

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES
TRIP REPORT

SUBJECT: Workshop on The Role of Natural Analogues in the Evaluation of the Adequacy of a Potential Site For a Radioactive Waste Repository
20.06002.01.071.009

DATE/PLACE: October 9–10, 2003
Electric Power Research Institute
Palo Alto, California

AUTHOR: David A. Pickett

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PERSONS PRESENT:

David Pickett (CNWRA)
Tim McCartin (NRC)

BACKGROUND AND PURPOSE OF TRIP:

The Electric Power Research Institute sponsored this workshop with the purpose, according to the meeting invitation, "to review both domestic and international practice in the application of natural analogues to evaluate the suitability of potential repository sites," with a focus on Yucca Mountain, and "to explore general considerations for the potential role of analogue information in decision-making or confidence-building." Bill Miller (Enviros Consulting Ltd., UK) was contracted by Electric Power Research Institute to organize the meeting and produce a report with the assistance of an advisory panel consisting of Mick Apted (Monitor Scientific), Bob Bernero (consultant), Maria Jose Gimeno (Research Centre for Energy, Environment, and Technology, Spain), Paul Hooker (Enviros Consulting Ltd., UK), John Kessler (Electric Power Research Institute), Rod McCullum (Nuclear Energy Institute), Alan Ross (consultant), and Patrik Sellin (Swedish Nuclear Fuel and Waste Management Company). U.S. Nuclear Regulatory Commission (NRC) was invited to attend as observers and to present its perspective on the role of analogs in the licensing process. An attendance list is not yet available, but among the U.S. parties represented at the Electric Power Research Institute workshop were U.S. Department of Energy (DOE), NRC, Center for Nuclear Waste Regulatory Analyses (CNWRA), the Nuclear Waste Technical Review Board, Nye County, Clark County, the U.S. Geological Survey, and the Nuclear Energy Institute.

Enviros is also coordinating the European Commission-sponsored "NAnet" project, <http://www.enviros.com/zztop/nanet/nanetmain.htm>, which is promoting the use and communication of analogs and developing a database of natural analog information that they hope will be useful primarily to performance assessment specialists, but also to decision-makers, the scientific community, and the public. Both NRC and DOE will be invited to a NAnet workshop in May, 2004, at which the project will solicit international input and feedback on their approach to organizing and using analog information.

SUMMARY OF PERTINENT POINTS:

The Electric Power Research Institute consultants were clearly looking for ways to recommend more formalized approaches to using analogs in support of a licensing case, both technical (e.g., "what is the formal process for evaluating a particular analog's applicability?") and nontechnical (e.g., "what is the most useful way to convey analog information to different audiences?"). Such formalization may prove elusive, at least for potential near-term Yucca Mountain licensing activities. Nevertheless, some important points came out of the extensive meeting discussions:

- Most uses of analogs are qualitative; most of the meeting participants viewed analogs as a means for providing confidence in models and concepts ("warm tummy feeling" was the most popular catch phrase of the meeting).
- The safety case is strengthened if analogs are used not only to support models, but also to test them (it appears such use by DOE in the potential license application would be limited).
- Explicit analog use in performance assessments can be increased by better communication between analog researchers and performance assessment modelers. In any case, participants felt that natural analog information is more pervasive in programs than it may seem.
- It is critical that the use of an analog be accompanied by explanation of its particular limitations. On the other hand, even partial analogs can be useful if they address a specific feature or process.
- Analogues can be misused if one stops looking when one finds an example that supports a particular model or concept. The search for analog information should be open-ended and open-minded.
- DOE will apply analogs in its safety case chiefly to natural, rather than engineered, repository systems. They will continue analog studies throughout the licensing process and, perhaps, beyond.

SUMMARY OF ACTIVITIES:

The meeting opened with an introductory presentation by Miller and Hooker (both of whom also led frequent discussions during the workshop). Following was a summary of DOE analog uses and studies by Abe Van Luik (U.S. Department of Energy), in which he discussed the Natural Analogue Synthesis Report (TDR-NBS-GS-000027 Rev 00 ICN 02; to be revised in Spring 2004) and noted that, while Peña Blanca work continues, only data collected to date will be included in the license application. Van Luik stressed that analog information is an important part of model development and can support multiple lines of reasoning, but the information is often buried in low-level documents. My presentation on the NRC perspective followed; a copy is attached to this trip report. Whereas Tim McCartin and I stressed that the regulation provides for, but does not require, DOE use of natural analog information, members of the audience were clearly of the opinion that NRC will be both using analogs and expecting DOE to do so.

