE	SW	O&G	65	1215	6586	7154	568	28	3.17	586	1	MISSP						
14	22N	8W			NE	SE	O&G	85						0.01	2		MISSP						
15	22N	8W			SW	NW	O&G	84						0.47	83		MISSP						
15	22N	8W	N2	S2	NW	NE	O&G	84	1268	6625	7190	565	1	0.23	41	1	MISSP				10	1	
15	22N	8W				SW	O&G	84	1263	6664	7224	560	1	0.22	40	1	MISSP				2	1	1
15	22N	8W			NW	SE	O&G	66	1233	6622	7188	566	46	5.18	958	1	MISSP				22	2	4
16	22N	8W			N2	NW	O&G	83	1247	6592	7168	576		0.20	35	1	MISSP				64	1	
16	22N	8W			N2	NE	O&G	84	1264	6508	7048	540		0.05	9	1	MISSP				4	1	
16	22N	8W		E2	NE	SW	O&G	66	1259	6656	7228	572	45	5.54	1020	1	MISSP				24	2	2
17	22N	8W		SW	NE	NW	O&G	84	1246	6625				0.10	18	1	MISSP				2	1	
17	22N	8W		N2	SE	NE	O&G	84	1242	6636	7200	564	1	0.13	24	1	MISSP				32	1	1
17	22N	8W			NE	SW	O&G	66	1243	6656	7227	571	14	2.18	398	1	MISSP				44	1	2
17	22N	8W		NW	SE	SE	O&G	85	1229	6640	7202	562		0.23	40	1	MISSP				64	1	
18	22N	8W		E2	SW	SW	O&G	84	1235	6748	7310	562	1	0.08	15	1	MISSP				92	1	
18	22N	8W			NW	SE	O&G	67	1272	6702			5	0.95	172		MISSP						
19	22N	8W		S2	NW	NE	O&G	84	1279	6718				0.26	46	1	MISSP						
19	22N	8W			NW	SE	O&G	66	1293	6779			13	2.25	409		MISSP						
20	22N	8W		E2	NW	NW	O&G	84	1263	6696	7304	608		0.55	97	1	MISSP				38	1	
20	22N	8W		E2	NW	SW	O&G	84	1266	6742	7316	574	1		1	1	MISSP				41	1	1

