CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: 9th Workshop of the Natural Analogue Working Group (20.01402.871.022)

DATE/PLACE: June 20–21, 2002
Aarau, Switzerland

AUTHOR: David Pickett

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PERSONS PRESENT: David Pickett

BACKGROUND AND PURPOSE OF TRIP:

David Pickett acted as U.S. representative at the 9th Workshop of the Natural Analogue Working Group, an international organization formed to foster the study of natural analogues to geologic disposal of nuclear waste. The Center for Nuclear Waste Regulatory Analyses (CNWRA) has been actively involved in the Natural Analogue Working Group for many years, and one purpose of this trip was to maintain a high level of visibility for the U.S. Nuclear Regulatory Commission (NRC)-sponsored analogues program. The workshop was sponsored by the Swiss National Cooperative for the Disposal of Radioactive Waste and was hosted by Dr. Russell Alexander of that organization. The workshop featured overviews of natural analogue efforts in several national repository programs, as well as discussions on future directions for Natural Analogue Working Group and analogue studies in general. Dr. Pickett made two presentations: (1) NRC-sponsored activities at the Peña Blanca analogue site, and (2) summarizing other U.S. analogue activities. The latter presentation emphasized how the U.S. Department of Energy (DOE) plans to use natural analogues in their safety case.

SUMMARY OF PERTINENT POINTS:

Presentations were made on natural analogue activities and applications in Switzerland, the United States, France, Spain, Sweden, Germany, Finland, Japan, the Czech Republic, and South Africa, and on European Commission-sponsored programs. The consensus of the attendees was that to be viable, natural analogue programs must continue to increase opportunities for direct application to performance assessment and confidence building. In addition, it was decided that, in the absence of organizational funding, the Natural Analogue Working Group would continue to exist on a more informal footing, facilitated by communication and information gathering at a web site.

SUMMARY OF ACTIVITIES:

With the exception of the presentation on Peña Blanca and an overview of European Commission-sponsored activities, the workshop consisted of talks on the natural analogue programs in individual countries. Presentations are discussed in their agenda order.

Pedro Hernan, of Empresa Nacional de Residuos Radiactivos (ENRESA, or the Spanish National Radioactive Waste Company), reported the imminent publication by ENRESA of a major natural analogue report. The three main components of this analogue study are MATRIX, ARCHEO, and BARRA. Highlights of the MATRIX project, at the Mina Fe site, Spain, are recent (1–3 Ma) oxidation of primary pitchblende in a near-surface environment, the retention of reducing conditions at 20 m [66 ft] depth despite a fractured host, and the coprecipitation of U(VI) with Fe(III). Potential parallels to CNWRA observations at Peña Blanca may warrant careful study of this analogue. BARRA concerns thermal and geochemical effects on a clay barrier analogue in southern Spain, while the ARCHEO project studies corrosion processes and rates in archaeological materials up to thousands of years old. ENRESA is also involved in the BORIS project, which is studying the migration of radionuclides from injection wells in Russia.

Ales Laciok, of the Czech Nuclear Research Institute Řež plc (NRI), discussed natural analogues in the context of Czech plans for a deep geological repository. The Ruprechtov analogue comprises the largest single research project in the Czech repository program. At the site, uranium has accumulated in organic-rich volcaniclastic deposits. Anthropogenic analogues are also being studied, including uranium-rich (0.1 to 2 weight percent) glassware in landfills and cementitious materials in contact with thermal spa waters, some of which contain appreciable radionuclide contents.

Russell Alexander, the NAGRA host for the workshop, summarized Swiss natural analogue activities. An important document on "disposal feasibility" in Switzerland will come out later this year. Natural analogue observations will be cited in this report, for example, in demonstrating low hydraulic conductivity of candidate host rocks, preservation of wood and archaeological artifacts on long time scales, and long life of spent fuel analogues. Identified areas where analogues may provide needed information in the future include geochemical speciation and erosion. Alexander discussed ongoing studies at Maqarin, Jordan, of a natural hyperalkaline plume and the resulting geochemical evolution of host rock. For example, observed fracture sealing and resulting hydrogeologic effects have been incorporated into performance assessments for candidate Swiss sites.

