SEQUOYAH FUELS
A GENERAL ATOMICS COMPANY

RE: 0329-N

August 8, 2003

Federal Express

Susan Frant, Chief
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
And Safeguards, NMSS
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, MD 20852-2738

Subject: License No. SUB-1010, Docket No. 040-08027
Reclamation Plan Acceptance Review, Request for Additional Information

Dear Ms. Frant:

In a letter dated March 24, 2003, your staff accepted the Sequoyah Fuels Corporation (SFC) Reclamation Plan for technical review. A request for additional information (RAI) was included in that letter. Enclosed, please find SFCs response to the majority of the RAI contained in the request (Enclosure 1). This response does not include questions related to protecting water resources, GW1 and GW2. SFC is currently working on the disposal cell liner configuration and leakage detection system in order to complete our response to your questions. We plan to submit our responses with any necessary changes to the Reclamation Plan by August 29, 2003.

Also enclosed with this letter is a complete revision to Appendix A (Enclosure 3) and Appendix E (Enclosure 2) of the Reclamation Plan submitted in January of this year. These appendices have been revised in response to your RAI. Please remove Appendix A from your copy of the Reclamation Plan and replace it with Enclosure 3. Remove Appendix E and replace it with Enclosure 2. Discard the current Appendix A and Appendix E. A spine insert is included inside the binder cover of Appendix E to replace the spine in the Reclamation Plan, Appendix E – H.

NMSS01

HIGHWAY 10 & I-40 PO BOX 610, GORE, OKLAHOMA 74435 (918) 489-5511 FAX: (918) 489-2291

If you have any questions, don't hesitate to call me at (918) 489-5511, ext. 13 or Craig Harlin at ext. 14.

Sincerely,

John H. Ellis
President

xc: Myron Fliegel, US NRC (3 copies)
Rebecca Tadesse, US NRC (2 copies)
Al Gutterman, ML&B
Acting Chief, EPA Reg 6
Pat Gwin, Cherokee Nation
Patricia Ballard, NRMNC
Michael Broderick, OKDEQ
Kelly Burch, OKAG
Timothy Hartsfield, USACE

ENCLOSURE 1
Sequoyah Fuels Corporation
Reclamation Plan Acceptance Review
Request for Additional Information

SFC Responses to Request for Additional Information
August 8, 2003

ENCLOSURE 1
Sequoyah Fuels Corporation
Reclamation Plan Acceptance Review
SFC Responses to Request for Additional Information

This enclosure outlines the responses for the Requests for Additional Information (RAIs) prepared by the U.S. Nuclear Regulatory Commission (NRC) in their acceptance review of the Reclamation plan for the Sequoyah Fuels Corporation facility near Gore, Oklahoma.

The NRC RAIs are organized by the following technical areas: (1) geology, (2) seismology, (3) geotechnical stability, (4) surface water hydrology and erosion protection, (5) protecting groundwater resources, and (6) disposal of non-11e.(2) byproduct material. The RAIs are presented below, followed by the response (in bold type) and where the supporting information is found.

Geology

G1. *Requirement to account for potential capable faults [criterion 4(e) of 10 CFR 40, Appendix A].* Please provide information to demonstrate that SFC has investigated and analyzed known and potential faults within 200 miles of the site that might be capable faults. The following types of information should be provided for each potential capable fault: name, location, length, distance from site, evidence that it is a capable fault (see 10 CFR part 100, Appendix A), evidence of the frequency and amount of displacement, and age of last movement. The investigation should seek to discover and include up-to-date information concerning potential capable faults, such as recent geological maps, geophysical surveys, and seismicity maps.

The NRC has reviewed seismic conditions in the vicinity of the site, and determined that none of the known faults near the site are capable faults (documented in the December 18, 1995 letter from John Hickey to SFC). In developing responses to this RAI, SFC updated previously submitted information and revised in its entirety Appendix E to the Reclamation Plan. The supporting information that was previously supplied to NRC, and expanded evaluation of seismic conditions in the site area have been presented in the revised Appendix E to the Reclamation Plan which has been included here as Enclosure 2 to this response. Discussion of the material provided (consistent with the criteria in 10 CFR 40 and applicable guidelines in 10 CFR 100) is included in Sections 3 and 4 of the revised Appendix E of the Reclamation Plan.

G2. *Requirement to account for geomorphic stability [criteria 4(d) and 6(1)(i) of 10 CFR 40, Appendix A.* Please provide information to demonstrate that SFC

has investigated and analyzed the terrain around the site to assure that there are not on-going or potential processes, such as gully erosion (e.g., gully #007), which would lead to impoundment instability over the next 200 to 1000 years. The types of information that should be provided are described in the geomorphic features and related sections of the "Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites under Title II of the Uranium Mill Tailings Radiation Control Act" (NUREG-1620). The analyses should consider the potential effects of headward erosion of gullies over the next 200 to 1000 years. The effects on the site geomorphic and hydrologic systems caused by future removal or degradation of nearby river-dams should be considered. [Note: criterion 4(d) refers to potential gully erosion of the terrain surrounding the planned impoundment; other requirements pertain to gully erosion of the cover material].

The SFC site, as well as planned reclaimed features, are hydraulically separate and erosionally stable from extreme flood events on the Illinois and Arkansas Rivers. In addition, the criteria for geomorphic stability have been incorporated in the disposal cell design by locating the cell at the top of the drainages and providing rock protection on the side slopes and perimeter apron of the completed cell. The stability of the site and these planned features in terms of gully intrusion potential is addressed in Section 6 of the revised Appendix E of the Reclamation Plan.

Seismology

S1. Provide an updated listing and a map (up to the present) showing the earthquake distribution within 200 miles of the site.

This information is provided in Section 4 of the revised Appendix E of the Reclamation Plan.

S2. Identify which tectonic province both the site and the June 20, 1926 earthquake are located in and the other tectonic provinces within 200 miles of the site. Estimate the acceleration at the site from this earthquake, using an updated attenuation equation.

This information is provided in Section 4 of the revised Appendix E of the Reclamation Plan.

S3. Is the site located in the same tectonic province as the Black Fox NPP Station? Explain.

As shown on Figure 3.1 of The revised Appendix E of the Reclamation Plan, the SFC Facility is located at approximately the contact between three tectonic provinces: (1) the Ozark uplift, (2) the Cherokee platform, and (3) the Arkoma basin. The Black Fox Nuclear Power Plant (NPP) site is within the Cherokee platform tectonic province.

S4. Discuss the effect of the earthquakes associated with the Nemaha Uplift, Ozark Uplift, Arkoma Basin-Ouachita Uplift, and Cherokee Basin-Central Oklahoma Platform on the site and estimate the acceleration, using a recent attenuation equation from the largest earthquake that has occurred or could occur in each of these uplifts and platform.

This information is provided in Section 4 of the revised Appendix E of the Reclamation Plan.

S5. Provide and clearly explain the ground motion acceleration that will be used for the seismic design for the site and the basis for choosing this value.

This information is provided in Section 5 of the revised Appendix E of the Reclamation Plan.

S6. Discuss whether recent fault mapping in the area identified any of the surrounding faults to be capable. If yes, estimate the maximum earthquake that could be generated from these faults (10 CFR 40, Appendix A).

Recent fault mapping in the area did not identify any of the surrounding faults to be capable. This is explained in Section 3 of the revised Appendix E of the Reclamation Plan.

<u>Geotechnical stability</u>

GT1 In the discussion of infiltration modeling, the statement is made, that with sufficient time for tree development, drainage through the bottom of the cover is essentially zero. This is based, in part, on modeling results that show a portion of the precipitation is stored as biomass, litter and in the soil. This assumes that the storage of precipitation (in biomass, litter, and the soil) continues to grow for

the design life of the cell. Please provide further justification that the storage capability of biomass, litter, and the soil will continue to grow, rather than reaching a steady state.

The modeling estimate of essentially zero infiltration is achieved after approximately 40 years of vegetation development. The estimated infiltration is based on reaching steady state biomass conditions at about 45 years, and not with increasing biomass throughout the design life of the disposal cell. This is discussed on page 13 of the Preliminary Design Report for the Disposal Cell at the Sequoyah Fuels Corporation Facility, included as Appendix C to the Reclamation Plan.

Surface water hydrology and erosion protection

SW1. Provide background information and analysis for conclusion #1 listed on page 2-8 of the Reclamation Plan which states that the river flooding will have no effect on the impoundment.

a. For example, where are the elevation changes being calculated, at the reservoir or at the nearest stream bank? Provide details.

b. Provide information on upstream dams and effects of failure.

The estimated flood contours from the 500-year event on the Arkansas River as well as estimated high water contours from a Tenkiller Ferry Dam breach analysis and a Weber Falls Lock and Dam breach analysis were taken from a flood insurance rate map and the US Army Core of Engineers emergency plans. The maximum water elevation in the site area from these sources is approximately 500 feet. The site facilities and planned disposal cell are above elevation 540 feet (see Figure 1 of this enclosure). Additional details are provided in Section 6 of the revised Appendix E of the Reclamation Plan.

SW2. Provide a discussion of the effects of stream hydraulics for the drainage streams at the site near the impoundment and back up data and modeling, if necessary.

This discussion is provided in Section 6 of the revised Appendix E of the Reclamation Plan.

SW3. Provide a discussion of the types of vegetation that will flourish on the soil cover.

The planned types of vegetation for the cover were provided in the Technical Specifications, Attachment A to the Reclamation Plan.

SW4. Provide maps and/or drawings delineating sub-basins on and near the impoundment.

This basin delineation map is provided in Section 6 of the revised Appendix E of the Reclamation Plan.

SW5. Provide construction specifications and the QA/QC program for rock placement and re-grading.

The construction specifications and QA testing were provided in the Technical Specifications, Attachment A to the Reclamation Plan.

<u>Disposal of non-11e.(2) byproduct material</u>

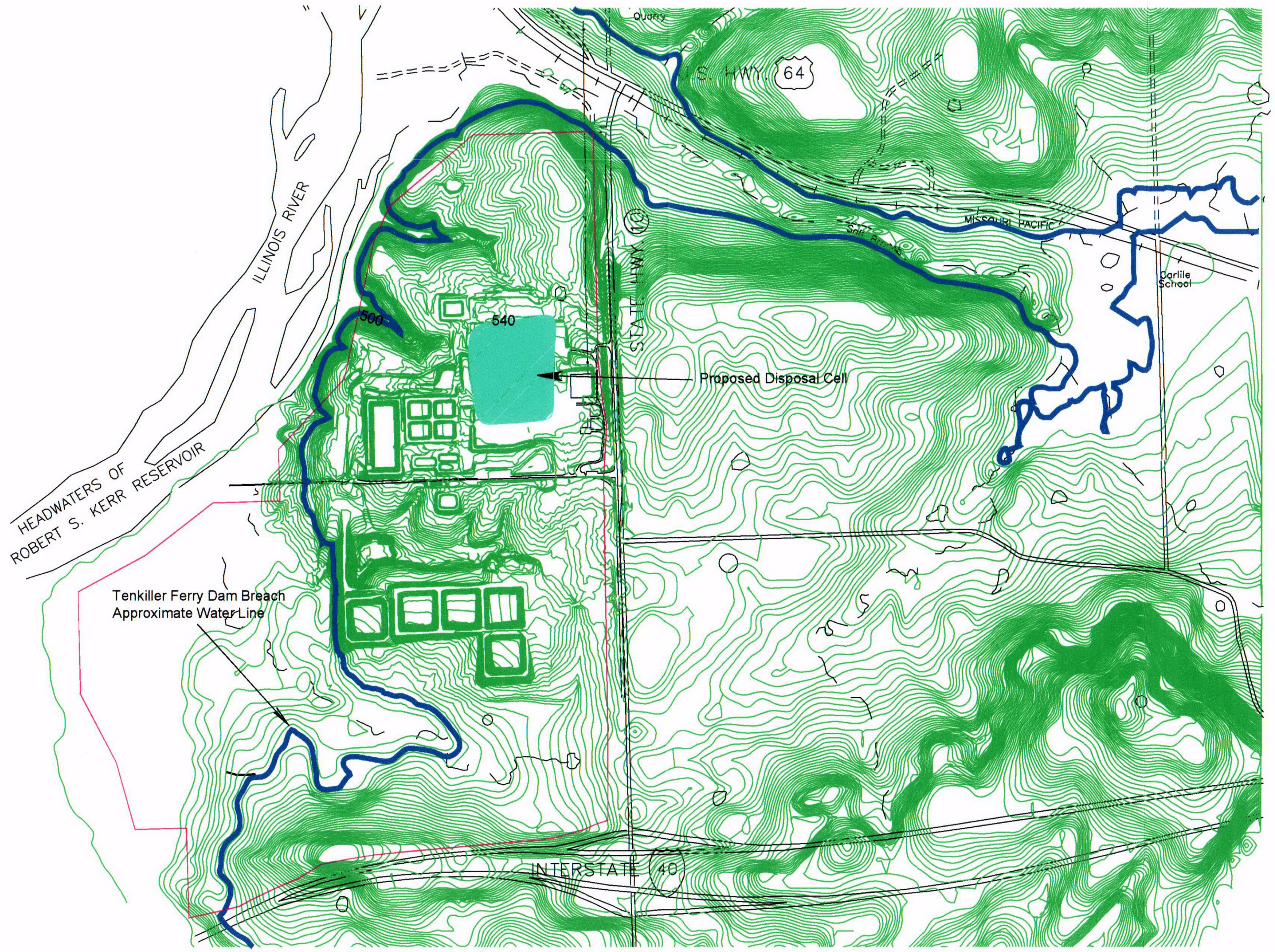
N1. Provide a complete description of the non-11e.(2) byproduct material proposed for disposal in the cell, including chemical analysis and radiological analysis. Identify locations where the non-11e.(2) byproduct material is currently located.

Non-11e.(2) byproduct material proposed for disposal in the cell includes the soils; buildings, equipment and concrete; scrap metal; solid waste burials; drummed contaminated trash; Emergency Basin sediment and soils; North Ditch sediment and soils; the Interim Soil Storage Cell; and Calcium Fluoride sludge and basin liners. Appendix A of the Reclamation Plan has been revised to better describe the non-11e.(2) materials, and the revised Appendix A is provided with this response as Enclosure 3. Locations of non-11e.(2) materials are identified on Figure A-1 in the revised Appendix A to the Reclamation Plan.

Chemical and radiological analyses information is also included in the revised Appendix A to the Reclamation Plan.

N2. In the SFC response to RIS 2000-23 criterion 4, the following statement is made: "Testing has shown that uranium is less leachable from the CaF sludge than from most of the 11e.(2) materials that will be placed in the cell." Provide details of the testing referred to.

Details of testing of the CaF sludge are included as Attachments 1 and 2 of the revised Appendix A to the Reclamation Plan.



SEQUOYAH FUELS CORPORATION	
Title: Maximum Credible Flood Event Water Level Relative to Disposal Cell Location	
PREPARED BY: SFC	Filename: SFC0096A
Reviewed by: CH	Figure No. 1
Date: 07/27/2003	

C01

ENCLOSURE 2
Sequoyah Fuels Corporation
Reclamation Plan Acceptance Review
Request for Additional Information

Sequoyah Facility Seismicity Evaluation
August 8, 2003

SEQUOYAH FUELS CORPORATION
FACILITY SEISMICITY EVALUATION

Prepared For:
Sequoyah Fuels Corporation
I-40 & Highway 10
Gore, Oklahoma 74435

Prepared By:
MFG Inc.
3801 Automation Way, Suite 100
Fort Collins, Colorado 80525

July 2003

consulting
scientists and
engineers

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) has reviewed seismic conditions in the vicinity of the Sequoyah Fuels Corporation (SFC) Facility in Sequoyah County, Oklahoma, and has determined that none of the known faults near the site are capable faults. This was documented in the December 18, 1998 letter from John Hickey to SFC (NRC, 1998b). This report expands and updates the review of seismic conditions and seismicity in the SFC Facility area, and assesses the disposal cell design for seismic events, following guidance given in the Code of Federal Regulations (Appendix A to 10 CFR 40 and Appendix A to 10 CFR 100). This report has been prepared for SFC by MFG, Inc.

1.1 Background

NRC requested that SFC evaluate the potential for seismic activity in the facility area in order to evaluate alternatives for reclamation. Specifically, SFC was asked to (1) account for capable faults in the area as defined in Appendix A of 10 CFR Part 100, (2) document the historical occurrence of seismic events in the area, (3) estimate site acceleration caused by historical and predicted earthquake events, and (4) discuss the input parameters used in the seismic stability analyses.

1.2 Scope of Report

This report has been structured to provide information responding to the four requested seismicity items listed above, as well as geomorphic stability information. The seismicity information in this report has been organized to (1) consolidate previously submitted documentation regarding seismic conditions and seismicity at the SFC Facility, (2) assess faults near the site in terms of capable faults (as defined in Appendix A of 10 CFR 100), (3) assess whether faults within a 200-mile radius of the site are capable of impacting the stability of the site, and (4) determine if the disposal cell design can provide adequate slope stability for potential "random" earthquake events. Supporting information is provided in appendices for this report.

2.0 REGULATORY CRITERIA

2.1 Capable Faults

Regulatory criteria for evaluating seismic conditions for nuclear reactor sites are outlined in Appendix A of 10 CFR 100. Although the SFC Facility is not a nuclear reactor, these criteria will be followed (as applicable) for documenting the capable faults in the site area.

As defined in 10 CFR 100 Appendix A III, (g), a capable fault is a fault that has exhibited one or more of the following characteristics:

1. Movement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the past 500,000 years.
2. Macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.
3. A structural relationship to a capable fault, according to characteristics (1) or (2) above, such that movement on one fault could be reasonably expected to be accompanied by movement on the other.

Faults that are considered of significance in determining the vibratory ground motion at the site are capable faults with minimum lengths as shown in the table below.

Distance from the Site (miles)	Minimum Fault Length (miles)
0-20	1
20-50	5
50-100	10
100-150	20
150-200	40

2.2 Seismicity

The design seismicity and vibratory ground motion at the site are determined following criteria given in Appendix A of 10 CFR 100 and Appendix A of 10 CFR 40. As stated in Appendix A of 10 CFR 40, Technical Criterion 6, design of the waste disposal area shall provide reasonable assurance of control of radiological hazards for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years.

2.3 Seismic Analysis

The approach for evaluation of the seismic stability of earth structures was based on procedures outlined in Seed (1979) and ICOLD (1989). The methods of analysis represent current state of practice, based on the seismicity of the site and the expected response to seismic vibration of the structure to be analyzed. Evaluation of long-term stability (200 to 1,000 years) dictates the use of the maximum credible earthquake as the seismic event producing the maximum acceleration at the structure.

3.0 REGIONAL GEOLOGY AND FAULTING

3.1 Regional Structure

The SFC Facility is located on the southwest flank of a large tectonic feature known as the Ozark Uplift, a major tectonic feature extending from east-central Missouri to northwest Arkansas and northeast Oklahoma (Arbenz, 1956). Quaternary-age alluvial and terrace deposits exist along and adjacent to the major rivers in the region. Bedrock formations present in the region consist of Pennsylvanian, Mississippian, Devonian, Silurian and Ordovician-aged shale, limestone, siltstone and sandstone formations (over 300 million years old). The geological formations regionally dip to the southwest at one to four degrees toward another tectonic feature known as the Arkoma Basin or Shelf. Other major tectonic provinces within a 200-mile radius of the site include the Cherokee Basin-Central Oklahoma Platform (northwest of the site), Nemaha Uplift (northwest of the site), Anadarko Basin and Shelf (west of the site). These provinces are shown in Figure 3.1. The SFC Facility geology is discussed in more detail in the Draft Site Characterization Report (SFC, 1996).

3.2 Faulting

The horst and graben type structural movement found in the area coincides with normal faults, which suggest that tensional forces have been responsible for their formation (Blythe, 1959). Although these faults are not exposed at the surface, some are visible in highway cuts and others are revealed by low hummocky parallel ridges that stretch across pasture lands. Quaternary-aged terrace deposits and alluvial material cover most all of the Atoka Formation Bedrock in the area except where streams and manmade activity has exposed portions of bedrock

The minimum fault lengths for vibratory ground motion in Section 2 (from Appendix A of 10 CFR 100) are established as a guide for determining the Safe Shutdown Earthquake for nuclear reactor sites. Although these criteria are conservative for the design of the disposal cell at the SFC Facility, these minimum fault lengths were used for evaluating faults in the site area.

3.2.1 Faults Within 5 Miles of Site

Figure 3.2 shows all known faults within 5 miles of the SFC Facility, as presented in SFC (1997b). These faults include: (1) the Marble City Fault and its splay (MCF), (2) faults associated with the South Fault of Warner Uplift (SFWU), and (3) the Carlile School Fault. NRC concluded that none of these faults are capable faults (NRC, 1998a), as discussed below.

3.2.1.1 Marble City Fault

As concluded in the December 3, 1998 NRC letter (1998a), the MCF does not meet the criteria for being a capable fault. It does not appear to have experienced displacement in the last 35,000 years or two displacements in the last 500,000 years (Black Fox and Arkansas Nuclear One SERs). There is no macroseismicity associated with it (Earthquake Map of OK, 1995, and updates and interviews with Kenneth Luza). In addition, it is not structurally related to a known capable fault (Black Fox and Arkansas Nuclear One SERs).

The trace of the MCF and its relationship to the CF is shown differently on the Tectonic Map of Oklahoma Showing Surface Structural Features (Arbenz, 1956), Hydrologic Atlas 1 Map (Marcher 1969), and others by Chenoweth (1983), SFC (1996), and Van Arsdale (1998). SFC questions the basis of the state maps in the vicinity of SFC and believes the fault is shown incorrectly. A detailed discussion of the consistency between various geologic maps is in an April 8, 1998 letter to NRC from SFC (SFC, 1998b). However, NRC concluded that the location of the MCF and its relationship to other faults near the SFC site do not need to be pinpointed for the purpose of ascertaining seismic design basis at the site (NRC, 1998a).

3.2.1.2 South Fault of Warner Uplift

The SFWU is tectonically similar to the MCF, in that it is one of a series of northeast-trending normal faults that are arrayed on the southwestern flank of the Ozark uplift or dome. The SFWU is seismotectonically similar to the MCF in that it does not meet any of the criteria for capable faults (e.g., reasons similar to that for MCF as above).

3.2.1.3 Carlile School Fault

As discussed by Van Arsdale (1998) and NRC (1998a), the Carlile School Fault (CF) lies within the transition zone between the Ozark uplift and the Arkoma Basin. The trace of the CF is a narrow zone of tilted Pennsylvanian Atoka Formation strata, marked by a rubbly vegetated ridge approximately 200 feet wide by up to 20 feet high and up to one mile long. The fault has a northeast strike, a displacement of about 100 feet down to the southeast, and a moderate dip to the southeast. Van Arsdale indicates that the fault zone is characterized by rock strata with dips up to 17 degrees southeast, which interrupt the regional southwestern dips of about 5 degrees. During Van Arsdale's site investigation (1998), he found no surface evidence that the Carlile School Fault extends beyond its mapped trace (Fig. 1 in Van Arsdale, 1998), or that it is continuous with the MCF, as has been previously mapped (Arbenz, 1956).

The fault does not meet any of the criteria for a capable fault. The absence of disruption of Quaternary and Holocene sediments that veneer the fault zone as well as the lack of steep scarps show no evidence of the late Quaternary displacement. The fault is estimated to be older than 2 million years (Van Arsdale, 1998 and SFC, 1996). There is no definitive relationship of macroseismicity to the CF (e.g., earthquake map of OK, 1995). The CF does not appear to be structurally related or connected to the MCF (Chenoweth, 1983, and Van Arsdale, 1998); and the MCF is not a capable fault (Black Fox and Arkansas Nuclear One reports). Therefore, based on this information, there is no evidence that the CF is a capable fault.

The NRC concluded that SFC's belief that the east-west splay of the CF that appeared previously in Figure 9 of SFC (1997b) is a remnant of injection well modeling is reasonable and acceptable (NRC, 1998a). Thus, the east-west splay, the only fault that has been suggested to occur within the site boundary, has little or no basis in fact, and need not be considered in establishing the seismic design basis.

3.2.2 Known Active Faults within 200 Miles of Site

Documented Quaternary faults of tectonic origin located within 200 miles of the site that meet the minimum length requirements for vibratory ground motion include the Meers fault and the

Humboldt fault zone. Two other faults located within 200 miles of the site (the Criner fault and the Washita Valley fault) show no Quaternary tectonic movement (Van Arsdale, Ward, and Cox, 1989; Crone and Wheeler, 2000). The Reelfoot scarp and New Madrid seismic zone is tectonically active, but falls outside the 200-mile range. The Meers fault and Humboldt fault zone are discussed below.

3.2.2.1 Meers Fault

The Meers fault, also referred to as the Thomas fault and the Meers Valley fault, is located in southwestern Oklahoma in the Frontal Wichita fault system that is the boundary between the Anadarko basin and the Wichita Mountains. It is the only significant fault within a 200-mile radius of the site with positive documentation of Quaternary tectonic movement. The fault is approximately 54 km (34 miles) long, with the closest section of the fault approximately 306 km (190 miles) from the site. Paleosiesmic studies of the fault establish the occurrence of two late Holocene events, one between 1,100 to 1,300 years ago, and another between 2,000 and 2,900 years ago. Evidence shows temporal clustering of events, and prior to the Holocene events, no surface faulting events have occurred for 100,000 years or more. A recurrence interval of 600 to 1,700 years is estimated based on the two documented Holocene events. A maximum slip-rate, based on two most recent movements is estimated to be between 0.9 and 4.9 mm/yr, but a value of 0.2 mm/yr probably reflects long-term displacement rates (Crone and Wheeler, 2000). Based on the length of fault, the maximum credible earthquake (MCE) associated with the Meers fault is approximately Richter magnitude 7.2.

3.2.2.2 Humboldt Fault Zone

The Humboldt fault zone is a north-northeasterly trending complex set of faults that bound the eastern margin of the Nemaha uplift in Nebraska, Kansas, and Oklahoma. The fault zone and the adjacent uplift are known based on drill-hole data from the region. Because the faults are only known from subsurface data, details of the fault slip and fault patterns are limited. Although convincing surficial evidence of large, prehistoric earthquakes is absent in the area, a regional seismograph network indicate that the structures are currently tectonically active. Based on the length of the fault segments in the Humboldt fault zone, Steepes and others (1990) suggest that

infrequent magnitude 6 or greater earthquakes could occur. The nearest part of the fault zone to the site is close to Oklahoma City, approximately 140 miles from the site.

3.2.3 Other Faults Between 5 and 200 Miles From Site

Faults meeting the minimum length requirements for vibratory ground motion are shown on Figures 3.3 through 3.7. These figures show known faults, as shown on state geologic maps (Cederstrand 1996, Queen and Green, 1997, Anderson, J.A, 1979) regardless of whether or not the faults are considered capable. It is unlikely that the majority of these faults meet the definition of a capable fault, as defined in Appendix A of 10 CFR 100, III, (g). Faults within the states of Kansas, Texas, and Louisiana have not been considered in this report. In lieu of providing positive evidence that all of the faults shown on Figures 3.3 through 3.7 are inactive, for the purposes of this report, all faults were conservatively considered capable. The MCE associated with the faults were evaluated, along with the impact such an earthquake will have on the site. MCE and seismicity at the site is addressed in Section 4.3.

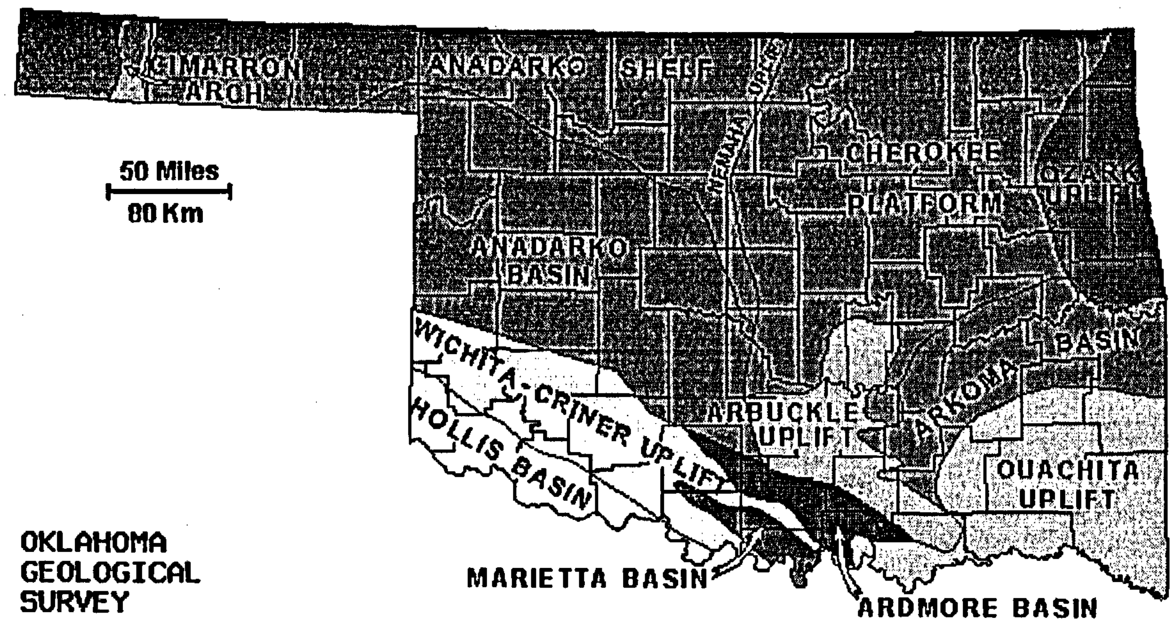
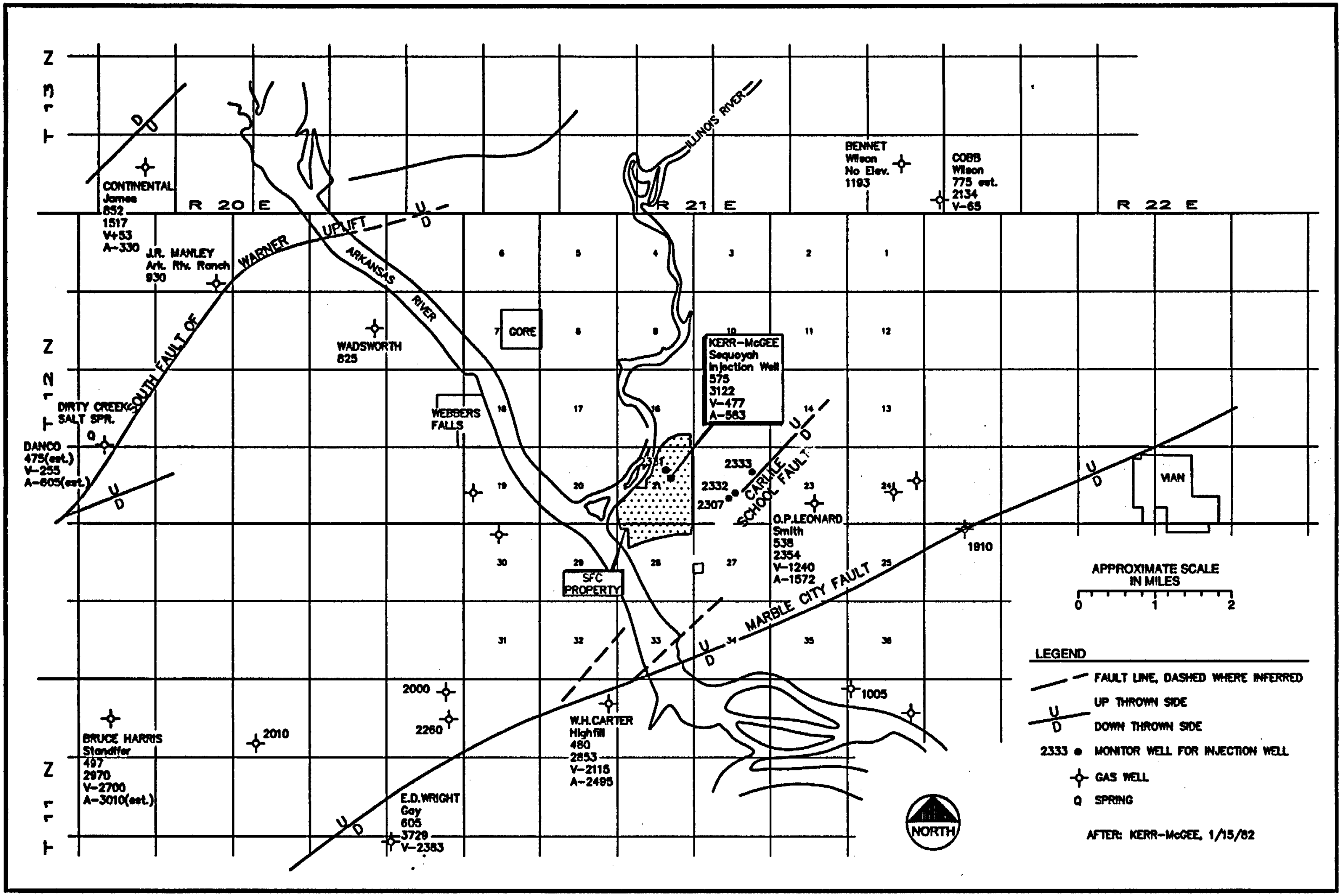


Figure 3.1 Geologic Provinces of Oklahoma (From Northcutt and Campbell, 1995)



consulting scientists and engineers

FIGURE 3.2
FAULTS WITHIN FIVE MILES RADIUS OF SITE
(ADAPTED FROM FIGURE 9 OF FRI, 1997 AND VAN ARSDALE, 1998)

Date:	JULY 2003
Project:	180734
File:	FAULT-03-JUL.dwg

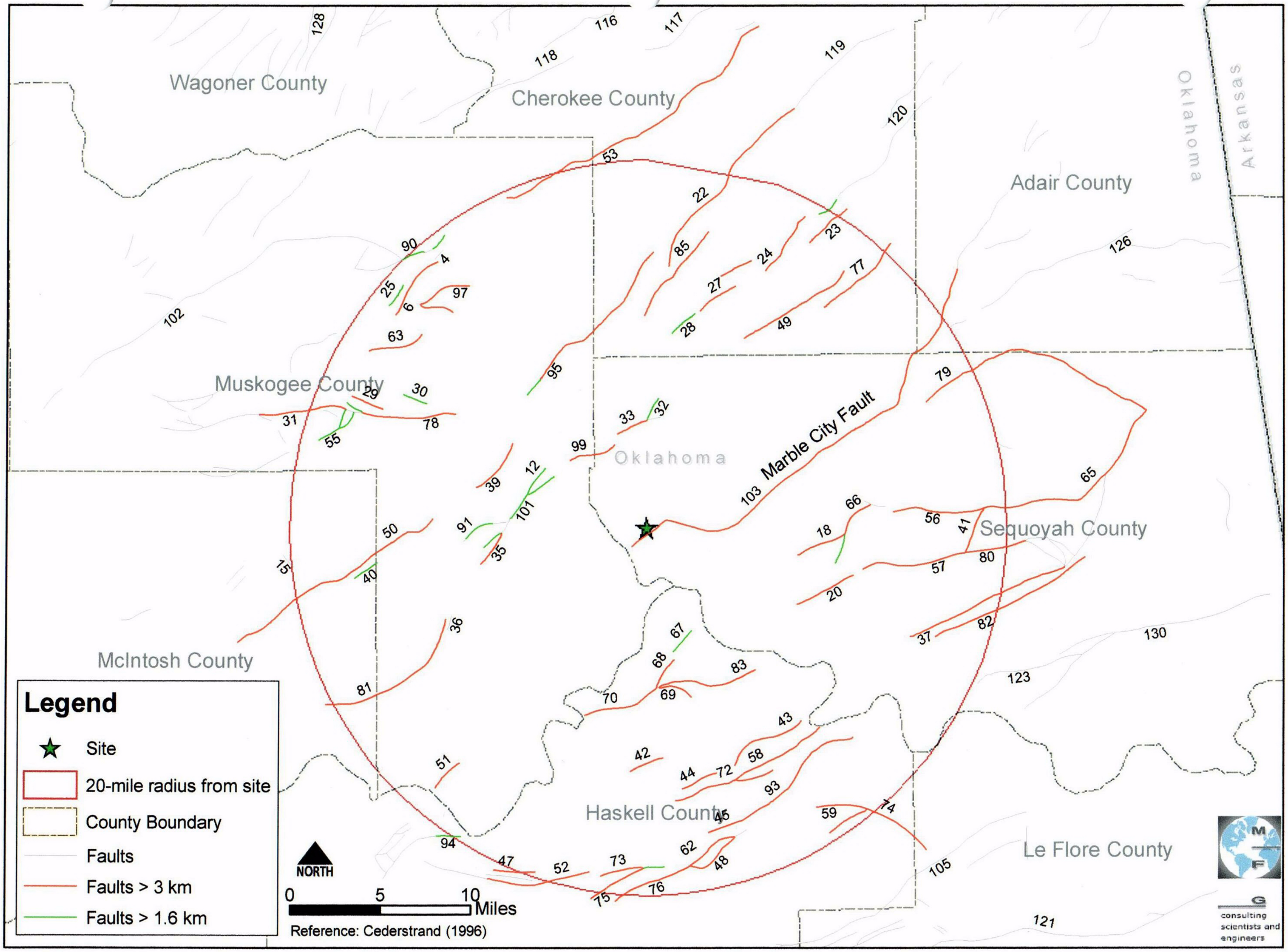


Figure 3.3. Faults located within 20 miles of site

C02

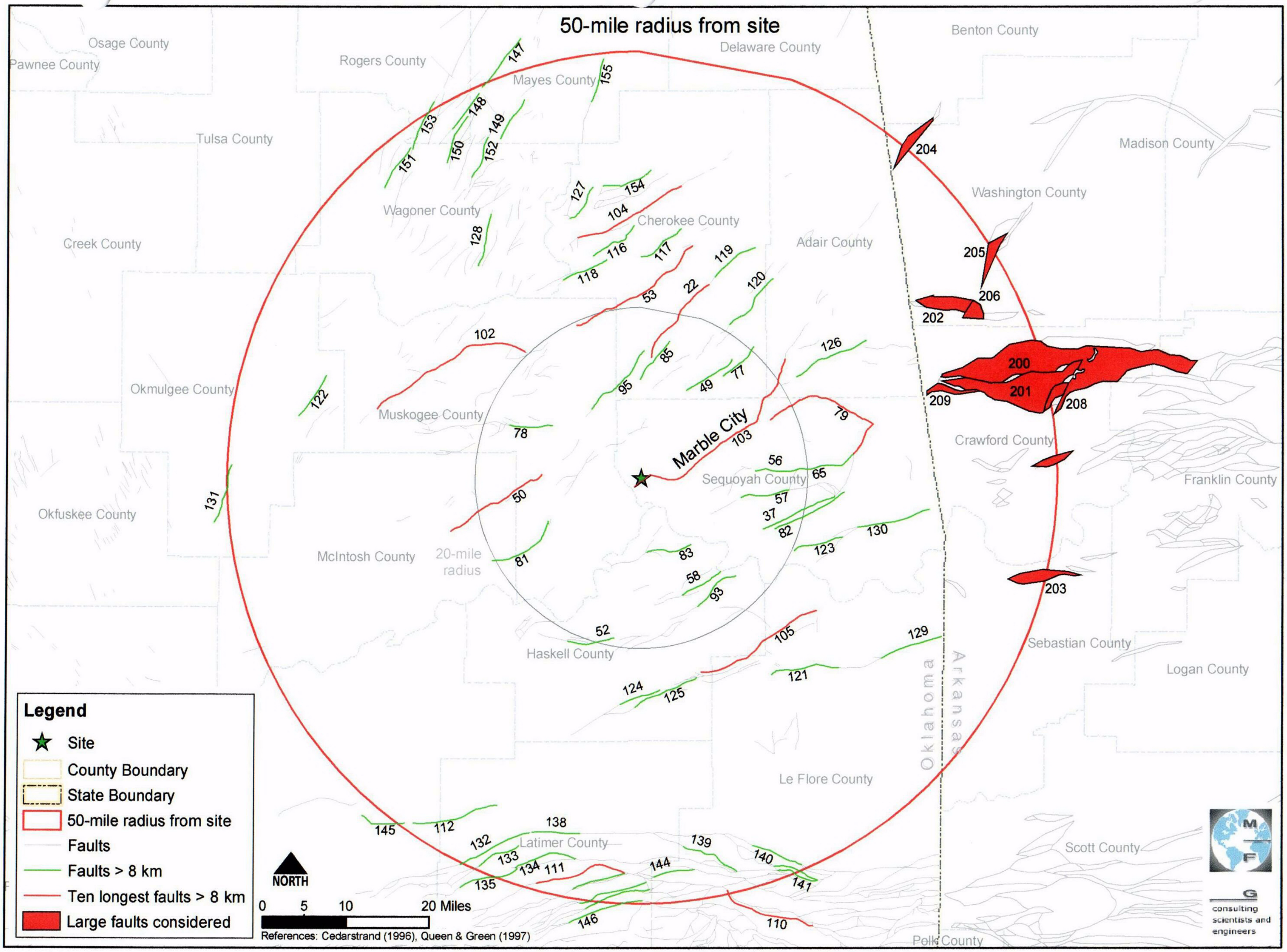


Figure 3.4. Faults located within 50 miles of site

C03

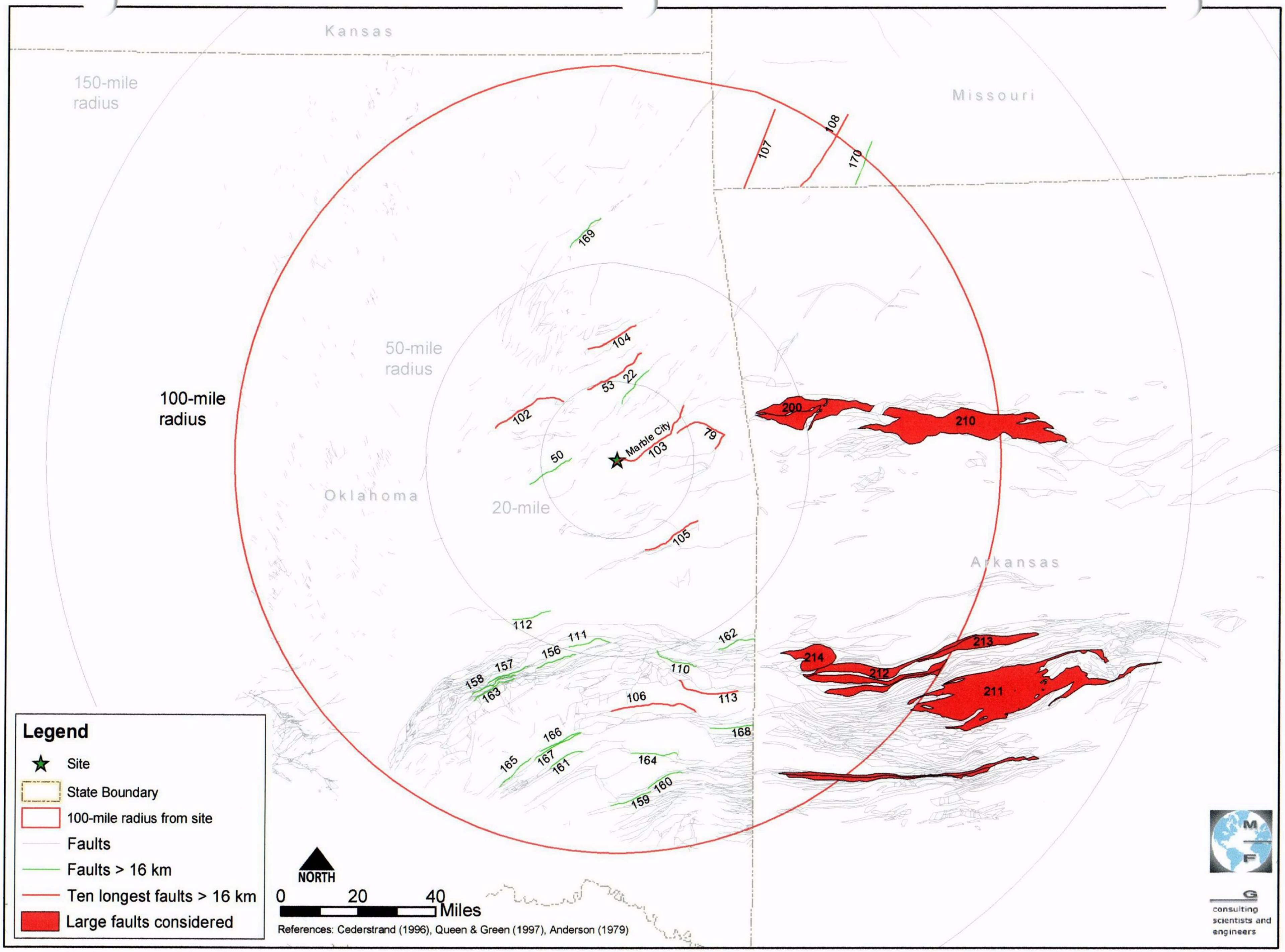


Figure 3.5. Faults located within 100 miles of site

C04

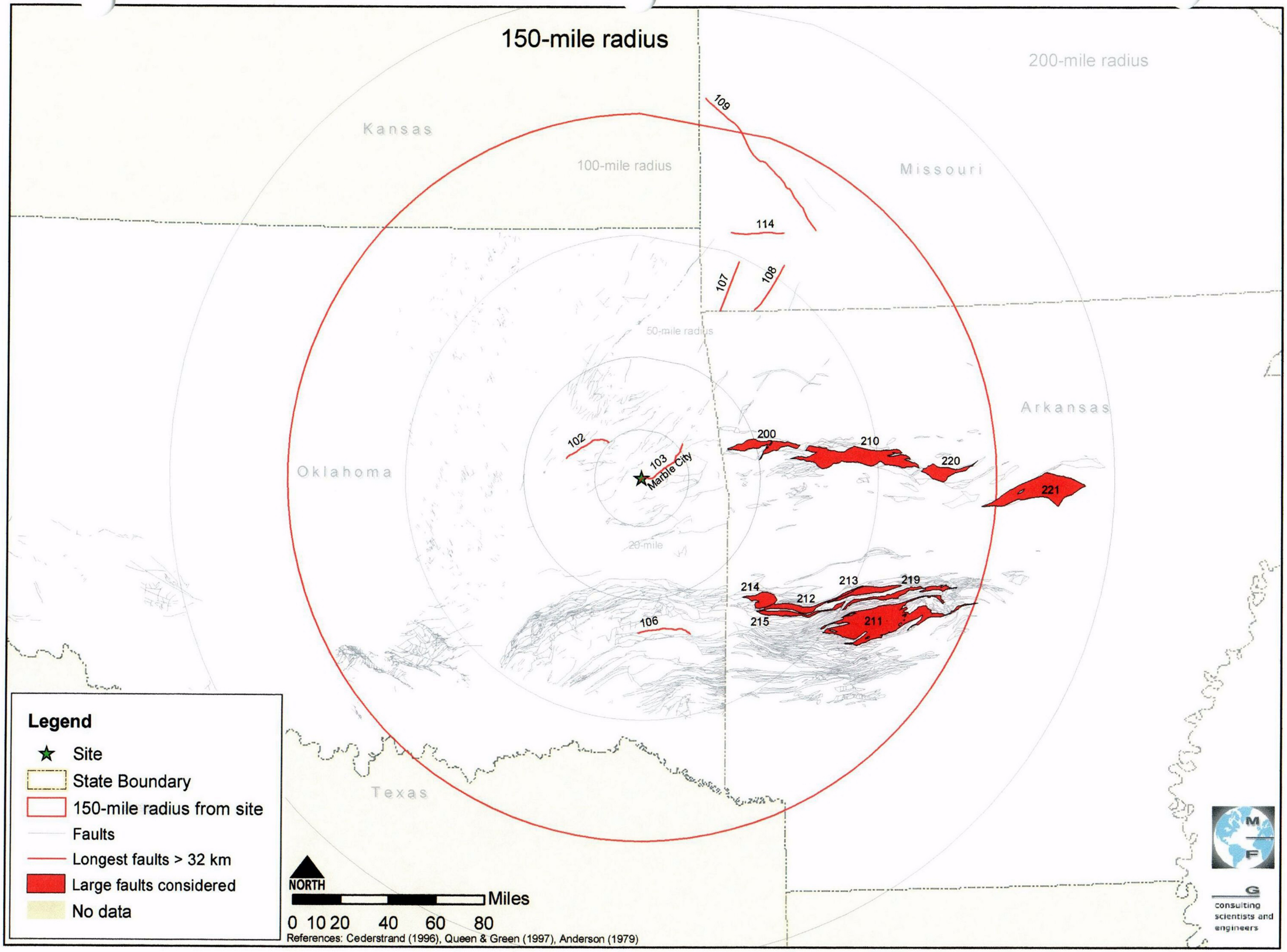


Figure 3.6. Faults located within 150 miles of site

C05

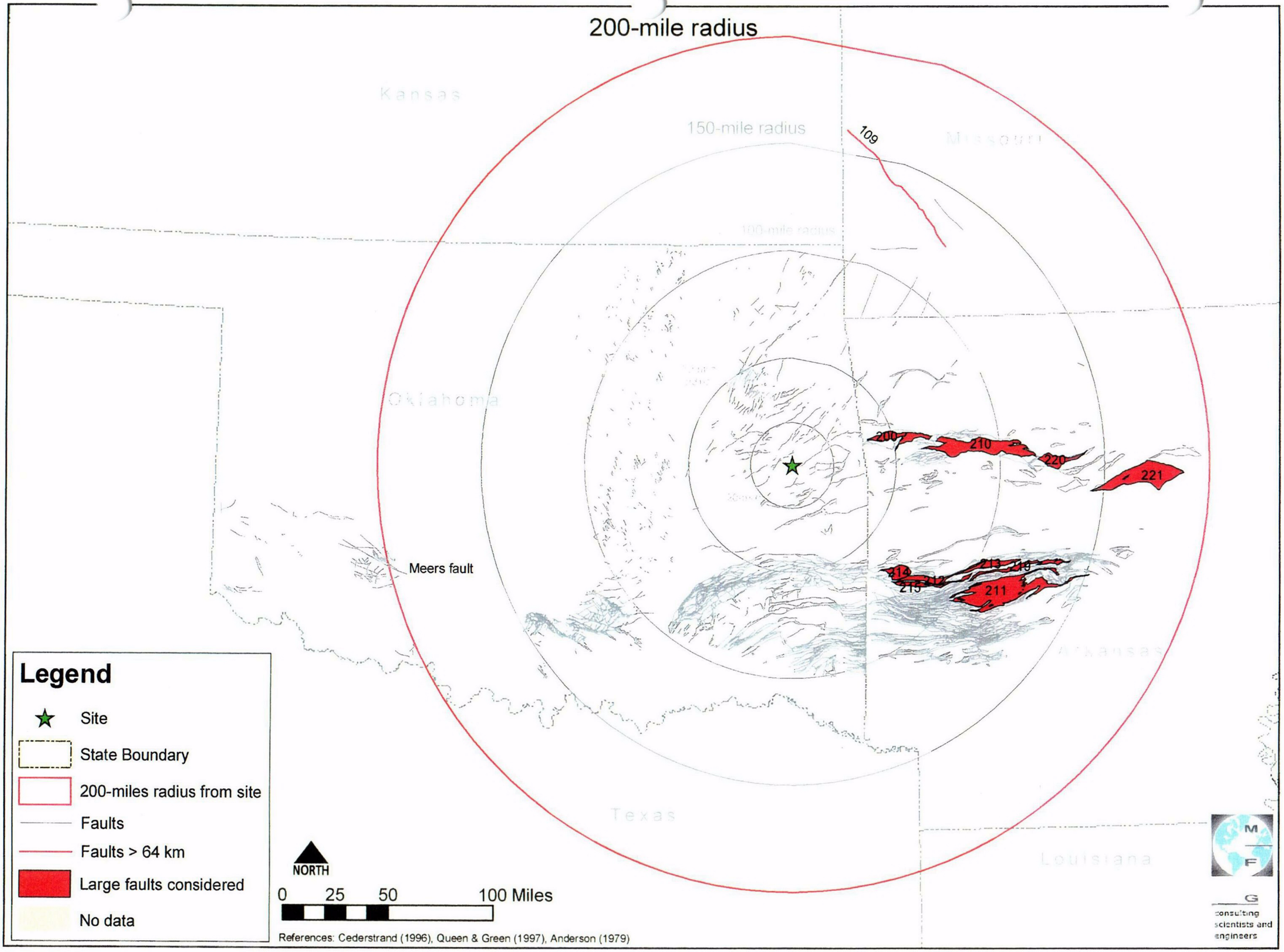


Figure 3.7. Faults located within 200 miles of site

C06

4.0 SEISMIC ACTIVITY HISTORY

Two approaches were used to quantify the potential seismicity in the site area. The first approach consisted of determining the maximum credible earthquake associated with potentially active faults in the site area. Since many earthquakes are not associated with a surface expression of a fault, the second approach consisted of evaluating the seismic history of a tectonic province, with probabilistic modeling to predict expected future events. Prior to discussing the two approaches, the sources of information and seismic activity are reviewed.

4.1 Sources of Information

Surface tracing of faults, as shown on geologic maps (Arbenz 1956, Marcher 1969, Cederstrand 1996, Queen and Green 1997, Anderson, 1979) were used to quantify length of fault and distance from site. National Earthquake Information Center (NEIC) earthquake database from 1534 to 2003 was searched to document known earthquake events with epicenters within the area of interest. The results were compared with data published by the Oklahoma Geological Survey from 1900 to 1998 compiled in Lawson and others (1979), Lawson and Luza (1983) Luza and Lawson (1993), and subsequent publications.

4.2 Seismic Activity

The site seismicity was reviewed in terms of: (1) general regional data, and (2) site area site-specific data, as discussed below.

4.2.1 General Seismicity

Based on general seismicity information, the site is within a region of low seismicity. The region is classified as a Zone 1 area in U.S. Army Corps of Engineers (1982), with a recommended seismic coefficient of 0.025 g (where g is the acceleration of gravity). The region is classified as a Zone 1 area in IBCO (1991), with a recommended seismic coefficient of 0.075 g. USGS National Seismic Hazard Mapping Project (1996) show 0.03 g, 0.045 g and 0.09 g as the peak horizontal acceleration with 10 percent, 5 percent, and 2 percent (respectively) probability of exceedance in 50 years.

The probability-of-exceedance contour lines are shown in Appendix A. Assuming the occurrence of independent main events is represented by a Poisson relationship, the probability of exceedance and return period are related by the following equation:

$$R = 1 - (1 - \frac{1}{T})^n$$

Where R = Risk, or probability of exceedance at least once in an interval
T = average return period, in years
n = number of years in an interval

Therefore, the USGS accelerations listed above correspond to 475-year, 975-year, and 2,475-year return periods.

4.2.2 Recorded Seismicity

A review of recorded or documented seismic activity within a 300-mile radius of the site was conducted from data compiled by the National Earthquake Information Center (NEIC) of the U.S. Geological Survey. The data were compiled from prior to 1811 through April 2003. The results were compared with data published by the Oklahoma Geological Survey from 1900 to 1998 compiled in Lawson and others (1979), Lawson and Luza (1983) Luza and Lawson (1993), and subsequent publications.

This data shows activity of low magnitude, with epicenters primarily in the central and south-central portion of the state. The largest recorded events from the NEIC data are summarized in Table 4.1. Because site accelerations are dependent on both magnitude of earthquake, and the distance of epicenter from site, it is important to also look at smaller events that occur close to the site. These events are summarized in Tables 4.2 through 4.4. Events producing the greatest vibratory ground motions at the site based on attenuation models (see Section 4.3) are (1) the New Madrid events of 1811 and 1812, (2) a magnitude 4.2 event in Sequoyah County on June 20, 1926, (3) a magnitude 2.9 event in Muskogee County on March 31, 1975, (4) a magnitude 5.5 event in south-central Oklahoma on October 22, 1882, and (5) a magnitude 3.4 event on October 8, 1915 in Rogers County. A complete record of events within a 300-mile radius of the site is included in Appendix B.1

Table 4.1 Summary of Events With Magnitude 5.0 and Larger

Rank	Date	Richter Magnitude	Distance from Site (mi)	(km)	Comments
1	Dec 16, 1811	7.2	263	424	New Madrid MO, a.m.
2	Dec 16, 1811	7.0	263	424	New Madrid MO, p.m.
3	Jan 5, 1843	6.0	257	414	New Madrid MO
4	Oct 22, 1882	5.5	116	186	South-central OK
5	Apr 24, 1867	5.1	263	424	Northeast KS
6	Oct 21, 1965	5.1	267	429	Southeast MO
7	Apr 9, 1952	5.0	156	251	El Reno, OK
8	March 25, 1976	5.0	259	416	Northeast AR

* Events of Richter Magnitude 5.0 or greater, within 300-mile radius of site.

Table 4.2 Summary of Events Between Magnitude 4.0 and 4.9*

Rank	Date	Richter Magnitude	Distance from Site• (mi)	(km)
1	Jun 20, 1926	4.2	12	19
2	Apr 27, 1961	4.1	43	69
3	Oct 30,1956	4.0	63	101
4	May 2, 1969	4.6	71	114
5	June 1, 1939	4.3	82	132
6	June 2, 1977	4.3	83	133
7	Sep 6, 1997	4.5	96	155
8	Jun 15, 1959	4.0	104	167
9	Feb 16, 1956	4.1	136	219
10	Jan 1, 1969	4.4	139	224
11	Feb 15, 1974	4.2	149	239
12	Jan 18, 1995	4.2	151	243
13	Feb 29, 1920	4.3	153	246
14	Feb 24, 1982	4.0	161	259
15	Jan 24, 1982	4.0	162	261
16	Jan 21, 1982	4.7	163	262
17	May 4, 2001	4.7	163	263
18	Jan 21, 1982	4.1	163	263
19	Dec 28, 1929	4.0	165	265

* Events within 270-km (168-mile) radius of site with Richter Magnitude between 4.0 and 4.9.

Table 4.3 Summary of Events Between 3.0 and 3.9 Magnitude*

Rank	Date	Richter Magnitude	Distance from Site (mi)	(km)
1	Oct 8, 1915	3.4	22	36
2	Nov 18, 1973	3.1	40	65
3	Jan 11, 1961	3.8	48	77
4	Mar 13, 1963	3.1	78	125
5	Apr 2, 1956	3.7	95	152
6	Oct 20, 2002	3.4	102	164
7	Mar 14, 1936	3.6	103	166
8	Jun 8, 1937	3.6	104	167
9	Sep 6, 1985	3.6	112	180
10	May 7, 1963	3.0	112	180
11	Apr 12, 1934	3.9	112	181
12	Jul 8, 1925	3.9	118	190

* Events within 200-km (124-mile) radius of site with Richter Magnitude between 3.0 and 3.9.

Table 4.4 Summary of Events Between 2.0 and 2.9 Magnitude*

Rank	Date	Richter Magnitude	Distance from Site (mi)	(km)
1	Mar 31, 1975	2.9	14	22
2	Mar 1, 1971	2.5	29	47
3	Mar 16, 1976	2.7	30	48
4	May 18, 1962	2.6	33	53
5	Dec 25, 1973	2.8	42	68
6	Mar 13, 1971	2.7	45	73
7	Dec 16, 1987	2.1	50	80
8	May 25, 1986	2.2	51	82
9	Mar 11, 1993	2.7	52	84
10	Nov 22, 1980	2.5	52	84
11	Jan 6, 1984	2.5	53	85
12	Jun 5, 1988	2.1	53	85
13	Sep 23, 1985	2.9	53	86
14	Dec 19, 1976	2.9	54	87
15	Sep 16, 1990	2.5	54	88
16	Mar 5, 1978	2.9	55	89
17	Sep 1, 1962	2.8	56	90

* Events within 100-km (62-mile) radius of site with Richter Magnitude greater than 2.0

The data summarized in the tables above show more low-magnitude events from recent years. This reflects the fact that seismographs that directly measure ground movement (to calculate the release of energy by the Richter Magnitude scale) came into use in the latter part of the twentieth century. Earlier seismic events (such as those in the nineteenth century) were based on observed damage and correlated with the Modified Mercalli earthquake intensity scale, then converted to Richter Magnitude. It should be noted that seismic events of Richter Magnitude 3.0 or less, which correlate roughly with Modified Mercalli intensity III or less, are generally not noticeable.

The recorded events in Tables 4.1 through 4.4 are used to estimate seismic acceleration at the site as outlined below.

4.3 Capable Faults

Existing faults within a 200-mile radius of the site and of minimum length for vibratory ground motion belong in one of two categories: (1) faults that are known to be capable, which include the Meers fault and Humboldt fault zone; and (2) faults that are not known if they are capable, but for purposes of this study will be assumed to be capable (which include the faults shown in Figures 3.3 through 3.7). Faults that are known not to be capable, which include the Carlile

School Fault, the south fault of the Warner Uplift, and the Marble City fault were not considered further in the seismic analysis.

4.3.1 Maximum Credible Earthquake

Several empirical relationships that relate fault parameters to earthquake magnitude have been used to estimate the maximum credible earthquake (MCE) associated with the fault. Relations used in this report are as follows:

$M_s = 2.012 + 1.142 \log L$ (Slemmons, 1982 for world-wide reverse faults)

$M_s = 0.809 + 1.341 \log L$ (Slemmons, 1982 for world-wide normal faults)

Where M_s = surface wave magnitude
L = rupture length (in meters)

Faults were grouped by distance from the site, with ranges corresponding to those shown on Figures 3.3 through 3.7. For each buffer zone, the most critical (i.e. longest) faults were analyzed. Based on the above equations, the MCE associated with the critical faults were calculated, as shown in Appendix B.6. Data for the faults within the state of Arkansas showed faults as polygon areas, while data for faults in Oklahoma and Missouri were modeled as lines. In order to use the above equations for the faults within Arkansas, the centerline length of the polygon area was measured, and surface wave magnitude based on fault length was used.

4.3.2 Attenuation

Attenuation relationships presented in Campbell (1981) were used to estimate the peak ground motions at the site due to seismic events. Maximum site ground accelerations for the MCE associated with faults shown in Figures 3.3 through 3.7 are shown in Appendix B.6. In addition the most significant estimated peak ground accelerations at the site from historic seismic events is shown in Table 4.5. A complete list of seismic events within a 300-mile radius of the site and the estimated peak ground accelerations at the site is presented in Appendix B.1.

Table 4.5 Site Ground Vibratory Motion for Critical Earthquakes

Rank	Date	Richter Magnitude	Distance From Site		Site Acceleration (g)	Comments
			(mi)	(km)		
1	Jun 20, 1926	4.2	12	19	0.023	Sequoyah County
2	Dec 16, 1811	7.2	263	424	0.011	New Madrid, MO a.m.
3	Dec 16, 1811	7.0	263	424	0.009	New Madrid, MO p.m.
4	Mar 31, 1975	2.9	14	22	0.007	Muskogee County
5	Oct 22, 1882	5.5	116	186	0.006	South-Central OK
6	Oct 8, 1915	3.4	22	36	0.006	Rogers County

The maximum estimated accelerations at the site from the recorded earthquake events range from 0.006 g to 0.023 g. The estimated site acceleration from the largest recorded earthquake in site area (the New Madrid event) is 0.011 g.

4.4 Random Earthquakes

The random earthquake approach was taken to determine the design event for earthquakes not associated with identifiable faults, as is the case for most U.S. earthquakes east of the Rocky Mountains. In this semi-probabilistic method, tectonic provinces are established to group regions with similar seismological characteristics. It is assumed that the spatial distribution of earthquakes is uniform across the province. Within the province, historical data of earthquake events are evaluated and magnitude-frequency plots are generated. From the magnitude-frequency plots, magnitudes of differing return periods can be extrapolated. These frequency plots show the probability of earthquake events occurring within the study area. To determine the probability that an earthquake event occurs within a certain part of the study area, the magnitude-frequency must be normalized for area. Five different areas were evaluated.

The first study area is a hypothetical province modeled as a circle with radius of 300 miles that surrounds the site. This circle was picked to look at seismic events occurring closest to the site, including the New Madrid events of 1811 and 1812. The second study area is a circle with a 200-mile radius that approximates the Ozark Uplift tectonic province (in which the site is located), but the site not at the center of this circle. In addition, three of the surrounding tectonic provinces were evaluated to determine what impact an earthquake event in an adjacent province will have on the site. The tectonic provinces and the approximated study areas are shown in Figure 4.1. It should be noted that the boundaries of geologic and tectonic provinces vary

between sources. The boundaries in Figure 4.1 show a generalized boundary of the provinces on a national scale, as shown by Central Energy Team. Figure 3.1 shows a more detailed diagram of the provinces in the state of Oklahoma. It is assumed that the state map is more accurate in describing the province boundaries close to the site, and that the site is located in the Ozark Uplift, as documented in previous reports.

In order to aid in the search of the NEIC database, the provinces are approximated as circular areas. The Nemaha Uplift, which is long and thin, is not easily approximated in this way and is not analyzed separately. However, the area of the Nemaha Uplift is approximately covered in the circle approximations of the Cherokee Platform and the Anadarko Basin, and its exclusion as an individual province is not expected to significantly affect the results of the random earthquake analysis. Figures 4.2 through 4.6 show the earthquake events in each area. For each area, a log-frequency versus magnitude plot was generated, and a straight line fit to the data. The frequency-magnitude data was then normalized with respect to area as described in Lawson (1985) to be of the form

$$M = a + b * \log \frac{A_p}{y * A}$$

where
M = Magnitude of earthquake
y = return period in years
A_p = area of province used in earthquake search
A = area of interest

The Ozark Uplift area produced the greatest magnitude earthquake of 6.7 associated with a 1000-year return period event. Since this province is also the closest to the site (site is within the Ozark Uplift), random earthquakes generated within the Ozark Uplift will govern the seismic design. Typically shallow crustal earthquakes larger than magnitude 6.5 are associated with surface-fault rupture and will not occur randomly. Therefore, events with magnitudes larger than 6.5 are not considered in the random event analysis. Table 4.6 summarizes the earthquake magnitude results for the Ozark Uplift. Frequency versus magnitude graphs for these areas are shown in Appendix B.

Table 4.6 Probabilistic Assessment of Random Earthquakes Within the Ozark Uplift*

	Circle Radius From Site (miles)			
Recurrence Interval (years)	**200**	**50**	**10**	**5**
1,000	6.7	5.5	4.0	3.4
2,000	>6.7	5.8	4.3	3.7
10,000	>6.7	6.5	5.0	4.4

* Values in Richter Magnitude

Taking the earthquake magnitudes shown in Table 4.6 and applying attenuation equations (assuming the epicenter is located as the mean radius of the circle area), the site accelerations are calculated as shown in Table 4.7.

Table 4.7 Site Accelerations from Random Earthquakes Within the Ozark Uplift*

	Mean Radius From Site (mile)			
Recurrence Interval (years)	**141**	**36**	**7**	**3.5**
1,000	0.01	0.02	0.03	0.04
2,000	---	0.03	0.04	0.05
10,000	---	0.05	0.08	0.09

*Values in fraction of gravitation acceleration (g).

The calculated maximum accelerations from Table 4.7 range from 0.01 to 0.09 g.

