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Geothermal Studies and Analyses

Report 6A. Status of DOE Geothermal Technical Report Collections

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TABLE OF CONTENTS

1.0	SUMMARY.....	1
1.1	Background and Purpose	1
1.2	General Findings.....	1
1.3	Functional Requirements for Retrieval	2
1.4	Five Specific Important Sites.....	3
1.5	Possible Improvements.....	4
2.0	GENERAL RESULTS	7
2.1	Summary Tables.....	7
2.2	Evaluation of Site Usefulness	9
2.3	Contents of a Useful Geothermal Library.....	9
3.0	DETAILS ABOUT REFERENCE SITES.....	11
3.1	Libraries Closely Related to the DOE Geothermal Energy Program.....	11
	DOE HQ - Geothermal Energy Program Home Page(s)	11
	EREN - DOE Energy Efficiency and Renewable Energy Database	11
	BNL - Brookhaven National Laboratory	12
	INEEL - Idaho National Engineering and Environmental Laboratory	13
	INEEL.1 - Laboratory Home Page	13
	INEEL.2 - DOE Geothermal Research Program Technical Site.....	13
	INEEL.3 - Geothermal Technical Library	13
	LANL - Los Alamos National Laboratory	15
	LLNL - Lawrence Livermore National Laboratory.....	16
	NREL - National Renewable Energy Laboratory.....	17
	SNL - Sandia National Laboratories	17
3.2	Other Government Libraries and Bibliographies	18
	LOC - Library of Congress	18
	NTIS - National Technical Information System	18
	OSTI - Information Bridge.....	19
	OSTI.1 - The Information Bridge Itself.....	19
	OSTI.2 - Other Search Engines.....	20
	OSTI.3 - How Technical Reports Get to OSTI	20
3.3	Other Important Geothermal Energy Libraries.....	22
	GHC at OIT - Geothermal Heat Center at Oregon Institute of Technology	22
	GRC - Geothermal Resources Council Library	22
	GRC.1 - GRC Library WWW Database.....	22
	GRC.2 - Usage of GRC Library Resources	23
	GRC.3 - Other Materials in GRC Library	25
	SMU - Geothermal Heat Mapping Lab at Southern Methodist University	25
	VTGDB - Virginia Tech Geothermal Database WWW Home Page.....	26
	WDC-CON - Washington, D.C. area DOE HQ Contractors.....	26

	WWWeb Sites with Specialized Geothermal Links.....	27
4.0	CONCLUSIONS	28
5.0	REFERENCES	29
	Appendix A. Details: GRC Library Database	30

Foreword

Scientific and engineering literature has often been cited as having a useful life of only five years, and more recently in some fields, as brief as two years. The author believes this is not the case for technical studies of geothermal energy, where many significant studies were done by a small community of technical experts during the last 40 or so years. Many of the findings, particularly about the physical characteristics of geothermal prospecting areas, data and theory of geochemistry, and interactions between geochemicals and materials, were won at great expense in the 1970's and 1980's -- in large part through funding by the U.S. Department of Energy and its predecessors. Most of this information was imparted only to paper, not to computer files. Even most of the most relevant bibliographies are on paper alone.

Much of this information is about to be lost, as the originators, lab managers, and librarians retire. DOE has made some efforts to store and catalog some of this information. However, the scope and method of the work has varied among sites, and most of the decisions about contents, format, and access modes were made long before either the personal computer or Internet existed.

This paper is an initial survey to begin to make some sense out of what has been done, and what the U.S. geothermal energy community might need to do in the future to preserve this information, and make the most relevant parts of it retrievable easily by many.

In the middle of this work, the author recalled an article about the condition of Buddhist temples in Burma. "... there are more pagodas and temples in Burma than anywhere else in the world. It is a popular belief that the restoration of a religious building gains merit for the original founder and not for the donor of the restoration. Many pagodas were therefore preserved by the next generation of the family of the donor, but they were then allowed to fall into decay." Consequently, Burmese cities are full of temples, many of them half ruined.¹ My hope is that I and my colleagues do not let something similar happen to our current stores of U.S. geothermal energy information.

Discussions with colleagues indicated many thought that studies like this should be considered "works in progress," and that no one paper can get to most of the answers. So this is written as a starting point, not an end.