Willie Meyer represented South Africa's Atomic Energy Corporation. The main South African natural analogue site is the monazite ore occurrence at Steenkampskraal. Key observations are mobilization (partly by colloids) of uranium, thorium, and rare earth elements during monazite alteration. Mining activities may force the analogue project to close and move to the vicinity of the Vaalputs intermediate waste repository site, which has occurrences of uranium- and thorium-enriched clay horizons. If international interest in these sites is lacking, the natural analogue project will be closed down.

The status of the German nuclear waste disposal program was discussed by Walter Steininger of the Forschungszentrum Karlsruhe (FZK). The moratorium on new nuclear power plants is now in force; the law also mandates permanent waste disposal. While exploration of Gorleben as a candidate site is currently on hold, the government still intends to open a repository for all levels of nuclear waste by 2030. Most German natural analogue activity appears to be in cooperation with other national programs.

Ulrich Nosek of the German organization Gesellschaft für Anlagen- und Reaktorsicherheit (GRS), the German research organization for nuclear reactor and waste safety issues, spoke

on work at the Ruprechtov analogue, Czech Republic. The chief focus of Gesellschaft für Anlagen- und Reaktorsicherheit Ruprechtov studies is uranium migration in clay sediments. Investigators are attempting to model uranium transport from the granitic source rock through the sediments using, among other tools, uranium-series disequilibrium.

Russell Alexander gave a talk on the Japanese natural analogue program (the representative of which could not attend). A new, more structured research program at the Tono analogue was started this year; previous efforts were not sharply focused on Japanese repository concepts. The Tono study is being approached as a repository program, incorporating, for example, a formal scenario analysis. Aside from Tono, which may provide quantitative input to performance assessment, the key motivation for analogue work appears to be in raising the level of public acceptance of the geological repository concept. To that end, the Japanese are surveying all analogue programs for potentially useful information.

David Pickett then presented recent NRC-sponsored analogue efforts at the CNWRA. These activities have been in two areas: Nopal I uranium-series systematics and uranium mobility, and performance assessment applications and implications. The uranium-series work is focused on understanding the timing of recent radionuclide mobilization as recorded in secondary deposits around the ore body and as reflected in radium depletions in the ore body. This information is useful in assessing models of the nature and timing of radionuclide migration at the potential Yucca Mountain repository. In performance assessment, natural analogue data from Nopal I have been used to develop alternative release models. In a more general sense, the concept of natural decay-series disequilibrium has been explored with regard to potential performance assessment implications (e.g., differential isotopic release and disequilibrium as a measure of geochemical system behavior).

Alexander followed with a description of the European Commission perspective on natural analogue programs. Natural analogues for nuclear waste disposal fall under the European Commission EURATOM Nuclear Energy Programme. Although there are currently no funded analogue-specific efforts, a new project has been approved for creating a "Thematic Network" for reviewing the broad spectrum of natural analogue information and recommending future directions aimed at maximizing the usefulness of analogue studies. The project, called "NAnet" and headed by Bill Miller of QuantiSci (United Kingdom), is expected to commence in September. (Miller has contacted the CNWRA about potential unfunded involvement in the project).

The group finished the first day with a round-table discussion on the future of the Natural Analogue Working Group. While it would seem that some of the goals of the Natural Analogue Working Group are being addressed by the NAnet project, some believe NAnet is not properly focused. Furthermore, there are many active analogue researchers who are not involved in NAnet (i.e., some in Europe such as Alexander, and most workers outside Europe). It was agreed that the Natural Analogue Working Group should not be abandoned, because it can continue to serve as an informal network for communicating about ongoing work, results, and plans, and for forming collaborations. No specific plans were made for future formal Natural Analogue Working Group meetings. The main venue for Natural Analogue Working Group communications will be a web site. This has been attempted previously with little success, but it was believed that if new emphasis is placed on the web site as the key to communication, analogue workers will respond.