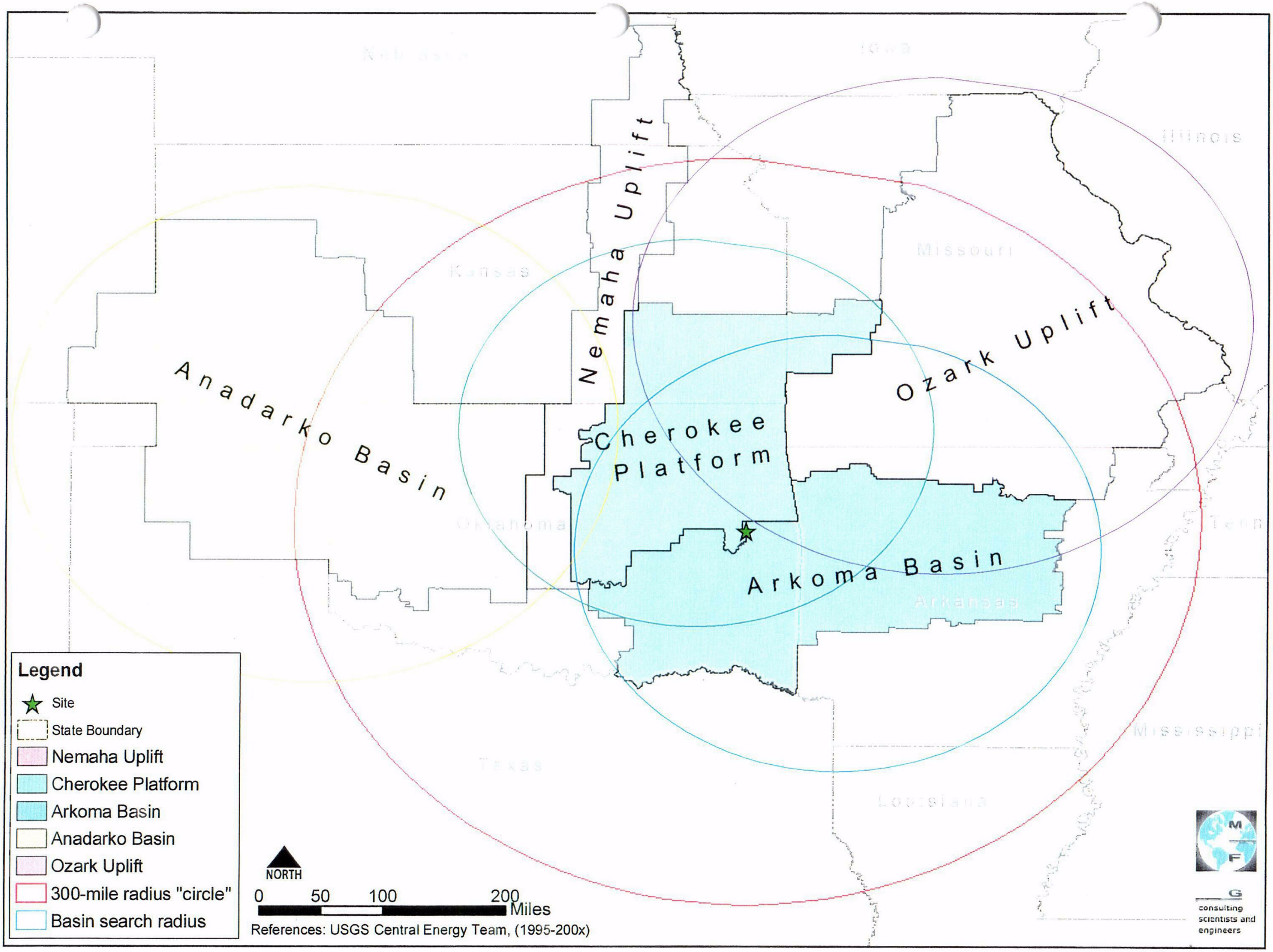


Figure 4.1. Tectonic provinces within 200 miles of site

C07

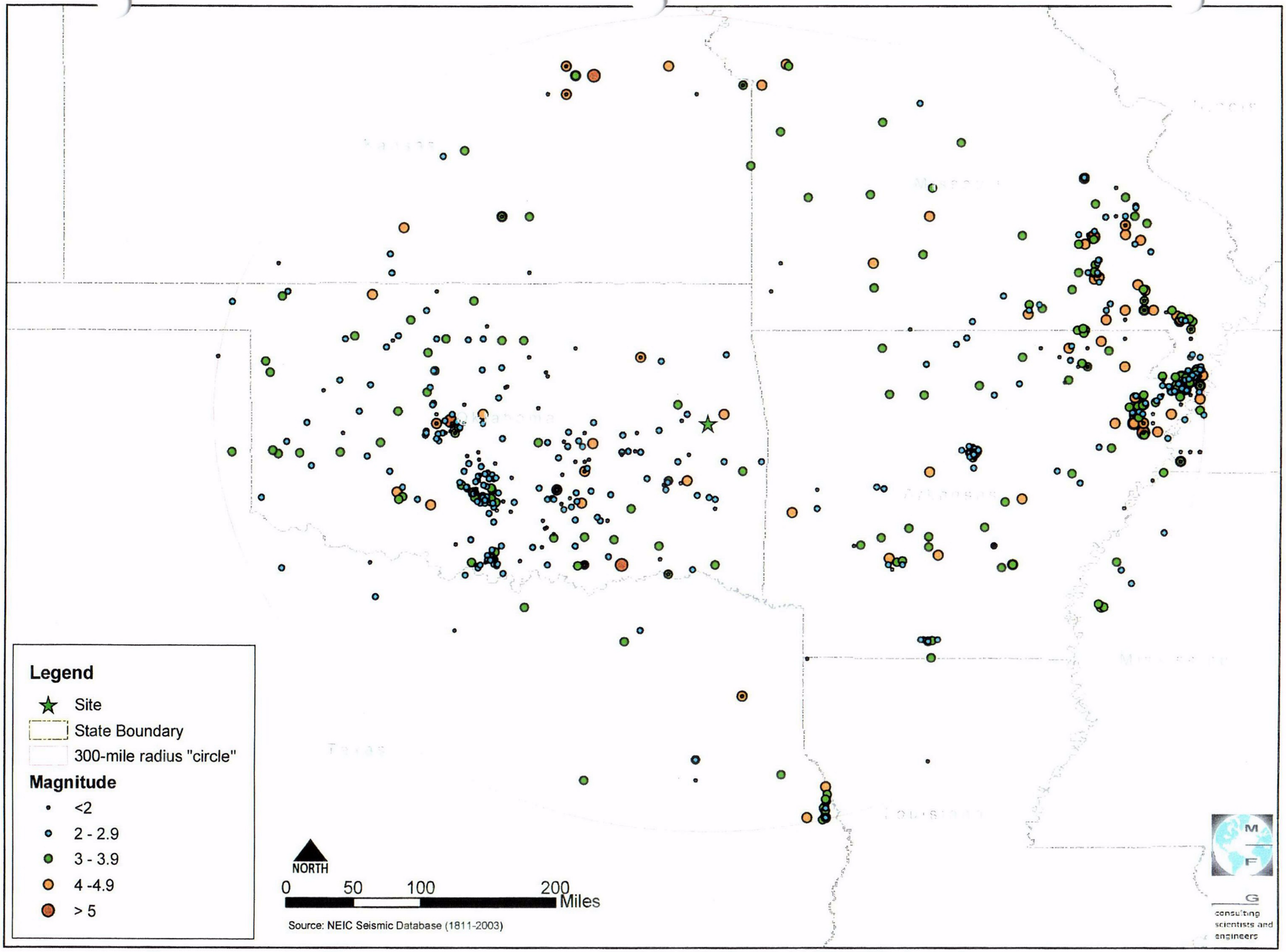


Figure 4.2. Seismic activity within a 300-mile radius of site

C08

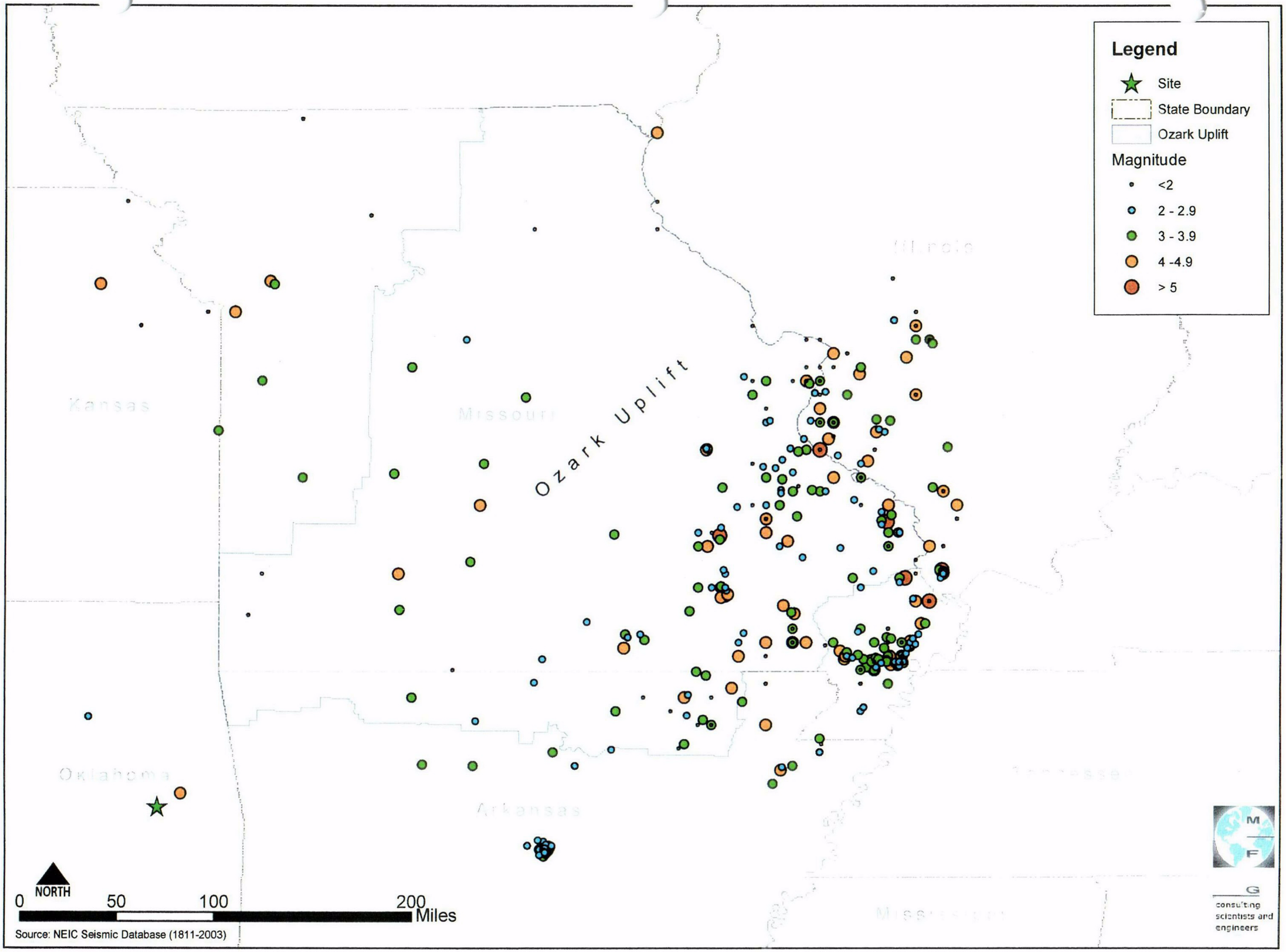


Figure 4.3. Seismic activity within Ozark Uplift

C09

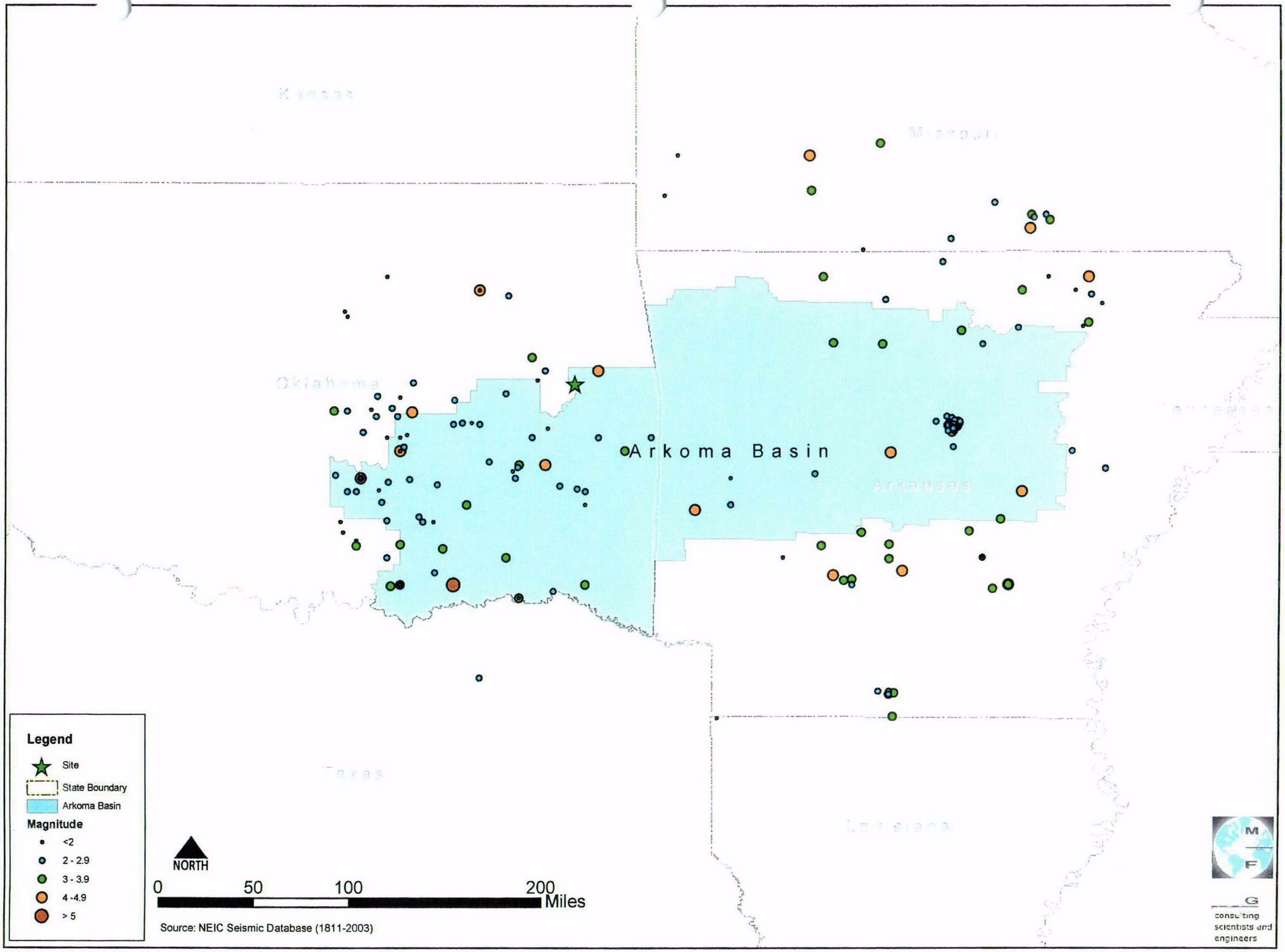


Figure 4.4. Seismic activity within the Arkoma Basin

C10

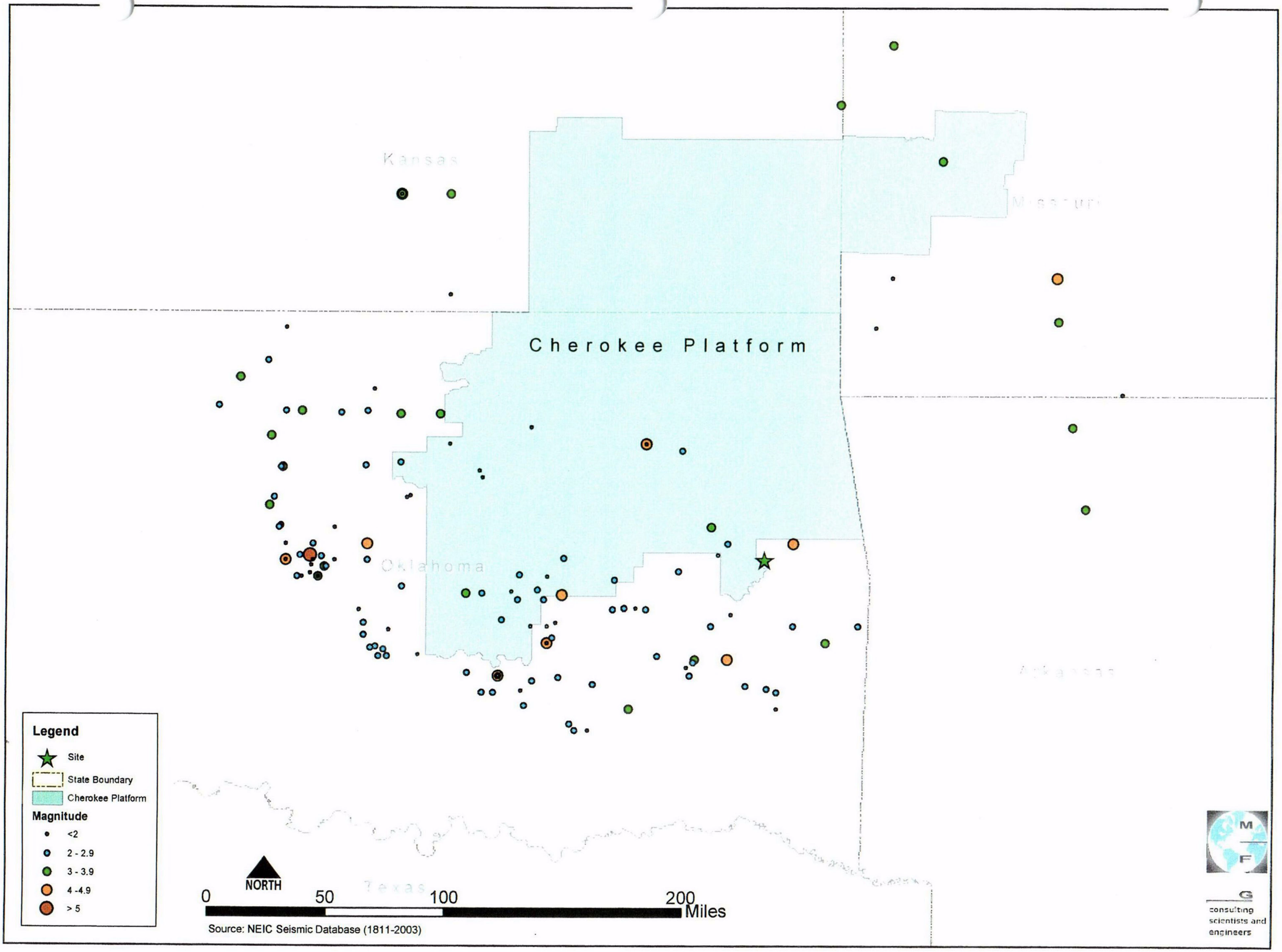


Figure 4.5. Seismic activity within the Cherokee Platform

C11

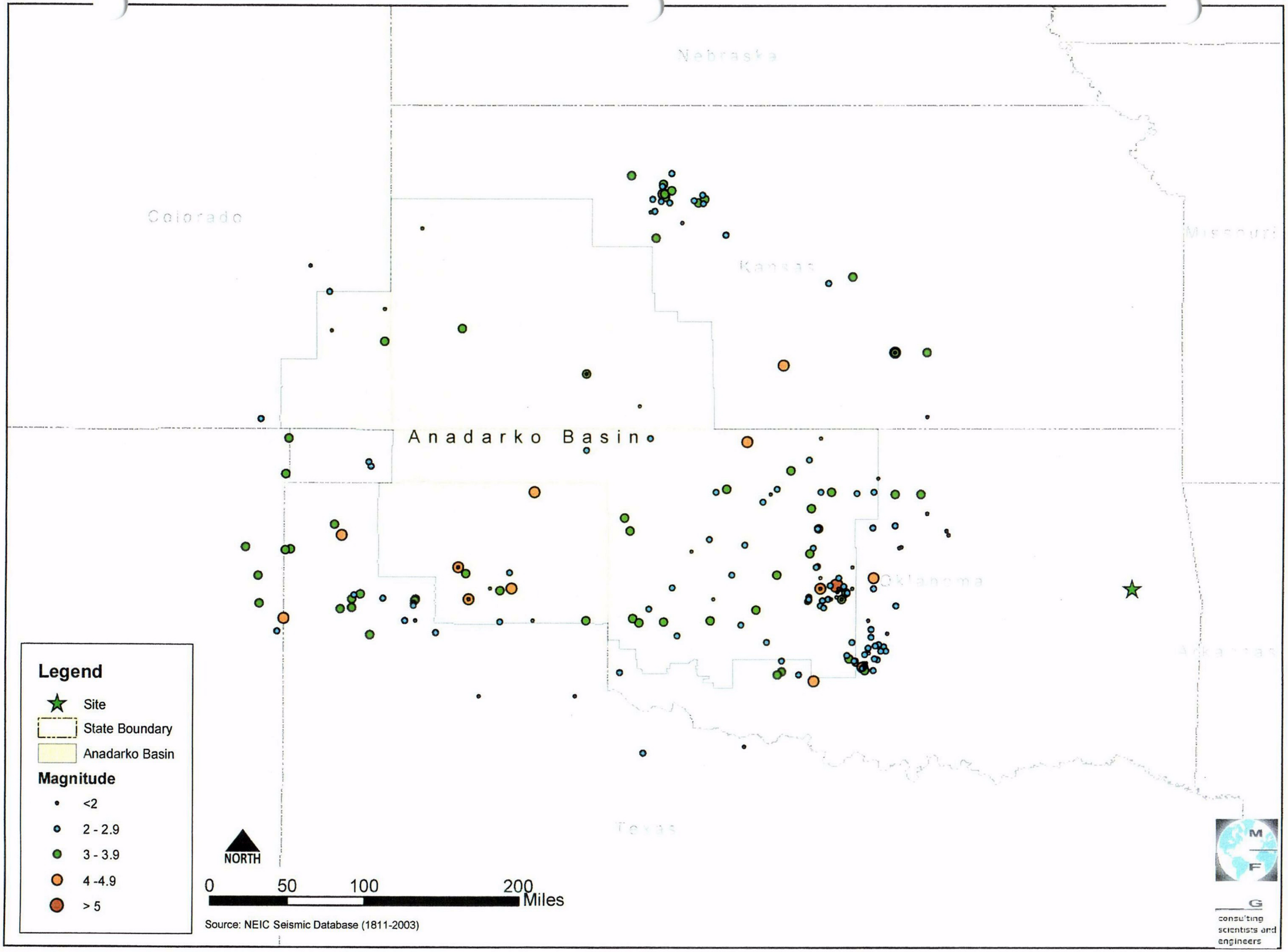


Figure 4.6. Seismic activity within the Anadarko Basin

C12

5.0 INPUT FOR SEISMIC ANALYSIS

5.1 Seismic Accelerations

As discussed in Section 4.3, review of documented seismic events within a 200-mile radius of the site resulted in a maximum acceleration at the site of 0.023 g (Table 4.5). From Appendix B.6, peak accelerations at the site due to a MCE along the Humboldt fault zone is 0.012 g and along the Meers fault is 0.015 g. The seismic analysis review in Appendix C of MFG (2002) resulted in an estimated peak acceleration at the site of less than 0.050 g.

Using very conservative evaluation techniques associated with "random" events in the site area (Section 4.4), the maximum estimated acceleration at the site would be 0.09 g. From review of all capable faults in the site area (Appendix B.6) the estimated maximum acceleration at the site would be 0.145 g, based on the very conservative assumption that all capable faults are active. These maximum or peak accelerations are listed in Table 5.1.

Table 5.1 Peak Accelerations Associated With Seismic Events

Seismic Event	Peak Horizontal Acceleration (g)
MCE associated with known active fault (Meers)	0.015
MCE associated with known active fault (Humboldt fault zone)	0.012
MCE associated with all capable faults considered as active	0.145
Random earthquake within five miles of site at 10,000 year recurrence interval	0.09
June 20, 1926 Sequoyah County earthquake	0.023

5.2 Pseudostatic Analyses

If the materials in the structure are not susceptible to liquefaction or loss of shear strength, a pseudostatic analysis of the structure from seismic-induced accelerations is conducted. This consists of a stability analysis under an equivalent constant acceleration (described in Seed, 1979) or an evaluation of seismic-induced deformations (described in Makdisi and Seed, 1978). The equivalent, constant acceleration used in these analyses is the seismic coefficient, which is a fraction of the maximum seismically-induced acceleration anticipated at the site during the design period. The U.S. Department of Energy (1989) recommends that a seismic coefficient of

two-thirds of the peak acceleration be used to analyze long-term stability. The pseudostatic analyses for the disposal cell were conducted with a seismic coefficient of 0.05 g (MFG, 2002).

5.3 Pseudostatic Analysis Results

The pseudostatic stability analyses (MFG, 2002) used a coefficient of 0.05 g, with resulting factors of safety of 1.8 and higher. These factors of safety are significantly higher than the NRC minimum criterion of 1.1 for pseudo-static analyses.

In order to assess potentially higher seismic accelerations, the disposal cell was re-analyzed by increasing the seismic coefficient until the factor of safety decreased to 1.1. These analyses demonstrate the facility has adequate stability up to a seismic coefficient of 0.19 g. This seismic coefficient corresponds to a peak horizontal acceleration of 0.28 g, which is significantly higher than the conservative peak values in Table 5.1. Outputs from the additional stability analyses are presented in Appendix C.

6.0 GEOMORPHIC STABILITY

6.1 Topographic Setting

The SFC site is located above the east bank of the Illinois River at its confluence with the Arkansas River. The site is on the western end of a broad upland area approximately 100 feet above the normal elevation of the Illinois River (as impounded by the Robert S. Kerr Reservoir). The regional topography is shown in Figure 6.1 (from SFC, 1998a). The drainage basin boundaries for the site area are delineated on the figure.

6.2 Geologic Setting

The SFC site is underlain by a sequence of approximately 400 feet of sedimentary siltstones and sandstones of the Atoka Formation. The Atoka Formation is of the Pennsylvanian geologic period (with these sedimentary rocks formed approximately 280 to 325 million years before present).

The Atoka Formation sedimentary rocks are mantled or covered with alluvial terrace deposits of the Quaternary geologic period. These terrace deposits were placed during the Pleistocene epoch (approximately 10,000 to 1,000,000 years before present) during high-water stages of flow on the Arkansas and Illinois Rivers. These high-water stages were most likely from melting periods of Pleistocene glaciation. Subsequent downcutting of the Illinois and Arkansas Rivers has left these deposits above the current river elevations. More recent alluvial deposits are found along the banks of the Illinois and Arkansas Rivers (SFC, 1998a).

The site is in an area of low seismic activity, with no significant faulting in the area within the last 35 million years (SFC, 1998a). This indicates that seismically-induced features that would be susceptible to erosion are not present.

6.3 Erosional Stability

The topographic and geologic descriptions above indicate that the site is on an upland area of Pennsylvanian-age sedimentary rocks that have been mantled with Pleistocene epoch terrace

deposits and recent alluvial deposits. Erosion during the Quaternary period has been limited to downcutting of the bed of the Arkansas and Illinois Rivers, with no significant erosion of the sedimentary rocks or overlying alluvial deposits at the western end of the upland area.

Figure 1 from ESCI (1996) shows the results of flood analyses conducted by the U.S. Army Corps of Engineers and Sequoyah County. The estimated flood contours from the 500-year event on the Arkansas River are shown on the figure, as well as estimated high water contours from a Tenkiller Ferry Dam breach analysis and a Weber Falls Lock and Dam breach analysis. The maximum water elevation in the site area from these analyses is approximately 500 feet. The site facilities and planned disposal cell are above elevation 540 feet.

6.4 Summary

The SFC site, as well as planned reclaimed features, are hydraulically separate and erosionally stable from extreme flood events on the Illinois and Arkansas Rivers, as summarized below.

1. The location of planned reclaimed site features is at an elevation approximately 100 feet above the normal elevations of the Illinois and Arkansas Rivers in the site area. The location of planned site features is at an elevation a minimum of 40 feet above the estimated extreme flood stage of the Illinois and Arkansas Rivers.

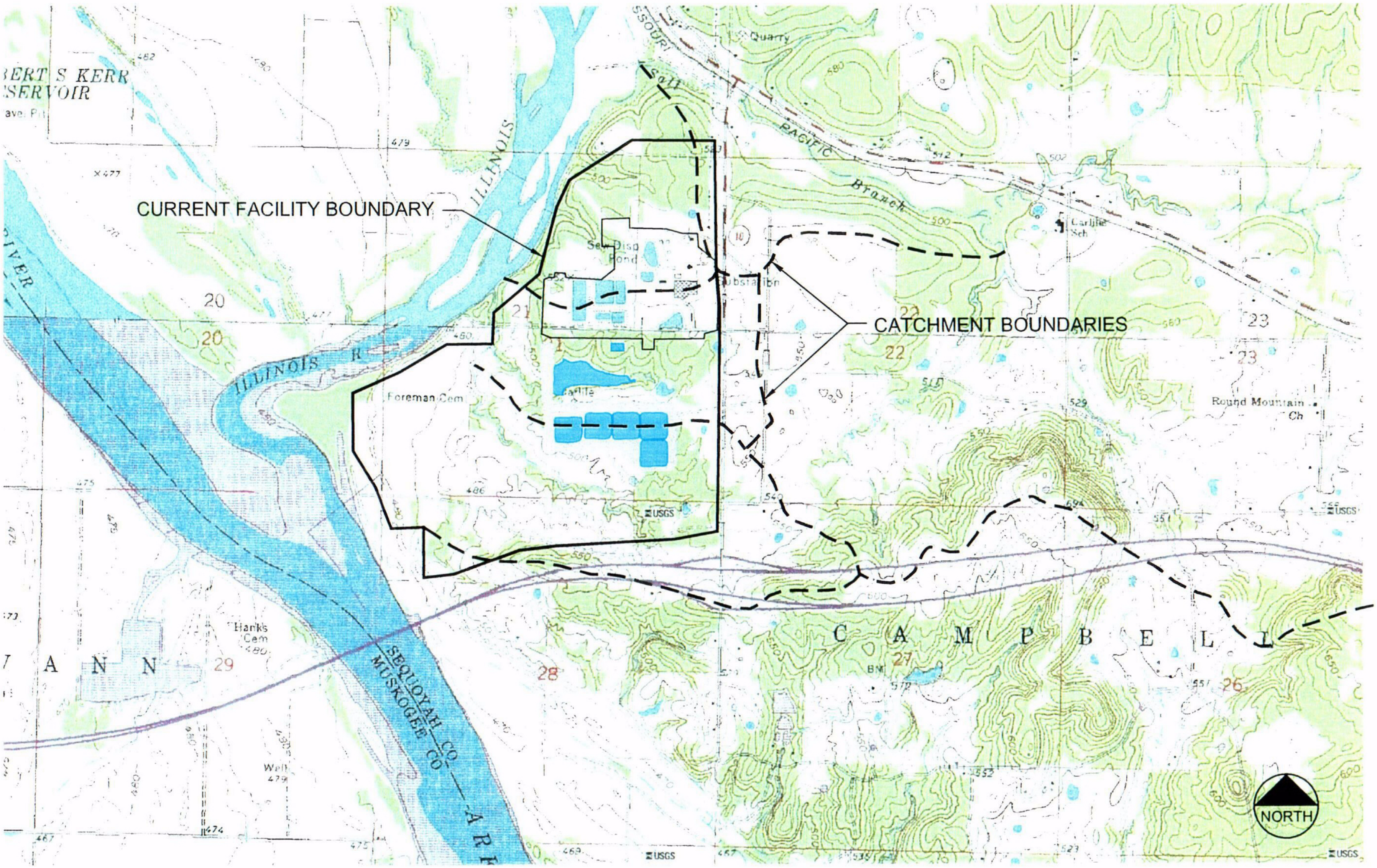
2. The recent geomorphologic history of the site indicates that the most significant periods of erosion and sediment deposition from rivers in the site area coincided with glacial periods over 10,000 years ago. Estimated extreme flow events (under probable maximum precipitation calculation methods) are significantly lower than the Pleistocene epoch flows that were experienced over sustained periods at the site.

3. The Pennsylvanian-age sedimentary rocks that form the foundation for reclaimed features at the SFC site are not susceptible to rapid or significant erosion that would expose the planned reclaimed features at the site.

4. The current topography of the Arkansas and Illinois River basins in the site area shows a large area of lower elevation to the west of the site. There is not a constriction of flow or a bend in the bed of either river that would indicate significant flow velocities or a potential for riverbed migration toward the upland area where the site is located.

5. The reclaimed topography of the disposal cell includes diverting runoff away from the drainage to the west. The reclamation plan also provides rock protection

for long-term erosion protection on the side slopes and perimeter apron areas of the disposal cell.



After U.S.G.S. 7.5 Min. Topographic quadrangles, Gore, OK (1974) and Stigler NE, OK (1963).

consulting scientists and engineers

FIGURE 6.1
FACILITY TOPOGRAPHY MAP

Date:	JULY 2003
Project:	100734
File:	QUADS-CUT.DWG

C13

7.0 REFERENCES

Anderson, K.H, 1979. Geologic Map of Missouri, Missouri Geological Survey.

Arbenz, J.K., 1956. Tectonic Map of Oklahoma Showing Surface Structural Features.

Arkansas Nuclear One Safety Evaluation Report.

Black Fox Safety Evaluation Report.

Blythe, J.G., 1959. Atoka Formation on the North Side of the McAlester Basin, pp 36-37, Oklahoma Geological Survey, Circular 47.

Bonilla, M.G., Mark, R.K., and Lienkaemper, J.J., 1984. Statistical relations among earthquake magnitude, surface rupture length, and surface fault displacement *Bulletin of the Seismological Society of America*, Vol. 74, pp. 2379-2411.

Campbell, K.W., 1981. Near-Source Attenuation of Peak Horizontal Acceleration, *Bulletin of the Seismological Society of America*, Vol. 71, No. 6, pp. 2039-2070, December.

Cederstrand, J.R. 1996. Digital Geologic Map of Oklahoma: U.S. Geological Survey Open-File Reports 96-370 through 96-381, U.S. Geological Survey.

Central Energy Team, National Oil and Natural Gas Assessment Interactive maps, 1995-2003. http://certmapper.cr.usgs.gov, U.S. Geological Survey.

Chenoweth, P.A., 1983. Geologic Map of Webber Falls Area.

Crone, A.J., and Wheeler, R.L., 2000. Data for Quaternary Faults, Liquefaction features, and Possible Tectonic Features in the Central and Eastern United States, East of the Rocky Mountain Front, *U.S. Geological Survey Open-File Report 00-0260*, U.S. Geological Survey.

Earth Science Consultants, Inc. (ESCI), 1996. "Conceptual Design Report, Decommissioning, Excavation, and Stabilization/Solidification Program," prepared for Sequoyah Fuels Corporation.

International Commission on Large Dams (ICOLD), Committee on Seismic Aspects of dam Design, 1989. Selecting Seismic Parameters for Large Dams, *Bulletin 72*, ICOLD, Paris.

International Conference of Building Officials (IBCO), 1991. Uniform Building Code.

Lawson, J.E., 1985. Expected Earthquake Ground-Motion Parameters at the Arcadia, Oklahoma, Dam Site, Special Publication 85-1, Oklahoma Geological Survey, submitted to U.S. Army Corps of Engineers, Tulsa District.

Lawson, J.E., and Luza, K.V., 1983. Oklahoma Earthquakes 1983, *Oklahoma Geology Notes*, Oklahoma Geological Survey, University of Oklahoma, pp 32-42.

Lawson, J.E., Luza, K.V., DuBois, R.L., and Foster, P.H., 1979. Inventory, Detection, and Catalog of Oklahoma Earthquakes, Oklahoma Geological Survey, University of Oklahoma.

Linsley, R.K., M.A. Kohler, and J.L.H. Paulhus, 1975. *Hydrology for Engineers*. Second Edition, McGraw-Hill.

Luza, K.V., and Lawson, J.E., 1993. Oklahoma Seismic Network, *NUREG/CR-6043*, U.S. Nuclear Regulatory Commission, July.

Marcher, 1969. Hydrologic Atlas 1 map, Oklahoma Geological Survey.

MFG, Inc. (MFG), 2002. "Preliminary Design Report for the Disposal Cell at the Sequoyah Fuels Corporation Facility." Prepared for Sequoyah Fuels Corporation, December.

MFG, Inc. (MFG), 2003. "Corrective Action Plan Report." Prepared for Sequoyah Fuels Corporation. June.

National Earthquake Information Center (NEIC), 2003. Earthquake Hazards Program, URL:http:/neic.usgs.gov/neis/epic/index.html, U.S. Geological Survey.

Northcutt, R.A., and Campbell, J.A., 1995. Geologic Provinces of Oklahoma, Oklahoma Geological Survey, *Open-File Report 5-95*.

Queen, J.E., and Green, G.N., 1997. Digital Geologic Map of Arkansas, U.S. Geological Survey, 1997

Roberts/Schornick and Associates, Inc. (RSA), 1991. "Facility Environmental Investigation, Findings Report," (four volumes), prepared for Sequoyah Fuels Corporation, July 31.

Seed, H.B., 1979. Considerations in the Earthquake-Resistant Design of Earth and Rockfill Dams, *Geotechnique*, Vol. 29, No. 3, pp 215-263.

Sequoyah Fuels Corporation (SFC), 1996. Draft Site Characterization Report, February 2, 1996, Docket 40-8027.

Sequoyah Fuels Corporation (SFC), 1997a. "License SUB-1010; Docket No. 40-8027 Response to NRC Questions Related to Seismic Conditions Near the Sequoyah Facility." Letter to John W. N. Hickey, NRC, from John H. Ellis, SFC, July 22, 1997.

Sequoyah Fuels Corporation (SFC), 1997b. "Final RCRA Facility Investigation of the Sequoyah Fuels Uranium Conversion Industrial Facility." September.

Sequoyah Fuels Corporation (SFC), 1998a. "Site Characterization Report."

Sequoyah Fuels Corporation (SFC), 1998b. "License SUB-1010; Docket No. 40-8027 Seismic Conditions Near the Sequoyah Facility." Letter to James C. Shepherd, NRC, from Craig Harlin, SFC, April 8, 1998.

Shepherd Miller, Inc (SMI), 2001. "Sequoyah Fuels Corporation Facility Site Seismicity and Seismic Analysis Review." Technical Memorandum to Craig Harlin, SFC, from Clint Strachan, SMI, June 4.

Slemmons, D.B, 1982. Determination of design earthquake magnitudes for microzonation, *Proceedings of Third International Earthquake Microzonation Conference*, Vol.1, pp. 119-130.

Steeples, D.W., Bennett, B.C, Park, C., Miller R.D., and Knapp, R.W., 1990, Microearthquakes in Kansas and Nebraska 1977-1989; U.S. Nuclear Regulatory Commission, *NUREG/CR-5629 RA*.

U.S. Army Corps of Engineers (COE), 1982. Engineering and Design Stability for Earth and Rockfill Dams, EM 1110-2-1902.

U.S. Code of Federal Regulation (CFR), Title 10, Part 100, Appendix A.

U.S. Code of Federal Regulations (CFR), Title 10, Part 40, Appendix A.

U.S. Geological Survey, 1996. National Seismic Hazard Mapping Project, Open-File Report 96-532, URL:http://geohazards.cr.usgs.gov/eq/, June 1996.

U.S. Nuclear Regulatory Commission (NRC), 1997a. "Transmittal of Questions Related to Seismic conditions Near your Site." Letter to John H. Ellis, SFC, from John W. N. Hickey, NRC, April 23, 1997.

U.S. Nuclear Regulatory Commission (NRC), 1997b. "Nuclear regulatory Commission Staff's Evaluations of Sequoyah Fuel Corporation's Response to NRC's Questions Related to Seismic Conditions Near the Sequoyah Facility." Letter to John H. Ellis, SFC, from John W. N. Hickey, NRC, December 15, 1997.

U.S. Nuclear Regulatory Commission (NRC), 1998a. "Sequoyah Fuels Corporation (SFC) Site Evaluation of Faults and Faulting: Input to Safety Evaluation Report." Note to James Shepherd, Sequoyah Fuels Corporation, from Philip Justus, NRC, December 3.

U.S. Nuclear Regulatory Commission (NCR), 1998b. "Transmittal of NRC's Response to Evaluation of Seismic Conditions Near Your Site." Letter to John H. Ellis, SFC, from John W. N. Hickey, NRC, December 18, 1998.

U.S. Nuclear Regulatory Commission (NRC), 1990. Final Staff Technical Position, Design of Erosion Protective Covers for Stabilization of Uranium Mill Tailings Sites. August.

U.S. Nuclear Regulatory Commission (NRC), 1999. Design of Erosion Protection for Long-term Stabilization. *NUREG-1623*, Draft Report for Comment, February.

U.S. Nuclear Regulatory Commission (NRC), 2002. Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act. *NUREG-1620*, Draft Report for Comment, January.

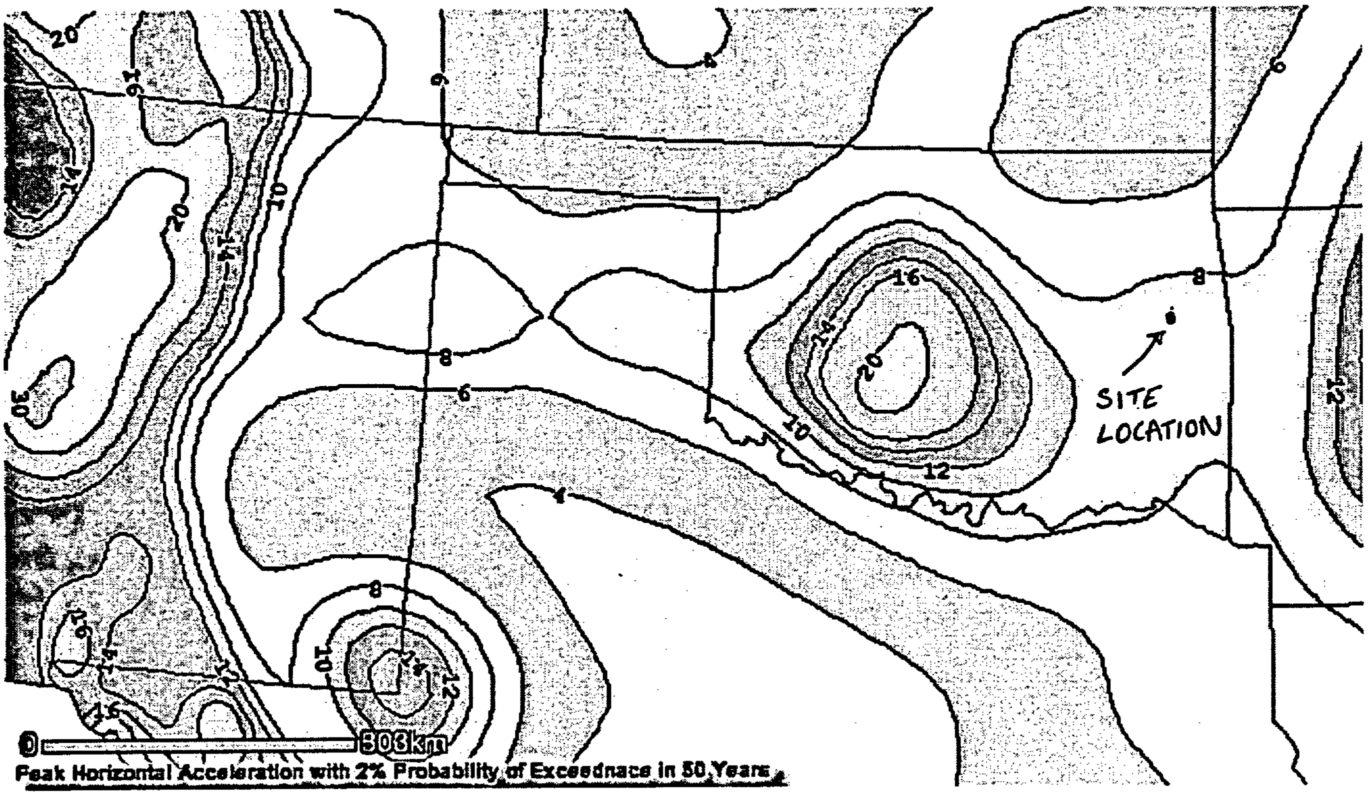
Van Arsdale, R. 1998. "Paleoseismoligic Analysis of the Carlile Fault in Sequoyah County, Oklahoma." Report prepared for Sequoyah Fuels Corporation (SFC), March 6, 1998.

Van Arsdale, R., Ward, C., and Cox, R., 1989. Post-Pennsylvanian reactivation along the Washita Valley faults, southern Oklahoma, U.S. Nuclear Regulatory Commission, *NUREG/CR-5375*.

Wyss, M., 1979. Estimating maximum expectable magnitude of earthquakes from fault dimensions, *Geology*, Vol. 7, No. 7, pp. 336-340.

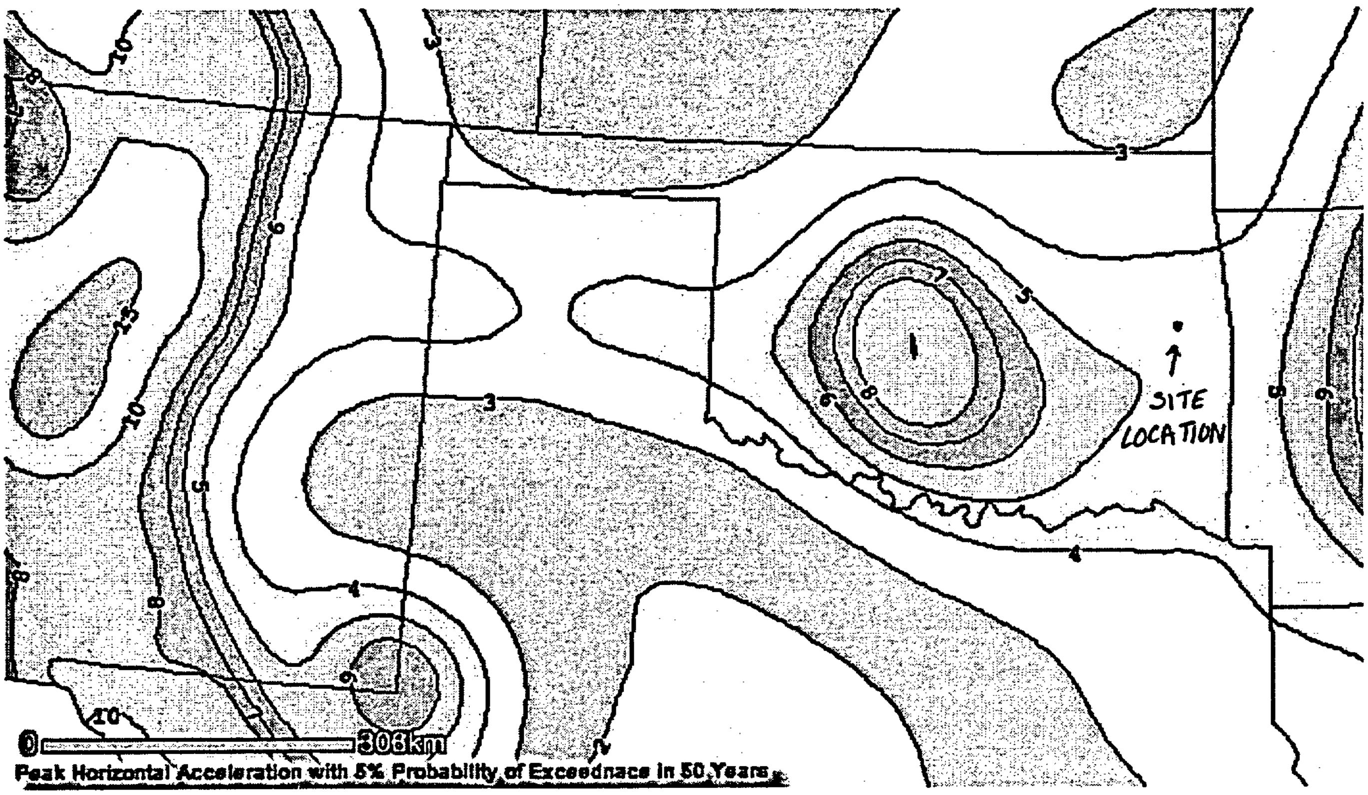
APPENDIX A

CONTOUR LINES OF PEAK HORIZONTAL ACCELERATIONS

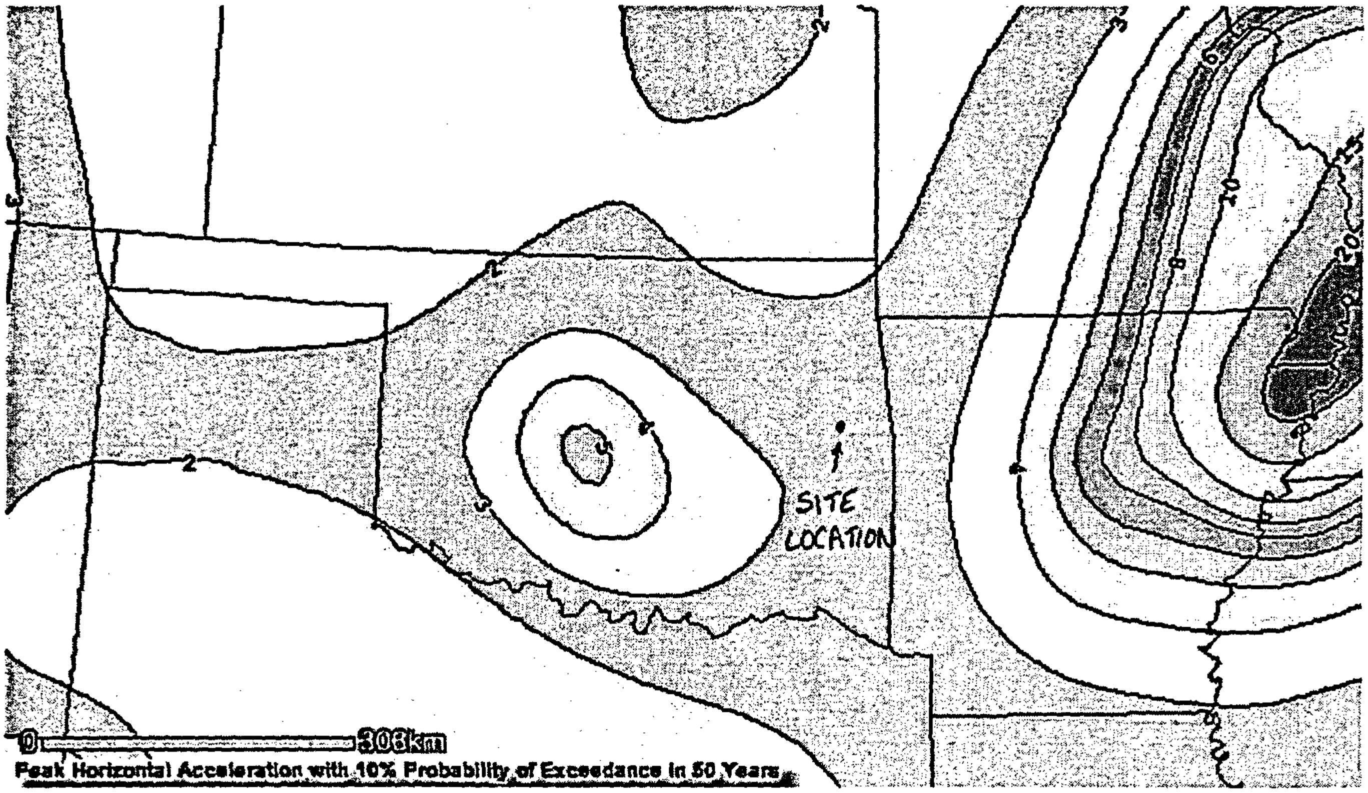


USGS National Seismic Hazard Mapping Project
Open File 96-532, June 1996
http://geohazards.cr.usgs.gov/eq/

2% probability of Exceedance in 50 years = 2475 year return period



5% probability of exceedance in 50 years
= 975-year return period



10% probability of exceedance in 50 years
= 475-year return period

APPENDIX B

SEISMIC ACTIVITY

APPENDIX B.1

SEISMIC ACTIVITY WITHIN A 300-MILE RADIUS OF SITE

NEIC: Earthquake Search Results

U. S. GEOLOGICAL SURVEY

EARTHQUAKE DATA BASE

FILE CREATED: Mon Jun 2 14:12:44 2003
Circle Search Earthquakes= 645
Circle Center Point Latitude: 35.504N Longitude: 95.076W
Radius: 483.000 km
Catalog Used: SRA & PDE
Data Selection: Eastern, Central and Mountain States of U.S. (SRA) & Historical & Preliminary Data (PDE)

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
SRA	1926	6	20	1420	35.6	-94.9		4.2	FASRA	5...	....	19	0.023072157
SRA	1811	12	16	815	35.4	-90.4		7.2	FASRA	E...	....	424	0.011000128
SRA	1811	12	16	1415	35.4	-90.4		7	FASRA	E...	....	424	0.009275599
SRA	1975	3	31	95206	35.6	-95.3		2.9	HzSRA	....	....	22	0.006630355
SRA	1882	10	22	2215	34	-96		5.5	FASRA	6...	....	186	0.006219522
SRA	1915	10	8	1650	35.7	-95.4		3.4	FASRA	3...	....	36	0.006000462
SRA	1961	4	27	730	34.9	-95.3		4.1	FASRA	5...	....	69	0.005436788
SRA	1969	5	2	113321.7	35.29	-96.31	8	4.6	mb GS	5...	....	114	0.004865924
SRA	1843	1	5	245	35.5	-90.5		6	FASRA	7...	....	414	0.004037142
SRA	1961	1	11	140	34.9	-95.5		3.8	FASRA	5...	....	77	0.003735104
SRA	1956	10	30	103621	36.2	-95.8		4	MLSRA	7...	....	101	0.003310621
SRA	1939	6	1	730	35	-96.4		4.3	FASRA	4...	....	132	0.003210286
PDE	1997	9	6	233800.91	34.66	-96.43	5	4.5	MnTUL	5F..	....	155	0.003206199
SRA	1977	6	2	232910.6	34.56	-94.17	10	4.3	mb GS	6...	....	133	0.003184226
SRA	1952	4	9	162928.4	35.53	-97.85	10	5	FASRA	7...	....	251	0.002929686
SRA	1973	11	18	100352.7	35	-94.7		3.1	MnSRA	....	....	65	0.002455113
SRA	1976	3	16	73945.3	35.43	-95.6		2.7	HzSRA	4...	....	48	0.002413888
SRA	1982	1	21	3354.8	35.18	-92.21	3	4.7	MnTUL	6..G	....	262	0.002159069
PDE	2001	5	4	64212.68	35.21	-92.19	10	4.7	MnSLM	6D..	....	263	0.002150177
SRA	1971	3	1	192732.1	35.1	-94.9		2.5	MDSRA	....	....	47	0.002078405
SRA	1962	5	18	24029.3	35.1	-95.4		2.6	MLSRA	....	....	53	0.001989406
SRA	1969	1	1	233538.7	34.99	-92.69	7	4.4	MnDG	6..G	....	224	0.001974722
SRA	1959	6	15	1245	34.8	-96.7		4	FASRA	5...	....	167	0.00192172
SRA	1867	4	24	2022	39.2	-96.3		5.1	FASRA	7...	....	424	0.001810115
SRA	1973	12	25	41132	35.1	-94.5		2.8	MnSRA	....	....	68	0.001805037
SRA	1965	10	21	20439.1	37.48	-90.94	7	5.1	mb GS	6..G	....	429	0.001787247
PDE	1976	3	25	4120.5	35.59	-90.48	15	5	MnSLM	6D..	....	416	0.001694905
SRA	1956	4	2	160318	34.2	-95.6		3.7	FASRA	5...	....	152	0.001642324
SRA	1878	11	19	552	35.5	-90.7		4.9	FASRA	6...	....	396	0.001639907
SRA	1920	2	29	302	37.2	-93.3		4.3	FASRA	4...	....	246	0.001636359
SRA	1934	4	12	140	33.9	-95.5		3.9	FASRA	5...	....	181	0.001615389
SRA	1956	2	16	2330	35.6	-97.5		4.1	FASRA	6...	....N..	219	0.001561621
SRA	1974	2	15	223546.6	34.07	-93.12	14	4.2	mb GS	3...	....	239	0.001548611
SRA	1971	3	13	192215.3	35.2	-95.8		2.7	MnSRA	....	....	73	0.001533182
SRA	1925	7	8	16	36.3	-93.2		3.9	FASRA	4...	....	190	0.001532569
SRA	1985	9	23	10344.1	34.72	-95.06	5	2.9	MnSRA	....	....	86	0.001525692
PDE	1995	1	18	155139.42	34.77	-97.6	5	4.2	MnTUL	5F..	....	243	0.001520976
SRA	1976	12	19	82636.7	34.92	-95.73	5	2.9	MnSRA	2...	....	87	0.001506688
SRA	1978	3	5	144650.5	34.7	-95	7	2.9	MnSRA	....	....	89	0.00147001
SRA	1939	6	19	214312	34.1	-92.6		4.3	FASRA	5...	....	274	0.001455762
SRA	1906	1	8	15	39.3	-96.6		4.9	FASRA	7...	....	442	0.001455554
SRA	1843	2	17	5	35.5	-90.5		4.8	FASRA	5...	....	414	0.001433246
SRA	1883	12	5	1520	36.3	-91.2		4.6	FASRA	5...	....	360	0.001403099
SRA	1936	3	14	1720	34	-95		3.6	FASRA	5...	....	166	0.001369051

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
SRA	1937	6	8	1426	35.3	-96.9		3.6	FASRA	4...	....	167	0.001360158
PDE	2000	6	27	12845	35.8	-92.75	0	3.9	MnCER	.F..	....	213	0.001353869
SRA	1938	9	18	33428.3	35.41	-90.25	1	4.8	FASRA	5...	....	437	0.001351546
SRA	1918	10	4	921	34.7	-91.7		4.4	FASRA	5...	....	320	0.001341203
SRA	1962	9	1	20956.1	35.2	-96		2.8	MLSRA	....	....	90	0.001332063
SRA	1966	2	13	231937.8	37.04	-90.9	6	4.7	mb GS	...G	....	412	0.001321422
PDE	1993	3	11	11501.5	35.21	-95.93	5	2.7	MnTUL	3F..	....	84	0.00131671
SRA	1927	5	7	828	35.7	-90.4		4.7	FASRA	6...	....	423	0.001284154
SRA	1982	1	21	154538.6	35.19	-92.2	4	4.1	MnTUL	3..G	....	263	0.001280244
SRA	1959	6	17	102710.6	34.64	-98.06	5	4.2	FASRA	6...	....	287	0.001269647
SRA	1985	9	6	221702.8	35.81	-93.12	10	3.6	MnSRA	5...	....	180	0.001253883
SRA	1963	3	3	173010.6	36.64	-90.05	9	4.8	MnDG	6..G	....	469	0.001251715
SRA	1957	3	19	163739	32.6	-94.7		4.3	FASRA	5...	....	323	0.001217668
SRA	1963	3	13	93334	34.6	-95.9		3.1	MLSRA	....	....	125	0.001208813
SRA	1982	2	24	192714.1	35.2	-92.24	5	4	MnTUL	5..G	....	259	0.001193859
SRA	1982	1	24	32244.7	35.2	-92.22	4	4	MnTUL	5..G	....	261	0.001183928
PDE	1990	11	15	114441.4	34.76	-97.59	5	3.9	MnTUL	5F..	....	243	0.00117342
PDE- W	2002	10	20	21813	34.27	-96.08	5	3.4	MnTUL	5F..	....	164	0.001166866
SRA	1929	12	28	30	35.5	-98		4	FASRA	6...	....	265	0.001164535
SRA	1952	4	11	2030	35.4	-97.8		3.9	FASRA	4...	....	247	0.001152799
SRA	1952	4	16	558	35.4	-97.8		3.9	FASRA	3...	....	247	0.001152799
SRA	1952	4	16	605	35.4	-97.8		3.9	FASRA	5...	....	247	0.001152799
SRA	1919	5	27	306	37.7	-97.3		4.2	FASRA	4...	....	314	0.00115155
PDE	1998	4	28	141301.68	34.78	-98.42	5	4.2	MnGS	6D..	....	314	0.00115155
SRA	1897	12	2	710	39.1	-94.5		4.5	FASRA	4...	....	402	0.001141518
SRA	1956	1	6	115807.4	37.58	-98.35	29	4.4	FASRA	6...	....	372	0.001138906
SRA	1965	11	4	74337.9	37.03	-90.93	4	4.5	mb GS	...G	....	409	0.001120312
SRA	1950	2	8	103706.7	37.7	-92.7		4.2	FASRA	5...	....	323	0.001116743
PDE	1989	4	27	164749.85	36.01	-89.77	10	4.7	MnBLA	6D..	....	482	0.001114368
SRA	1980	11	22	193502.8	35.38	-95.99	5	2.5	MnSRA	....	....	84	0.001107619
PDE	1976	3	25	10011.9	35.61	-90.48	15	4.5	MnSLM	.F..	....	416	0.001099849
SRA	1984	1	6	171449.8	36.16	-95.58	5	2.5	MDSRA	4...	....	85	0.001093481
SRA	1982	1	22	235422.8	35.22	-92.21	0	3.9	MnTUL	.F.G	....	262	0.001081301
SRA	1982	3	1	1209.5	35.19	-92.21	8	3.9	MnTUL	5..G	....	262	0.001081301
SRA	1923	10	28	1710	35.5	-90.4		4.5	FASRA	7...	....	423	0.001080091
SRA	1915	12	7	1840	36	-90		4.6	FASRA	5...	....	462	0.001070131
SRA	1974	2	15	224904.4	34.03	-93.04	17	3.8	mb GS	5...	....	247	0.001057248
PDE	1990	9	16	211332.4	34.8	-95.53	5	2.5	MnTUL	4F..	....	88	0.001053071
SRA	1911	3	31	1657	34	-91.8		4.2	FASRA	7...	....	342	0.001049515
PDE	1988	8	29	5650.5	35.53	-95.36	5	0.9	MDTUL	....	....	25	0.001034579
PDE	1987	6	7	73524.3	35.17	-95.28	5	1.5	MDTUL	....	....	41	0.001016059
SRA	1982	7	5	41349.8	35.18	-92.23	6	3.8	MnTUL	.F.G	....	261	0.000995789
SRA	1968	10	14	144254	34	-96.4		3.5	HzSRA	6...	....	206	0.000993247
SRA	1982	1	21	3735.6	35.16	-92.24	1	3.79	MwSRT	.F.G	....	260	0.000991333
SRA	1924	1	1	305	36	-90		4.5	FASRA	6...	....	462	0.000981397
SRA	1964	5	23	112534.5	36.58	-90.02	3	4.5	mb GS	5..G	....	470	0.000963258
SRA	1975	11	29	142944.9	34.68	-97.42	14	3.6	MnSRA	6...	....	232	0.000951841
SRA	1955	1	25	72439.1	36.07	-89.83	8	4.5	FASRA	6...	....	478	0.00094575
SRA	1937	5	17	4946	36.1	-90.6		4.3	FASRA	4...	....	409	0.000942234
SRA	1964	4	28	211841	31.63	-93.8	14	4.4	mb GS	5...	....	445	0.000937436
SRA	1967	6	4	161412.6	33.55	-90.84	6	4.4	MnDG	6..G	....	445	0.000937436
SRA	1954	2	2	1653	36.7	-90.3		4.4	FASRA	5...	....	449	0.000928363
SRA	1956	11	26	41243.3	36.91	-90.39	1	4.4	FASRA	6...	....	449	0.000928363
PDE	1995	9	15	3133.26	36.87	-98.69	5	4.1	MnGS	5F..	....	358	0.000915842
SRA	1901	1	4	312	37.9	-94		3.8	FASRA	5...	....	282	0.000915483
SRA	1946	10	8	11202.5	37.5	-90.6		4.4	FASRA	5...	....	457	0.000910714
SRA	1984	1	24	153409.6	35.03	-96.37	5	2.8	MnSRA	5...	....	128	0.000908781
PDE	1997	3	16	190727.95	34.21	-93.43	5	3.4	MnGS	4F..	....	207	0.000906117
PDE	1991	7	7	212402.69	36.66	-91.64	5	4	MnGS	6D..	....	334	0.000905678
PDE	1992	12	17	71804.27	34.74	-97.58	5	3.6	MnGS	4F..	....	243	0.000905117
SRA	1901	2	15	15	36	-90		4.4	FASRA	4...	....	462	0.000900007
SRA	1954	4	27	20927	35.1	-90		4.4	FASRA	5...	....	463	0.000897894
SRA	1984	3	3	114202.4	35.51	-96.3	5	2.6	MnSRA	5...	....	111	0.000892316

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
SRA	1946	5	15	61001	36.6	-90.8		4.2	FASRA	4...	....	403	0.00087808
PDE	1986	5	25	102744.8	36.23	-94.88	5	2.2	MDTUL	....	....	82	0.000877081
SRA	1942	6	12	450	36.4	-97.9		3.7	FASRA	3...	....	273	0.000869684
PDE	1987	12	8	14240.3	36.06	-98.02	5	3.7	MnGS	5F..	....	273	0.000869684
SRA	1964	4	28	211835	31.3	-93.8		4.4	mb GS	....	....	480	0.000863382
SRA	1929	9	23	11	39	-96.6		4.2	FASRA	5...	....	410	0.000861797
PDE	1992	6	30	12549.3	35.26	-96.42	5	2.7	MDTUL	2F..	....	125	0.000855187
SRA	1966	2	26	81017.7	37.05	-90.88	1	4.2	mb GS	...G	....	413	0.000854995
SRA	1971	10	1	184938.5	35.77	-90.49	9	4.2	MnDG	5..G	....	416	0.000848295
SRA	1982	5	31	182119.8	35.2	-92.23	2	3.6	MnTUL	4..G	....	260	0.000840989
PDE	1987	3	14	44303.5	34.79	-96.33	5	2.8	MnTUL	....	....	139	0.000830917
SRA	1947	12	1	84733	36.7	-90.6		4.2	FASRA	4...	....	424	0.00083091
SRA	1982	5	31	174920.4	35.19	-92.2	1	3.6	MnSRA	4...	....	263	0.000830568
SRA	1972	2	1	54209.5	36.37	-90.85	3	4.1	mb GS	5..G	....	392	0.000829838
PDE	1987	12	16	70458.6	34.88	-95.51	5	2.1	MDTUL	....	....	80	0.000826236
PDE	2002	2	8	160713.6	34.73	-98.36	5	3.8	MnTUL	5F..	....	311	0.000823092
SRA	1970	11	17	21354.1	35.86	-89.95	14	4.3	MnDG	6..G	....	465	0.000819567
SRA	1967	7	21	91448.8	37.44	-90.44	12	4.3	MnSTT	6..G	....	467	0.000815751
PDE	1996	11	29	54133.68	35.92	-89.93	20	4.3	MnGS	5F..	....	467	0.000815751
SRA	1919	7	26	1255	37.7	-97.3		3.8	FASRA	4...	....	314	0.000814548
SRA	1925	1	27	2242	36.2	-91.7		3.8	FASRA	3...	....	314	0.000814548
SRA	1964	5	23	150034.9	36.6	-90.01	8	4.3	mb GS	3..G	....	471	0.000808223
SRA	1966	2	12	43212.8	35.96	-89.87	1	4.3	mb GS	4..G	....	473	0.000804508
SRA	1974	2	15	223238.2	34.04	-92.98	17	3.5	MnSRA	3...	....	251	0.00080134
SRA	1981	7	11	210921.8	34.85	-97.73	5	3.5	MnSRA	5...	....	252	0.000797884
SRA	1982	1	19	43949.5	35.19	-92.25	1	3.5	MnTUL	4..G	....	259	0.000774471
PDE	1988	6	5	25655.5	34.74	-95.19	5	2.1	MDTUL	....	....	85	0.000773565
SRA	1982	9	25	231705.5	35.21	-92.23	5	3.5	MnSRA	.F..	....	260	0.000771234
SRA	1986	12	21	173258.1	35.14	-96.68	5	2.8	MnSRA	....	....	150	0.000764911
SRA	1982	1	20	140130.7	35.2	-92.21	0	3.5	MnTUL	4..G	....	262	0.000764836
SRA	1983	1	19	23040.2	35.19	-92.21	5	3.5	MnSRA	5...	....	262	0.000764836
SRA	1923	11	26	2325	35.5	-90.4		4.1	FASRA	4...	....	423	0.000763939
SRA	1976	12	11	70501.1	38.1	-91.04	0	4.2	mb GS	....	....N..	461	0.000758667
SRA	1961	12	25	125816.8	39.32	-94.24	9	4.1	FABAR	5..G	....	429	0.000752329
PDE	1998	10	30	174122.2	36.8	-97.6	5	3.5	MnTUL	.F..	....	268	0.000746239
SRA	1963	5	7	200329	34.3	-96.4		3	MLSRA	....	....N..	180	0.000746025
SRA	1911	3	31	1810	34	-91.8		3.8	FASRA	4...	....	342	0.000742314
PDE	2000	8	22	201214	36.49	-91.11	8	3.9	MnCER	.F..	....	374	0.000734457
SRA	1964	6	2	23	31.3	-94		4.2	mb GS	5...	....	476	0.000732708
SRA	1964	6	3	30	31.3	-94		4.2	mb GS	5...	....	476	0.000732708
SRA	1922	3	28	1642	36.7	-90.4		4.1	FASRA	3...	....	441	0.000730097
SRA	1906	1	16	240	39.3	-96.6		4.1	FASRA	3...	....	442	0.000728301
SRA	1963	7	8	235142.1	36.97	-90.47	0	4.1	mb GS	....	....	444	0.000724734
SRA	1920	10	3	1415	38.6	-94.3		3.8	FASRA	3...	....	350	0.000723885
PDE	1999	10	21	818	36.49	-91.02	19	3.9	MnGS	.F..	....	381	0.000719796
PDE	1975	9	13	12502.8	34.14	-97.37	5	3.4	MnTUL	4F..	....	258	0.000713217
SRA	1976	10	20	40539.8	34.75	-96.12		2.5	MnSRA	....	....	126	0.000713024
SRA	1965	3	6	210850.3	37.4	-91.03	7	4	MnDG	3..G	....	418	0.000709673
SRA	1982	2	1	72502.6	35.19	-92.22	7	3.4	MnTUL	4..G	....	261	0.000704308
SRA	1982	11	21	163528.6	35.21	-92.22	1	3.4	MnSRA	4...	....	261	0.000704308
PDE	1988	12	25	155757.7	34.19	-92.7	13	3.4	MDTEI	4F..	....	261	0.000704308
SRA	1875	11	8	1040	39.3	-95.5		4	FASRA	5...	....	422	0.000702361
SRA	1962	8	10	204719	34.8	-97.4		3.2	MLSRA	....	....N..	225	0.000696015
PDE	1975	10	12	25811.2	34.82	-97.41	20	3.2	MnTUL	....	....	225	0.000696015
SRA	1882	7	28		37.6	-90.6		4.1	FASRA	3...	....	462	0.000694082
SRA	1880	7	14	230	35.1	-90		4.1	FASRA	4...	....	463	0.000692452
SRA	1929	10	21	2125	39.2	-96.5		4	FASRA	5...	....	428	0.00069166
SRA	1984	2	3	43828	34.67	-97.36	5	3.2	MnSRA	5...	....	227	0.00068935
SRA	1927	1	7	930	38.4	-97.7		3.9	FASRA	4...	....	397	0.000688308
SRA	1982	5	3	75448.7	33.99	-96.47	5	3.1	MnSRA	6...	....	210	0.000687991
SRA	1976	1	16	194256.9	35.9	-92.16	7	3.4	MnSRA	5...	....	267	0.000687116
PDE	1986	2	14	60904.72	34.87	-95.37	5	1.8	MnTUL	....	....	75	0.000683558
SRA	1983	10	23	193446.9	34.82	-96.89	5	2.9	MnSRA	....	....	181	0.00068003

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
PDE	1997	5	31	32641.34	33.18	-95.97	5	3.4	MnGS	.F..	....	270	0.000678819
SRA	1982	8	18	101856.9	34.47	-96.23	5	2.7	MnSRA	....	....	155	0.0006769
PDE	1986	12	25	84617.4	35.4	-95.84	5	1.7	MDTUL	....	....	70	0.000675678
SRA	1918	10	13	930	36.1	-91		3.8	FASRA	5...	....	374	0.000673517
SRA	1952	12	25	42324	35.9	-89.8		4.1	FASRA	4...	....	479	0.000667334
PDE	2001	8	4	11325.38	34.29	-93.21	5	3.1	MnGS	3F..	....	216	0.000667237
SRA	1930	11	16	1230	34.3	-92.7		3.3	FASRA	5...	....	254	0.00066525
SRA	1975	10	30	3714.1	35.3	-96.8		2.7	HzSRA	....	....	158	0.000662938
SRA	1977	6	2	233512.2	34.6	-93.9	10	2.6	MnSRA	....	....	146	0.000662456
PDE	1995	6	1	44929.32	34.29	-96.73	5	3	MnGS	5F..	....	202	0.000658125
SRA	1947	12	16	327	35.6	-90.1		4	FASRA	5...	....	450	0.000654966
SRA	1976	10	22	171550.5	36.38	-97.06		3	MnSRA	....	....	203	0.000654601
SRA	1982	2	1	55508.2	35.18	-92.23	5	3.3	MnTUL	4..G	....	261	0.000645871
SRA	1908	11	12	12	38.7	-93.2		3.8	FASRA	4...	....N..	391	0.000641732
SRA	1986	10	7	120639.1	35.26	-96.58	5	2.5	MDSRA	....	....	139	0.000640832
SRA	1984	9	27	130305.2	35.2	-92.19	10	3.3	MnSRA	4...	....	264	0.000637894
SRA	1985	11	8	195648.5	35.22	-92.19	4	3.3	MnSRA	.F..	....	264	0.000637894
PDE	1998	7	7	184444.46	34.72	-97.59	5	3.2	MnGS	....	....	244	0.000637288
SRA	1961	12	25	121958.3	39.3	-94.21	11	3.9	FABAR	4..G	....	427	0.00063588
SRA	1965	10	21	40649.2	37.45	-90.94	1	3.9	mb GS	....	....	428	0.000634265
SRA	1975	6	16	15928.2	34.2	-96.5		2.9	HzSRA	....	....	194	0.00063063
SRA	1974	11	10	61918.6	34.8	-96.7		2.7	HzSRA	....	....	167	0.000624185
PDE-	Q 2003	4	30	45622	35.94	-89.89	24	4	MnGS	4F..	....	471	0.000623267
SRA	1984	11	20	105732	34.71	-97.41	5	3.1	MnSRA	4...	....	230	0.000623193
SRA	1977	11	26	41818.1	34.39	-92.91	10	3.1	MnSRA	4...	....	232	0.000617352
SRA	1932	4	9	1017	31.7	-96.4		3.9	FASRA	6...	....	439	0.000616998
SRA	1926	10	27	1622	36.7	-90.4		3.9	FASRA	4...	....	441	0.000613955
SRA	1926	10	27	1627	36.7	-90.4		3.9	FASRA	4...	....	441	0.000613955
SRA	1956	1	29	44415.5	35.76	-89.8	16	4	FASRA	6...	....	478	0.000613346
SRA	1963	2	7	211836	34.4	-92.1		3.4	MnSRA	....	....	297	0.000611984
SRA	1917	5	9	9	36.8	-90.4		3.9	FASRA	3...	....	444	0.000609444
SRA	1982	8	9	111231.6	35.19	-92.24	4	3.2	MnSRA	.F..	....	259	0.000597252
PDE	1997	9	17	181631.63	35.62	-90.46	5	3.8	MnGS	5F..	....	418	0.000596777
SRA	1982	6	30	162155.4	35.19	-92.23	7	3.2	MDTEC	.F.G	....	260	0.000594754
PDE	1974	12	13	50357.6	34.67	-91.88	5	3.4	MnSLM	5F..	....	305	0.000594545
PDE	1991	1	24	50026.9	36.38	-97.3	5	3	MnGS	5F..	....	222	0.000593911
SRA	1985	9	18	155404.6	33.55	-97.05	5	3.3	MnSRA	5...	....	282	0.000593738
SRA	1982	1	27	232942.2	35.2	-92.22	1	3.2	MnSRA	3...	....	261	0.000592276
PDE-	W 2002	5	31	95710.02	34.03	-97.62	5	3.3	MnGS	3F..	....	284	0.000589192
SRA	1985	12	5	225941.2	35.88	-89.99	5	3.9	MnSRA	5...	....	461	0.000585037
PDE	1988	5	20	230622.61	37.29	-92.77	5	3.3	MnTUL	....	....	286	0.000584712
SRA	1965	2	14	200320.3	36.94	-93.29	0	3	MnSRA	....	....	226	0.000582487
SRA	1879	9	26	310	35.1	-90		3.9	FASRA	3...	....	463	0.000582289
SRA	1927	2	3	8	36.7	-90.4		3.8	FASRA	4...	....	441	0.000562998
SRA	1967	6	29	135706.5	33.55	-90.81	2	3.8	MnSRA	5...	....	446	0.000556135
SRA	1986	9	4	173317.4	34.48	-96.5	5	2.6	MnSRA	....	....	172	0.000554318
PDE	1988	3	24	22547.9	35.41	-96.57	5	2.3	MDTUL	....	....	136	0.000551837
SRA	1979	11	27	91036.8	35.63	-98.41	5	3.3	MnSRA	....	....	302	0.000551095
PDE	1974	8	11	142945	36.92	-91.17	4	3.6	MnSLM	5F..	....	384	0.000550341
SRA	1983	6	21	183259.9	34.96	-97.4	5	2.9	MnSRA	....	....	220	0.00055001
SRA	1982	1	18	23212.6	35.19	-92.26	2	3.1	MnSRA	4...	....	258	0.000549995
SRA	1982	9	27	102232.5	35.19	-92.23	5	3.1	MnSRA	3...	....	260	0.000545394
SRA	1975	12	4	185959.9	38.24	-94.62	0	3.3	MnSRA	....	....N..	306	0.000543263
SRA	1982	1	21	11338.7	35.14	-92.23	9	3.1	MnSRA	.F..	....	261	0.000543121
SRA	1983	3	30	41225.4	35.19	-92.23	3	3.1	MnSRA	4...	....	261	0.000543121
PDE	1992	8	10	200304.2	34.98	-97.45	5	2.9	MDTUL	4F..	....	223	0.000541966
SRA	1968	10	11	85542	34	-96.4		2.8	HzSRA	3...	....	206	0.000541756
SRA	1968	10	18	211410	34	-96.4		2.8	MnSRA	....	....	206	0.000541756
SRA	1980	11	2	100048.9	35.46	-97.76	1	3	MnSRA	5...	....	243	0.000538302
SRA	1963	6	12	163852	34.7	-96.8		2.6	MLSRA	....	....	180	0.000527574
PDE	1994	8	20	104544.65	36.14	-91.06	5	3.5	MnGS	4F..	....	369	0.000527017
PDE	2001	9	22	14036.29	34.83	-93.26	5	2.6	MnGS	.F..	....	181	0.000524404
PDE	1987	6	1	174433.2	34.62	-97.38	5	2.9	MnTUL	4F..	....	232	0.000519136