1.0 SUMMARY

1.1 Background and Purpose

It is clear to many users that U.S. geothermal technical publications and data, and citations to them, are broadly scattered among a number of different libraries. The libraries are maintained by the federal government in generalized collections, at the Department of Energy's National Laboratories; a library maintained by the main U.S. geothermal energy association, the Geothermal Resources Council (GRC); and libraries maintained by individual firms and consultants in the geothermal industry.

Geothermists have been as busy as bees for the past 25 years, and have produced a large literature. Because of declines in the rate of geothermal system development by industry and large reductions in government funding for geothermal research, the impetus for using and extending many of the studies and reports has declined since the late 1980's. Today, many collections are being hidden in closets, shifted from place to place, discarded, or simply lost.

The Office of Wind and Geothermal Technologies (OWGT) at the Department of Energy (DOE) Washington Headquarters asked PERI to conduct this brief survey of where the technical literature developed by the DOE Geothermal Research Program has ended up, how to find it, and what broad steps might be useful to ensure that important information remains accessible.

1.2 General Findings

The author scanned a few "theoretical" and "best practice" papers from the archiving community. The working consensus is that many groups are struggling with what to do first and most thoroughly, now that computer storage and the Internet have arrived to supplement or replace standard practices for archiving information on paper. The computer and Internet offer much improved ability to "retrieve" citations and full text. But it also seems to be the case that standards for long term electronic storage have yet to be carved out. So there is a danger that any particular database software and hardware used today may not be supportable in just a few years. Data have to be migrated to newly sophisticated storage systems at five to ten year intervals, and provision has to be made for doing that.

The author believes it would be very difficult to get a consensus on which reports are the most valuable to maintain, so he did not try to do that here. Once we have some sense of what is where, we can poll the U.S. geothermal community at open meetings to get a better idea of continuing relevance. However, *a priori*, the author believes that data related to exploration and the characteristics of U.S. geothermal resources are some of the most important information to maintain, because they are very expensive to obtain in the first place. Intense use of Dr. David Blackwell's geothermal exploration references and thermal gradient database WWWeb site supports this idea. Joel Renner, the manager of the INEEL Geothermal Research Group, supported this idea directly.

We tried to get some sense of relevance from operators of some of the main collections. In 2001, the GRC Library database was searched often for "geothermal energy in India." At the GeoHeat Center, information on geothermal heat pumps is downloaded most frequently.

A few best sites for searching for geothermal references and reports have emerged. They are described in Sections 1.4 and 2.2.

The general state of affairs is that excellent introductory information is easy to find. Some very detailed reports are available that you can find and use if you know a lot about geothermal energy systems and research. There is not much in the middle ground of what used to be called "useful secondary sources."

1.3 Functional Requirements for Retrieval

There are a number of different "levels" of need and use.

- a. Getting access to full text. Either for free, by paying for reports through subscription to a service, or on a per report basis. Varieties of this include:
 - Getting full text near instantly, via the Internet or other service.
 - Getting mailed electronic copy via CD ROM, diskette, etc.
 - Getting full paper copy via mail.
- b. Getting access to an abstract to clarify the relevance of a paper beyond that indicated by bibliographic information.
- c. Getting access to bibliographic information. Titles, keywords, and authors are particularly important here. Varieties include:
 1. A library searchable by database software. Good examples include the GRC, OSTI, and DOE Geothermal Technical Site Research Project Summary collections.
 2. A comprehensive list presented as one or more files searchable using a word processor. Dr. David Blackwell's geothermal exploration bibliography is a very good example of this.

Three main functions have to be served by these systems if the technical information base created by the \$1.5 billion of geothermal R&D is to be preserved:

- a. Ability to identify that work was done in a technical area and that specific reports exist.

Here a broad history of the U.S. Geothermal research program and the main events in U.S. geothermal energy system deployment would be especially valuable. Each section of the history could point to one or more reference collections as most relevant.
- b. Preserving one or more copies of all relevant reports.

This will require cataloging, to compare contents of collections. Lists of publications from the National Laboratories' publications databases, where they exist, would be extremely

useful. It is likely, but not certain, that copies of most of the reports distributed through OSTI (Office of Science and Technology Information, the DOE agency that tracks and disseminates DOE technical reports) might still exist at OSTI or some contractor related to it.