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
20	22N	8W		N2	SE	NE	O&G	87	1234		7218			0.10	18		MISSP						
20	22N	8W			NW	SE	O&G	66	1244	6704	7266	562	14	2.97	537	1	MISSP				9	2	
21	22N	8W			N2	NW	O&G	83	1228	6652	7216	564	1	0.80	142	1	MISSP				22	1	
21	22N	8W			NE	NE	O&G	77	1264	6700			6	1.41	254		MISSP						
21	22N	8W			NW	NE	O&G	66	1215	6662	7214	552	26	2.92	540	1	MISSP				28	2	2
22	22N	8W		W2	NE	NW	O&G	84	1240	6662	7240	578		0.10	18	1	MISSP				8	1	
22	22N	8W			N2	NE	O&G	84									MISSP						
22	22N	8W		NW	SE	NE	O&G	87	1219	6630	7210	580				1	MISSP				1	1	
22	22N	8W		N2	NW	SE	O&G	65	1215	6640	7220	580	41	4.70	868	1	MISSP				27	2	2
22	22N	8W			SW	SW	O&G	84						0.58	102		MISSP						
23	22N	8W	N2	S2	NW	NW	O&G	82	1235	6621			1	0.15	27		MISSP						
23	22N	8W			NE	NE	O&G	83	1228	6621			1	0.27	49		MISSP						
23	22N	8W			NE	SW	O&G	64	1194	6578			55	6.42	1185	1	MISSP				25	2	
24	22N	8W		SE	NW	NW	O&G	84	1240	6592	7178	586	1	0.22	40	1	MISSP				4	1	
24	22N	8W			NE	SW	O&G	65	1219	6583	7172	589		6.13	1079	1	MISSP				57	2	
24	22N	8W			SE	SE	O&G	84	1232	6582	7174	592	2	0.24	44	1	MISSP				77	1	
24	22N	8W			N2	NE	O&G	85	1248	6590	7154	564	1		1	1	MISSP				10	1	
25	22N	8W			NE	NW	O&G	84	1217	6596	7190	594	12	0.32	68	1	MISSP				83	1	
25	22N	8W			NE	NE	O&G	84	1212	6580	7172	592	3	0.19	36	1	MISSP				120	1	
25	22N	8W			NE	SW	O&G	64	1214	6642	7240	598	146	2.07	510	1	MISSP	HUNTN				4	
25	22N	8W			NE	SE	O&G	84	1214	6620	7206	586	2		2	1	MISSP				2	1	
26	22N	8W			NE	NW	O&G	64	1202	6620	7220	600	52	4.90	914	1	MISSP					4	
26	22N	8W		SE	SE	NE	O&G	78	1202	6613	7220	607	84	0.69	205	1	MISSP						
26	22N	8W			NE	SW	O&G	63	1217	6660	7248	588	84	0.43	160	1	MISSP					4	
26	22N	8W			SE	SE	O&G	82	1219	6652	7256	604	15	0.04	22	1	MISSP				48	1	
27	22N	8W	W2	W2	E2	NW	O&G	83	1211	6648	7230	582	4	0.50	92	1	MISSP	HUNTN			52	1	
27	22N	8W	S2	W2	SE	NE	O&G	77	1198	6626	7214	588	4	0.70	127		MISSP						
27	22N	8W			SE	SW	O&G	83	1213	6680	7264	584	8	0.07	20	1	MISSP	MANNG			91	1	
27	22N	8W			NW	SE	O&G	64	1209	6656	7238	582	62	2.03	419	1	MISSP					4	1
28	22N	8W				NW	DRY	86	1218	6680	7254	574				1					8	1	1
28	22N	8W		E2	NW	NW	O&G	87	1218	6680	7248	568				1	MISSP						
28	22N	8W			NW	NE	O&G	84	1283	6662	7234	572	3	0.42	77	1	HUNTN				22	1	
28	22N	8W			NW	SE	O&G	64	1207		7258		18	1.34	254		MISSP						
28	22N	8W			NW	SW	O&G	84	1223	6700	7284	584	1		1	1	MISSP				2	1	1
29	22N	8W		W2	NE	NW	O&G	84	1275	6786			2	0.58	104	1	MISSP						
29	22N	8W			NE	SW	O&G	65	1214	6736	7326	590	23	1.61	306	1	MISSP					4	
29	22N	8W	E2	E2	W2	SE	O&G	84	1213	6720	7326	606	4	0.26	50	1	MISSP				2	1	
30	22N	8W		E2	NW	NE	O&G	84	1295	6792	7378	586	4	0.10	22	1	MISSP				10	1	
30	22N	8W		S2	NW	SW	O&G	84	1280	6816	7402	586	1	0.10	19	1	MISSP				3	1	1
30	22N	8W			NW	SE	O&G	66	1266	6805	7378	573	21	1.06	208	1	MISSP					4	
31	22N	8W			NW	NW	O&G	84	1253	6812	7405	593	5	0.19	38	1	MISSP				66	1	
31	22N	8W			SW	NE	O&G	66	1219	6796	7387	591	19	1.21	232		MISSP						
31	22N	8W	NE	NE	SW	SW	O&G	83	1234	6836	7398	562	15	0.31	70	1	MISSP				120	1	
31	22N	8W			SW	SE	O&G	85	1218	6806	7374	568	7		7	1	MISSP	HUNTN			50	1	
32	22N	8W	NW	SE	NW	NW	O&G	84	1224	6756	7350	594	6	0.29	57		MISSP						
32	22N	8W	E2	E2	NW	NE	O&G	83	1220				6	0.71	131	1	MISSP						
32	22N	8W			SW	SW	O&G	83	1216	6794	7382	588	31	0.54	126	1	MISSP				41	1	
32	22N	8W			NW	SE	O&G	67					24	0.85	174		MISSP						
33	22N	8W			SW	NW	O&G	84	1215	6744	7348	604	2	0.20	37	1	MISSP				5	1	
33	22N	8W			SW	NE	O&G	65	1210	6736	7294	558	15	1.50	279	1	MISSP						
33	22N	8W			SE	SW	O&G	84					5	0.05	14		MISSP						
33	22N	8W			SE	SE	O&G	84	1200	6730	7314	584	1		1	1	MISSP				78	1	
34	22N	8W			NW	NW	O&G	83	1212	6712	7296	584	4	0.17	34	1	MISSP				60	1	
34	22N	8W			SW	NE	O&G	64	1204	6687	7274	587	13	1.89	346	1	MISSP					4	
34	22N	8W			SW	SW	O&G	85	1204	6687	7320	633	6		6	1	MISSP				22	1	
34	22N	8W			NW	SW	O&G	83	1216	6708	7298	590	7	0.24	49	1	MISSP				46	1	

