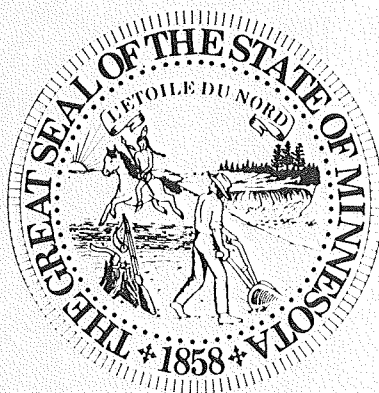


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STATE OF MINNESOTA

***Review of the U.S. Department of Energy's
National Survey of Crystalline Rocks***

April 1986



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STATE OF MINNESOTA

REVIEW OF THE U.S. DEPARTMENT OF ENERGY'S
NATIONAL SURVEY OF CRYSTALLINE ROCKS

I. INTRODUCTION

In February of 1983, the U.S. Department of Energy (DOE) formally notified the Governors of 17 eastern states that crystalline rock formations in those states were under consideration for the nation's second repository for high-level radioactive waste. The DOE divided the states among three regions, as follows: North Central Region - Minnesota, Wisconsin, Michigan; Northeastern Region - Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania; and Southeastern Region - Maryland, Virginia, North Carolina, South Carolina, and Georgia.

The notification of the Governors was followed by the April, 1983, release of a document entitled A National Survey of Crystalline Rocks and Recommendations of Regions to be Explored for High-Level Waste Repository Sites (OCD-1). This document summarized the results of a nationwide crystalline rock survey that was purported to be the basis for the selection of the 17 states. Although a number of states have criticized the scope and quality of the national survey before and after its publication, the DOE has continued to portray the survey as a systematic and thorough effort that fully justified the selection of the 17 subject states.

In August, 1985, in an effort to conduct a complete review of the national survey, the State of Minnesota informally requested

that the Crystalline Repository Project Office in Chicago provide the State with pertinent background documents and records related to the preparation of the national survey. The DOE failed to respond and, on October 10, 1985, the State of Minnesota filed a Freedom-of-Information-Act request for the materials. The request was subsequently withdrawn following agreement by the DOE to provide the materials, which were finally received by the State on November 26, 1985.

Review of these documents revealed that the initial national survey of crystalline rocks, conducted in 1979 and summarized in a draft report labeled ONWI-50, was seriously flawed. The survey was found to be underfunded, and it was assigned little of the time or staff resources necessary for such an important undertaking.

As a result, the technical work performed by the DOE contractor was extremely poor, as evidenced by the harsh criticism leveled at the draft report (ONWI-50) by state technical reviewers and other interested parties. The survey relied on out-of-date scientific literature. Certain geologic screening variables that favored selection of eastern crystalline rock were exaggerated. Definitions were applied inconsistently and water resources were not adequately addressed. There was no weighting of variables to indicate relative importance, and the few western crystalline rock bodies that survived the distorted screening were subsequently eliminated for arbitrary reasons.

Over three years later this same survey was resurrected (with only four months of additional effort) under a different cover (OCD-1) without any state or public review and comment period. This "new" survey, with exactly the same format and conclusions

as the original, was intended to serve as the foundation for all future siting work.

The review of the available national survey documents, as well as other historical records, also indicated a bias towards concentration of the crystalline rock studies in the eastern United States. This bias is attributable, in some part, to the concept of "regionality" and inappropriate interpretations of the Nuclear Waste Policy Act of 1982 that suggest a goal of locating a second repository in the eastern half of the country. When Congress passed the Nuclear Waste Policy Act, it included references to regionality, but did not mandate that the DOE place a second repository in the eastern United States or that a second repository be sited in crystalline rock.

Based on the interrelated factors introduced above, it is apparent that the DOE decision to focus the crystalline repository program on three regions in the eastern half of the United States was not based on sound technical judgement and information, nor was it the product of a systematic and thorough decision process. This failing is a serious one because it reveals that the very foundation of the crystalline repository siting process was technically flawed and biased. This affects not only the technical credibility of the program, but also the assumption that it has been executed in a fair and equitable manner.