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
SRA	1962	4	28	60911	35.3	-98.6		3.3	MLSRA	....	....	320	0.000517457
SRA	1931	12	10	81136	35.9	-89.8		3.8	FASRA	4...	....	479	0.00051458
PDE	1987	1	24	160817	35.83	-98.1	5	3.1	MnTUL	5F..	....	275	0.000513111
SRA	1977	9	12	23630.1	33.95	-95.24	5	2.5	MnSRA	....	....	172	0.000508313
SRA	1982	12	19	51542.9	34.89	-97.58	5	2.9	MnSRA	....	....	237	0.000507232
SRA	1979	2	27	225454.8	35.96	-91.2	10	3.4	MnSRA	5...	....	354	0.00050559
SRA	1982	1	18	12307.3	35.19	-92.25	2	3	MnSRA	.F..	....	259	0.000502226
SRA	1982	6	26	155605.7	35.19	-92.24	5	3	MDSRA	.F..	....	259	0.000502226
PDE	1986	4	29	235718.7	35.17	-96	5	1.7	MDTUL	....	....	92	0.000501984
PDE	1998	11	11	53821.04	34.81	-93.18	5	2.6	MnGS	....	....	189	0.000500304
PDE	1989	2	20	115918	35.32	-96.46	5	2.1	MDTUL	....	....	127	0.000499921
SRA	1984	6	17	4139.1	36.13	-92.73	5	2.8	MnSRA	....	....	222	0.000499419
SRA	1982	2	12	53212.2	35.18	-92.23	3	3	MnSRA	4...	....	261	0.000498041
SRA	1986	5	24	81601.5	35.18	-92.22	5	3	MnSRA	....	....	262	0.000495973
SRA	1985	5	5	13930.8	34.66	-97.53	5	2.9	MnSRA	.F..	....	242	0.000495841
SRA	1929	12	7	802	39.2	-96.5		3.6	FASRA	5...	....	428	0.000489074
SRA	1964	4	24	73351.9	31.42	-93.81	5	3.7	mb GS	5...	....	467	0.000485069
SRA	1963	6	5	170208	34.7	-96.8		2.5	MLSRA	....	....N..	180	0.000483786
SRA	1962	9	7	225344	34.7	-98.4		3.2	MLSRA	....	....N..	315	0.000482703
SRA	1964	4	24	12054.2	31.38	-93.81	1	3.7	mb GS	5...	....	471	0.000480588
SRA	1981	12	17	54454.7	36.39	-97.66	5	2.9	MnSRA	....	....	252	0.000474472
SRA	1932	11	22	75642	36	-90.2		3.6	FASRA	3...	....	444	0.000469927
SRA	1974	12	16	23021.7	35.34	-97.29	23	2.6	HzSRA	3...	....	201	0.000467896
PDE	1992	4	30	130.9	36.92	-90.41	5	3.6	MDSLM	4F..	....	447	0.000466496
SRA	1965	12	9	220451	37.4	-91.1		3.5	MnSRA	....	....	413	0.000466223
SRA	1978	5	18	1922.4	35.5	-97.5	5	2.7	MnSRA	3...	....	219	0.000464793
PDE	1989	2	23	4355.7	35.21	-95.86	5	1.4	MDTUL	....	....	78	0.000463223
SRA	1982	6	12	150027.6	35.2	-92.26	4	2.9	MDSRA	4...	....	258	0.000462479
SRA	1976	9	25	140655.8	35.58	-90.47	8	3.5	MnSRA	5...	....	417	0.000461359
SRA	1982	11	21	162739.4	35.2	-92.24	5	2.9	MnSRA	3...	....	259	0.000460536
PDE	1988	1	31	1243.48	35.68	-90.46	10	3.5	MnGS	5F..	....	418	0.000460158
PDE	1992	10	5	44408.6	36.4	-97.5	5	2.8	MDTUL	5F..	....	240	0.000458805
SRA	1981	6	26	83327	35.85	-90.07	9	3.6	MnSRA	5...	....	454	0.000458675
SRA	1968	10	12	214644	34	-96.4		2.6	MnSRA	....	....	206	0.000455553
PDE	1996	4	11	215457.63	34.97	-91.16	5	3.3	MnGS	5F..	....	360	0.000455217
SRA	1982	1	21	120301.8	35.2	-92.21	0	2.9	MDSRA	.F..	....	262	0.000454801
PDE	1994	4	29	32858.68	36.25	-98.09	5	3	MnGS	4F..	....	284	0.000454317
PDE	1994	7	4	72827.8	34.68	-97.56	5	2.8	MnGS	....	....	244	0.000450627
PDE	2001	3	30	171355.6	37.93	-93.33	5	3.1	MnGS	....	....	311	0.000448829
PDE	1992	8	9	210552.1	34.77	-96.49	5	2.2	MDTUL	1F..	....	152	0.00044837
PDE	1993	1	14	170610.45	36.6	-98.28	5	3.1	MnGS	4F..	....	312	0.000447264
SRA	1976	4	19	44246.9	36.04	-99.79	8	3.5	MnSRA	4...	....	430	0.000446201
SRA	1979	9	13	4921.5	35.19	-99.47	1	3.4	MnSRA	4...	....	400	0.000442657
PDE	1991	7	2	34901.7	37.49	-91.71	5	3.3	MDSLM	....	....	373	0.000437979
PDE	1987	6	18	22156.7	35.12	-96.35	5	1.9	MnTUL	....	....	123	0.000435269
PDE	1996	8	11	181749.88	33.58	-90.87	10	3.5	MnGS	....	....	440	0.000435176
SRA	1969	2	2	124932	33.3	-95.8		2.8	MnSRA	....	....	253	0.000433212
PDE	1988	10	13	144206.8	34.09	-96.14	5	2.4	MDTUL	....	....	184	0.000433144
SRA	1985	12	31	182726.1	34.7	-97.46	5	2.7	MnSRA	....	....	234	0.000432468
SRA	1974	2	15	225305.1	34	-92.98	20	2.8	MnSRA	.F..	....	254	0.000431357
PDE	2001	7	24	140235	37.7	-97	5	3	MnGS	.F..	....	298	0.00043114
SRA	1979	3	18	204419.5	35.38	-98.12	5	2.9	MnSRA	3...	....	276	0.000429756
PDE	1994	6	10	233402.92	33.01	-92.67	5	3.2	MnGS	3F..	....	353	0.000426438
SRA	1979	1	29	192010.4	34.92	-97.38	5	2.6	MnSRA	....	....	219	0.000426207
PDE	1986	7	26	41723.8	34.59	-96.62	5	2.3	MnTUL	....	....	173	0.00042474
SRA	1966	3	17	931	35.8	-92		2.9	MnSRA	....	....	280	0.000423079
SRA	1982	12	14	214955	34.46	-97.38	5	2.7	MnSRA	....	....	239	0.000422632
SRA	1982	12	22	174253.7	35.4	-97.93	5	2.8	MnSRA	....	....	259	0.000422303
SRA	1982	3	9	160142.3	35.19	-92.23	6	2.8	MDSRA	....	....	260	0.000420536
SRA	1983	2	4	95813.9	35.2	-92.23	1	2.8	MDSRA	....	....	260	0.000420536
SRA	1982	1	21	130011.7	35.21	-92.22	1	2.8	MDSRA	....	....	261	0.000418783
SRA	1983	2	17	193145.3	35.18	-92.22	5	2.8	MDSRA	.F..	....	261	0.000418783
SRA	1982	2	2	92646.2	35.91	-90.05	12	3.5	MnSRA	4...	....	456	0.000418585

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
PDE	1993	1	8	130118.8	35.83	-90.03	21	3.5	MnTUL	4F..	....	457	0.000417588
SRA	1982	10	29	192739.2	35.21	-92.21	1	2.8	MDSRA	3...	....	262	0.000417043
PDE	1986	6	30	195551.2	34.71	-96.75	5	2.3	MDTUL	....	....	176	0.000416869
SRA	1967	7	6	164351	35.8	-90.4		3.4	MnSRA	....	....	424	0.000415459
SRA	1982	1	21	25639.2	35.15	-92.21	1	2.8	MDSRA	....	....	263	0.000415318
SRA	1982	1	21	115353.6	35.15	-92.21	6	2.8	MDSRA	.F..	....	263	0.000415318
SRA	1982	12	22	204716.8	35.2	-92.2	1	2.8	MDSRA	.F..	....	263	0.000415318
SRA	1978	9	23	73403.7	33.97	-91.92	33	3.1	MnSRA	4...	....	335	0.000413951
SRA	1930	3	26	856	35.1	-90		3.5	FASRA	4...	....	463	0.000411702
PDE	1992	8	10	112123.1	34.62	-96.54	5	2.2	MDTUL	....	....	165	0.00041007
SRA	1963	4	19	143155	36.7	-90.1	0	3.5	MnSRA	....	....	466	0.000408818
SRA	1967	8	25	191518	37.1	-91.1	0	3.3	MnSRA	....	....	398	0.000408124
SRA	1979	2	4	1656	34.67	-97.16	5	2.5	MnSRA	....	....	211	0.000406974
SRA	1979	7	31	191105.6	36.09	-97.3	5	2.5	MnSRA	....	....	211	0.000406974
SRA	1968	11	15	104125	34	-96.8		2.6	HzSRA	....	....	229	0.000405994
PDE	1988	6	21	231245.6	34.51	-96.26	5	2.1	MDTUL	....	....	154	0.000405342
PDE	1990	3	12	164801.44	36.41	-92.3	0	2.8	MDTEI	4F..	....	269	0.000405247
PDE	1987	12	6	174348.2	34.66	-97.39	5	2.6	MnTUL	....	....	230	0.000404074
SRA	1976	4	16	185948.7	36.16	-99.84	14	3.4	MnSRA	4...	....	436	0.000403029
PDE	1986	9	2	131959	34.68	-96.48	5	2.1	MDTUL	....	....	157	0.000396921
SRA	1979	11	5	163525.9	36.46	-91.04	6	3.2	MnSRA	4...	....	378	0.000395836
PDE	1993	3	16	73810.2	35.67	-90.55	10	3.3	MnGS	4F..	....	410	0.00039514
PDE	1992	1	21	113621	38	-92.67	5	3.1	MDSLM	4F..	....	350	0.00039468
PDE- W	2003	4	7	100212.51	33.89	-97.69	5	2.9	MnGS	.F..	....	299	0.000393905
SRA	1984	10	4	122509.3	34.74	-97.5	5	2.6	MnSRA	....	....	236	0.000392906
SRA	1984	8	17	180401.9	34.77	-97.33	5	2.5	MnSRA	....	....	220	0.000388889
PDE	2001	5	4	83143	35.25	-92.23	0	2.7	MDCER	....	....	259	0.00038724
PDE	1989	7	20	60750.42	36.43	-98.88	5	3.1	MnGS	3F..	....	357	0.000386265
SRA	1982	2	16	123820.5	35.19	-92.23	5	2.7	MDSRA	4...	....	260	0.000385619
SRA	1982	3	1	60409.1	35.2	-92.23	6	2.7	MDSRA	.F..	....	260	0.000385619
SRA	1982	11	17	190043.2	35.2	-92.23	1	2.7	MDSRA	.F..	....	260	0.000385619
PDE	1986	12	8	175011.8	35.77	-97.33	5	2.4	MnTUL	....	....	205	0.000385086
SRA	1977	1	6	161954	34.7	-96.73	5	2.2	MnSRA	2...	....	175	0.000384636
SRA	1982	1	21	32739.4	35.18	-92.22	7	2.7	MDSRA	....	....	261	0.000384012
SRA	1982	1	21	154826.8	35.21	-92.22	0	2.7	MDSRA	.F..	....	261	0.000384012
SRA	1982	1	22	84754.8	35.23	-92.22	1	2.7	MDSRA	....	....	261	0.000384012
SRA	1983	3	29	84045.8	35.19	-92.23	3	2.7	MnSRA	.F..	....	261	0.000384012
SRA	1983	3	30	42054.2	35.2	-92.22	4	2.7	MnSRA	3...	....	261	0.000384012
SRA	1985	8	2	42310.8	35.22	-92.21	7	2.7	MDSRA	....	....	261	0.000384012
SRA	1973	10	3	35019.8	35.87	-90.04	6	3.4	MnSLM	4..G	....	456	0.000383827
SRA	1985	1	24	121242.4	34.92	-97.43	5	2.5	MnSRA	....	....	223	0.000383199
SRA	1968	10	11	93337	34	-96.4		2.4	HzSRA	3...	....	206	0.000383052
SRA	1982	1	21	140912.7	35.19	-92.21	0	2.7	MDSRA	....	....	262	0.000382417
SRA	1976	6	23	82117.8	34.1	-97.4		2.7	MnSRA	3...	....	263	0.000380835
SRA	1977	6	30	230322	34.19	-96.96	5	2.5	MnSRA	....	....	225	0.000379493
SRA	1982	9	27	171712.3	35.03	-92.22	2	2.7	MDSRA	.F..	....	264	0.000379265
PDE	1992	12	17	40117.57	34.76	-97.6	5	2.6	MnGS	....	....	244	0.000378907
PDE	1989	12	25	82926.95	35.24	-90.74	5	3.2	MnGS	5F..	....	394	0.000378372
SRA	1972	5	7	21208.7	35.93	-89.97	1	3.4	MnSLM	4..G	....	463	0.000377515
SRA	1963	7	14	81027	35	-97.7		2.6	MLSRA	....	....	245	0.000377224
SRA	1983	12	9	205210.5	33.18	-92.7	5	3	MnSRA	4...	....	337	0.000377128
SRA	1981	11	6	123641	31.92	-95.2	3	3.2	MnSRA	5...	....	396	0.000376293
PDE	1987	2	26	20407.2	35.31	-96.62	5	1.9	MnTUL	....	....	141	0.000375161
SRA	1981	5	25	225018.2	36.76	-91.63	1	3	MnSRA	3...	....	339	0.000374707
PDE	2001	3	3	104613	33.19	-92.66	5	3	MnSLM	.F..	....	339	0.000374707
SRA	1979	7	24	22406.3	36.07	-97.51	5	2.5	MnSRA	....	....	228	0.000374062
SRA	1982	1	15	95217	35.71	-98.03	5	2.7	MnSRA	....	....	268	0.000373108
SRA	1964	4	28	3045.7	31.4	-93.82	6	3.4	mb GS	5...	....	469	0.000372262
SRA	1962	10	23	175558	35	-98.5		2.9	MLSRA	....	....N..	316	0.000370897
SRA	1979	2	27	825	34.2	-92		2.9	MnSRA	4...	....	316	0.000370897
SRA	1974	5	10	11517.8	34.2	-97.3		2.6	MnSRA	....	....	249	0.000370634
SRA	1981	7	1	224330.1	34.95	-97.55	5	2.5	MnSRA	....	....	233	0.000365334
SRA	1986	1	26	20340.6	34.73	-97.46	5	2.5	MnSRA	....	....	233	0.000365334

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
SRA	1970	2	6	45302	37.9	-90.6	0	3.4	MnSRA	2...	....	479	0.00036381
PDE	1990	3	18	162233	36.72	-91.49	5	3	MDTEI	4F..	....	349	0.000363036
SRA	1963	2	2	165739	34.7	-98.2		2.8	MLSRA	....	....N..	298	0.000362517
PDE	1999	10	21	84948.49	36.51	-91.05	11	3.1	MnGS	.F..	....	379	0.000361924
SRA	1986	5	24	124813.5	36.58	-89.88	10	3.4	MnSRA	4...	....	482	0.000361346
PDE	1997	3	11	133030.92	34.72	-97.5	5	2.5	MnGS	.F..	....	237	0.000358628
PDE	1999	11	26	655	36.34	-92.41	0	2.6	MDTEI	.F..	....	257	0.000358094
SRA	1985	5	3	73340.4	34.66	-97.48	5	2.5	MnSRA	....	....	238	0.000356988
PDE	1996	12	19	162957.72	35.08	-97.65	5	2.5	MnGS	4F..	....	238	0.000356988
SRA	1982	1	18	93259.3	35.19	-92.26	2	2.6	MDSRA	....	....	258	0.000356584
SRA	1973	1	10	163815.3	36.4	-98		2.7	MnSRA	3...	....	281	0.00035436
SRA	1979	6	25	171113.8	35.56	-90.45	7	3.2	MnSRA	4...	....	419	0.000353865
SRA	1964	4	26	32450.2	31.55	-93.78	5	3.3	MnSRA	....	....	454	0.000353641
SRA	1982	2	3	62446.6	35.19	-92.23	3	2.6	MDSRA	.F..	....	260	0.000353599
SRA	1982	7	5	30744.6	35.19	-92.23	5	2.6	MnSRA	.F..	....	260	0.000353599
SRA	1982	3	10	30142.6	35.2	-92.22	7	2.6	MDSRA	.F..	....	261	0.000352125
SRA	1980	7	18	142946.9	35.18	-99.7	5	3.2	MnSRA	....	....	421	0.000352035
SRA	1979	7	25	31537.3	33.97	-97.55	5	2.7	MnSRA	5...	....	283	0.000351635
SRA	1968	10	11	22555	34	-96.4		2.3	HzSRA	3...	....	206	0.000351246
PDE	1995	4	5	53116.23	35.2	-99.03	5	3	MnGS	....	....	360	0.000350978
SRA	1982	6	4	212337.9	35.22	-92.21	1	2.6	MDSRA	.F..	....	262	0.000350662
SRA	1982	11	12	3939.3	35.2	-92.21	3	2.6	MDSRA	.F..	....	262	0.000350662
SRA	1982	11	21	184239.8	35.2	-92.21	1	2.6	MDSRA	....	....	262	0.000350662
SRA	1984	7	12	12717.6	35.23	-92.21	2	2.6	MDSRA	.F..	....	262	0.000350662
SRA	1982	1	21	31528.9	35.16	-92.21	3	2.6	MDSRA	.F..	....	263	0.000349211
PDE	2000	10	8	101623.78	35.39	-97.98	5	2.6	MnGS	.F..	....	263	0.000349211
SRA	1962	6	1	112338.6	35.38	-90.39	1	3.2	MnSTT	...G	....	425	0.00034843
PDE	1986	6	1	195238.2	35.66	-96.9	5	2	MDTUL	....	....	165	0.000344802
SRA	1985	5	4	70712.5	36.27	-90.77	9	3.1	MnSRA	3...	....	397	0.000344098
SRA	1964	9	24	80934	37.1	-91.1	0	3.1	MnSRA	....	....	398	0.000343157
SRA	1978	3	9	63050.8	34.01	-97.38	5	2.6	MnSRA	2...	....	268	0.000342126
SRA	1985	11	26	23024.3	35.22	-92.35	4	2.5	MDSRA	....	....	249	0.000339857
SRA	1985	2	10	141552.2	36.43	-98.41	5	2.8	MnSRA	....	....	317	0.00033893
SRA	1984	10	4	131223.4	36.85	-91.91	5	2.8	MnSRA	....	....	321	0.000334335
SRA	1964	5	2	63454	31.3	-93.8		3.3	MnSRA	....	....	480	0.00033284
SRA	1986	2	5	133618.2	35.26	-92.27	6	2.5	MnSRA	....	....	255	0.000331162
SRA	1962	6	1	112340.5	34.98	-90.18		3.2	MnSRA	....	....	449	0.000328205
PDE	2002	1	25	103127.6	34	-97.53	5	2.6	MnTUL	.F..	....	279	0.000327469
PDE	1997	9	20	55550.43	37.18	-90.92	5	3.1	MnGS	....	....	416	0.000327025
SRA	1979	2	5	53109.4	35.84	-90.1	10	3.2	MnSRA	4...	....	452	0.000325834
PDE	1987	6	2	202537	34.71	-96.56	5	1.9	MDTUL	....	....	161	0.00032473
SRA	1983	7	31	140700.1	35.2	-92.22	5	2.5	MnSRA	....	....	261	0.000322884
SRA	1983	7	12	832	35.18	-92.21	7	2.5	MnSRA	.F..	....	262	0.000321542
SRA	1983	5	15	40023.6	34.83	-98.36	5	2.7	MnSRA	....	....	308	0.000320681
SRA	1964	5	7	2010	31.5	-93.8		3.2	MnSRA	3...	....	459	0.000320428
SRA	1975	12	19	52925	34.1	-97.4		2.5	MnSRA	2...	....	263	0.000320212
SRA	1979	9	17	204150.5	35.32	-97.97	5	2.5	MnSRA	4...	....	263	0.000320212
SRA	1964	4	24	120708.2	31.48	-93.79	9	3.2	MnSRA	4...	....	461	0.000318915
SRA	1975	1	10	153101.5	38.11	-91.03	0	3.2	MnSRA	....	....N..	462	0.000318164
PDE	2001	12	17	15444.76	33.2	-92.7	10	2.8	MnGS	.F..	....	336	0.00031812
SRA	1979	9	16	155720.8	35.34	-98	5	2.5	MnSRA	4...	....	265	0.000317582
SRA	1982	9	8	123510.8	34.01	-97.34	5	2.5	MnSRA	....	....	265	0.000317582
SRA	1985	5	6	21116.2	34.97	-97.48	5	2.3	MnSRA	5...	....	226	0.000317548
PDE	1974	12	13	101321.9	36.7	-91.63	5	2.8	MnSLM	....	....	337	0.000317092
SRA	1980	7	8	13444	34	-97.35	5	2.5	MnSRA	....	....	266	0.000316282
PDE	1987	1	17	41353.8	35.05	-97.52	5	2.3	MnTUL	....	....	227	0.000316026
SRA	1979	12	9	231258.7	33.99	-97.35	5	2.5	MnSRA	3...	....	267	0.000314993
SRA	1965	11	3	123322	37.1	-91.1	0	3	MnSRA	....	....	398	0.000314658
PDE-W	2002	10	26	200555.93	34.03	-90.68	5	3.1	MnGS	....	....	433	0.000313073
PDE	1999	5	13	141822.75	39.1	-94.7	5	3	MnGS	.D..	....I..	400	0.000312946
SRA	1982	3	13	14149.9	35.7	-98.04	5	2.5	MnSRA	....	....	269	0.000312444
PDE	1997	1	9	30725.99	33.2	-92.6	5	2.8	MnGS	.F..	....	342	0.000312049
SRA	1964	4	24	74717.1	31.38	-93.8	5	3.2	MnSRA	....	....	471	0.000311551

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
SRA	1975	1	2	91857.3	34.87	-91.07	8	2.9	MnSRA	2...	....	371	0.000311456
SRA	1969	1	20	1925	37.7	-90.5	0	3.2	MnSRA	3...	....	476	0.00030799
PDE	1987	12	8	14547.5	36.06	-98.03	5	2.5	MnTUL	....	....	273	0.000307464
SRA	1976	5	22	74046.1	36.03	-89.83	9	3.2	MnSRA	5...	....	477	0.000307287
SRA	1974	3	12	123029.2	35.64	-89.8	5	3.2	MnSRA	....	....	478	0.000306587
SRA	1962	7	14	42349	36.5	-89.9		3.2	MnSLM	...G	....	479	0.00030589
SRA	1970	2	6	428	37.9	-90.6	0	3.2	MnSRA	2...	....	479	0.00030589
SRA	1983	5	16	140303.8	38.48	-92.36	5	3	MnSRA	....	....	409	0.000305456
SRA	1964	4	27	215027	31.3	-93.8		3.2	MnSRA	4...	....	480	0.000305196
SRA	1984	1	28	212922.1	36.61	-89.92	1	3.2	MnSRA	4...	....	480	0.000305196
SRA	1979	3	18	200535	35.42	-98.11	5	2.5	MnSRA	....	....	275	0.000305031
SRA	1979	3	18	214210.5	35.39	-98.11	5	2.5	MnSRA	....	....	275	0.000305031
SRA	1979	3	19	34255.1	35.4	-98.11	5	2.5	MnSRA	....	....	275	0.000305031
PDE	1986	4	30	33610.7	34.93	-97.36	5	2.2	MDTUL	....	....	217	0.000304347
SRA	1983	7	8	94140.2	37.1	-90.94	10	3	MnSRA	....	....	411	0.000303838
SRA	1983	7	10	25425.4	37.11	-90.93	6	3	MnSRA	....	....	412	0.000303036
PDE	1986	2	24	235222.03	34.69	-97.48	5	2.3	MnTUL	....	....	236	0.000302929
PDE	1987	1	10	32150	34.55	-97.43	5	2.3	MnTUL	....	....	238	0.000300159
PDE	2001	5	2	91303	36.58	-92.24	1	2.5	MnSLM	....	....	281	0.000297947
SRA	1981	6	9	14630.2	31.76	-94.28		3	MnSRA	4...	....	421	0.00029599
SRA	1974	3	4	142428.1	35.69	-90.41	5	3	MnSRA	....	....	422	0.000295226
PDE	1995	12	1	143740.44	35.06	-99.34	5	2.9	MnGS	....	....	390	0.000294974
SRA	1976	4	17	24805.7	34.1	-97.4		2.4	MnSRA	2...	....	263	0.000293618
SRA	1977	3	26	213712.6	34.06	-97.37	5	2.4	mbSRA	3...	....	263	0.000293618
PDE	1974	2	16	94435.2	34	-93.13	1	2.3	MnSLM	....	....	243	0.000293442
SRA	1978	9	23	215626.2	36.32	-91.17	9	2.8	MnSRA	....	....	363	0.000292447
SRA	1979	6	7	73936.3	35.22	-99.76	2	3	MnSRA	4...	....	426	0.000292209
SRA	1967	2	12		36	-90		3.1	MnSRA	....	....	462	0.000291738
SRA	1984	9	27	131604	35.22	-92.17	10	2.4	MnSRA	.F..	....	265	0.000291206
SRA	1982	11	7	419	35.2	-100.2		3.1	MnSRA	....	....	466	0.000289013
SRA	1985	5	5	21602.6	34.84	-97.46	5	2.2	MnSRA	.F..	....	228	0.000288397
PDE	1992	11	23	115609.9	34.83	-97.67	5	2.3	MnTUL	....	....	247	0.000288272
SRA	1980	12	5	726.3	33.91	-97.28	5	2.4	MnSRA	.F..	....	268	0.000287659
PDE	1991	11	13	94315.9	35.72	-90.27	9	3	MDSLM	....	....	435	0.000285633
SRA	1978	4	3	122421.5	36.63	-90	9	3.1	MnSRA	....	....	473	0.000284359
PDE	1999	10	25	231958.37	36.85	-99.66	26	3	MnTUL	.F..	....	438	0.000283504
SRA	1983	2	12	192020.7	36.76	-91.52	12	2.7	MnSRA	....	....	348	0.000280765
SRA	1964	4	28	2407	31.3	-93.8		3.1	MnSRA	....	....	480	0.000279847
SRA	1964	6	3	22727.5	31.28	-93.83	23	3.1	mb GS	4...	....	482	0.000278583
SRA	1972	6	9	191518.9	37.62	-90.37	12	3.1	MnSRA	3...	....	482	0.000278583
SRA	1964	2	2	82243.8	35.31	-99.61	1	2.9	MnSRA	....	....	412	0.000277866
SRA	1978	5	17	231115.7	35.53	-97.91	5	2.3	MnSRA	1...	....	256	0.000277256
PDE	2000	7	9	85236	35.25	-90.87	16	2.8	MDCER	....	....	382	0.000276646
PDE	1989	2	7	222246.7	34.39	-96.83	5	2	MnTUL	....	....	202	0.000276646
PDE	1997	12	11	113457	37.1	-98.48	5	2.7	MnGS	....	....	353	0.000276438
SRA	1966	2	14	856.4	37.08	-90.89	1	2.9	MnGOR	...G	....	414	0.000276405
SRA	1985	11	20	112853.2	35.15	-92.26	1	2.3	MDSRA	.F..	....	258	0.000274917
SRA	1984	7	30	73346.5	37.83	-90.92	7	3	MnSRA	.F..	....	451	0.000274618
SRA	1983	1	10	170643.7	36.7	-98.11	4	2.5	MnSRA	....	....	303	0.000274473
PDE	1998	10	15	94722	35.62	-90.45	12	2.9	MnGS	....	....	419	0.000272815
SRA	1985	10	7	104435.9	35.92	-91.73	8	2.5	MDSRA	....	....	306	0.000271544
SRA	1982	1	28	215508.2	35.18	-92.23	5	2.3	MnSRA	.F..	....	261	0.000271478
SRA	1983	10	4	51158.1	36.17	-91.18	12	2.7	MDSRA	....	....	359	0.000271411
PDE	1994	4	23	194648	35.99	-90.06	5	3	MDSLM	....	....	456	0.000271341
PDE	1988	10	3	220201	34.47	-96.15	5	1.6	MnTUL	....	....	150	0.000270408
SRA	1985	12	13	105739.5	35.17	-92.22	3	2.3	MDSRA	.F..	....	262	0.00027035
PDE	1997	12	24	183211.9	33.2	-92.75	5	2.6	MnGS	.F..	....	333	0.000270095
SRA	1964	4	30	2030	31.5	-93.8		3	mb GS	3...	....	459	0.00026941
PDE	1974	12	25	132135	35.78	-90.01	10	3	MLPDE	2...	....	459	0.00026941
SRA	1970	11	5	102535	36	-90		3	MnSRA	....	....	462	0.000267506
SRA	1966	12	6	80047	38.9	-92.8	0	2.9	MnSLM	...G	....	427	0.000267255
PDE	1987	1	16	32535.79	35.89	-89.98	5	3	MnGS	3F..	....	463	0.000266877
SRA	1979	3	14	43715.3	35.52	-97.78	5	2.2	MnSRA	5...	....	245	0.000266679

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
PDE	1989	7	20	24948.55	36.4	-98.98	5	2.7	MnGS	....	....	365	0.000266557
PDE	1991	2	11	6.1	35.98	-89.95	14	3	MDSLM	2F..	....	466	0.000265007
SRA	1979	3	18	231901.3	34.1	-97.45	5	2.3	MnSRA	3...	....	267	0.000264843
PDE	1992	3	20	123935	34.81	-97.67	5	2.2	MDTUL	....	....	248	0.000263169
PDE	1992	11	21	22143.2	34.83	-97.68	5	2.2	MnTUL	....	....	248	0.000263169
SRA	1985	1	30	93512.4	35.93	-89.91	9	3	MnSRA	....	....	469	0.000263161
PDE	1986	12	14	115618.5	34.96	-96.64	5	1.6	MDTUL	....	....	154	0.000262771
SRA	1980	2	15	43235.4	34.05	-97.45	5	2.3	MnSRA	3...	....	270	0.00026164
PDE	1993	8	5	72137.4	36	-89.88	11	3	MDSLM	....	....	472	0.000261341
PDE	1987	2	19	55011.5	34.85	-97.49	5	2.1	MnTUL	....	....	231	0.000260707
PDE	1988	9	28	184834	34.47	-96.85	5	1.9	MnTUL	....	....	198	0.000259253
PDE	1975	8	25	71108	36.05	-89.84	11	3	MnSLM	....	....	476	0.00025895
SRA	1965	12	3	164456	37.1	-91	0	2.8	MnSRA	....	....	406	0.000258888
SRA	1966	2	14	141845	37.1	-91	0	2.8	MnSRA	....	....	406	0.000258888
SRA	1966	2	18	162652	36.7	-90.8	0	2.8	MnSRA	....	....	406	0.000258888
SRA	1981	7	11	201923.7	34.88	-97.75	5	2.2	MnSRA	2...	....	253	0.000257511
SRA	1973	5	25	144015.8	33.94	-90.63	5	2.9	MnSRA	3...	....	442	0.000257394
SRA	1970	2	6	422	37.9	-90.6	0	3	MnSRA	2...	....	479	0.000257185
SRA	1964	5	3	32412	31.3	-93.8		3	MnSRA	....	....	480	0.000256602
PDE	1988	9	18	114430.1	34.93	-97.19	5	1.9	MDTUL	....	....	202	0.000253668
SRA	1968	10	11	24042	34	-96.4		1.9	HzSRA	3...	....	206	0.00024831
PDE	1975	8	25	30128.4	37.23	-90.88	5	2.8	MnSLM	....	....	422	0.000248218
PDE	1987	5	15	82907.5	35.46	-97.75	5	2.1	MDTUL	....	....	242	0.000247831
SRA	1985	8	11	101623.2	35.96	-99.04	5	2.6	MDSRA	....	....	361	0.000247366
SRA	1979	12	16	123737.5	35.16	-98.74	5	2.5	HzSRA	....	....	335	0.000246051
SRA	1970	11	30	44653	36.2	-89.9		2.93	MwSTT	4..G	....	473	0.000245382
PDE	1992	11	18	214048.2	35.2	-97.55	5	2	MnTUL	....	....	227	0.000243642
SRA	1985	2	12	33052.1	35.86	-89.94	7	2.9	MnSRA	....	....	466	0.000242993
SRA	1984	2	10	183913.6	34.05	-97.42	5	2.2	MDSRA	4...	....	267	0.000242844
PDE	1990	2	7	120214.1	35.63	-98.83	5	2.5	MDTUL	....	....	340	0.000242113
SRA	1964	8	16	113531	31.4	-93.8		2.9	MnSRA	5...	....	469	0.000241301
SRA	1983	8	12	191250.8	37.54	-90.93	11	2.8	MnSRA	....	....	434	0.000240754
PDE	2000	8	30	161041	37.32	-90.33	2	2.9	MnGS	....	....	470	0.000240742
SRA	1978	5	18	3217.6	35.6	-97.83	5	2.1	MnSRA	2...	....	249	0.000240254
PDE	1995	3	23	111012.31	36.9	-99.6	5	2.8	MnGS	2F..	....	435	0.000240151
PDE	2002	3	12	105204.59	34.27	-97.63	5	2.2	MnTUL	.F..	....	270	0.000239908
PDE	1987	12	7	4401	34.58	-97.35	5	2	MDTUL	....	....	231	0.000239052
SRA	1981	8	1	15844.5	38.34	-97.93	10	2.7	MDSRA	....	....	404	0.000238663
SRA	1983	3	18	145611.5	36.02	-89.86	11	2.9	MnSRA	....	....	474	0.000238531
SRA	1983	6	5	130418.6	35	-91.32	14	2.5	MDSRA	....	....	346	0.000237545
SRA	1966	7	20	204028	37.1	-91	0	2.7	MnSRA	....	....	406	0.000237383
SRA	1971	4	13	140049.4	35.78	-90.22	1	2.8	MnSLM	...G	....	440	0.000237181
SRA	1964	4	24	125417	31.3	-93.8		2.9	MnSRA	....	....	480	0.000235286
SRA	1964	4	25	40533	31.3	-93.8		2.9	MnSRA	....	....	480	0.000235286
SRA	1964	4	25	60233	31.3	-93.8		2.9	MnSRA	....	....	480	0.000235286
SRA	1983	5	16	210821.1	34.72	-99.88	5	2.8	MnSRA	....	....	446	0.000233709
SRA	1981	4	29	150932.9	35.34	-90.14	8	2.8	MnSRA	.F..	....	448	0.000232573
PDE	1995	7	31	4748.2	37.69	-90.81	5	2.8	MDSLM	....	....	451	0.000230889
SRA	1974	2	24	75345.2	35.79	-90.48	5	2.7	MnSRA	....	....	417	0.000230572
PDE	1991	12	13	114145.8	35.84	-90.09	5	2.8	MDGS	4F..	....	452	0.000230332
SRA	1976	9	20	94016.2	34.16	-97.4		2.1	MnSRA	3...	....	259	0.000230171
SRA	1965	4	23	35754	37.2	-90.9	0	2.7	MnSRA	....	....	419	0.000229374
PDE	1989	2	5	83744.42	33.2	-92.78	5	2.4	MDTEI	.F..	....	331	0.000228582
PDE	1975	8	25	4414.5	37.23	-90.89	5	2.7	MnSLM	....	....	421	0.000228187
SRA	1973	1	8	91137.9	33.8	-90.52	5	2.8	MnSRA	3...	....	458	0.000227048
SRA	1980	5	30	74402.7	35.51	-99.39	5	2.6	MnSRA	....	....	391	0.000226771
SRA	1965	11	24	24858	37.4	-90.5	0	2.8	MnSRA	....	....	460	0.000225974
PDE	1993	5	19	15250.4	35.71	-90.38	5	2.7	MDSLM	4F..	....	425	0.00022585
SRA	1986	9	25	85635.5	35.88	-89.98	10	2.8	MnSRA	....	....	462	0.000224909
PDE	1996	10	13	111124.15	35.88	-89.99	5	2.8	MnGS	.F..	....	462	0.000224909
SRA	1983	12	10	92453.5	33.18	-92.7	5	2.4	MnSRA	2...	....	337	0.000224154
PDE	1986	11	26	221656.5	35.12	-97.54	5	1.9	MnTUL	....	....	227	0.000223403
PDE	1993	1	30	44253.34	34.04	-97.1	5	2	MnTUL	....	....	246	0.000223224

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
PDE- W	2002	8	11	231946.99	34.34	-90.17	5	2.8	MnGS	....	....	466	0.000222807
PDE	1986	6	10	74801.7	34.06	-95.59	5	1.5	MnTUL	....	....	167	0.000220596
SRA	1985	12	16	222004.3	35.74	-90.26	7	2.7	MnSRA	....	....	436	0.000219651
SRA	1980	11	1	52613.8	35.47	-97.84	8	2	MnSRA	3...	....	250	0.000219337
PDE	1987	6	29	72621	34.33	-96.73	5	1.7	MDTUL	....	....	198	0.000217972
PDE	1996	12	15	71956.84	36.03	-89.84	0	2.8	MnGS	....	....	476	0.000217714
SRA	1965	8	29	225515	37.1	-91	0	2.6	MnSRA	....	....	406	0.000217663
SRA	1966	3	25	130641	37.1	-91	0	2.6	MnSRA	....	....	406	0.000217663
PDE	1988	10	12	101146	35.88	-98.07	5	2.1	MnTUL	....	....	274	0.000216484
SRA	1964	4	24	172213	31.3	-93.8		2.8	MnSRA	....	....	480	0.000215739
PDE	1987	5	17	54104.9	35.89	-97.24	5	1.7	MnTUL	....	....	200	0.0002156
PDE	1991	3	23	100555	36.07	-89.79	8	2.8	MDSLM	5F..	....	481	0.000215251
PDE	1998	10	26	2952	37	-90.88	5	2.6	MnGS	....	....	411	0.00021478
SRA	1969	11	11	72822	36.2	-89.8	0	2.8	MnSRA	....	....	482	0.000214765
SRA	1979	7	13	72939.2	36.07	-89.78	9	2.8	MnSRA	4...	....	482	0.000214765
PDE	1988	3	30	154655.3	36.31	-98.54	5	2.3	MDTUL	....	....	325	0.00021381
SRA	1967	9	28	80231	37.1	-90.9	0	2.6	MnSRA	....	....	414	0.000213086
SRA	1985	5	14	84556.7	33.66	-98.65	5	2.5	MnSRA	....	....	386	0.000210867
SRA	1965	10	24	3909	37.5	-91.1	0	2.6	MnSRA	....	....	419	0.000210318
SRA	1965	10	27	22727	37.5	-91.1	0	2.6	MnSRA	....	....	419	0.000210318
PDE	1987	1	6	80049.3	34.81	-97.58	5	1.9	MDTUL	....	....	240	0.000210259
PDE	1988	7	5	232240	35.91	-98.71	5	2.3	MnTUL	....	....	331	0.000209593
SRA	1983	9	26	45817.3	35.6	-90.41	2	2.6	MDSRA	....	....	422	0.000208691
PDE- W	2002	7	29	112807	35.92	-90.03	8	2.7	MDCERI	....	....	458	0.000208186
PDE	1992	10	1	24058	35.93	-90.01	5	2.7	MDSLM	.F..	....	460	0.000207201
SRA	1983	12	22	233156	35.54	-89.96	13	2.7	MnSRA	....	....	463	0.000205739
PDE- W	2002	4	27	23343	35.96	-89.96	4	2.7	MDCERI	.F..	....	465	0.000204775
SRA	1974	10	1	84810.3	36.06	-89.93	5	2.7	MnSRA	....	....	468	0.000203346
SRA	1979	3	14	31056.8	35.5	-97.83	5	1.9	MnSRA	4...	....	249	0.000201996
PDE	1986	11	26	205338.6	34.96	-97.53	5	1.8	MnTUL	....	....	230	0.000201937
SRA	1964	5	24	203113	36.6	-90	0	2.7	MnSRA	....	....	472	0.00020147
PDE	1988	7	24	81354.8	35.08	-97.37	5	1.7	MDTUL	....	....	213	0.00020131
PDE	1988	3	19	92737.7	36.04	-96.82	5	1.4	MDTUL	....	....	168	0.00020096
SRA	1982	9	7	33156.8	36.23	-89.88	4	2.7	MDSRA	....	....	475	0.000200085
SRA	1978	9	15	55028.2	35.83	-89.81	11	2.7	MnSRA	....	....	477	0.000199171
PDE	1986	4	5	145451.35	34.4	-96.81	5	1.6	MnTUL	....	....	199	0.000198771
PDE	1992	12	2	81457.9	34.9	-97.54	5	1.8	MnTUL	....	....	234	0.000198181
SRA	1964	4	26	23524	31.3	-93.8		2.7	MnSRA	....	....	480	0.000197816
SRA	1964	8	19	235855	31.3	-93.8		2.7	MnSRA	....	....	480	0.000197816
SRA	1983	3	11	165045.3	36.79	-100.2	5	2.7	MnSRA	....	....	482	0.000196922
PDE	2000	10	1	111356	36.77	-90.76	4	2.5	MDCER	....	....	412	0.000196416
PDE	1986	11	2	40012	34.19	-96.86	5	1.7	MDTUL	....	....	218	0.000196287
SRA	1967	8	25	164136	37.1	-90.9	0	2.5	MnSRA	....	....	414	0.000195383
SRA	1978	7	21	25635.9	35.89	-90.13	5	2.6	HzSRA	....	....	449	0.000195061
SRA	1985	2	17	43445.5	35.83	-90.11	8	2.6	MnSRA	....	....	450	0.000194589
PDE	1986	11	27	61215.9	35.16	-97.67	5	1.8	MnTUL	....	....	238	0.000194556
PDE	1992	11	19	182230.62	34.81	-97.57	5	1.8	MDTUL	....	....	240	0.000192791
PDE	1988	6	14	21450	36.53	-97.46	5	1.8	MDTUL	....	....	242	0.000191057
SRA	1977	2	4	205229.3	34.06	-97.37	5	1.9	MnSRA	2...	....	263	0.000190314
SRA	1977	2	10	12816.3	34.06	-97.37	5	1.9	MnSRA	2...	....	263	0.000190314
PDE	1985	11	7	83533.32	34.22	-97.79	5	2	MnTUL	....	....	285	0.000190171
SRA	1986	1	1	141322.5	35.87	-89.99	1	2.6	MnSRA	....	....	461	0.000189537
SRA	1977	6	16	20246.6	34.04	-97.36	5	1.9	MnSRA	2...	....	264	0.000189529
SRA	1966	8	7	100755	37.7	-90.6	0	2.6	MnSRA	....	....	468	0.000186452
SRA	1986	7	18	144253.6	36.01	-89.88	9	2.6	MnSRA	....	....	472	0.000184732
PDE	1974	2	16	94313.7	33.95	-93.09	1	1.8	MnSLM	....	....	250	0.000184408
SRA	1982	7	13	43053.1	35.99	-89.86	13	2.6	MnSRA	3...	....	474	0.000183883
SRA	1979	5	22	34923.8	34.03	-97.47	5	1.9	MnSRA	3...	....	273	0.000182735
SRA	1964	4	24	33618	31.3	-93.8		2.6	MnSRA	....	....	480	0.000181381
SRA	1964	4	24	75056	31.3	-93.8		2.6	MnSRA	....	....	480	0.000181381
SRA	1964	4	24	230350	31.3	-93.8		2.6	MnSRA	....	....	480	0.000181381
SRA	1964	4	25	32308	31.3	-93.8		2.6	MnSRA	....	....	480	0.000181381
SRA	1968	7	22	4954	36.1	-89.8	0	2.6	MnSRA	....	....	481	0.00018097

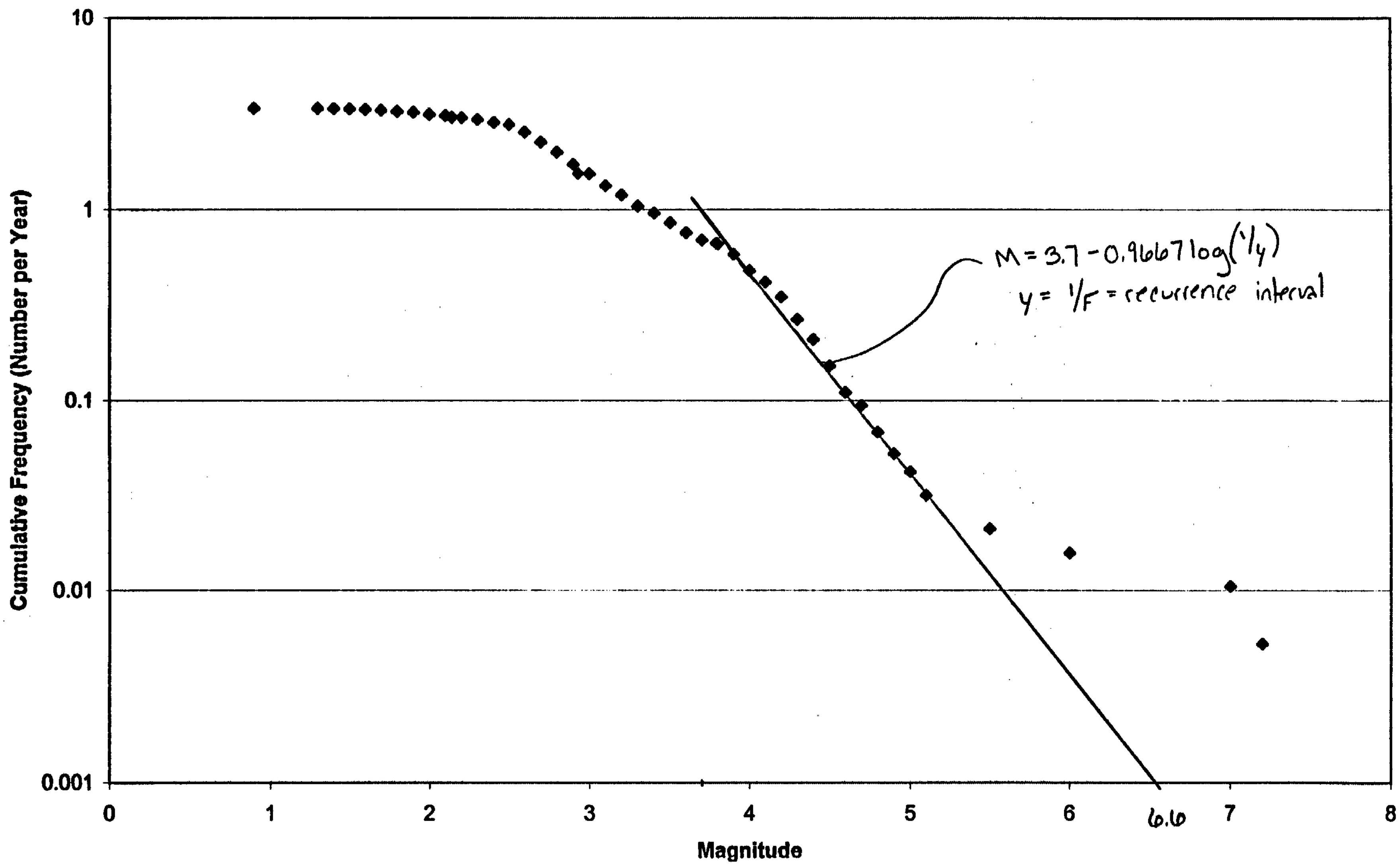
CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
SRA	1983	11	3	172240.5	37.79	-90.49	19	2.6	MnSRA	....	....	481	0.00018097
SRA	1984	11	20	105254.9	35.59	-89.76	3	2.6	MnSRA	....	....	481	0.00018097
PDE	1986	6	2	70811.2	34.65	-96.65	5	1.3	MDTUL	....	....	171	0.000180748
SRA	1970	7	6	93913	37.81	-90.49	0	2.6	MLSRA	3...	....N..	482	0.000180561
PDE	1992	3	3	123018.97	36.1	-89.79	10	2.6	MDSLM	3F..	....	482	0.000180561
PDE	1987	5	17	150119.8	35.88	-97.26	5	1.5	MDTUL	....	....	202	0.000179312
PDE	1986	12	23	211047.6	34.57	-97.2	5	1.6	MDTUL	....	....	219	0.000179085
PDE	1987	5	28	191802.7	34.68	-97.28	5	1.6	MDTUL	....	....	220	0.000178199
SRA	1985	11	17	222330.4	35.84	-90.07	14	2.5	MnSRA	....	....	454	0.00017671
PDE	1992	3	2	50827	34	-97.58	5	1.9	MDTUL	....	....	283	0.000175714
PDE	1987	2	4	134523.9	34.76	-97.58	5	1.7	MDTUL	....	....	242	0.000175184
PDE	1996	7	25	222915.96	37.3	-98.5	5	2.2	MnGS	.F..	....	365	0.000172767
SRA	1979	3	13	232922.6	35.42	-97.85	5	1.7	HzSRA	2...	....	251	0.000168354
SRA	1985	2	21	230120.8	36.07	-89.8	9	2.5	MnSRA	....	....	480	0.00016631
SRA	1976	3	13	72501.1	38.11	-91.04	0	2.4	MnSRA	....	....N..	461	0.00015935
PDE	1998	12	16	104534.1	35.85	-89.94	7	2.4	MnGS	....	....	466	0.000157488
SRA	1978	11	21	233122.1	35.97	-89.92	10	2.4	MLSRA	2...	....	468	0.000156755
PDE	1974	2	16	33855.5	33.95	-93.09	1	1.6	MnSLM	....	....	250	0.000155038
SRA	1982	7	3	45848.9	36.59	-89.96	14	2.4	MnSRA	.F..	....	476	0.000153888
PDE	1988	1	30	225920.4	36.38	-98.47	5	1.9	MnTUL	....	....	320	0.000153703
PDE	1988	6	19	224116.9	33.97	-99.66	5	2.3	MDTUL	....	....	452	0.000149281
SRA	1981	11	6	123933	31.92	-95.2		2.1	MDSRA	3...	....	397	0.000144555
PDE	1988	6	18	73954.37	34.03	-98.71	5	2	MDTUL	....	....	370	0.000143113
SRA	1979	6	3	55024.6	35.61	-90.52	5	2.1	MnSRA	3...	....	412	0.000138832
SRA	1971	4	7	343	35.9	-90.2		2.14	MwSTT	...G	....	443	0.000132812
SRA	1968	1	4	2230	34.85	-95.55				4...	....	84	0.000126938
SRA	1976	6	24	80239.5	34.1	-97.4		1.4	HzSRA	2...	....	263	0.000123342
PDE	1988	4	21	105808.1	35.85	-99.21	5	1.7	MDTUL	....	....	375	0.000108717
PDE	1986	12	22	1725	36.21	-100.4	5	2	MDTUL	....	....	482	0.000107293
SRA	1961	4	27	3	34.6	-95				3...	....	100	0.000104981
SRA	1961	4	27	5	34.6	-95				3...	....	100	0.000104981
SRA	1960	3	18	2130	36.2	-95.8				3...	....	101	0.000103849
SRA	1960	3	18	2330	36.2	-95.8				3...	....	101	0.000103849
SRA	1952	5	1	1140	35.4	-96.4				2...	....	120	8.60698E-05
SRA	1952	5	2	155	35.4	-96.4				2...	....	120	8.60698E-05
SRA	1954	4	11		35.1	-96.4				4...	....	128	8.02258E-05
SRA	1954	4	12	2305	35.1	-96.4				4...	....	128	8.02258E-05
SRA	1954	4	13	1848	35.1	-96.4				4...	....	128	8.02258E-05
SRA	1907	2	20		34.8	-93.9				....	....N..	132	7.75808E-05
SRA	1939	6	1	17	35	-96.4				.F..	....	132	7.75808E-05
SRA	1952	10	8	415	35.1	-96.5				4...	....	136	7.50981E-05
SRA	1924	6	3	40	36.3	-96.5				3...	....	155	6.51254E-05
SRA	1900	12			36	-96.8				4...	....	165	6.08367E-05
SRA	1901	4	1		36	-96.8				.F..	....	165	6.08367E-05
SRA	1901	4	8	1330	36	-96.8				.F..	....	165	6.08367E-05
SRA	1899	12	1	1850	36.9	-94.4				4...	....	166	6.04375E-05
SRA	1953	6	6	1740	34.8	-96.7				4...	....	167	6.00433E-05
SRA	1934	4	12		33.9	-95.5				3...	....	181	5.50008E-05
SRA	1935	11	29		36.2	-97				3...	....	190	5.21681E-05
SRA	1885	2	21		37.2	-94.3				3...	....	200	4.93323E-05
SRA	1938	4	26	542	34.2	-93.5				4...	....	204	4.82792E-05
SRA	1883	1	10	18	36.5	-92.9				3...	....	225	4.33901E-05
SRA	1918				35.5	-97.7				3...	....	237	4.10016E-05
SRA	1908	7	19		35.7	-97.7				3...	....	238	4.08139E-05
SRA	1907	1	2	745	37.1	-97				4...	....	247	3.9196E-05
SRA	1952	4	11	1830	35.4	-97.8				3...	....	247	3.9196E-05
SRA	1952	4	16		35.4	-97.8				3...	....	247	3.9196E-05
SRA	1952	4	16	1430	35.4	-97.8				3...	....	247	3.9196E-05
SRA	1952	7	17	30	35.4	-97.8				3...	....	247	3.9196E-05
SRA	1952	7	17	2	35.4	-97.8				3...	....	247	3.9196E-05
SRA	1952	8	14	2140	35.4	-97.8				4...	....	247	3.9196E-05
SRA	1953	3	16	1250	35.4	-97.9				3...	....	256	3.76967E-05
SRA	1910				35.5	-98				3...	....	265	3.63037E-05

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
SRA	1918	9	10	1530	35.5	-98				4...	....	265	3.63037E-05
SRA	1918	9	11	530	35.5	-98				6...	....	265	3.63037E-05
SRA	1918	9	11	9	35.5	-98				3...	....	265	3.63037E-05
SRA	1933	8	19	1930	35.5	-98				6...	....	265	3.63037E-05
SRA	1953	3	17	1312	35.6	-98				5...	....	265	3.63037E-05
SRA	1953	3	17	1425	35.6	-98				6...	....	265	3.63037E-05
SRA	1940	12	2	1616	33	-94				4...	....	294	3.24191E-05
SRA	1897	12	2	7	36.9	-98				4...	....	304	3.12587E-05
SRA	1919	7	26	11	37.7	-97.3				3...	....	314	3.01754E-05
SRA	1948	4	3	3	37.7	-97.3				4...	....	314	3.01754E-05
SRA	1960	5	4	163132	34.2	-92				4...	....	316	2.99673E-05
SRA	1957	3	19	174117	32.6	-94.7				3...	....	323	2.92602E-05
SRA	1957	3	19	2236	32.6	-94.7				3...	....	323	2.92602E-05
SRA	1957	3	19	2245	32.6	-94.7				3...	....	323	2.92602E-05
SRA	1979	8	26	1128	36.3	-91.5				4...	....	334	2.82116E-05
SRA	1919	4	8	1230	36.2	-91.3				3...	....N..	349	2.68928E-05
SRA	1950	3	20	1323	33.3	-97.8				4...	....	349	2.68928E-05
SRA	1979	2	27	225512	35.93	-91.24	10			4...	....	350	2.6809E-05
SRA	1941	10	18	748	35.4	-99				5...	....	356	2.6317E-05
SRA	1928	11	10	620	36.1	-91.1				4...	....	365	2.56106E-05
SRA	1928	12	26	325	36.1	-91.1				4...	....	365	2.56106E-05
SRA	1930	1	26	21	36.1	-91.1				4...	....	365	2.56106E-05
SRA	1918	10	15	10	36.1	-91				.F..	....	374	2.49397E-05
SRA	1919	11	3	2040	36.3	-91				4...	....	378	2.46522E-05
SRA	1881	5	19	15	39	-95.2				3...	....	387	2.4028E-05
SRA	1931	8	9	61837	39.1	-94.7				6...	....	400	2.31782E-05
SRA	1931	8	9	707	39.1	-94.7				4...	....	400	2.31782E-05
SRA	1931	8	9	715	39.1	-94.7				4...	....	400	2.31782E-05
SRA	1929	9	23	10	39	-96.6				4...	....	410	2.25628E-05
SRA	1895	10	30	1430	36.4	-90.6				3...	....	415	2.22667E-05
SRA	1895	10	30	20	36.4	-90.6				3...	....	415	2.22667E-05
SRA	1895	10	30	2230	36.4	-90.6				3...	....	415	2.22667E-05
SRA	1898	4	15	320	36.4	-90.6				.F..	....	415	2.22667E-05
SRA	1929	10	23		39	-96.8				3...	....	416	2.22084E-05
SRA	1898	1	27	135	34.6	-90.6				4...	....	420	2.19779E-05
SRA	1936	11	23	93840	36.6	-90.6				2...	....	420	2.19779E-05
SRA	1936	11	25	174235	36.6	-90.6				2...	....	420	2.19779E-05
SRA	1891	1	8		31.7	-95.2				3...	....?..	421	2.19211E-05
SRA	1891	1	8	6	31.7	-95.2				6...	....?..	421	2.19211E-05
SRA	1930	2	18	17	35.5	-90.4				3...	....	423	2.18081E-05
SRA	1958	5	20	125	35.5	-90.4				4...	....	423	2.18081E-05
SRA	1811	12	16	830	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	16	934	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	16	1320	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	16	1330	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	16	17	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	17	11	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	17	13	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	17	18	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	18	130	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	18	8	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	18	9	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	18	12	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	19		35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	19	3	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	20	1653	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	21	1	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	21	3	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	21	1030	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	21	1648	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	22	14	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	29		35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	29	2	35.4	-90.4				.F..	....	424	2.17521E-05

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
SRA	1811	12	30	17	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	31	1005	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1811	12	31	1045	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	1	621	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	1	15	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	2	3	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	2	630	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	3	8	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	3	14	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	4		35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	9		35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	9	9	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	11	1	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	11	13	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	12	3	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	12	15	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	13	17	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	13	18	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	13	21	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	14		35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	14	17	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	15	17	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	17	4	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	18	3	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	18	17	35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	20		35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	21		35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1812	1	22		35.4	-90.4				.F..	....	424	2.17521E-05
SRA	1965	4	22	13543	37.5	-91	0			....	....	426	2.16408E-05
SRA	1951	12	18	202	35.6	-90.3				3...	....	432	2.13134E-05
SRA	1951	12	18	8	35.6	-90.3				3...	....	432	2.13134E-05
SRA	1953	5	12	1850	35.6	-90.3				4...	....	432	2.13134E-05
SRA	1938	9	18	157	35.5	-90.3				.F..	....	433	2.12598E-05
SRA	1938	9	18	32946	35.5	-90.3				2...	....	433	2.12598E-05
SRA	1938	9	18	720	35.5	-90.3				3...	....	433	2.12598E-05
SRA	1699	12	25	19	34.9	-90.3				4...	....	439	2.09433E-05
SRA	1933	3	11	1248	36.7	-90.4				4...	....	441	2.08398E-05
SRA	1933	3	11	1304	36.7	-90.4				4...	....	441	2.08398E-05
SRA	1906	1	8	38	39.3	-96.6				.F..	....	442	2.07884E-05
SRA	1906	1	8	430	39.3	-96.6				.F..	....	442	2.07884E-05
SRA	1906	1	8	7	39.3	-96.6				3...	....	442	2.07884E-05
SRA	1906	1	8	9	39.3	-96.6				3...	....	442	2.07884E-05
SRA	1906	1	14	15	39.3	-96.6				4...	....	442	2.07884E-05
SRA	1906	1	20	530	39.3	-96.6				3...	....	442	2.07884E-05
SRA	1906	1	23	1340	39.3	-96.6				3...	....	442	2.07884E-05
SRA	1906	1	23	1425	39.3	-96.6				3...	....	442	2.07884E-05
SRA	1933	12	9		35.8	-90.2				3...	....	442	2.07884E-05
SRA	1933	12	9	850	35.8	-90.2				5...	....	442	2.07884E-05
SRA	1917	5	8		36.8	-90.4				3...	....	444	2.06864E-05
SRA	1917	5	9	15	36.8	-90.4				3...	....	444	2.06864E-05
SRA	1961	9	9	224255	35.96	-90.19	5			4...	....	444	2.06864E-05
SRA	1929	11	27	420	37.2	-99.7				4...	....	455	2.0142E-05
SRA	1947	9	20	2130	31.9	-92.7				5...	....	456	2.00938E-05
SRA	1877	12	17		35.7	-90				.F..	....	460	1.99035E-05
SRA	1884	2	15	12	37.7	-90.7				3...	....	460	1.99035E-05
SRA	1950	9	17	548	35.7	-90				3...	....	460	1.99035E-05
SRA	1963	6	28	95959.8	36.68	-90.16	0			....	....N..	460	1.99035E-05
SRA	1909	10	22	22	37.6	-90.6				4...	....	462	1.98096E-05
SRA	1929	2	26	815	37.6	-90.6				4...	....	462	1.98096E-05
SRA	1934	7	2	151041	35.2	-90				4...	....	462	1.98096E-05
SRA	1872	4	20	7	35.1	-90				3...	....	463	1.9763E-05
SRA	1872	8	20		35.1	-90				3...	....	463	1.9763E-05
SRA	1873	8	22	19	35.1	-90				3...	....	463	1.9763E-05

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAGNI	TUDE	IEFM NFPO TFS	DTSVNWG	DIST km	Peak Ground Accelerations (Campbell)
SRA	1875	10	28	3	35.1	-90				4...	....	463	1.9763E-05
SRA	1880	7	14	231	35.1	-90				2...	....	463	1.9763E-05
SRA	1881	10	7	1652	35.1	-90				4...	....	463	1.9763E-05
SRA	1888	11	3		35.1	-90				4...	....	463	1.9763E-05
SRA	1889	1	5		35.1	-90				3...	....	463	1.9763E-05
SRA	1889	6	6	428	35.1	-90				3...	....	463	1.9763E-05
SRA	1889	7	20	132	35.1	-90				6...	....	463	1.9763E-05
SRA	1891	1	14		35.1	-90				3...	....	463	1.9763E-05
SRA	1892	1	14	905	35.1	-90				3...	....	463	1.9763E-05
SRA	1894	7	18		35.1	-90				3...	....	463	1.9763E-05
SRA	1895	10	3		35.1	-90				3...	....	463	1.9763E-05
SRA	1901	9	14		35.1	-90				3...	....	463	1.9763E-05
SRA	1908	12	28		35.1	-90				3...	....	463	1.9763E-05
SRA	1941	11	15	307	35.1	-90				4...	....	463	1.9763E-05
SRA	1938	6	17		35.8	-89.9				3...	....	469	1.94876E-05
SRA	1970	1	7	1745	35.2	-89.9				4...	....	471	1.93974E-05
SRA	1972	9	6	22812	36.4	-89.9				2...	....	477	1.91316E-05
SRA	1946	11	7	204320	38	-90.7				2...	....	478	1.9088E-05
SRA	1938	9	28	1132	36.5	-89.9				3...	....	479	1.90446E-05
SRA	1940	2	14	1110	35.9	-89.8				3...	....	479	1.90446E-05
SRA	1950	5	1	1530	36.5	-89.9				2...	....	479	1.90446E-05
SRA	1952	12	25		35.9	-89.8				2...	....	479	1.90446E-05
SRA	1959	7	20	81526	35.9	-89.8				3...	....	479	1.90446E-05
SRA	1945	9	23	72323.2	36	-89.8				4...	....	480	1.90013E-05
SRA	1975	1	4		35.2	-89.8				3...	....	480	1.90013E-05

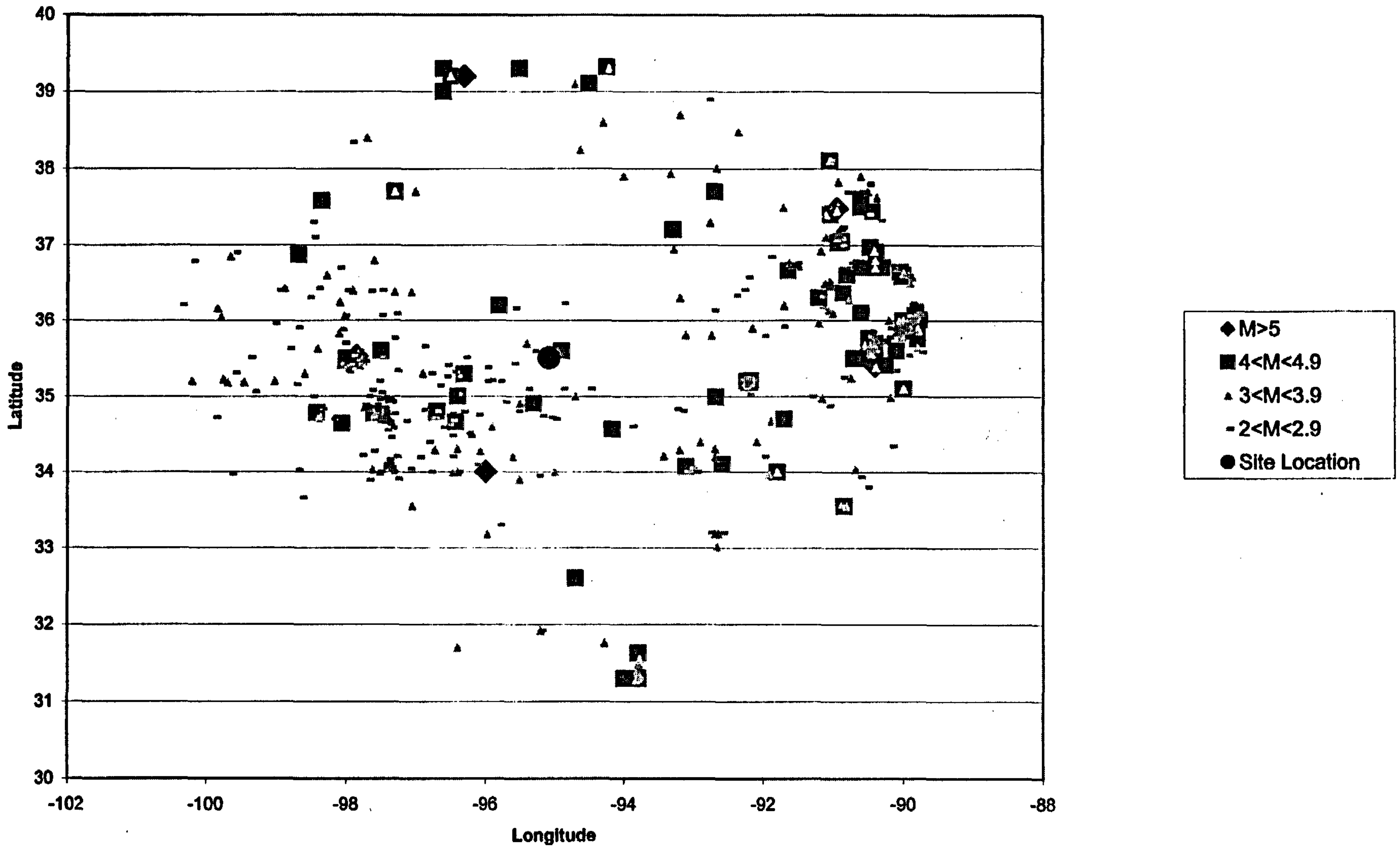
Magnitude vs. Earthquake Frequency



6/13/2003

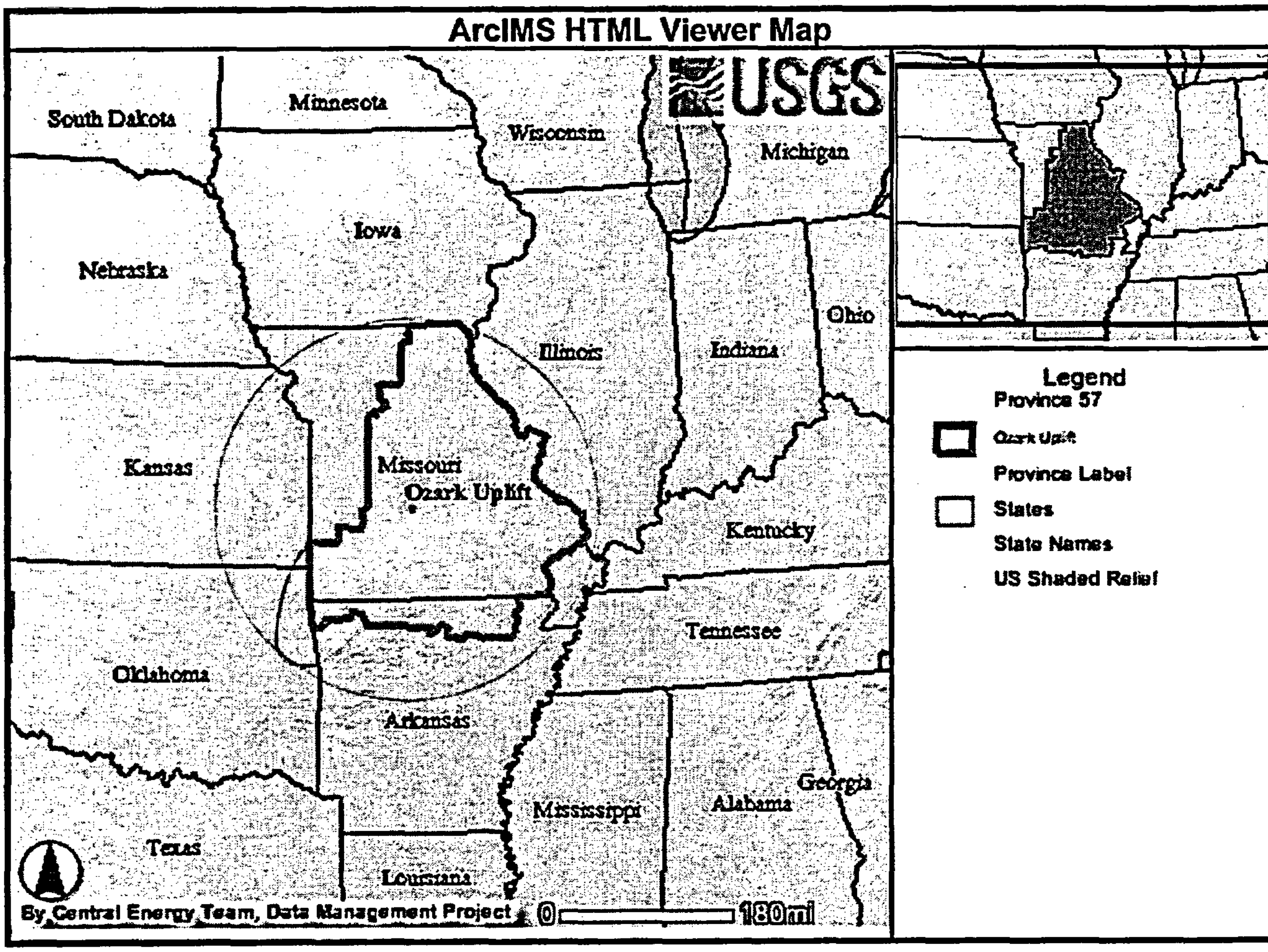
NEIC 1534-2003

Locations of Earthquakes



APPENDIX B.2

SEISMIC ACTIVITY WITHIN OZARK UPLIFT



radius = 200 mi = [illegible] km
center = 37 53 30 lat = 37.8[illegible] N
[illegible] 50 west = 92.7[illegible] W

NEIC: Earthquake Search Results

U. S. GEOLOGICAL SURVEY

EARTHQUAKE DATA BASE

FILE CREATED: Fri Jun 13 11:38:22 2003
Circle Search Earthquakes= 409
Circle Center Point Latitude: 37.892N Longitude: 92.781W
Radius: 320.000 km
Catalog Used: SRA
Data Selection: Eastern, Central and Mountain States of U.S. (SRA)

FILE CREATED: Fri Jun 13 11:40:51 2003
Circle Search Earthquakes= 48
Circle Center Point Latitude: 37.892N Longitude: 92.781W
Radius: 320.000 km
Catalog Used: PDE
Data Range: Year: 1967 - 2003 Month: 01/Day: 01 Month: 08/Day: 01
Data Selection: Historical & Preliminary Data