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
34	22N	8W			SW	SE	O&G	79	1217	6712	7308		2		2	1	MISSP				38	1	
35	22N	8W			SE	NW	O&G	62	1253	6746			11	0.71	136		MISSP					4	
35	22N	8W			SE	NE	O&G	65	1238	6702	7324	622	12	2.30	417		MISSP						
35	22N	8W			SE	SW	O&G	64	1260	6751	7355	604	101		101	1	MISSP						
35	22N	8W	NE	SE	NW	SE	O&G	83	1252	6728	7348	620	8	0.16	36	1	MISSP				149	1	
36	22N	8W		SE	NW	NW	O&G	84	1210	6648	7274	626	5	0.10	23	1	MISSP				2	1	
36	22N	8W		SE	NW	NE	O&G	84	1202	6625	7220	595	15	0.15	41	1	MISSP				12	1	
36	22N	8W			NW	SE	O&G	64					54	1.64	343		MISSP						
1	22N	9W				SW	O&G	80	1261	6631	7222	591	5	0.15	31	1	MISSP				10	1	1
1	22N	9W	NE	NE	NW	SE	O&G	68	1250	6586	7190	604	7	0.52	93	1	MISSP				52	2	4
2	22N	9W			SE	NW	DRY	85	1274							1							
2	22N	9W	SE	NW	NW	NW	DRY	81	1301	6650	7252	602				1					4	1	1
2	22N	9W			SE	NE	O&G	80	1279	6626	7228	602	9		9	1	MISSP						
2	22N	9W			NW	SW	O&G	86	1280	6648	7236	588	0	0.10	18	1	MISSP				15	1	
2	22N	9W			SE	SW	O&G	79	1300	6691	7268	577	4		4	1	MISSP				58	1	1
2	22N	9W		SW	SE	SE	O&G	77	1273	6658	7250	592	11	0.30	64	1	MISSP				25	1	
3	22N	9W			SE	NW	O&G	65	1316	6692	7300	608	15		15	1	MISSP	MANNG			19	2	4
3	22N	9W		SW	NW	NW	O&G	73	1329				4	0.30	57	1	MANNG	OSWGO					
3	22N	9W			NW	NE	O&G	65	1308	6666	7252	586	21		21	1	MISSP				17	2	2
3	22N	9W			SE	NE	O&G	77	1296				2	0.15	28		MANNG	OSWGO					
3	22N	9W	E2	W2	SW	SW	O&G	76	1334	6730	7342		9	0.20	44	1	MANNG	OSWGO				3	
3	22N	9W			SE	SE	O&G	79	1306	6714	7300	586	13	0.40	83	1	MISSP					2	2
4	22N	9W			NW	NW	O&G	65	1403	6807	7387	580	89		89	1	MISSP				134	2	2
4	22N	9W			SW	NE	O&G	65	1347	6739	7314	575	89		89	1	MISSP	MANNG					
4	22N	9W			NW	SW	O&G	67	1385				89		89	1	MANNG						
4	22N	9W			NW	SE	O&G	67	1344				89		89	1	MANNG						
5	22N	9W			NW	NW	O&G	66	1394	6812	7402	590	89		89	1	MISSP				8	1	
5	22N	9W			SE	NW	O&G	67	1382				37		37	1	MANNG	OSWGO					
5	22N	9W			SE	NE	O&G	67	1398				89		89	1	MANNG						
5	22N	9W			SE	SW	O&G	67	1371				89		89	1	MANNG						
5	22N	9W			NW	SE	O&G	65	1390	6810	7400	590	89		89	1	MISSP				6	2	
6	22N	9W			SE	NW	O&G	65	1378	6823			12		12	1	MISSP						
6	22N	9W			NE	NW	O&G	75	1385	6808	7396	588	4		4	1	OSWGO				8	1	
6	22N	9W	SW	NE	NW	NW	O&G	82	1385	6822	7414	592	3	0.03	8	1	MISSP	HUNTN			11	1	1
6	22N	9W			SE	NE	O&G	65	1375	6801	7398	597	26	0.40	96	1	MISSP				9	2	
6	22N	9W	N2	S2	NW	NE	O&G	81	1387	6790	7388	598	9		9	1	MISSP	OSWGO	HUNTN		13	1	
6	22N	9W			NW	SW	O&G	83									MISSP	MANNG	HUNTN				
6	22N	9W			SE	SW	O&G	65	1357	6820	7414	594	88	0.60	194	1	MISSP				23	2	2
6	22N	9W			NW	SE	O&G	65	1369	6809	7407	598	37		37	1	MISSP				26	2	2
7	22N	9W			SE	NW	O&G	77	1353	6810	7354	544	24	0.10	42		MISSP	OSWGO	MANNG				
7	22N	9W			NW	NE	O&G	65	1359	6829	7415	586				1	MISSP				14	2	2
7	22N	9W			SE	SW	O&G	76	1355	6846	7380	534	67	0.10	85	1	MISSP	OSWGO	MANNG		6	1	
7	22N	9W		NW	NW	SW	O&G	82	1352	6830	7428	598	4	0.20	39	1	MISSP	HUNTN			28	1	1
7	22N	9W			NW	SE	O&G	76	1358	6835	7366	531	71		71	1	MISSP	OSWGO	HUNTN		44	1	
7	22N	9W			SW	SE	O&G	83	1348	6830	7424	594	10		10	1	MISSP	OSWGO	HUNTN	VIOLA	4	1	
7	22N	9W			SE	SE	O&G	82	1342	6832	7410	578	26		26	1	MISSP	OSWGO	VIOLA		1	1	
8	22N	9W			NW	NW	O&G	67	1366				89		89	1	MANNG						
8	22N	9W			NW	NE	O&G	67	1371				89		89	1	MANNG						
8	22N	9W			NW	SW	O&G	70	1357				20		20	1	OSWGO						
8	22N	9W			NW	SE	O&G	67	1357				29		29	1	MANNG	OSWGO					
9	22N	9W			NW	NW	O&G	68	1378	6834	7414	580				1	MISSP	MANNG					
9	22N	9W			NW	NE	O&G	65	1349	6768	7370	602	75	0.40	145	1	MISSP				1	2	
9	22N	9W	W2	SE	SE	NE	O&G	77									MISSP	OSWGO	MANNG				
9	22N	9W			NW	SE	O&G	76	1366	6814	7410	596	19	0.10	37	1	MISSP						
9	22N	9W			SE	SE	O&G	76	1370	6832	7430	598	15	0.50	103	1	MISSP	MANNG					
9	22N	9W			SE	SW	O&G	77	1363	6824			12	0.20	47		MANNG	OSWGO					