II. MAJOR DEFICIENCIES IN THE NATIONAL CRYSTALLINE ROCK SURVEY METHODOLOGY

The first attempt at surveying the nation's crystalline rock was documented in a December, 1979, draft report entitled Crystalline Intrusives in the United States and Regional Geologic Characteristics Important for Storage of Radioactive Waste. This report was prepared by Dames & Moore for the Office of Nuclear Waste Isolation (ONWI) of Battelle Memorial Institute, a contractor for DOE. The report was labeled ONWI-50. The conclusions reached in the ONWI-50 draft included identification of eight regions in the U.S. that merited further siting consideration. In addition, three regions were described as potentially favorable; the Lake Superior, Northern Appalachian, and Southern Appalachian Regions. An insert to the ONWI-50 draft, entitled Department of Energy Position Statement on this Dames & Moore Draft Report, noted that, "DOE believes the Dames and Moore report provides sufficient information to designate these three regions as having priority for further regional studies" (Dames and Moore, 1979 - ONWI-50).

Comments on 1979 Draft Survey Highly Critical

Comments on the ONWI-50 draft were solicited from affected states and interested parties. State geologists and other experts who reviewed the report were highly critical of the quality of the data base and the methodology.

The South Carolina State Geologist concluded the following in his review, as transmitted to the Governor:

"ONWI-50 has many deficiencies. Our geologic reviewers all generally agreed that:

- the discussion of the regional and structural geology is vague and superficial, and in some sections so elementary that the text is of no value whatsoever;
- many references are outdated, some by approximately 10 years, not reflecting either the advances in geologic research within the past five years or so, or an awareness that some older works have been superseded;
- several statements in the report are just plain incorrect; and
- the report is poorly documented and written to the extent that it does not provide local, state and regional leaders with adequate geologic information upon which to make a decision.

It is apparent that the Dames and Moore staff member(s) who prepared this report (certainly the Southern Appalachians portion) were not qualified to do the thorough, sophisticated task required for radioactive waste storage."
(Olson, 1980)

Other comments were received from the faculty of the University of South Carolina:

"Geologic concepts are presented at a too elementary level, so much so that the impression is given that this is not intended as a technical report, or that the writers of the report were unwilling or incapable of presenting geologic concepts at much more than a high school level...The literature from regional geology cited in this report is minimally eight (8) years out of date. Most of the

presentation is overgeneralized and contains large gaps...We recommend that no judgements be made related to disposal of radioactive waste in South Carolina. This report does not provide any basis for a professional scientific evaluation." (Secor, et. al., 1980)

The Vermont State Geologist's comments included the following:

"The Dames and Moore paper...presents what I consider a very general and questionable evaluation. By its own admittance, too little is known (as revealed by the investigative depth of this report) of the critical characteristics to make accurate evaluations. (Ratte', 1980)

Similar comments were forwarded to the DOE from the Minnesota Geological Survey:

"Bluntly, the study is fundamentally ill conceived in terms of its technical objectives and incompetent in terms of its technical execution. In our opinion it was seriously flawed to begin with by the unrealistic constraint that it be based only on 'national' literature (whatever that means). But even accepting that arbitrary handicap it is an incompetent evaluation of the 'national' literature, ... can only conclude that the actual work of authorship on the report within the Dames and Moore staff was done by someone with limited qualifications in relevant fields of geology. ... To summarize our evaluation of the report: it makes inadequate and incompetent use of the geologic information in the public domain bearing on the problem of granitic environments for nuclear waste isolation, and it designates areas, makes evaluations and arrives at conclusions which are, to say the least, premature with respect to the existing data base and the definition of the problem." (Walton, 1980)

"Section 2.0 on crystalline intrusives is very poor. The writer is out of touch with the latest thinking on the form, origin, and classification of coarse-grained igneous rocks. ... Evidently there was no effort made to make the various maps in the ONWI report consistent with one another. This is just plain shoddy. The section on structure and seismicity (6.2) is incredibly bad. The writer has no comprehension of either the structures themselves or their significance. ... The section on mineral and energy resources is naive." (Southwick, 1980)

"...I must conclude that the authors of Chapter 6.0 [Lake Superior Crystalline Rocks] made very little attempt to survey the contemporary literature on the geology of the Lake Superior region--literature readily available in any reasonable-size geology library. ... Although I can understand the political reasons for the non-consultive policies established by DOE, I believe that total lack of any reference to "best available" data discredits the overall validity of the report, particularly in the eyes of professional geologists or informed layman who are knowledgeable of a particular area. ... There is yet another general problem that requires comment. As I have tried to show in my detailed comments, the authors have generalized so much that some of their data and conclusions are wrong. ... As the report now stands, Chapter 6.0 is at best simple-minded and at worst incomplete, erroneous, and misleading." (Morey, 1980)