- c. Enabling users (with a wide variety of needs) to get access (via e.systems or paper copies) to the contents of the reports. For geothermal energy information, in most cases, graphical contents are as important as text.

1.4 Five Specific Important Sites

We found five quite useful sites. We know that traffic is high at least three of those sites. If your site is not included on this list, it may be that we did not find it at all, or could not figure out how to access it properly. Note that in some cases URLs are broken up across lines using the convention: first.part/..second.part for the URL: first.part/second.part.

- a. **The Geothermal Resources Council (GRC) Library.** The GRC is the main geothermal interest association in the U.S. It maintains an extensive collection of 60,000 geothermal-related reports and data sets. It has 20,000 items indexed in a bibliographic database accessible from the WWW. Currently, it receives inquiries from more than 3,000 separate individuals per month. The GRC Library manager believes that the traffic is related mainly to people using the database to look up references to materials that the people already have access to locally. This a very important use. It was entirely unexpected by the author even though he frequently uses the GRC Library database this way himself.
- b. **OSTI - Information Bridge (OSTI-IB).** OSTI is a cross-programmatic information site supported by the Department of Energy. All the reports it holds and references are from studies funded by the DOE. It has bibliographic information with abstracts for about 15,000 geothermal items. It has full text (in Adobe .PDF format) for 1,770 relatively recent geothermal items.
- c. **DOE Geothermal Technical Site at INEEL.** This contains five years' worth of summaries of DOE-sponsored geothermal research. These are full text reports of four to eight or so pages long. This site also provides access to some text on federal laws and regulations for geothermal energy.

The technical summary information is very useful, but there is no search engine. If you know what you are looking for, you can access this site directly using the Table of Contents in the annual summaries. Otherwise go to www.eren.doe.gov/RE/...geothermal.html and use the search engine there. That engine has pointers to the Technical Site articles. This is one of the rare instances of cross links between DOE geothermal sites, other than lists of URLs.

- d. **OIT GeoHeat Center Library Database.** This is another very active site. Many of the reports can be downloaded by users. Most of the reports downloaded are related to geothermal direct use system to geothermal heat pumps.

- e. **SMU Geothermal Exploration Reports Collection.** Dr. David Blackwell's reference collection on geothermal exploration is also used frequently. Blackwell gets more frequent requests for copies of reports than he really likes to handle. Dr. Blackwell is internationally recognized as the primary expert on the distribution of heat in the earth beneath the U.S. An extensive bibliography on geothermal exploration reports and data sets is available on his WWWeb site. It is an excellent example of the very high quality of both depth of content and organization that one can get when a dedicated expert organizes a bibliographic database.

1.5 Possible Improvements

The situation is too complex to allow one author to lay out a comprehensive plan for "saving" the geothermal literature. However, a few possibly useful ideas are presented here.

- a. The DOE geothermal management team needs to set up a small committee decide what needs to be done, and how to do it. That group should work with the GRC Publications Committee, and also with at least one staff from the US Geological Survey library and one staff from the OSTI Information Bridge team. The particular focus should be how to maximize:
1. Retention of as many reports as possible,
 2. WWWeb access to citations on as many reports as possible, and
 3. Access to retrievable full text of more of the most important reports via the WWWeb.
- b. Whatever is done should facilitate two main functions:
1. Reminding current researchers, R&D managers, and geothermal developers of what has been done in the past. This needs to be done at an "intermediate" level of detail that today is almost entirely absent from the internet offerings on geothermal topics, except for one or two history pages accessible from the DOE Geothermal Energy Program home page. Lists of reports, brief histories, and annotated bibliographies are needed here.
 2. Retrieving full text of both new and older reports. The postings of the DOE Geothermal Program Summaries at the DOE Geothermal Technical Web Site (hosted at INEEL), and the 1,800 or so PDF files of DOE Technical reports available from OSTI are today's the best examples of such materials.
- c. The author believes that "reminding users of what has been done in the past" would best be done writing (new) brief topical histories that are posted on the DOE Geothermal Technical Web Site. Some of the materials could be scanned in, for example, from older *Transactions of the DOE Geothermal Program Review* and a few (but not all) of the *DOE Geothermal Progress Monitor* reports.

In all cases, staff at each of the main geothermal technology research teams at the National Laboratories should be funded to write a ten to twenty page history of what was undertaken

and accomplished in each of the main DOE geothermal research subprograms. In some cases, appropriate histories exist, and would need only adaptation to WWWeb format.