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
9	22N	9W		NW	NW	SW	O&G	79	1365	6849	7453	604	13	0.20	48		MISSP	OSWGO	MANNG				
10	22N	9W		SW	SE	NW	O&G	79	1354	6762	7362	600	3	0.16	31	1	MISSP	RDFRK			18	1	
10	22N	9W	E2	W2	SE	NE	O&G	77	1326	6735	7310	575	5		5	1	MISSP				6	1	1
10	22N	9W			SE	SW	O&G	65	1301	6804	7398	574	32	1.00	208	1	MISSP				30	1	
10	22N	9W			SE	SE	O&G	65	1328	6765	7339	574	9	0.79	148	1	MISSP				38	1	1
11	22N	9W		SW	NE	NW	O&G	85	1333	6737	7319	582	3		3	1	MISSP				26	1	
11	22N	9W	NE	NE	SW	NE	O&G	84	1284	6687	7262	575	2	0.15	28	1	MISSP				1	1	
11	22N	9W			SW	SW	DRY	65	1329	6770						1							
11	22N	9W			NW	SE	O&G	67	1303	6702	7306	604	13	1.17	219	1	MISSP					3	
12	22N	9W			NW	NW	O&G	84	1287	6664	7274	610	4	0.57	104	1	MISSP				8	1	
12	22N	9W		S2	NW	NE	O&G	87	1276	6642	7232	590				1	MISSP				2	1	
12	22N	9W			NW	SE	O&G	67	1288	6679	7302	623	8	0.73	136	1	MISSP				12	1	1
13	22N	9W			NE	NW	O&G	84	1335	6730	7350	620	1		1	1	MISSP				1	1	
13	22N	9W		E2	NW	NE	O&G	84	1296	6712	7312	600	1	0.07	13	1	MISSP				2	1	
13	22N	9W			NW	SE	O&G	67	1339	6784	7380	596	6	0.56	105	1	MISSP					3	
14	22N	9W			NE	NE	O&G	84	1324	6756	7362	606	1		1	1	MISSP				1	1	
14	22N	9W			NW	SE	O&G	67	1308	6752	7334	582	15	0.46	96	1	MISSP					3	
15	22N	9W			SE	NW	O&G	65	1356	6814	7401	587				1	MISSP				60	2	1
15	22N	9W			SW	NW	DRY	51	1349	6820	7410	590				1							
15	22N	9W			SE	NE	O&G	65	1318	6777	7368	591	27	0.40	97	1	MISSP				10	1	
15	22N	9W			SW	SW	O&G	69	1350	6834	7408	574	29		29	1	MISSP	MANNG			48	1	
15	22N	9W			NW	SE	O&G	76	1313	6786	7374	588	33	0.10	51	1	MISSP	MANNG			16	1	
16	22N	9W			SE	NW	O&G	69	1354	6823	7408	585	41	0.20	76	1	MISSP				15	1	
16	22N	9W			NW	NE	O&G	69	1358	6872	7414	542	35	0.20	70	1	MISSP	MANNG			23	1	
16	22N	9W			NW	SW	O&G	76	1353	6847	7440	593	48		48	1	MISSP	OSWGO	MANNG		13	1	
16	22N	9W			SW	SE	O&G	81	1349	6846	7430	584	3		3	1	MISSP				88	1	
16	22N	9W			NE	SE	O&G	70	1357	6833	7407	574	47		47	1	MISSP	MANNG			44	1	
17	22N	9W			NW	NW	O&G	76	1316	6842	7422	580	57	0.20	92	1	MISSP	OSWGO	MANNG		19	1	