Insufficient Time, Funding, and Effort

Such comments are not surprising given the time and the funding constraints of the national survey. In fact, the DOE internal communication records highlight some of the survey limitations:

"There simply is not enough time or money for the full blown exploration programs similar to those hitherto prosecuted in salt, in granitic rocks under the new assumptions [to allow for an adequate survey]. ...significant additional funds would be required and a granitic candidate site in the 1988-89 period might well prove unachievable." (Newcomb and George, 1981)

"...an attempt to explore every region in the country that exhibits potential, and thereby try to define the best site is currently a fiscal impossibility." (Nicks and Shipler, 1980)

The most damaging summary of the level and quality of effort expended in completing the national survey appeared in a letter from the DOE contractor office responsible for the ONWI-50 draft report:

"It is perhaps worth stating at the outset that all of us, both within ONWI and within DOE, grossly underestimated the impact of ONWI-50. This report was prepared almost as a formality. Since we (all parties since the inception of the NWTs Program) have said repeatedly that we would do a national screening and select regions for further evaluation based on this screening, it seemed pertinent to do so. However, it has never been the intent for this to be a really thorough study. In the case of Dames and Moore, something less than 1.0 man-year was expended on this task." (Carter, 1980)

The minimal level of investigation characteristic of the ONWI-50 draft report was clearly insufficient for a thorough national survey and regional selection process. The less than 1.0 man-year level of effort in 1979 permitted only a cursory examination of existing published literature, much of which was

apparently outdated, and was severely limited by time and budget constraints. Although comments on the draft report were solicited and received, DOE never released a final ONWI-50 report.

DOE Revives Flawed 1979 Draft Survey

The passage of the Nuclear Waste Policy Act in 1982 provided the DOE with access to new resources. Congress directed that the nuclear waste program be paid for by the utilities generating nuclear power and assessed fees to establish the Nuclear Waste Fund. This funding mechanism would have permitted a systematic and thorough national survey of crystalline rock and given the DOE an opportunity to correct the serious and fundamental problems that were evident in the 1979 ONWI-50 draft report.

The DOE, however, elected to resurrect the inferior technical work contained in the three-year-old ONWI-50 draft as the basis for a new report, entitled A National Survey of Crystalline Rocks and Recommendations of Regions to Be Explored for High-Level Radioactive Waste Repository Sites. The report, labeled OCRD-1, was intended to be the foundation for the post-Act crystalline repository siting program. In December, 1982, Battelle National Laboratory, the prime technical contractor for the Crystalline Repository Program, was directed to begin work on OCRD-1 (Smedes, 1985). Two months later, in February, 1983, an internal draft of the report was completed. This was one month after the Act was signed into law by the President (January 7, 1983).

No Public Review of 1983 Draft Survey

Contrary to usual practice, the draft OCRD-1 report was not made available for public review, despite the past criticism of the

ONWI-50 draft report and the three year time lapse since its issuance. This is particularly significant because OCRD-1 was the foundation of the crystalline repository program and the basis for the selection of the 17 states. It had to be issued before any of the other crystalline documents were released. In a February 24, 1983, letter to Dr. Sally Mann, Director of the DOE Crystalline Repository Project, the contractor (Battelle Memorial Institute) urged a hurried review of the internal draft so that other related reports would not be delayed:

"Ten copies of the subject document are attached for distribution and review. Please remember that this is an internal preliminary draft which is being reviewed by OCRD geotechnical and administrative staff, H. Smedes, the USGS, and your reviewers at the same time in order to compress total review time.

Review comments on this preliminary draft should be returned by 10 March. The short turn-around time is necessary so that all review comments can be addressed in the final document, which is to be issued around 1 April prior to release of the regional geologic and environmental characterization reports." (Madia, 1983)

After completion of the internal review, the final OCRD-1 report was released in April, 1983. Because the report was only issued in a final form, there are no state or peer group comments to cite as there were for the ONWI-50 draft report. Among the final OCRD-1 report's conclusions was the following:

"The results of the national geologic reconnaissance and evaluation summarized in this report indicate that...

