



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

OCT 18 1979

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. 62
NEW MADRID SEISMOTECTONIC STUDY

- 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's O379 and CR-0450 titled "New Madrid Seismotectonic Study Activities During Fiscal Years 1977 and 1978." The research efforts to produce these reports are a cooperative effort conducted by the Illinois Geological Survey, the Indiana Geological Survey, the Missouri Geological Survey, the Kentucky Geological Survey, the Arkansas Geological Survey, Vanderbilt University, the Alabama Geological Survey, Purdue University and Memphis State University. This cooperative geologic, seismic and geophysical effort was coordinated by Dr. Thomas Buschbach of St. Louis University.

SUMMARY

The New Madrid Seismotectonic Study is a coordinated program of geological, geophysical, and seismological investigations of the area within a 200 mile radius of New Madrid, Missouri. The study is designed to define the structural setting and tectonic history of the area in order to realistically evaluate earthquake risks in the siting of nuclear facilities. An important goal of the research program is to produce useful seismotectonic and seismic zoning maps for the study area.

Fiscal year 1978 was the second year of a five-year program. Results of aeromagnetic surveys funded in FY 77 were integrated with previously existing data in adjacent areas. Extensive gravity surveys were made in Kentucky and Indiana near the intersection of the 38th Parallel Lineament and the north-eastern extension of the New Madrid Seismic Zone. The stations were gravimetrically tied to the national network, and preliminary Bouguer gravity

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anomaly maps were constructed. An interesting relative positive anomaly occurs parallel to the Wabash Valley Fault System.

Seismic equipment was prepared for crustal seismic studies, and a seismic refraction line 150 kilometers long was monitored along the Wabash Valley Fault System. Geologic studies are underway in the Wabash River area, and seven stations of the Wabash Valley Seismic Network were installed and are currently operating.

Subsurface geologic studies during the year have:

1. located suspected faulting in Tertiary sediments of the Missouri Bootheel;
2. found fossils of Middle Cambrian Age in deep sediments of western Kentucky. The rocks are correlated with the Conasuag strata of Eastern United States and represent the oldest sedimentary rocks identified in our area;
3. indicated that a broad expanse of fine clastic sediments, possibly pre-late Cambrian Age, is present immediately below Cretaceous strata in the Pascola Arch area;
4. suggested that faulting does not occur in a continuous line along the base of the Tiptonville scarp, near Reelfoot Lake, Tennessee, as had been indicated by earlier trenching in the area; and
5. provided data for the preparation of preliminary maps showing rock types and configuration of the Precambrian igneous basement.

BACKGROUND

Refer to RIL No. 48, "A Tectonic Overview of the Midcontinent." The background information in RIL 48 applies equally to this RIL. It covers ACRS recommendations, relevance of 10 CFR Part 100 Appendix A to the study, and previous NRC effort and organization of the current programs.

Criteria for Study Area Selection

Late in 1811 and early in 1812, the New Madrid area was the site of the strongest series of earthquakes ever recorded in the central United States. The Saint Louis University seismograph network recorded close to 200 seismic events each year for the past two years, indicating that the area continues to be seismically active. Evaluating seismic risk for the surrounding region, especially when consideration is given to the siting of nuclear facilities, requires a better understanding of the structure and tectonics of the area and their relationship to the seismicity than is presently available.

Planning

An initial five-year program is planned; general plans for the first four years have been formulated (Table 1), and a generalized flow chart of NUREG/CR-0450 (Table 2) and this memo indicate the proposed timing of efforts

within the broad categories of this study. Research performed by State Geological Surveys and universities under contracts with the USNRC are fully coordinated in this cooperative study, and reports of research activities by those organizations during FY 77 and FY 78 are included. In addition, virtually all pertinent geologic research performed in the area by Federal and state agencies, and by the major universities, has been coordinated with the research projects funded through USNRC. Only the general scope and regional significance of research sponsored by the other agencies are reported in this summary.

New Madrid Research Programs

Nine research proposals were supported by the U.S. Nuclear Regulatory Commission for the cooperative study of geology, geophysics, and seismology in the New Madrid area.

The project titles of the coordinated research programs, the investigators, and the participating organizations are:

- A. Coordination of a Cooperative Seismotectonic Study of the New Madrid Area; T. C. Buschbach, Illinois State Geological Survey.
- B. An Integrated Geophysical and Geological Study of the Tectonic Framework of the 38th Parallel Lineament in the Vicinity of Its Intersection with the Extension of the New Madrid Fault Zone; L. W. Braile and W. J. Hinze, Purdue University; E. G. Lidiak, University of Pittsburgh, G. R. Keller, University of Texas at El Paso.
- C. Near Surface Geology of the Reelfoot Lake District of the New Madrid Earthquake Region; R. G. Stearns, Vanderbilt University.
- D. Structural Geologic Study of Southeastern Missouri; Thomas L. Thompson, Ira Satterfield, and Ronald Ward, Division of Geology and Land Survey, Missouri Department of Natural Resources.
- E. Paleozoic Geology of the New Madrid Area; H. P. Schwalb, Kentucky Geological Survey.
- F. A Study of Indiana Fault Locations, Displacements, Attitudes and Ages Within a 200-Mile Radius of New Madrid, Missouri; Dan M. Sullivan and Curtis H. Ault, Indiana Geological Survey.
- G. Structural Framework of the Mississippi Embayment of Southern Illinois; Dennis R. Kolata, Illinois State Geological Survey.
- H. Memphis Area Regional Seismic Network; Laurence Lackey, Memphis State University.
- J. A Seismological Study of the Northern Extent of the New Madrid Seismic Zone; R. B. Herrmann, St. Louis University.
- K. The Wabash Valley Fault System in Southeastern Illinois; Hubert M. Bristol and Janis D. Treworgy, Illinois State Geological Survey.
- L. Stratigraphy of the Pleistocene Loess Deposits in the New Madrid Region; John C. Frye, Geological Society of America; H. D. Glass and H. B. William, Illinois State Geological Survey.

RESULTS

NUREG's 0379 and CR-0450 describe data currently being gathered and present some preliminary results of the state of the earth's crust, including geologic history, basement geology, contemporary seismology, and geophysics of the area within a 200 mile radius of New Madrid, Missouri.

The present geologic and seismic data base is insufficient to evaluate the area fully. A satisfactory seismotectonic model for the New Madrid region should be based on the concepts developed from results of the studies and must consider the lateral and vertical variations in composition and physical properties, fault zones and intraplate boundaries imposed by past deformational and thermal events. It is clear from the reports that an understanding of the contemporary tectonism of this area requires definition of the tectonic history and sequence of events which have resulted in the present geologic setting in the interior of the North American Plate.

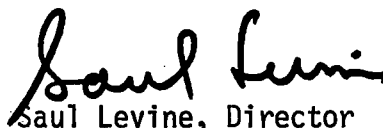
Study results are being used by Rondout Associates, Inc., in a project funded by the Office of Nuclear Reactor Regulation to produce a seismic zoning map for the Eastern U.S. Additionally, data gathered by the New Madrid Seismotectonic Study are considered by the NRR staff in making licensing decisions.

RECOMMENDATIONS

It is recommended that the information in NUREG-0379 and CR-0450 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 be continued in this area to attain the objectives previously stated, with redirection and modification of projects as deemed necessary by ongoing work.

Technical questions concerning NUREG-0379 results may be directed to Neil B. Steuer at 427-4370.



Saul Levine, Director
Office of Nuclear Regulatory Research

Enclosures:

1. NUREG-0379
2. NUREG/CR-0450
3. Table 1
4. Table 2

SUMMARY OF PROGRAM PLANNING
 COOPERATIVE SEISMOTECTONIC STUDY OF NEW MADRID AREA
 T. C. Buschbach, Coordinator

Year	Seismology	Geophysics	Geology
1977	<ol style="list-style-type: none"> 1. Survey of historical seismicity 2. Install 8-station broadband seismic array in Wabash Valley. 3. Install 8-station high frequency seismic array in New Madrid seismic zone. 	<ol style="list-style-type: none"> 1. Survey of gravity and magnetic coverage in area. 2. Gravity and magnetic surveys in areas lacking coverage. 3. Ground-magnetic surveys to check aeromagnetic anomalies. 	<ol style="list-style-type: none"> 1. Survey of subsurface data. 2. Sample studies of critical deep wells. 3. Determine location, depth, and petrology of igneous rocks in borings. 4. Survey of surface mapping. 5. Field mapping and fault studies with some trenching. 6. Construct work maps on Precambrian top, Ordovician structure, isopachs.
1978	<ol style="list-style-type: none"> 1. Acquire, process, and display data from New Madrid and Wabash Valley arrays. 2. Deep structural investigations. 3. Determine proposed locations for boreholes to Precambrian in New Madrid vicinity and suggest instrumentation that should be installed in holes. 	<ol style="list-style-type: none"> 1. Gravity and magnetic surveys in areas lacking coverage. 2. Detailed gravity and ground-magnetic surveys of critical anomalies. 3. Detailed interpretation of available magnetic and gravity data. 4. Seismic refraction across 38th Parallel Lineament. 	<ol style="list-style-type: none"> 1. Field mapping and fault studies with some trenching and drilling to show ages and extent of faults. 2. Geomorphology studies—Loess, gravel, terrace levels to determine recent warping and faulting. 3. Basement geology studies. 4. Dating of igneous rocks. 5. Sample and core studies of deep borings. 6. Studies of lineaments in the area.
1979	<ol style="list-style-type: none"> 1. Acquire, process, and display data from New Madrid and Wabash Valley arrays. 2. Synthesize seismologic data for input into geophysical studies for selection of traverses for deep reflection seismograph survey. 	<ol style="list-style-type: none"> 1. Complete all gravity and magnetic work in area. Reduce data, compile regional maps. 2. Deep reflection seismic survey across linear zones of earthquake activity. 3. Seismic refraction surveys in areas with faulted Tertiary sediments. 4. Seismic reflection-Wabash Valley 	<ol style="list-style-type: none"> 1. Field mapping and fault studies with some trenching and drilling. 2. Geologic interpretations of seismic activity and geophysics of New Madrid seismic zone to locate deep reflection seismic traverse. 3. Geomorphology studies (continued). 4. Complete structure and isopach maps. 5. Field checks of significant features established by remote sensing studies.
1980	<ol style="list-style-type: none"> 1. Summarize and compare seismologic data acquired from New Madrid area with data from Wabash Valley Area 2. Supervise installation of seismometer in Precambrian test to be drilled in area of high seismicity. 	<ol style="list-style-type: none"> 1. Integrate geophysical and geological observations in order to prepare finalized version of tectonic synthesis. 2. Supervise magnetic susceptibility and heat-flow studies for boreholes to be drilled into Precambrian rocks. 	<ol style="list-style-type: none"> 1. Prepare regional geologic maps, soil maps, and structure maps for New Madrid Area. 2. Supervise drilling of two or three boreholes into Precambrian rocks across crest of Pascola Arch.