37.892 -92.781

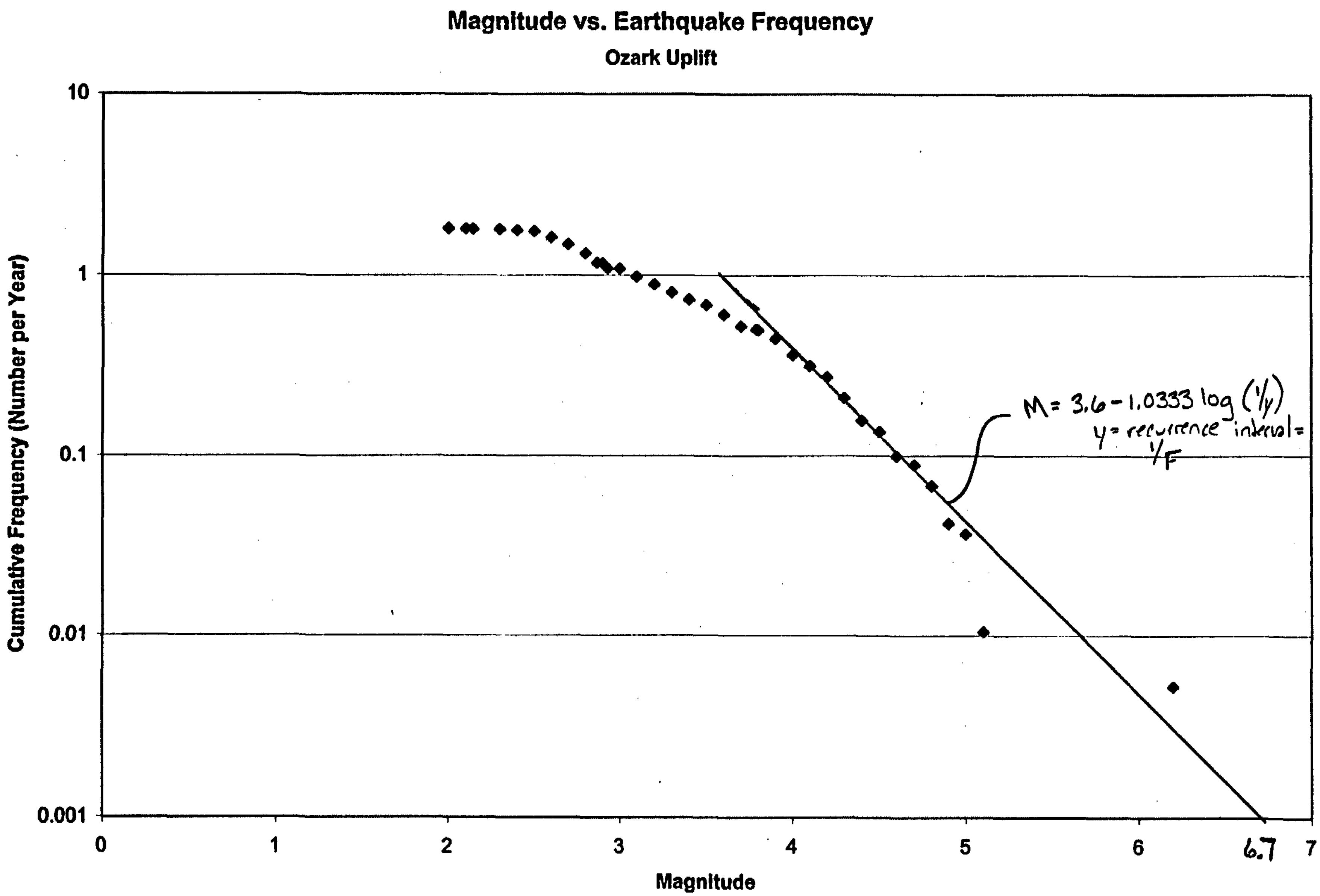
CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAG	NITUDE	IEFM NFPO TFS	DTSVNWK	DIST km	Peak Ground Acceleration (Campbell)	Rank	Frequency	MAGNI
SRA	1895	10	31	1108	37	-89.4		6.2	FASRA	9..	-----	314	0.006456	1	0.005236	6.2
SRA	1965	10	21	20439.1	37.48	-90.94	7	5.1	mb GS	6..G	-----	168	0.004924	2	0.010471	5.1
SRA	1917	4	9	2052	38.1	-90.2		5	FASRA	7...	-----	227	0.003266	3	0.015707	5
SRA	1965	8	14	131356.9	37.23	-89.31	1	5	mb GS	7..G	-----	315	0.002291	4	0.020942	5
SRA	1977	1	3	225648.5	37.58	-88.71	5	5	mb GS	6...	-----	272	0.002666	5	0.026178	5
PDE	1980	9	28	131851.3	37.17	-89.58	12	5	MnTUL	6D..	-----	284	0.002469	6	0.031414	5
PDE	1991	5	4	11854.91	36.56	-89.82	5	5	MnBLA	6D..	-----	300	0.002416	7	0.036649	5
SRA	1939	11	23	151452	38.18	-90.14	9	4.9	FASRA	6...	-----	234	0.002699	8	0.041885	4.9
SRA	1903	2	9	21	37.8	-89.3		4.8	FASRA	7...	-----	306	0.001960	9	0.04712	4.8
SRA	1903	11	4	1914	38.5	-89.6		4.8	FASRA	7...	-----	306	0.001969	10	0.052356	4.8
SRA	1905	8	22	800	37.2	-89.3		4.8	FASRA	6...	-----	316	0.001921	11	0.057592	4.8
SRA	1963	3	3	173010.6	36.64	-90.05	9	4.8	MnDG	6..G	-----	279	0.002207	12	0.062827	4.8
SRA	1970	12	24	101756.8	36.71	-89.54	15	4.8	mb GS	4...	-----	315	0.001928	13	0.068063	4.8
SRA	1902	1	24	1048	38.6	-90.3		4.7	FASRA	6...	-----	230	0.002486	14	0.073298	4.7
SRA	1966	2	13	231937.8	37.04	-89.9	8	4.7	mb GS	..G	-----	191	0.00304	15	0.078534	4.7
SRA	1982	1	21	3354.8	35.18	-92.21	3	4.7	MnTUL	6..G	-----	305	0.001831	16	0.08377	4.7
PDE	2001	5	4	64212.66	35.21	-92.19	10	4.7	MnSLM	6D..	-----	302	0.001851	17	0.089005	4.7
SRA	1883	12	5	1520	38.3	-91.2		4.6	FASRA	5...	-----	225	0.002336	18	0.094241	4.6
SRA	1909	10	23	710	37	-89.5		4.6	FASRA	5...	-----	306	0.001674	19	0.099476	4.6
SRA	1882	9	27	1020	39	-89.5		4.5	FASRA	6...	-----	311	0.001808	20	0.104712	4.5
SRA	1887	12	2	710	38.1	-94.5		4.5	FASRA	4...	-----	201	0.002421	21	0.109948	4.5
SRA	1922	3	23	220	37.4	-88.4		4.5	FASRA	6...	-----	303	0.001552	22	0.115183	4.5
SRA	1984	1	16	80957.6	36.84	-89.46	6	4.5	mb GS	..G	-----	316	0.001482	23	0.120419	4.5
SRA	1984	5	23	112534.5	36.56	-90.02	3	4.5	mb GS	5..G	-----	286	0.001658	24	0.125654	4.5
SRA	1965	11	4	74337.9	37.03	-90.93	4	4.5	mb GS	..G	-----	180	0.002587	25	0.13089	4.5
SRA	1968	3	31	175809.6	38.02	-89.85	1	4.5	mb GS	...	-----	257	0.001866	26	0.136126	4.5
SRA	1944	9	25	113723	37.9	-90.1		4.4	FASRA	4...	-----	235	0.001675	27	0.141361	4.4
SRA	1946	10	8	11202.5	37.5	-90.6		4.4	FASRA	5...	-----	187	0.002269	28	0.146597	4.4
SRA	1954	2	2	1853	38.7	-90.3		4.4	FASRA	5...	-----	256	0.001709	29	0.151832	4.4
SRA	1956	11	26	41243.3	36.91	-90.39	1	4.4	FASRA	6...	-----	236	0.001849	30	0.157068	4.4
SRA	1877	7	15	40	37.7	-89.2		4.3	FASRA	4...	-----	315	0.001251	31	0.162304	4.3
SRA	1909	8	16	2245	38.3	-90.1		4.3	FASRA	4...	-----	239	0.001668	32	0.167539	4.3
SRA	1920	2	29	302	37.2	-93.3		4.3	FASRA	4...	-----	89	0.004909	33	0.172775	4.3
SRA	1920	5	1	1515	38.5	-89.5		4.3	FASRA	5...	-----	295	0.001344	34	0.17801	4.3
SRA	1937	5	17	4946	36.1	-90.6		4.3	FASRA	4...	-----	277	0.001439	35	0.183246	4.3
SRA	1965	4	9	130123.3	36.23	-89.79	11	4.3	FASRA	6...	-----	285	0.001509	36	0.188482	4.3
SRA	1984	5	23	180034.9	36.6	-90.01	8	4.3	mb GS	3..G	-----	284	0.0014	37	0.193717	4.3
SRA	1967	7	21	91448.8	37.44	-90.44	12	4.3	MnSTT	6..G	-----	212	0.001923	38	0.198953	4.3
SRA	1975	6	13	224027.5	36.54	-89.68	9	4.3	mb GS	6..G	-----	312	0.001264	39	0.204188	4.3
SRA	1983	5	15	51621.6	36.77	-89.57	9	4.3	MnSRA	5...	-----	287	0.001334	40	0.209424	4.3
SRA	1819	9	2	830	37.7	-89.7		4.2	FASRA	6...	-----	272	0.001346	41	0.21466	4.2
SRA	1882	10	15	550	39	-89.5		4.2	FASRA	5...	-----	311	0.001164	42	0.219895	4.2
SRA	1882	10	15	1035	39	-89.5		4.2	FASRA	5...	-----	311	0.001164	43	0.225131	4.2
SRA	1922	3	22	222930	37.4	-89.4		4.2	FASRA	7...	-----	303	0.001197	44	0.230366	4.2
SRA	1926	6	29	1420	36.8	-94.9		4.2	FASRA	5...	-----	316	0.001144	45	0.235602	4.2
SRA	1946	5	15	61001	36.6	-90.6		4.2	FASRA	4...	-----	226	0.001645	46	0.240838	4.2
SRA	1947	6	30	42353	38.4	-90.2		4.2	FASRA	6...	-----	233	0.001592	47	0.246073	4.2
SRA	1947	12	1	84733	38.7	-90.6		4.2	FASRA	4...	-----	234	0.001585	48	0.251309	4.2
SRA	1950	2	8	103706.7	37.7	-92.7		4.2	FASRA	5...	-----	22	0.019632	49	0.256545	4.2
SRA	1965	2	28	81017.7	37.05	-90.88	1	4.2	mb GS	..G	-----	192	0.001964	50	0.26178	4.2
SRA	1971	10	1	184938.5	36.77	-90.49	9	4.2	MnDG	5..G	-----	311	0.001164	51	0.267016	4.2
SRA	1976	12	11	70501.1	36.1	-91.04	0	4.2	mb GS	...	...N.	154	0.002493	52	0.272251	4.2
SRA	1882	7	20		37.6	-90.6		4.1	FASRA	3...	-----	194	0.001781	53	0.277487	4.1
SRA	1922	3	28	1642	38.7	-90.4		4.1	FASRA	3...	-----	248	0.001365	54	0.282723	4.1
SRA	1953	9	11	162628	38.8	-90.1		4.1	FASRA	6...	-----	254	0.00133	55	0.287958	4.1
SRA	1961	12	25	125816.8	39.32	-94.24	9	4.1	FABAR	5..G	-----	203	0.001696	56	0.293194	4.1
SRA	1983	7	6	235142.1	36.97	-90.47	0	4.1	mb GS	...	-----	228	0.001495	57	0.298429	4.1
SRA	1972	2	1	64209.5	36.37	-89.85	3	4.1	mb GS	5..G	-----	240	0.001414	58	0.303665	4.1
SRA	1982	1	21	164538.6	35.19	-92.2	4	4.1	MnTUL	3..G	-----	304	0.001094	59	0.308901	4.1
PDE	1987	6	13	211712.8	38.6	-89.69	5	4.1	MnTUL	4F..	-----	309	0.001075	60	0.314136	4.1
SRA	1875	11	8	1040	38.3	-85.5		4	FASRA	5...	-----	283	0.001084	61	0.319372	4
SRA	1903	11	27	7	37	-89.5		4	FASRA	5...	-----	305	0.000996	62	0.324607	4
SRA	1905	4	13	1630	40.4	-91.4		4	FASRA	5...	-----	302	0.00101	63	0.329843	4
SRA	1908	9	28	1934	38.6	-89.8		4	FASRA	4...	-----	316	0.000952	64	0.335079	4
SRA	1965	3	6	210850.3	37.4	-91.03	7	4	MnDG	3..G	-----	163	0.001973	65	0.340314	4
SRA	1974	8	5	80810.7	38.65	-89.91	12	4	mb GS	5...	-----	264	0.001160	66	0.34555	4
SRA	1982	1	24	32244.7	35.2	-92.22	4	4	MnTUL	5..G	-----	302	0.00101	67	0.350785	4
SRA	1982	2	24	192714.1	35.2	-92.24	5	4	MnTUL	5..G	-----	302	0.00101	68	0.356021	4
PDE	1991	7	7	212402.7	38.66	-91.64	5	4	MnGS	6D..	-----	170	0.001665	69	0.361257	4
SRA	1903	10	5	298	38.3	-90.2		3.9	FASRA	3...	-----	230	0.001246	70	0.366492	3.9
SRA	1917	5	9	8	38.8	-90.4		3.9	FASRA	3...	-----	243	0.001173	71	0.371728	3.9
SRA	1921	9	9	3	38.3	-90.1		3.9	FASRA	4...	-----	239	0.001196	72	0.376963	3.9
SRA	1923	3	8	245	38.9	-89.4		3.9	FASRA	4...	-----	315	0.000885	73	0.382199	3.9
SRA	1924	6	7	542	38.5	-89.8		3.9	FASRA	4...	-----	306	0.000913	74	0.387435	3.9
SRA	1925	7	8	18	38.3	-93.2		3.9	FASRA	4...	-----	180	0.001625	75	0.39267	3.9
SRA	1926	10	27	1622	38.7	-90.4		3.9	FASRA	4...	-----	248	0.001148	76	0.397906	3.9
SRA	1926	10	27	1627	38.7	-90.4		3.9	FASRA	4...	-----	248	0.001148	77	0.403141	3.9
SRA	1927	2	2	139	37.4	-89.7		3.9	FASRA	4...	-----	277	0.001018	78	0.408377	3.9
SRA	1945	3	28	14558	38.8	-90.2		3.9	FASRA	3...	-----	239	0.001196	79	0.413613	3.9
SRA	1961	12	25	121958.3	39.3	-94.21	11	3.9	FABAR	4..G	-----	199	0.001456	80	0.418848	3.9
SRA	1965	10	21	40649.2	37.46	-90.94	1	3.9	mb GS	...	-----	169	0.00174	81	0.424084	3.9
SRA	1982	1	22	236422.8	35.22	-92.21	8	3.9	MnTUL	.F.G	-----	300	0.000933	82	0.429319	3.9
SRA	1982	3	1	1200.5	35.16	-92.21	8	3.9	MnTUL	5..G	-----	303	0.000923	83	0.434555	3.9
PDE	2000	8	27	12845	36.8	-92.79	8	3.9	MnCER	.F..	-----	232	0.001234	84	0.439791	3.9
PDE	2000	8	22	201214	36.46	-91.11	5	3.9	MnCER	.F..	-----	214	0.001347	85	0.445026	3.9
SRA	1901	1	4	312	37.8	-94		3.8	FASRA	5...	-----	107	0.002618	86	0.450262	3.8
SRA	1906	11	12	12	38.7	-93.2		3.8	FASRA	4...	...N.	95	0.002944	87	0.455497	3.8
SRA	1918	10	13	830	38.1	-91		3.8	FASRA	4...	-----	254	0.001026	88	0.460733	3.8
SRA	1920	10	3	1418	38.6	-94.3		3.8	FASRA	3...	-----	164	0.001760	89	0.465969	3.8
SRA	1921	10	9	700	38.3	-90.1		3.8	FASRA	3...	-----	239	0.001096	90	0.471204	3.8
SRA	1926	1	27	2242	38.2	-91.7		3.8	FASRA	3...	-----	210	0.001261	91	0.47644	3.8
SRA	1926	12	13	2303	38.7	-89.9		3.8	FASRA	4...	-----	295	0.000872	92	0.481675	3.8
SRA	1927	2	3	9	38.7	-90.4		3.8	FASRA	4...	-----	248	0.001053	93	0.486911	3.8
SRA	1958	3	10	13430.8	36.62	-89.96	7	3.8	mb GS	3..G	-----	300	0.000856	94	0.492147	3.8
SRA	1982	7	6	41348.8	35.16	-92.23	6	3.8	MnTUL	.F.G	-----	304	0.000844	95	0.497382	3.8
SRA	1982	1	21	3736.8	35.16	-92.24	1	3.79	MnSRT	.F.G	-----	305	0.00083	96	0.502618	3.79
SRA	1933	11	16	82901	38.8	-90.8		3.7	FASRA	4...	-----	205	0.001181	97	0.507853	3.7
SRA	1946	8	2	102212.9	35.4	-89.7		3.7	FASRA	4...	-----	316	0.000734	98	0.513089	3.7
SRA	1958	8	28	164124.8	38.32	-89.78	5	3.7	MnSRA	4...	-----	288	0.000806	99	0.518325	3.7
PDE	1989	8	14	1608.5	36.74	-89.71	2	3.7	MnTUL	8F..	-----	300	0.000786	100	0.52356	3.7
SRA	1907	1	31	830	38.9	-89.8		3.6	FASRA	5...	...N.	307	0.000762	101	0.528795	3.6

Rank	Frequency	MAGNI
1	0.005236	6.2
2	0.010471	5.1
7	0.036649	5
8	0.041885	4.9
13	0.068063	4.8
17	0.089005	4.7
19	0.099476	4.6
26	0.136126	4.5
30	0.157068	4.4
40	0.209424	4.3
52	0.272251	4.2
60	0.314136	4.1
69	0.361257	4
85	0.445026	3.9
95	0.497382	3.8
96	0.502618	3.79
100	0.52356	3.7
116	0.60733	3.6
131	0.685864	3.5
140	0.732984	3.4
153	0.801047	3.3
169	0.884817	3.2
187	0.979058	3.1
207	1.08377	3
208	1.089005	2.93
222	1.162304	2.9
223	1.167539	2.87
252	1.319372	2.8
282	1.47644	2.7
308	1.612565	2.6
333	1.743455	2.5
337	1.764398	2.4
341	1.78534	2.3
342	1.790576	2.14
343	1.795812	2.1
344	1.801047	2
345	1.806283	2
346	1.811518	2

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAG	NITUDE	IEFM NFPO TFS	DTSVNWH	DIST km				
SRA	1930	12	23	1444	36.5	-89.7		3.6	FASRA	4..	----	194	0.001156	102	0.534031	3.6
SRA	1932	11	22	75642	36	-90.2		3.6	FASRA	3..	----	311	0.000602	103	0.539267	3.6
SRA	1942	1	14	180506.4	36.6	-89.2		3.6	FASRA	3..	----	230	0.000922	104	0.544503	3.6
SRA	1944	1	7	51815	37.5	-89.7		3.6	FASRA	4..	----	275	0.000791	105	0.549738	3.6
SRA	1945	1	16	2	37.8	-90.2		3.6	FASRA	4..	----	227	0.000975	106	0.554974	3.6
SRA	1949	1	14	34519.6	36.4	-89.7		3.6	FASRA	5..	----	319	0.000573	107	0.560209	3.6
SRA	1951	8	20	23643	36.7	-89.9		3.6	FASRA	4..	----	287	0.000617	108	0.565445	3.6
SRA	1952	5	28	86414	36.6	-89.7		3.6	FASRA	4..	----	305	0.0007	109	0.570681	3.6
SRA	1974	8	5	80711	36.5	-89.9		3.6	MnSTT	..G	----	282	0.00077	110	0.575916	3.6
SRA	1982	5	31	174820.4	35.19	-92.2	1	3.6	MnSRA	4..	----	304	0.00071	111	0.581152	3.6
SRA	1982	5	31	182119.8	35.2	-92.23	2	3.6	MnTUL	4..G	----	302	0.000715	112	0.586387	3.6
SRA	1985	9	6	221702.8	36.61	-89.12	10	3.6	MnSRA	5..	----	232	0.000952	113	0.591623	3.6
PDE	1980	11	9	33915.9	38.54	-89.82	8	3.6	MnGS	5F..	----	317	0.000676	114	0.596859	3.6
PDE	1982	4	30	130.9	38.92	-90.41	5	3.6	MDSLM	4F..	----	235	0.000939	115	0.602094	3.6
PDE	2002	3	12	83048.29	37.17	-89.96	5	3.6	MnGS	.F..	----	281	0.000837	116	0.60733	3.6
SRA	1933	8	4	43415	37.9	-89.9		3.5	FASRA	4..	----	263	0.000794	117	0.612565	3.5
SRA	1963	4	16	143155	36.7	-90.1	6	3.5	MnSRA	....	----	271	0.000737	118	0.6178[illegible]	3.5
SRA	1965	8	15	41901	37.2	-90.3		3.5	MnSLM	5..G	----	316	0.000624	119	0.6230[illegible]	3.5
SRA	1965	12	9	220451	37.4	-91.1		3.5	MnSRA	....	----	198	0.001325	120	0.6282[illegible]	3.5
SRA	1976	12	13	83555.1	37.81	-90.26	9	3.5	MnSRA	5..	----	222	0.000916	121	0.633508	3.5
SRA	1980	7	5	85440.1	38.58	-88.8	4	3.5	MnSRA	4..	----	318	0.00062	122	0.638743	3.5
SRA	1981	4	8	16313	36.87	-89.38	1	3.5	MnSRA	.F..	----	316	0.000624	123	0.643979	3.5
SRA	1982	1	19	43849.5	35.19	-92.25	1	3.5	MnTUL	4..G	----	303	0.000653	124	0.649215	3.5
SRA	1982	1	20	140130.7	35.2	-92.21	8	3.5	MnTUL	4..G	----	302	0.000655	125	0.65445	3.5
SRA	1982	9	25	231705.6	35.21	-92.23	5	3.5	MnSRA	.F..	----	301	0.000658	126	0.659686	3.5
SRA	1983	1	19	23040.2	35.19	-92.21	5	3.5	MnSRA	5..	----	304	0.000651	127	0.664921	3.5
PDE	1980	8	14	173128	38.54	-89.82	11	3.5	MnSLM	4F..	----	317	0.000622	128	0.670157	3.5
PDE	1982	8	28	84138.4	37.63	-89.66	5	3.5	MDSLM	5F..	----	274	0.000728	129	0.675393	3.5
PDE	1993	2	6	20945.5	36.66	-89.73	7	3.5	MDTEI	4F..	----	302	0.000655	130	0.680628	3.5
PDE	1994	8	20	104644.7	36.14	-91.08	5	3.5	MnGS	4F..	----	247	0.000615	131	0.685864	3.5
SRA	1907	7	4	920	37.8	-90.4		3.4	FASRA	4..	----	300	0.000697	132	0.691099	3.4
SRA	1967	7	6	164351	36.8	-90.4		3.4	MnSRA	....	----	314	0.000576	133	0.696335	3.4
SRA	1970	2	6	45302	37.9	-90.6	0	3.4	MnSRA	2..	----	191	0.000969	134	0.701571	3.4
SRA	1975	2	13	194358	36.55	-89.59	3	3.4	MnSRA	5..	----	319	0.000566	135	0.706806	3.4
SRA	1976	1	16	194256.9	35.9	-92.16	7	3.4	MnSRA	5..	----	227	0.00082	136	0.712042	3.4
SRA	1979	2	27	225454.8	36.96	-91.2	10	3.4	MnSRA	5..	----	256	0.000719	137	0.717277	3.4
SRA	1982	2	1	72602.6	35.19	-92.22	7	3.4	MnTUL	4..G	----	303	0.000609	138	0.722513	3.4
SRA	1982	11	21	163528.6	35.21	-92.22	1	3.4	MnSRA	4..	----	301	0.000603	139	0.727749	3.4
SRA	1986	5	24	124813.5	36.58	-89.66	10	3.4	MnSRA	4..	----	296	0.000618	140	0.732984	3.4
SRA	1826	3	17	2115	36.6	-90.2		3.3	FASRA	2..	----	230	0.000711	141	0.73822	3.3
SRA	1949	8	8	195136	38.1	-90.3		3.3	FASRA	3..	----	219	0.000782	142	0.743455	3.3
SRA	1967	8	25	191518	37.1	-91.1	0	3.3	MnSRA	....	----	172	0.001018	143	0.748691	3.3
SRA	1975	12	4	185959.9	38.24	-91.82	0	3.3	MnSRA	....	..N..	165	0.001063	144	0.753927	3.3
SRA	1982	2	1	85508.2	35.18	-92.23	5	3.3	MnTUL	4..G	----	304	0.000547	145	0.759162	3.3
SRA	1984	9	27	130305.2	36.2	-92.19	10	3.3	MnSRA	4..	----	303	0.000549	146	0.764398	3.3
SRA	1985	2	16	195610	37.23	-90.33	5	3.3	MnSRA	4..	----	313	0.00053	147	0.769634	3.3
SRA	1985	11	8	195848.5	35.22	-92.19	4	3.3	MnSRA	.F..	----	300	0.000555	148	0.774869	3.3
PDE	1968	5	28	230622.6	37.29	-92.77	5	3.3	MnTUL	....	----	67	0.002823	149	0.780105	3.3
PDE	1980	9	27	14753.1	37.17	-89.62	7	3.3	MDSLM	5F..	----	280	0.000576	150	0.78534	3.3
PDE	1991	7	2	34901.7	37.49	-91.71	5	3.3	MDSLM	....	----	104	0.001754	151	0.790576	3.3
PDE	1993	3	16	73810.2	35.67	-90.55	10	3.3	MnGS	4F..	----	316	0.000525	152	0.795812	3.3
PDE	1993	8	27	834	38.09	-90.36	16	3.3	MnGS	5F..	----	213	0.000806	153	0.801047	3.3
SRA	1871	7	25	1840	36.5	-90		3.2	FASRA	3..	----	262	0.000615	154	0.806283	3.2
SRA	1942	11	17	1818	38.8	-90.2		3.2	FASRA	4..	----	230	0.000652	155	0.811518	3.2
SRA	1962	7	14	22344	36.58	-90.82	1	3.2	MnSRA	3..	----	301	0.000507	156	0.816754	3.2
SRA	1962	7	14	42349	36.5	-89.9		3.2	MnSLM	..G	----	286	0.000513	157	0.82199	3.2
SRA	1969	1	20	1925	37.7	-90.5	0	3.2	MnSRA	3..	----	201	0.000787	158	0.827225	3.2
SRA	1970	2	6	428	37.9	-90.6	0	3.2	MnSRA	2..	----	191	0.000832	159	0.832461	3.2
SRA	1973	1	12	115656.2	37.89	-90.48	17	3.2	MnSLM	4..G	----	202	0.000783	160	0.837696	3.2
SRA	1974	8	11	142945.4	38.93	-91.16	8	3.2	MnSRA	5..	----	178	0.000896	161	0.842932	3.2
SRA	1975	1	10	163101.6	38.11	-91.03	8	3.2	MnSRA	....	..N..	155	0.001044	162	0.848168	3.2
SRA	1979	11	5	163525.9	36.46	-91.04	6	3.2	MnSRA	4..	----	221	0.00071	163	0.853403	3.2
SRA	1982	1	27	232942.2	35.2	-92.22	1	3.2	MnSRA	3..	----	302	0.000505	164	0.858639	3.2
SRA	1982	6	30	162155.4	35.19	-92.23	7	3.2	MDTEC	.F.G	----	303	0.000504	165	0.863874	3.2
SRA	1982	8	9	111231.6	35.19	-92.24	4	3.2	MnSRA	.F..	----	303	0.000504	166	0.86911	3.2
SRA	1984	1	28	212922.1	36.61	-89.92	1	3.2	MnSRA	4..	----	290	0.000528	167	0.874346	3.2
PDE	1992	12	27	191258.9	37.5	-89.63	5	3.2	MnGS	4F..	----	281	0.000547	168	0.879581	3.2
PDE	1996	7	20	21034.44	38.53	-89.63	5	3.2	MnGS	....	----	317	0.000479	169	0.884817	3.2
SRA	1963	5	2	10921.4	36.67	-89.54	10	3.1	MnSRA	....	----	317	0.00044	170	0.890052	3.1
SRA	1964	9	24	80934	37.1	-91.1	0	3.1	MnSRA	....	----	172	0.000855	171	0.895288	3.1
SRA	1965	8	15	80729	37.22	-89.3	2	3.1	MnDG	5..G	----	316	0.000441	172	0.900524	3.1
SRA	1972	6	9	191518.9	37.62	-90.37	12	3.1	MnSRA	3..	----	214	0.000674	173	0.905759	3.1
SRA	1978	4	3	122421.5	38.63	-90	8	3.1	MnSRA	....	----	283	0.000497	174	0.910995	3.1
SRA	1978	9	20	122408.9	38.58	-90.28	1	3.1	MnSRA	5..	----	232	0.000617	175	0.91623	3.1
SRA	1982	1	18	23212.6	35.19	-92.26	2	3.1	MnSRA	4..	----	303	0.000462	176	0.921466	3.1
SRA	1982	1	21	11338.7	35.14	-92.23	9	3.1	MnSRA	.F..	----	309	0.000452	177	0.926702	3.1
SRA	1982	9	27	102232.5	35.19	-92.23	5	3.1	MnSRA	3..	----	303	0.000462	178	0.931937	3.1
SRA	1983	3	30	41225.4	35.19	-92.23	3	3.1	MnSRA	4..	----	303	0.000462	179	0.937173	3.1
SRA	1985	5	4	70712.5	38.27	-90.77	9	3.1	MnSRA	3..	----	253	0.000562	180	0.942408	3.1
PDE	1987	6	15	160516.3	36.57	-89.71	5	3.1	MnGS	....	----	309	0.000452	181	0.947644	3.1
PDE	1987	8	31	171235.5	38.31	-89.69	5	3.1	MnSLM	4F..	----	275	0.000513	182	0.95288	3.1
PDE	1991	10	3	114804.8	36.84	-89.43	5	3.1	MnGS	3F..	----	318	0.000438	183	0.958115	3.1
PDE	1992	1	21	113821	36	-92.67	5	3.1	MDSLM	4F..	----	15	0.011792	184	0.963351	3.1
PDE	1994	4	6	173855.8	38.12	-89.27	10	3.1	MDSLM	4F..	----	309	0.000452	185	0.968586	3.1
PDE	2001	3	30	171355.6	37.93	-90.33	5	3.1	MnGS	....	----	48	0.003406	186	0.973822	3.1
PDE-Q	2003	5	2	32903	38.73	-89.66	1	3.1	MnSLM	....	----	303	0.000462	187	0.979058	3.1
SRA	1965	2	14	200320.3	38.94	-90.29	0	3	MnSRA	....	----	114	0.001225	188	0.984293	3
SRA	1965	8	14	54618.4	37.21	-89.29	1	3	MnDG	4..G	----	317	0.000403	189	0.989529	3
SRA	1965	11	3	123322	37.1	-91.1	0	3	MnSRA	....	----	172	0.000784	190	0.994764	3
SRA	1970	2	6	422	37.9	-90.6	0	3	MnSRA	2..	----	191	0.000690	191	1	3
SRA	1971	10	18	63831	36.7	-89.6		3	MnSLM	...G	----	311	0.000412	192	1.005236	3
SRA	1981	5	25	225018.2	36.76	-91.83	1	3	MnSRA	3..	----	101	0.000842	193	1.010471	3
SRA	1982	1	16	12307.3	35.19	-92.25	2	3	MnSRA	.F..	----	303	0.000423	194	1.015707	3
SRA	1982	2	12	53212.2	35.18	-92.23	3	3	MnSRA	4..	----	304	0.000422	195	1.020942	3
SRA	1982	6	28	165605.7	35.19	-92.24	5	3	MDSRA	.F..	----	303	0.000423	196	1.026178	3
SRA	1983	8	16	140303.8	38.48	-92.36	5	3	MnSRA	....	----	74	0.001967	197	1.031414	3
SRA	1983	7	6	94140.2	37.1	-90.94	10	3	MnSRA	....	----	184	0.000728	198	1.036649	3
SRA	1983	7	10	25425.4	37.11	-90.93	6	3	MnSRA	....	----	186	0.000724	199	1.041885	3
SRA	1984	1	12	24815.7	37.59	-89.75	2	3	MnSRA	3..	----	269	0.000482	200	1.04712	3
SRA	1984	7	30	73346.5	37.83	-90.92	7	3	MnSRA	.F..	----	183	0.000631	201	1.052356	3
SRA	1986	5	24	81601.5	35.18	-92.22	6	3	MnSRA	....	----	306	0.00042	202	1.057592	3
PDE	1989	4	15	183951.2	38.86	-89.71	5	3	MnGS	....	----	309	0.000414	203	1.062827	3
PDE	1990	3	16	162233	38.72	-91.49	5	3	MDTEI	4F..	----	173	0.000779	204	1.068063	3
PDE	1994	2	28	182049.1	37.83	-89.38	5	3	MDSLM	5F..	----	290	0.00043	205	1.073298	3
PDE	1995	6	29	82720.1	38.59	-89.79	5	3	MnGS	....	----	301	0.000426	206	1.078534	3
PDE	1995	6	29	200746.2	36.56	-89.77	10	3	MnGS	....	----	304	0.000422	207	1.08377	3
SRA	1970	11	30	44653	38.2	-89.9		2.93	MnSTT	4..G	----	317	0.000379	208	1.089005	2.93
SRA	1966	2	14	858.4	37.09	-89.89	1	2.9	MnGOR	...G	----	180	0.000649	209	1.094241	2.9
SRA	1966	3	17	931	36.8	-92		2.9	MnSRA	....	----	242	0.000496	210	1.099476	2.9
SRA	1966	12	6	80047	38.9	-92.5	0	2.9	MnSLM	...G	----	111	0.001157	211	1.104712	2.9
SRA	1974	8	22	223359.4	38.23	-89.73	1	2.9	MnSRA	4..	----	270	0.00044	212	1.109948	2.9
SRA	1976	8	20	91416.6	36.52	-89.78	8	2.9	MnSRA	....	----	305	0.000385	213	1.115183	2.9
SRA	1982	1	21	120301.8	36.2	-92.21	6	2.9	MDSRA	.F..	----	302	0.00039	214	1.120419	2.9
SRA	1982	6	12	180027.6	36.2	-92.25	4	2.9	MDSRA	4..	----	302	0.00039	215	1.125654	2.9
SRA	1982	10	2	234350.6	38.56	-89.65	11	2.9	MDSRA	....	----	318	0.000372	216	1.13089	2.9
SRA	1982	11	21	162739.4	36.2	-92.24	8	2.9	MnSRA	3..	----	302	0.00039	217	1.136126	2.9
SRA	1983	12	28	223007.8	38.31	-90.27	3	2.9	MnSRA	2..	----	224	0.000526	218	1.141361	2.9
SRA	1985	7	10	43814.4	36.76	-89.46	13	2.9	MnSRA	....	----	318	0.000368	219	1.146597	2.9
PDE	1991	3	21	74137.8	36.86	-89.75	16	2.9	MDSLM	3F..	----	307	0.000383	220	1.151832	2.9
PDE	2000	8	30	161041	37.32	-90.33	2	2.9	MnGS	....	----	225	0.000537	221	1.157068	2.9
PDE	2002	2	17	230141	38.64	-89.63	7	2.9	MDCER	....	----	317	0.00037	222	1.162304	2.9
SRA	1965	8	14	90431.3	37.21	-89.29	1	2.87	MnSTT	...G	----	317	0.00036	223	1.167539	2.87
SRA	1965	11	24	34856	37.4	-90.5	0	2.8	MnSRA	....	----	208	0.000536	224	1.172775	2.8
SRA	1965	12	3	164456	37.1	-91	0	2.8	MnSRA	....	----	180	0.000627	225	1.17801	2.8
SRA	1966	2	14	141845	37.1	-91	0	2.8	MnSRA	....	----	180	0.000627	226	1.183246	2.8

CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAG	NITUDE	IEFM NFPO TFS	DTSVNWI	DIST km				
SRA	1965	2	10	182652	38.7	-90.8	6	2.8	MnSRA	....	-----	219	0.000507	227	1.188482	2.8
SRA	1967	6	5	113732	38.3	-90.6	6	2.8	MnSLM	3..G	-----	195	0.000572	228	1.193717	2.8
SRA	1974	12	13	181322.5	38.74	-91.61	3	2.8	MnSRA	....	-----	184	0.000694	229	1.198953	2.8
SRA	1975	12	3	30033.7	36.56	-89.6	8	2.8	MnSRA	6...	-----	318	0.000338	230	1.204188	2.8
SRA	1977	11	9	62145.7	36.61	-89.59	10	2.8	MnSRA	....	-----	316	0.00034	231	1.209424	2.8
SRA	1978	9	23	215828.2	38.32	-91.17	9	2.8	MnSRA	....	-----	225	0.000492	232	1.21466	2.8
SRA	1982	1	21	25639.2	36.15	-82.21	1	2.8	MDSRA	....	-----	308	0.00035	233	1.219895	2.8
SRA	1982	1	21	115353.6	36.15	-82.21	6	2.8	MDSRA	.F..	-----	308	0.00035	234	1.225131	2.8
SRA	1982	1	21	130011.7	36.21	-82.22	1	2.8	MDSRA	....	-----	301	0.000359	235	1.230366	2.8
SRA	1982	2	11	25424.7	36.61	-89.6	7	2.8	MDSRA	.F..	-----	315	0.000341	236	1.235602	2.8
SRA	1982	3	9	180142.3	36.19	-82.23	6	2.8	MDSRA	....	-----	303	0.000356	237	1.240838	2.8
SRA	1982	10	29	182739.2	36.21	-82.21	1	2.8	MDSRA	3...	-----	301	0.000359	238	1.246073	2.8
SRA	1982	12	22	204716.8	36.2	-82.2	1	2.8	MDSRA	.F..	-----	303	0.000356	239	1.251309	2.8
SRA	1983	2	4	95613.9	36.2	-82.23	1	2.8	MDSRA	....	-----	302	0.000357	240	1.256545	2.8
SRA	1983	2	17	183145.3	36.18	-82.22	6	2.8	MDSRA	.F..	-----	305	0.000353	241	1.26178	2.8
SRA	1983	8	12	181250.8	37.54	-90.83	11	2.8	MnSRA	....	-----	167	0.000681	242	1.267016	2.8
SRA	1984	6	17	4138.1	38.13	-92.73	5	2.8	MnSRA	....	-----	195	0.000575	243	1.272251	2.8
SRA	1984	10	4	131223.4	38.85	-91.91	5	2.8	MnSRA	....	-----	138	0.000837	244	1.277487	2.8
SRA	1985	1	12	132336.3	36.57	-89.59	5	2.8	MnSRA	....	-----	318	0.000338	245	1.282723	2.8
SRA	1985	7	21	212211.8	37.98	-90.62	6	2.8	MnSRA	....	-----	180	0.000592	246	1.287958	2.8
SRA	1986	1	21	182034.4	36.57	-89.6	7	2.8	MnSRA	....	-----	317	0.000339	247	1.293194	2.8
SRA	1986	2	17	191306.7	37.94	-90.4	4	2.8	MnSRA	....	-----	209	0.000533	248	1.298429	2.8
SRA	1986	7	8	62947.4	36.78	-89.92	5	2.8	MnSRA	....	-----	291	0.000386	249	1.303665	2.8
PDE	1990	3	12	164801.4	36.41	-82.3	6	2.8	MDTEI	4F..	-----	169	0.000672	250	1.308901	2.8
PDE	1995	7	31	4748.2	37.69	-90.81	5	2.8	MDSLM	....	-----	174	0.000651	251	1.314136	2.8
PDE	2001	6	13	72824	36.62	-89.57	6	2.8	MnGS	....	-----	317	0.000339	252	1.319372	2.8
SRA	1964	5	24	203113	38.6	-90	6	2.7	MnSRA	....	-----	285	0.000349	253	1.324607	2.7
SRA	1965	4	23	35754	37.2	-90.9	6	2.7	MnSRA	....	-----	183	0.000565	254	1.329843	2.7
SRA	1965	8	16	111938	37.2	-90.3		2.7	MnSLM	...G	-----	316	0.000312	255	1.335079	2.7
SRA	1966	7	30	204028	37.1	-91	0	2.7	MnSRA	....	-----	180	0.000575	256	1.340314	2.7
SRA	1972	6	21	23117	37.1	-90.9		2.7	MnSLM	...G	-----	260	0.000372	257	1.34655	2.7
SRA	1974	2	24	75345.2	35.79	-90.48	5	2.7	MnSRA	....	-----	310	0.000318	258	1.350785	2.7
SRA	1974	8	1	220907.8	38.31	-90.57	1	2.7	MnSRA	....	-----	190	0.000516	259	1.356021	2.7
SRA	1975	8	25	4414.4	37.23	-90.91	5	2.7	MnSRA	....	-----	180	0.000675	260	1.361257	2.7
SRA	1982	1	21	32730.4	36.18	-82.22	7	2.7	MDSRA	....	-----	304	0.000325	261	1.366492	2.7
SRA	1982	1	21	140912.7	36.19	-82.21	0	2.7	MDSRA	....	-----	303	0.000326	262	1.371728	2.7
SRA	1982	1	21	164826.8	36.21	-82.22	0	2.7	MDSRA	.F..	-----	301	0.000329	263	1.376963	2.7
SRA	1982	1	22	84754.8	35.23	-82.22	1	2.7	MDSRA	....	-----	290	0.000331	264	1.382199	2.7
SRA	1982	2	16	123820.5	36.19	-82.23	6	2.7	MDSRA	4...	-----	303	0.000326	265	1.387435	2.7
SRA	1982	3	1	80409.1	36.2	-82.23	5	2.7	MDSRA	.F..	-----	302	0.000328	266	1.39267	2.7
SRA	1982	8	7	33186.8	36.23	-89.86	4	2.7	MDSRA	....	-----	316	0.000312	267	1.397906	2.7
SRA	1982	11	17	180043.2	36.2	-82.23	1	2.7	MDSRA	.F..	-----	302	0.000328	268	1.403141	2.7
SRA	1983	2	12	182020.7	36.76	-81.52	12	2.7	MnSRA	....	-----	166	0.00062	269	1.408377	2.7
SRA	1983	3	28	84045.8	36.19	-82.23	3	2.7	MnSRA	.F..	-----	303	0.000326	270	1.413613	2.7
SRA	1983	3	30	42064.2	36.2	-82.22	4	2.7	MnSRA	3...	-----	302	0.000328	271	1.418848	2.7
SRA	1983	6	28	80822.6	37.02	-89.52	14	2.7	MnSRA	....	-----	304	0.000325	272	1.424084	2.7
SRA	1983	10	4	51158.1	38.17	-91.18	12	2.7	MDSRA	....	-----	238	0.000425	273	1.429319	2.7
SRA	1985	7	6	80812.7	38.54	-89.64	6	2.7	MnSRA	....	-----	316	0.000312	274	1.434555	2.7
SRA	1985	8	2	42316.8	35.22	-82.21	7	2.7	MDSRA	....	-----	300	0.00033	275	1.439791	2.7
SRA	1985	10	4	185130.9	36.67	-89.53	6	2.7	MnSRA	....	-----	318	0.00031	276	1.445026	2.7
SRA	1986	2	18	110112.8	38.25	-89.77	6	2.7	MnSRA	....	-----	287	0.000375	277	1.450262	2.7
SRA	1986	11	8	182147.2	38.11	-90.42	9	2.7	MnSRA	3...	-----	256	0.000482	278	1.455497	2.7
PDE	1991	6	28	105230	36.57	-89.6	5	2.7	MDSLM	....	-----	317	0.000311	279	1.460733	2.7
PDE	1992	12	27	101410	37.5	-89.62	10	2.7	MDSLM	....	-----	282	0.000353	280	1.465969	2.7
PDE	1993	6	16	147126	37.65	-89.76	10	2.7	MDSLM	.F..	-----	286	0.000373	281	1.471204	2.7
PDE	2001	6	4	83143	35.25	-82.23	6	2.7	MDCER	....	-----	297	0.000334	282	1.47644	2.7
SRA	1955	8	29	225515	37.1	-91	6	2.6	MnSRA	....	-----	180	0.000528	283	1.481675	2.6
SRA	1955	10	24	3909	37.5	-91.1	6	2.6	MnSRA	....	-----	164	0.000625	284	1.486911	2.6
SRA	1955	10	27	22727	37.5	-91.1	6	2.6	MnSRA	....	-----	164	0.000625	285	1.492147	2.6
SRA	1956	3	25	130641	37.1	-91	6	2.6	MnSRA	....	-----	180	0.000528	286	1.497382	2.6
SRA	1956	8	7	100755	37.7	-90.6	6	2.6	MnSRA	....	-----	183	0.000489	287	1.502618	2.6
SRA	1967	9	28	80231	37.1	-90.9	6	2.6	MnSRA	....	-----	186	0.000503	288	1.507853	2.6
SRA	1970	7	6	83913	37.81	-90.40	6	2.6	MLSRA	3...	...N.	201	0.000466	289	1.513089	2.6
SRA	1974	4	5	184114.2	38.63	-90.78	1	2.6	MnSRA	2...	-----	194	0.000486	290	1.518325	2.6
SRA	1974	8	28	111533.1	36.66	-89.52	5	2.6	MnSRA	....	-----	318	0.000284	291	1.52356	2.6
SRA	1977	1	4	23416.4	37.58	-89.75	5	2.6	MnSRA	....	-----	280	0.000341	292	1.528796	2.6
SRA	1981	12	27	211042.7	37.17	-89.32	2	2.6	MDSRA	....	-----	318	0.000286	293	1.534031	2.6
SRA	1982	1	18	83250.3	36.19	-82.26	2	2.6	MDSRA	....	-----	303	0.000299	294	1.539267	2.6
SRA	1982	1	21	31528.9	36.16	-82.21	3	2.6	MDSRA	.F..	-----	307	0.000295	295	1.544503	2.6
SRA	1982	2	3	62446.6	36.19	-82.23	3	2.6	MDSRA	.F..	-----	303	0.000299	296	1.549738	2.6
SRA	1982	3	16	30142.6	36.2	-82.22	7	2.6	MDSRA	.F..	-----	302	0.0003	297	1.554974	2.6
SRA	1982	6	4	212337.9	35.22	-82.21	1	2.6	MDSRA	.F..	-----	300	0.000303	298	1.560209	2.6
SRA	1982	7	5	30744.6	36.19	-82.23	6	2.6	MDSRA	.F..	-----	303	0.000299	299	1.565445	2.6
SRA	1982	11	12	3939.3	36.2	-82.21	3	2.6	MDSRA	.F..	-----	302	0.0003	300	1.570681	2.6
SRA	1982	11	21	184239.8	36.2	-82.21	1	2.6	MDSRA	....	-----	302	0.0003	301	1.575916	2.6
SRA	1982	11	24	120752.2	36.53	-89.62	6	2.6	MnSRA	....	-----	318	0.000284	302	1.581152	2.6
SRA	1983	11	3	172240.5	37.79	-90.49	19	2.6	MnSRA	....	-----	201	0.000466	303	1.586387	2.6
SRA	1983	11	17	143234.8	36.56	-89.59	5	2.6	MnSRA	....	-----	319	0.000283	304	1.591623	2.6
SRA	1984	2	22	170640.7	37.97	-90.63	18	2.6	MnSRA	....	-----	197	0.000476	305	1.596859	2.6
SRA	1984	6	17	174000.2	38.06	-90.07	1	2.6	MnSRA	....	-----	238	0.000389	306	1.602094	2.6
SRA	1984	7	12	12717.8	35.23	-82.21	2	2.6	MDSRA	.F..	-----	290	0.000304	307	1.60733	2.6
SRA	1985	11	8	181012.5	38.18	-90.32	3	2.6	MnSRA	....	-----	218	0.000428	308	1.612565	2.6
SRA	1965	8	14	80927	37.2	-90.3		2.5	MnSLM	..G	-----	318	0.000282	309	1.617801	2.5
SRA	1967	8	25	184136	37.1	-90.9	6	2.5	MnSRA	....	-----	186	0.000461	310	1.623037	2.5
SRA	1973	4	18	122153.1	38.61	-90.24	21	2.5	MnSRA	....	-----	232	0.000387	311	1.628272	2.5
SRA	1975	8	26	30128.5	37.23	-90.91	6	2.5	MnSRA	....	-----	180	0.000484	312	1.633508	2.5
SRA	1977	4	16	173111.8	37.22	-89.61	10	2.5	MnSRA	....	-----	272	0.000309	313	1.638743	2.5
SRA	1978	9	7	81612.4	38.56	-89.86	9	2.5	MnSRA	....	-----	314	0.000284	314	1.643979	2.5
SRA	1979	9	12	195946.2	37.74	-89.96	3	2.5	MnSRA	3...	-----	240	0.00034	315	1.649215	2.5
SRA	1981	9	30	142637	36.58	-89.65	6	2.5	MnSRA	....	-----	314	0.000264	316	1.65445	2.5
SRA	1982	9	6	212253.4	36.56	-89.62	4	2.5	MDSRA	....	-----	316	0.000262	317	1.659686	2.5
SRA	1983	1	29	113718	36.7	-89.54	5	2.5	MnSRA	....	-----	316	0.000262	318	1.664921	2.5
SRA	1983	2	22	180316.5	37.8	-90.16	18	2.5	MnSRA	....	-----	230	0.000371	319	1.670157	2.5
SRA	1983	7	12	832	36.18	-82.21	7	2.5	MnSRA	.F..	-----	305	0.000273	320	1.675393	2.5
SRA	1983	7	31	140700.1	36.2	-82.22	6	2.5	MnSRA	....	-----	302	0.000275	321	1.680628	2.5
SRA	1983	10	21	233831	36.60	-89.5	12	2.5	MnSRA	....	-----	319	0.00026	322	1.685864	2.5
SRA	1984	1	6	171448.8	36.16	-85.58	8	2.5	MDSRA	4...	-----	314	0.000264	323	1.691099	2.5
SRA	1984	11	19	112533.4	37.39	-89.05	8	2.5	MnSRA	....	-----	247	0.000343	324	1.696335	2.5
SRA	1985	3	28	145532.1	39.04	-89.86	8	2.5	MnSRA	....	-----	300	0.000277	325	1.701571	2.5
SRA	1985	10	7	104435.9	36.92	-91.73	5	2.5	MDSRA	....	-----	238	0.000357	326	1.706806	2.5
SRA	1985	11	28	23024.3	36.22	-82.36	4	2.5	MDSRA	....	-----	299	0.000279	327	1.712042	2.5
SRA	1986	2	5	133618.2	36.26	-82.27	6	2.5	MnSRA	....	-----	295	0.000283	328	1.717277	2.5
SRA	1986	5	29	90029.6	36.60	-89.56	10	2.5	MnSRA	....	-----	316	0.000262	329	1.722513	2.5
SRA	1986	5	29	64459	38	-89.9	5	2.5	MnSRA	....	-----	253	0.000334	330	1.727749	2.5
SRA	1986	12	16	213.3	36.73	-89.52	5	2.5	MnSRA	....	-----	316	0.000262	331	1.732984	2.5
PDE	2000	10	1	111358	36.77	-89.76	4	2.5	MDCER	....	-----	217	0.000395	332	1.73822	2.5
PDE	2001	5	2	91303	36.90	-82.24	1	2.5	MnSLM	....	-----	193	0.000677	333	1.743455	2.5
SRA	1974	3	27	161057	38.52	-90.16	1	2.4	MnSRA	2...	-----	239	0.000326	334	1.748691	2.4
SRA	1978	3	13	72801.1	38.11	-91.04	8	2.4	MnSRA	....	...N.	194	0.000526	335	1.753927	2.4
SRA	1982	7	3	45848.9	36.89	-89.86	14	2.4	MnSRA	.F..	-----	288	0.000266	336	1.759162	2.4
SRA	1984	9	27	131804	36.22	-82.17	10	2.4	MnSRA	.F..	-----	301	0.000253	337	1.764398	2.4
SRA	1982	1	28	215608.2	36.18	-82.23	5	2.3	MnSRA	.F..	-----	304	0.00023	338	1.769634	2.3
SRA	1985	11	20	112853.2	36.15	-82.26	1	2.3	MDSRA	.F..	-----	307	0.000227	339	1.774869	2.3
SRA	1985	12	13	195738.5	36.17	-82.22	3	2.3	MDSRA	.F..	-----	305	0.000229	340	1.780105	2.3
PDE	1990	10	30	65562.77	37.14	-89.62	5	2.3	MnGS	.F..	-----	291	0.000241	341	1.78534	2.3
SRA	1971	4	7	343	38.9	-90.2		2.14	MwSTT	...G	-----	318	0.000191	342	1.790576	2.14
SRA	1980	8	21	183944.2	38.03	-90.48	10	2.1	MnSRA	.F..	-----	202	0.000302	343	1.795812	2.1
SRA	1978	1	23	8630.6	36.56	-89.6	9	2	MLSRA	4...	-----	319	0.000166	344	1.801047	2
SRA	1980	8	20	44304.7	37.04	-90.36	8	2	MnSRA	.F..	-----	213	0.000261	345	1.806283	2
PDE	1991	5	4	11488.25	36.56	-89.8	9	2	MnSLM	....	-----	302	0.000179	346	1.811518	2
SRA	1795	1	8	9	37.9	-89.9				6...	-----	253	3.82E-06	347	1.816754	
SRA	1818	4	11	20	38.6	-90.2				3...	-----	230	4.08E-06	348	1.82199	
SRA	1819	9	17		38.1	-90.8				4...	-----	282	3.08E-06	349	1.827225	
SRA	1819	9	17	4	38.1	-90.8				4...	-----	282	3.08E-06	350	1.832461	
SRA	1820	11	9	22	37.3	-89.5				5...	-----	306	3.22E-06	351	1.837696	

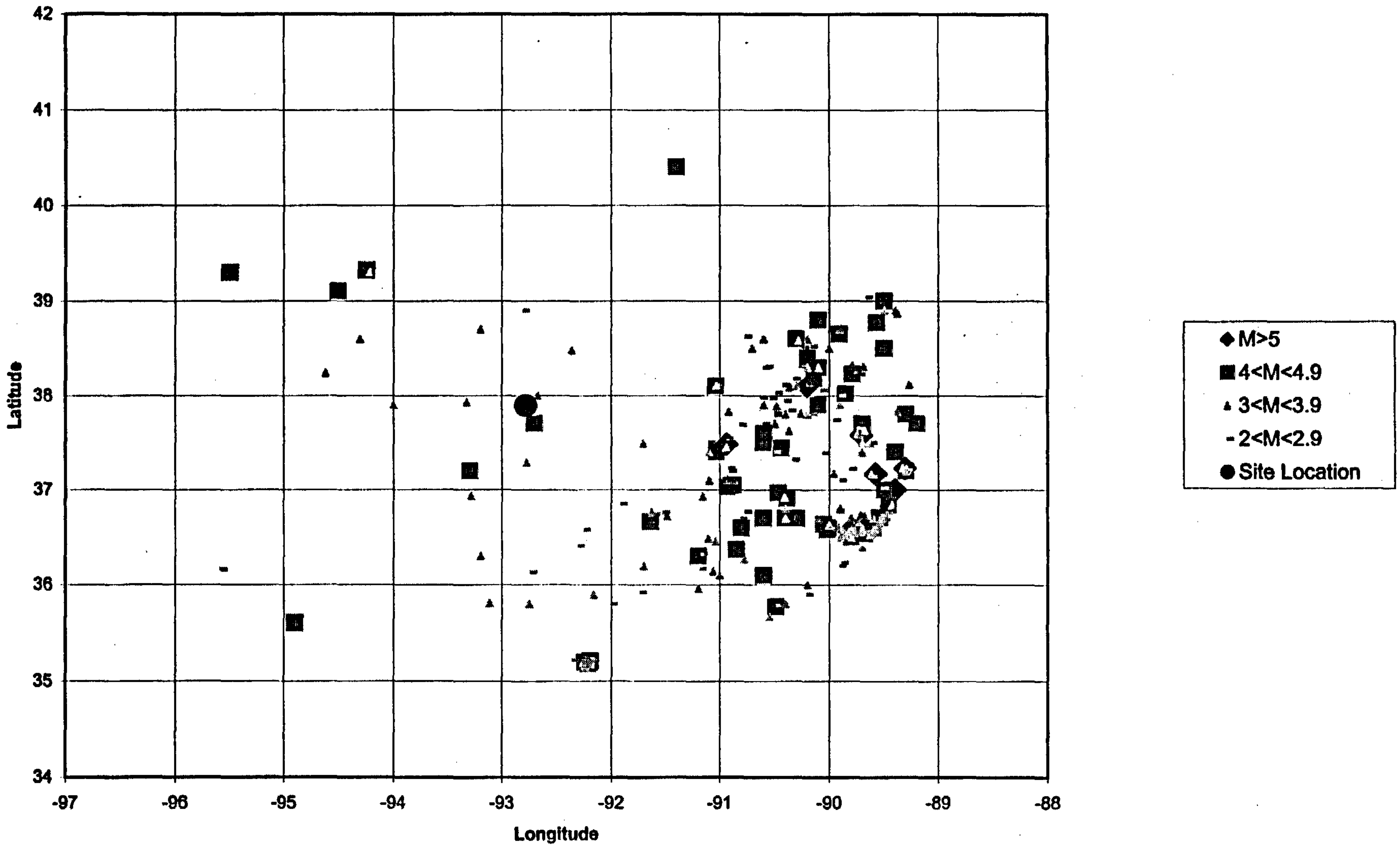
CAT	YEAR	MO	DA	ORIG TIME	LAT	LONG	DEP	MAG	NITUDE	IEFM NFPO TPS	DTSVNWI	DIST km			
SRA	1827	8	14		38.6	-90.2				3...	-----	239	4.06E-05	362	1.842932
SRA	1840	5	21	530	38.5	-90.2				3...	-----	235	4.14E-05	363	1.848168
SRA	1846	3	28	1725	38.6	-89.6				3...	-----	316	3E-05	364	1.853403
SRA	1872	7	9	230	38.8	-93.5				4...	-----	220	4.46E-05	365	1.858639
SRA	1881	5	19	15	39	-86.2				3...	-----	244	3.97E-05	366	1.863874
SRA	1882	10	15	430	39	-89.5				5...	-----	311	3.06E-05	367	1.86911
SRA	1882	10	22	610	38.9	-90.4				3...	-----	315	3.01E-05	368	1.874346
SRA	1882	11	16	315	38.6	-90.2				3...	-----	239	4.06E-05	369	1.879581
SRA	1883	1	10	19	36.5	-92.9				3...	-----	184	6.56E-05	370	1.884817
SRA	1883	1	10	2025	37.4	-89.3				3...	-----	311	3.06E-05	371	1.890052
SRA	1883	11	15	314	38.7	-90.2				4...	-----	242	4.01E-05	372	1.895286
SRA	1884	2	16	12	37.7	-90.7				3...	-----	184	6.4E-05	373	1.900524
SRA	1885	2	21		37.2	-94.3				3...	-----	184	6.56E-05	374	1.905759
SRA	1886	3	18	550	37.6	-89.2				3...	-----	317	2.99E-05	375	1.910995
SRA	1895	10	30	1430	36.4	-90.6				3...	-----	254	3.8E-05	376	1.91623
SRA	1895	10	30	20	36.4	-90.6				3...	-----	254	3.8E-05	377	1.921466
SRA	1895	10	30	2230	36.4	-90.6				3...	-----	254	3.8E-05	378	1.926702
SRA	1895	11	2	216	37	-89.4				4...	-----	314	3.02E-05	379	1.931937
SRA	1895	11	2	8	37	-89.4				3...	-----	314	3.02E-05	380	1.937173
SRA	1895	11	2	17	37	-89.4				3...	-----	314	3.02E-05	381	1.942408
SRA	1895	11	17		37	-89.4				3...	-----	314	3.02E-05	382	1.947644
SRA	1898	4	15	320	36.4	-90.6				F..	-----	254	3.8E-05	383	1.95288
SRA	1899	12	1	1850	38.9	-94.4				4...	-----	180	6.53E-05	384	1.958115
SRA	1903	3	17	1150	38.1	-89.5				3...	-----	315	3.01E-05	385	1.963351
SRA	1903	11	3	18	37.8	-89.3				3...	-----	306	3.1E-05	386	1.968586
SRA	1905	8	22	1045	38.9	-91.4				3...	-----	282	3.63E-05	387	1.973822
SRA	1906	2	24	515	38.7	-92.3				3...	-----	204	4.83E-05	388	1.979058
SRA	1906	3	6		38.7	-91.4				4...	-----	233	4.18E-05	389	1.984293
SRA	1906	11	24	515	38.7	-92.3				3...	-----	204	4.83E-05	390	1.989529
SRA	1907	12	11	432	38.6	-90.2				4...	-----	239	4.06E-05	391	1.994764
SRA	1909	10	22	22	37.6	-90.6				4...	-----	194	6.1E-05	392	2
SRA	1911	2	28	9	38.7	-90.3				4...	-----	234	4.16E-05	393	2.005236
SRA	1911	2	28	11	38.7	-90.3				4...	-----	234	4.16E-05	394	2.010471
SRA	1917	4	9	2335	38.1	-90.2				4...	-----	227	4.3E-05	395	2.015707
SRA	1917	5	9		38.8	-90.4				3...	-----	243	3.99E-05	396	2.020942
SRA	1917	5	9	16	38.8	-90.4				3...	-----	243	3.99E-05	397	2.026178
SRA	1918	7	1	1902	39.7	-91.4				4...	-----	233	4.18E-05	398	2.031414
SRA	1918	10	15	10	36.1	-91				F..	-----	254	3.8E-05	399	2.036649
SRA	1919	4	8	1230	38.2	-91.3				3...	...N..	229	4.26E-05	400	2.041885
SRA	1919	11	3	2040	38.3	-91				4...	-----	237	4.1E-05	401	2.04712
SRA	1920	5	1	15	38.9	-90.3				3...	-----	243	3.99E-05	402	2.052356
SRA	1920	5	1	1600	38.5	-89.5				3...	-----	296	3.23E-05	403	2.057592
SRA	1921	9	9	545	38.3	-90.1				3...	-----	239	4.06E-05	404	2.062827
SRA	1921	10	9	1150	38.3	-90.1				3...	-----	239	4.06E-05	405	2.068063
SRA	1925	7	13		38.8	-90				5...	-----	283	3.46E-05	406	2.073298
SRA	1927	3	18	1725	39.9	-86.3				5...	-----	311	3.06E-05	407	2.078534
SRA	1928	4	15	1605	37.4	-89.7				4...	-----	277	3.46E-05	408	2.08377
SRA	1928	11	19	920	38.1	-91.1				4...	-----	248	3.9E-05	409	2.089005
SRA	1928	12	28	325	38.1	-91.1				4...	-----	248	3.9E-05	410	2.094241
SRA	1929	2	28	815	37.6	-90.6				4...	-----	194	6.1E-05	411	2.099476
SRA	1930	1	28	21	38.1	-91.1				4...	-----	248	3.9E-05	412	2.104712
SRA	1930	5	28	1731	39.7	-91.4				3...	-----	233	4.18E-05	413	2.109948
SRA	1930	8	8	1831	39.7	-91.4				4...	-----	233	4.18E-05	414	2.115183
SRA	1931	8	9	81837	39.1	-94.7				6...	-----	214	4.58E-05	415	2.120419
SRA	1931	8	9	707	39.1	-94.7				4...	-----	214	4.58E-05	416	2.125654
SRA	1931	8	9	715	39.1	-94.7				4...	-----	214	4.58E-05	417	2.13089
SRA	1931	12	17	210819	38.6	-90.2				2...	-----	239	4.06E-05	418	2.136126
SRA	1933	3	11	1248	38.7	-90.4				4...	-----	248	3.9E-05	419	2.141361
SRA	1933	3	11	1304	38.7	-90.4				4...	-----	248	3.9E-05	420	2.146597
SRA	1933	7	13	144230	37.9	-89.8				3...	-----	253	3.82E-05	421	2.151832
SRA	1933	10	24		37.3	-89.5				3...	-----	296	3.22E-05	422	2.157068
SRA	1934	4	17	135323	37.9	-89.9				3...	-----	253	3.82E-05	423	2.162304
SRA	1934	5	16	1428	37.9	-89.9				4...	-----	253	3.82E-05	424	2.167539
SRA	1935	1	30	22	40.5	-94				3...	-----	307	3.09E-05	425	2.172775
SRA	1936	10	20	2117	36.6	-90.6				2...	-----	316	3E-05	426	2.17801
SRA	1936	10	31	161136	36.6	-89.6				2...	-----	316	3E-05	427	2.183246
SRA	1936	11	23	93840	36.6	-90.6				2...	-----	240	4.04E-05	428	2.188482
SRA	1936	11	25	174235	36.6	-90.6				2...	-----	240	4.04E-05	429	2.193717
SRA	1936	12	20	224112	37.3	-89.5				2...	-----	296	3.22E-05	430	2.198953
SRA	1937	3	19	1158	37.7	-89.9				3...	-----	254	3.8E-05	431	2.204188
SRA	1937	8	5	2131	38.6	-90.2				2...	-----	239	4.06E-05	432	2.209424
SRA	1937	8	5	2312	38.7	-90.1				3...	-----	280	3.87E-05	433	2.21466
SRA	1938	1	17	418	37.7	-89.9				3...	-----	254	3.8E-05	434	2.219895
SRA	1938	3	16	1012	36.6	-89.6				2...	-----	316	3E-05	435	2.225131
SRA	1939	9	28	1132	36.5	-89.9				3...	-----	298	3.19E-05	436	2.230366
SRA	1940	2	4	173230	37.2	-89.5				3...	-----	299	3.18E-05	437	2.235602
SRA	1940	11	23	2115	38.2	-90.1				6...	-----	237	4.1E-05	438	2.240838
SRA	1941	10	27	359	36.7	-89.7				3...	-----	303	3.14E-05	439	2.246073
SRA	1941	11	15	2004	38.3	-90.2				3...	-----	230	4.24E-05	440	2.251309
SRA	1941	11	22	2155	37.3	-89.5				3...	-----	296	3.22E-05	441	2.256545
SRA	1942	1	8	1815	39	-90.7				3...	-----	219	4.47E-05	442	2.26178
SRA	1942	1	23	160038.2	38.6	-90.3				2...	-----	230	4.24E-05	443	2.267016
SRA	1942	1	29	221215.3	38.6	-90.3				2...	-----	230	4.24E-05	444	2.272251
SRA	1942	1	30	15	38.7	-90.3				2...	-----	234	4.16E-05	445	2.277487
SRA	1942	11	19	10	38.6	-90.2				4...	-----	239	4.06E-05	446	2.282723
SRA	1942	11	30	165306	38.8	-89.7				3...	-----	298	3.19E-05	447	2.287958
SRA	1942	12	27	2040	38.6	-90.3				3...	-----	230	4.24E-05	448	2.293194
SRA	1943	5	29	2005	38.9	-90.2				2...	-----	251	3.86E-05	449	2.298429
SRA	1943	5	24	2033	38.9	-90.2				2...	-----	251	3.86E-05	450	2.303665
SRA	1943	6	8	1950	38.6	-90.4				3...	-----	222	4.4E-05	451	2.308901
SRA	1943	6	16	1940	38.4	-90.8				F..	-----	199	4.86E-05	452	2.314136
SRA	1943	6	18		38.4	-90.8				F..	-----	199	4.86E-05	453	2.319372
SRA	1945	5	21	751	38.8	-90.2				4...	-----	239	4.06E-05	454	2.324607
SRA	1946	11	7	204320	38	-90.7				2...	-----	183	5.43E-05	455	2.329843
SRA	1949	8	11	1632	38.6	-90.3				3...	-----	230	4.24E-05	456	2.335079
SRA	1949	8	28		38.6	-90.7				3...	-----	198	4.90E-05	457	2.340314
SRA	1950	5	1	1530	38.5	-89.9				2...	-----	298	3.19E-05	458	2.34555
SRA	1952	12	25	165927	36.7	-89.8				3...	-----	311	3.05E-05	459	2.350785
SRA	1959	1	6	1907	38.7	-90.3				3...	-----	234	4.16E-05	460	2.356021
SRA	1961	9	9	224256	36.96	-90.19		5		4...	-----	314	3.02E-05	461	2.361257
SRA	1963	6	26	95950.8	36.60	-90.16		9		---	...N..	288	3.30E-05	462	2.366492
SRA	1965	4	22	13643	37.5	-91		0		---	-----	162	6.21E-05	463	2.371728
SRA	1972	9	6	22812	38.4	-89.9				2...	-----	304	3.13E-05	464	2.376963
SRA	1979	2	27	225612	36.93	-91.24		10		4...	-----	267	3.75E-05	465	2.382199
SRA	1979	6	26	1128	38.3	-91.5				4...	-----	210	4.65E-05	466	2.387435
SRA	1982	7	1	4030.6	39.34	-90.67		5		---	-----	314	3.02E-05	467	2.39267
				min	35.14	-95.96									
				max	40.5	-89.2									



6/13/2003

Ozark Uplift NEIC 1534-2003

Locations of Earthquakes- Ozark Uplift



6/13/2003

Ozark Uplift NEIC 1534-2003

Ozark Uplift

Best-Fit Line of Semi-log Frequency-Magnitude plot: M=b+mlog(1/y)

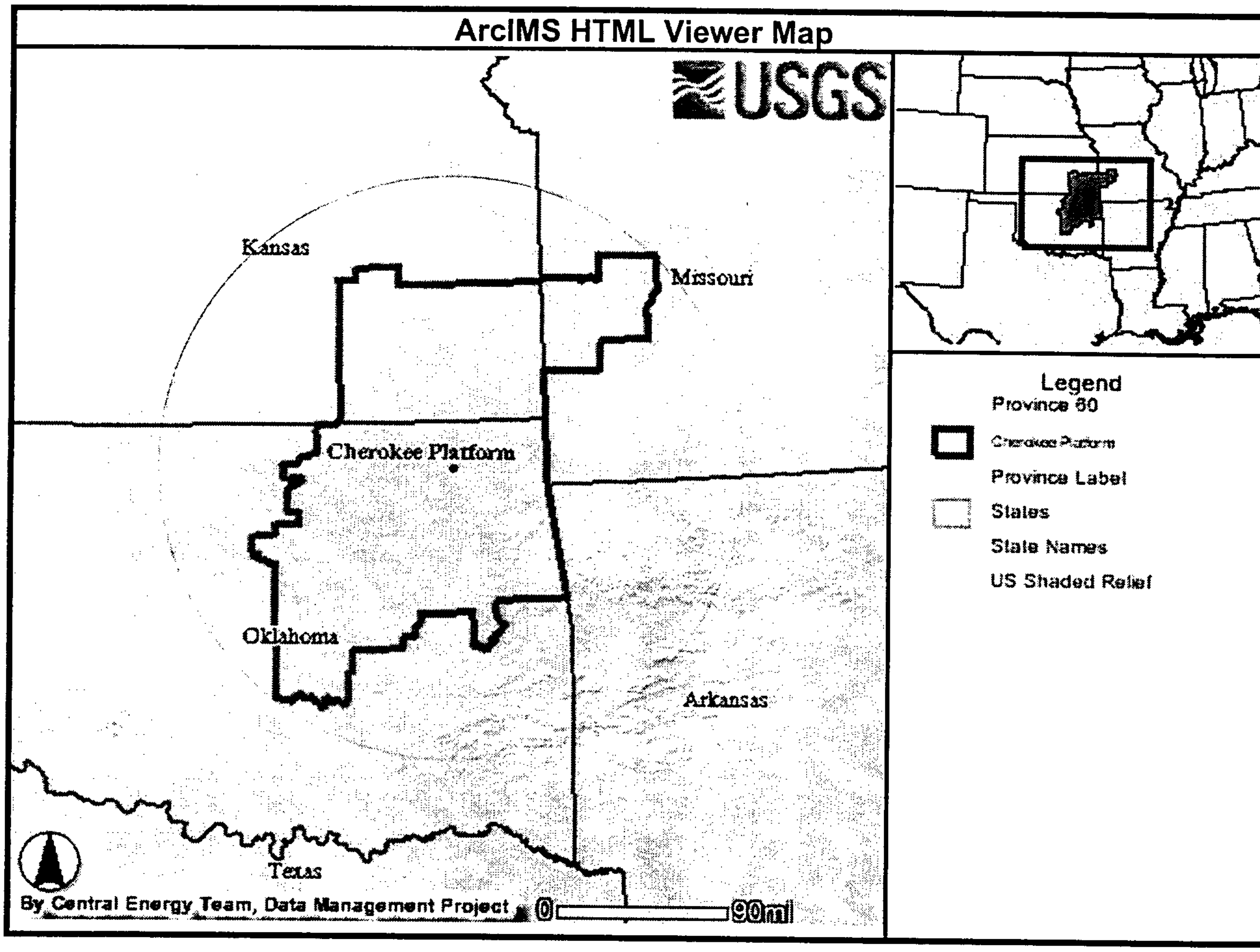
b=	3.6	
m=	-1.0333	
Radius of province (km)=		320
Area of province (km)=		321,699

Recurrence Interval y (years)	Radius of Area (km)	Area (km^2)	Magnitude (M)	Probability of Occurrence within 1000 years	Average radius of points within circle (km)	Peak Ground Acceleration (Campbell (1981)Attenuation equation)
1,000	320	321699	6.7	63%	226	0.014
1,000	100	31416	5.7	63%	71	0.020
1,000	10	314	3.6	63%	7	0.038
1,000	5	79	3.0	63%	4	0.046
1,000	1	3	1.5	63%	1	0.068
2,000	320	321699	7.0	39%	226	0.018
2,000	100	31416	6.0	39%	71	0.026
2,000	10	314	3.9	39%	7	0.049
2,000	5	79	3.3	39%	4	0.058
2,000	1	3	1.8	39%	1	0.085
10,000	320	321699	7.7	10%	226	0.033
10,000	100	31416	6.7	10%	71	0.046
10,000	10	314	4.6	10%	7	0.084
10,000	5	79	4.0	10%	4	0.099
10,000	1	3	2.6	10%	1	0.136

Campbell, Kenneth W. (1981) Near-source attenuation of peak horizontal acceleration,
Bulletin fo the Seismological Society of Ameraica, Vol. 71, No. 6, pp.2039-2070.