17	22N	9W	SW	NE	SE	NW	O&G	81	1352	6850			23	0.10	41		MISSP	OSWGO	MANNG	VIOLA			
17	22N	9W		S2	SW	NW	O&G	82	1352	6854	7438	584	6	0.04	13	1	MISSP	MANNG	VIOLA		5	1	1
17	22N	9W	N2	S2	NW	NE	O&G	77	1345	6836	7426		43	0.10	61	1	MISSP	OSWGO	MANNG		41	1	
17	22N	9W			NW	SW	O&G	77	1348	6852	7428	576	13	0.04	20	1	MISSP				35	1	
17	22N	9W			NW	SE	O&G	76	1332	6846			19		19	1	MISSP	OSWGO	MANNG				
17	22N	9W		S2	SW	SE	O&G	82	1351	6866	7428	562	10		10	1	MISSP	MANNG	VIOLA				
17	22N	9W	N2	SE	SE	SE	DRY	81															
17	22N	9W	NE	SE	SE	SE	O&G	81	1346	6895	7474	579	13		13	1	MISSP	RDFRK	MANNG		29	1	
18	22N	9W			SE	NW	O&G	79	1343	6874	7420	546	46	0.10	64		MISSP	OSWGO	MANNG				
18	22N	9W			NW	NW	O&G	77	1344	6869	7470	601	45	0.10	63	1	MISSP	MANNG	HUNTN		19	1	
18	22N	9W		W2	NW	NE	O&G	80					22	0.10	40		MISSP	OSWGO	HUNTN				
18	22N	9W			SE	NE	O&G	77	1344	6852	7440	588	34	0.10	52	1	MISSP	OSWGO	MANNG	HUNTN	27	1	
18	22N	9W			NW	SW	O&G	77	1339	6882	7490	608		0.25	44	1	MISSP	OSWGO	MANNG		2	1	
18	22N	9W			SE	SW	O&G	78	1337	6895	7494	599	75		75	1	HUNTN				4	1	
18	22N	9W		S2	SE	SW	O&G	81	1339							1	MISSP	OSWGO	MANNG	VIOLA			
18	22N	9W			NW	SE	O&G	78	1337	6870			30	0.10	48	1	MISSP	OSWGO	MANNG				
18	22N	9W		SE	SE	SE	O&G	80	1339	6908	7502	594	15		15	1	MISSP	HUNTN			4	1	
19	22N	9W			SE	NW	O&G	78	1332	6909	7516	607	17	0.12	38	1	MISSP	OSWGO	MANNG		7	1	
19	22N	9W			NW	NW	O&G	79	1334	6905			18	0.10	36		MISSP	OSWGO	MANNG	HUNTN			
19	22N	9W		NW	NW	NE	O&G	81	1337	6886	7488	602	3		3	1	MISSP	VIOLA			14	1	
19	22N	9W			SE	NE	O&G	79	1341	6922	7512	590	25	0.25	69	1	MISSP	OSWGO	MANNG	HUNTN	46	1	
19	22N	9W			NE	SW	DRY	65	1335	6942	7558	616				1					20	2	2
19	22N	9W		NW	NW	SW	O&G	80	1337	6942			4		4	1	MISSP	OSWGO			24	1	
19	22N	9W	NW	SE	SE	SE	O&G	79	1340	6973	7520	547	9	0.08	23		MISSP	OSWGO	MANNG	HUNTN			
20	22N	9W		W2	NW	NW	O&G	79	1334	6910	7522	612	22		22	1	MISSP				14	1	
20	22N	9W		NE	NE	NW	O&G	83	1339	6868			23		23	1	MISSP	OSWGO			1	1	
20	22N	9W			SE	NW	O&G	79	1341	6886			28	0.10	46		MISSP	OSWGO	MANNG	HUNTN			
20	22N	9W		NE	SW	NE	DRY	64	1336	6883	7470	587				1						4	

