



UNITED STATES
NUCLEAR REGULATORY COMMISSION
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MEMORANDUM FOR: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Robert B. Minogue, Director
Office of Standards Development

FROM: Saul Levine, Director
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER NO. 71
REGIONAL TECTONICS AND SEISMICITY OF EASTERN NEBRASKA
ANNUAL REPORT JUNE 1, 1977 - MAY 30, 1978

REFERENCES:

1. Letter W. R. Stratton to Dixie Lee Ray dated May 16, 1973, Subject: Report on Seismic Research
2. Title 10, Chapter 1, Part 100, CFR Appendix A - Seismic and Geologic Siting Criteria for Nuclear Power Plants
3. Memo N. B. Steuer to R. J. Mattson dated July 15, 1975, Subject: U.S. Tectonic Province Map

INTRODUCTION

This memo transmits NUREG/CR-0876 entitled, "Regional Tectonics and Seismicity of Eastern Nebraska." The research effort to produce this report was conducted by the Nebraska Geological Survey. This research is a cooperative geologic, seismic and geophysical effort of the State Geological Surveys of Oklahoma, Kansas, Nebraska, Iowa and Minnesota to study the earth science parameters of the Nemaha Uplift and the Midcontinent Gravity Anomaly. The Nemaha Uplift and Midcontinent Gravity Anomaly are buried geologic structures along which may be mechanisms that have caused earthquakes. Hence, a knowledge of the Nemaha Uplift and Midcontinent Gravity Anomaly and whether or not they are localizers of earthquakes are of vital importance in the siting and licensing of nuclear power plants.

SUMMARY

This annual report presents and interprets the information obtained by the Conservation and Survey Division (Nebraska Geological Survey) during contract year June 1, 1977, to May 30, 1978, under contract number NRC-04-76-315 with the U.S. Nuclear Regulatory Commission. The

information pertains to the geology, structure, tectonics, and seismicity of eastern Nebraska with emphasis on the vicinity of the Humboldt Fault Zone in western Richardson and eastern Pawnee counties. Some of the information presented here results from a combination of studies begun in earlier years, but the greater part results from studies begun during the contract year.

The scope of the studies is summarized as follows:

1. Rock outcrops in western Richardson and eastern Pawnee counties were reexamined and reevaluated, and 64 test holes were drilled to determine the altitude of the upper surface of the Tarkio Limestone of Pennsylvanian age.
2. The possible relation of earthquakes in eastern Nebraska to Pleistocene glaciation was evaluated.
3. Three new seismograph installations were established in southeastern Nebraska.
4. Gravity surveys of western Richardson and eastern Pawnee counties were extended to the northern end of the Humboldt Fault Zone and were evaluated.
5. Ground magnetic surveys in western Richardson and eastern Pawnee counties were made and evaluated.
6. Gravity and ground magnetic surveys of the Elk Creek Anomaly were made and evaluated.

Discussions of the results of these studies constitute the report.

CRITERIA FOR STUDY AREA SELECTION AND OBJECTIVES OF STUDY

The midcontinent area of the United States has a number of population centers that have undergone rapid growth during the period since the second World War. This increased growth, in conjunction with the increase in fossil fuel costs, has stimulated electrical generation companies to consider nuclear power plants as a viable means to provide additional energy. There are, at the present time, two operating and four proposed nuclear power plants in Nebraska, Kansas, and Oklahoma. At least three more are being considered for this same area. All of the existing and proposed plants are located within or adjacent to an area which has been designated as seismic risk zone 2--an area having had earthquakes with resulting moderate damage and corresponding to seismicity up to MM VII.

NRC rigorous guidelines must be adhered to before a permit to construct a nuclear power plant is granted to an applicant. Local, as well as regional seismicity and structural relationships play an integral role in the final design criteria for nuclear power plants. This requires that a value for the maximum expectable seismic event be assigned at a proposed site. The existing historical record of seismicity is inadequate in a number of areas of the Midcontinent region because of the lack of instrumentation and/or the sensitivity of the instruments deployed to monitor earthquake events. This inadequacy has made it necessary to rely on the delineation of major tectonic provinces that are based on broad regional geologic structure and associated seismicity. The delineation of tectonic provinces, which accurately reflect the potential magnitude of seismic events, is an important cost and risk factor in assigning appropriate design criteria for nuclear power plants.

Many earthquakes have occurred along the Nemaha Uplift, and they have, in the past, been ascribed to crustal adjustment associated with that structure. More recently, geologists have theorized that they are related to Precambrian basement configuration, structure and lithology, and are genetically related to the Arbuckle, Nemaha, and Keweenaw Mafic Belt structures stretching from Southern Oklahoma to the Northern Peninsula of Michigan. Little is known about the relationships of these structures, and this project will be a part of a larger study effort to investigate their possible interaction.