The second day of the workshop opened with a description of Finnish analogue research by Lasse Ahonen of the Geological Survey of Finland. Activity at the well-studied Palmottu analogue has slowed, and the final report on Phase II has been released. A study of native copper at Hyrkkölä has been useful for understanding the potential behavior of the copper canisters planned for the Finnish repository. A major new permafrost study has begun at the Lupin gold mine in Canada, under the premise that permafrost may form above a Finnish repository under future climates. One potentially adverse result of this would be the subsurface formation of saline water pockets, leading to more corrosive groundwater.

Laurent Trotignon of the French Commissariat à l'Energie Atomique (Commissariat à l'Energie Atomique, the Atomic Energy Commission) spoke on the natural analogue program in France. Commissariat à l'Energie Atomique is a major participant in studies at Maqarin. As mentioned above in the discussion of NAGRA activities, Maqarin offers a look at long-term evolution of a hyperalkaline plume. Key activities include understanding of aqueous speciation of radionuclide analogues such as rhenium, alteration of cements and clays, microbial activity at high pH, and modeling coupled transport and geochemistry. Thermal effects on argillite (the proposed repository host rock in France) are being studied at the site in France of a basaltic intrusion into clay. Archaeological analogues of metal and glass are under study. Also, French researchers have proposed that the Bangombé natural reactor in Gabon (the only natural reactor to not have been mined out) be designated as an "international geochemical observatory," allowing long-term study and monitoring aimed at understanding uraninite alteration and radionuclide migration.

David Pickett gave an overview of how the DOE is intending to use natural analogues in its safety case for the proposed repository at Yucca Mountain. The talk was based on the recently released "Natural Analogue Synthesis Report" (TDR–NBS–GS–000027 Rev 00 ICN 02). As stated in the report, DOE will use natural analogues "to provide qualitative and quantitative information to test and provide added confidence to process models abstracted for performance assessment." Direct incorporation of analogue-derived parameters is not expected. The report discusses a wide variety of analogue types and sites addressing each repository barrier and process model. DOE planned activities at Peña Blanca were also discussed.

For the final formal presentation, Alexander briefly outlined the Swedish program conducted by the Svensk Kärnbränslehantering (SKB, or Swedish Nuclear Fuel & Waste Management Company). SKB researchers are currently involved in the aforementioned Maqarin, NAnet, and Lupin permafrost projects, and are also studying bentonites (backfill analogue) in Spain and a mudrock/native copper occurrence in the United Kingdom.

CONCLUSIONS:

The workshop gave an interesting and useful overview of the state of natural analogue programs in several nations. A common theme was the use of analogues to build confidence, both in models and in the concept of geologic disposal. Direct application to performance assessment remains a mostly elusive goal, but it is hoped that progress may be made by the European Commission's NAnet project. Despite the recent conclusion of major projects such as Palmottu and Oklo, the international natural analogue community remains vibrant and relevant. The focus of the community appears to be shifting to smaller projects, more focused on particular features and processes. The Natural Analogue Working Group intends to

continue to serve this community, and may try to expand its scope to other areas such a nonradioactive toxic wastes.

PROBLEMS ENCOUNTERED:

None.

PENDING ACTIONS:

None.

RECOMMENDATIONS:

Natural analogues can be effective tools for risk-informing NRC waste repository evaluations by revealing which natural processes and features have been effective at mobilizing or retaining radionuclides. It is recommended that the NRC and CNWRA continue to participate actively in the Natural Analogue Working Group. It appears likely that the Natural Analogue Working Group will continue to function as a forum for communication and potential collaboration.

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