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
20	22N	9W			SE	NE	O&G	78	1336	6885	7474	589	26	0.15	52	1	MISSP	OSWGO	MANNG	HUNTN			
20	22N	9W			SE	SW	O&G	79	1335	6938	7530	592	13	0.10	31	1	MISSP	OSWGO	MANNG	HUNTN	24	1	
20	22N	9W			NW	SE	O&G	79	1333	6883	7535	652	13		13		MISSP	OSWGO	MANNG				
21	22N	9W			NW	NW	O&G	79	1339	6865	7456	591	34		34	1	MISSP	OSWGO	MANNG		60	1	
21	22N	9W	S2	N2	NW	NE	O&G	78	1346	6866	7450	584	17		17	1	MISSP	OSWGO	MANNG	HUNTN	1	1	
21	22N	9W			NW	SW	O&G	79	1338	6878	7474	596	7	0.10	25		MISSP	MANNG					
21	22N	9W			NW	SE	O&G	78	1336	6890	7474	584	13		13	1	MISSP	OSWGO	MANNG	HUNTN	2	1	
22	22N	9W			SW	NW	O&G	81	1344	6884	7446	562	4		4	1	MISSP				42	1	
22	22N	9W			NE	NE	O&G	77	1323	6810	7350	540	14		14		MISSP	MANNG					
22	22N	9W			NE	SW	O&G	79	1356	6882			2		2		MISSP	MANNG					
22	22N	9W			SW	SW	O&G	79	1344	6896	7464	568	13	0.05	22	1	MISSP	OSWGO	MANNG		1	1	
22	22N	9W			NW	SE	O&G	69	1335	6868			3		3	1	MISSP						
22	22N	9W			NE	SE	O&G	80	1324	6852	7426	574	3	0.15	29	1	MISSP				4	1	
23	22N	9W			SE	SW	O&G	85	1307				1	0.20	36	1	MISSP						
23	22N	9W			NW	SE	O&G	67	1282	6794	7382	588	17	2.73	497	1	MISSP						
24	22N	9W			NW	SE	O&G	67	1298	6798	7410	612	11	2.28	412	1	MISSP				19	1	
25	22N	9W			NE	NW	O&G	84					2		2		MISSP						
25	22N	9W			SW	SW	O&G	84	1261	6810	7402	592	2	0.05	11	1	MISSP				28	1	
25	22N	9W			NW	SE	O&G	66	1285	6822	7410	588	23	1.61	306	1	MISSP					4	
26	22N	9W		E2	NW	NW	O&G	84	1300	6865	7452	587	2	0.16	30	1	MISSP				12	1	
26	22N	9W			SE	SW	O&G	84	1280	6830	7464	574	7	0.11	26	1	MISSP				2	1	
26	22N	9W			NW	SE	O&G	66	1280	6860	7428	568	22	0.95	189	1	MISSP					4	
27	22N	9W			NE	NW	O&G	80	1317	6900	7464	564	4		4	1	MISSP				5	1	
27	22N	9W			SW	NE	O&G	81	1324	6900	7482	582	7	0.15	33	1	MISSP				29	1	
27	22N	9W			SW	SW	O&G	80	1331	6962	7550	588	3		3	1	MISSP				18	1	1
27	22N	9W			SW	SE	O&G	80					7	0.04	14		MISSP						
27	22N	9W			NW	SE	O&G	67	1318	6906	7485	579	7	0.04	14		MISSP						
28	22N	9W			NW	NW	O&G	78	1332	6915	7524	609	8	0.12	29	1	MISSP	OSWGO	RDFRK	MANNG	2	1	
28	22N	9W			SW	NE	O&G	67	1335	6926	7514	588				1	MISSP						
28	22N	9W			NW	NE	O&G	81	1342	6929	7520	591	2		2	1	MISSP	MANNG			46	1	
28	22N	9W			NW	SW	O&G	78					6	0.08	20	1	MISSP	OSWGO	MANNG	HUNTN	8	1	
28	22N	9W			NW	SE	O&G	81	1337	6954	7548	594	5		5	1	MISSP				23	1	
29	22N	9W			NW	NW	O&G	79	1340	6974	7568	594	13	0.12	34	1	MISSP	OSWGO	MANNG		108	1	
29	22N	9W			NW	SW	O&G	80	1335	6985	7530	545	7		7		MISSP	OSWGO	MANNG				
29	22N	9W			SE	NE	O&G	80	1317	6923	7538	615	1		1	1	MISSP				147	1	
30	22N	9W			NW	NE	O&G	79	1341	6966	7574	608	9	0.10	27	1	MISSP	OSWGO	MANNG	HUNTN	28	1	
31	22N	9W			NW	NW	DRY	70	1329	7054	7690	636				1					53	1	
31	22N	9W			SE	NW	O&G	80	1343	7072			2		2		MISSP	OSWGO	INOLA				
31	22N	9W			NW	NE	O&G	80	1336	7040			2		2		MISSP	OSWGO					
31	22N	9W	N2	N2	N2	SW	DRY	73	1337	7078													
31	22N	9W		SE	SE	SW	O&G	82	1344	7056	7690	634	8		8		MISSP						
31	22N	9W			NW	SW	O&G	81					3	0.07	15		MISSP	OSWGO	MANNG				
31	22N	9W			SW	SW	DRY	59	1341							1							
31	22N	9W			SE	SE	O&G	81	1387	7040	7654	614	1	0.11	20	1	MISSP	OSWGO			106	1	1
32	22N	9W			SE	NW	O&G	80	1312	7022	7636	614	3		3	1	MISSP				16	1	
32	22N	9W			NW	NE	O&G	81	1315	7002	7608	606	4		4	1	MISSP				194	1	
32	22N	9W			SE	SW	DRY	81	1322	7050	7660	610				1					52	1	
33	22N	9W			NW	NW	O&G	79	1334	6984	7612	628	9	0.03	14		MISSP	OSWGO	MANNG	HUNTN	19	1	
33	22N	9W			NW	NE	O&G	81	1335	7004	7596	592	4	0.02	8	1	MISSP	OSWGO			65	1	
33	22N	9W			NE	SW	DRY	58	1326	7002	7630	628				1							
33	22N	9W			NW	SW	O&G	80	1333	7024	7656	632	9	0.03	14	1	MISSP	OSWGO	MANNG		50	1	
33	22N	9W			SE	SE	O&G	80	1332	7010			14	0.02	18		MISSP						
34	22N	9W			SE	NW	O&G	81	1326	6980	7570	590	19	0.05	28	1	MISSP				4	1	
34	22N	9W			SE	NE	O&G	81	1314	6964	7554	590	34	0.25	78	1	MISSP	OSWGO	HUNTN		87	1	
34	22N	9W			NW	SW	O&G	81	1330	7000	7598	598	6		6	1	MISSP	RDFRK			14	1	
34	22N	9W			SE	SW	O&G	81	1328	6990	7590	600	5	0.06	16	1	MISSP	OSWGO			31	1	