3. On the basis of the evaluation, it is concluded that three of the regions could be explored more

effectively and sites probably could be found, characterized, verified, and licensed more readily there than elsewhere. They are the Lake Superior Region, Northern Appalachians, and Southern Appalachians." (U.S. DOE, 1983a - OCRD-1)

It comes as no surprise that the conclusions of OCRD-1 and the ONWI-50 draft are exactly the same, given the fact that only two months were spent developing the internal draft of OCRD-1. In addition, it was necessary for the DOE to endorse the direction that had already been taken two years before when the National Waste Terminal Storage Program Office was instructed to begin studies in the regions identified in the ONWI-50 draft, despite the absence of a final report. "Regional studies were begun in October, 1980, in the Northeastern and Southeastern regions and in December, 1980, for the North Central Region (Minnesota initially)." (U.S. DOE, 1983b)

The OCRD-1 report failed to remedy the deficiencies in the ONWI-50 draft. Superficial changes did little to improve on the poor quality of the technical work. Like the ONWI-50 draft, the methodology documented in OCRD-1 is illogical and biased in a manner that results in a preference for eastern crystalline rock bodies that could eventually lead to a location for the second repository in the eastern part of the country. The illogical methodology, and the bias that unreasonably targets eastern regions, are evident in various aspects of the national survey that are summarized in the following discussions.

Exaggeration of Certain Screening Variables

The ONWI-50 draft identified 11 national screening criteria that were used to evaluate regions (Dames and Moore, 1979 - ONWI-50):

- 1) Depth, Thickness, and Land Requirements
- 2) Mechanical, Thermal, and Chemical Properties
- 3) Ground Water Hydrology
- 4) Tectonic Stability and Erosion Rates
- 5) Fault, Lineament, and Joint Concentrations
- 6) Seismicity
- 7) Quaternary Volcanism
- 8) Mineral and Energy Resources
- 9) Glaciation
- 10) Flooding and Surface Water Hydrology
- 11) Quaternary Faults

OCRD-1 used a slightly different list of evaluation factors (U.S. DOE, 1983a- OCRD-1):

- 1) Vertical Displacement in the Earth's Crust
- 2) High-Temperature Convective Ground Water Systems
- 3) Ground Water Hydraulic Gradients
- 4) Areas of Extreme Erosion
- 5) Earthquake Epicenters
- 6) Horizontal Ground Acceleration
- 7) Quaternary Volcanism
- 8) Mineral Deposits
- 9) Quaternary Faults

The ONWI-50 draft list of 11 variables included five that are closely related and can be grouped under the category of tectonics (#4, #5, #6, #7, and #11). In the OCRD-1 list, seven of the nine variables can be grouped under the category of tectonics (#1, #2, #4, #5, #6, #7, and #9). Because of the broad, regional scale tectonic evolution in the U.S., the western portion of the country is more prone to experience these types of tectonically related geologic phenomena. Thus, the independent consideration of each of these seven factors exaggerates the unfavorability of western regions and makes

eastern crystalline rock look more suitable for repository development.

Moreover, the relative importance that the DOE assigned to tectonic phenomena does not appear to be consistent with the two sites now under consideration for the first repository at Yucca Mountain, Nevada and Hanford, Washington. Both sites are located in tectonically active areas. In addition, the seismic characteristics of the northern and eastern portions of the country were largely overlooked, as noted by the Minnesota Geological Survey in its review of the ONWI-50 draft:

"Faults, in fact, are abundant. Joint patterns are complex. Major zones of schistose inclusions occur in most granitic bodies. Cataclastic zones occur on large and small scales. The seismic history cannot be glossed over lightly; there is a real seismic history in the Lake Superior area that is related to crustal structures and probably to glacial rebound as well." (Southwick, 1980)

The two lists of evaluation factors are basically the same, although the OCRD-1 list added High-Temperature Convective Ground Water Systems and dropped Glaciation and Flooding and Surface Water Hydrology. Because these changes would tend to disfavor the north and eastern parts of the country, these modifications further enhanced selection of crystalline rock bodies in the East.

Failure to Weight Screening Variables

A significant deficiency in the national screening methodology was the absence of weighting factors. The principal author of OCRD-1 was a proponent of weighting factors (Smedes, 1980 and Smedes, 1980a); however, this approach was abandoned in favor of

presenting all data in a map format. Communication from the DOE Program Manager to Smedes indicated that, "maps are self-explanatory and are the clearest way to delineate where future studies should be focused." (Neff, 1980).

Weighting of siting variables is a standard procedure in the first and second repository site screening methodologies in order to differentiate between variables that are not equally important or lack comparable data bases. Specific examples can be found in the DOE Siting Guidelines (U.S. DOE, 1984), the draft Environmental Assessments for the first repository program, and the Screening Methodology (U.S. DOE, 1985a) for the Crystalline Repository Project.