The "international perspective" then followed, with presentations on NAnet (Hooker) and the analog programs in Sweden (Sellin) and Spain (Gimeno). The key product of the NAnet project (completion date December 2004) is to be a database of analog sites with detailed information and references, as well as critical reviews that may help guide their application. Sellin discussed the use of analogs in the Swedish repository program, which has two candidate sites with licensing expected to begin in 2008. Analogs have proven most useful for constraining materials behavior (uranium oxide, copper, and bentonite). Gimeno described a Spanish project that has produced a detailed, comprehensive catalog of analog sites and their uses in repository safety assessments. Thursday's final presentation, by John Stuckless (United States Geological Survey), presented a number of qualitative analogs with emphasis on the stability and water flow characteristics of underground openings. This presentation prompted discussion on the importance of considering counter-analogs to adopted models.

On Friday, Mick Apted (Monitor Scientific) and another Electric Power Research Institute consultant made presentations on analogs for magma-repository interactions, including a dike intruding into alluvial gravel and a smelter analog for spent fuel disruption. However, McCartin pointed out their potential mis-characterization of relevant CNWRA magma interaction models and advised that a future DOE/NRC technical exchange would address the issue. The final formal presentation (Hooker) concerned the NAnet experience in public communication; NAnet is strongly focused on devising means for better communicating analog information to various audiences. Next, Bob Bernero described the licensing process, pointing out that the Atomic Safety Licensing Board(s) and their staffs are important audiences for analog information that had not been mentioned during the workshop. Others added the general scientific community to the list of audiences. The workshop concluded with a discussion that produced many of the points listed above under "Summary of Pertinent Points."

CONCLUSIONS:

NRC/CNWRA attendance at this workshop was useful in providing the audience a sense of regulator expectations with respect to natural analogs. In addition, we gained a better understanding not only of planned DOE uses of analogs, but also of how the broader international community is making efforts to better incorporate and communicate analog information within their programs and to stakeholders.

PROBLEMS ENCOUNTERED:

None.


PENDING ACTIONS:

None.

RECOMMENDATIONS:

Efforts, such as those in the NAnet and Spanish projects, to categorize and systematically present natural analog information should be monitored and studied. In addition, the upcoming Enviro workshop report to Electric Power Research Institute will be obtained.

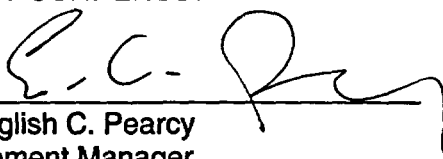
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ATTACHMENT

**Natural Analogs and the Yucca Mountain Review Plan:
NRC Perspective**

**David A. Pickett
CNWRA**

**Presented at Workshop on "The Role of Natural Analogues In the
Evaluation of the Adequacy of a Potential Site For a Radioactive
Waste Repository"**

**Electric Power Research Institute, Palo Alto, California
October 9, 2003**

Natural Analogs and the Yucca Mountain Review Plan: NRC Perspective

David A. Pickett
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Presented at Workshop on "The Role of Natural Analogues in the Evaluation of the
Adequacy of a Potential Site For a Radioactive Waste Repository"
Electric Power Research Institute, Palo Alto, California
October 9, 2003



S O U T H W E S T R E S E A R C H I N S T I T U T E

Center for Nuclear Waste
Regulatory Analyses

Natural Analogs in Code of Federal Regulations, Title 10, Part 63

- No specific requirements
- Natural analog studies are mentioned as potential elements of supporting information for models assessing performance, e.g., 63.21(c)(15), describing the Safety Analysis Report:
 - “Analyses and models that will be used to assess performance of the geologic repository must be supported by using an appropriate combination of such methods as field tests, in situ tests, laboratory tests that are representative of field conditions, monitoring data, and natural analog studies.”