SEC	TWP	RGE	S4	S3	S2	S1	ST	YR	ELEV	MISSP	WDFRD	MSISO'	CUOIL'	CUGAS'	EQOIL'	LOGGD'	$PAY1	$PAY2	$PAY3	$PAY4	MSPOR'	LTYPE'	FINDR'
34	22N	9W	N2	S2	NE	SE	O&G	81	1319	6950	7540	590	6		6	1	MISSP				11	1	
35	22N	9W		W2	E2	NW	O&G	84	1282	6900	7474	574	17	0.08	31	1	MISSP				1	1	
35	22N	9W			SW	NE	O&G	67	1278	6883	7460	577	44		44	1	MISSP						
35	22N	9W			SW	SW	DRY	69	1307	6940	7526	586											
35	22N	9W			E2	SW	O&G	84	1298	6935	7518	583	23	0.40	93	1	MISSP						
35	22N	9W			SW	SE	O&G	68	1283	6910	7481	571	101		101	1	SMPSN						
36	22N	9W			SE	NW	O&G	66	1257	6825	7427	602	25	0.86	176	1	MISSP						
36	22N	9W			SW	NE	O&G	62	1252	6825						1	RDFRK						
36	22N	9W		NW	SE	NE	O&G	85	1268	6834	7415	581		0.02	4	1	MISSP				1	1	
36	22N	9W			SE	SW	O&G	84	1277	6854	7452	598	14	0.38	81	1	MISSP				13	1	
36	22N	9W			NW	SE	O&G	64									MISSP	HUNTN					
36	22N	9W			SE	SE	O&G	84	1265	6820	7414	594	9	0.16	37	1	MISSP				1	1	