APPENDIX B.3

SEISMIC ACTIVITY WITHIN CHEROKEE BASIN-CENTRAL OKLAHOMA PLATFORM



radius = 155 miles [illegible]

[illegible]

[illegible]

NEIC: Earthquake Search Results

U. S. GEOLOGICAL SURVEY

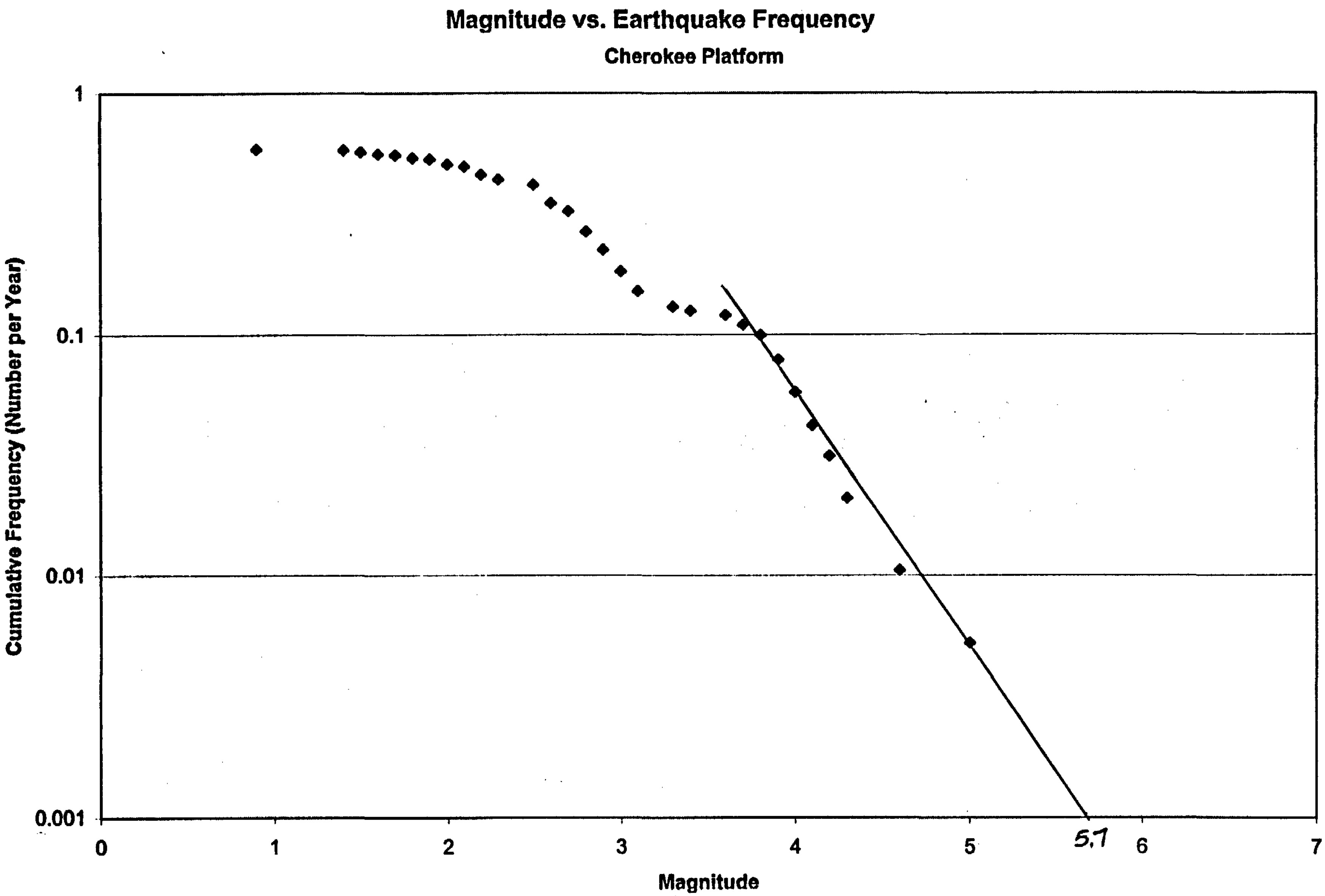
EARTHQUAKE DATA BASE

FILE CREATED: Fri Jun 13 14:09:24 2003
Circle Search Earthquakes= 116
Circle Center Point Latitude: 36.647N Longitude: 95.671W
Radius: 250.000 km
Catalog Used: SRA
Data Selection: Eastern, Central and Mountain States of U.S. (SRA)

FILE CREATED: Fri Jun 13 14:10:16 2003
Circle Search Earthquakes= 37
Circle Center Point Latitude: 36.647N Longitude: 95.671W
Radius: 250.000 km
Catalog Used: PDE
Date Range: Year: 1987 - 2004
Data Selection: Historical & Preliminary Data

CAT	YEAR	MO	DA	ORIG TIMI	LAT	LONG	DEP	MAG NITUDE	IEFM NFPO TFS	DTSVNWK	DIST km	Peak Ground Accelerations (Campbell)	Rank	Frequency	MAGNI	Rank	Frequency	MAGNI
SRA	1952	4	9	162928.4	35.53	-97.85	10	5 FASRA	7...	....	232	0.00319	1	0.005236	5	1	0.005236	5
SRA	1969	5	2	113321.7	35.29	-96.31	8	4.6 mb GS	5...	....	161	0.003354	2	0.010471	4.6	2	0.010471	4.6
SRA	1920	2	29	302	37.2	-93.3		4.3 FASRA	4...	....	219	0.001858	3	0.015707	4.3	4	0.020942	4.3
SRA	1939	8	1	730	35	-96.4		4.3 FASRA	4...	....	194	0.002117	4	0.020942	4.3	6	0.031414	4.2
SRA	1919	5	27	306	37.7	-97.3		4.2 FASRA	4...	....	185	0.002044	5	0.026178	4.2	8	0.041885	4.1
SRA	1926	6	20	1420	35.6	-94.9		4.2 FASRA	5...	....	135	0.002875	6	0.031414	4.2	11	0.057592	4
SRA	1956	2	16	2330	35.6	-97.5		4.1 FASRA	6...	...N..	201	0.001714	7	0.036649	4.1	15	0.078534	3.9
SRA	1961	4	27	730	34.9	-95.3		4.1 FASRA	5...	....	196	0.001761	8	0.041885	4.1	19	0.099476	3.8
SRA	1929	12	28	30	35.5	-98		4 FASRA	6...	....	245	0.001268	9	0.04712	4	21	0.109948	3.7
SRA	1956	10	30	103621	36.2	-95.8		4 MLSRA	7...	....	50	0.007048	10	0.052356	4	23	0.120419	3.6
SRA	1959	6	15	1245	34.8	-96.7		4 FASRA	5...	....	224	0.001398	11	0.057592	4	24	0.125654	3.4
SRA	1925	7	8	16	36.3	-93.2		3.9 FASRA	4...	....	224	0.001282	12	0.062827	3.9	25	0.13089	3.3
SRA	1952	4	11	2030	35.4	-97.8		3.9 FASRA	4...	....	236	0.001211	13	0.068063	3.9	29	0.151832	3.1
SRA	1952	4	16	558	35.4	-97.8		3.9 FASRA	3...	....	236	0.001211	14	0.073298	3.9	35	0.183246	3
SRA	1952	4	16	605	35.4	-97.8		3.9 FASRA	5...	....	236	0.001211	15	0.078534	3.9	43	0.225131	2.9
SRA	1901	1	4	312	37.9	-94		3.8 FASRA	5...	....	203	0.001306	16	0.08377	3.8	51	0.267016	2.8
SRA	1919	7	26	1255	37.7	-97.3		3.8 FASRA	4...	....	185	0.001447	17	0.089005	3.8	62	0.324607	2.7
SRA	1920	10	3	1415	38.6	-94.3		3.8 FASRA	3...	....	248	0.001053	18	0.094241	3.8	67	0.350785	2.6
SRA	1961	1	11	140	34.9	-95.5		3.8 FASRA	5...	....	194	0.001374	19	0.099476	3.8	80	0.418848	2.5
SRA	1942	6	12	450	36.4	-97.9		3.7 FASRA	3...	....	201	0.001213	20	0.104712	3.7	84	0.439791	2.3
PDE	1987	12	8	14240.3	36.06	-96.02	5	3.7 MnGS	5F..	....	221	0.001094	21	0.109948	3.7	88	0.460733	2.2
SRA	1937	6	8	1426	35.3	-96.9		3.6 FASRA	4...	....	185	0.001217	22	0.115183	3.6	95	0.497382	2.1
SRA	1965	9	6	221702.6	35.81	-93.12	10	3.6 MnSRA	5...	....	247	0.000889	23	0.120419	3.6	97	0.507853	2
SRA	1915	10	8	1650	35.7	-95.4		3.4 FASRA	3...	....	107	0.001854	24	0.125654	3.4	102	0.534031	1.9
SRA	1975	12	4	185959.9	38.24	-94.62	0	3.3 MnSRA	....	...N..	199	0.000867	25	0.13089	3.3	103	0.539267	1.8
SRA	1963	3	13	93334	34.6	-95.9		3.1 MLSRA	....	....	227	0.000632	26	0.136126	3.1	106	0.554974	1.7
SRA	1973	11	18	100352.7	35	-94.7		3.1 MnSRA	....	....	202	0.000718	27	0.141361	3.1	107	0.560209	1.6
PDE	1987	1	24	160817	35.83	-96.1	5	3.1 MnTUL	5F..	....	236	0.000606	28	0.146597	3.1	109	0.570681	1.5
PDE	1993	1	14	170610.5	36.6	-96.28	5	3.1 MnGS	4F..	....	232	0.000617	29	0.151832	3.1	111	0.581152	1.4
SRA	1965	2	14	200320.3	36.94	-93.29	0	3 MnSRA	....	....	214	0.000618	30	0.157068	3	112	0.586387	0.9
SRA	1978	10	22	171550.5	36.38	-97.06		3 MnSRA	....	....	127	0.00109	31	0.162304	3			
SRA	1980	11	2	100048.9	35.46	-97.76	1	3 MnSRA	5...	....	229	0.000574	32	0.167539	3			
PDE	1991	1	24	50026.9	36.36	-97.3	5	3 MnGS	5F..	....	148	0.000923	33	0.172775	3			
PDE	1994	4	29	32658.66	36.25	-96.09	5	3 MnGS	4F..	....	221	0.000597	34	0.17801	3			
PDE	2001	7	24	140235	37.7	-97	5	3 MnGS	.F..	....	165	0.00062	35	0.183246	3			
SRA	1975	3	31	95206	35.6	-95.3		2.9 HzSRA	....	....	120	0.001063	36	0.188482	2.9			
SRA	1976	12	19	82636.7	34.92	-95.73	5	2.9 MnSRA	2...	....	191	0.000641	37	0.193717	2.9			
SRA	1978	3	5	144650.5	34.7	-95	7	2.9 MnSRA	....	....	224	0.000539	38	0.198953	2.9			
SRA	1981	12	17	64454.7	36.39	-97.66	5	2.9 MnSRA	....	....	180	0.000684	39	0.204188	2.9			
SRA	1983	6	21	183259.9	34.96	-97.4	5	2.9 MnSRA	....	....	244	0.000491	40	0.209424	2.9			
SRA	1983	10	23	193446.9	34.82	-96.89	5	2.9 MnSRA	....	....	230	0.000524	41	0.21466	2.9			
SRA	1985	9	23	10344.1	34.72	-95.06	5	2.9 MnSRA	....	....	220	0.00055	42	0.219895	2.9			
PDE	1992	8	10	200304.2	34.98	-97.45	5	2.9 MDTUL	4F..	....	244	0.000491	43	0.225131	2.9			
SRA	1962	9	1	20956.1	35.2	-96		2.8 MLSRA	....	....	163	0.000699	44	0.230366	2.8			
SRA	1973	12	25	41132	35.1	-94.5		2.8 MnSRA	....	....	201	0.000556	45	0.235602	2.8			
SRA	1982	12	22	174253.7	35.4	-97.93	5	2.8 MnSRA	....	....	246	0.000447	46	0.240838	2.8			
SRA	1984	1	24	153409.6	35.03	-96.37	5	2.8 MnSRA	5...	....	189	0.000595	47	0.246073	2.8			
SRA	1985	2	10	141552.2	36.43	-96.41	5	2.8 MnSRA	....	....	246	0.000447	48	0.251309	2.8			
SRA	1986	12	21	173258.1	35.14	-96.68	5	2.8 MnSRA	....	....	189	0.000595	49	0.256545	2.8			
PDE	1987	3	14	44303.5	34.79	-96.33	5	2.8 MnTUL	....	....	214	0.00052	50	0.26178	2.8			
PDE	1992	10	5	44406.6	36.4	-97.5	5	2.8 MDTUL	5F..	....	166	0.000685	51	0.267016	2.8			
SRA	1971	3	13	192215.3	35.2	-95.8		2.7 MnSRA	....	....	180	0.000654	52	0.272251	2.7			
SRA	1973	1	10	163815.3	36.4	-98		2.7 MnSRA	3...	....	210	0.000487	53	0.277487	2.7			
SRA	1974	11	10	61918.6	34.8	-96.7		2.7 HzSRA	....	....	224	0.000454	54	0.282723	2.7			
SRA	1975	10	12	25814.1	35.12	-97.52	24	2.7 MnSRA	....	....	237	0.000427	55	0.287958	2.7			
SRA	1975	10	30	3714.1	35.3	-96.8		2.7 HzSRA	....	....	180	0.000575	56	0.293194	2.7			
SRA	1976	3	16	73945.3	35.43	-95.6		2.7 HzSRA	4...	....	135	0.000787	57	0.298429	2.7			
SRA	1978	5	18	1922.4	35.5	-97.5	5	2.7 MnSRA	3...	....	206	0.000492	58	0.303665	2.7			
SRA	1982	1	15	95217	35.71	-96.03	5	2.7 MnSRA	....	....	236	0.000428	59	0.308901	2.7			
SRA	1982	8	18	101856.9	34.47	-96.23	5	2.7 MnSRA	....	....	246	0.00041	60	0.314136	2.7			
PDE	1992	6	30	12549.3	35.26	-96.42	5	2.7 MDTUL	2F..	....	167	0.000624	61	0.319372	2.7			
PDE	1993	3	11	11501.5	35.21	-95.93	5	2.7 MnTUL	3F..	....	161	0.00065	62	0.324607	2.7			
SRA	1962	5	18	24029.3	35.1	-95.4		2.6 MLSRA	....	....	173	0.000551	63	0.329843	2.6			
SRA	1963	6	12	163852	34.7	-96.8		2.6 MLSRA	....	....	238	0.000389	64	0.335079	2.6			
SRA	1974	12	16	23021.7	35.34	-97.29	23	2.6 HzSRA	3...	....	205	0.000458	65	0.340314	2.6			
SRA	1979	1	29	192010.4	34.92	-97.38	5	2.6 MnSRA	....	....	245	0.000377	66	0.34555	2.6			
SRA	1984	3	3	114202.4	36.51	-96.3	5	2.6 MnSRA	5...	....	137	0.00071	67	0.350785	2.6			
SRA	1963	8	5	170206	34.7	-96.8		2.5 MLSRA	....	...N..	238	0.000357	68	0.356021	2.5			
SRA	1971	3	1	192732.1	35.1	-94.9		2.5 MDSRA	....	....	185	0.00047	69	0.361257	2.5			
SRA	1976	10	20	40539.6	34.75	-96.12		2.5 MnSRA	....	....	214	0.000401	70	0.366492	2.5			
SRA	1979	7	24	22406.3	36.07	-97.51	5	2.5 MnSRA	....	....	176	0.000496	71	0.371728	2.5			
SRA	1979	7	31	191105.6	36.09	-97.3	5	2.5 MnSRA	....	....	158	0.000557	72	0.376963	2.5			
SRA	1980	11	22	193502.8	35.38	-95.99	5	2.5 MnSRA	....	....	143	0.000621	73	0.382199	2.5			
SRA	1982	3	13	14149.9	35.7	-96.04	5	2.5 MnSRA	....	....	237	0.000359	74	0.387435	2.5			
SRA	1983	1	10	170643.7	36.7	-96.11	4	2.5 MnSRA	....	....	217	0.000395	75	0.39267	2.5			
SRA	1984	1	6	171449.8	36.16	-95.58	5	2.5 MDSRA	4...	....	54	0.001788	76	0.397906	2.5			
SRA	1985	1	24	121242.4	34.92	-97.43	5	2.5 MnSRA	....	....	248	0.000341	77	0.403141	2.5			
SRA	1986	10	7	120639.1	35.26	-96.58	5	2.5 MDSRA	....	....	174	0.000502	78	0.408377	2.5			
PDE	1987	12	8	14547.5	36.06	-96.03	5	2.5 MnTUL	....	....	221	0.000387	79	0.413613	2.5			
PDE	1990	9	16	211332.4	34.8	-95.53	5	2.5 MnTUL	4F..	....	205	0.00042	80	0.418848	2.5			

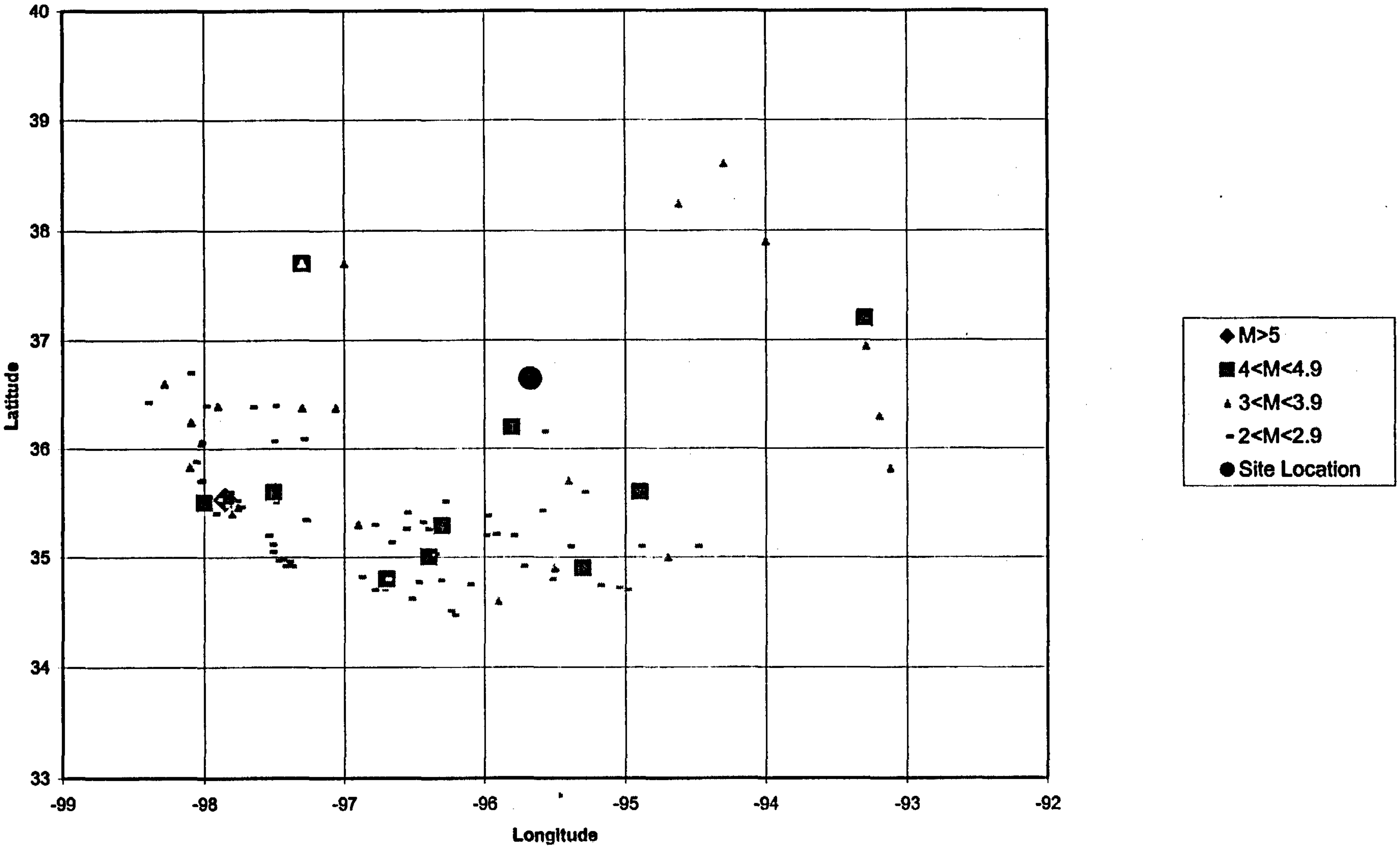
CAT	YEAR	MO	DA	ORIG TIM	LAT	LONG	DEP	MAG	NITUDE	IEFM NFPO TFS	DTSVNWK	DIST km				
SRA	1978	5	17	231115.7	35.53	-97.91	5	2.3	MnSRA	1...	....	236	0.000303	81	0.424064	2.3
SRA	1985	5	6	21116.2	34.97	-97.48	5	2.3	MnSRA	5...	....	247	0.000288	82	0.429319	2.3
PDE	1987	1	17	41353.8	35.05	-97.52	5	2.3	MnTUL	....	....	243	0.000293	83	0.434555	2.3
PDE	1988	3	24	22547.9	35.41	-96.57	5	2.3	MDTUL	....	....	159	0.000466	84	0.439791	2.3
SRA	1977	1	6	161954	34.7	-96.73	5	2.2	MnSRA	2...	....	238	0.000278	85	0.445026	2.2
SRA	1979	3	14	43715.3	35.52	-97.78	5	2.2	MnSRA	5...	....	227	0.00029	86	0.450262	2.2
PDE	1992	8	9	210552.1	34.77	-96.49	5	2.2	MDTUL	1F..	....	220	0.0003	87	0.455497	2.2
PDE	1992	8	10	112123.1	34.62	-96.54	5	2.2	MDTUL	....	....	238	0.000275	88	0.460733	2.2
SRA	1978	5	18	3217.6	35.6	-97.83	5	2.1	MnSRA	2...	....	226	0.000267	89	0.465969	2.1
PDE	1987	5	15	62907.5	35.46	-97.75	5	2.1	MDTUL	....	....	229	0.000263	90	0.471204	2.1
PDE	1987	12	16	70458.6	34.88	-95.51	5	2.1	MDTUL	....	....	196	0.000312	91	0.47644	2.1
PDE	1988	6	5	25655.5	34.74	-95.19	5	2.1	MDTUL	....	....	215	0.000282	92	0.481675	2.1
PDE	1988	6	21	231245.6	34.51	-96.26	5	2.1	MDTUL	....	....	243	0.000247	93	0.486911	2.1
PDE	1988	10	12	101146	35.88	-96.07	5	2.1	MnTUL	....	....	231	0.000261	94	0.492147	2.1
PDE	1989	2	20	115918	35.32	-96.46	5	2.1	MDTUL	....	....	163	0.000381	95	0.497382	2.1
SRA	1980	11	1	52613.8	35.47	-97.84	5	2	MnSRA	3...	....	234	0.000236	96	0.502618	2
PDE	1992	11	18	214048.2	35.2	-97.55	5	2	MnTUL	....	....	233	0.000237	97	0.507853	2
SRA	1979	3	14	31056.8	35.5	-97.83	5	1.9	MnSRA	4...	....	232	0.000218	98	0.513089	1.9
PDE	1987	2	26	20407.2	35.31	-96.62	5	1.9	MnTUL	....	....	171	0.000304	99	0.518325	1.9
PDE	1987	6	2	202537	34.71	-96.56	5	1.9	MDTUL	....	....	229	0.000221	100	0.52356	1.9
PDE	1987	6	18	22156.7	35.12	-96.35	5	1.9	MnTUL	....	....	180	0.000288	101	0.528796	1.9
PDE	1988	9	18	114430.1	34.93	-97.19	5	1.9	MDTUL	....	....	235	0.000215	102	0.534031	1.9
PDE	1988	6	14	21450	36.53	-97.46	5	1.8	MDTUL	....	....	160	0.0003	103	0.539267	1.8
SRA	1979	3	13	232922.6	35.42	-97.85	5	1.7	HzSRA	2...	....	238	0.000178	104	0.544503	1.7
PDE	1987	5	17	64104.9	35.89	-97.24	5	1.7	MnTUL	....	....	163	0.000269	105	0.549738	1.7
PDE	1988	7	24	81354.8	35.08	-97.37	5	1.7	MDTUL	....	....	231	0.000184	106	0.554974	1.7
PDE	1988	10	3	220201	34.47	-96.15	5	1.6	MnTUL	....	....	244	0.000159	107	0.560209	1.6
PDE	1987	5	17	150119.8	35.88	-97.26	5	1.5	MDTUL	....	....	166	0.000222	108	0.565445	1.5
PDE	1987	6	7	73524.3	35.17	-95.28	5	1.5	MDTUL	....	....	168	0.000219	109	0.570681	1.5
PDE	1988	3	19	92737.7	36.04	-96.82	5	1.4	MDTUL	....	....	123	0.000262	110	0.575916	1.4
PDE	1989	2	23	4355.7	35.21	-95.86	5	1.4	MDTUL	....	....	160	0.000212	111	0.581152	1.4
PDE	1988	8	29	5650.5	35.53	-95.36	5	0.9	MDTUL	....	....	126	0.000178	112	0.586387	0.9
SRA	1883	1	10	18	36.5	-92.9				3...	....	248	3.9E-05	113	0.591623	
SRA	1885	2	21		37.2	-94.3				3...	....	136	7.51E-05	114	0.596859	
SRA	1897	12	2	7	36.9	-98				4...	....	209	4.7E-05	115	0.602094	
SRA	1899	12	1	1850	36.9	-94.4				4...	....	116	8.93E-05	116	0.60733	
SRA	1900	12			36	-96.8				4...	....	124	8.3E-05	117	0.612565	
SRA	1901	4	1		36	-96.8				.F..	....	124	8.3E-05	118	0.617801	
SRA	1901	4	8	1330	36	-96.8				.F..	....	124	8.3E-05	119	0.623037	
SRA	1907	1	2	745	37.1	-97				4...	....	128	8.02E-05	120	0.628272	
SRA	1908	7	19		35.7	-97.7				3...	....	210	4.88E-05	121	0.633508	
SRA	1910				35.5	-98				3...	....	245	3.95E-05	122	0.638743	
SRA	1918	9	10	1530	35.5	-98				4...	....	245	3.95E-05	123	0.643979	
SRA	1918	9	11	530	35.5	-98				6...	....	245	3.95E-05	124	0.649215	
SRA	1918	9	11	9	35.5	-98				3...	....	245	3.95E-05	125	0.65445	
SRA	1918				35.5	-97.7				3...	....	222	4.4E-05	126	0.659686	
SRA	1919	7	26	11	37.7	-97.3				3...	....	185	5.37E-05	127	0.664921	
SRA	1924	6	3	40	36.3	-96.5				3...	....	83	0.000129	128	0.670157	
SRA	1933	8	19	1930	35.5	-98				6...	....	245	3.95E-05	129	0.675393	
SRA	1935	11	29		36.2	-97				3...	....	129	7.95E-05	130	0.680628	
SRA	1939	6	1	17	35	-96.4				.F..	....	194	5.1E-05	131	0.685864	
SRA	1948	4	3	3	37.7	-97.3				4...	....	185	5.37E-05	132	0.691099	
SRA	1952	4	11	1630	35.4	-97.8				3...	....	236	4.12E-05	133	0.696335	
SRA	1952	4	16		35.4	-97.8				3...	....	236	4.12E-05	134	0.701571	
SRA	1952	4	16	1430	35.4	-97.8				3...	....	236	4.12E-05	135	0.706806	
SRA	1952	5	1	1140	35.4	-96.4				2...	....	153	6.61E-05	136	0.712042	
SRA	1952	5	2	155	35.4	-96.4				2...	....	153	6.61E-05	137	0.717277	
SRA	1952	7	17	30	35.4	-97.8				3...	....	236	4.12E-05	138	0.722513	
SRA	1952	7	17	2	35.4	-97.8				3...	....	236	4.12E-05	139	0.727749	
SRA	1952	8	14	2140	35.4	-97.8				4...	....	236	4.12E-05	140	0.732984	
SRA	1952	10	8	415	35.1	-96.5				4...	....	187	5.31E-05	141	0.73822	
SRA	1953	3	16	1250	35.4	-97.9				3...	....	243	3.99E-05	142	0.743455	
SRA	1953	3	17	1312	35.6	-98				5...	....	239	4.06E-05	143	0.748691	
SRA	1953	3	17	1425	35.6	-98				6...	....	239	4.06E-05	144	0.753927	
SRA	1953	6	6	1740	34.8	-96.7				4...	....	224	4.36E-05	145	0.759162	
SRA	1954	4	11		35.1	-96.4				4...	....	183	5.43E-05	146	0.764398	
SRA	1954	4	12	2305	35.1	-96.4				4...	....	183	5.43E-05	147	0.769634	
SRA	1954	4	13	1848	35.1	-96.4				4...	....	183	5.43E-05	148	0.774869	
SRA	1960	3	18	2130	36.2	-95.8				3...	....	50	0.000223	149	0.780105	
SRA	1960	3	18	2330	36.2	-95.8				3...	....	50	0.000223	150	0.78534	
SRA	1961	4	27	3	34.6	-95				3...	....	234	4.16E-05	151	0.790576	
SRA	1961	4	27	5	34.6	-95				3...	....	234	4.16E-05	152	0.795812	
SRA	1968	1	4	2230	34.85	-95.55				4...	....	199	4.96E-05	153	0.801047	



6/13/2003

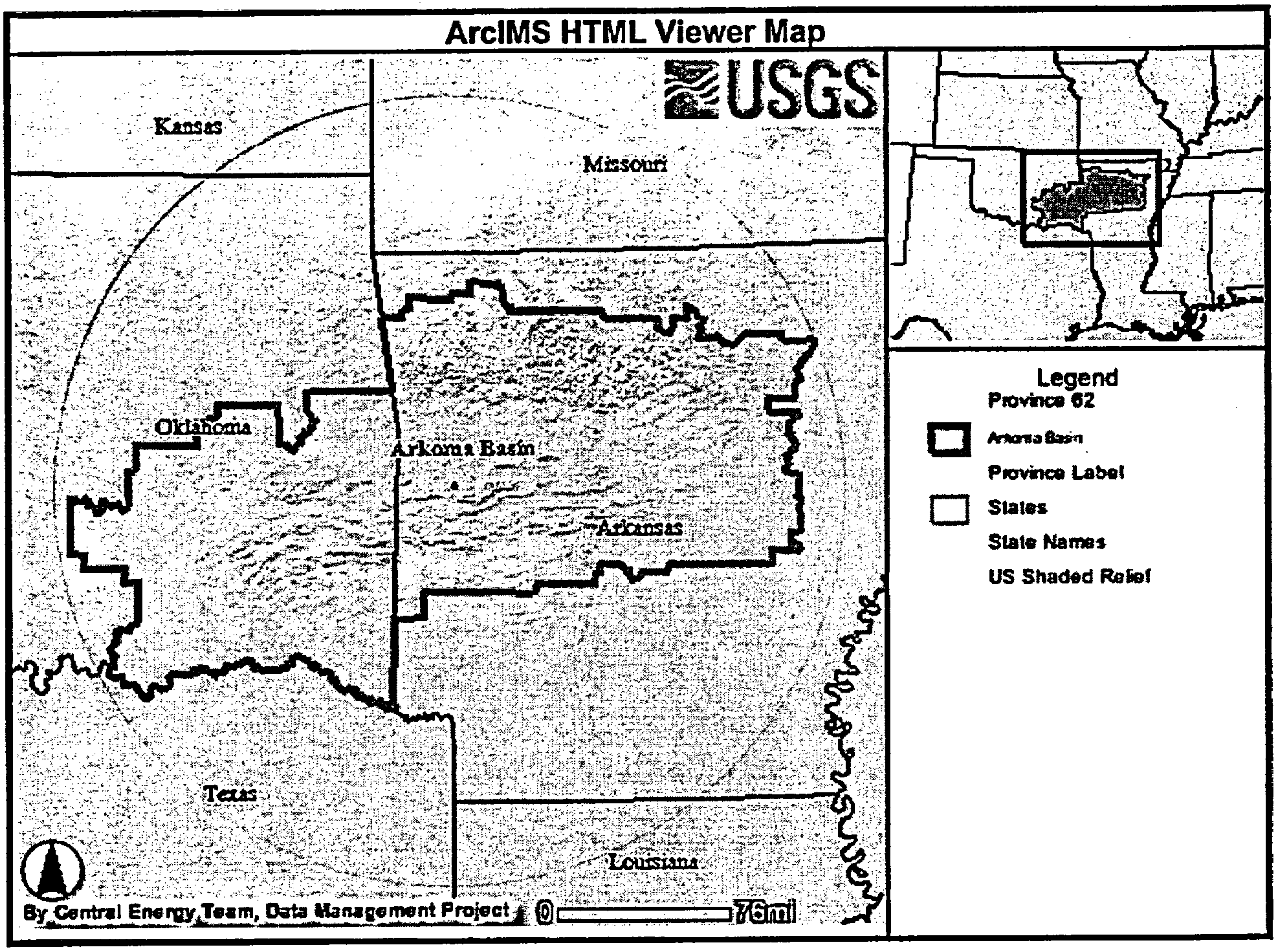
Cherokee Platform NEIC 1534-2003

Locations of Earthquakes- Cherokee Platform



APPENDIX B.4

SEISMIC ACTIVITY WITHIN ARKOMA BASIN



radius = 175 miles = [illegible] km

center = 35° [illegible] = 35.[illegible]

[illegible] 94.[illegible]

Arkoma Basin

NEIC: Earthquake Search Results

U. S. GEOLOGICAL SURVEY

EARTHQUAKE DATA BASE

FILE CREATED: Fri Jun 13 11:43:00 2003
Circle Search Earthquakes= 189
Circle Center Point Latitude: 35.245N Longitude: 94.000W
Radius: 282.000 km
Catalog Used: SRA
Data Selection: Eastern, Central and Mountain States of U.S. (SRA)

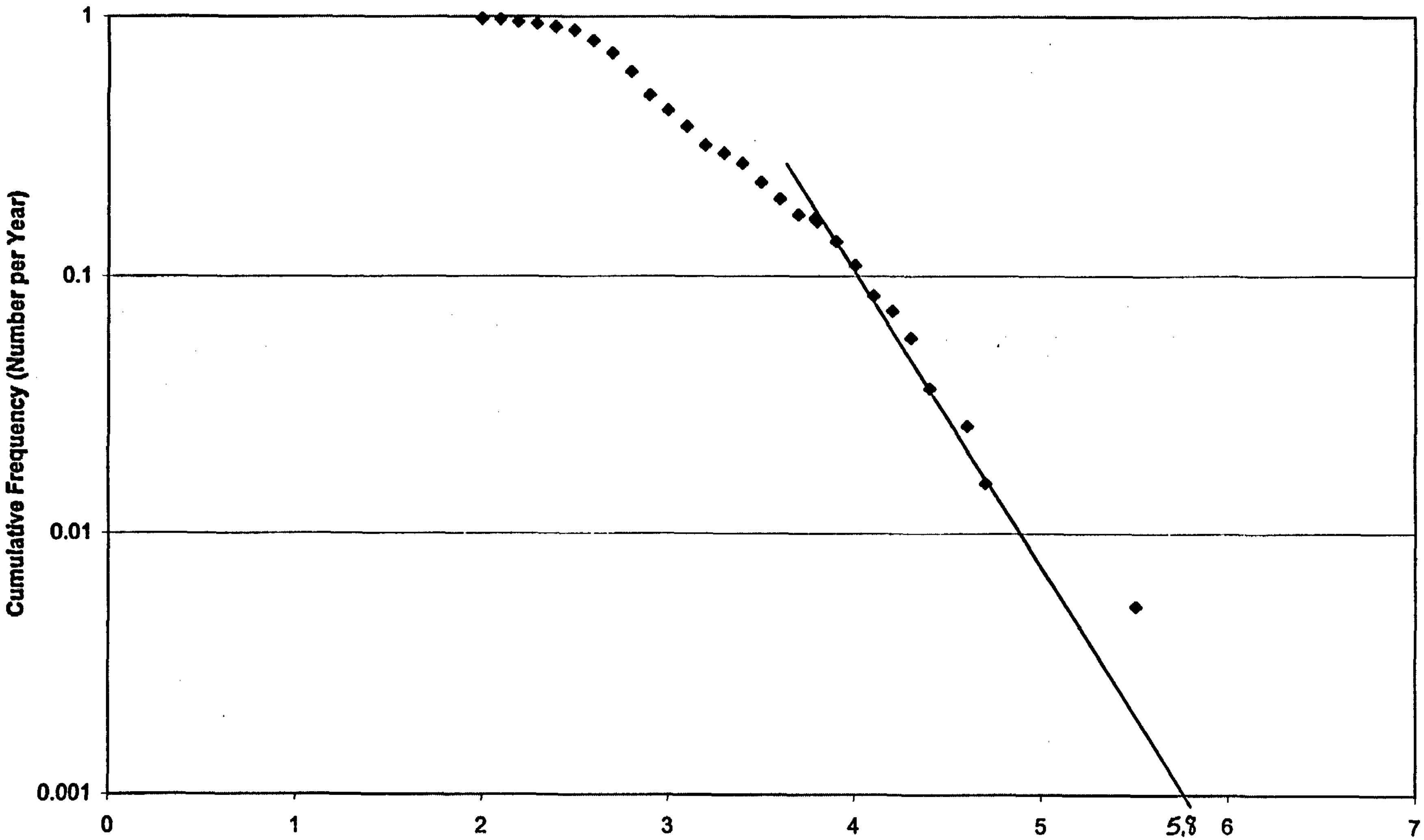
FILE CREATED: Fri Jun 13 11:43:57 2003
Circle Search Earthquakes= 40
Circle Center Point Latitude: 35.245N Longitude: 94.000W
Radius: 282.000 km
Catalog Used: PDE
Date Range: Year: 1987 - 2003
Data Selection: Historical & Preliminary Data

CAT	YEAR	MO	DA	ORIG TIM	LAT	LONG	DEP	MAGNITUDE	IEFM NFPO TFS	DTSVNWK	DIST km	Peak Ground Accelerations (Campbell)	Rank	Frequency	MAGNI	Rank	Frequency	MAGNI
SRA	1882	10	22	2215	34	-96		5.5 FASRA	6...	....	229	0.004973	1	0.005236	5.5	1	0.005236	5.5
SRA	1982	1	21	3354.8	35.18	-92.21	3	4.7 MnTUL	6..G	....	163	0.003607	2	0.010471	4.7	3	0.015707	4.7
PDE	2001	5	4	64212.68	35.21	-92.19	10	4.7 MnSLM	6D..	....	164	0.003583	3	0.015707	4.7	5	0.026178	4.6
SRA	1883	12	5	1520	36.3	-91.2		4.6 FASRA	5...	....	278	0.001857	4	0.020942	4.6	7	0.036649	4.4
SRA	1969	5	2	113321.7	35.29	-96.31	8	4.6 mb GS	5...	....	210	0.002517	5	0.026178	4.6	11	0.057592	4.3
SRA	1918	10	4	921	34.7	-91.7		4.4 FASRA	5...	....	218	0.002034	6	0.031414	4.4	14	0.073298	4.2
SRA	1969	1	1	233538.7	34.99	-92.69	7	4.4 MnDG	6..G	....	122	0.003809	7	0.036649	4.4	16	0.08377	4.1
SRA	1920	2	29	302	37.2	-93.3		4.3 FASRA	4...	....	225	0.001803	8	0.041885	4.3	21	0.109948	4
SRA	1939	6	1	730	35	-96.4		4.3 FASRA	4...	....	220	0.001847	9	0.04712	4.3	26	0.136126	3.9
SRA	1939	6	19	214312	34.1	-92.6		4.3 FASRA	5...	....	180	0.002296	10	0.052356	4.3	31	0.162304	3.8
SRA	1977	6	2	232910.6	34.56	-94.17	10	4.3 mb GS	6...	....	77	0.005736	11	0.057592	4.3	32	0.167539	3.79
SRA	1911	3	31	1657	34	-91.8		4.2 FASRA	7...	....	244	0.001514	12	0.062827	4.2	33	0.172775	3.7
SRA	1926	6	20	1420	35.6	-94.9		4.2 FASRA	5...	....	90	0.004452	13	0.068063	4.2	38	0.198953	3.6
SRA	1974	2	15	223546.6	34.07	-93.12	14	4.2 mb GS	3...	....	153	0.002511	14	0.073298	4.2	44	0.230366	3.5
SRA	1961	4	27	730	34.9	-95.3		4.1 FASRA	5...	....	124	0.002891	15	0.078534	4.1	52	0.272251	3.4
SRA	1982	1	21	154538.6	35.19	-92.2	4	4.1 MnTUL	3..G	....	163	0.002151	16	0.08377	4.1	57	0.298429	3.3
SRA	1956	10	30	103621	36.2	-95.8		4 MLSRA	7...	....	194	0.001634	17	0.089005	4	61	0.319372	3.2
SRA	1959	6	15	1245	34.8	-96.7		4 FASRA	5...	....	251	0.001235	18	0.094241	4	72	0.376963	3.1
SRA	1982	1	24	32244.7	35.2	-92.22	4	4 MnTUL	5..G	....	162	0.001986	19	0.099476	4	83	0.434555	3
SRA	1982	2	24	192714.1	35.2	-92.24	5	4 MnTUL	5..G	....	160	0.002013	20	0.104712	4	95	0.497382	2.9
PDE	1991	7	7	212402.7	36.66	-91.64	5	4 MnGS	6D..	....	264	0.001169	21	0.109948	4	117	0.612565	2.8
SRA	1925	7	8	16	36.3	-93.2		3.9 FASRA	4...	....	137	0.002184	22	0.115183	3.9	138	0.722513	2.7
SRA	1934	4	12	140	33.9	-95.5		3.9 FASRA	5...	....	202	0.001434	23	0.120419	3.9	154	0.806283	2.6
SRA	1982	1	22	235422.8	35.22	-92.21	0	3.9 MnTUL	.F.G	....	162	0.001822	24	0.125654	3.9	169	0.884817	2.5
SRA	1982	3	1	1209.5	35.19	-92.21	8	3.9 MnTUL	5..G	....	162	0.001822	25	0.13089	3.9	174	0.910995	2.4
PDE	2000	6	27	12845	35.8	-92.75	0	3.9 MnCER	.F..	....	128	0.002351	26	0.136126	3.9	179	0.937173	2.3
SRA	1911	3	31	1810	34	-91.8		3.8 FASRA	4...	....	244	0.001071	27	0.141361	3.8	182	0.95288	2.2
SRA	1925	1	27	2242	36.2	-91.7		3.8 FASRA	3...	....	233	0.001126	28	0.146597	3.8	186	0.973822	2.1
SRA	1961	1	11	140	34.9	-95.5		3.8 FASRA	5...	....	141	0.001942	29	0.151832	3.8	187	0.979058	2
SRA	1974	2	15	224904.4	34.03	-93.04	17	3.8 mb GS	5...	....	180	0.001694	30	0.157068	3.8			
SRA	1982	7	5	41349.8	35.18	-92.23	6	3.8 MnTUL	.F.G	....	161	0.001682	31	0.162304	3.8			
SRA	1982	1	21	3735.6	35.16	-92.24	1	3.79 MwSRT	.F.G	....	160	0.001679	32	0.167539	3.79			
SRA	1956	4	2	160318	34.2	-95.6		3.7 FASRA	5...	....	186	0.001319	33	0.172775	3.7			
SRA	1936	3	14	1720	34	-95		3.6 FASRA	5...	....	165	0.001378	34	0.17801	3.6			
SRA	1937	6	8	1426	35.3	-96.9		3.6 FASRA	4...	....	263	0.000831	35	0.183246	3.6			
SRA	1982	5	31	174920.4	35.19	-92.2	1	3.6 MnSRA	4...	....	163	0.001396	36	0.188482	3.6			
SRA	1982	5	31	182119.8	35.2	-92.23	2	3.6 MnTUL	4..G	....	161	0.001415	37	0.193717	3.6			
SRA	1985	9	6	221702.8	35.81	-93.12	10	3.6 MnSRA	5...	....	101	0.002346	38	0.198953	3.6			
SRA	1968	10	14	144254	34	-96.4		3.5 HzSRA	6...	....	259	0.000774	39	0.204188	3.5			
SRA	1974	2	15	223238.2	34.04	-92.98	17	3.5 MnSRA	3...	....	163	0.001281	40	0.209424	3.5			
SRA	1982	1	19	43949.5	35.19	-92.25	1	3.5 MnTUL	4..G	....	159	0.001316	41	0.21466	3.5			
SRA	1982	1	20	140130.7	35.2	-92.21	0	3.5 MnTUL	4..G	....	162	0.001289	42	0.219895	3.5			
SRA	1982	9	25	231705.5	35.21	-92.23	5	3.5 MnSRA	.F..	....	161	0.001298	43	0.225131	3.5			
SRA	1983	1	19	23040.2	35.19	-92.21	5	3.5 MnSRA	5...	....	162	0.001289	44	0.230366	3.5			
SRA	1915	10	8	1650	35.7	-95.4		3.4 FASRA	3...	....	136	0.00143	45	0.235602	3.4			
SRA	1963	2	7	211836	34.4	-92.1		3.4 MnSRA	....	....	197	0.000956	46	0.240838	3.4			
SRA	1976	1	16	194256.9	35.9	-92.16	7	3.4 MnSRA	5...	....	181	0.001048	47	0.246073	3.4			
SRA	1979	2	27	225454.6	35.96	-91.2	10	3.4 MnSRA	5...	....	265	0.000693	48	0.251309	3.4			
SRA	1982	2	1	72502.6	35.19	-92.22	7	3.4 MnTUL	4..G	....	162	0.001183	49	0.256545	3.4			
SRA	1982	11	21	163526.6	35.21	-92.22	1	3.4 MnSRA	4...	....	161	0.00119	50	0.26178	3.4			
PDE	1988	12	25	155757.7	34.19	-92.7	13	3.4 MDTEI	4F..	....	166	0.001152	51	0.267016	3.4			
PDE-W	2002	10	20	21813	34.27	-96.08	5	3.4 MnTUL	5F..	....	218	0.000857	52	0.272251	3.4			
SRA	1930	11	16	1230	34.3	-92.7		3.3 FASRA	5...	....	158	0.001114	53	0.277487	3.3			
SRA	1982	2	1	55508.2	35.18	-92.23	5	3.3 MnTUL	4..G	....	161	0.001092	54	0.282723	3.3			
SRA	1984	9	27	130305.2	35.2	-92.19	10	3.3 MnSRA	4...	....	165	0.001063	55	0.287958	3.3			
SRA	1985	11	8	195648.5	35.22	-92.19	4	3.3 MnSRA	.F..	....	164	0.00107	56	0.293194	3.3			
PDE	1988	5	20	230622.6	37.29	-92.77	5	3.3 MnTUL	....	....	252	0.000671	57	0.298429	3.3			
SRA	1982	1	27	232942.2	35.2	-92.22	1	3.2 MnSRA	3...	....	162	0.000995	58	0.303665	3.2			
SRA	1982	6	30	162155.4	35.19	-92.23	7	3.2 MDTEC	.F.G	....	161	0.001001	59	0.308901	3.2			
SRA	1982	8	9	111231.6	35.19	-92.24	4	3.2 MnSRA	.F..	....	160	0.001008	60	0.314136	3.2			
PDE	1994	6	10	233402.9	33.01	-92.67	5	3.2 MnGS	3F..	....	276	0.000557	61	0.319372	3.2			
SRA	1963	3	13	93334	34.6	-95.9		3.1 MLSRA	....	....	187	0.00078	62	0.324607	3.1			
SRA	1973	11	18	100352.7	35	-94.7		3.1 MnSRA	....	....	69	0.002302	63	0.329843	3.1			
SRA	1974	12	13	50355.5	34.49	-91.86	3	3.1 MnSRA	5...	....	212	0.000681	64	0.335079	3.1			
SRA	1977	11	26	41618.1	34.39	-92.91	10	3.1 MnSRA	4...	....	137	0.001094	65	0.340314	3.1			
SRA	1978	9	23	73403.7	33.97	-91.92	33	3.1 MnSRA	4...	....	237	0.000603	66	0.34555	3.1			
SRA	1982	1	18	23212.6	35.19	-92.26	2	3.1 MnSRA	4...	....	158	0.000937	67	0.350785	3.1			
SRA	1982	1	21	11336.7	35.14	-92.23	9	3.1 MnSRA	.F..	....	161	0.000918	68	0.356021	3.1			
SRA	1982	5	3	75448.7	33.98	-96.47	5	3.1 MnSRA	6...	....	263	0.000534	69	0.361257	3.1			
SRA	1982	9	27	102232.5	35.19	-92.23	5	3.1 MnSRA	3...	....	161	0.000918	70	0.366492	3.1			
SRA	1983	3	30	41225.4	35.19	-92.23	3	3.1 MnSRA	4...	....	161	0.000918	71	0.371728	3.1			
PDE	2001	8	4	11325.38	34.29	-93.21	5	3.1 MnGS	3F..	....	127	0.001188	72	0.376963	3.1			
SRA	1963	5	7	200329	34.3	-96.4		3 MLSRA	....	....N..	243	0.000538	73	0.382199	3			
SRA	1965	2	14	200320.3	36.94	-93.29	0	3 MnSRA	....	....	198	0.000673	74	0.387435	3			
SRA	1981	5	25	225018.2	36.76	-91.63	1	3 MnSRA	3...	....	271	0.000478	75	0.39267	3			
SRA	1982	1	18	12307.3	35.19	-92.25	2	3 MnSRA	.F..	....	159	0.000854	76	0.397906	3			
SRA	1982	2	12	53212.2	35.18	-92.23	3	3 MnSRA	4...	....	161	0.000842	77	0.403141	3			
SRA	1982	8	26	155605.7	35.19	-92.24	5	3 MDSRA	.F..	....	160	0.000848	78	0.408377	3			
SRA	1983	12	9	205210.5	33.18	-92.7	5	3 MnSRA	4...	....	257	0.000506	79	0.413613	3			
SRA	1986	5	24	81601.5	35.18	-92.22	5	3 MnSRA	....	....	162	0.000837	80	0.418848	3			

CAT	YEAR	MO	DA	ORIG TIMI	LAT	LONG	DEP	MAG	NITUDE	IEFM NFPO TFS	DTSVNWK	DIST km			
PDE	1990	3	18	162233	36.72	-91.49	5	3	MOTEI	4F..	....	279	0.000463	81	0.424084	3
PDE	1995	6	1	44929.32	34.29	-96.73	5	3	MnGS	5F..	....	271	0.000478	82	0.429319	3
PDE	2001	3	3	104613	33.19	-92.66	5	3	MnSLM	.F..	....	259	0.000502	83	0.434555	3
SRA	1966	3	17	931	35.8	-92		2.9	MnSRA	....	....	191	0.000641	84	0.439791	2.9
SRA	1975	1	2	91857.3	34.87	-91.07	8	2.9	MnSRA	2...	....	270	0.00044	85	0.445026	2.9
SRA	1975	3	31	95206	35.6	-95.3		2.9	HzSRA	....	....	124	0.001026	86	0.450262	2.9
SRA	1975	6	16	15928.2	34.2	-96.5		2.9	HzSRA	....	....	256	0.000466	87	0.455497	2.9
SRA	1976	12	19	82636.7	34.92	-95.73	5	2.9	MnSRA	2...	....	161	0.000772	88	0.460733	2.9
SRA	1978	3	5	144650.5	34.7	-95	7	2.9	MnSRA	....	....	109	0.00118	89	0.465969	2.9
SRA	1979	2	27	825	34.2	-92		2.9	MnSRA	4...	....	216	0.000561	90	0.471204	2.9
SRA	1982	1	21	120301.8	35.2	-92.21	0	2.9	MDSRA	.F..	....	162	0.000767	91	0.47644	2.9
SRA	1982	6	12	150027.6	35.2	-92.26	4	2.9	MDSRA	4...	....	158	0.000788	92	0.481675	2.9
SRA	1982	11	21	162739.4	35.2	-92.24	5	2.9	MnSRA	3...	....	160	0.000778	93	0.486911	2.9
SRA	1983	10	23	193446.9	34.82	-96.89	5	2.9	MnSRA	....	....	267	0.000446	94	0.492147	2.9
SRA	1985	9	23	10344.1	34.72	-95.06	5	2.9	MnSRA	....	....	112	0.001146	95	0.497382	2.9
SRA	1962	9	1	20956.1	35.2	-96		2.8	MLSRA	....	....	182	0.00062	96	0.502618	2.8
SRA	1968	10	11	85542	34	-96.4		2.8	HzSRA	3...	....	259	0.000422	97	0.507853	2.8
SRA	1968	10	18	211410	34	-96.4		2.8	MnSRA	....	....	259	0.000422	98	0.513089	2.8
SRA	1969	2	2	124932	33.3	-95.8		2.8	MnSRA	....	....	271	0.000402	99	0.518325	2.8
SRA	1973	12	25	41132	35.1	-94.5		2.8	MnSRA	....	....	48	0.002631	100	0.52356	2.8
SRA	1974	2	15	225305.1	34	-92.96	20	2.8	MnSRA	.F..	....	166	0.000685	101	0.528796	2.8
SRA	1974	12	13	101322.5	36.74	-91.61	3	2.8	MnSRA	....	....	271	0.000402	102	0.534031	2.8
SRA	1982	1	21	25639.2	35.15	-92.21	1	2.8	MDSRA	....	....	163	0.000699	103	0.539267	2.8
SRA	1982	1	21	115353.6	35.15	-92.21	6	2.8	MDSRA	.F..	....	163	0.000699	104	0.544503	2.8
SRA	1982	1	21	130011.7	35.21	-92.22	1	2.8	MDSRA	....	....	161	0.000708	105	0.549738	2.8
SRA	1982	3	9	160142.3	35.19	-92.23	6	2.8	MDSRA	....	....	161	0.000708	106	0.554974	2.8
SRA	1982	10	29	192739.2	35.21	-92.21	1	2.8	MDSRA	3...	....	162	0.000704	107	0.560209	2.8
SRA	1982	12	22	204716.8	35.2	-92.2	1	2.8	MDSRA	.F..	....	163	0.000699	108	0.565445	2.8
SRA	1983	2	4	95813.9	35.2	-92.23	1	2.8	MDSRA	....	....	160	0.000713	109	0.570681	2.8
SRA	1983	2	17	193145.3	35.18	-92.22	5	2.8	MDSRA	.F..	....	161	0.000708	110	0.575916	2.8
SRA	1984	1	24	153409.6	35.03	-96.37	5	2.8	MnSRA	5...	....	216	0.000515	111	0.581152	2.8
SRA	1984	6	17	4139.1	36.13	-92.73	5	2.8	MnSRA	....	....	150	0.000765	112	0.586387	2.8
SRA	1984	10	4	131223.4	36.85	-91.91	5	2.8	MnSRA	....	....	259	0.000422	113	0.591623	2.8
SRA	1986	12	21	173258.1	35.14	-96.68	5	2.8	MnSRA	....	....	243	0.000453	114	0.596859	2.8
PDE	1987	3	14	44303.5	34.79	-96.33	5	2.8	MnTUL	....	....	218	0.000509	115	0.602094	2.8
PDE	1990	3	12	164801.4	36.41	-92.3	0	2.8	MDTEI	4F..	....	200	0.000559	116	0.60733	2.8
PDE	2001	12	17	15444.76	33.2	-92.7	10	2.8	MnGS	.F..	....	256	0.000428	117	0.612565	2.8
SRA	1971	3	13	192215.3	35.2	-95.8		2.7	MnSRA	....	....	163	0.000641	118	0.617801	2.7
SRA	1974	11	10	61918.6	34.8	-96.7		2.7	HzSRA	....	....	251	0.000401	119	0.623037	2.7
SRA	1975	10	30	3714.1	35.3	-96.8		2.7	HzSRA	....	....	254	0.000396	120	0.628272	2.7
SRA	1976	3	16	73945.3	35.43	-95.6		2.7	HzSRA	4...	....	146	0.000722	121	0.633508	2.7
SRA	1982	1	21	32739.4	35.18	-92.22	7	2.7	MDSRA	....	....	162	0.000645	122	0.638743	2.7
SRA	1982	1	21	140912.7	35.19	-92.21	0	2.7	MDSRA	....	....	162	0.000645	123	0.643979	2.7
SRA	1982	1	21	154826.8	35.21	-92.22	0	2.7	MDSRA	.F..	....	161	0.00065	124	0.649215	2.7
SRA	1982	1	22	84754.8	35.23	-92.22	1	2.7	MDSRA	....	....	161	0.00065	125	0.65445	2.7
SRA	1982	2	16	123820.5	35.19	-92.23	5	2.7	MDSRA	4...	....	161	0.00065	126	0.659686	2.7
SRA	1982	3	1	60409.1	35.2	-92.23	6	2.7	MDSRA	.F..	....	161	0.00065	127	0.664921	2.7
SRA	1982	8	18	101856.9	34.47	-96.23	5	2.7	MnSRA	....	....	221	0.00046	128	0.670157	2.7
SRA	1982	9	27	171712.3	35.03	-92.22	2	2.7	MDSRA	.F..	....	163	0.000641	129	0.675393	2.7
SRA	1982	11	17	190043.2	35.2	-92.23	1	2.7	MDSRA	.F..	....	161	0.00065	130	0.680628	2.7
SRA	1983	2	12	192020.7	36.76	-91.52	12	2.7	MnSRA	....	....	279	0.000357	131	0.685864	2.7
SRA	1983	3	29	84045.8	35.19	-92.23	3	2.7	MnSRA	.F..	....	161	0.00065	132	0.691099	2.7
SRA	1983	3	30	42054.2	35.2	-92.22	4	2.7	MnSRA	3...	....	161	0.00065	133	0.696335	2.7
SRA	1983	10	4	51158.1	36.17	-91.18	12	2.7	MDSRA	....	....	275	0.000363	134	0.701571	2.7
SRA	1985	8	2	42310.8	35.22	-92.21	7	2.7	MDSRA	....	....	162	0.000645	135	0.706806	2.7
PDE	1992	6	30	12549.3	35.26	-96.42	5	2.7	MDTUL	2F..	....	220	0.000462	136	0.712042	2.7
PDE	1993	3	11	11501.5	35.21	-95.93	5	2.7	MnTUL	3F..	....	175	0.000593	137	0.717277	2.7
PDE	2001	5	4	83143	35.25	-92.23	0	2.7	MDCER	....	....	160	0.0006[illegible]4	138	0.722513	2.7
SRA	1962	5	18	24029.3	35.1	-95.4		2.6	MLSRA	....	....	128	0.0007[illegible]4	139	0.727749	2.6
SRA	1963	6	12	163852	34.7	-96.8		2.6	MLSRA	....	....	262	0.000351	140	0.732984	2.6
SRA	1968	10	12	214644	34	-96.4		2.6	MnSRA	....	....	259	0.000355	141	0.73822	2.6
SRA	1977	6	2	233512.2	34.6	-93.9	10	2.6	MnSRA	....	....	72	0.001427	142	0.743455	2.6
SRA	1982	1	18	93259.3	35.19	-92.26	2	2.6	MDSRA	....	....	158	0.000608	143	0.748691	2.6
SRA	1982	1	21	31528.9	35.16	-92.21	3	2.6	MDSRA	.F..	....	163	0.000588	144	0.753927	2.6
SRA	1982	2	3	62446.6	35.19	-92.23	3	2.6	MDSRA	.F..	....	161	0.000596	145	0.759162	2.6
SRA	1982	3	10	30142.6	35.2	-92.22	7	2.6	MDSRA	.F..	....	162	0.000592	146	0.764398	2.6
SRA	1982	6	4	212337.9	35.22	-92.21	1	2.6	MDSRA	.F..	....	162	0.000592	147	0.769634	2.6
SRA	1982	7	5	30744.6	35.19	-92.23	5	2.6	MnSRA	.F..	....	161	0.000596	148	0.774869	2.6
SRA	1982	11	12	3939.3	35.2	-92.21	3	2.6	MDSRA	.F..	....	162	0.000592	149	0.780105	2.6
SRA	1982	11	21	184239.8	35.2	-92.21	1	2.6	MDSRA	....	....	162	0.000592	150	0.78534	2.6
SRA	1984	3	3	114202.4	35.51	-96.3	5	2.6	MnSRA	5...	....	211	0.000444	151	0.790576	2.6
SRA	1984	7	12	12717.6	35.23	-92.21	2	2.6	MDSRA	.F..	....	163	0.000588	152	0.795812	2.6
SRA	1986	9	4	173317.4	34.48	-96.5	5	2.6	MnSRA	....	....	244	0.000379	153	0.801047	2.6
PDE	2001	9	22	14036.29	34.83	-93.26	5	2.6	MnGS	.F..	....	81	0.001256	154	0.806283	2.6
SRA	1963	6	5	170206	34.7	-96.8		2.5	MLSRA	....	....N..	262	0.000322	155	0.811518	2.5
SRA	1971	3	1	192732.1	35.1	-94.9		2.5	MDSRA	....	....	83	0.001122	156	0.816754	2.5
SRA	1976	10	20	40539.6	34.75	-96.12		2.5	MnSRA	....	....	201	0.000429	157	0.82199	2.5
SRA	1977	9	12	23630.1	33.95	-95.24	5	2.5	MnSRA	....	....	183	0.000475	158	0.827225	2.5
SRA	1980	11	22	193502.8	35.38	-95.99	5	2.5	MnSRA	....	....	181	0.000481	159	0.832461	2.5
SRA	1983	6	5	130418.6	35	-91.32	14	2.5	MDSRA	....	....	245	0.000346	160	0.837696	2.5
SRA	1983	7	12	832	35.18	-92.21	7	2.5	MnSRA	.F..	....	162	0.000543	161	0.842932	2.5
SRA	1983	7	31	140700.1	35.2	-92.22	5	2.5	MnSRA	....	....	161	0.000546	162	0.848168	2.5
SRA	1984	1	6	171449.8	36.16	-95.58	5	2.5	MDSRA	4...	....	175	0.000499	163	0.853403	2.5
SRA	1985	10	7	104435.9	35.92	-91.73	8	2.5	MDSRA	....	....	218	0.000393	164	0.858639	2.5
SRA	1985	11	26	23024.3	35.22	-92.35	4	2.5	MDSRA	....	....	150	0.00059	165	0.863874	2.5
SRA	1986	2	5	133618.2	35.26	-92.27	6	2.5	MnSRA	....	....	157	0.000561	166	0.86911	2.5
SRA	1986	10	7	120639.1	35.26	-96.58	5	2.5	MDSRA	....	....	234	0.000364	167	0.874346	2.5
PDE	1990	9	16	211332.4	34.8	-95.53	5	2.5	MnTUL	4F..	....	148	0.000599	168	0.879581	2.5
PDE	2001	5	2	91303	36.58	-92.24	1	2.5	MnSLM	....	....	217	0.000395	169	0.884817	2.5
SRA	1968	10	11	93337	34	-96.4		2.4	HzSRA	3...	....	259	0.000299	170	0.890052	2.4
SRA	1983	12	10	92453.5	33.18	-92.7	5	2.4	MnSRA	2...	....	257	0.000301	171	0.895288	2.4
SRA	1984	9	27	131604	35.22	-92.17	10	2.4	MnSRA	.F..	....	166	0.000484	172	0.900524	2.4
PDE	1988	10	13	144206.8	34.09	-96.14	5	2.4	MDTUL	....	....	234	0.000333	173	0.905759	2.4
PDE	1989	2	5	83744.42	33.2	-92.78	5	2.4	MDTEI	.F..	....	252	0.000308	174	0.910995	2.4
SRA	1968	10	11	22555	34	-96.4		2.3	HzSRA	3...	....	259	0.000274	175	0.91623	2.3
SRA	1982	1	28	215508.2	35.18	-92.23	5	2.3	MnSRA	.F..	....	161	0.000459	176	0.921466	2.3
SRA	1985	11	20	112853.2	35.15	-92.26	1	2.3	MDSRA	.F..	....	158	0.000469	177	0.926702	2.3
SRA	1985	12	13	105739.5	35.17	-92.22	3	2.3	MDSRA	.F..	....	162	0.000456	178	0.931937	2.3
PDE	1988	3	24	22547.9	35.41	-96.57	5	2.3	MDTUL	....	....	234	0.000306	179	0.937173	2.3
SRA	1977	1	6	161954	34.7	-96.73	5	2.2	MnSRA	2...	....	258	0.000254	180	0.942408	2.2
PDE	1992	8	9	210552.1	34.77	-96.49	5	2.2	MDTUL	1F..	....	233	0.000282	181	0.947644	2.2
PDE	1992	8	10	112123.1	34.62	-96.54	5	2.2	MDTUL	....	....	242	0.00027	182	0.95288	2.2
PDE	1987	12	16	70458.8	34.88	-95.51	5	2.1	MDTUL	....	....	143	0.000439	183	0.958115	2.1
PDE	1988	6	5	25655.5	34.74	-95.19	5	2.1	MDTUL	....	....	122	0.000522	184	0.963351	2.1

CAT	YEAR	MO	DA	ORIG TIM	LAT	LONG	DEP	MAG	NITUDE	IEFM NFPO TFS	DTSVNWK	DIST km				
PDE	1968	6	21	231245.6	34.51	-96.26	5	2.1	MDTUL	....	....	222	0.000272	185	0.968586	2.1
PDE	1969	2	20	115918	35.32	-96.46	5	2.1	MDTUL	....	....	224	0.00027	186	0.973822	2.1
PDE	1969	2	7	222246.7	34.39	-96.83	5	2	MnTUL	....	....	275	0.000196	187	0.979058	2
SRA	1968	10	11	24042	34	-96.4		1.9	HzSRA	3...	....	259	0.000194	188	0.984293	1.9
PDE	1967	2	26	20407.2	35.31	-96.62	5	1.9	MnTUL	....	....	238	0.000212	189	0.989529	1.9
PDE	1967	6	2	202537	34.71	-96.56	5	1.9	MDTUL	....	....	240	0.00021	190	0.994764	1.9
PDE	1967	6	18	22156.7	35.12	-96.35	5	1.9	MnTUL	....	....	214	0.000238	191	1	1.9
PDE	1968	9	28	184834	34.47	-96.85	5	1.9	MnTUL	....	....	274	0.000182	192	1.005236	1.9
PDE	1967	6	29	72621	34.33	-96.73	5	1.7	MDTUL	....	....	268	0.000157	193	1.010471	1.7
PDE	1968	10	3	220201	34.47	-96.15	5	1.6	MnTUL	....	....	214	0.000184	194	1.015707	1.6
PDE	1967	6	7	73524.3	35.17	-95.28	5	1.5	MDTUL	....	....	116	0.000328	195	1.020942	1.5
PDE	1968	3	19	92737.7	36.04	-96.82	5	1.4	MDTUL	....	....	270	0.00012	196	1.026178	1.4
PDE	1969	2	23	4355.7	35.21	-95.86	5	1.4	MDTUL	....	....	169	0.0002	197	1.031414	1.4
PDE	1968	8	29	5650.5	35.53	-95.36	5	0.9	MDTUL	....	....	127	0.000177	198	1.036649	0.9
SRA	1883	1	10	18	36.5	-92.9				3...	....	170	5.89E-05	199	1.041885	
SRA	1885	2	21		37.2	-94.3				3...	....	218	4.49E-05	200	1.04712	
SRA	1899	12	1	1650	36.9	-94.4				4...	....	187	5.31E-05	201	1.052356	
SRA	1900	12			36	-96.8				4...	....	266	3.62E-05	202	1.057592	
SRA	1901	4	1		36	-96.8				.F..	....	266	3.62E-05	203	1.062627	
SRA	1901	4	8	1330	36	-96.8				.F..	....	266	3.62E-05	204	1.068063	
SRA	1907	2	20		34.8	-93.9				....	....N..	50	0.000223	205	1.073298	
SRA	1919	4	8	1230	36.2	-91.3				3...	....N..	266	3.62E-05	206	1.078534	
SRA	1924	6	3	40	36.3	-96.5				3...	....	254	3.8E-05	207	1.08377	
SRA	1928	11	10	620	36.1	-91.1				4...	....	278	3.45E-05	208	1.089005	
SRA	1928	12	26	325	36.1	-91.1				4...	....	278	3.45E-05	209	1.094241	
SRA	1930	1	26	21	36.1	-91.1				4...	....	278	3.45E-05	210	1.099476	
SRA	1934	4	12		33.9	-95.5				3...	....	202	4.88E-05	211	1.104712	
SRA	1938	4	26	542	34.2	-93.5				4...	....	124	8.3E-05	212	1.109948	
SRA	1939	6	1	17	35	-96.4				.F..	....	220	4.45E-05	213	1.115183	
SRA	1940	12	2	1616	33	-94				4...	....	248	3.9E-05	214	1.120419	
SRA	1952	5	1	1140	35.4	-96.4				2...	....	218	4.49E-05	215	1.125654	
SRA	1952	5	2	155	35.4	-96.4				2...	....	218	4.49E-05	216	1.13089	
SRA	1952	10	8	415	35.1	-96.5				4...	....	228	4.28E-05	217	1.136126	
SRA	1953	6	6	1740	34.8	-96.7				4...	....	251	3.85E-05	218	1.141361	
SRA	1954	4	11		35.1	-96.4				4...	....	219	4.47E-05	219	1.146597	
SRA	1954	4	12	2305	35.1	-96.4				4...	....	219	4.47E-05	220	1.151832	
SRA	1954	4	13	1848	35.1	-96.4				4...	....	219	4.47E-05	221	1.157068	
SRA	1960	3	18	2130	36.2	-95.8				3...	....	194	5.1E-05	222	1.162304	
SRA	1960	3	18	2330	36.2	-95.8				3...	....	194	5.1E-05	223	1.167539	
SRA	1960	5	4	163132	34.2	-92				4...	....	216	4.54E-05	224	1.172775	
SRA	1961	4	27	3	34.6	-95				3...	....	115	9.02E-05	225	1.17801	
SRA	1961	4	27	5	34.6	-95				3...	....	115	9.02E-05	226	1.183246	
SRA	1968	1	4	2230	34.65	-95.55				4...	....	147	6.9E-05	227	1.188482	
SRA	1979	2	27	225512	35.93	-91.24	10			4...	....	261	3.69E-05	228	1.193717	
SRA	1979	8	26	1128	36.3	-91.5				4...	....	254	3.8E-05	229	1.198953	

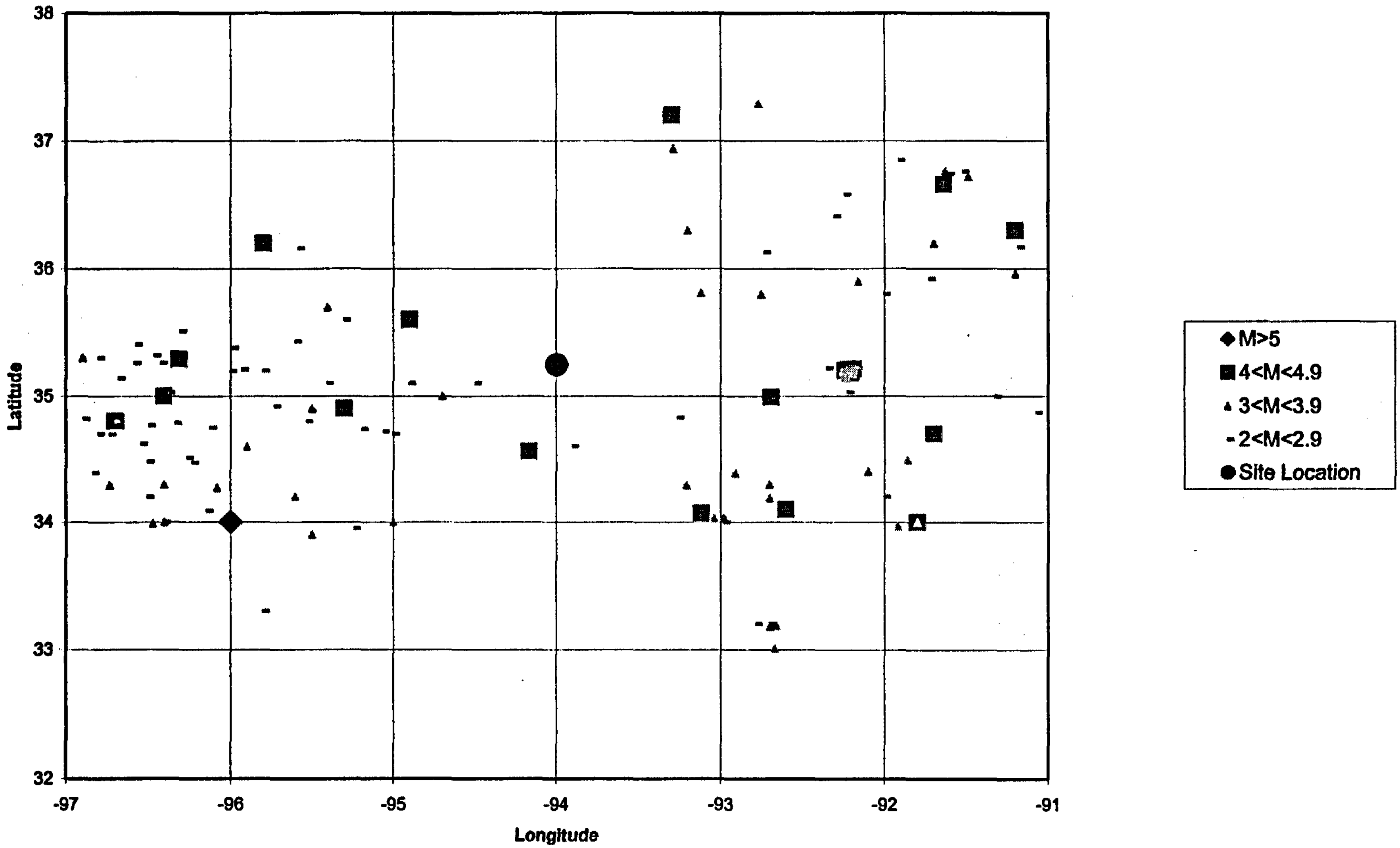
Magnitude vs. Earthquake Frequency
Arkoma Basin