The Siting Guidelines assign higher weights to geologically related post-closure variables than to pre-closure variables. The draft Environmental Assessments investigate, at considerable length, the ranking of sites based on the use of weights (for example, the pairwise-comparison method and the utility-estimation method). Likewise, the Crystalline Repository Program used many different sets of weights in the application of the screening methodology in an attempt to incorporate varying opinions concerning the distribution of weights. Use of weighting factors, along with other improvements in the methodology, may well have produced a different outcome from that presented in OCRD-1.

Inconsistent Use of the "Exposed" Rock Definition

Selection of the northern and eastern regions of the country also was enhanced by the definition employed in OCRD-1 for "exposed rock". The definition states that, "By 'exposed' is meant rock bodies which would be shown on a small scale geologic map as bedrock rather than surficial deposits...". Accompanying

this definition is the following rationale for investigating only "exposed rock":

- "* Considerably more information exists on exposed crystalline rocks, relative to what is known about the enormous volumes of crystalline rock which lie buried beneath younger rocks. These exposed crystalline rocks, occupy vast volumes, occur in a wide variety of geologic and geographic environments, and consequently have a reasonable likelihood of occurring in regions which contain suitable sites.

- * Exposed crystalline rock can be mapped, studied, and sampled directly to determine and evaluate factors that relate to criteria for site suitability, whereas deeply buried rock masses can only be evaluated through time-consuming drilling and geophysical surveys." (U.S. DOE, 1983a - OCRD-1)

In reality, much of what was classified as "exposed rock" in OCRD-1 is actually covered with up to hundreds of feet of glacial overburden. Therefore, the two-point rationale for investigating exposed rock does not actually apply to many rock bodies in the northern and northeastern regions of the country. If exposed crystalline rock would have been defined as that which is actually exposed, many of the eastern rock bodies would have been eliminated. On the other hand, the rock masses in the western U.S. would have been relatively unaffected by this altered definition because they are largely exposed at the surface.

The definition of exposed crystalline bedrock was further modified after the final OCRD-1 to exclude rock bodies overlain by pre-quatertiary age rocks (Laughon, 1984). This still allowed, however, inclusion of rock bodies covered with thick

glacial overburden. The Minnesota Geological Survey responded to the new modification in an April 16, 1984, letter to the DOE:

"..., I would summarize by saying that, by an arbitrary definition of the types of "cover" that you exclude from consideration, you have delineated large areas of Minnesota as crystalline rock bodies which are in fact just as effectively covered as if they were overlain by pre-Quaternary rocks. Clearly a criterion with respect to cover cannot be based on geologic age, since this is incidental to the effectiveness with which the rock is covered, but must be based on some criterion that relates directly to the effective degree of exposure of the rock bodies that are delineated." (Walton, 1984)

In a reply letter, the DOE contractor agreed that there was no technical basis for the distinction:

"With regard to the criterion relating to cover, distinguishing rock bodies on the basis of the age of overlying materials was a programmatic decision to separate rock bodies to be investigated by the DOE crystalline program from those which might be investigated by the USGS, in their buried pluton program. More important than actual age is the fact that rock bodies be covered by unconsolidated material rather than rock. There has never been any implication that this distinction held any significance in terms of ability to investigate covered rock bodies or in terms of the long-term performance of a potential repository site." (Yonk, 1984)

Inadequate Consideration of Water Resources

One aspect of siting that was not adequately addressed in the national screening was water resources, even though the DOE

stated that, "The most important criterion that must be considered for site selection is hydrology" (U.S. DOE, 1983a - OCRD-1). Proper consideration of water resources might or might not have resulted in any relative favorability between east and west; however, the absence of such criteria is a serious omission.

Rather than a lack of available information, there was an apparent lack of effort in collecting and incorporating current data resources. At the time the ONWI-50 draft or the OCRD-1 reports were prepared, relevant hydrologic information was plentiful and readily available from the U.S. Geological Survey (USGS), individual state agencies, and other organizations such as the U.S. Water Resources Council. For example, the Council published an extensive report (U.S. Water Resources Council, 1978) outlining information on national water resources by region. The USGS developed WATSTORE as a national data base to promote easy access to large amounts of data. Other USGS sources of information included water atlases, water data reports, and open file reports. State agencies and state geological surveys also published numerous reconnaissance-type reports and maps (Kanivetsky, 1978 and Cutwright, 1982).