APPENDIX C

STATISTICAL EQUATIONS

LINEAR CORRELATION COEFFICIENT "r"

$$r = \frac{\sum (X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum (X - \bar{X})^2 /(n - 1)}\sqrt{\sum (Y - \bar{Y})^2 /(n-1)}}$$

where: X = independent variable

$\bar{X}$ = mean of independent variable

Y = dependent variable

$\bar{Y}$ = mean of independent variable

n = number of pairs of variables

"t" TEST OF CORRELATION

$$t = \frac{r\sqrt{n - 2}}{\sqrt{1 - r^2}}$$

ANOVA

$$F = MS_R/MS_D$$

$$MS_R = SS_R/1$$

$$MS_D = SS_D/(n-2)$$

$$SS_R = \sum_{i=1}^{n} (\hat{Y}_i - \bar{Y})^2$$

$$SS_D = SS_T - SS_R$$

$$SS_T = \sum_{i=1}^{n} (Y - \bar{Y})^2$$

$$\hat{Y}_i = b_0 + b_1 X_i$$

$$b_1 = \frac{\sum_{i=1}^{n} X_i Y_i - \left(\sum_{i=1}^{n} X_i \sum_{i=1}^{n} Y_i\right) / n}{\sum_{i=1}^{n} X_i^2 - \left(\sum_{i=1}^{n} X_i\right)^2 / n}$$

$$b_0 = \bar{Y} - b_1\bar{X}$$

APPENDIX D

QUADRAT DATA

QUADRAT DATA

(All production is in thousands of barrels of oil equivalent per quadrat.)
(Lineament data are number of lineament intersections per quadrat.)

Quadrat Data Central Area

	6-Mile Lineament Intersect	Single Zone Mer-Os Cum Prod	All Zones Total Cum Prod
1	70.0	3177	3177
2	79.5	3134	3445
3	61.5	2403	2403
4	42 0	722	722
5	7.5	805	916
6	1.0	271	1119
7	7.0	28	374
8	52.5	882	922
9	56.0	1435	1435
10	82.5	2304	2380
11	110.0	4096	4210
12	91.5	2973	3485
13	67.0	3421	3421
14	67.5	3349	4310
15	117.5	2543	2543
16	124.5	2217	2217
17	74.0	2033	2033
18	51 0	978	1148
19	43.0	202	734
20	6.0	27	778
21	12.0	284	891
22	30.5	583	639
23	21.0	552	552
24	50.0	341	490
25	51.0	1563	1658
26	97.5	4974	4974
27	91.0	5359	6394
28	119.0	2375	2517
29	72.5	2413	2846
30	61 0	1658	1658
31	23.0	902	958
32	24.5	544	689
33	12.0	298	828
34	12.0	68	172
35	1.0	63	639
36	9.0	659	1195
37	51.5	1943	1943
38	62.5	1833	2579
39	32.0	1193	3001
40	27.5	1371	2094
41	43.0	245	947
42	40.5	385	1193
43	49.5	982	1198
44	22.5	544	718
45	2.0	126	3251
46	15.5	234	386
47	25.5	215	675
48	18.0	168	896

Quadrat Data Urban Area

6-Mile Lineament Intersect	Single Zone Mer-Os Cum Prod	All Zones Total Cum Prod
0.0	1077	1077
27.0	2017	2017
5.0	1933	1933
0 0	544	1364
23.5	2888	3119
24.0	2768	2768

Quadrat Data Sand Dune Area

6-Mile Lineament Intersect	Single Zone Mer-Os Cum Prod	All Zones Total Cum Prod
0.0	112	2377
0.0	251	1937
0.0	1004	3121
0.0	524	1910
0.0	108	611
0.0	145	1366
0.0	69	707
0.0	300	1235
0.0	52	238
0.0	182	396

VITA

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Doctor of Philosophy

Thesis: A METHOD FOR PREDICTING FRACTURE-ENHANCED PERMEABILITY IN REGIONS OF "FLAT-LYING" STRATA

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