This would require reports from: Brookhaven (cements, chemistry, effluent clean up), Lawrence Berkeley (geology, reservoir simulation, geochemistry, geophysics), Lawrence Livermore (geophysics, geochemistry), Los Alamos (hot dry rock, Caribbean basin), NREL (conversion cycles, institutional factors), Idaho (exploration, reservoir research, geopressured), Oak Ridge (chemistry, Hawaii EIS), Pacific Northwest (economics studies), Sandia (drilling, instrumentation, magma energy), UC San Diego (chemistry modeling), and University of Utah (exploration research).

- d. Each of the above groups, or organizations, should be "encouraged" to work up a single (long) list of all of the geothermal technical publications it has produced. The start of these lists could probably be gotten from OSTI, via requests to staff there, so that the Laboratory staff would have to create relatively few new entries. A citation in standard scientific form (Authors, Title, Organization, Publisher, Date, Pages) would probably suffice. Dr. Blackwell's list of geothermal exploration reports is a good type example.
- e. The vision that would be most difficult to satisfy would be that a researcher could get access to at least bibliographic material, with abstracts, at the same Internet site for both Government and private sector publications. The Government sector is fairly well covered today by three sites: OSTI (Information Bridge and DOE Gray Literature), the the DOE Geothermal Program Technical WWWeb site at INEEL, and the search engine at the "RE" page of the EREN site. The private sector information is covered well only at the GRC Library database. How these could be brought together is important to consider.
- f. Could the OSTI geothermal reference listings be exported to the GRC, INEEL, and/or other DOE Geothermal Group library database systems? If that could be done, it would vastly broaden the searchable listings at the various sites. For example, it appears that GRC and OSTI-IB share about 4,000 citations. GRC has 16,000 (non-Government items) most of which are not referenced at OSTI-IB, while OSTI-IB has 10,000 government reports not at GRC. Combining the two sets into a single searchable database would give geothermal researchers and developers $4,000 + 16,000 + 10,000 = 30,000$ items to search over.
- g. A simpler question: Could the full OSTI listings be obtained to use to help the GRC and the National Lab geothermal libraries reduce the cost of their indexing DOE reports they have on their shelves? This could be similar to the suggestion above, but perhaps could show two sources in a {Library Location} field, e.g., [OSTI] or [OSTI, INEEL], or at some far future date: [OSTI, INEEL, GRC, LBL].
- h. Finally, someone at DOE HQ needs to check out the degree to which geothermal groups at the Laboratories are submitting copies of their technical reports to the OSTI site. Clearly, if reports are submitted they are now being posted as .PDF files, searchable and downloadable. OWGT could use this site effectively to make many of its sponsored reports more accessible to its various audiences.

2.0 GENERAL RESULTS

2.1 Summary Tables

The tables below summarize many of the findings. We did not search the for geothermal sites at the following National Laboratories, for lack of time: Argonne NL, Oak Ridge NL, and Pacific Northwest NL.

Collections of DOE Geothermal Program, at DOE HQ and National Laboratories:

Library	Abstract?	Full Text?	Number of items found	
			Geothermal	Exploration
OWGT Home Pages at EREN [a]	Yes	Some	~70	17
Items at eren.doe.gov/	No	Some	16,367	70 ?
Items at eren.doe.gov/..RE/geothermal.html [b]	No	Many	6,419	485
OWGT Technical Site at INEEL [b]	Yes	Yes	500	75
Brookhaven, BNL	No	No	20	0
Idaho, INEEL, Geothermal R&D Group Library [c]	No	No	3,500	1,000
Idaho, INEEL, Home Page	Some	Most	~10	~5
Lawrence Berkeley, LBNL	No	No	105	~40
Lawrence Livermore, LLNL	No	No	86	2
Los Alamos, LANL	No	Some	4,876	381
Nat. Renewable Energy, NREL, (Not OWGT)	Most	No	~10	0
Sandia, SNL, Main Library	No	No	645	10
Sandia, Geothermal Research Group	Yes	Some	45	7

[a] There are very good "Introduction to Geothermal" pages here.