The only inclusion of hydrologic factors was the inference of high hydraulic gradients from high relief areas (U.S. DOE, 1983a - OCRD-1) when applying screening variable #2 (Low Hydraulic Gradient and Low Permeability). This inference has no real technical basis because the magnitudes of hydraulic gradients that occur at potential repository depths may have little or no relationship to topography. Furthermore, this inference results in the relative favorability of the eastern rock bodies (low relief, therefore, low hydraulic gradient) when compared to areas in the west which generally have higher relief.

Arbitrary Deferral of Rock Bodies

Figure 1 (U.S. DOE, 1983a - OCRD-1) delineates the rock bodies that survived the application of seven out of the nine evaluation factors that were based on the national screening variables. Despite the emphasis on factors that favored eastern rock bodies, significant rock masses were still evident in Washington, Idaho, Wyoming, Montana and Arizona, as well as in the North Central, Northeast, and Southeast regions, and in scattered locations in other parts of the country. At this point in the national survey, the DOE called upon several other arbitrary and technically unsound reasons to defer the rock bodies outside the three eastern regions.

Occurrences in Idaho, Wyoming and Montana were eliminated because of high relief considerations (high erosion potential, possible inaccessibility, and inferred high hydraulic gradients). The DOE did not, however, defer the high relief areas associated with the Appalachians, even though the same criteria would have applied. It should be noted that the first repository site at Yucca Mountain in southern Nevada also would fall under the category of high relief. Although the DOE considered high relief to be a significant problem for some of the potential second repository crystalline rock bodies, it does not recognize it as a problem for first repository sites. This inconsistent approach is similar to that taken by the DOE with regard to seismicity.

Deferrals of the rock bodies in South Dakota, Oklahoma, Texas, and other areas were based on the fact that these areas were labeled as "scattered." There is no definition of "scattered," nor is there a technical explanation offered in OCRD-1 or elsewhere as to why a "scattered" rock body would be an inferior host rock for a repository.