6/13/2003

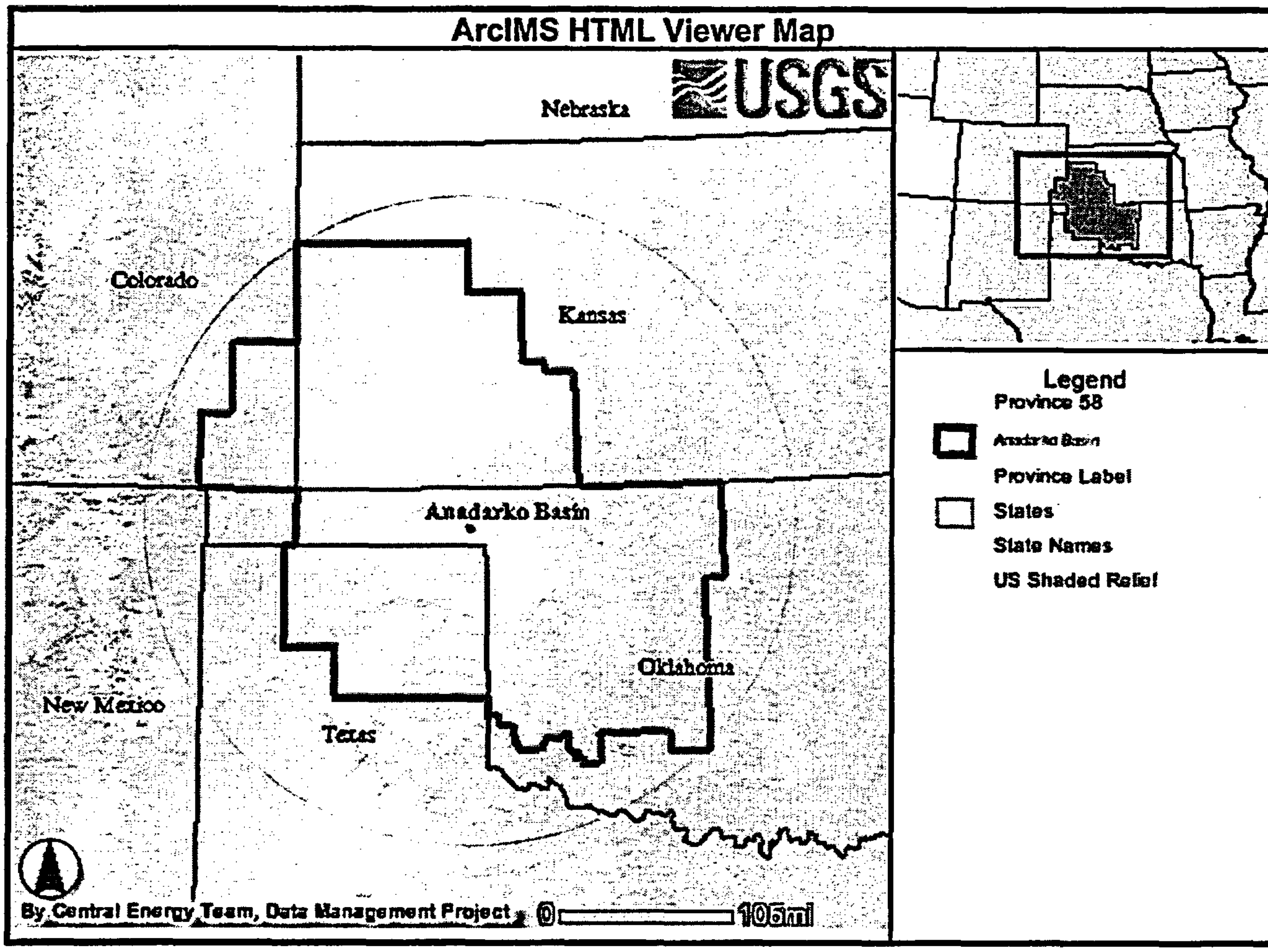
Arkoma NEIC 1534-2003

Locations of Earthquakes- Arkoma Basin



APPENDIX B.5

SEISMIC ACTIVITY WITHIN ANADARKO BASIN



radius = 200 miles = 320 km
center = 36 38 14 North = 36.637 N
100 9 50 West = 100.164 W

NEIC: Earthquake Search Results

U. S. GEOLOGICAL SURVEY

EARTHQUAKE DATA BASE

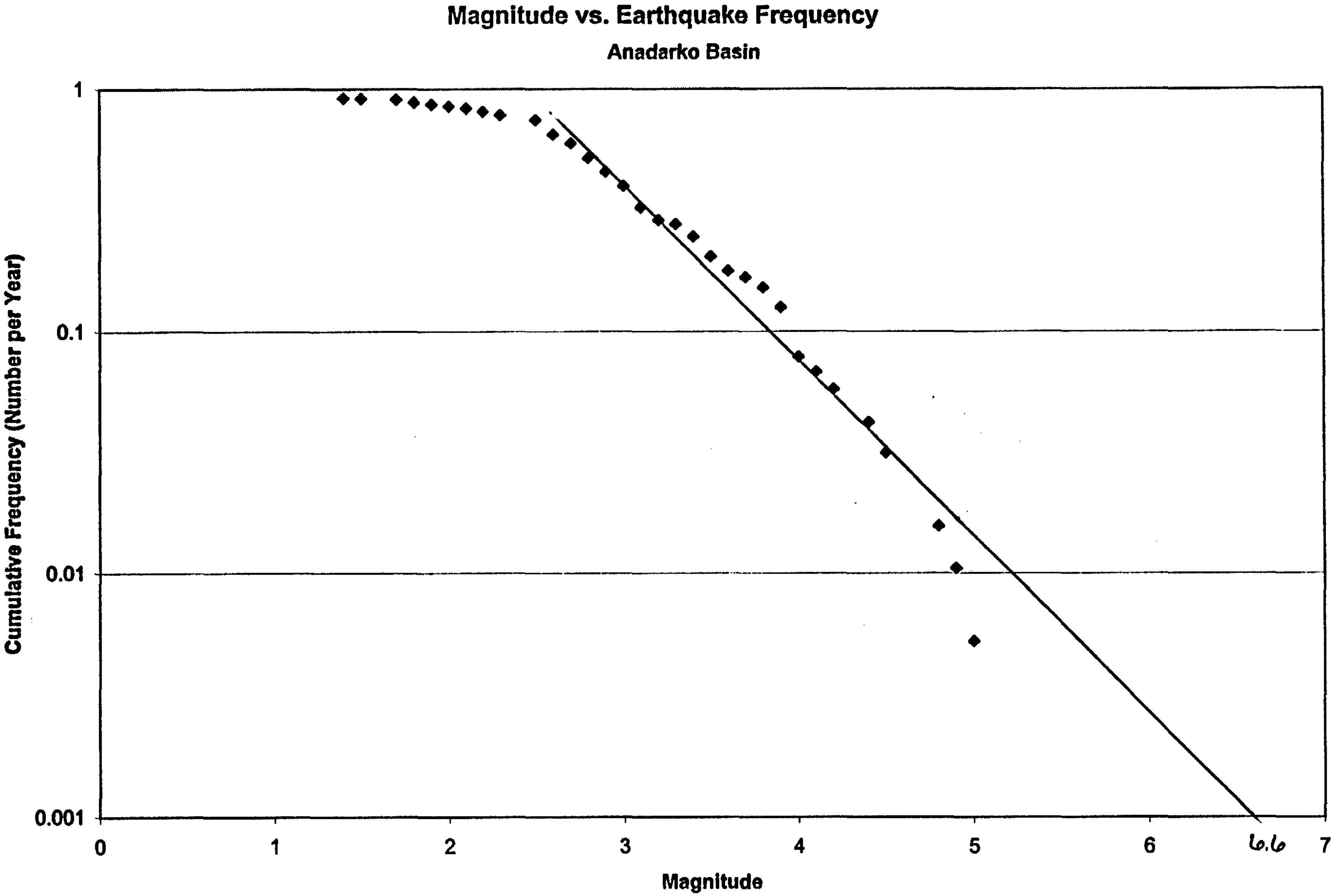
FILE CREATED: Fri Jun 13 11:47:19 2003
Circle Search Earthquakes= 140
Circle Center Point Latitude: 36.637N Longitude: 100.164W
Radius: 320.000 km
Catalog Used: SRA
Data Selection: Eastern, Central and Mountain States of U.S. (SRA)

FILE CREATED: Fri Jun 13 11:48:02 2003
Circle Search Earthquakes= 78
Circle Center Point Latitude: 36.637N Longitude: 100.164W
Radius: 320.000 km
Catalog Used: PDE
Date Range: Year: 1987 - 2004
Data Selection: Historical & Preliminary Data

CAT	YEAR	MO	DA	ORIG TIM	LAT	LONG	DEP	MAG	NITUDE	IEFM NFPO TFS	DTSVNWt	DIST km	Peak Ground Accelerations (Campbell)	Rank	Frequency	MAGNI	Rank	Frequency	MAGNI
SRA	1952	4	9	162928.4	35.53	-97.85	10	5	FASRA	7...	....	242	0.003048	1	0.005236	5	1	0.005236	5
SRA	1925	7	30	1217	35.4	-101.3		4.9	FASRA	6...	....	171	0.004068	2	0.010471	4.9	2	0.010471	4.9
SRA	1948	3	12	0429::	36	-102.5		4.8	FASRA	6...	....	221	0.00283	3	0.015707	4.8	3	0.015707	4.8
SRA	1936	6	20	32406	35.7	-101.4		4.5	FASRA	6...	....	152	0.003275	4	0.020942	4.5	6	0.031414	4.5
SRA	1959	2	10	2005	35.5	-100.9		4.5	FASRA	5...	....N..	142	0.003524	5	0.026178	4.5	8	0.041885	4.4
SRA	1974	2	15	133349.2	36.4	-100.69	0	4.5	mb GS	5..G	....	53	0.010135	6	0.031414	4.5	11	0.057592	4.2
SRA	1951	6	20	183711.1	35.22	-103.04	1	4.4	FASRA	5...	....	302	0.001428	7	0.036649	4.4	13	0.068063	4.1
SRA	1956	1	6	115807.4	37.58	-98.35	29	4.4	FASRA	6...	....	192	0.002334	8	0.041885	4.4	15	0.078534	4
SRA	1919	5	27	306	37.7	-97.3		4.2	FASRA	4...	....	280	0.001304	9	0.04712	4.2	24	0.125654	3.9
SRA	1959	6	17	102710.6	34.64	-98.06	5	4.2	FASRA	6...	....	292	0.001246	10	0.052356	4.2	29	0.151832	3.8
PDE	1995	1	18	155139.4	34.77	-97.6	5	4.2	MnTUL	5F..	....	310	0.001168	11	0.057592	4.2	32	0.167539	3.7
SRA	1956	2	16	2330	35.6	-97.5		4.1	FASRA	6...	....N..	265	0.00127	12	0.062827	4.1	34	0.17801	3.6
PDE	1995	9	15	3133.26	36.87	-98.69	5	4.1	MnGS	5F..	....	134	0.002659	13	0.068063	4.1	39	0.204188	3.5
SRA	1929	12	28	30	35.5	-98		4	FASRA	6...	....	232	0.001345	14	0.073298	4	47	0.246073	3.4
PDE	1989	6	8	181843.4	39.17	-99.48	5	4	MnGS	5F..	....	286	0.001072	15	0.078534	4	53	0.277487	3.3
SRA	1927	1	7	930	38.4	-97.7		3.9	FASRA	4...	....	292	0.000961	16	0.08377	3.9	55	0.287958	3.2
SRA	1952	4	11	2030	35.4	-97.8		3.9	FASRA	4...	....	253	0.001123	17	0.089005	3.9	62	0.324607	3.1
SRA	1952	4	16	558	35.4	-97.8		3.9	FASRA	3...	....	253	0.001123	18	0.094241	3.9	76	0.397906	3
SRA	1952	4	16	605	35.4	-97.8		3.9	FASRA	5...	....	253	0.001123	19	0.099476	3.9	87	0.455497	2.9
SRA	1966	7	20	90458.8	35.64	-101.33	3	3.9	mb GS	5...	....7..	151	0.001966	20	0.104712	3.9	99	0.518325	2.8
SRA	1982	10	14	125246.3	36.1	-102.57	5	3.9	MnSRA	4...	....	223	0.001288	21	0.109948	3.9	114	0.596859	2.7
PDE	1990	11	15	114441.4	34.76	-97.59	5	3.9	MnTUL	5F..	....	312	0.000894	22	0.115183	3.9	124	0.649215	2.6
PDE	2000	8	17	10605.45	35.39	-101.81	5	3.9	MnGS	.F..	....	203	0.001426	23	0.120419	3.9	142	0.743455	2.5
PDE	2000	12	16	220654	35.4	-101.8	5	3.9	MnGS	.F..	....	201	0.001442	24	0.125654	3.9	149	0.780105	2.3
SRA	1904	10	28	406	37.5	-100.2		3.8	FASRA	5...	....	95	0.002978	25	0.13089	3.8	154	0.806283	2.2
SRA	1919	7	26	1255	37.7	-97.3		3.8	FASRA	4...	....	280	0.000923	26	0.136126	3.8	159	0.832461	2.1
SRA	1968	4	21	70807	37.8	-102.1	33	3.8	mb GS	....	....	214	0.001235	27	0.141361	3.8	162	0.848168	2
PDE	1989	6	16	145353.1	39.14	-99.46	5	3.8	MnGS	5F..	....	284	0.000908	28	0.146597	3.8	165	0.863874	1.9
PDE	2002	2	8	160713.6	34.73	-98.36	5	3.8	MnTUL	5F..	....	267	0.000972	29	0.151832	3.8	168	0.879581	1.8
SRA	1942	6	12	450	36.4	-97.9		3.7	FASRA	3...	....	204	0.001193	30	0.157068	3.7	173	0.905759	1.7
PDE	1987	12	8	14240.3	36.06	-98.02	5	3.7	MnGS	6F..	....	202	0.001206	31	0.162304	3.7	174	0.910995	1.5
PDE-W	2002	6	19	121420.3	36.57	-103.03	5	3.7	MnGS	3F..	....	256	0.000933	32	0.167539	3.7	175	0.91623	1.4
PDE	1988	4	14	93931.47	39.09	-99.15	5	3.6	MnGS	4F..	....	286	0.000758	33	0.172775	3.6			
PDE	1992	12	17	71804.27	34.74	-97.58	5	3.6	MnGS	4F..	....	314	0.000685	34	0.17801	3.6			
SRA	1970	1	12	112115.1	35.89	-103.4		3.5	mb GS	6...	....	302	0.000655	35	0.183246	3.5			
SRA	1976	4	19	44246.9	36.04	-99.79	8	3.5	MnSRA	4...	....	74	0.003012	36	0.188482	3.5			
SRA	1976	6	24	152732	35.62	-103.28	5	3.5	MLSRA	5...	....	302	0.000655	37	0.193717	3.5			
SRA	1981	7	11	210921.8	34.85	-97.73	5	3.5	MnSRA	5...	....	296	0.00067	38	0.198953	3.5			
PDE	1991	5	30	220744	39.2	-99.4	5	3.5	MnTUL	4F..	....	292	0.00068	39	0.204188	3.5			
SRA	1936	7	12	23	36.9	-103		3.4	FASRA	4...	....	254	0.000725	40	0.209424	3.4			
SRA	1978	4	16	185948.7	36.16	-99.84	14	3.4	MnSRA	4...	....	60	0.003465	41	0.21466	3.4			
SRA	1979	9	13	4921.5	35.19	-99.47	1	3.4	MnSRA	4...	....	171	0.001115	42	0.219895	3.4			
SRA	1980	6	9	223712.3	35.48	-101.01	1	3.4	MnSRA	5...	....	148	0.001304	43	0.225131	3.4			
SRA	1983	4	3	45521.2	35.45	-102.32	5	3.4	MnSRA	....	....	234	0.000793	44	0.230366	3.4			
SRA	1984	4	3	45524	35.32	-102.4		3.4	MnSRA	....	....	248	0.000745	45	0.235602	3.4			
SRA	1984	5	21	133014	35.4	-102.4		3.4	MnSRA	....	....	243	0.000761	46	0.240838	3.4			
PDE	1989	7	13	183522.9	39.17	-99.47	5	3.4	MnGS	5F..	....	287	0.000635	47	0.246073	3.4			
SRA	1962	4	28	60911	35.3	-98.6		3.3	MLSRA	....	....	204	0.000844	48	0.251309	3.3			
SRA	1979	11	27	91036.8	35.63	-98.41	5	3.3	MnSRA	....	....	193	0.000897	49	0.256545	3.3			
PDE	1992	7	15	25640.75	38.76	-99.55	5	3.3	MnTUL	4F..	....	241	0.000704	50	0.26178	3.3			
PDE	1993	9	29	20119.06	35.87	-102.98	5	3.3	MnGS	3F..	....	267	0.00063	51	0.267016	3.3			
PDE	1993	11	30	30731.82	35.86	-103.03	5	3.3	MDSNM	4F..	....	271	0.00062	52	0.272251	3.3			
PDE	2000	8	7	171908	35.39	-101.81	5	3.3	MnGS	.F..	....	202	0.000653	53	0.277487	3.3			
SRA	1962	9	7	225344	34.7	-98.4		3.2	MLSRA	....	....N..	267	0.000578	54	0.282723	3.2			
SRA	1980	7	18	142946.9	35.18	-99.7	5	3.2	MnSRA	....	....	166	0.000969	55	0.287958	3.2			
SRA	1982	3	16	110302.7	35.36	-103.27	5	3.1	MnSRA	3...	....	313	0.000446	56	0.293194	3.1			
SRA	1982	11	7	419	35.2	-100.2		3.1	MnSRA	....	....	159	0.000931	57	0.298429	3.1			
SRA	1984	5	21	133113.5	35.07	-102.23	5	3.1	MnSRA	....	....	254	0.000559	58	0.303665	3.1			
SRA	1986	3	3	114517.4	35.31	-102.51	5	3.1	MnSRA	....	....	258	0.00055	59	0.308901	3.1			
PDE	1987	1	24	160817	35.83	-98.1	5	3.1	MnTUL	5F..	....	206	0.000703	60	0.314136	3.1			
PDE	1989	7	20	60750.42	36.43	-98.88	5	3.1	MnGS	3F..	....	117	0.001299	61	0.319372	3.1			
PDE	1993	1	14	170610.5	36.6	-98.28	5	3.1	MnGS	4F..	....	168	0.000677	62	0.324607	3.1			
SRA	1976	10	22	171550.5	36.38	-97.06		3	MnSRA	....	....	279	0.000463	63	0.329843	3			
SRA	1979	8	7	73936.3	35.22	-99.76	2	3	MnSRA	4...	....	161	0.000842	64	0.335079	3			
SRA	1980	11	2	100046.9	35.46	-97.76	1	3	MnSRA	5...	....	252	0.000517	65	0.340314	3			
SRA	1988	8	2	40405.2	39.34	-99.78	5	3	MnSRA	4...	....	302	0.000425	66	0.34555	3			
SRA	1988	10	20	43249	37.92	-101.37	5	3	MnSRA	4...	....	177	0.00078	67	0.350785	3			
PDE	1991	1	24	50026.9	36.38	-97.3	5	3	MnGS	5F..	....	258	0.000504	68	0.356021	3			
PDE	1994	4	29	32858.68	36.25	-98.09	5	3	MnGS	4F..	....	190	0.000703	69	0.361257	3			
PDE	1995	4	6	53116.23	35.2	-99.03	5	3	MnGS	....	....	189	0.000707	70	0.366492	3			
PDE	2000	8	7	183409	35.39	-101.81	5	3	MnGS	.F..	....	202	0.000658	71	0.371728	3			
PDE	2000	8	7	213621	35.39	-101.81	5	3	MnGS	.F..	....	202	0.000658	72	0.376963	3			
PDE	2000	8	10	133950	35.39	-101.81	5	3	MnGS	.F..	....	202	0.000658	73	0.382199	3			
PDE	2001	7	24	140235	37.7	-97	5	3	MnGS	.F..	....	304	0.000422	74	0.387435	3			
PDE-W	2002	11	1	110856.3	39.12	-99.09	5	3	MnGS	.F..	....	291	0.000442	75	0.39267	3			
PDE-W	2003	4	17	173159.1	39.26	-99.48	5	3	MnGS	.F..	....	296	0.000434	76	0.397906	3			
SRA	1962	10	23	175558	35	-98.5		2.9	MLSRA	....	....N..	235	0.000512	77	0.403141	2.9			
SRA	1964	2	2	82243.8	35.31	-99.61	1	2.9	MnSRA	....	....	155	0.000805	78	0.408377	2.9			
SRA	1975	2	2	203922.6	35.1	-103.1		2.9	MLSRA	....	....	315	0.000372	79	0.413613	2.9			
SRA	1979	3	18	204419.5	35.38	-98.12	5	2.9	MnSRA	3...	....	230	0.000524	80	0.418848	2.9			

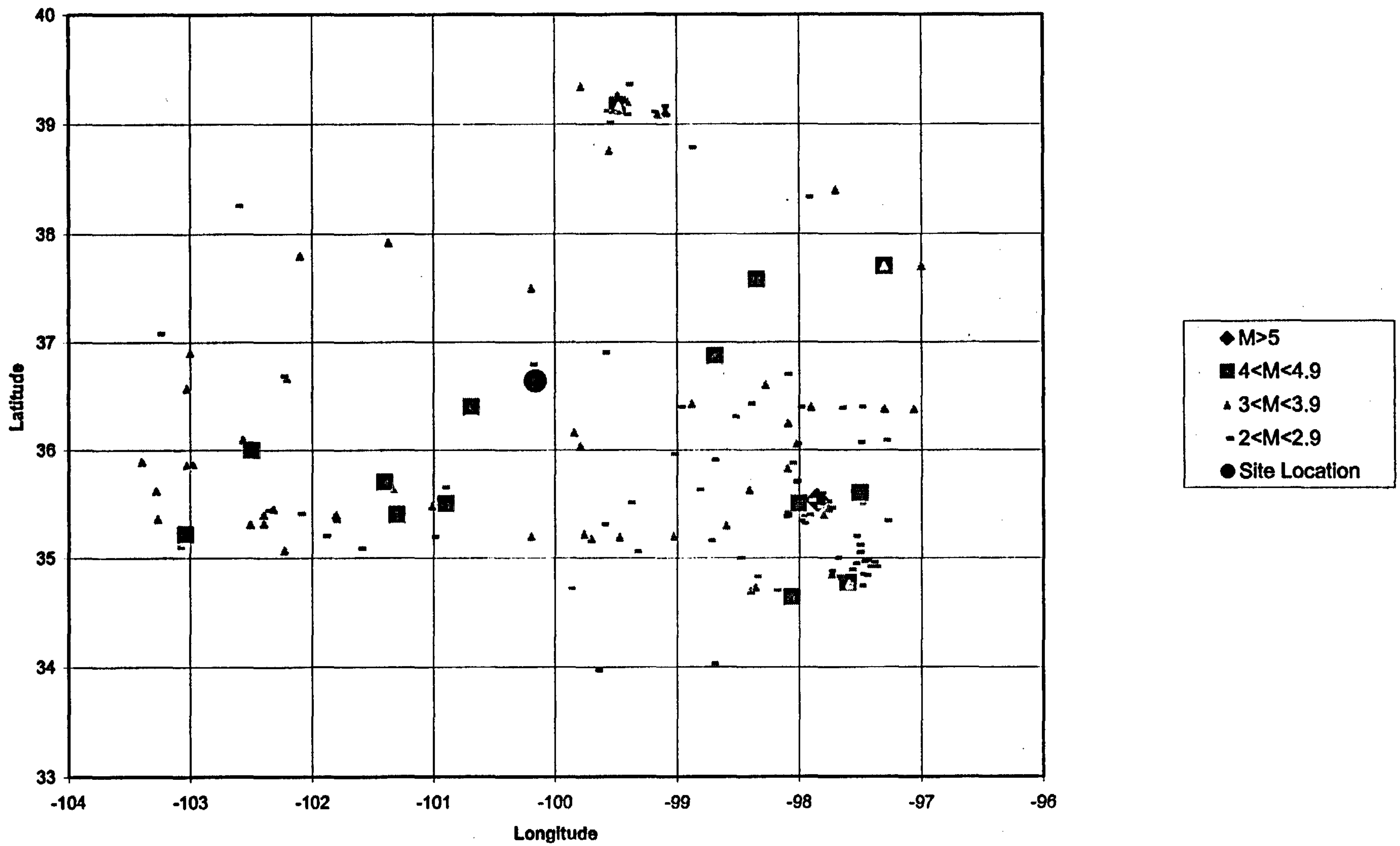
CAT	YEAR	MO	DA	ORIG TIM	LAT	LONG	DEP	MAG	NITUDE	IEFM NFPO TFS	DTSVNWK	DIST km				
SRA	1980	2	21	204203.5	35.19	-101.01	1	2.9	MnSRA	....	....	177	0.000697	81	0.424084	2.9
SRA	1981	12	17	54454.7	36.39	-97.66	5	2.9	MnSRA	....	....	225	0.000537	82	0.429319	2.9
SRA	1982	12	19	51542.9	34.89	-97.58	5	2.9	MnSRA	....	....	303	0.000388	83	0.434555	2.9
SRA	1983	6	21	183259.9	34.96	-97.4	5	2.9	MnSRA	....	....	311	0.000377	84	0.439791	2.9
PDE	1992	6	10	200304.2	34.98	-97.45	5	2.9	MDTUL	4F..	....	305	0.000385	85	0.445026	2.9
PDE	1995	12	1	143740.4	35.06	-99.34	5	2.9	MnGS	....	....	190	0.000645	86	0.450262	2.9
PDE-W	2003	1	10	102922.5	38.26	-102.62	5	2.9	MnGS	....	....	281	0.000421	87	0.455497	2.9
SRA	1963	2	2	165739	34.7	-98.2		2.8	MLSRA	....	....N..	278	0.000391	88	0.460733	2.8
SRA	1982	12	22	174253.7	35.4	-97.93	5	2.8	MnSRA	....	....	243	0.000453	89	0.465969	2.8
SRA	1983	5	16	210821.1	34.72	-99.88	5	2.8	MnSRA	....	....	214	0.00052	90	0.471204	2.8
SRA	1985	2	10	141552.2	36.43	-96.41	5	2.8	MnSRA	....	....	158	0.000723	91	0.47644	2.8
PDE	1992	10	5	44408.6	36.4	-97.5	5	2.8	MDTUL	5F..	....	239	0.000461	92	0.481675	2.8
PDE	1995	3	23	111012.3	36.9	-99.6	5	2.8	MnGS	2F..	....	58	0.002144	93	0.486911	2.8
PDE	1995	6	28	33857.39	35.44	-102.38	5	2.8	MnGS	....	....	239	0.000461	94	0.492147	2.8
PDE	2000	2	4	13626.88	39.09	-99.42	5	2.8	MnGS	.F..	....	280	0.000388	95	0.497382	2.8
PDE	2002	3	31	25408.13	35.36	-101.62	5	2.8	MnGS	.F..	....	206	0.000542	96	0.502618	2.8
PDE-W	2002	11	1	141956.2	39.08	-99.1	5	2.8	MnGS	.F..	....	286	0.000379	97	0.507853	2.8
PDE-W	2002	12	11	142523.5	39.36	-99.4	5	2.8	MnGS	....	....	309	0.000348	98	0.513089	2.8
PDE-W	2003	4	1	130949.6	39.24	-99.49	5	2.8	MnGS	.F..	....	295	0.000367	99	0.518325	2.8
SRA	1973	1	10	163815.3	36.4	-98		2.7	MnSRA	3...	....	195	0.000527	100	0.52356	2.7
SRA	1975	10	12	25814.1	35.12	-97.52	24	2.7	MnSRA	....	....	291	0.000341	101	0.528796	2.7
SRA	1976	3	30	92703.3	36.64	-102.23	1	2.7	MnSRA	5...	....	184	0.000562	102	0.534031	2.7
SRA	1978	5	18	1922.4	35.5	-97.5	5	2.7	MnSRA	3...	....	270	0.00037	103	0.539267	2.7
SRA	1981	8	1	15844.5	38.34	-97.93	10	2.7	MDSRA	....	....	273	0.000366	104	0.544503	2.7
SRA	1982	1	15	95217	35.71	-98.03	5	2.7	MnSRA	....	....	217	0.000469	105	0.549738	2.7
SRA	1983	3	11	165045.3	36.79	-100.2	5	2.7	MnSRA	....	....	17	0.007362	106	0.554974	2.7
SRA	1983	5	15	40023.6	34.83	-98.36	5	2.7	MnSRA	....	....	258	0.000389	107	0.560209	2.7
PDE	1988	6	16	153445.2	39.16	-99.11	5	2.7	MnTUL	3F..	....	294	0.000337	108	0.565445	2.7
PDE	1989	3	24	112646.1	37.06	-103.26	5	2.7	MnTUL	....	....	279	0.000357	109	0.570681	2.7
PDE	1989	7	6	11231.06	39.01	-99.56	5	2.7	MnGS	3F..	....	268	0.000373	110	0.575916	2.7
PDE	1989	7	20	24948.55	36.4	-98.96	5	2.7	MnGS	....	....	106	0.001002	111	0.581152	2.7
PDE	1990	7	1	130634.8	35.41	-102.11	5	2.7	MnTUL	....	....	221	0.00046	112	0.586387	2.7
PDE	1992	4	2	94124	39.1	-99.5	5	2.7	MnGS	.F..	....	279	0.000357	113	0.591623	2.7
PDE	2000	8	2	122130.1	35.2	-101.9	5	2.7	MnGS	.F..	....	223	0.000456	114	0.596859	2.7
SRA	1963	7	14	81027	35	-97.7		2.6	MLSRA	....	....	287	0.000318	115	0.602094	2.6
SRA	1974	12	16	23021.7	35.34	-97.29	23	2.6	HzSRA	3...	....	296	0.000307	116	0.60733	2.6
SRA	1979	1	29	192010.4	34.92	-97.38	5	2.6	MnSRA	....	....	315	0.000287	117	0.612565	2.6
SRA	1980	5	30	74402.7	35.51	-99.39	5	2.6	MnSRA	....	....	143	0.000678	118	0.617801	2.6
SRA	1984	10	4	122509.3	34.74	-97.5	5	2.6	MnSRA	....	....	319	0.000283	119	0.623037	2.6
SRA	1985	8	11	101823.2	35.96	-99.04	5	2.6	MDSRA	....	....	125	0.000784	120	0.628272	2.6
PDE	1988	9	15	62401.5	39.11	-99.19	5	2.6	MnTUL	....	....	287	0.000318	121	0.633508	2.6
PDE	1989	1	27	5648.42	39.12	-99.58	5	2.6	MnTUL	.F..	....	279	0.000327	122	0.638743	2.6
PDE	1992	12	17	40117.57	34.76	-97.6	5	2.6	MnGS	....	....	311	0.000291	123	0.643979	2.6
PDE	2000	10	8	101623.8	35.39	-97.98	5	2.6	MnGS	.F..	....	240	0.000386	124	0.649215	2.6
SRA	1979	3	18	200535	35.42	-98.11	5	2.5	MnSRA	....	....	228	0.000374	125	0.65445	2.5
SRA	1979	3	18	214210.5	35.39	-98.11	5	2.5	MnSRA	....	....	230	0.000371	126	0.659686	2.5
SRA	1979	3	19	34255.1	35.4	-98.11	5	2.5	MnSRA	....	....	230	0.000371	127	0.664921	2.5
SRA	1979	7	24	22406.3	36.07	-97.51	5	2.5	MnSRA	....	....	246	0.000344	128	0.670157	2.5
SRA	1979	7	31	191105.6	36.09	-97.3	5	2.5	MnSRA	....	....	263	0.00032	129	0.675393	2.5
SRA	1979	9	16	155720.6	35.34	-98	5	2.5	MnSRA	4...	....	242	0.000351	130	0.680628	2.5
SRA	1979	9	17	204150.5	35.32	-97.97	5	2.5	MnSRA	4...	....	245	0.000346	131	0.685864	2.5
SRA	1979	12	16	123737.5	35.16	-98.74	5	2.5	HzSRA	....	....	206	0.000413	132	0.691099	2.5
SRA	1981	7	1	224330.1	34.95	-97.55	5	2.5	MnSRA	....	....	301	0.000276	133	0.696335	2.5
SRA	1982	3	13	14149.9	35.7	-98.04	5	2.5	MnSRA	....	....	217	0.000395	134	0.701571	2.5
SRA	1982	9	3	105520.5	38.79	-98.89	11	2.5	MDSRA	4...	....	263	0.00032	135	0.706806	2.5
SRA	1983	1	10	170643.7	36.7	-98.11	4	2.5	MnSRA	....	....	183	0.000475	136	0.712042	2.5
SRA	1985	1	24	121242.4	34.92	-97.43	5	2.5	MnSRA	....	....	311	0.000267	137	0.717277	2.5
SRA	1985	5	30	84706.1	35.65	-100.92	5	2.5	MDSRA	....	....	128	0.000701	138	0.722513	2.5
SRA	1986	12	11	12300.6	35.09	-101.61	5	2.5	MnSRA	....	....	215	0.000399	139	0.727749	2.5
PDE	1987	12	8	14547.5	36.06	-98.03	5	2.5	MnTUL	....	....	202	0.000427	140	0.732984	2.5
PDE	1990	2	7	120214.1	35.63	-98.83	5	2.5	MDTUL	....	....	164	0.000535	141	0.73822	2.5
PDE	2002	1	16	152532.5	35.34	-101.82	5	2.5	MnGS	.F..	....	207	0.000416	142	0.743455	2.5
SRA	1978	5	17	231115.7	35.53	-97.91	5	2.3	MnSRA	1...	....	237	0.000302	143	0.748691	2.3
SRA	1985	5	6	21116.2	34.97	-97.48	5	2.3	MnSRA	5...	....	304	0.00023	144	0.753927	2.3
PDE	1987	1	17	41353.8	35.05	-97.52	5	2.3	MnTUL	....	....	296	0.000237	145	0.759162	2.3
PDE	1988	3	30	154655.3	36.31	-98.54	5	2.3	MDTUL	....	....	149	0.0005	146	0.764398	2.3
PDE	1988	6	19	224116.9	33.97	-99.66	5	2.3	MDTUL	....	....	298	0.000235	147	0.769634	2.3
PDE	1988	7	5	232240	35.91	-98.71	5	2.3	MnTUL	....	....	153	0.000485	148	0.774869	2.3
PDE	1992	11	23	115609.9	34.83	-97.67	5	2.3	MnTUL	....	....	301	0.000232	149	0.780105	2.3
SRA	1979	3	14	43715.3	35.52	-97.78	5	2.2	MnSRA	5...	....	247	0.000264	150	0.78534	2.2
SRA	1981	7	11	201923.7	34.88	-97.75	5	2.2	MnSRA	2...	....	292	0.00022	151	0.790576	2.2
SRA	1985	5	5	21602.6	34.84	-97.46	5	2.2	MnSRA	.F..	....	315	0.000203	152	0.795812	2.2
PDE	1992	3	20	123935	34.81	-97.67	5	2.2	MDTUL	....	....	303	0.000212	153	0.801047	2.2
PDE	1992	11	21	22143.2	34.83	-97.68	5	2.2	MnTUL	....	....	300	0.000214	154	0.806283	2.2
SRA	1976	3	30	65316	36.68	-102.25		2.1	MnSRA	5...	....	186	0.00033	155	0.811518	2.1
SRA	1978	5	18	3217.6	35.6	-97.83	5	2.1	MnSRA	2...	....	239	0.000251	156	0.816754	2.1
PDE	1987	2	19	55011.5	34.85	-97.49	5	2.1	MnTUL	....	....	312	0.000188	157	0.82199	2.1
PDE	1987	5	15	82907.5	35.46	-97.75	5	2.1	MDTUL	....	....	253	0.000236	158	0.827225	2.1
PDE	1988	10	12	101146	35.88	-98.07	5	2.1	MnTUL	....	....	205	0.000297	159	0.832461	2.1
SRA	1980	11	1	52613.8	35.47	-97.84	8	2	MnSRA	3...	....	246	0.000223	160	0.837696	2
PDE	1988	6	18	73954.37	34.03	-98.71	5	2	MDTUL	....	....	317	0.000169	161	0.842932	2
PDE	1992	11	18	214048.2	35.2	-97.55	5	2	MnTUL	....	....	284	0.000191	162	0.848168	2
SRA	1979	3	14	31056.8	35.5	-97.83	5	1.9	MnSRA	4...	....	245	0.000206	163	0.853403	1.9
PDE	1987	1	6	80049.3	34.81	-97.58	5	1.9	MDTUL	....	....	309	0.00016	164	0.858639	1.9
PDE	1988	1	30	225920.4	36.38	-96.47	5	1.9	MnTUL	....	....	154	0.000341	165	0.863874	1.9
PDE	1988	6	14	21450	36.53	-97.46	5	1.8	MDTUL	....	....	242	0.000191	166	0.86911	1.8
PDE	1992	11	19	182230.6	34.81	-97.57	5	1.8	MDTUL	....	....	309	0.000146	167	0.874346	1.8
PDE	1992	12	2	81457.9	34.9	-97.54	5	1.8	MnTUL	....	....	305	0.000148	168	0.879581	1.8
SRA	1979	3	13	232922.6	35.42	-97.85	5	1.7	HzSRA	2...	....	248	0.000171	169	0.884817	1.7
PDE	1987	2	4	134523.9	34.76	-97.58	5	1.7	MDTUL	....	....	313	0.000132	170	0.890052	1.7
PDE	1987	5	17	54104.9	35.89	-97.24	5	1.7	MnTUL	....	....	275	0.000152	171	0.895288	1.7
PDE	1988	4	21	105808.1	35.85	-99.21	5	1.7	MDTUL	....	....	122	0.000369	172	0.900524	1.7
PDE	1988	7	24	81354.8	35.06	-97.37	5	1.7	MDTUL	....	....	305	0.000136	173	0.905759	1.7
PDE	1987	5	17	150119.8	35.88	-97.26	5	1.5	MDTUL	....	....	273	0.000129	174	0.910995	1.5
PDE	1988	3	19	92737.7	36.04	-96.82	5	1.4	MDTUL	....	....	306	0.000105	175	0.91623	1.4
SRA	1897	12	2	7	36.9	-98				4...	....	195	5.07E-05	176	0.921466	
SRA	1900	12			36	-96.8				4...	....	310	3.06E-05	177	0.926702	
SRA	1901	4	1		36	-96.8				.F..	....	310	3.06E-05	178	0.931937	
SRA	1901	4	8	1330	36	-96.8				.F..	....	310	3.06E-05	179	0.937173	
SRA	1904	10	28	400	37.5	-100.2				4...	....	95	0.000111	180	0.942408	
SRA	1907	1	2	745	37.1	-97				4...	....	286	3.34E-05	181	0.947644	
SRA	1907	4			35.2	-101.8				5...	....	217	4.51E-05	182	0.95288	
SRA	1908	7	19		35.7	-97.7				3...	....	244	3.97E-05	183	0.958115	
SRA	1910				35.5	-98				3...	....	232	4.2E-05	184	0.963351	

CAT	YEAR	MO	DA	ORIG TIM	LAT	LONG	DEP	MAG	NITUDE	IEFM NFPO TFS	DTSVNWK	DIST km			
SRA	1917	3	28	1956	35.4	-101.3				6...	....	171	5.85E-05	185	0.968586
SRA	1917	3	28	2338	35.4	-101.3				.F..	....	171	5.85E-05	186	0.973822
SRA	1918	9	10	1530	35.5	-98				4...	....	232	4.2E-05	187	0.979058
SRA	1918	9	11	530	35.5	-98				6...	....	232	4.2E-05	188	0.984293
SRA	1918	9	11	9	35.5	-98				3...	....	232	4.2E-05	189	0.989529
SRA	1918				35.5	-97.7				3...	....	255	3.79E-05	190	0.994764
SRA	1919	7	26	11	37.7	-97.3				3...	....	280	3.42E-05	191	1
SRA	1921	10	15	255	36.5	-102.8				3...	....	311	3.05E-05	192	1.005236
SRA	1925	7	29	1130	34.5	-101.2				4...	....?..	254	3.8E-05	193	1.010471
SRA	1925	7	30	8	34.5	-100.3				5...	....	237	4.1E-05	194	1.015707
SRA	1925	7	31	18	35.5	-101.1				3...	....	151	6.7E-05	195	1.020942
SRA	1926	3	10		38.85	-101.75				....	....?..	282	3.39E-05	196	1.026178
SRA	1928	9	29	717	38.1	-102.1				4...	....	236	4.12E-05	197	1.031414
SRA	1929	11	27	420	37.2	-99.7				4...	....	74	0.000146	198	1.036649
SRA	1932	1	29	15	39	-99.6				5...	....	266	3.62E-05	199	1.041885
SRA	1933	8	19	1930	35.5	-98				6...	....	232	4.2E-05	200	1.04712
SRA	1935	11	29		36.2	-97				3...	....	287	3.33E-05	201	1.052356
SRA	1936	6	19	21	35.2	-100.7				3...	....?..	166	6.04E-05	202	1.057592
SRA	1936	6	20	31337	35.7	-101.4				3...	....	152	6.65E-05	203	1.062827
SRA	1936	6	20	31827	35.7	-101.4				4...	....	152	6.65E-05	204	1.068063
SRA	1941	10	18	748	35.4	-99				5...	....	172	5.81E-05	205	1.073298
SRA	1942	9	10	10	38.9	-99.3				4...	....	262	3.68E-05	206	1.078534
SRA	1948	4	3	3	37.7	-97.3				4...	....	280	3.42E-05	207	1.08377
SRA	1952	4	11	1830	35.4	-97.8				3...	....	253	3.82E-05	208	1.089005
SRA	1952	4	16		35.4	-97.8				3...	....	253	3.82E-05	209	1.094241
SRA	1952	4	16	1430	35.4	-97.8				3...	....	253	3.82E-05	210	1.099476
SRA	1952	7	17	30	35.4	-97.8				3...	....	253	3.82E-05	211	1.104712
SRA	1952	7	17	2	35.4	-97.8				3...	....	253	3.82E-05	212	1.109948
SRA	1952	8	14	2140	35.4	-97.8				4...	....	253	3.82E-05	213	1.115183
SRA	1953	3	16	1250	35.4	-97.9				3...	....	245	3.95E-05	214	1.120419
SRA	1953	3	17	1312	35.6	-98				5...	....	226	4.32E-05	215	1.125654
SRA	1953	3	17	1425	35.6	-98				6...	....	226	4.32E-05	216	1.13089
SRA	1956	1	14	1840	37.9	-102.6				3...	....	257	3.75E-05	217	1.136126
SRA	1956	1	14	1849	37.9	-102.6				4...	....	257	3.75E-05	218	1.141361



6/13/2003 Anadarko Basin NEIC 1534-2003

Locations of Earthquakes- Anadarko Basin



APPENDIX B.6

MAXIMUM CREDIBLE EARTHQUAKE AND SITE GROUND VIBRATORY MOTION FOR CRITICAL FAULTS

Maximum Credible Earthquake and Site Ground Vibratory Motion for Critical Faults

Fault ID*	Fault Length (km)	Distance from Site (km)	MCE (Slemmons, 1982, normal faults)	MCE (Slemmons, 1982, reverse faults)	Horizontal Acceleration at Site (Campbell, 1981) (g)	Comments
			#NUM!	#NUM!	#NUM!	
Faults Located Within 20 miles of Site						
103	42.1	1	7.0		0.661	Marble City fault, not capable
79	29.5	27	6.8		0.124	
53	28.3	31	6.8		0.108	
50	21.1	19	6.6		0.145	
22	18.6	23	6.5		0.120	
95	15.7	16	6.4		0.150	
37	15.2	25	6.4		0.100	
82	15.2	28	6.4		0.092	
81	14.4	20	6.4		0.121	
65	11.9	30	6.3		0.076	
49	11.0	19	6.2		0.115	
93	10.0	25	6.2		0.086	
85	9.7	19	6.2		0.109	
57	9.5	20	6.1		0.103	
52	9.3	31	6.1		0.068	
83	9.0	14	6.1		0.136	
58	8.8	23	6.1		0.085	
77	8.5	26	6.1		0.076	
78	8.5	20	6.1		0.097	
56	8.2	22	6.1		0.087	
31	7.9	29	6.0		0.066	
43	7.6	21	6.0		0.088	
76	7.5	30	6.0		0.063	
70	7.2	14	6.0		0.122	
74	6.6	32	5.9		0.056	
6	6.2	29	5.9		0.059	
24	6.2	25	5.9		0.069	
45	6.0	27	5.9		0.064	
72	5.8	23	5.9		0.071	
20	5.7	15	5.8		0.105	
80	5.5	29	5.8		0.056	
75	5.4	30	5.8		0.054	
39	5.3	14	5.8		0.108	
63	5.2	26	5.8		0.060	
48	5.1	28	5.8		0.056	
97	4.9	27	5.8		0.058	
62	4.8	28	5.7		0.055	
23	4.6	29	5.7		0.052	
18	4.6	14	5.7		0.105	
59	4.6	29	5.7		0.052	
99	4.4	8	5.7		0.168	South Fault of Warner Uplift
41	4.2	29	5.7		0.050	
27	4.0	20	5.6		0.070	
46	4.0	31	5.6		0.045	
73	3.9	30	5.6		0.047	
47	3.8	32	5.6		0.043	
66	3.7	18	5.6		0.075	

Maximum Credible Earthquake and Site Ground Vibratory Motion for Critical Faults

Fault ID*	Fault Length (km)	Distance from Site (km)	MCE (Slemmons, 1982, normal faults)	MCE (Slemmons, 1982, reverse faults)	Horizontal Acceleration at Site (Campbell, 1981) (g)	Comments
71	3.5	24	5.6		0.056	
35	3.4	13	5.5		0.095	
44	3.4	22	5.5		0.058	
42	3.2	20	5.5		0.062	
51	3.2	27	5.5		0.048	
69	3.2	14	5.5		0.087	
38	3.1	26	5.5		0.049	
26	3.1	23	5.5		0.054	
33	3.1	9	5.5		0.132	
29	3.1	26	5.5		0.048	
68	3.0	12	5.5		0.100	
Hypothetical	3.0	8	5.5		0.137	
Faults Located Within 50 Miles of Site						
102	32.9	32	6.9		0.112	
105	25.9	39	6.7		0.085	
104	22.7	47	6.7		0.068	
110	18.9	79		6.9	0.049	
111	18.1	73		6.9	0.052	
Hypothetical	18.1	32		6.9	0.112	
200	50.0	61	7.1		0.074	
201	29.4	61	6.8		0.059	
203	14.1	74	6.4		0.034	
204	12.4	76	6.3		0.031	
205	10.6	75	6.2		0.029	
202	10.5	63	6.2		0.035	
209	10.1	58	6.2		0.038	
207	8.5	76	6.1		0.026	
208	6.7	79	5.9		0.022	
206	4.1	69	5.7		0.020	
Faults Located Within 100 Miles of Site						
106	36.7	100		7.2	0.050	
108	36.2	135	6.9		0.029	
107	34.9	123	6.9		0.032	
113	26.8	94		7.1	0.048	
Hypothetical	26.8	80		7.1	0.055	
211	10.2	158		6.6	0.019	
216	109.7	145		7.8	0.054	
212	76.2	118		7.6	0.057	
210	88.7	102	7.4		0.059	
217	85.1	147		7.6	0.048	
215	61.6	119		7.5	0.052	
213	51.5	151		7.4	0.038	
214	23.3	105		7.0	0.040	
Faults Located Within 150 Miles of Site						
109	118.0	202	7.6		0.034	
114	35.6	173	6.9		0.022	
219	80.5	162		7.6	0.042	

Maximum Credible Earthquake and Site Ground Vibratory Motion for Critical Faults

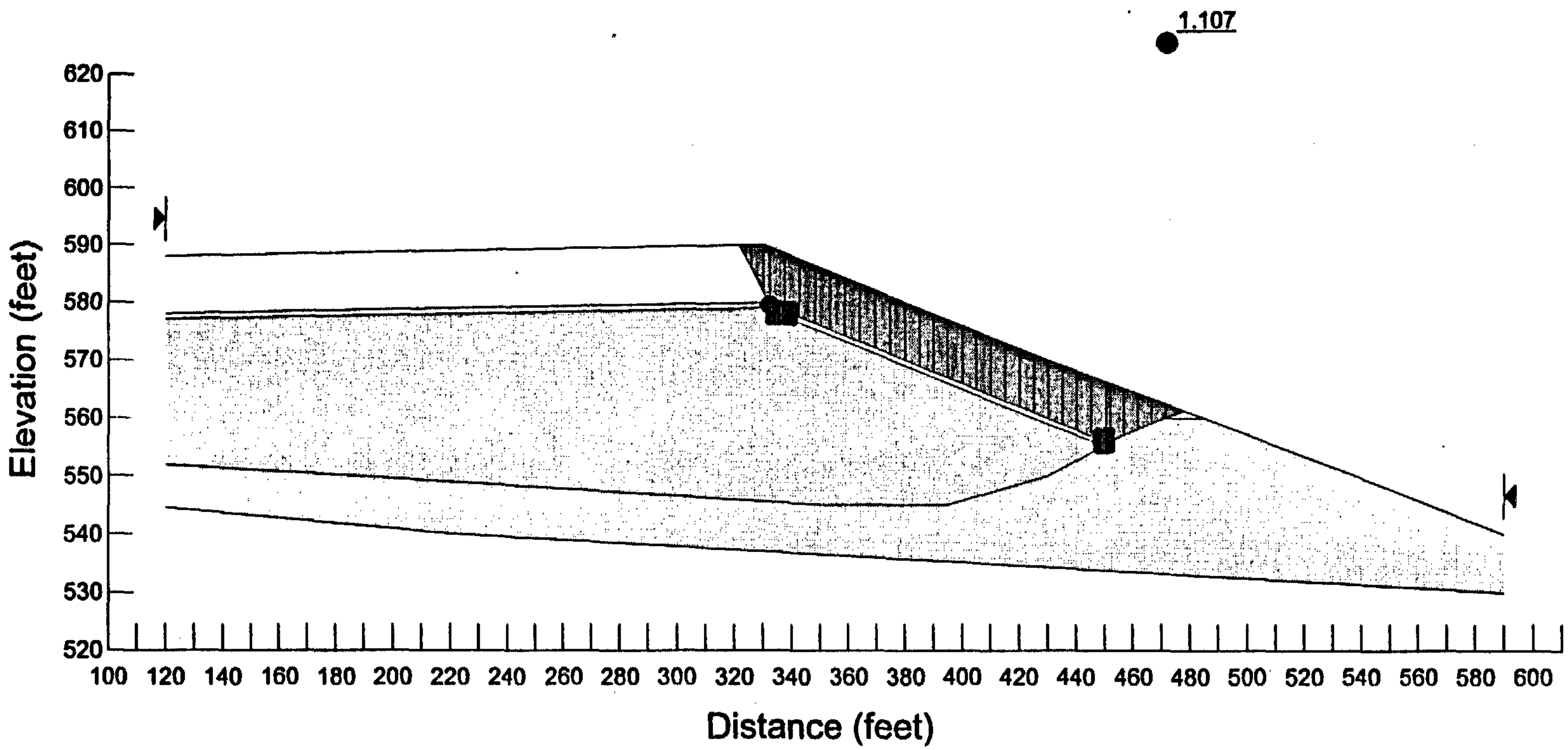
Fault ID*	Fault Length (km)	Distance from Site (km)	MCE (Slemmons, 1982, normal faults)	MCE (Slemmons, 1982, reverse faults)	Horizontal Acceleration at Site (Campbell, 1981) (g)	Comments
221	72.2	232	7.3		0.023	
220	39.3	190	7.0		0.021	
Humboldt	—	225.26	6.5		0.012	Humboldt
Faults Located Within 200 Miles of Site						
Meers Fault	54.0	306	7.2		0.015	Meers Fault

* Shown on Figures 3.3 through 3.7

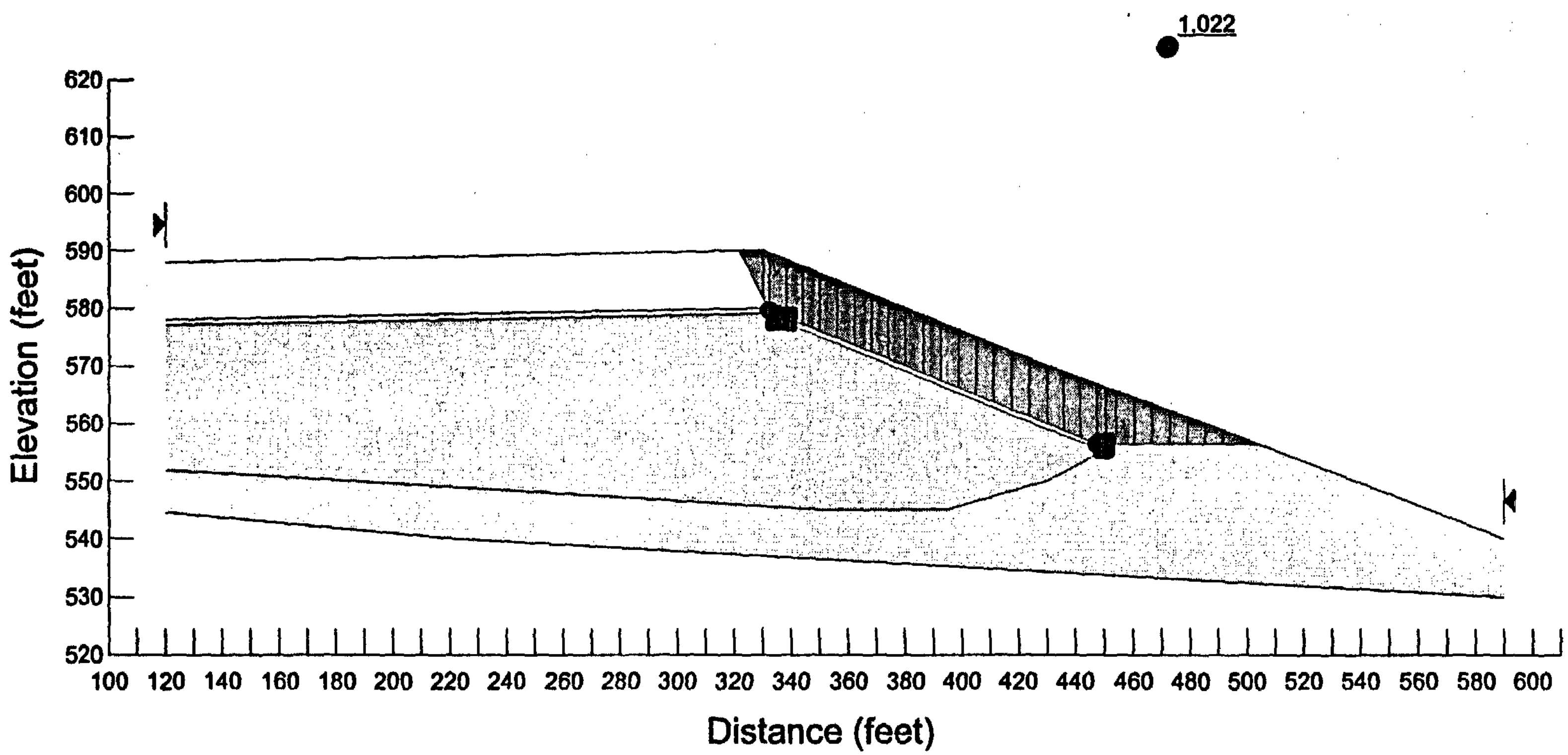
APPENDIX C

STABILITY OUTPUT

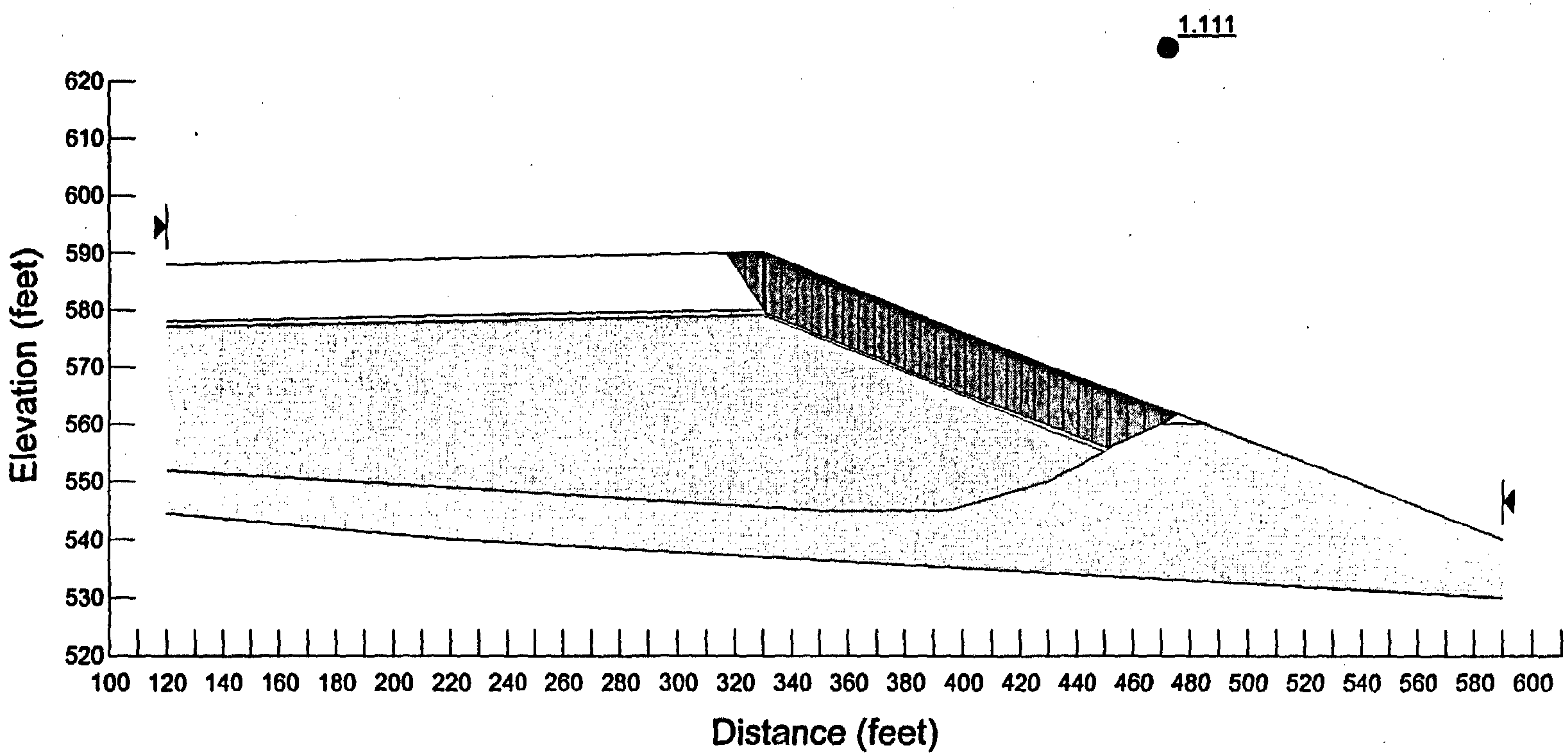
Description: Sequoyah Fuels
Comments: Disposal Cell - Critical Section 1
File Name: Seq1blockseismicyield.slz
Last Saved Date: 6/20/2003
Analysis Method: Spencer
Slip Surface Option: Block Specified
Seismic Coefficient: Horizontal0.19g



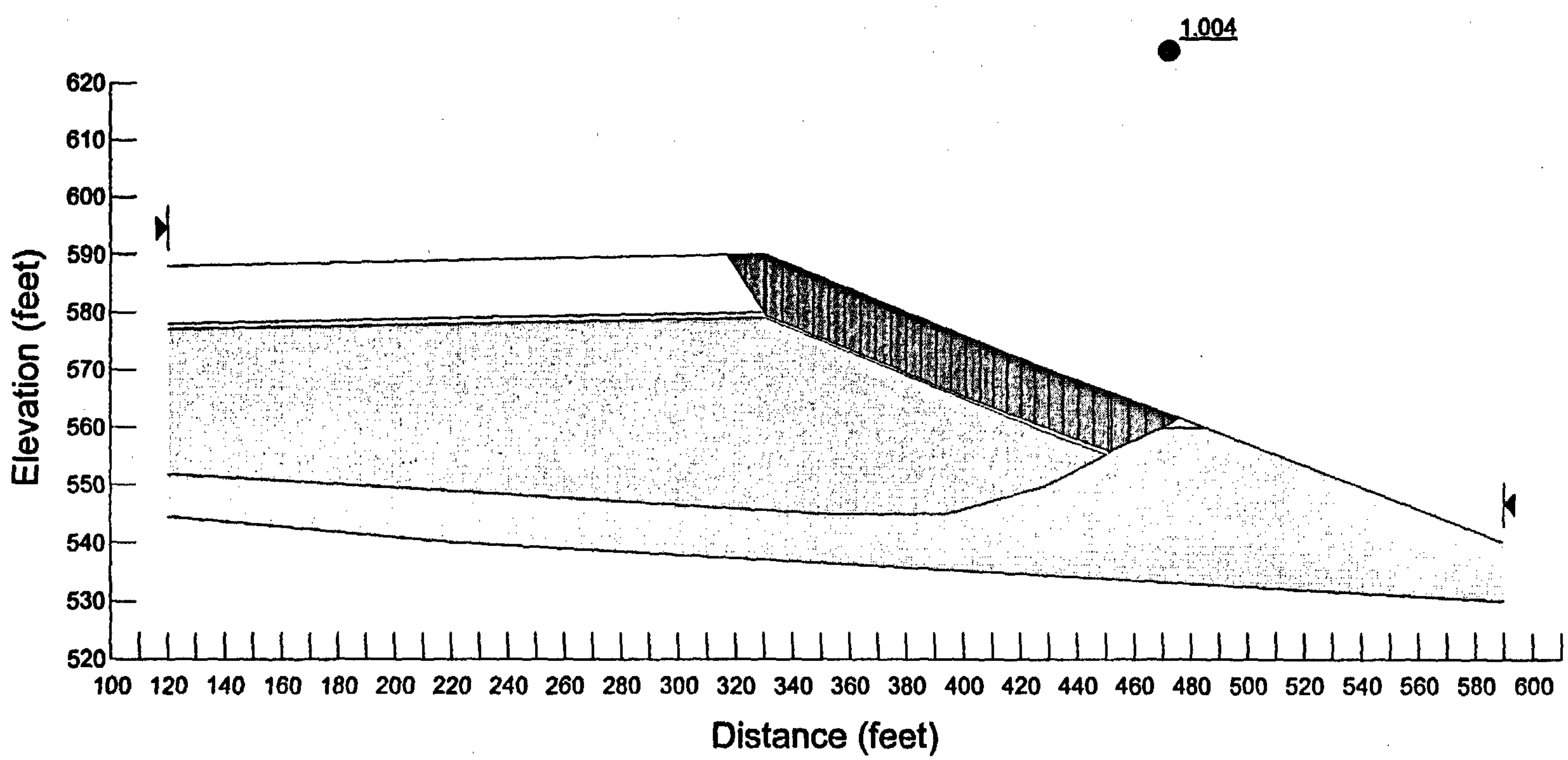
Description: Sequoyah Fuels
Comments: Disposal Cell - Critical Section 1
File Name: Seq1blockseismicyield.slz
Last Saved Date: 6/20/2003
Analysis Method: Spencer
Slip Surface Option: Block Specified
Seismic Coefficient: Horizontal 0.22g



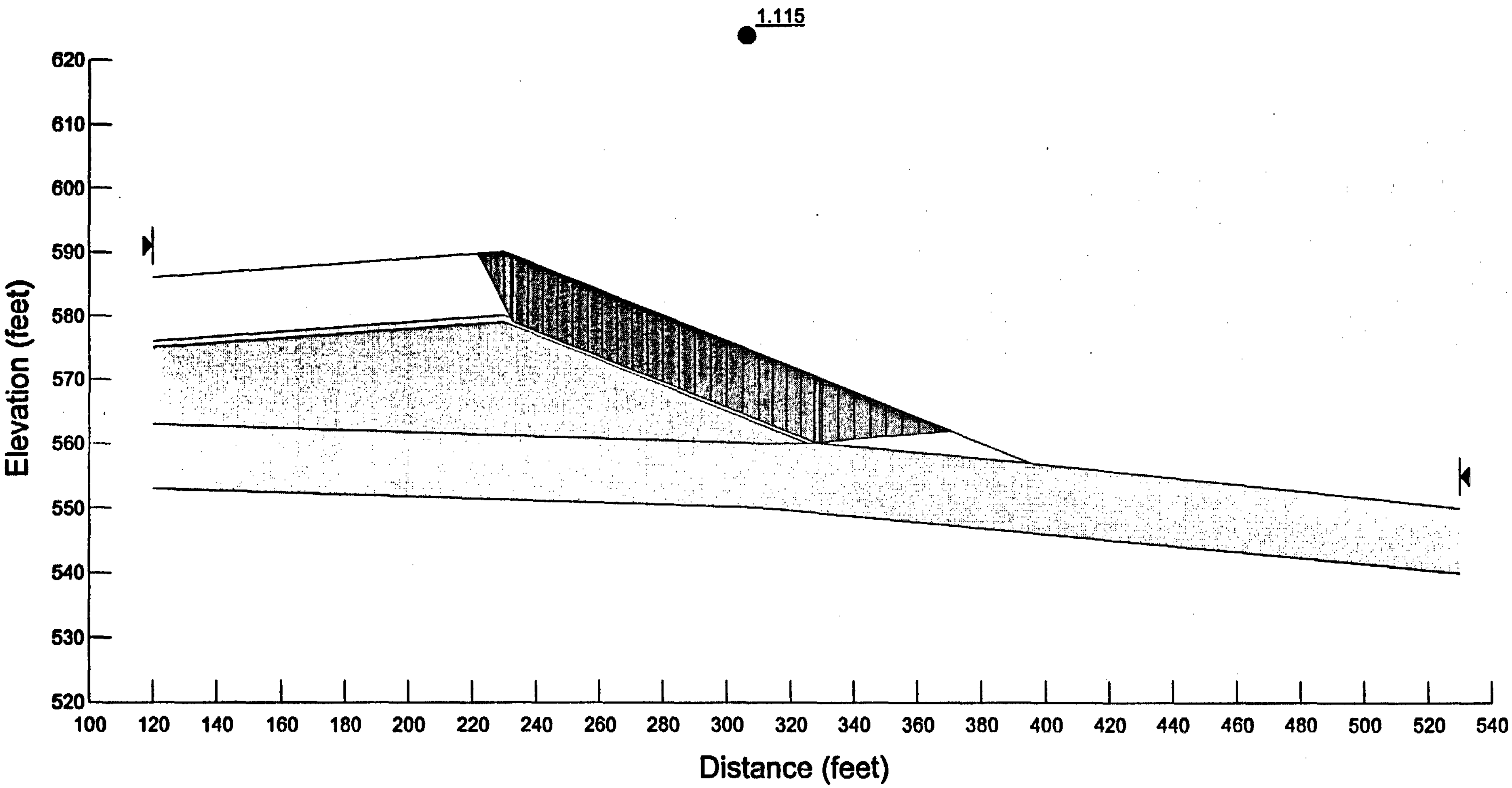
Description: Sequoyah Fuels
Comments: Disposal Cell - Critical Section 1
File Name: Seq1specifyseismicyield.slz
Last Saved Date: 6/20/2003
Analysis Method: Spencer
Slip Surface Option: Fully Specified
Seismic Coefficient: Horizontal 0.19g



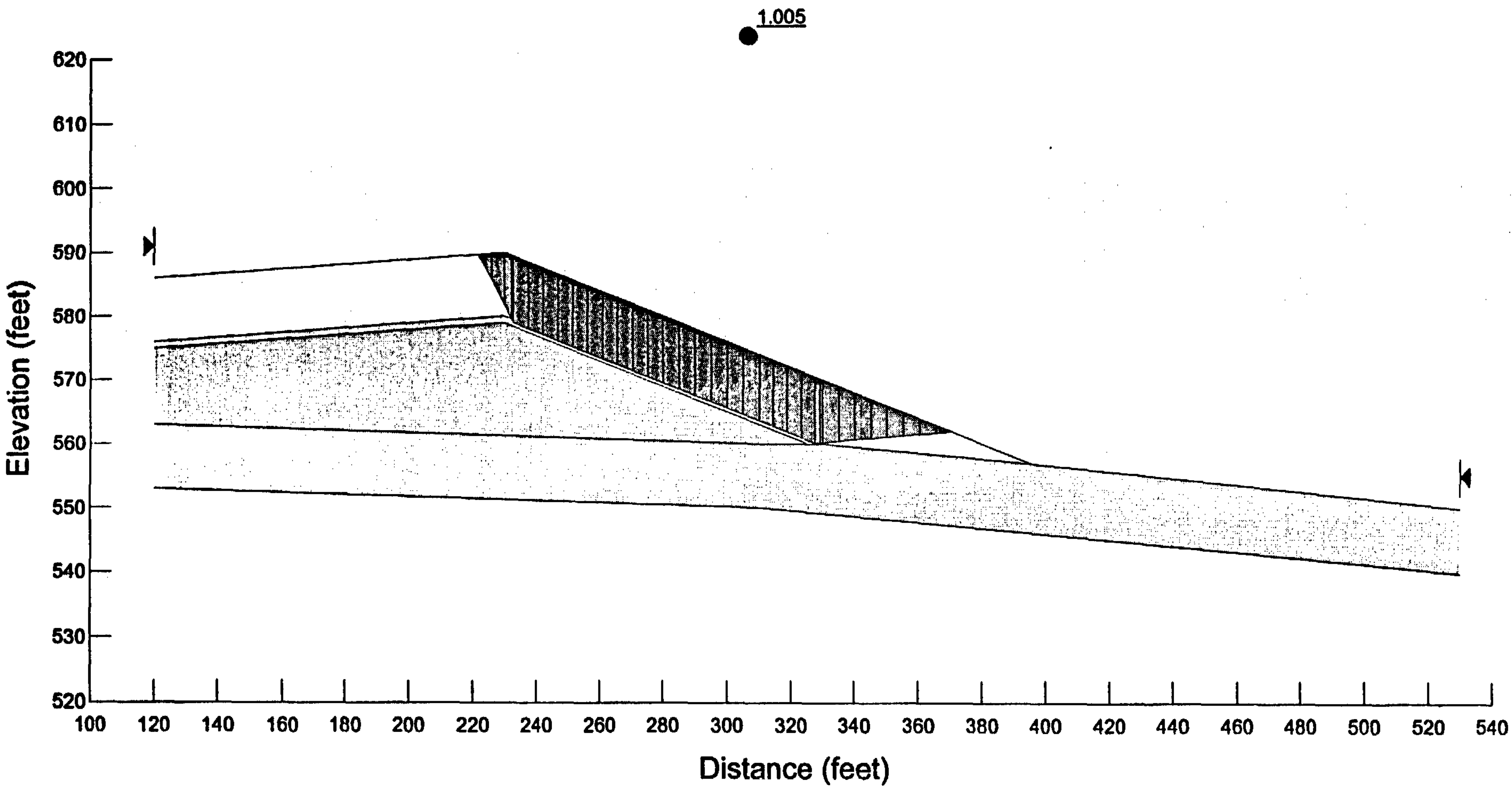
Description: Sequoyah Fuels
Comments: Disposal Cell - Critical Section 1
File Name: Seq1specifyseismicyield.slz
Last Saved Date: 6/20/2003
Analysis Method: Spencer
Slip Surface Option: Fully Specified
Seismic Coefficient: Horizontal 0.23g



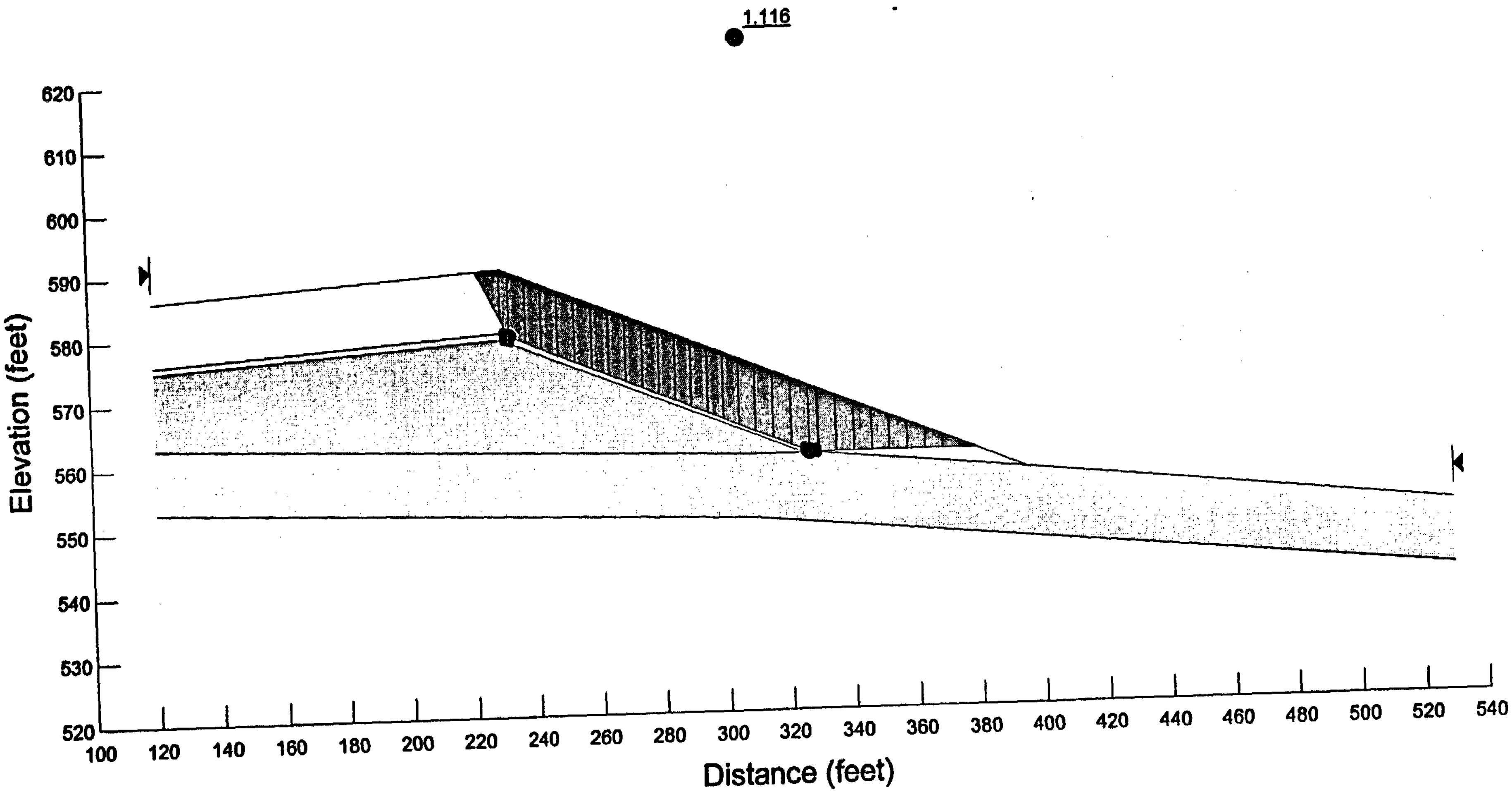
Description: Sequoyah Fuels
Comments: Disposal Cell - Critical Section 2
File Name: Seq2fseismicyield.slz
Last Saved Date: 6/20/2003
Analysis Method: Spencer
Slip Surface Option: Fully Specified
Seismic Coefficient: Horizontal 0.19g



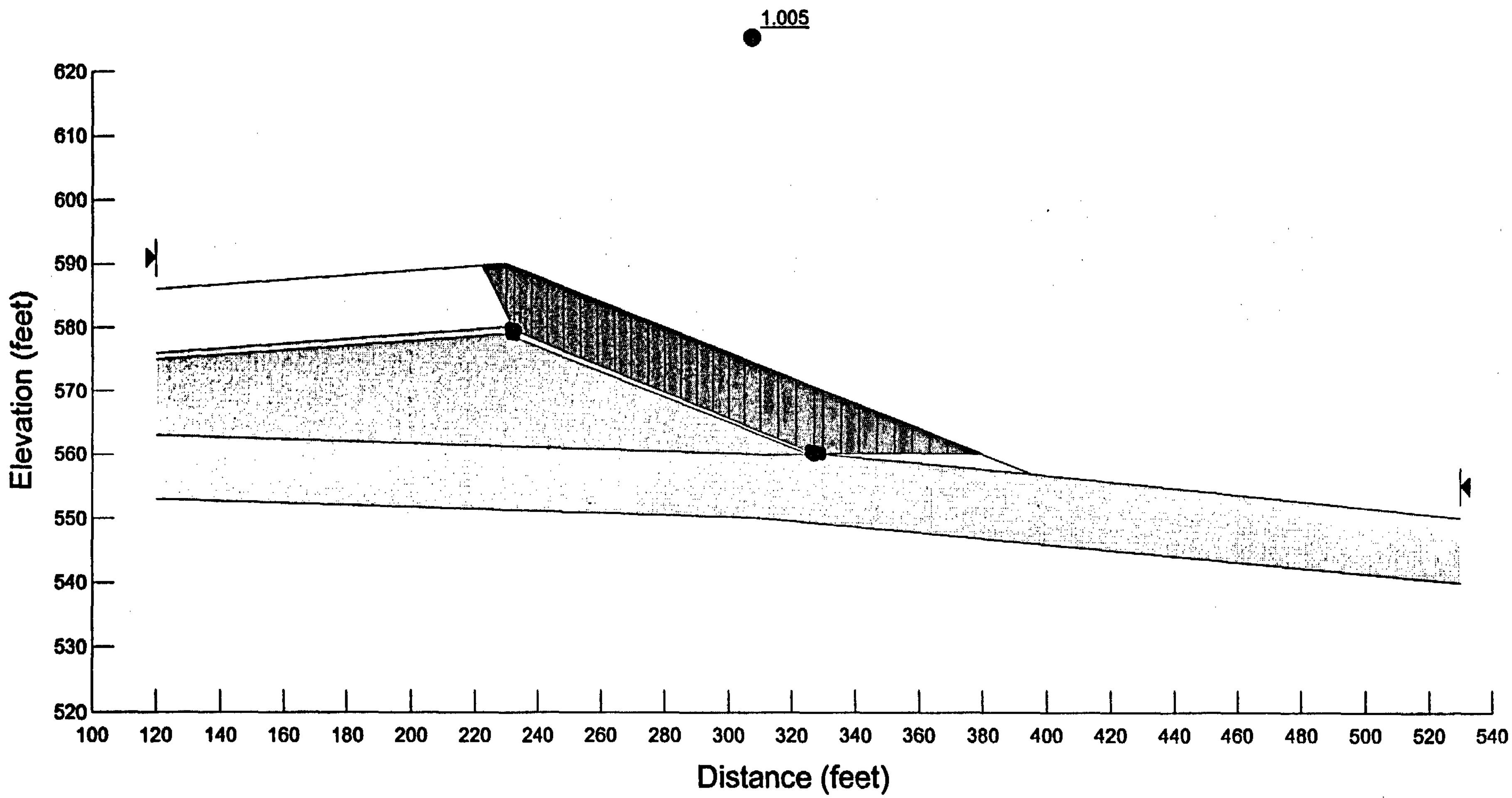
Description: Sequoyah Fuels
Comments: Disposal Cell - Critical Section 2
File Name: Seq2fseismicyield.slz
Last Saved Date: 6/20/2003
Analysis Method: Spencer
Slip Surface Option: Fully Specified
Seismic Coefficient: Horizontal 0.23g



Description: Sequoyah Fuels
Comments: Disposal Cell - Critical Section 2
File Name: Seq2blockseismicyield.slz
Last Saved Date: 6/20/2003
Analysis Method: Spencer
Slip Surface Option: Block Specified
Seismic Coefficient: Horizontal0.19g



Description: Sequoyah Fuels
Comments: Disposal Cell - Critical Section 2
File Name: Seq2blockseismicyield.slz
Last Saved Date: 6/20/2003
Analysis Method: Spencer
Slip Surface Option: Block Specified
Seismic Coefficient: Horizontal0.23g



APPENDIX D

PREVIOUS NRC CORRESPONDENCE

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 23, 1997

Mr. John H. Ellis, President
Sequoyah Fuels Corporation
P.O. Box 610
Gore, Oklahoma 74435

SUBJECT: TRANSMITTAL OF QUESTION RELATED TO SEISMIC CONDITIONS NEAR YOUR SITE

Dear Mr. Ellis:

During the scoping process for the environmental impact statement (EIS) for the remediation of your facility, and in subsequent public meetings, the question of potential for seismic activity in the area was raised. Therefore, as part of the EIS, the Nuclear Regulatory Commission will consider this potential in evaluating remediation alternatives. This is consistent with the opinion expressed by Sequoyah Fuels Corporation (SFC) that the criteria of Appendix A to 10 CFR Part 40 are applicable to the SFC facility because of the similarity between the materials at SFC and those at mill tailing sites. While it is clear that SFC does not have mill tailings as defined in the Atomic Energy Act Section 11(e)(2), NRC will evaluate the applicability of the technical criteria of Appendix A to SFC in the development of the EIS.