Table 1 - Summary of Program Planning

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Table 2

Generalized Flow Chart - New Madrid Seismotectonic Study

	1977	1978	1979	1980	1981	
GEOLOGY	Geologic history and geologic setting					Construct usable seismotectonic maps
		Structural history and structural setting				
		Basement geology and configuration of basement surface				
				Borehole(s) to Precambrian in area of high seismicity	Construction of regional geologic maps and structure maps. Show location and age of faults.	
		Location, age, petrology of intrusive rocks				
		Quaternary geology studies				
GEOPHYSICS	Geophysical measurements of the earth: Gravity, Magnetics, Resistivity, Seismic					
		Integrate geophysical data-compile regional maps				Analysis of contemporary geodynamics: Relationship of seismic activity to geologic and tectonic history of the area.
	Overview of tectonic setting					
		Overview of crustal rifting				
			Evaluation of tectonic hypotheses			
			Seismic refraction across 38th Parallel			
				Seismic reflection in Wabash Valley		
SEISMOLOGY	Establish seismograph arrays					
	Interpret data from seismograph arrays					
		Focal mechanism studies				Comparison of the nature of seismicity near New Madrid with seismicity in surrounding regions.
			Ground motion modelling			
				Install seismometer, etc. in borehole to Precambrian		

RESULTS

NUREG's 0379 and CR-0450 describe data currently being gathered and present some preliminary results of the state of the earth's crust, including geologic history, basement geology, contemporary seismology, and geophysics of the area within a 200 mile radius of New Madrid, Missouri.

The present geologic and seismic data base is insufficient to evaluate the area fully. A satisfactory seismotectonic model for the New Madrid region should be based on the concepts developed from results of the studies and must consider the lateral and vertical variations in composition and physical properties, fault zones and intraplate boundaries imposed by past deformational and thermal events. It is clear from the reports that an understanding of the contemporary tectonism of this area requires definition of the tectonic history and sequence of events which have results in the present geologic setting in the interior of the North American Plate.

Study results are being used by Roundout Associates, Inc., in a project funded by the Office of Nuclear Reactor Regulation to produce a seismic zoning map for the Eastern U.S. Additionally, data gathered by the New Madrid Seismotectonic Study are considered by the NRR staff in making licensing decisions.

RECOMMENDATIONS

It is recommended that the information in NUREG-0379 and CR-0450 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 be continued in this area to attain the objectives previously stated, with redirection and modification of projects as deemed necessary by ongoing work.

Technical questions concerning NUREG-0379 results may be directed to Neil B. Steuer at 427-4370.

DISTRIBUTION:

Subject Murley, cy
Circ Shao, cy
Chron Beratan, cy
Steuer, rf Jackson, cy
Harbour, cy Larkins, cy
Kenneally, cy Budnitz, cy
Levine, cy

Saul Levine, Director
Office of Nuclear Regulatory Research

Enclosures:

1. NUREG-0379
2. NUREG/CR-0450
3. Table 1
4. Table 2

OFFICE	SD:BC	NRR/BO	GRSR/RSR:D	RES	RES:D
Steuer/Harbour			V. C. Shao	J. Larkins	
Kenneally	L. Beratan	R. Jackson	T. E. Murley	R. Budnitz	S. Levine
DATE	08/30/79	9/12/79	9/14/79	/ /79	/ /79

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OFFICE ▶	SSRB/GRSR *	SD:BC*	NRR:BC*	GRSR:AD* RSR:D	RES	RES:D
SURNAME ▶	Steuer/Harbour Kenneally	L. Beratan	R. Jackson	L. Q. Shao T. E. Murley	J. Larkins R. Budnitz	S. Levine
DATE ▶	8/30/79	9/12/79	9/14/79	10/2/79	1/79	1/79

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Original Signed By
Saul Levine

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