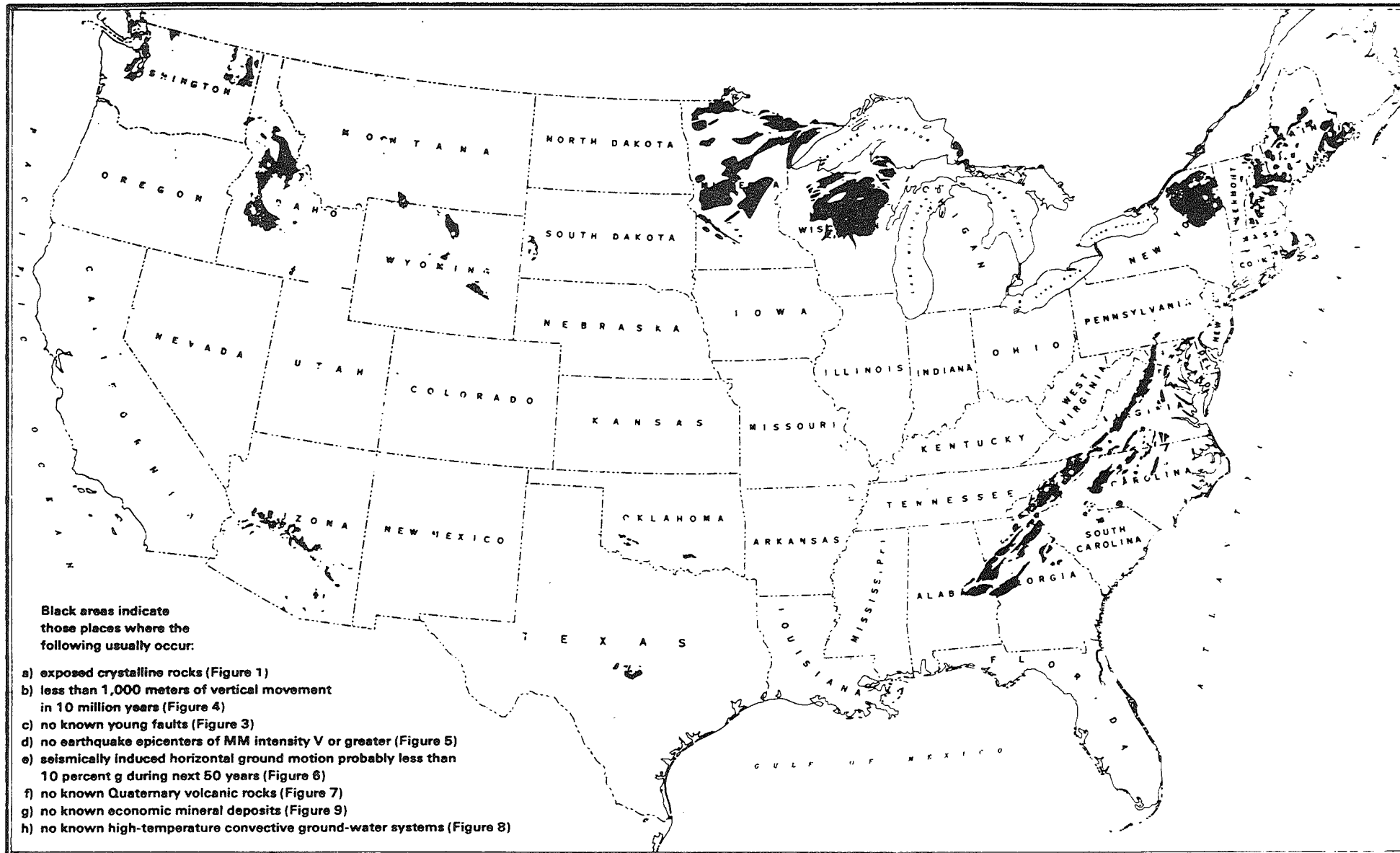


Figure 17. Results of Combining the Data from Figure 1 and Figures 3 Through 9

Figure 1. (From U.S. DOE, 1983a - OCRD-1)

In the case of the rock bodies in Arizona, the following reason was given for their deferral:

"The extensive, though small, occurrences in Arizona, [were eliminated] because the U.S. Geological Survey already is studying geologic environments in that part of the Basin and Range Region." (U.S. DOE, 1983a - OCRD-1)

This rationale is incomprehensible because it would make sense to further investigate, rather than eliminate, areas where the U.S. Geological Survey has already initiated studies.

There also is no explanation given for the deferral of crystalline rock bodies in Washington State (see Figure 1). It appears that the DOE could think of no reason to defer these sites, and simply dropped them without mention.

Finally, with regard to the screening criteria, there is a marked inconsistency between the use and selection of criteria at the national level when compared to the more detailed region-to-area level. The variables of rock-mass size, seismicity, faulting, and mineral deposits were used to disqualify areas in the national survey screening. These same variables, however, were used only to judge relative favorability, not to disqualify, in the region-to-area screen (U.S. DOE, 1985a). This is illogical because the later region-to-area screen is supposedly more discriminating. Furthermore, the criteria of high hydraulic gradient and high-temperature, convective ground water systems were considered important enough to disqualify rock masses at the national level, yet they were not considered at all in the more recent region-to-area methodology (U.S. DOE, 1985a).

III. DEVELOPMENT AND IMPACT OF REGIONALITY BIAS

An explanation for the preference for eastern crystalline rock bodies, before and after passage of the Nuclear Waste Policy Act of 1982 rests, at least in part, with the concept of "regionality." The past history of the federal government's nuclear waste program indicates that a regional distribution of repositories had been advanced for many years.

In 1977, when continued expansion of the nuclear power industry was anticipated, the Energy Research and Development Administration (ERDA) examined a regional distribution of six repositories. Even then, the reason for multiple repositories appeared more political than technical. "These officials stated that the six-repository program was not proposed due to waste volume considerations, but to gain experience in formations other than salt and to gain regional acceptance for the program." (Comptroller General of the United States, 1977) (The Comptroller General was critical of the ERDA plans and subsequently called for further cost-benefit evaluation of the need for that many repositories.)

As a concept, regionality also was endorsed by the Interagency Review Group (IRG) on Nuclear Waste Management in its March, 1979, "Report to the President." This endorsement was based on transportation costs, distributing the burden of repository siting, and a much larger volume of high-level radioactive waste than will be produced according to the most recent projections (U.S. DOE, 1985b). Although technical considerations were initially viewed as still more important than a regional distribution of repositories (IRG, 1979), the perceived regionality requirement appears to have eventually superceded other technical aspects of siting in the ONWI-50 draft report.