S O U T H W E S T R E S E A R C H I N S T I T U T E

Center for Nuclear Waste
Regulatory Analyses

Natural Analogs in the Yucca Mountain Review Plan (YMRP Rev 2; NUREG-1804)

- Restricted to sections on post-closure performance assessment.
- One type of information source that may be used (i) by DOE to support models and parameters or (ii) by NRC staff to evaluate DOE models and parameters.
- Scenario analysis and event probability, e.g.,
 - Review Method on FEPs screening (§ 2.2.1.2.1.2): “Consider information from site and regional characterization, natural analog studies, and the repository design, during this evaluation.”
 - Acceptance Criterion on probability models (§ 2.2.1.2.2.3): “Probability models are justified through comparison with output from detailed process-level models and/or empirical observations (e.g., laboratory testing, field measurements, or natural analogs, including Yucca Mountain site data).”



Natural Analogs in the YMRP (cont.)

- Model Abstractions: mentioned in all 14 sections, typically under data and model justification, data uncertainty, model uncertainty, and model support, e.g.,
 - Degradation of Engineered Barriers (§ 2.2.1.3.1.2), Review Method on Data Uncertainty: “Confirm that the U.S. Department of Energy has used parameters...that are based on laboratory experiments, field measurements, natural analog or industrial analog research, and process-level modeling studies, conducted under conditions relevant to the range of environmental conditions in the emplacement drifts located in the unsaturated zone at Yucca Mountain.”



S O U T H W E S T R E S E A R C H I N S T I T U T E

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Regulatory Analyses

Natural Analogs in the YMRP (cont.)

- Radionuclide Transport in the Unsaturated Zone (§ 2.2.1.3.7.3), Acceptance Criterion on Data Sufficiency: “Data...used in the total system performance assessment abstraction are based on appropriate techniques. These techniques may include laboratory experiments, site-specific field measurements, natural analog research, and process-level modeling studies.”
- Volcanic Disruption of Waste Packages (§ 2.2.1.3.10.2), Review Method on Model Uncertainty: “Examine the model parameters, considering available site characterization data, laboratory experiments, field measurements, natural analog research, and process-level modeling studies, and evaluate their consistency.”



Natural Analogs in the YMRP (cont.)

- Item 20 in Appendix B, Acceptance Review Checklist:
 - “An explanation of measures used to support models for performance assessments. These models should be supported using an appropriate combination of methods such as field tests, in situ tests, laboratory tests representative of field conditions, monitoring data, and natural analog studies.
 - ☐ Accept for Review
 - ☐ Accept, but Request for Additional Information Prepared
 - ☐ Reject, Inadequate to Support Detailed Review”



NRC Natural Analog Activities

- Peña Blanca – as a geochemical analog
 - Alteration
 - Fracture transport
 - Recent mobility
 - Basis for two optional source terms in Total-system Performance Assessment (TPA)
 - Potential implications of uranium isotope fractionation, decay-series disequilibrium



NRC Natural Analog Activities (cont.)

- Igneous Activity
 - Active basaltic eruptions for tephra dispersal processes: Cerro Negro, Nicaragua; Tolbachik, Russia
 - Historically active volcanoes for eruption processes: Tolbachik, Russia; Sunset Crater, AZ; Heimaey, Iceland; Parícutin, Mexico
 - Eroded volcanoes for subsurface characteristics: San Rafael, UT; Fortification Hill, NV
 - Volcanic fields for evolutionary patterns: Reveille Range-Lunar Crater, NV; Big Pine, CA; Cima, CA; San Francisco Volcanic Field, AZ



NRC Natural Analog Activities (cont.)

- Container Life
 - Literature review of meteoritic iron plus a small number of naturally occurring alloys
 - Experimental and literature study of josephinite – natural iron-nickel alloy (55-75 percent Ni)
 - Archeological analogs
- Unsaturated Flow
 - Bishop Tuff, California (analog silicic tuff, e.g., infiltration, fracture- and fault-related permeability effects)
- Seismicity
 - Bishop Tuff (normal fault system development)



S O U T H W E S T R E S E A R C H I N S T I T U T E

Center for Nuclear Waste
Regulatory Analyses

Summary

- No regulatory requirements
- YMRP suggests natural analogs as one component of support for models and parameters
- NRC analog studies are diverse and focused on key technical issues