Preliminary evaluation of the Marble City and Carlile School faults by NRC staff indicates that we do not have sufficient information to determine the potential for movement of these faults. Therefore, in accordance with the criterion in 10 CFR 40, Appendix A, which addresses seismicity, NRC needs to determine if these faults are capable, as defined in 10 CFR Part 100, Appendix A. To assist us in this determination, we request answers to the enclosed questions. Please provide a response within 90 days of the date of this letter.

If you have any questions on this matter, please contact Jim Shepherd at 301-415-6712.

Sincerely,

John W. N. Hickey, Chief
Low-Level Waste and Decommissioning
Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Docket 40-8027
License SUB-1010

Enclosure: As stated

cc: SFC distribution list

NRC QUESTIONS ON FAULTS NEAR THE SEQUOYAH FUELS SITE

- Geologic Stability Issue - Capable Fault

Question 1. Are any of the faults mapped at or near the site capable faults (e.g., Carlile, Marble City, South Fault of Warner Uplift, unnamed faults, or their splays or 'parents')? Explain.

Question 2. Are any of the basement (blind) faults at or near the site capable faults? Explain.

Question 3. a) Is there any seismic activity associated with these faults? Explain.

b) What is the seismic history of the area within 100 km of the site? Explain.

- Geomorphic Stability Issue - Mass Movement

Question What is the potential for mass movement, such as landslide, earthflow, slumping and the like, to significantly affect erosion- or radon-protection barriers over the next 1000 years? Explain.

The responses should contain all documentation necessary to enable a reviewer to unambiguously determine how the conclusions were reached. Details of the bases for assessments of potential hazards made by SFC that were considered and found to be either significant or of little consequence should be transparent to a reviewer. Investigations and assessments should be conducted to the extent practicable.

The demonstration of whether or not a fault is a capable fault is based on four criteria (10 CFR Part 100, Appendix A). If any of the criteria is present, the fault is a capable fault if it: 1) moved at least once in the last 35,000 years; 2) moved at least twice in last 500,000 years; 3) is structurally related to a known capable fault; and 4) is associated with seismicity (discussed under seismic hazard issue). Generally, a literature search does not yield sufficient direct evidence about the age of movement or structural connectivity of specific faults. Hard evidence must be provided for each candidate active fault. Traditionally, the tools of the trade on

this matter include field or photo observation of outcrops or trench exposures that show faults offsetting or covered by Quaternary deposits; borehole logs correlating dated materials that cover or are offset by faults; seismic reflection surveys across faults; geomorphic evidence of fault activity; alignment of hypocenters of recorded earthquakes; and paleoseismic effects, such as sand boils. NRC staff's preliminary review of available SFC documents did not identify sufficient bases for concluding that the Carlile Fault or other faults near the site are or are not capable faults.

The evaluation of mass movement hazard potential similarly requires hard evidence derived from field and photo observations. NRC staff's identification of a potential mass-movement hazard is based on the significant topographic relief and proximity of head walls of gullies to the proposed facilities on site. Surficial masses of rocks and sediments that are actively moving down slope are generally detectable by direct observation of well-known clues. Rocks and soils subject to such movements in any given region are well known by local geologists. Such material in and near a site can be tested or monitored. The boundaries of unstable masses or zones that might become unstable in the next 1000 years that are in a position to affect erosion- or radon-protection barriers may be readily mapped.

REFERENCES:

U.S. Code of Federal Regulation, Part 100, Appendix A, Title 10,"Energy."

U. S. Nuclear Regulatory Commission, *"Final Standard Review Plan for the Review and Remedial Action of Inactive Mill Tailings Sites Under Title I of the Uranium Mill Tailings Radiation Control Act, Revision 1,"* June 1993.

SEQUOYAH FUELS
A GENERAL ATOMICS COMPANY

RE: 9746-N

July 22, 1997

Certified Mail
Return Receipt Requested

Mr. John W. N. Hickey, Chief
Low-Level Waste and Decommissioning
Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: License SUB-1010; Docket No. 40-8027
Response to NRC Questions Related to Seismic Conditions Near The Sequoyah Facility

Dear Mr. Hickey:

Your letter dated April 23, 1997 transmitted NRC Staff questions concerning seismic conditions surrounding the Sequoyah Fuels Corporation (SFC) Facility located near Gore, Oklahoma. You requested that SFC respond to these questions within 90 days. I have enclosed SFC's response to the Staff's questions with this letter.

SFC has submitted information about the structural geology and seismic conditions at its facility on previous occasions as a result of applications for license renewal, a license amendment request, and site characterization for decommissioning. The NRC has access to this information on SFC's docket. Since reference have been made in the enclosed response to additional materials that may not be readily accessible to your staff, I have enclosed those materials as attachments to the response.

HIGHWAY 10 & I-40 PO BOX 610, GORE, OKLAHOMA 74435 (918) 489-5511 FAX: (918) 489-2291

Should you or your staff have questions with regard to the enclosed response during the course of your review, please contact Kenny Schlag at (918) 489-3307 or Craig Harlin at (918) 489-3386.

Sincerely,

John H. Ellis
President, SFC

XC: James C. Shepherd, NRC NMSS/LLDR (without attachments)
Alvin Gutterman, Morgan, Lewis & Bockius (without attachments)

Response to NRC Questions Related to Seismic Conditions Near the Sequoyah Facility

Geologic Stability Issue - Capable Fault

Question 1

Are any of the faults mapped at or near the site capable faults (e.g. Carlisle, Marble City, South Fault of Warner Uplift, unnamed faults, or their splays or parents')? Explain.

Response

None of the faults mapped at or near the Facility are believed to be capable faults as described in 10 CFR Part 100, Appendix A.

The Facility geology is discussed in detail in the Draft Site Characterization Report[1]. In summary, the Facility is located on the southwest flank of a large tectonic feature known as the Ozark Uplift[2]. Bedrock formations present in the region consist of Pennsylvanian, Mississippian, Devonian, Silurian and Ordovician-aged shale, limestone, siltstone and sandstone formations (>300 million years old). The geological formations regionally dip to the southwest at one to four degrees toward another tectonic feature known as the Arkoma Basin. The horst and graben type faulting found in the area are normal faults which suggest that tensional forces have been responsible for their formation[3].

The planes of the various faults are not exposed at the surface, however, some are visible in highway cuts and others are revealed by low hummocky parallel ridges which stretch across pasture lands. Quaternary-aged terrace deposits and alluvial material cover most all of the Atoka Bedrock in the area except where streams and manmade activity has exposed portions of bedrock. There is no direct evidence that any of the faults mapped near the Facility extend from the bedrock into these Quaternary-aged terrace deposits which suggests any fault movement was prior to the deposition of these terrace deposits (>1 million years).

---

[1]Sequoyah Fuels Corporation, Draft Site Characterization Report, February 2, 1996, Docket 40-8027.

[2]J. K. Arbenz, Tectonic Map of Oklahoma Showing Surface Structural Features, 1956. (Attachment 1)

[3]J. G. Blythe, Atoka Formation On The North Side Of The McAlester Basin, pp 36-37, Oklahoma Geological Survey, Circular 47, 1959. (Attachment 2)

Question 2

Are any of the basement (blind) faults at or near the site capable faults? Explain.

Response

None of the basement faults mapped at or near the Facility are believed to be capable faults as described in 10 CFR Part 100, Appendix A.

The known basement faults mapped below the Atoka Formation are in the Arbuckle Formation. Some of these faults were discussed as possible hydrologic barriers in the Class I Injection Well Data Evaluation Report[4]. In fact, some faults mapped in the Arkoma Basin to the south of the Facility which transect Mississippian and older units apparently do not cut Atoka strata. These basement faults therefore, are a result of movements which occurred in Mississippian and in early Desmoinesian time (>320 million years)[5]. For most recorded seismic activity in the state, the focal depth is unknown. All available evidence indicates that no Oklahoma hypocenters have occurred deeper than 15-20 km[6].

Question 3

a) Is there any seismic activity associated with these faults? Explain.
b) What is the seismic history of the area within 100 km of the site? Explain.

Response

a) There is no evidence of seismic activity associated with any faults in the Ozark Uplift in Eastern Oklahoma.

The Oklahoma Geological Survey Observatory (OGS) in Leonard, Oklahoma, routinely tracks eleven seismic stations across the state. This data, managed by the Observatory in Leonard, shows no evidence that the observed earthquake hypocenters are in any way connected to the tensional faults mapped in the area. The OGS has concluded in a publication entitled the Oklahoma

---

[4]Roberts/Schornick and Associates, Final Class I Injection Well Data Evaluation Report, Sequoyah Fuels Corporation, April 4, 1995, Docket 40-8027.

[5]J. G. Blythe, Atoka Formation On The North Side Of The McAlester Basin, p. 36, Oklahoma Geological Survey, Circular 47, 1959.

[6]J. E. Lawson, Jr. and K. V. Luza, Oklahoma Earthquake Catalog, pp. 17, 18, Oklahoma Geological Survey, 1995. (Attachment 3)

Earthquake Catalog[7] that there has been little tectonic activity in this area since late Pennsylvanian time. The Earthquake Map of Oklahoma[8] shows the majority of seismic activity in Oklahoma occurring in the central portion of the state.

b) The seismic history of the area has been documented by the OGS in the Oklahoma Earthquake Catalog which presents the earthquakes that have been felt in Oklahoma from 1882 to 1994. A portion of this historical earthquake data was submitted in response to a similar information request by the NRC in 1983[9]. The NRC reviewed this data and published their conclusions in NUREG 1157[10]. A probabilistic acceleration map and seismic risk map are also included in NUREG 1157. Additional information on earthquakes in Oklahoma can be found on the internet (see Internet Sites in the References).

Geomorphic Stability Issue - Mass Movement

<u>Question</u>

What is the potential for mass movement, such as landslide, earthflow, slumping and the like, to significantly affect erosion - or radon protection barriers over the next 1000 years? Explain.

<u>Response</u>

There is very little potential for mass movement of earthen material at the Facility over the next 1000 years.

The Facility is situated on relatively flat lying bedrock. The topographic relief relative to the proposed disposal cell is depicted on Figure 1[11] which is attached. The regional

---

[7]J. E. Lawson, Jr. and K. V. Luza, Oklahoma Earthquake Catalog, p. 4, Oklahoma Geological Survey, 1995.

[8]J. E. Lawson, Jr. and K. V. Luza, Earthquake Map of Oklahoma (Map GM-35), Oklahoma Geological Survey, 1995. (Attachment 4)

[9]Kerr McGee Nuclear Corporation, Responses to U.S. Nuclear Regulatory Commission Site Visit Information Requests, Questions 38, August 19, 1983, Docket 40-8027.

[10]U. S. Nuclear Regulatory Commission, Environmental Assessment for Renewal of Special Nuclear Material License No. SUB-1010, Sequoyah Fuels Corporation, Docket No. 40-8027, NUREG-1157, August 1985.

[11]Sequoyah Fuels Corporation, Draft Decommissioning Alternatives Study Report, Appendix C, December 17, 1996, Docket 40-8027.

dip of the bedrock is to the southwest at one to four degrees[12]. The natural sandstone and shale sequences appear to be very stable when exposed. There is no visible evidence of natural sloughing or major fracturing at or near the Facility which would indicate a potential for mass movement of the physical structures at the site. In particular, the drainage area which makes the closest approach to the proposed disposal cell, designated as Outfall 005, is heavily vegetated along the entire drainage and shows no signs of mass movement even on the most pronounced relief. This is consistent with the rock and soil structure in this region where surficial masses are not prone to such movements.

The engineered controls of the Robert S. Kerr Navigational System (Arkansas River) as well as Lake Tenkiller Dam (Illinois River) reduce the risk from major catastrophic flooding which could alter loose, exposed bedrock along the river systems. However, any slope failure due to flooding would be limited to the immediate area along the river banks.

The disposal cell will be designed to avoid the affects on performance due to mass movement such as landslides and earth-type failures of manmade embankments according to published regulatory guidance and industry standards.

---

[12]Sequoyah Fuels Corporation, Draft Site Characterization Report, February 2, 1996, Docket 40-8027.

Additional References

J. E. Lawson, Jr. and K. V. Luza, Oklahoma Earthquakes, 1995, Oklahoma Geology Notes, Vol. 56, No. 2, April 1996. (Attachment 5)

J. E. Lawson, Jr., Expected Earthquake Ground-Motion Parameters at the Arcadia, Oklahoma, Dam Site, Special Publication 85-1, 1985. (Attachment 6)

R. L. DuBois, Seismic Risk in Oklahoma, May 5, 1972, Earth Sciences Division, University of Oklahoma, August 19, 1983, Docket 40-8027.

Service Testing Laboratory, Report of Atterberg Limits, Shrinkage Limits, Unconfined Compression, and Compression Tests, August 19, 1983, Docket 40-8027.

US Nuclear Regulatory Commission, Final Environmental Statement related to the Sequoyah Uranium Hexafluoride Plant, NUREG-75/007, February 1975, Docket 40-8027.

D. L. Warner, Environmental Assessment Related to Proposed Deep Well Injection of Liquid Raffinate At The Kerr McGee Sequoyah Facility, Oklahoma, March 1983, Docket 40-8027.

Sequoyah Fuels Corporation, Responses to EPA Comments on the Final Class I Injection Well Report, July 7, 1996, Docket 40-8027.

Internet Sites

gopher://wealaka.okgeosurvey1.gov/, Oklahoma Geological Survey gopher server

www.ou.edu/special/ogs-pttc, Oklahoma Geological Survey web site

http://geology.cr.usgs.gov/, US Geological Survey web site for the central region

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

RECEIVED
DEC 22

December 15, 1997

Mr. John H. Ellis, President
Sequoyah Fuels Corporation
P. O. Box 610
Gore, Oklahoma 74435

SUBJECT: NUCLEAR REGULATORY COMMISSION STAFF'S EVALUATIONS OF SEQUOYAH FUEL CORPORATION'S RESPONSE TO NRC'S QUESTIONS RELATED TO SEISMIC CONDITIONS NEAR THE SEQUOYAH FACILITY

Dear Mr. Ellis:

The staff has reviewed your response of July 22, 1997, to Nuclear Regulatory Commission's (NRC's) questions on seismic conditions in the vicinity of the Gore, Oklahoma site. Following the requirements in Part 40, the staff found that Sequoyah Fuel Corporation (SFC) staff did not provide sufficient information about the tectonic characteristics of the site. In order to fully evaluate the potential for activity along the faults near the site and to ensure that related issues of geologic stability and seismicity required by Part 40 will be met, the licensee needs to provide a complete evaluation of the tectonic setting and seismicity of the site. Specific questions and comments are in the enclosure.

Based on staff experience with similar concerns for geologic and seismicity issues, the SFC site characterization effort required would be routine. We recommend that SFC staff meet with NRC staff to discuss and plan a program of investigation and ensure that the planned program will be adequate and the information collected will be appropriate for complete characterization of the site.

If you have any questions, please contact Jim Shepherd of my staff at (301)415-6712.

Sincerely,

John W. N. Hickey, Chief
Low-Level Waste and Decommissioning
Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Docket 40-8027
License SUB-1010

Enclosures: As stated

Enclosure

NRC STAFF COMMENTS ON SEQUOYAH FUEL CORPORATION RESPONSE TO APRIL 23, 1997, QUESTIONS RELATED TO SEISMIC CONDITIONS

Reference: "Response to NRC Questions Related to Seismic Conditions Near the Sequoyah Facility - License SUB01010; Docket No. 40-8027" from J.H. Ellis, Sequoyah Fuel Corporation (SFC), to J.W.N. Hickey, NRC, dated July 22, 1997

BACKGROUND

STAFF PRELIMINARY ANALYSIS OF SEISMICITY AT THE SEQUOYAH FUEL CORPORATION FACILITY

NRC staff has performed a preliminary review of the seismic activities at the Sequoyah site. On the basis of this review, the staff concludes that the Sequoyah area appears to have a lower level of historical seismicity than the central area of Oklahoma around El Reno, and, therefore, the seismic hazard at Sequoyah is likely to be less than that at central Oklahoma. Earthquakes detected and located by the Oklahoma Geological Survey (OGS), during the period 1882 to 1994, are listed in the Oklahoma Earthquake Catalog (Lawson and Luza, 1995). A plot of the earthquakes from 1897 to 1995 is shown in Figure 1. This figure shows that, in an area of 50 km radius centered around SFC, the seismic activity is low.

The largest event in Oklahoma occurred on April 9, 1952, in north central Oklahoma and has a magnitude of 5.5. The earthquake activities around this area appear to be concentrated in a zone 40 km wide by 145 km long that extends northeast from El Reno. This zone is about 275 km from SFC. Another concentration of earthquake sources in the Anadarko basin has occurred within a 135 km long by 40 km wide zone situated between Canadian County and the south edge of Garvin County. Earthquake activity along the Amarillo-Wichita uplift and the associated fault zone seems to be very quiet compared to those at El Reno and Garvin County. In the Arkoma basin and Ozark Uplift, earthquake data produce a broad pattern of epicenter locations.

On September 6, 1997, an earthquake of magnitude 4.4 was recorded 1.5 km north of Topelo, Oklahoma. The earthquake was felt in the Ada area, Norman, and Oklahoma City. The earthquake epicenter is located about 80 km from the SFC site. If this earthquake is not associated with a tectonic feature, it should be considered as a floating earthquake and the ground motion acceleration should be estimated at the SFC site.

On June 20, 1926, an earthquake of magnitude 4.3 occurred in Sequoyah County; the resulting ground motion acceleration from this earthquake should be estimated and provided by SFC.

The staff preliminarily concludes, after examining the earthquake history in the area, talking with Dr. James Lawson, Jr., of OGS, examining the Oklahoma earthquake maps on the Internet (1997), and assuming no capable faults exist within the site area, that the site area of the SFC

could be considered as a low-seismic activity area. Meanwhile, a large ground motion acceleration could be generated if any of the following faults is a capable fault: Carlile Fault, the Marble City Fault, or the South Fault of Warner Uplift.

Question 1

Are any of the faults mapped at or near the site capable faults (e.g., Carlile, Marble City, South Fault of Warner Uplift, unnamed faults, or their slays or parents)? Explain.

Comment on SFC's Response

The basis provided by SFC to support its key response statement, "There is no direct evidence that any of the faults mapped near the Facility extend from the bedrock into these Quaternary-aged terrace deposits which suggests any fault movement was prior to the deposition of these terrace deposits (>1 million years).", is inadequate for the staff to reach a conclusion that none of the faults is a capable fault.

Basis for Comment

(a) One criterion for identification of a capable fault is the observation that it moved once in the last 35,000 years or more than once in the last 500,000 years (10 CFR Part 100, Appendix A). SFC has not described any site investigation that bears on this criterion. For example, SFC has not provided evidence that the Quaternary (the last 2,000,000 years) deposits that cover the faults are known to not have been disturbed by movement on the faults. More precisely, SFC has not provided evidence of the age of the terrace deposits, for example, at locations on or adjacent to the site, sufficient to determine whether or not such sediments have been undisturbed by faulting for the last 35,000 years or for whatever period of time their age represents.

(b) SFC has suggested that macroseismicity does not appear to be associated with the mapped faults on or near the site (SFC's response to Question 3a). This suggests that the faults may not be capable faults. However, the evidence presented, the sparse historical record in and of itself, is insufficient to assert categorically that the faults are not capable faults (see NRC comments in response to Question 3a).

(c) SFC has not presented evidence to the effect that the faults under consideration are or are not structurally related to faults known to be capable faults. Such evidence would be relevant to a determination of capable fault as discussed in 10 CFR Part 100, Appendix A.

(d) There appear to be faults known to exist beneath the site and near the site, some of which appear to be structurally connected (i.e., Carlile and unnamed E-W splay); there may be undetected additional buried or blind faults beneath the site [e.g., the buried channel identified in the Site Characterization Report (SCR)(1996), Fig. 14, could reflect an eroded bedrock fault or fracture zone]; at least one of the known faults has been utilized in subsurface groundwater tests (i.e., Carlile Fault); a scarp that could be a fault

scarp underlain by the Carlile Fault is veneered by Quaternary deposits (SCR, 1996, Fig. 10); and at least one of the faults that is mapped on the site (i.e., unnamed E-W splay along the southern site boundary) has not been shown on any site cross sections. [Point of clarification: What is the location of the Carlile Fault with respect to well #2332? See discrepant locations in SCR, Figs. 9 and 11, cf. 10, 15 and others.]

Recommendations

1) SFC should conduct additional geologic characterization of the faults to the necessary extent discussed in NRC's Standard Review Plan (1993), and DOE's Technical Approach Document (1989).

The purpose of the additional information is to provide an adequate basis for SFC to demonstrate, and for NRC to determine, that the faults are, or are not, capable faults. In addition, the location and geometry of the faults and splays on or adjacent to the site are of potential significance in understanding groundwater travel time and flow pathways.

2) SFC should consider meeting with staff to discuss SFC's plans to conduct necessary fault investigations prior to implementing its plans.

The purpose of such a meeting would be for staff to provide SFC with early feedback on the adequacy and sufficiency of the plans.

Question 2

Are any of the basement (blind) faults at or near the site capable faults? Explain.

Comment on SFC's Response

The basis provided by SFC to support its key statement, "None of the basement faults mapped at or near the Facility are believed to be capable faults as described in 10 CFR Part 100, Appendix A.", is inadequate for staff to reach a conclusion that none of the faults is a capable fault.

Basis for Comment

(a) SFC reasoned that some faults in the Arkoma Basin, south of the site, cut rocks older than the Atoka but do not cut the Atoka, and, therefore, some deep (basement) faults are much older than 320 million years and could not be capable faults. By implication, SFC suggested that at least some of the basement faults in and near the site are not capable faults. However, SFC has indicated that the Carlile Fault and the South Fault of Warner Uplift (SCR, 1996, Fig. 11) cut both the Atoka and some of the Arbuckle strata. Thus, these faults have not been precluded from consideration as capable faults.

(b) SFC has stated that "...no Oklahoma hypocenters have occurred deeper than 15-20 km,..." and, "...(f)or most recorded seismic activity in the state, the focal depth is unknown." It is not clear how these observations support a conclusion that basement

faults at or near the site are not capable faults.

(c) SFC has submitted evidence that geologic structures, (e.g., individual faults, fault systems, tilted fault blocks, regional unconformity of Paleozoic on Precambrian granitic rocks, and a regional synclinal fold) occur within 10 kms of the site and beneath the site (SCP, 1996, Fig. 11; Tectonic Map of Oklahoma, 1956). However, SFC documents do not tie such features to a tectonic model that might support its view that the faults are not capable faults. Also, some of the tectonic features are not shown on site maps, in particular, the E-W trending splay of the Carlile Fault is not shown on hydrologic maps. SFC indicates in its structural cross section (ibid., Fig 11) that the Carlile and South Fork of Warner Uplift Faults are not rooted in the granitic basement. The origin and history of activity of these faults is not clear.

Recommendations

1) SFC should examine whether or not the surface faults are structurally connected to granitic basement and clearly describe their geological relationship and history of their activity.

The purpose of this information on potential relationship of the known faults to deep basement features is to support a determination of whether or not the faults are capable faults, and a determination of the size of the earthquake that could be generated if they are capable faults.

(2) SFC should consider meeting with staff to discuss SFC's plans to assess the seismic potential of the known faults (i.e., are they capable faults).

The purpose of such a meeting is for staff to provide early feedback to SFC on the adequacy and sufficiency of its plans.

Question 3

a) Is there any seismic activity associated with these faults? Explain.

SFC's Response

The applicant responded to NRC's question stating that, "There is no evidence of seismic activity associated with any faults in the Ozark Uplift in Eastern Oklahoma." Examining the data managed by OGS, the applicant concluded that the observed earthquakes are not connected to the mapped faults in the area, and there has been little seismic activity in the Sequoyah area since late Pennsylvanian time.

Comments on SFC's Response

The staff examined the seismicity map around Sequoyah and found that the seismic activity in the area produced a broad pattern of epicenter locations, and there is no clear indication of alignment of seismic activity along the Carlile Fault, the Marble City Fault, or the South Fault of Warner Uplift. The lack of recent seismic activity along these faults is not conclusive evidence

that they are not capable faults. Also, it should be noted that the seismic history of the area is very short and the seismic instrumentations in the area have been installed recently.

Recommendation

The number and amount of slips and recurrence rate on the potentially capable faults within the site vicinity should be determined, if the faults are capable.

The purpose of this information is to estimate the earthquake magnitude which may be used to design the facility.

(b) What is the seismic history of the area within 100 km of the site? Explain.

SFC's Response

The applicant responded to this question by referring the staff to information submitted in 1983 and to probabilistic acceleration maps published in 1976 and 1990.

Comments on SFC's Response

The staff expected the applicant to provide recent information on the seismic activity in the area and discuss new seismic hazard maps. For example, the U.S. Geological Survey recently published new seismic hazard maps (National Seismic Hazard Mapping Project, 1997)--the applicant should update its information. Also, since the issuance of SFC's' response, there was an earthquake on September 6, 1997, which was felt at several locations in Oklahoma. What is the resulting acceleration from this earthquake at the site? Also, the applicant did not provide adequate information on the June 26, 1926, event that occurred in Sequoyah County and its resulting acceleration at the site.

In a response to a question from NRC staff regarding the ground motion design acceleration for the disposal cell, SFC (1996) refers the staff to a probabilistic seismic hazard map in the Draft Decommissioning Alternative Study Report (December 17, 1996) showing the horizontal acceleration at the site, with 90 percent probability of not exceeded in 50 years, is less than 5 percent of gravity. Meanwhile, in the Conceptual Design Report (December 6, 1996), the applicant uses a probabilistic seismic hazard map showing the horizontal acceleration at the site with 90 percent probability of not exceeded in 250 years. is 9 percent of gravity.

In 10 CFR Part 40, Appendix A, it is stated that the facility must control radiological hazard for 1000 years, to the extent reasonably achievable, and, in any case, for at least 200 years.

Recommendations

(1) Provide updated seismic information within 100 km of SFC, including recent events and recent seismic hazard maps.

(2) Identify the tectonic provinces surrounding the Sequoyah site and the associated maximum credible earthquake (floating earthquake) associated with each province and

estimate the corresponding acceleration at the site [Technical Approach Documents (TAD), Revision II, 1989]..

(3) Capable faults within 50 km radius of the SFC facility should be identified, and the associated magnitude and acceleration at the site should be estimated (TAD, Revision II, 1989).

(4) For the purpose of the seismic hazard evaluation, a 1000-year design life should be adopted (TAD, Revision II, 1989); and the applicant should state and provide the ground motion acceleration that will be used for the seismic design of the cell and the bases for choosing this value.

(5) The applicant needs to perform a new slope stability analysis based on the appropriate horizontal earthquake coefficient (EQC), ground motion acceleration (A), and the projected years of performance of the cell. In the Conceptual Design Report, the applicant equates EQC to A. It is believed that EQC = 2/3 A (Standard Review Plan, 1993).

The purpose of this information is to determine the ground motion acceleration needed for the design of the facility.

Question on Geomorphic Stability Issue - Mass Movement

What is the potential for mass movement, such as landslide, earthflow, slumping and the like, to significantly affect erosion - or radon protection barriers over the next 1000 years? Explain.

Comments on SFC's Response

The basis provided by SFC to support a key statement, "There is very little potential for mass movement of earthen material at the Facility over the next 1000 years." is inadequate for staff to reach a conclusion about the potential locations and rates of mass movements to affect the proposed disposal cell.

Additionally, another key statement, "The disposal cell will be designed to avoid the affects on performance due to mass movement such as landslides..." cannot be evaluated at this time because SFC has not identified what affects on performance due to mass movement it is considering for design.

Basis for Comments

(a) SFC has made pertinent and important observations, such as, "There is no visible evidence of natural sloughing or major fracturing at or near the Facility which would indicate a potential for mass movement..." and "...the drainage area which makes the closest approach to the proposed disposal cell..." is heavily vegetated along the entire drainage and shows no signs of mass movement...". However, no supporting documentation was provided with the response.

(b) The statement that the natural sandstone and shale sequences appear to be very stable when exposed is not documented.

(c) The statement that in the site region surficial masses are not prone to mass movements is not documented.

(d) SFC's statements regarding the reduced risk of flooding by engineered controls and slope failure being limited to the immediate area along the river_banks appear to be based on the assumption that the controls will be in effect and effective over the next 1000 years. The basis for this was not discussed.

Recommendations

(1) SFC should document its observations, measurements, and the supporting bases for its conclusion that there is very little potential for mass movement at the Facility over the next 1000 years. In particular, quantification of magnitude and rates at specific locations of heads-of-valleys with potential for encroachment on the facility's side slopes (for example, headward erosion by mass movement) are needed to support the conclusion. In this case, photographs, annotated maps, topographic profiles, or similar representations of observations/measurements and appropriate calculations would be appropriate. The general standard for adequate documentation would be that a knowledgeable reviewer would be able to reach the same or similar conclusions about the potential for mass movement over the next 1000 years.

The purpose of this recommendation is to provide staff the technical bases with which to resolve the issue.

(2) SFC should consider meeting with staff to discuss SFC's plans to address this request for documentation of data sufficient to resolve the issue.

The purpose of such a meeting is for staff to provide early feedback to SFC on the adequacy and sufficiency of its plans, i.e., to facilitate resolution of the issue.

References

J.H. Ellis, Sequoyah Fuel Corporation, "Decommissioning Alternative Study Report," letter to J.W. Hickey, U.S. Nuclear Regulatory Commission, October 18, 1996.

J.H. Ellis, Sequoyah Fuel Corporation, "Response to NRC Questions Related to Seismic Conditions Near the Sequoyah Facility," letter to J.W. Hickey, U.S. Nuclear Regulatory Commission, July 22, 1997.

Internet, "Gopher://wealaka.okgeosurvey1.gov," 1997.

Lawson E. James and Kenneth V. Luza, Oklahoma Earthquake Catalog, the University of Oklahoma, Norman, Oklahoma, 1995.

National Seismic Hazard Map Project, "Seismological Research Letters," Vol. 68, No. 1, January/February 1997.

Sequoyah Fuel Corporation, Site Characterization Report, February 1996.

"Standard Review Plan for the Review and Remedial Action of Inactive Mill Tailings Sites under Title I of the Uranium Mill Tailings Radiation Control Act, Revision I," U.S. Nuclear Regulatory Commission, June 1993.

U.S. Code of Federal Regulations, Part 100, Appendix A, Title 10, "Energy," 1997.

"Technical Approach Document, Revision II, ULTRA-DOE/ AL 050425.0002, December 1989.

SEQUOYAH FUELS
A GENERAL ATOMICS COMPANY

RE: 9823-N

April 8, 1998

Certified Mail Receipt No. Z 107 892 434
Return Receipt Requested

Mr. James C. Shepherd, Project Manager
Low-Level Waste and Decommissioning
Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: License SUB-1010; Docket No. 40-8027
Seismic Conditions Near the Sequoyah Facility

Reference: Letter from John W. N. Hickey to John H. Ellis dated December 15, 1997

Dear Mr. Shepherd:

In response to the referenced letter, SFC met with the NRC staff and toured the area surrounding the Sequoyah Facility. SFC has since completed several tasks identified at the meeting. I have enclosed two documents which describe the results of these tasks for your review.

The first task was to clear up some discrepancies in the geological maps submitted to NRC as part of the Site Characterization Report. The second task focused on determining whether the local faults are capable. SFC conducted a field study with the assistance of Dr. Roy Van Arsdale to determine if the Carlile School fault is a capable fault, and to recommend a course of action for SFC to pursue based on his findings.

In addition, SFC has met with or contacted the Corps of Engineers Tulsa District, the Oklahoma Department of Transportation, the Oklahoma Geological Survey, geologists who had worked at the Facility previously, petroleum geologists familiar with the area, seismic brokers, and a licensed geotechnical engineer to determine if any additional work had been done that might be useful. Useful data would have included reports or

HIGHWAY 10 & I-40 PO BOX 610, GORE, OKLAHOMA 74435 (918) 489-5511 FAX: (918) 489-2291

papers prepared during dam construction, bridge or highway construction, siting studies or petroleum related activities such as seismic reflection lines in the area. No information was found that would aid in understanding the seismic conditions at the Facility. However, SFC's review did locate seismic information contained within reports submitted to the NRC on Black Fox and Arkansas Nuclear One reactor sites that is relevant to the Sequoyah Facility which lies within the study area for both of these reactor sites. No capable faults were found in the Webber Falls area during these siting studies.

Once you and the NRC staff have had a chance to review this material, I would recommend that we hold a teleconference to discuss our findings. Please contact me at (918) 489-3386 to establish for such a meeting.

Sincerely,

Craig L. Harlin

Craig Harlin, Director
Regulatory Affairs

XC: Philip Justus, NRC NMSS/DWM/ENGB
Abou-Bakr Ibrahim, NRC NMSS/DWM/ENGB
Alvin Gutterman, Morgan, Lewis & Bockius

Regional Geology Relating to Seismic Conditions at the Sequoyah Facility

Introduction

In April 1997, Sequoyah Fuels Corporation (SFC) received a request for information related to the seismic conditions near the Sequoyah Facility. More specifically, SFC was asked to provide information needed to determine whether any of the faults mapped at or near the facility are capable faults (ie: the Carlile School fault and the Marble City fault). SFC responded in July 1997 by providing published literature, maps and references to previous NRC safety evaluations. Follow up questions from NRC resulted in a site tour by the reviewers and discussion of NRC's additional data requests including the resolution of inconsistencies between geological maps within the draft Site Characterization Report (SCR). On the seismic issue, the concern centers on whether the Carlile School fault is a capable fault or is connected to a capable fault. SFC subsequently retained Dr. Roy Van Arsdale, a specialist in neotectonics and paleoseismicity with field experience in Oklahoma, to respond to this concern (resume enclosed). SFC has also evaluated the various maps and associated databases and it is the purpose of this document to resolve questions about inconsistencies between the various geologic maps.

Discussion

Hugh Miser of the U.S. Geological Survey mapped the State of Oklahoma in 1954. Miser referenced a University of Oklahoma master's thesis written by Lyle W. Stewart as a basis for his interpretation of the southwestern portion of Sequoyah County. We were unable to locate this thesis to confirm how the faults in the area were originally mapped. The University of Oklahoma main library and geologic library were searched and no record exists that this thesis was ever completed or even conducted. Furthermore, no record of enrollment could be found for a Lyle W. Stewart at Oklahoma University, Oklahoma State University, or at Tulsa University.

The Oklahoma Geological Survey (OGS) subsequently published the Hydrologic Atlas 1 map (HA1) in 1969. The HA1 utilized Hugh Miser's State Geological Map (1954) for the geological interpretation of the area surrounding SFC, but there is no record of field verification of the faults. Both the State Geologic Map and HA1 depict a continuous fault extending from the vicinity of the SFC facility toward the northeast for approximately 20 miles. This fault is not named on either of the maps, but is believed to have been named the Marble City fault during work performed by Kerr McGee for the Sequoyah Facility. As portrayed on the state maps, the northern end of the Carlile School fault merges with the Marble City fault. SFC believes that details of the State Geologic Map and its derivative HA1, in the vicinity of SFC are incorrect.

The Webber Falls Area geology was initially studied for the purpose of plant siting by Kerr McGee geologists in the late 1960s. Maps and drawings prepared by Kerr McGee prior to construction of the Sequoyah Facility were found dating back as far as 1967. This information included depth to bedrock maps and subsurface mapping based on historical gas well records. The majority of the geological maps and reports were prepared for a proposed deep injection disposal well. This work, along with the early siting studies, was performed by different geologists with different objectives, resulting in inconsistencies with the interpretation of regional structures. For example, a structure contour map of the Viola Formation was constructed. This map was made from very few wells and so any faults, interpreted from the top of the Viola (at depth of approx. 2000 feet), were projected to the surface resulting in the interpreted merging of the Carlile School fault and the Marble City fault. However, there are no surface geologic data to support this interpretation.

Dr. Phillip A. Chenowith conducted surface geologic mapping of the Webber Falls Area for Kerr McGee between 1973 and 1984 as indicated from internal memos and preliminary reports. A map produced by Chenowith (Webber Falls Area Geologic Map, 1983) based upon his field work depicted the Marble City Fault and the Carlile School

Fault as two separate faults. This is the only geologic map that can be documented as being based upon field investigation.

As part of the Facility Environmental Investigation (FEI) conducted in 1990, SFC described the site and regional geology. While site geology was developed from hundreds of borehole data collected over a relatively small area (200 acres), the majority of the information collected for regional geology was from historical records and documents submitted as part of SFC's licensed activities since 1969. The regional geologic map presented in the FEI (Figure 44) was taken from the State map HA1.

In April, 1995 SFC submitted the Class I Injection Well Data Evaluation Report to the EPA as part of a RCRA Facility Investigation, and responded to comments from the EPA in July 1995. During the preparation of that report, additional geologic information and maps of the area were found and incorporated into the regional geology description for the Facility. Early injection tests designed to quantify the reservoir available for the injection well were conducted by Kerr McGee and its consultants. The injection tests suggested that the reservoir was limited in extent. The consultants performing this test hypothesized that a hydraulic boundary existed south of the Facility and drew an east/west splay off the Carlile School Fault as the southern boundary. The NRC rejected these early test results and studies performed years later did not identify or adopt the earlier interpretation of the bounding fault hypothesis. Although this fault was never identified in the field, it was included on the updated regional map submitted to the NRC in 1996 as part of the Draft Site Characterization Report (SCR).

In February, 1998, Dr. Roy Van Arsdale reviewed the local geologic literature, including various maps, and conducted a field investigation of the Carlile School fault. His work was reported to SFC in a report dated March 6, 1998 and is included as an attachment to this report. During the field investigation of the Carlile School fault, Dr. Van Arsdale looked for evidence as to whether the Carlile School fault merges with the Marble City

fault as depicted on the State Geologic Map. As discussed in the Van Arsdale report there is no indication that the Carlile School fault merges with the Marble City fault.

Conclusions

As described and mapped in the Van Arsdale Report (1998) the Carlile School fault does not connect with the Marble City fault. The Van Arsdale Report is consistent with the Chenowith map produced in 1983, which was also based on field investigation. In addition, no evidence for an east/west splay was found during the Van Arsdale Study, nor does it appear on the Chenowith map. This splay is thought to be an artifact of the modeling used to explain early injection well test results which did not withstand peer review. Based on the above discussion, SFC feels justified in using the Chenowith map for the regional geology setting at the SFC Facility.

Van Arsdale concluded that the Carlile School fault, the closest known fault, is not a capable fault and shows no signs of movement during the Quarternary period. This is consistent with conclusions from recent regional work conducted at the Black Fox and Arkansas Nuclear One reactor sites. Both of these power plants demonstrated that there are no capable faults within 150 to 200 mile radius of those facilities. Those radii include the area of the SFC Facility. In conclusion, SFC believes that there are no capable faults in the area and the seismic acceleration value for the purpose of disposal cell design at the Sequoyah Facility should be determined according to the "Technical Approach Document, December 1989."

3-6-98

Mr. Kenneth Schlag
Sequoyah Fuels
I-40 and Highway 10
Gore, Oklahoma 74435

Dear Mr. Schlag,

Enclosed please find two copies of the final report prepared for the paleoseismological analysis of the Carlile fault. This report represents the conclusions reached based on a field study that I conducted at your site from February 26 through March 2, 1998. I have also enclosed a copy of my resume for your records.

Please send a copy of the attached materials that may accompany my report to the NRC. Please call me if you have any questions.

Sincerely,

Roy Van Arsdale

Dr. Roy Van Arsdale

Paleoseismologic Analysis of the Carlile Fault

in Sequoyah County, Oklahoma

Dr. Roy Van Arsdale
Professor of Geology
Department of Geological Sciences and
Center for Earthquake Research and Information
University of Memphis
Memphis, Tennessee

During the time period of February 26 through March 2, 1998, I studied the Carlile fault in Sequoyah County, Oklahoma, to determine if the fault has been active during the Quaternary Period (past 2 million years). The Carlile fault was walked and studied along its total surface trace and for a half mile to the northeast and southwest along its projected trace (Fig. 1).

The Carlile fault (also called the Carlile School fault) lies within the transition zone between the Ozark uplift and the Arkoma Basin. Within this area the regional strike and dip of the surface Pennsylvanian Atoka Formation strata is N65W, 5SW. The Carlile

fault is mapped as a northeast striking, down-to-the-southeast normal fault with less than 100 feet of displacement (Sequoyah Fuels, 1996). At the surface, the fault can be traced as a narrow zone of tilted Pennsylvanian Atoka Formation strata. Within the fault zone the strata are oriented approximately N30E, 20SE. The strike of N30E is essentially parallel to the northeast-striking Carlile fault. The Carlile fault can be traced at the surface from 600 feet north of Highway 64 southwest for 4,600 feet; giving the fault a length of nearly one mile. The northeastern and southwestern ends of the fault were inspected and there is no surface evidence that the Carlile fault extends beyond its mapped trace (Fig. 1) or that it is continuous with the Marble City fault as has been previously mapped (Arbenz, 1956).

The Carlile fault zone for much of its length is a low ridge, 200 feet wide by 20 feet high, that is also locally a drainage divide between unnamed tributaries of the Salt Branch creek (Figs. 1, 2A, and 2C). However, the fault zone is not everywhere a ridge (Fig. 2B); the central portion of the fault zone trends obliquely across a ridge. The fault ridge is truncated at its northeastern and southwestern ends, and is breached in its central portion by streams that flow west across the fault zone. The fault ridge has a rounded crest with margins that slope less than 8 degrees. Locally, the ridge has small mounds of rock apparently put there by ranchers who removed rocks from the adjacent fields and dumped them on the ridge.

The Carlile fault was walked along its full length to determine if there is any evidence that the Paleozoic fault has been active during the Quaternary. Specifically, the fault zone was inspected for evidence of a fault scarp like that expressed along the Meers Fault of central Oklahoma (Crone and Luza, 1990). Folds and fractures in the Carlile fault zone reflect dip slip drag folding. Thus, if Quaternary faulting had occurred, it would result in the formation of a fault scarp. No fault scarp exists along the Carlile fault. Similarly, the flood plains along the streams that truncate the ridge at both ends and the stream that flows across the center of the ridge do not have fault scarps on their surfaces (Figs. 3 and 4). Furthermore, inspection of cut banks in those streams did not reveal any faults.

Another line of evidence indicates the Carlile fault has not been active during the Quaternary. If dip-slip movement had occurred during the Quaternary, then the topography on one side of the fault should be higher than on the other. As illustrated in the three topographic profiles constructed perpendicular to the fault, elevations are higher on the southeast along profiles A-A' and C-C', but higher on the northwest along B-B' (Fig. 2). I believe the Carlile fault ridge is an erosional ridge, not a tectonic ridge. Apparently, the different orientation of the strata or perhaps greater cementation of the fault zone has made it more resistant to erosion and resulted in a ridge morphology over most of the fault zone length.

In summary, this field study has revealed that the Carlile fault is less than one mile long, has no surface evidence that it connects with any other faults, has not been active in the Quaternary, and thus is not a seismically capable fault.

References

Arbenz, J. K., 1956, Tectonic map of Oklahoma showing surface structural features: Oklahoma Geological Survey, 1:750,000.

Crone, A. J., and Luza, K. V., 1990, Style and timing of Holocene surface faulting on the Meers fault, southwestern Oklahoma: Geological Society of America Bulletin, v. 102, p. 1-17.

Sequoyah Fuels, 1996, Site characterization report.

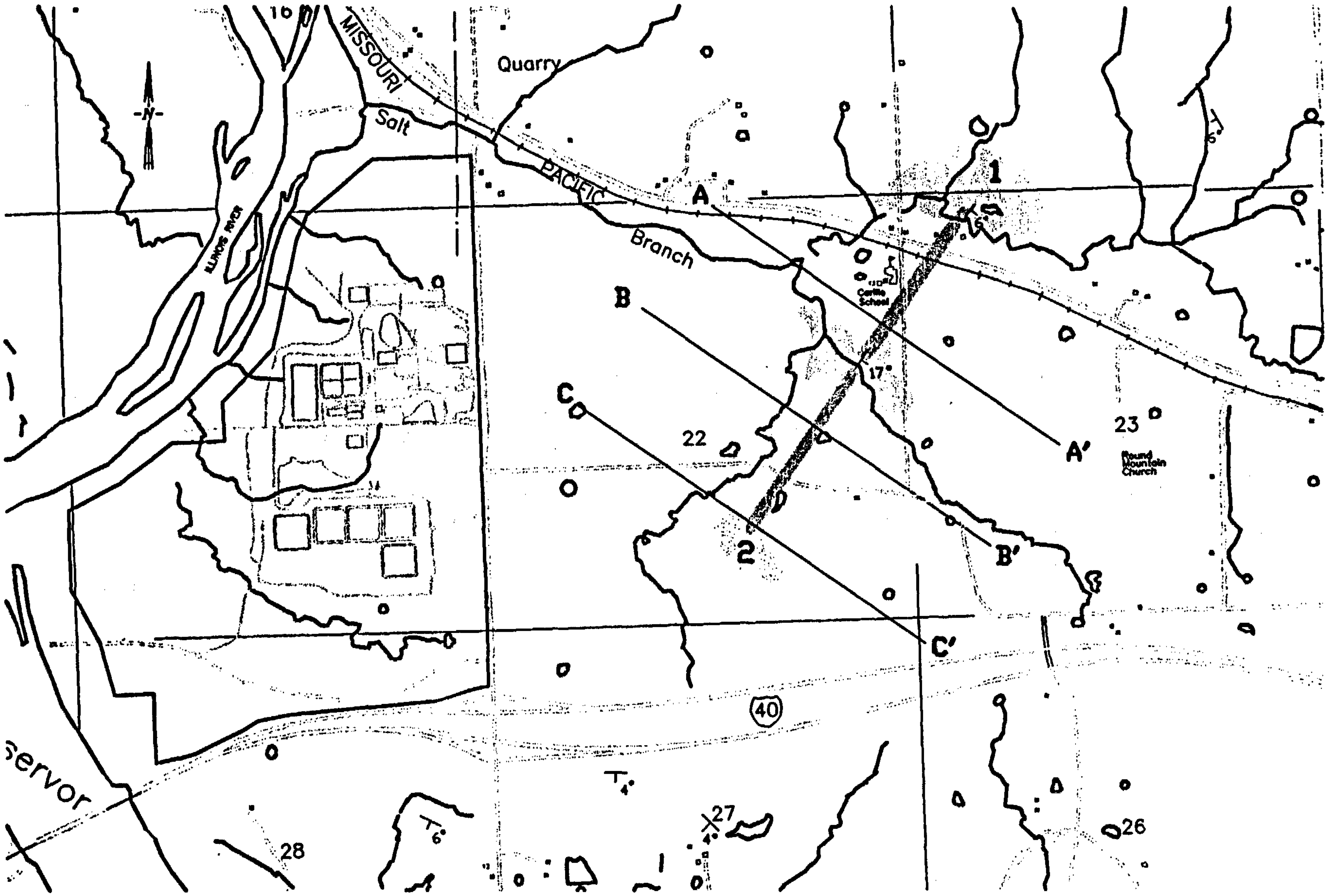


Figure 1

Lt. Gray indicates location of Carlile fault zone.

Tan indicates areas along the fault zone where streams have truncated the zone and deposited alluvial flood plains.

A – A' Topographic profiles A-A', B-B', and C-C' are illustrated in figure 2. The photograph in figure 3 was taken at location 1 and the photograph in figure 4 was taken at location 2.

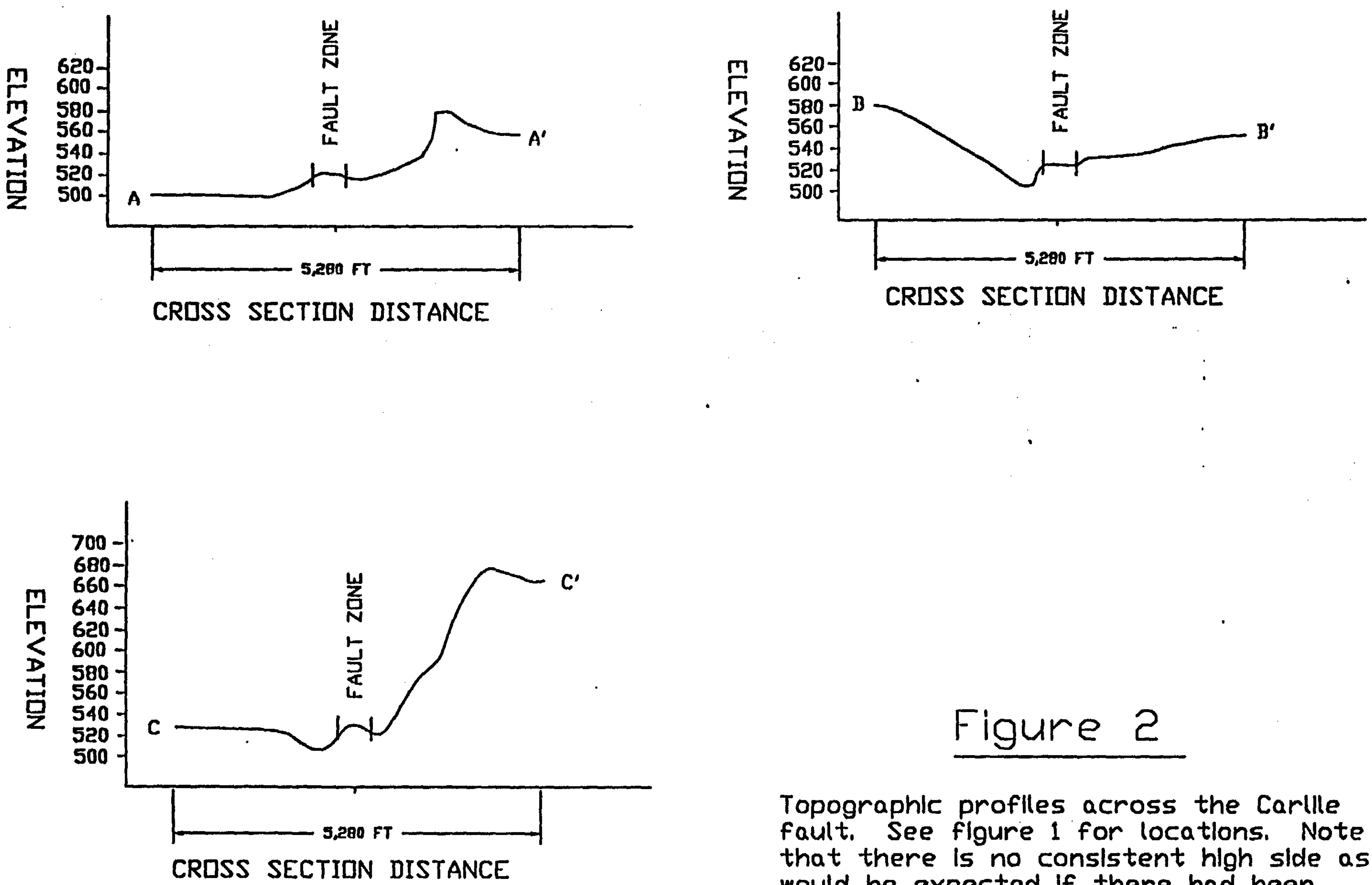


Figure 2

Topographic profiles across the Carlile fault. See figure 1 for locations. Note that there is no consistent high side as would be expected if there had been Quarternary fault movement.

Figure 3. Photograph taken at location 1 of figure 1 looking southwest at the northeastern termination of the Carlile fault ridge. The fault ridge is in the background with buildings on top. No fault scarp exists on the flood plain visible in the middle or foreground of the photograph.

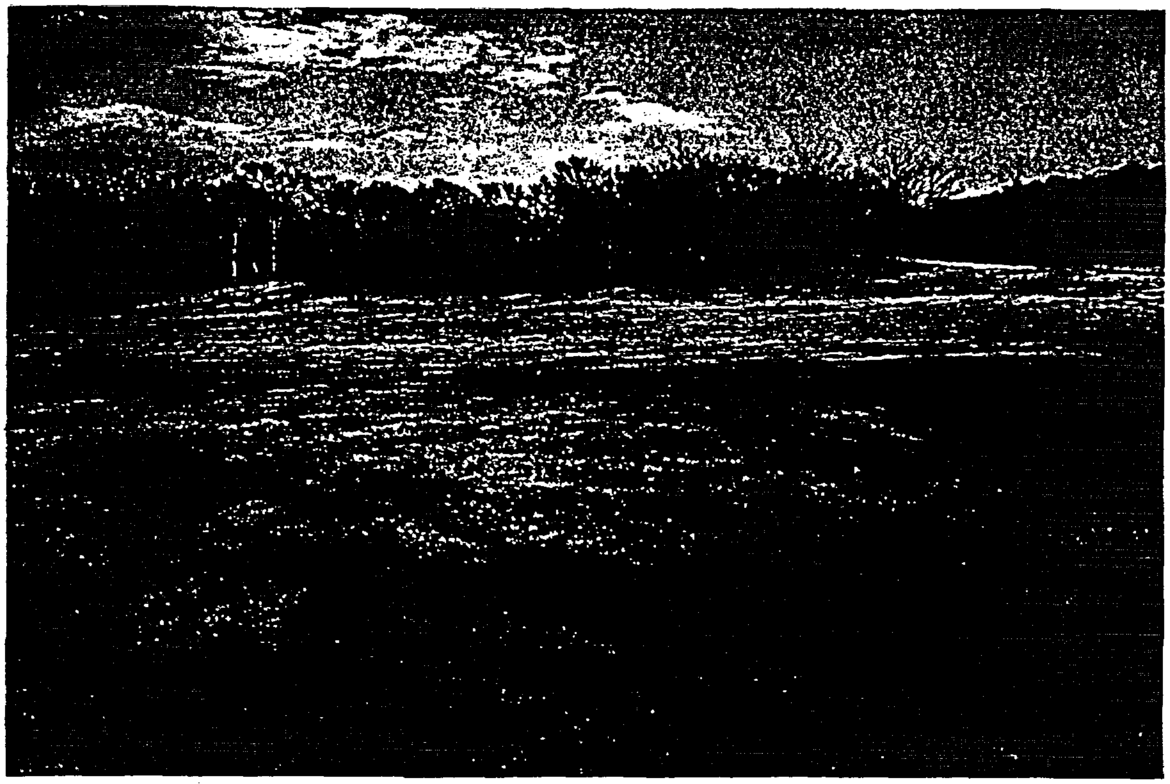


Figure 4. Photograph taken at location 2 of figure 1 looking northeast at the southwestern termination of the Carlile fault ridge. The Carlile fault ridge is the high ground in the background. No fault scarp exists on the flood plain in the middle or foreground of the photograph.

CURRICULUM VITAE

Roy B. Van Arsdale — Geological Sciences — Professor

DEGREES

B.A.	Geology	Rutgers University at New Brunswick	1972
M.S.	Geology	University of Cincinnati	1974
Ph.D.	Geology	University of Utah	1979

EXPERIENCE

Geologist	Lamont Doherty Geological Observatory	1971
Geologist	Standard Oil of California	1974
Geologist	Union Carbide Corporation	1975-1976
Geologist	Gulf Mineral Exploration	1977
Assistant Professor of Geology	Eastern Kentucky University	1980-1983
Associate Professor of Geology	Eastern Kentucky University	1984
Assistant Professor of Geology	University of Arkansas	1985-1987
Associate Professor of Geology	University of Arkansas	1988-1993
Professor of Geology	University of Arkansas	1993
Associate Professor of Geology	University of Memphis	1993
Professor of Geology	University of Memphis	1994

TEACHING EXPERIENCE

Introductory Geology (U)	Eastern Kentucky University
Structural Geology (U)	Eastern Kentucky University
Geomorphology (U)	Eastern Kentucky University
Geology of Soils (U)	Eastern Kentucky University
Geology Field Camp (U)	Eastern Kentucky University
Tectonics (G)	Eastern Kentucky University
Advanced Structural Geology (G)	Eastern Kentucky University
Seminars (G)	Eastern Kentucky University
Introductory Geology (U)	University of Arkansas
Structural Geology (U)	University of Arkansas
Geomorphology (U)	University of Arkansas
Geology Field Camp (U)	University of Arkansas
Tectonics (G)	University of Arkansas
Advanced Structural Geology (G)	University of Arkansas
Seminars (G)	University of Arkansas
Introductory Geology (U)	University of Memphis
Structural Geology (U)	University of Memphis
Geomorphology (U)	University of Memphis
Tectonics (G)	University of Memphis
Quaternary Geology (G)	University of Memphis
Seminars (G)	University of Memphis

STUDENT ADVISING/MENTORING

Graduate Student	Robin Mihills	1998
Graduate Student	Jason Broughton	1998
Graduate Student	Aaron Broughton	1998
Appendix B attached		

Currently on 4 Masters and 2 Doctoral committees.

RESEARCH/SCHOLARSHIP/CREATIVE ACTIVITIES

PUBLICATIONS

Refereed Journal Publications

Van Arsdale, R.B., 1982, Influence of calcrete on the geometry of arroyos, near Buckeye Arizona. Bulletin of the Geological Society of America, v. 93, p. 20-26.

Cox, J.M., and Van Arsdale, R.B., 1986, Petrographic study of the Valley View and Clay's Ferry Sandstone dikes in east-central Kentucky. Transactions of the Kentucky Academy of Science, 47 (1-2), p. 43-51.

Nelson, A.R., and Van Arsdale, R.B., 1986, Structure and Holocene fault movement within Strawberry Valley, Basin and Range - Colorado Plateau transition zone, Utah. Neotectonics, An International Journal of Crustal Dynamics, v. 1, n. 1, p. 7-37.

Van Arsdale, R.B., 1986, Quaternary displacement on faults within the Kentucky River fault system of east-central Kentucky. Bulletin of the Geological Society of America, v. 97, n. 11, p. 1382-1392.

Cox, R.T., and Van Arsdale, R.B., 1988, Structure and chronology of the Washita Valley fault, Southern Oklahoma Aulacogen. Shale Shaker, July-August, p. 2-13.

Van Arsdale, R.B., Costello, P., and Marcelletti, N., 1989, Denudation of highwalls near Manchester, Kentucky. Engineering Geology, v. 26, n. 2, p. 111-123.

Van Arsdale, R.B. and Schweig, E.S., 1990, Subsurface structure of the eastern Arkoma basin. American Association of Petroleum Geologists Bulletin, v. 74, n. 7, p. 1030-1037.

Schweig, E.S., Van Arsdale, R.B., and Burroughs, R.K., 1991, Subsurface structure in the vicinity of an intraplate earthquake swarm, central Arkansas. Tectonophysics, v. 186, n. 1/2, p. 107-114.

Luzietti, E.A., Kanter, L.R., Schweig, E.S., Shedlock, K.M., and Van Arsdale, R.B., 1992, Shallow deformation along the Crittenden County fault zone near the southeastern boundary of the Reelfoot rift, northeast Arkansas. Seismological Research Letters, v. 63, n. 3, p. 263-276.

Schweig, E.S., Fan Shen, Kanter, L.R., Luzietti, E.A., Van Arsdale, R.B., Shedlock, K.M., and King, K.W., 1992, Shallow seismic reflection survey of the Bootheel lineament, southeastern Missouri. Seismological Research Letters, v. 63, n. 3, p. 285-296.

Stahle, D.W., Van Arsdale, R.B., and Cleaveland, M.K., 1992, Tectonic signal in baldcypress trees at Reelfoot Lake, Tennessee. Seismological Research Letters, v. 63, n. 3, p. 439-448.

Kelson, K.I., Van Arsdale, R.B., Simpson, G.D., and Lettis, W.R., 1992, Assessment of the style and timing of surficial deformation along the central Reelfoot scarp, Lake County, Tennessee. Seismological Research Letters, v. 63, n. 3, p. 349-356.

Van Arsdale, R.B., Schweig, E.S., Kanter, L.R., Williams, R.A., Shedlock, K.M., and King, K.W., 1992, Preliminary shallow seismic reflection survey of Crowley's Ridge, northeast Arkansas. Seismological Research Letters, v. 63, n. 3, p. 309-320.

Van Arsdale, R.B., Stahle, D.W., and Cleaveland, M.K., 1993, Applications of dendrochronology to earthquake studies in the New Madrid seismic zone of the central United States. Quaternary Proceedings, n. 3, p. 85-91.

Van Arsdale, R.B., Williams, R.A., Schweig, E.S., Shedlock, K.M., Kanter, L.R., and King, K.W., 1994, Preliminary seismic reflection study of Crowley's Ridge, northeast Arkansas. U.S. Geological Survey Professional Paper 1538 C, p. C1-C16.

Van Arsdale, R.B., Williams, R.A., Schweig, E.S., Shedlock, K.M., Odum, J.K., and King, K.W., 1995, The origin of Crowley's Ridge, northeastern Arkansas: erosional remnant or tectonic uplift? Bulletin of the Seismological Society of America, v. 85, n. 4, p. 963-986.

Van Arsdale, R.B., Kelson, K.I., and Lumsden, C.H., 1995, Northern extension of the Tennessee Reelfoot scarp into Kentucky and Misscuri. Seismological Research Letters, v. 55, n. 5, p. 57-62.

Kelson, K.I., Simpson, G.D., Van Arsdale, R.B., Harris, J.B., Haraden, C.C., and Lettis, W.R., 1996, Multiple Late Holocene earthquakes along the Reelfoot fault, central New Madrid seismic zone. Journal of Geophysical Research, v. 101, n. B-3, p. 6151-6170.

Schweig, E.S., and Van Arsdale, R.B., 1996, Neotectonics of the upper Mississippi embayment: in "Geology of the lower Mississippi Valley: implications for engineering, the half century since Fisk, 1944" edited by R. Saucier, L. Smith, and W. Autin. Engineering Geology, v. 45, p. 185-203.

Van Arsdale, S.K., and Van Arsdale, R.B., 1997, A case study in earthquake hazards education: preparing nurses for a New Madrid earthquake. Seismological Research Letters, v. 68, n. 3, p. 444-447.

Cox, R.T., and Van Arsdale, R.B., 1997, Hotspot origin of the Mississippi embayment and its possible impact on contemporary seismicity. Engineering Geology, v. 46, n. 3/4, p. 5-12.

Van Arsdale, R.B., Purser, J.L., Stephenson, W., and Odum, J., 1998, Faulting along the southern margin of Reelfoot Lake, Tennessee. in press with Bulletin of the Seismological Society of America.

Van Arsdale, R.B., Stahle, D.W., Cleaveland, M.K., and Guccione, M.J., 1998, Earthquake signals in tree-ring data from the New Madrid seismic zone. in press with Geology.

Refereed Abstract Publications

Van Arsdale, R.B., 1979, Geometry and most recent movement along Strawberry normal fault Wasatch County, Utah: Geol. Soc. of Am., v. 11, n. 7, p. 531.

Van Arsdale, R.B., 1981, Influence of calcrete on the geometry of arroyos, southwestern Arizona: Geol. Soc. of Am., v. 13, n. 5, p. 263.

Van Arsdale, R.B., Wilson, J., TenHarmsel, R., and Sergeant, R., 1982, Investigation of late Tertiary to Recent movement along the Kentucky River fault system in southern Clark County, Kentucky: Geol. Soc. of Am., v. 14, n. 5, p. 291.

Van Arsdale, R B., Paul, D., Dugan, T., and Cox, J.M., 1983, Late Tertiary to Recent movement along the Kentucky River fault system in east-central Kentucky: Geol. Soc. of Am., v. 15, n. 4, p. 229.

Stickney, J.F., Chadwick, D.L., and Van Arsdale, R.B., 1984, Investigation of recent movement along the Rough Creek fault system in portions of Daviess, Mclean, and Webster Counties, Kentucky: Geol. Soc. of Am., v. 16, n. 3, p. 199.

Van Arsdale, R.B., 1984, Post-Pliocene-Pleistocene (?) movement within the Kentucky River fault system of east-central Kentucky: Geol. Soc. of Am., v. 16, n. 3, p. 203.

Van Arsdale, R.B., and Sergeant, R. 1985, Post-Pliocence displacement on faults within the Kentucky River fault zone of east-central Kentucky: Geol. Soc. of Am., v. 17, n. 7, p. 739.

Gustafson, T.J., Van Arsdale, R.B., and Monrad, J.R., 1986, Structural geology of the Boonesboro limestone mine, Madison County, Kentucky: Geol. Soc. of Am., v. 18, n. 3, p. 224.

Cox, R.T., and Van Arsdale, R.B., 1986, Style and timing of displacement along the Washita Valley fault, Oklahoma: Geol. Soc. of Am., v. 18, n. 6, p. 573.

Burroughs, R.K., and Van Arsdale, R.B., 1987, Structural geology of the Enola, Arkansas earthquake swarm: Geol. Soc. of Am., v. 19, n. 7, p. 606.

Chiu, J.M., Pujol, J., Nava, S., Steiner, G., Schweig, E.S., Johnston, A.C., and Van Arsdale, R.B., 1988, An intrusion related Arkansas earthquake swarm source zone?: Seismological Research Letters, v. 59, p. 102.

Schweig, E.S., Van Arsdale, R.B., and Bieler, D.B., 1988, Structural history of the Arkansas earthquake swarm area, eastern Arkoma basin, Arkansas: Transactions, American Geophysical Union, v. 69, n. 44, p. 1458.

Van Arsdale, R.B. and Schweig, E.S., 1989, Geology of an intraplate earthquake swarm: Enola, Arkansas, 1982: Geological Association of Canada annual meeting, v. 14, p. A108.

Van Arsdale, R.B. and Schweig, E.S., 1989, Structure of the eastern Arkoma Basin: Geol. Soc. of Am., v. 21, n. 6, p. A366.

Schweig, E.S., Kanter, L.R., Li, L., Van Arsdale, R.B., Shedlock, K.M., Luzietti, E.A., and King, K.W., 1990, A seismic reflection survey of the Bootheel Lineament in Missouri: Trans. Am. Geophys. Union, v. 71, n. 43, p. 1436.

Luzietti, E.A., Shedlock, K.M., King K.W., McKeown, F.A., Schweig, E.S., Kanter, L.R., and Van Arsdale R.B., 1990, A seismic reflection survey of the Crittenden County fault, northeast Arkansas: Trans. Am. Geophys. Union, v. 71, n. 43, p. 1435.

Van Arsdale, R.B., Scherer, G.G., Schweig, E.S., Kanter, L.R., Williams, R.A., Shedlock, K.M., and King, K.W., 1990, Seismic reflection survey of Crowley's Ridge, Arkansas: Trans. Am. Geophys. Union, v. 71, n. 43, p. 1435.

Guccione, M.J., Shingleur, R.A., Van Arsdale, R.B., and Pratt, M., 1991, Origin of some Prairie mounds in northwestern Arkansas: Geol. Soc. of Am., v. 23, n. 4, p. 28.

Schweig, E.S., Kanter, L.R., Van Arsdale, R.B., Luzietti, E.A., and Shedlock K.M., 1991, Shallow seismic reflection surveys in the New Madrid seismic zone: results and plans for the future: Trans. Am. Geophys. Union, EOS, April 23, p. 264.

Van Arsdale, R.B., Stahle, D.W., and Cleaveland, M.K., 1991, Tectonic deformation revealed in baldcypress tree-rings of Reelfoot Lake, Tennessee: Trans. Am. Geophys. Union, EOS, April 23, p. 196.