When the Nuclear Waste Policy Act was passed in 1982, Congress included some provisions related to regionality. Section 112(a) of the Nuclear Waste Policy Act requires, "...the Secretary [of the DOE] to consider...the advantages of regional distribution in the siting of repositories." Section 114(a) of the Act also requires that, "In making site recommendations and approvals subsequent to the first site recommendation, the Secretary and the President, respectively, shall also consider the need for regional distribution of repositories and the need to minimize, to the extent practicable, the impacts and cost of transporting spent fuel and solidified high-level radioactive waste." It is important to note that, in both sections, the Act does not mandate an eastern U.S. site, but only requires that the DOE consider the advantages of, and need for, a regional distribution of repositories.

The DOE has never formally indicated nor investigated the need for a regional distribution of repositories. But it is likely that the DOE applied the regionality concept in order to satisfy a preconceived notion that a repository should be located in the East. This is evidenced by the following quote from the February, 1983, internal draft OCRD-1 report, the decision-basis document for the identification of states and regions in the crystalline repository program:

"The transfer of program management responsibilities [from the Nuclear Waste Terminal Storage Program Office to the Crystalline Rock Project Office (CRP) in Chicago on October 5, 1982] was the result of DOE's intent to place more emphasis on investigations in crystalline rock, in order to provide potentially suitable sites for a second or subsequent repository in a geographical region in the eastern half of the country." (U.S. DOE, 1983 - Internal Draft OCRD-1)

This quote was deleted from the publically available final OCRD-1 report. (It should be noted that the transfer of the program to the CRP on October 5, 1982, preceded Congressional passage of the Act on December 20, 1982, and Presidential approval on January 7, 1983.) It is, therefore, evident that the DOE had already targeted the eastern part of the country for a crystalline repository prior to the passage of the Act, particularly because it was earlier noted that studies of the regions identified in the ONWI-50 draft were initiated in 1980 (U.S. DOE, 1983b).

Further misinterpretation of the Act is evident in another quote from the internal draft of OCRD-1, which states that, "Although crystalline rocks have been considered since 1957..., the Nuclear Waste Policy Act of 1982 has mandated their consideration for a second repository." (U.S. DOE 1983 - Internal Draft OCRD-1) There is, however, no particular reference to crystalline rock in the NWPA.

Consideration of regionality in these early documents was premature. The DOE Siting Guidelines (U.S. DOE, 1984) state that, "...after the site for the first repository has been recommended, the Secretary [of the DOE] shall give due consideration to the need for, and the advantages of, a regional distribution in the siting of subsequent repositories." (10CFR 960.3-1-3). At the time OCRD-1 was released, eastern region sites in Louisiana and Mississippi were still under consideration for the first repository. It was inappropriate for the DOE to emphasize the eastern region for a second repository site on the basis of regionality while it was still possible for the first repository to also be located in the east.

IV. CONCLUSIONS AND RECOMMENDATIONS

This study undertook the review of all of the existing federal documents provided by the DOE under a State of Minnesota FOIA request pertaining to the national survey of crystalline rock bodies that was conducted by the DOE. It is evident from the review of these documents that the process by which the DOE selected 17 states in three regions (North Central, Northeastern, Southeastern) for further consideration for a second repository for high-level radioactive waste was inadequate. It is clear that this conclusion is not Minnesota's alone, but also that of individuals directly involved in the preparation of the national survey, as well as those who provided critical review. This inadequacy is attributable to the following:

- the lack of commitment, sufficient funding, and time necessary to complete a thorough and systematic survey;
- an illogical screening process that resulted in the East appearing more favorable;
- the inappropriate and premature application of the regionality concept which may have led to the arbitrary deferrals of rock masses outside the three targeted eastern regions;
- and, most importantly, a clearly inferior technical effort put forth in the collection and analysis of geologic information.

While the DOE would prefer that the states and tribes ignore past decisionmaking and concentrate on the Crystalline Repository Program as it presently stands, action is necessary to restore credibility to that program and a sound technical

footing for any future siting work. For these reasons, it is recommended that DOE:

- 1) Suspend the current Crystalline Repository Program siting effort;
- 2) Reevaluate and demonstrate the need for a second repository;
- 3) Justify the choice of appropriate geological media;
- 4) Justify the need for regionality considerations if more than one repository is necessary; and
- 5) Initiate a new national survey, after the above actions have been taken, that has the following essential characteristics: sound technical criteria, proper geologic evaluations, reliance on current literature, full public and peer review, and sufficient time and resources to do a thorough job.

The new survey would permit the DOE to take advantage of new U.S. Geological Survey studies on repository siting, regional aquifer system analyses, and deep, unsaturated zones. It also would allow the DOE to incorporate some of the recent developments in the study of unsaturated zones and buried plutons.

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