The objectives of the project are to delineate the Nemaha Uplift and its associated structures, to investigate the relationships between the Nemaha Uplift and the Keweenaw Mafic Belt, and to assign realistic values for maximum seismic magnitude in the region. In order to carry out the above objectives, the Geological Surveys of Oklahoma, Kansas, and Nebraska have established seismic networks in Oklahoma, central and eastern Kansas, and eastern Nebraska. Seismic data from the networks are collected and forwarded to the Oklahoma Geological Survey. Seismograms already in existence, but unpublished, are being gathered and compiled. Gravity and aeromagnetic studies are being performed, and detailed field studies undertaken where necessary. Final results will be presented in the form of a series of maps and tables at a scale of 1:1,000,000 accompanied by explanatory text. These will outline the relative seismicity in the study area and attempt to correlate it with tectonic features known from surficial and subsurface geological and geophysical evidence.

This investigation will be closely related to an NRC-sponsored study conducted by the Geological Surveys of Minnesota and Michigan and the University of Minnesota and Michigan Technological University.

BACKGROUND

Support for Licensing Decisions

In 1973 (Ref. 1), the ACRS recommended that investigations be initiated to determine the reasons for, and source of, earthquakes in areas of the eastern U.S. where large shocks have occurred.

This recommendation also was, in part, brought about by Appendix A, 10 CFR Part 100 (Ref. 2) which establishes requirements for seismic and geologic site investigations for nuclear power plants and associated nuclear facilities necessary for evaluation of the site and for providing information needed for engineering designs. Paragraph (6), Section IV of Appendix A requires that, where possible, epicenters of historically reported earthquakes be correlated with tectonic structures, any part of which is within 200 miles of the site; and that epicenters or locations of highest intensity, which cannot reasonably be correlated with tectonic structures, should be identified with tectonic provinces, any part of which is within 200 miles of the site.

This part of the Regulation was developed to take into account the fact that tectonic settings of the eastern U.S. are significantly different from those of western U.S. The Regulation does not provide guidance in the form of a map to establish seismotectonic provinces in the East. This has resulted in lengthy licensing delays because of the time needed to resolve controversies among applicants and the public and NRC regarding tectonic province boundary locations.

In 1974, the Office of Standards Development undertook an effort to develop an eastern U.S. Seismotectonic Province Map; however, when the map was completed, there was a consensus opinion that it was not adequate to clarify Appendix A to 10 CFR which requires the tectonic province approach. There remained specific information needs to be satisfied in order to develop a map which will be a useful regulatory tool. That is, more geologic data and seismologic input are needed to more accurately delineate eastern U.S. seismotectonic provinces. Consequently, the cooperative geologic and seismic programs were undertaken with state geological surveys and universities to gather regional data to: (1) help delineate tectonic provinces; (2) identify earthquake source mechanisms; (3) improve knowledge of regional geologic conditions; (4) provide data to confirm past licensing decisions; (5) expand the existing geologic and seismic data base; and (6) to provide a consistent data base.

Approximately 23 state geological surveys and universities are cooperating under NRC funding to provide data needed to develop a data base for an eastern U.S. seismotectonic province map. The studies are being conducted in three phases: Phase I -- existing data compilation (complete); Phase II -- new data acquisition; and Phase III -- problem

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areas of the eastern U.S. and a seismotectonic provinces map. Many of these cooperative programs were funded initially by the Office of Standards Development (Ref. 3). Later, the program responsibility was transferred to the Office of Nuclear Regulatory Research because of their long-term nature.

RESULTS

This is an interim report, hence, results and conclusions are preliminary, and may be modified or changed as additional data are obtained. Please refer to Page 2; results to date are summarized under "The Scope of the Studies."

RECOMMENDATIONS

It is recommended that the information contained in NUREG/CR-0876 be considered by the Office of Standards Development and the Office of Nuclear Reactor Regulation as input to the development of a tectonic province or seismic zoning map of the eastern U.S. and to provide a basis and guide for ongoing studies in the area.

Additionally, RES recommends that studies and data gathering activities be continued in this area so that we may better understand the geology and seismicity of the eastern U.S. Researchers should make annual oral presentations to all NRC geologists and seismologists so that work progress can be discussed and studies redirected and/or modified, if necessary.

Technical questions concerning NUREG/CR-0876 results may be directed to Neil B. Steuer at 427-4370.



Saul Levine, Director
Office of Nuclear Regulatory Research

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Original Signed By
Saul Levine

Saul Levine, Director
Office of Nuclear Regulatory Research

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