Kanter, L.R., Schweig, E.S., Luzietti, E.A., Shedlock, K.M., and Van Arsdale, R.B., 1991, Cenozoic deformation along the Crittenden county fault zone, northeastern Arkansas: Seismological Research Letters, v. 62, p. 175-176.

Schweig, E.S., Kanter, L.R., Shen, F., Li, Y., Van Arsdale, R.B., Luzietti E.A., and Shedlock, K.M., 1991, The Bootheel lineament: results of trenching and shallow seismic reflection studies: Seismological Research Letters, v. 62, p. 183.

Van Arsdale, R.B., Schweig, E.S., Kanter, L.R., Williams, R.A., and Shedlock, K.M., 1991, Preliminary study of the subsurface structure of Crowley's Ridge, northeast Arkansas: Seismological Research Letters, v. 62, p. 188-189.

Van Arsdale, R.B., Williams, R.A., Schweig, E.S., Kanter, L.R., Shedlock, K.M., King, K.W., and Odum, J.K., 1992, Tectonic origin of Crowley's Ridge, northeastern Arkansas: Geol. Soc. of Am., v. 24, n. 7, p. A153.

Nicholas, D.P., Schweig, E.S., Kanter, L.R., Odum, J.K., Stephenson, W.J., Shedlock, K.M., and Van Arsdale, R.B., 1992, New shallow seismic reflection survey across the Crittenden County fault zone in the New Madrid seismic zone: Trans. Am. Geophys. Union, EOS, v. 73, n. 43, p. 390.

Gillson, R.G., McKague, H.L., and Van Arsdale, R.B.,1992, Analysis of borehole elongation at the Nevada test site, Nevada, using the Digital Surveyor: Trans. Am. Geophys. Union, EOS, v. 73, n. 43, p. 560.

Kelson, K.I., Van Arsdale, R.B., Simpson, G.D., and Lettis, W.R., 1992, Evidence for late Holocene deformation along the central Reelfoot scarp, New Madrid seismic zone: Trans. Am. Geophys. Union, EOS, v. 73, n. 43, p. 353.

Van Arsdale, R.B., Kelson, K.I., Simpson, G.D., Unruh, J.R., and Lettis, W.R., 1993, Deformation along the central Reelfoot scarp and Lake County uplift, northwestern Tennessee: Geol. Soc. of Am., v. 25, n. 3, p. 86-87.

Guccione, M.J., Hehr, L.H., and Van Arsdale, R.B., 1993, Anastomosing stream sediments in the flood basin of the Mississippi River: Fifth International Conference of Fluvial Sedimentology, p. 45.

Guccione, M.J., Van Arsdale, R.B., and Hehr, L.H., 1993, Evidence for Late Holocene tectonic deformation in the New Madrid Seismic Zone, Big Lake, Northeastern Arkansas: Geol. Soc. of Am., v. 25, n. 6, p. A-460-461.

Van Arsdale, R.B., Williams, R.A., and Schweig, E.S., 1993, Seismic reflection study of Crowley's Ridge, northeastern Arkansas: Geol. Soc. of Am., v. 25, n. 6, p. A-70.

Kelson, K.I., Simpson, G.D., Haraden, C.C., Lettis, W.R. , and Van Arsdale, R.B., 1994, Multiple Holocene earthquakes along the Reelfoot fault, central New Madrid seismic zone: Geol. Soc. of Am., v. 26, n. 7, p. A-189.

Van Arsdale, R.B., Stahle, D.W., and Cleaveland , M.K., 1994, New Madrid earthquake signals in Baldcypress at Reelfoot Lake, TN, and Lake St. Francis, AR: Geol. Soc. of Am., v. 26, n. 1, p. A-29.

Van Arsdale, R.B., Kelson, K.I., Simpson, G.D., Lumsden, C.H., and Harris, J.B., 1994, Northern extension of the Reelfoot scarp, Kentucky and Missouri: Geol. Soc. of Am., v. 26, n. 7, p. A-189.

Kendall, J.D., Braden, A., Sinor, N., Guccione, M.J., Van Arsdale, R.B., and Drouin, P., 1995, Implications for late Wisconsin deglaciation in the lower Mississippi valley from a terrace in northeastern Arkansas: Geol. Soc. of Am., v. 27, n. 3, p. 63.

Guccione, M.J., and Van Arsdale, R.B., 1995, Holocene surface deformation and drainage disruption: evidence for paleoseismology in the New Madrid seismic zone, midcontinent USA. Terra Nostra, International Union for Quaternary Research, p. 99.

Schweig, E.S., Tuttle, M.P., Guccione, M.J., Van Arsdale, R.B., and Kelson, K.I., 1995, Paleoseismology in stable continental regions: a case study of the New Madrid seismic zone, USA. Terra Nostra, International Union for Quaternary Research, p. 246.

Harris, J.B., Woolery, E.W., Wang, Z., Kelson, K.I., Simpson, B.D., and Van Arsdale, R.B., 1995, S-wave seismic reflection profiling over the Reelfoot scarp: a link between trenching and conventional P-wave seismic reflection data. Geol. Soc. of Am., v. 27, n. 6, p. 393.

Guccione, M.J., and Van Arsdale, R.B., 1995, Response of stream geomorphology and sedimentology to progressive Holocene deformation across the St. Francis River, New Madrid seismic zone, midcontinent, USA. Geol. Soc. of Am., v. 27, n. 6, p. 394.

Drouin, P.E., Van Arsdale, R.B., and Guccione, M.J., 1996, Paleoseismic investigation of Crowley's Ridge near Jonesboro, Arkansas. Geol. Soc. of Am., v. 28, n. 2, p. 11.

Cox, R.T., and Van Arsdale, R.B., 1996, Mid-Cretaceous uplift of the Mississippi embayment. Geol. Soc. of Am., v. 28, n. 2, p. 8.

Van Arsdale, S.K., and Van Arsdale, R.B., 1996, The New Madrid earthquake: preparing nurses. Natural Disaster Reduction, Proceedings of the Conference Sponsored by the American Society of Civil Engineers, Dec. 3-5, p. 97-98

Purser, J.L., Van Arsdale, R.B., Stephenson, W.J., and Odum, J.K., 1996, Seismic reflection profile along the southern margin of Reelfoot Lake, New Madrid seismic zone, Tennessee. Geol. Soc. of Am., v. 28, n. 7, p. 283.

Cox, R.T., and Van Arsdale, R.B., 1997, Possible track of the Bermuda hotspot across the southeastern U.S. Geol. Soc. of Am., v. 29, n. 3, p. 10.

Johnston, A.C., Van Arsdale, R.B., and Pujol, J., 1997, A great thrust fault across the Mississippi River in 1812: a historical, geological, and seismological reconstruction. Seis. Res. Lett., v. 68, n. 2, p. 297.

Purser, J.L., and Van Arsdale, R.B., 1997, Structure of the Lake County uplift: New Madrid seismic zone. Geol. Soc. of Am., v. 29, n.6, p. A-205.

Book Reviews

Van Arsdale, R.B., 1983, Ryder's Standard Geographic Reference, Journal of Geological Education, v. 31, n. 4, p. 344.

Nonrefereed Publications

Van Arsdale, R.B., 1979, Geology of Strawberry Valley and regional implications: Ph.D. dissertation, University of Utah, 65 p.

Van Arsdale, R.B. and Sergeant, R.E., 1986, Post-Pliocene displacement on faults within the Kentucky River fault system of east-central Kentucky: U.S. Nuclear Regulatory Commission Report NUREG/4685, Washington, D.C., 36 p.

Van Arsdale, R.B., Ward, C.C., and Cox, R.T., 1989, Post-Pennsylvanian reactivation along the Washita Valley fault, southern Oklahoma: U.S. Nuclear Regulatory Commission Report NUREG/CR-5375, Washington, D.C., 48 p.

Cox, R.T. and Van Arsdale, R.B., 1991, Investigation of the relationship of earthquakes and underground waste disposal in the El Dorado area, Arkansas: Arkansas Water Resources Research Center, Misc.Pub. 76, 38 p.

Van Arsdale, R.B., Stahle, D.W., and Cleaveland, M.K., 1991, Tectonic deformation revealed in baldcypress trees at Reelfoot lake, Tennessee: U.S. Nuclear Regulatory Commission, NUREG/CR-5749, 12 p.

Van Arsdale, R.B., Schweig, E.S., Jordan, D.W., and Pryor, W.A., 1992, Mississippi river sedimentology and New Madrid earthquake seismicity: Geological Society of Kentucky 1992 field trip guide, 56 p.

Schweig, E.S., and Van Arsdale, R.B., 1993, The New Madrid seismic zone - a field trip: 1993 National Earthquake Conference - earthquake hazard reduction in the central and eastern United States, 24 p.

Kelson, K.I., Van Arsdale, R.B., Simpson, G.D., and Lettis, W.R., 1993, Late Holocene episodes of deformation along the central Reelfoot scarp, Lake County, Tennessee: Proceedings of the 1993 National Earthquake Conference - Earthquake hazard reduction in the central and eastern United States, a time for examination and action, v. 1, p. 195-203.

Van Arsdale, R.B., and Hall, G., 1995, Baldcypress tree ring elemental concentrations at Reelfoot Lake, Tennessee, from AD 1795 to AD 1820. U.S. Nuclear Regulatory Commission NUREG/GR-0014, 10 p.

Van Arsdale, R.B., 1997, Hazard in the heartland: the New Madrid seismic zone. May Geotimes, p. 16-19.

Van Arsdale, R.B., 1998, Seismic hazards of the upper Mississippi embayment. US Army Corps of Engineers Waterways Experiment Station contract report GL-98-1, 126 p.

SUPPORT

External

Funded	U.S. Nuclear Regulatory Commission	$100,000	1981-1984
Funded	National Science Foundation	$29,913	1981-1983
Funded	Arkansas Science and Technology Authority	$29,100	1986
Funded	U. S. Nuclear Regulatory Commission	$48,631	1987
Funded	Arkansas Science and Technology Authority	$59,200	1989
Funded	U. S. Nuclear Regulatory Commission	$10,565	1990
Funded	United States Geological Survey	$31,515	1990
Funded	United States Geological Survey	$70,734	1991
Funded	United States Geological Survey	$139,609	1991
Funded	United States Geological Survey	$44,278	1991
Funded	United States Geological Survey	$39,197	1993
Funded	U. S. Nuclear Regulatory Commission	$15,618	1993
Funded	United States Geological Survey	$83,404	1993
Funded	United States Geological Survey	$83,999	1993
Funded	United States Geological Survey	$23,313	1994
Funded	United States Geological Survey	$42,285	1994
Funded	Australian Research Council	$10,472	1996
Funded	United States Geological Survey	$29,635	1996

Funded	United States Geological Survey	$37,988	1996
Funded	United States Geological Survey	$43,000	1996
Funded	United States Geological Survey	$37,723	1997
Funded	Mid America Earthquake Center	$40,000	1998
Funded	Mid America Earthquake Center	$50,000	1998
Pending	Department of Energy	$1,946,630	1998

Internal

Funded	Faculty Research Grant	$4000	1995

SERVICE

Department

Graduate Advisor
Faculty Search Committee
Graduate Council
Dean's Faculty Advisory Committee

Professional Society Memberships

American Geophysical Union
American Association of Petroleum Geologists
Geological Society of America
Seismological Society of America

Professional Consultation Activities

Reviewer for National Science Foundation research grants
Reviewer for United States Geological Survey research grants
Reviewer for Geological Society of America Bulletin
Reviewer for Quaternary Research
Reviewer for Geophysical Research Letters
Reviewer for Seismological Research Letters
Consulting for Army Corps of Engineers
Consulting for Risk Engineering
Guest Editor of Engineering Geology

APPENDIX B

Chairman Role Master Theses

Wilson, J.K., 1981, Investigation of late Tertiary to recent movement along the east bounding fault of the Shearer Graben within the Kentucky River fault system in southern Clark County, Kentucky, 128 p.

TenHarmsel, R.L., 1982, Investigation of late Tertiary to recent movement along the bounding faults of the Shearer Graben within the Kentucky River fault system in southern Clark County, Kentucky, 198 p.

Paul, D.A., 1982, Investigation of late Tertiary to recent movement along northwest-trending faults within the Kentucky River fault system in northeast Madison and Clark Counties, Kentucky, 145 p.

Dugan, T.E., 1983, Investigation of late Tertiary to recent movement along faults within the Kentucky River fault system in northern Madison, southern Fayette, and southern Clark Counties, Kentucky, 199 p.

Cox, J.M., 1983, Investigation of late Tertiary to recent movement along the Kentucky River fault system in northwest Madison and southeast Jessamine Counties, Kentucky, 170 p.

Stickney, J.F., 1985, Investigation of recent movement along the Rough Creek fault system in Webster and McLean Counties, Kentucky, 95 p.

Tillman, J.W., 1985, Post-Pliocene displacement history of the Kentucky River fault in northwest Madison and southeast Jessamine Counties, Kentucky, 62 p.

Gustafson, T.J., 1986, The structural geology of the Boonesboro limestone mine, Madison County, Kentucky, 84 p.

Jacobs, B.B., 1986, Trench investigation of Quaternary movement along the east-bounding fault of the Shearer graben within the Kentucky River fault system in southeast Clark County, Kentucky, 60 p.

Gilchrist, W.B., 1986, Trench investigation of late Tertiary to recent movement along the southwest-bounding fault of the Shearer graben within the Kentucky River fault system in southeast Clark County, Kentucky, 56 p.

Cox, R.T., 1987, Style and timing of displacement along the Washita Valley Fault, Murray County, Oklahoma, 54 p.

Marcelletti, N., 1987, A statistical analysis of slope-profile development on contour surface coal mines, Clay County, Kentucky, 156 p.

Burroughs, R.K., 1988, Structural geology of the Enola, Arkansas, earthquake swarm, 65 p.

Duran, W.K., 1988, Geology of the Cass and Yale 7.5 minute quadrangles of Franklin and Johnson Counties, Arkansas, 70 p.

Ward, C.C., 1989, Post-Pennsylvanian reactivation along the Washita Valley fault, southern Oklahoma, 64 p.

Scherer, G.G., 1991, High resolution seismic reflection study along the northern segment of Crowley's Ridge, northeast Arkansas, 66 p.

McMurtrey, W.G, 1992, High resolution seismic reflection profiling of the southern segment of Crowley's Ridge, northeastern Arkansas, 70 p.

Gillson, R.G., 1993, Analysis of borehole elongation in Yucca Flat and Pahute Mesa, Nevada, using the Digital Downhole Surveyor, 378 p.

Drouin, P.E., 1995, A paleoseismic study of Crowley's Ridge and a west bounding fault of the Reelfoot rift, 67 p.

Lumsden, C.H., 1995, The northern extension of the Reelfoot scarp into Kentucky and Missouri, 56 p.

Axford, P.W., 1996, A structural interpretation of the topography of the Reelfoot scarp and Lake County uplift, 54 p.

Purser, J.L., 1996, Shallow seismic reflection survey along the southern margin of Reelfoot Lake, Tennessee, and regional implications, 76 p..

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 18, 1998

Mr. John H. Ellis, President
Sequoyah Fuels Corporation
P.O. Box 610
Gore, Oklahoma 74435

SUBJECT: TRANSMITTAL OF NRC'S RESPONSE TO EVALUATION OF SEISMIC CONDITIONS NEAR YOUR SITE

Dear Mr. Ellis:

The U.S. Nuclear Regulatory Commission has completed its review of the information related to seismic conditions in the vicinity of your site. This review demonstrated that none of the known faults near your site are capable faults, as defined in Section III of Appendix A to Title 10 Code of Federal Regulations Part 100. A copy of the review is included for your information.

If you have any questions on this matter, please contact Jim Shepherd at 301-415-6712.

Sincerely,

John W. N. Hickey, Chief
Low-Level Waste and Decommissioning
Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Docket 40-8027
License SUB-1010

Enclosure: As stated

cc: SFC distribution list

Sequoyah Fuels Corporation

Letter dated: 12/18/98

cc: Alvin Gutterman, Esq.
Craig Harlin
JoKay Dowell
Pat Gwin
Michael Broderick
Michael Hebert, P.E.
Dr. Loren Mason
Kathy Peter
Charles Scott
Merritt Youngdeer
Troy Poteete
President, S.A.F.E.S.T
Jeannine Hale, Esq.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 03, 1998

NOTE TO: James Shepherd, Project Manager
Sequoyah Fuels Corporation
LLDP/DWM/NMSS

FROM: Philip S. Justus, Senior Geologist
ENGB/DWM/NMSS

SUBJECT: **SEQUOYAH FUELS CORPORATION (SFC) SITE EVALUATION OF FAULTS AND FAULTING: INPUT TO SAFETY EVALUATION REPORT**

BACKGROUND AND CONCLUSIONS:

This report documents my evaluation of the faults that have been mapped, assumed to be present, or otherwise mentioned in reports, letters, and maps concerning faults in and around the SFC site near Gore, Oklahoma. In particular, this report is in response to materials submitted by C.H. Harlin of SFC to you dated April 8, 1998, with the subject, "License SUB-1010; Docket No. 40-8027 - Seismic Conditions Near the Sequoyah Facility." Based on the information that I have reviewed and the field observations that I made, I do not consider that the known faults are capable faults according to the definition of 10 CFR Part 100, Appendix A. Therefore, these faults need not be considered as seismic sources for the purposes of determining the seismic design basis. This note may be used as input to a Safety Evaluation Report. The bases for my conclusions are described in the sections below.

At your request, I performed a preliminary evaluation of SFC submittals for the purposes of determining whether or not faults that were indicated to occur on or near the site are capable faults, and whether or not other geologic hazards might exist and would need to be considered in design. The information available to me was insufficient to make definitive findings on the above issues. A request for additional information from SFC, along with the reasons for requesting each bit of information, was prepared and sent to SFC.

SFC responses were evaluated and found to be inadequate for reaching regulatory conclusions. Constructive comments and guidance intended to lead SFC to develop supporting bases for its conclusions on each issue were prepared, discussed by teleconference, and sent to SFC. A site visit for NRC staff was arranged and made (participants included Dr. Ibrahim and myself). In addition, Dr. Ibrahim and I visited the offices of the State Geologist, the State Seismologist, interviewed various geoscientists, obtained written reports and discussed several issues regarding the site with them.

ENCLOSURE

SFC's April 8, 1998, report and additional reports were reviewed (e.g., relevant parts of Black Fox and Arkansas Nuclear One reactor safety evaluation reports). The combination of the above materials and results of investigations provided a sufficient basis for determining that none of the known faults near the SFC site are capable faults.

FAULTS ON AND AROUND SFC SITE:

The faults on and around the SFC site that are candidates for capable faults include: (1) faults associated with the South Fault of Warner Uplift (near dam a few miles upriver from Webbers Falls, OK); (2) Carlile School Fault and an E-W splay from the Carlile Fault (=Carlile School Fault) near the southern boundary of the SFC property; and (3) Marble City Fault and its splay. These are all shown in the SFC Site Characterization Report (SCR) of 2/2/96, Figure 9; Attachment 1.

The Carlile Fault, the closest fault to the site, is shown to intersect the Marble City Fault (MCF) on one map, but not on another. Both maps were submitted by SFC. Also, a cross section showed that parts of the South Fault of Warner Uplift (SFWU) and the Carlile fault (CF) were a few thousand feet deep and did not penetrate the granite basement rocks (SCR, Figure 11, attachment 2). The fault lengths, fault-zone widths, depth, and connectivity of the faults on the SFC maps and cross sections are not well constrained, and vary from map to map. This is due to a dearth of data that may only be derived from better exposures, borehole penetrations and geophysical surveys. These and other discrepancies have been satisfactorily explained in the April 8, 1998, letter.

Other map sources of fault information submitted by SFC or consulted by me include the tectonic map of OK (Arbenz, 1956), Hydrologic Atlas map HA-1 (Marcher, 1969), geologic map of Webber Falls area (Chenoweth, 1983), and trace map of the Carlile Fault (Van Arsdale, 1998, in subject document). Of the faults on these maps, the Chenoweth map and others submitted by SFC based on its own or its consultants' investigations are most relevant to the capable fault issue. The SFC-sponsored maps have some bases to support them, whereas, the smaller scale state maps do not appear to have bases traceable to observations of the geology made in the vicinity of the SFC site. Therefore, I am relying much more heavily on the observations and interpretations of local geology and local features of faults in the SFC reports and maps than on abstractions of them made from the state reports and maps.

ASSESSMENT OF SELECTED FAULTS DISCUSSED IN SFC'S "REGIONAL GEOLOGY RELATING TO SEISMIC CONDITIONS AT THE SEQUOYAH FACILITY" SUBMITTED APRIL 8, 1998, AND IN OTHER DOCUMENTS:

I. Marble City Fault (MCF). The trace of the MCF near the SFC site has not been located consistently by SFC (e.g., Chenoweth, 1983; SCR, 1996; Van Arsdale, 1998). For example, the location of the MCF with regard to the Carlile Fault (CF) is near the northern terminus of the CF and the MCF does not intersect the CF at the surface (Chenoweth, Attachment 3; and Van

Arsdale, Attachment 4 show the CF to be 1 mile long), whereas the location of the MCF is near the southern terminus of the CF in the SCR (the CF is shown to be 4 mi long; Attachment 1).

The MCF is not a capable fault (10 CFR Part 100, Appendix A) because it does not appear to meet any of the criteria for being a capable fault (i.e., (i) there was no single displacement on it in the last 35,000 years or two displacements in the last 500,000 years (e.g., Black Fox and Arkansas Nuclear One-SERs); (ii) there is no macroseismicity associated with it (e.g., Earthquake Map of OK, 1995, and updates and interviews with Kenneth Luza); and (iii) it is not structurally related to a known capable fault (e.g., Black Fox and Arkansas Nuclear One SERs). Therefore, the location of the MCF and its relationship to other faults near the SFC site do not need to be pinpointed for the purpose of ascertaining seismic design basis at the site.

II. South Fault of Warner Uplift (SFWU). The SFWU is tectonically similar to the MCF, in that it is one of a series of northeast-trending normal faults that are arrayed on the southwestern flank of the Ozark dome. The SFWU is seismotectonically similar to the MCF in that it does not meet any of the criteria for capable faults (e.g., reasons similar to that for MCF in I, above). Therefore, I do not consider the SFWU to be a capable fault.

III. Carlile Fault, or Carlile School Fault (CF). The trace of the CF is marked by a rubbly vegetated ridge up to about 12 feet in relief and up to one mile long. The fault has a northeast strike, displacement of about 100 feet down to the southeast and a moderate dip to the southeast (Attachments 1, 2). Van Arsdale (attachment to the subject report) indicates that the fault zone is characterized by rock strata with dips up to 17 degrees southeast which interrupt the regional southwestern dips of about 5 degrees. The fault does not meet any of the criteria for a capable fault. On the criterion of youthful displacement: the absence of disruption of Quaternary and Holocene sediments that veneer the fault zone (Van Arsdale, ibid; and SCR, Figure 10) and the lack of steep scarps militates against displacements in the Late Quaternary Period. On the criterion of macroseismicity: there is no definitive relationship of macroseismicity to the CF (e.g., Earthquake Map of OK, 1995). On the criterion of structural relationship to a capable fault: the CF does not appear to be connected to the MCF (Chenoweth; and Van Arsdale, ibid.); and the MCF is not a capable fault (e.g., Black Fox and Arkansas Nuclear One reports). Therefore, based on available information, there is no evidence that the CF is a capable fault. The CF need not be investigated in further detail for the purpose of ascertaining the seismic design basis.

SFC's explanation for the E-W splay of the CF that appears in attachment 1 (dashed line) is reasonable and acceptable (April 8, 1998 letter). Thus, the E-W splay, the only fault that has been suggested to occur within the site boundary, has little or no basis in fact, and need not be considered in establishing the seismic design basis.

The faults mentioned in I, II, and III, above, in particular, the CF and the E-W splay of the CF, may need to be considered for purposes other than as potential contributors to seismic design

basis. For example, if the faults or features they represent have a significant effect on groundwater flow, they may need to be characterized for purposes of understanding or constraining attributes of groundwater flow and contaminant transport.

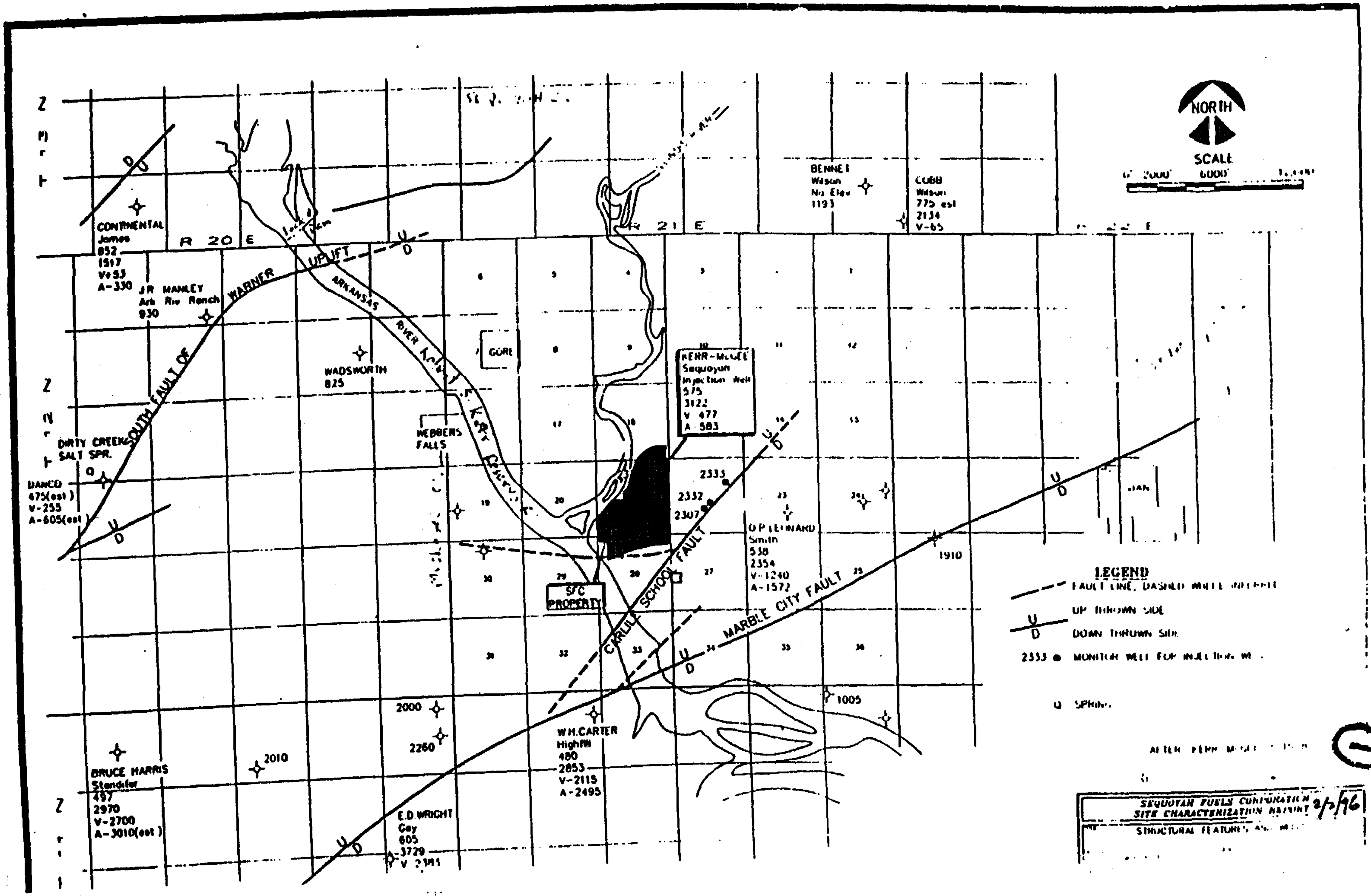
CONCLUSION REGARDING CAPABLE FAULTS IN THE SFC SITE VICINITY:

As described above, based on the results of reviews of faults and fault investigations relevant to the identification and investigation of faults near the SFC site that may be capable faults according to the definition of 10 CFR Part 100, Appendix A, the staff finds no evidence to support a conclusion that such capable faults exist on or near the SFC site. Specifically, the CF, MCF, and SFWU described above are not considered to be capable faults.

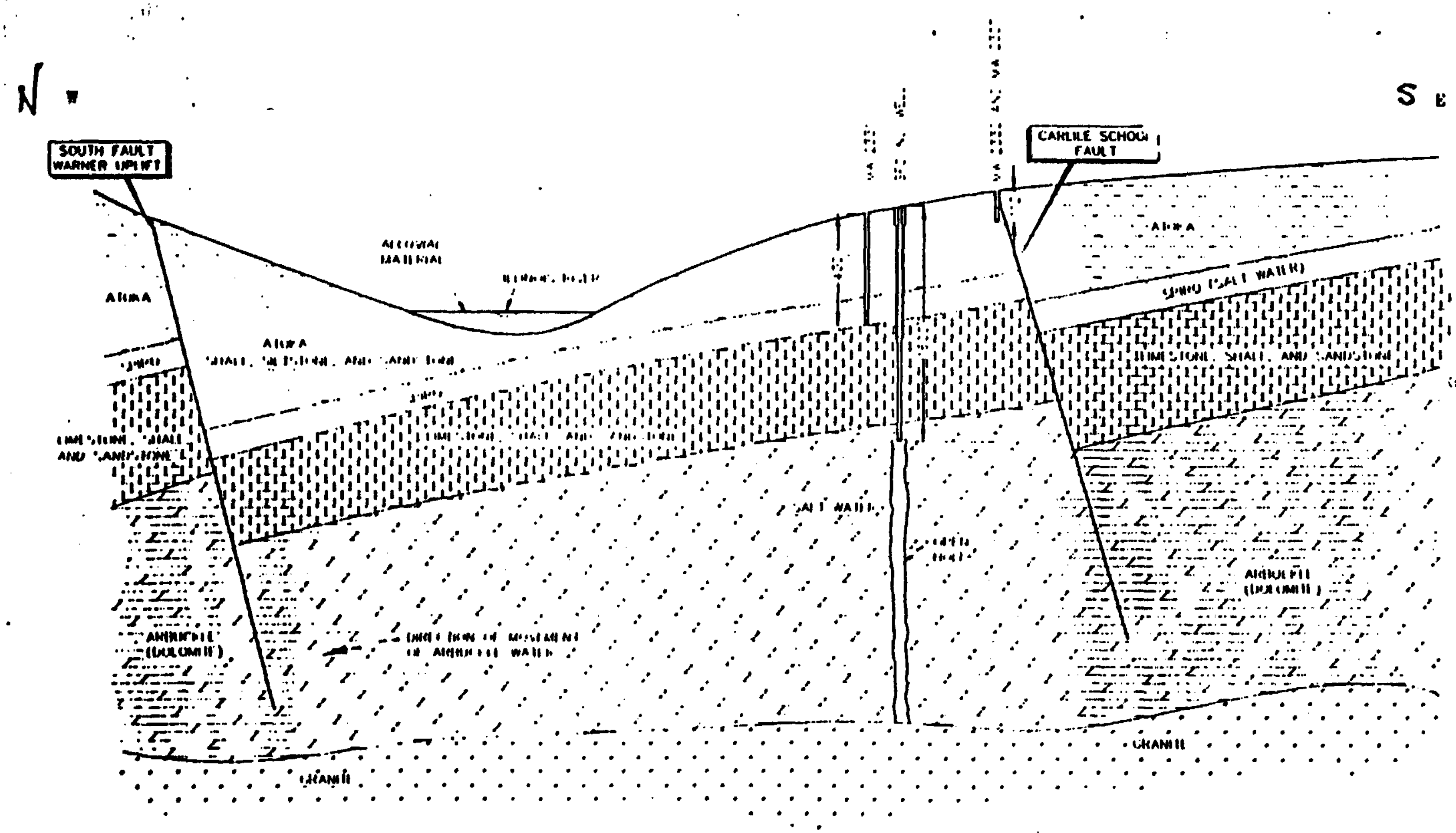
cc: Bill Reamer
David Brooks
Bakr Ibrahim

Attachments:

1. Structural Features and Wells, Fig. 9, SFC Site Characterization Report, 2/2/96
2. Regional Geological Cross Section, Fig. 11, ibid.
3. Portion of Geologic Map of Webber(sic) Falls Area, by P.A. Chenoweth, July 1983
4. Location of Carlile fault zone, Fig. 1, Paleoseismological Analysis of the Carlile Fault in Sequoyah County, OK, by R. Van Arsdale, undated attachment to the subject report.



NORTH
SCALE
R 20 E
R 21 E
CONTINENTAL
James
852
1517
V+53
A-330
JR MANLEY
Ark Riv Ranch
930
WARNER
UPLIFT
SOUTH FAULT OF
ARKANSAS
RIVER
GORE
WADSWORTH
825
WEBBERS FALLS
DIRTY CREEK
SALT SPR.
DANCO
475(est)
V-255
A-605(est)
KERR-McGEE
Sequoyah
Injection Well
575
3122
V 477
A 583
BENNET
Wilson
No Elev
1193
COBB
Wilson
775 est
2134
V-65
2335
2332
2307
O P LEONARD
Smith
538
2354
V-1240
A-1572
1910
SFC PROPERTY
CARLILE SCHOOL FAULT
MARBLE CITY FAULT
2000
2260
1005
W.H.CARTER
Highfill
480
2853
V-2115
A-2495
BRUCE HARRIS
Standifer
497
2970
V-2700
A-3010(est)
2010
E.D.WRIGHT
Gay
605
3729
LEGEND
FAULT LINE, DASHED WHERE INFERRED
UP THROWN SIDE
DOWN THROWN SIDE
2335 MONITOR WELL FOR INJECTION WELL
SPRING
SEQUOYAH FUELS CORPORATION
SITE CHARACTERIZATION REPORT
STRUCTURAL FEATURES
2/7/96



SEQUOYAH FUELS CORPORATION
SITE CHARACTERIZATION REPORT

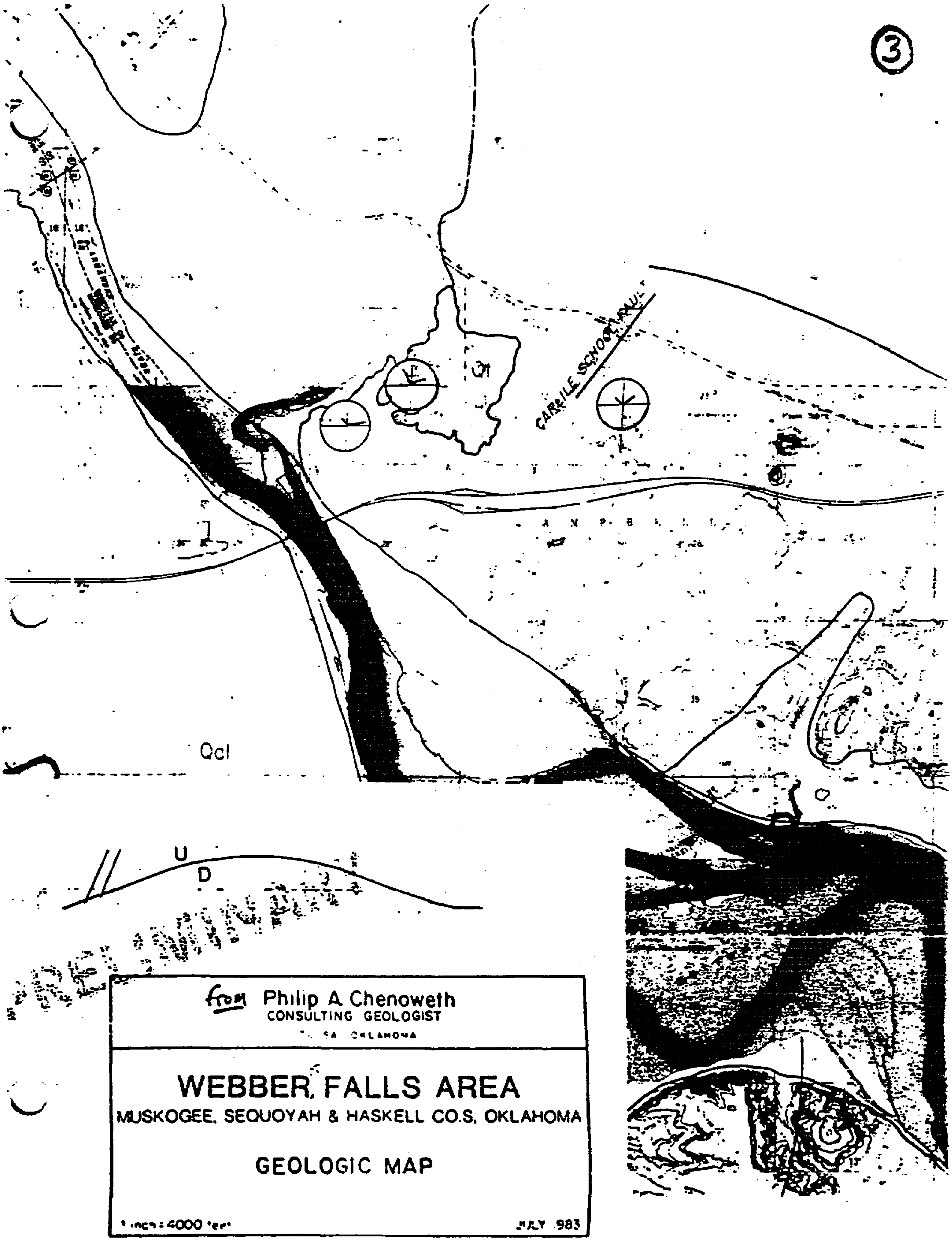
REGIONAL GEOLOGICAL CROSS SECTION

93092M18 | N/A

REV. 0

DATE 12/18/95

FIGURE NO. 11


3
CARLILE SCHOOL FAULT
Qcl
U
D
from Philip A. Chenoweth
CONSULTING GEOLOGIST
WEBBER FALLS AREA
MUSKOGEE, SEQUOYAH & HASKELL CO.S, OKLAHOMA
GEOLOGIC MAP
1 inch = 4000 feet
JULY 1983

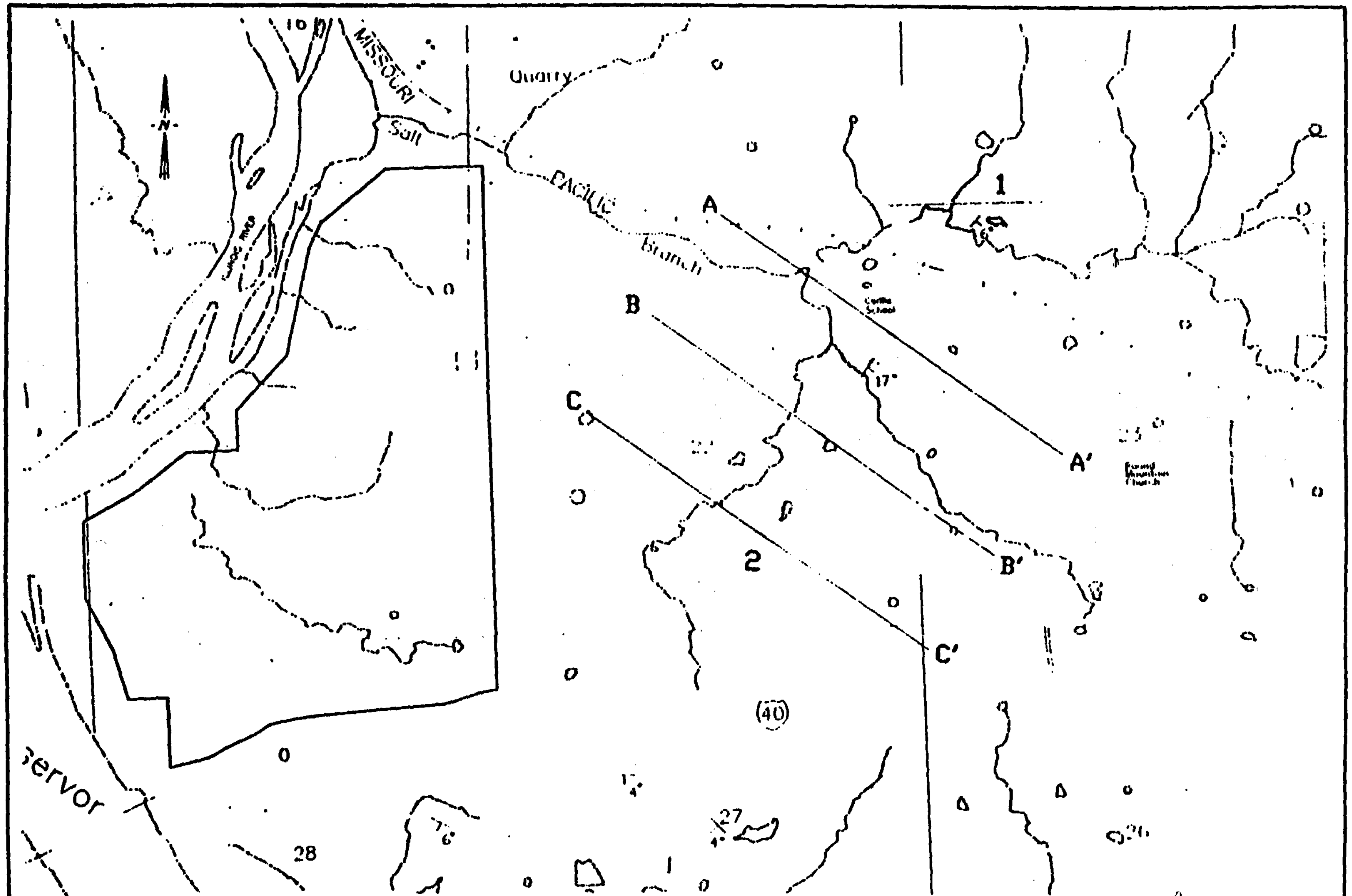


Figure 1

Lt. Gray indicates location of Carlile fault zone.

Tan indicates areas along the fault zone where streams have truncated the zone and deposited alluvial flood plains.

Topographic profiles A-A', B-B', and C-C' are illustrated in [illegible]

(4)

ENCLOSURE 3
Sequoyah Fuels Corporation
Reclamation Plan Acceptance Review
Request for Additional Information

Assessment of Non-11e.(2) Materials for Disposal in The Cell
August 8, 2003

APPENDIX A

Assessment of Non-11e.(2) Materials for Disposal in The Cell

Compliance With Interim Guidance on Disposal of Non-Atomic Energy Act of 1954, Section 11e.(2) Byproduct Material in Tailings Impoundments

NRC Regulatory Information Summary 2000-23 (November 30, 2000) provides guidance on disposal of wastes that are not 11e.(2) byproduct material in tailings impoundments. The policy identifies eight considerations. The discussion below addresses each of these considerations and shows that they are consistent with SFC's disposal in the disposal cell of the non-11e.(2) byproduct material wastes described above.

RIS 2000-23 Criterion 1. In reviewing licensee requests for the disposal of wastes that have radiological characteristics comparable to those of Atomic Energy Act of 1954, Section 11e.(2) byproduct material [hereafter designated as "11e.(2) byproduct material"] in tailings impoundments, the Nuclear Regulatory Commission staff will follow the guidance set forth below. Since mill tailings impoundments are already regulated under 10 CFR Part 40, licensing of the receipt and disposal of such material [hereafter designated as "non-11e.(2) byproduct material"] should also be done under 10 CFR Part 40.

SFC Response: The SFC non-11e.(2) byproduct materials have radiological characteristics comparable to those of 11e.(2) byproduct material. These materials are comprised of soil, demolition debris, and calcium fluoride (CaF) sludge, all of which are contaminated with low levels of source material, primarily natural uranium. The first two types of material are typical of a uranium mill operation and are similar to the 11e.(2) material that SFC also plans to place in the disposal cell. The third type of material, CaF sludge, is not found at a typical uranium mill, but it has radiological characteristics comparable to 11e.(2) byproduct material. These non-11e.(2) materials are depicted on Figure A-1, and described in more detail in Attachment 1.

The radiological contaminants in all three types of non-11e.(2) byproduct material are U_{nat}, Th_{230} and Ra_{226}. These radiological contaminants are also the radiological contaminants in typical uranium mill tailings, including the SFC 11e.(2) byproduct material. The maximum concentrations of U_{nat}, Th_{230} and Ra_{226} in SFC's non-11e.(2) byproduct material are lower than respective the maximum concentrations in the SFC 11e.(2) byproduct material. In addition, the average concentrations also are lower in the non-11e.(2) byproduct material. The concentrations of these radiological contaminants in the SFC non-11e.(2) byproduct material are comparable to the concentrations in 11e.(2) byproduct material at typical conventional uranium mills. Table 1 provides estimated average and maximum concentrations of U_{nat}, Th_{230} and Ra_{226} in the three classes of non-11e.(2) wastes along with comparable concentrations in the SFC 11e.(2) materials and in 11e.(2) materials at typical conventional uranium mills.

RIS 2000-23 Criterion 2. Special nuclear material and Section 11e.(1) byproduct material waste should not be considered as candidates for disposal in a tailings impoundment, without compelling reasons to the contrary. If staff believes that such

material should be disposed of in a tailings impoundment in a specific instance, a request for Commission approval should be prepared.

SFC Response: The SFC non-11e.(2) byproduct materials do not contain any special nuclear material or Section 11e.(1) byproduct material.

RIS 2000-23 Criterion 3. The 11e.(2) licensee must provide documentation showing necessary approvals of other affected regulators (e.g., the U.S. Environmental Protection Agency or State) for material containing listed hazardous wastes or any other material regulated by another Federal agency or State because of environmental or safety considerations.

SFC Response: There are no necessary approvals of other regulators because the non-11e.(2) materials do not contain any wastes that are listed as hazardous under the Resource Conservation and Recovery Act (RCRA), and there is no other Federal agency or State that regulates the land disposal of any of the constituents of the non-11e(2) byproduct material because of environmental considerations. Although the site is subject to an Administrative Order issued by the U.S. Environmental Protection Agency (EPA) under RCRA (the principal contaminant of concern being arsenic in groundwater), the EPA's concerns are not with any of the non-11e.(2) wastes that SFC wants to place in the disposal cell.

As discussed above, the non-11e.(2) byproduct material consists of three types of material: soils, demolition debris and CaF sludge. The soils are very similar to the SFC soils that are 11e(2) byproduct material and do not contain any hazardous wastes.

The demolition debris will consist of the materials resulting from demolition of buildings and equipment. The debris from buildings/equipment that were not used in the front end of the SFC process is non-11e.(2) byproduct material. Demolition debris that is non-11e.(2) byproduct material is very similar to the demolition debris that is 11e.(2) byproduct material. Like typical older uranium mill tailings sites, some of the SFC buildings and equipment contain asbestos bearing materials. About half of the asbestos is 11e.(2) material, the other half is not. Asbestos is not a listed hazardous waste under RCRA. Asbestos is regulated under the Clean Air Act, and therefore is incorporated by reference as a hazardous substance in the Comprehensive Environmental Resource and Liability Act (CERCLA), but it will not migrate in the subsurface and would not present any environmental risk when buried in the cell. No approvals from EPA or the State are required for the land disposal of asbestos.

The CaF sludge was generated by using lime (CaO) to neutralize the acidic wastewater from the conversion process fluorine scrubber systems. Excess lime was used during the neutralization step and the pH was then adjusted to near neutral using sulfuric acid. As a result, the sludge is primarily composed of CaF, CaO and CaS. The sludge also contains about 45% water and an average of about 700 ppm natural uranium.

Attachment 2 provides the results of a detailed chemical analysis of the CaF sludge that was performed as part of the EPA RCRA Facility Investigation completed in 1996. It shows that the sludge samples did not contain RCRA hazardous waste. Attachment 3 provides the results of TCLP leachability analysis on the CaF sludge, demonstrating that it is not a RCRA Hazardous Waste due to Toxic Characteristics.

There is some buried CaF sludge at the site that has not been tested. SFC plans to excavate this sludge during reclamation, test it for chemical constituents and dispose of it accordingly. If it has similar characteristics to the previously tested CaF sludge, it will be included in the disposal cell as non-11e.(2) byproduct material.

Since no listed or characteristically hazardous materials are included in the non-11e.(2) byproduct material, no approval from other Federal or State regulators is required for disposal of these materials in the disposal cell.

RIS 2000-23 Criterion 4. The 11e.(2) licensee must demonstrate that there will be no significant environmental impact from disposing of this material.

SFC Response: No significant environmental impact will result from disposing of the non-11e.(2) byproduct material in the disposal cell. The non-11e.(2) byproduct material that consists of soil and demolition debris is chemically and physically very similar to the soil and demolition debris that is classified as 11e.(2) byproduct material. While the CaF sludge is chemically different from the 11e.(2) byproduct materials, no adverse chemical reaction with other materials in the cell is anticipated. Testing has shown that uranium is less leachable from the CaF sludge than from most of the 11e.(2) materials that will be placed in the cell. Reduction of the water content, which is planned prior to placement in the cell, will result in a structurally acceptable material that will not contribute to cell subsidence. Consequently, including the non-11e.(2) byproduct materials in the disposal cell will not have a significant affect on the ability of the disposal cell to assure that the contaminants in the disposal cell remain isolated from the environment, or to have any other significant environmental impact.

Thus, the only environmental impact of disposal of this non-11e.(2) byproduct material in the disposal cell will be an increase of approximately 20% in the volume of material for disposal in the cell. Any decision not to place the non-11e.(2) byproduct material in the disposal cell would result in a need for separate disposal of this material. If two disposal cells are required, the amount of land dedicated to disposal would be greater due to the need for a buffer area around each cell. Consequently, placing the 11e.(2) and non-11e.(2) byproduct material in the same cell will minimize the total area devoted to disposal of these materials, and minimize the environmental impact of disposal of the non-11e.(2) byproduct material.

RIS 2000-23 Criterion 5. The 11e.(2) licensee must demonstrate that the proposed disposal will not compromise the reclamation of the tailings impoundment by demonstrating compliance with the reclamation and closure criteria of Appendix A of 10 CFR Part 40.

SFC Response: Sections 3 and 4 of this Reclamation Plan demonstrates how disposal of both the 11e.(2) byproduct material and the non-11e.(2) byproduct material will comply with the reclamation and closure criteria of Appendix A of 10 CFR Part 40. It shows that including the non-11e.(2) material in the disposal cell will not compromise compliance with the reclamation and closure criteria.

RIS 2000-23 Criterion 6. The 11e.(2) licensee must provide documentation showing approval by the Regional Low-Level Waste Compact in whose jurisdiction the waste originates as well as approval by the Compact in whose jurisdiction the disposal site is located, for material which otherwise would fall under Compact jurisdiction.

SFC Response: This criterion is not applicable because SFC's non-11e.(2) byproduct material is not "material which otherwise would fall under Compact jurisdiction". The relevant regional low level compact – the Central Interstate Low-Level Radioactive Waste Compact (CILLRWC)– does not require approval for a generator of radioactive waste to dispose of that waste on its own site.

Oklahoma is a member of the CILLRWC, 42 U.S.C 2021d. The CILLRWC provides, in part:

> ARTICLE VI–OTHER LAWS AND REGULATIONS
>
> a. Nothing in this compact shall be construed to:
>
> * * *
>
> 3. prohibit or otherwise restrict the management and waste on the site where it is generated if such is otherwise lawful;

While the quoted sentence uses the phrase "management and waste," it was apparently intended to read "management of waste." ARTICLE II–DEFINITIONS of the CILLRWC states that "As used in this compact, unless the context clearly requires a different construction: * * * h. "management of waste" means the storage, treatment <u>or disposal of waste</u>" (emphasis added). This definition makes clear that SFC's disposal of waste on the SFC site does not fall under CILLRWC jurisdiction. The same conclusion would be reached even if the phrase "management and waste" is not corrected, since the word "management" should be interpreted in light of the definition of "management of waste," and therefore understood to mean that the CILLRWC does not restrict the right of a generator to dispose of its own waste on its own site.

RIS 2000-23 Criterion 7. The U.S. Department of Energy (DOE) and the State in which the tailings impoundment is located, should be informed of the U.S. Nuclear Regulatory Commission findings and proposed action, with a request to concur within 120 days. A concurrence and commitment from either DOE or the State to take title to the tailings impoundment after closure must be received before granting the license amendment to the 11e.(2) licensee.

SFC Response: SFC understands that the NRC will contact the DOE and the State. In anticipation of this, SFC sent a letter to the DOE on 11/18/02 requesting concurrence with the proposed disposal. SFC also sent a copy of its letter to the NRC and the attorney for the State of Oklahoma.

RIS 2000-23 Criterion 8: The mechanism to authorize the disposal of non-11e.(2) byproduct material in a tailings impoundment is an amendment to the mill license under 10 CFR Part 40, authorizing the receipt of the material and its disposal. Additionally, an exemption to the requirements of 10 CFR Part 61, under the authority of 10 CFR 61.6, must be granted, if the material would otherwise be regulated under Part 61. (If the tailings impoundment is located in an Agreement State with low-level waste licensing authority, the State must take appropriate action to exempt the non-11e.(2) byproduct material from regulation as low-level waste.). The license amendment and the 10 CFR 61.6 exemption should be supported with a staff analysis addressing the issues discussed in this guidance.

SFC Response: SFC's request for an amendment to authorize decommissioning of the SFC facility in accordance with this Reclamation Plan includes a request for authorization to dispose of the non-11e.(2) material in the disposal cell.

An exemption from 10 CFR Part 61 is not required in this case because Part 61 is not applicable to SFC's disposal of its own waste materials. The scope of the Part 61 is stated in 10 CFR Section 61.1, which states in pertinent part,

> (a) the regulations in this part establish, for land disposal of radioactive waste, the procedures, criteria, and terms and conditions upon which the Commission issues licenses for the disposal of radioactive wastes containing byproduct, source and special nuclear material <u>received from other persons. Disposal of waste by an individual licensee is set forth in part 20 of this chapter.</u> Applicability of the requirements in this part to Commission licenses for waste disposal facilities in effect on the effective date of this rule will be determined on a case-by-case basis and implemented through terms and conditions of the license or by orders issues by the Commission.

(emphasis added). Since SFC does not propose to receive any waste for any other person, Part 61 is not applicable, and no exemption from it is required. This contrasts with the usual circumstance in which the Commission is asked to authorize disposal of non-11e.(2) byproduct materials in a mill tailings pile. In the typical mill tailings case, all of the wastes at the mill are, by definition, 11e.(2) byproduct material, and the requests for authorization to dispose of non-11e.(2) byproduct material do relate to material the licensee intends to receive from a third party for disposal.

Similarly, no exemption is required from the state of Oklahoma. Although the State does have regulatory authority over land disposal of byproduct, source and special nuclear material, the agreement between the NRC and the State of Oklahoma only provides that Oklahoma shall have authority to regulate land disposal of waste material received from other persons. 65 Fed. Reg. 60695, 60696 (October 12, 2000). In

addition, the Oklahoma Radiation Management rules and regulations incorporate by reference 10 CFR § 61.1. (See Oklahoma Administrative Code Section 252:410-10-61(a)(1)(A)). Since SFC will not be receiving any wastes from other persons, the State does not have jurisdiction over SFC's onsite disposal of its non-11e.(2) byproduct material.

Table 1: Characteristics of 11e.(2) and Non-11e.(2) Materials

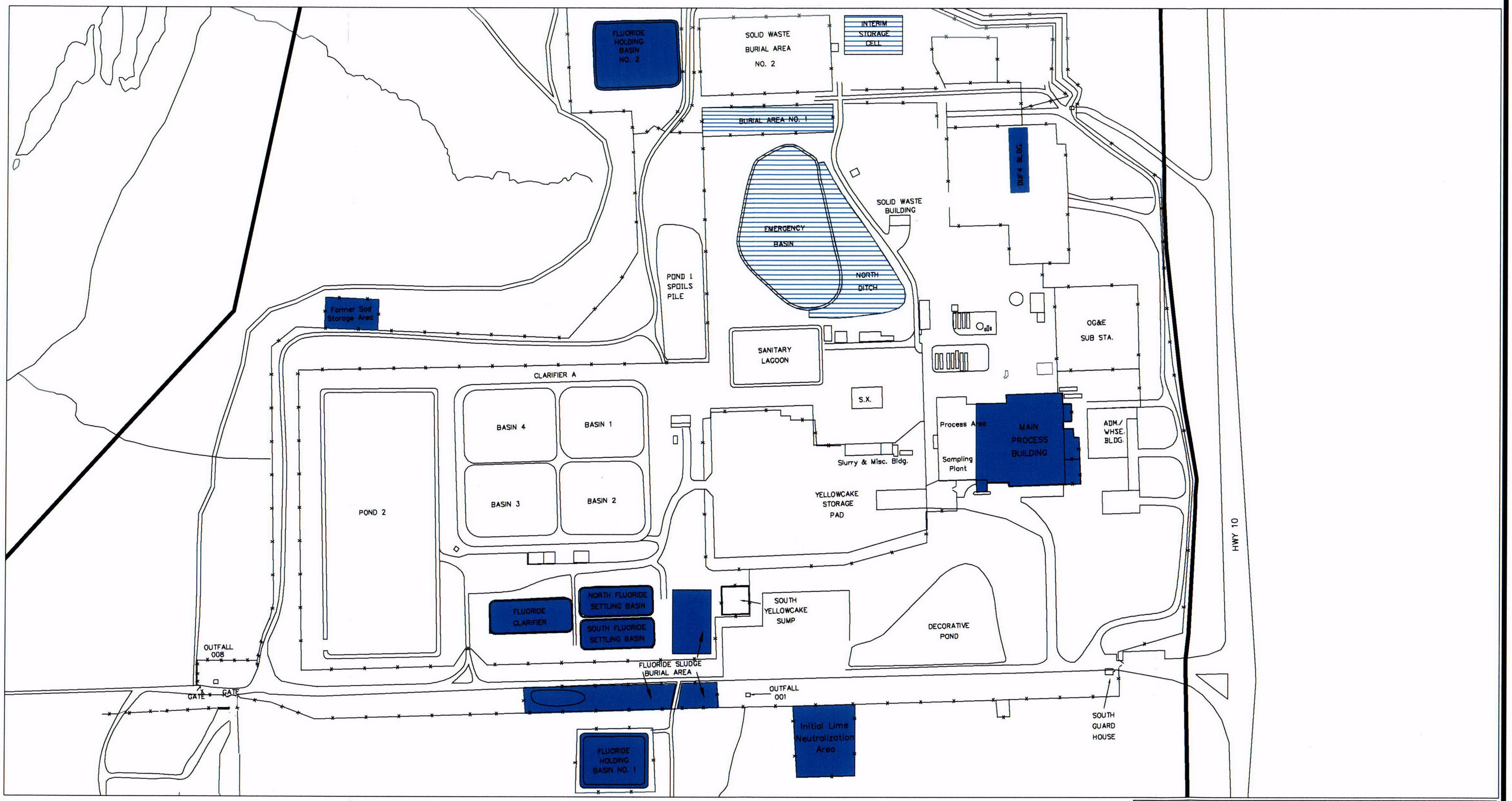
Constituent	Raffinate Sludge[a] (11e.(2))	SFC Soils[b] (non-11e.(2))	SFC Demolition Debris (non-11e.(2))	SFC CaF Sludge (non-11e.(2))	Average Inactive U Mill Tailings[d]
Uranium (pCi/g)	2,500 – 19,200 Avg – 8900	0.7 – 310.7 Avg – 22.6	Surface Contamination Only	56 – 1100 Avg – 376.1	38 – 380
Th-230 (pCi/g)	2,930 – 48,200 Avg – 23,030	3.1– 19.0 Avg – 11.1	Surface Contamination Only	4.8[c]	340 – 1000
Ra-226 (pCi/g)	<14 – 190 Avg - 118	1.6– 1.7 Avg – 1.7	Surface Contamination Only	0.8[c]	340 - 1000

[a] Results obtained during SFC Site Characterization and RCRA Facility Investigation activities, and reported in the subsequent results reports.

[b] Results obtained during SFC Site Characterization For Units 1, 23, and 29, and reported in the subsequent results report.

[c] Results based on one sample of CaF Sludge taken from Unit 14.

[d] Data provided for the average inactive mill tailings column represent the range in average concentrations measured at each of 19 tailings piles. Thorium-230 activity concentration is assumed to be the same as radium-226 activity concentration. Data from Table 3-2 and EPA-520/4-82-013-1, "Final Environmental Impact Statement for Remedial Action Standards for Inactive Uranium Processing Sites (40CFR192)", Volume 1, (Final Report), Office of Radiation Programs, Washington D.C., October, 1982.



Key

(solid blue)	Non-11e.(2) material
(blue hatched)	Co-Mingled 11e.(2) and non-11e.(2)

SEQUOYAH FUELS CORPORATION

Title: Location of Non-IIe.(2) Materials Reclamation plan Appendix A	
PREPARED BY: SFC	Filename: SFC0095A
Reviewed by: CH	Figure No. A-1
Date: 07/07/2003	

C14

Attachment 1
Summary of SFC Non-11e.(2) Material

Non-11e.(2) byproduct material proposed for disposal in the cell includes the soils; buildings, equipment and concrete; scrap metal; solid waste burials; drummed contaminated trash; Emergency Basin sediment and soils; North Ditch sediment and soils; the Interim Soil Storage Cell; and Calcium Fluoride sludge and basin liners. Locations of non-11e.(2) materials are identified on Figure A-1.

Soils

Approximately 10% of the soil identified for disposal in the cell is contaminated with non-11e.(2) byproduct material. This soil is primarily located under the eastern portion of the Main Process Building, 1986 Incident Soils Storage Area, the DUF_4 Building, and the Cylinder Storage Pad. These areas are designated as Units 1, 23, 29 and 30 respectively in the SFC Site Characterization Report (SCR). Chemical and radiological analyses for these areas were included in the SCR, and include:

Unit 1

Soil samples have been collected from fifty-seven (57) locations in and around this unit. Sample depths ranged from the surface to seventy-nine (79) feet deep. Of the 851 uranium analyses, 758 (89.1%) were less than 35 pCi/g and 784 (92.1%) were less than 110 pCi/g. The maximum uranium concentration observed was approximately 7,100.

Unit 23

Soil samples have been collected from forty-seven (47) locations in and around this unit. Sample depths ranged from the surface to fifty-two (52) feet deep. Of the 239 uranium analyses, 238 (99.6%) were less than 35 pCi/g and 239 (100%) were less than 110 pCi/g. The maximum uranium concentration observed was approximately 36.6 pCi/g.

Unit 29

Soil samples have been collected from seventeen (17) locations in and around this unit. Sample depths ranged from the surface to forty-five (45) feet deep. Of the 103 uranium analyses, 101 (98.1%) were less than 35 pCi/g and 103 (100%) were less than 110 pCi/g. The maximum uranium concentration observed was approximately 68 pCi/g.

Unit 30

Soil samples have been collected from thirteen (13) locations in and around this unit. Sample depths ranged from the surface to forty-six (46) feet deep. Of the 171 uranium analyses, 162 (94.7%) were less than 35 pCi/g and 165 (96.5%) were less than 110 pCi/g. The maximum uranium concentration observed was approximately 650 pCi/g.

Buildings, Equipment, Concrete

Approximately 50% of the buildings, equipment and concrete identified for disposal in the cell is contaminated with non-11e.(2) byproduct material. There is an estimated 216,091,000 pounds (1,080,455 cubic feet) of building and equipment debris, with a total uranium concentration of 0.025%, for a total uranium content of 24,556 kgs. Total Ra-226 and Th-230 contamination are each estimated to be less than 0.01 Ci.

Scrap Metal

Approximately 50% of the scrap metal identified for disposal in the cell is contaminated with non-11e.(2) byproduct material. Most of this scrap metal is currently stored on the Yellowcake Storage Pad. Scrap metal includes pipe, beams and siding. The total estimated scrap metal is 20,000,000 pounds (100,000 cubic feet), with a total uranium concentration of 0.002%, for a total uranium content of 227 kgs. Ra-226 and Th-230 contamination is negligible.

Solid Waste Burials

Approximately 50% of the materials in the Solid Waste Burials is estimated to be contaminated with non-11e.(2) byproduct material. This material is buried in Solid Waste Burial Area #1, designated as Unit 5 in the SFC SCR. As stated in the SCR, buried materials include contaminated equipment, scrap metal, lab sample bottles, defective 55-gallon yellowcake drums, insulation, combustible trash, pipe containing calcium sulfate deposits, UF_4 ash, yellowcake, incinerator ash, and miscellaneous material from spill cleanups. Due to the physical nature of the burial area contents, SFC concluded that it is not possible to obtain representative samples without full exhumation. Since the burial area may include containers such as drums, there also is a concern that sampling may cause the spread of contamination by disturbing or penetrating the drums with a sampling device. Therefore, the burial area was not characterized by direct sampling during site characterization.

Drummed Contaminated Trash

Approximately 50% of the drummed contaminated trash is estimated to be contaminated with non 11e.(2) byproduct material. Most of this drummed trash is currently stored in the Cell Rooms (southeast corner) of the Main Process Building. There is an estimated 165,300 pounds (6,250 cubic feet) of drummed contaminated waste, with a total uranium concentration of 0.029%, for a total uranium content of 22 kgs. Ra-226 and Th-230 contamination is negligible.

Emergency Basin Sediment and Soil

An estimated 75% contamination in the Emergency Basin sediment and soil is non-11e.(2) byproduct material.

The Emergency Basin is designated as Unit 6 in the SFC SCR. Source samples were collected from eight (8) locations from the Emergency Basin. Sample depths ranged from the surface to one-half foot. Uranium concentrations ranged from approximately 1,600 to 6,000 pCi/g, nitrate from 3.8 to 210 µg/g and fluoride from 1,800 to 9,900 µg/g.

Twelve locations were probed during 1995 characterization activities to determine the depth of the sediment. The sediment depth varied from a maximum of 8 inches to a minimum of 1 inch.

Soil samples have been collected from nineteen (19) locations around the Emergency Basin. Sample depths ranged from the surface to four and a half (4.5) feet deep. Of the 75 uranium analyses, 50 (66.7%) were less than 35 pCi/g and 66 (88%) were less than 110 pCi/g. The maximum uranium concentration observed was approximately 3,500 pCi/g.

North Ditch Sediment and Soil

An estimated 75% contamination in the North Ditch sediment and soil is non-11e.(2) byproduct material. The North Ditch is designated as Unit 9 in the SFC SCR.

Sediment samples have been collected from seven (7) locations from the North Ditch. Uranium concentrations ranged from approximately 0.1 to 22,000 pCi/g, nitrate from 2.5 to 930 µg/g and fluoride from 810 to 15,000 µg/g.

Ten locations were probed during 1995 characterization activities to determine the depth of the sediment. The sediment depth varied from a high of 40 inches to a low of 10 inches, averaging 19.1 inches.

Soil samples have been collected from fourteen (14) locations around the North Ditch. Sample depths ranged from the surface to five (5) feet deep. Of the 62 uranium analyses, 37 (59.7%) were less than 35 pCi/g and 48 (77.4%) were less than 110 pCi/g. The maximum uranium concentration observed was approximately 510 pCi/g.

Interim Soils Storage Cell

Approximately 50% of the contaminated material in the Interim Soils Storage Cell is estimated to be contaminated with non-11e.(2) byproduct material.

Three primary sources of uranium-contaminated soils were initially placed into the Interim Storage Cell. These sources were the soil (sod) contaminated by the 1986 cylinder rupture (non-11e.(2) byproduct material); limestone gravel associated with a former hydrofluoric acid neutralization area; and soils from various excavation activities around the solvent extraction building which were temporarily stored on the yellowcake storage pad. The volume and uranium concentration of each of these units of contaminated soils are provided in the following table.

Soils Stored In the Interim Soil Storage Cell

	Approximate Volume (ft^3)	Concentration Average (µg/g)	Natural Uranium Range (µg/g)
Soil from 1986 accident	12,150	150	98 - 262
Gravel and soil from hydrofluoric acid neutralization pile	65,880	14	4 – 430
Soil excavated from around solvent extraction building	44,500	1220	<270 – 4082
Soil and ash drums	18,375	105	<3.4 – 6770
Soil and clay from Pond 4	13,932	7	<3.4 - 39
Total Volume	**154,887**		

Additional soils from other areas have also been placed in the cell. The respective volumes and concentrations, however, are small compared to the four primary units described above.

Calcium Fluoride Sludge and Basin Liners

The contamination of the calcium fluoride sludge and basin liners is considered to be 100% non-11e.(2) byproduct material. This material is currently located in the Fluoride Holding Basin #1, Fluoride Holding Basin #2 and the Fluoride Sludge Burial Areas. There is approximately 48,459,200 pounds (625,289 cubic feet) of calcium fluoride sludge, with an estimated uranium concentration of 0.032 wt %, for a total of 6,975 pounds (4.7 Ci) of uranium. Ra-226 contamination is estimated at 1.0 pCi/g for a total of 0.009 Ci Ra-226. Th-230 contamination is estimated at 188.0 pCi/g for a total of 1.80 Ci Th-230. Chemical analysis of the fluoride sludge is included in Attachment 1 of the Reclamation Plan.

Table 15: Study Area 1 Source Sampling Results

All Results Reported in UNITS -µg/g								
Metal	SD013	SD016	Upper P.I. Value	Background Conc. in U.S. Soils		EPA Risk Based Conc. for Soils		Subpart S SWMU Corrective Action Level for Soil
	24-Jan-95	24-Jan-95	RFI Bkgd Soil	Average	Range	Residential	Industrial	
Ag	< 0.6	< 0.6	0.6			390	5100	200
Al	4780	839	16760	72000	700 - > 10000	78000	100000	
As	133.0	17.3	39.8	7.2	< 0.1 - 97	23	310	80
Ba	40.5	13.9	188.4	580	10 - 5000	5500	72000	4000
Be	<0.05	< 0.05	1.6	0.92	< 1 - 15	0.15	0.67	0.2
Ca	369000	349000	3221	24000	100 - 320000			
Cd	< 0.7	< 0.7	8.1			39	510	40
Co	< 0.8	< 0.8	21.5	9.1	< 3 - 70	4700	61000	
Cr	30.2	15.2	33.5	54	1 - 2000	390	5100	400
Cu	48.6	14.8	23.1	25	< 1 - 700	2900	38000	
Fe	2660	1060	55793	26000	100 - 100000			
Hg	0.05	0.02	0.044	0.09	< 0.01 - 4.6	23	310	20
K	957.0	74.4	714	15000	50 - 63000			
Li	23.1	1.87	12.7	24	< 5 - 140	1600	20000	
Mg	2850	7250	1895	9000	50 - > 100000			
Mn	82.0	99.7	718	550	< 2 - 7000	390	5100	
Mo	< 1.2	< 1.2	1.2	0.97	< 3 - 15	390	5100	
Na	2020	3140	2305.3	12000	< 500 - 100000			
Ni	66.0	28.1	21.5	19	< 5 - 700	1600	20000	2000
P	241	112	315.4	430	< 20 - 6800			
Pb	< 10.0	< 10.0	32.7	19	< 10 - 70			
Sb	< 10.0	< 10.0	10.0	0.66	< 1 - 8.8	31	410	30
Se	< 10.0	< 10.0	10.0	0.3	< 0.1 - 4.3	390	5100	
Sr	74.9	65.7	27.9	240	< 5 - 3000	47000	610000	
Tl	< 10.0	< 10.0	24.3					
V	< 0.6	< 0.6	44.1	80	< 7 - 500	550	7200	
Zn	<0.5	< 0.5	58.0	60	< 5 - 2900	23000	310000	

SD013 - Calcium Fluoride Sludge (S.W. Area) SD016 - Calcium Fluoride Sludge Basin No. 1 (North)

Table 16: Summary Of Organics And Mercury Analysis
Positive Values Greater Than Or Equal To The Detection Limit Are Reported:

Source Investigation Samples:

SD013 (Fluoride Sludge Burial - Southwest Area)		
Mercury (Total)	PQL=0.01 mg/kg	Result=0.05 mg/kg
Acetone	PQL=0.1 mg/kg	Result=0.2 mg/kg
Di-n-butylphthalate	PQL=0.2 mg/kg	Result=0.35 mg/kg
SD013 Duplicate		
Mercury (Total)	PQL=0.01 mg/kg	Result=0.04 mg/kg
Acetone	PQL=0.1 mg/kg	Result=0.3 mg/kg
SD016 (Fluoride Settling Basin No. 1 - North)		
Mercury (Total)	PQL=0.01 mg/kg	Result=0.02 mg/kg
Acetone	PQL=0.1 mg/kg	Result=0.2 mg/kg

Attachment 3
TCLP Leachability[1] Analysis On CaF Sludge

FLUORIDE SLUDGE March, 1993[2]									
ANALYSIS	As	Ba	Cd	Cr	Pb	Hg	Se	Ag	U
Total Metals, mg/kg Fluoride Holding Basin 1	141.0	14.0	<0.3	22.8	2.8	NA[3]	<3.0	1.9	NA
Total Metals, mg/kg Fluoride Holding Basin 2	2.5	13.6	<0.3	16.4	2.0	NA	<3.0	1.8	NA
Total Metals, mg/kg Fluoride Settling Basin 1	67.1	23.3	<0.3	18.3	4.4	NA	<3.0	2.0	NA
Total Metals, mg/kg Fluoride Settling Basin 2	17.2	20.5	<0.3	13.9	3.1	NA	<3.0	5.3	NA
Total Metals, mg/kg Fluoride Clarifier	3.5	14.4	<0.3	11.1	2.5	NA	<3.0	<0.3	NA
Leachable Metals, mg/l Composite Sample[4]	0.018	0.30	<0.025	<0.05	<0.01	<0.0002	<0.01	<0.05	NA
Total Metals, mg/kg Composite Sample[3]	NA	NA	NA	NA	NA	NA	NA	NA	1245

NOTES:

(1) The term "leachable" as used here means the sample was extracted utilizing methodology associated with the RCRA TCLP procedure.
(2) Only a partial list of parameters are included here.
(3) In the table the term "NA" means "not available".
(4) A composite sample from each impoundment which stores the sludge was combined into a single composite sample and analyzed.