[b] **A search engine at eren.doe.gov/RE/geothermal.html lets you search across the technical summary reports at the OWGT Technical Site at INEEL!**

[c] Only part of this is on line. Numbers are estimated counts of paper reports

Other DOE and Federal Sites

Library	Abstract?	Full Text?	Number of items found	
			Geothermal	Exploration
OSTI (DOE), Energy Information Bridge Reference Database	Yes	Some	14,850	4,140
OSTI, DOE Gray Literature Collection	Yes	Yes	1,770	?
NTIS, National Technology Information Center	No. But will have by mid 2002.		300+	?
USGS, U.S. Geological Survey	No	Some	617	103
Library of Congress	No	No	874	28

Other Libraries

Library	Abstract?	Full Text?	Number of items found	
			Geothermal	Exploration
GRC - Geothermal Resources Council Library				
GRC, Paper Collection	Paper	Paper	60,000	?
GRC, All Computer Databases	Some	Some	20,000	4,670
GRC, Main CPU Database	No	No	16,000	4,470
SMU, Southern Methodist University (Dr. David Blackwell)	No	No	~450	~450
EGI, Earth and Geosciences Institute, Univ. of Utah	No	No	Not sure	Not sure
OIT GeoHeat Center, Internet	Most	Many	~300	5
OIT GeoHeat Center, Library	No	No	5,750	?
VT-GDB, VA Tech Geothermal DB	No	No	7	Many
WDC-CON, Washington DC Area DOE HQ Contractors	No	No	~1,000	~30

2.2 Evaluation of Site Usefulness

In general, if you want to find a lot of useful references you should use some combination of the following five sites.

a. Geothermal Resources Council Library Database.

Good for finding references to some of the technical reports published by DOE, *Geothermics* (journal), the GRC (Transactions, Bulletin), and reports published by the OIT GeoHeat Center. Few abstracts. You can not download reports, but can order paper copies for a fee.

b. OSTI Databases. There are two important databases here. All of OSTI's references are DOE-supported technical and programmatic reports. A few of these reports were published in other places, e.g., the *GRC Transactions*. The OSTI Information Bridge database has 14,000 geothermal items, most with abstracts included. The OSTI DOE Gray Literature database has 1,770 geothermal items; all can be downloaded as Adobe .PDF files. **It used to be that only government staff and contractors could gain access to these databases. That is no longer the case.** Contractors can still get paper reports for free, with a letter from their contracting sponsor.

c. INEEL: DOE Geothermal Program Technical Site. This site gives you access to brief summaries of five recent years of DOE Geothermal Program research projects. You can tell what the research was about, and find contacts to researchers and DOE R&D managers. Who could ask for more? Most users could, since you mostly have to know what you are looking for to find the relevant projects. Unfortunately, there is no search engine.

But, happily you can go to www.eren.doe.gov/RE/geothermal.html and use the search engine there to search among these articles. That engine has pointers to the Technical Site articles. This is one of the rare instances of cross links between DOE geothermal sites, other than lists of URLs.

d. GHC at OIT: Here there are lots of good papers on geothermal direct use (heating functions) and geothermal (ground source, or earth coupled) heat pumps.

e. Dr. David Blackwell's Exploration Reports List, at SMU: Downloading this long list (600 or 700 references) gives you both a good idea of where geothermal exploration has been concentrated in the U.S., and who has done much of that work. Use these cues and clues in searches at the first two sources listed above, and you'll have found much of the information relevant to exploration history.

2.3 Contents of a Useful Geothermal Library

Since one can't find most of what one needs directly from the Internet, many of us have to have a library with relevant secondary and primary sources. Based on the his own research work over the years and comments from others, the author believes a good working geothermal technical library needs to have the following in it.

- a. A few of the common texts on Geothermal Energy. Many of the commonly available books will do. Armitage on *Geothermal Energy* is good, and Armitage and Tester on *Heat Mining* (a.k.a., Hot Dry Rock) is good.

The DOE 1980 *Sourcebook on the Production of Electricity from Geothermal Energy Handbook*, by Kestin *et al.*, remains useful; although out of print, there are still a few copies floating about. The OIT GeoHeat Center *Geothermal Direct-Use Engineering and Design Guidebook*, third edition -- 1998, is very useful.

- b. International symposium volumes: United Nations Geothermal Conference, San Francisco, 1975; GRC International Volumes, 1990 and 1995. World Geothermal Congress Volumes: Italy, 1995; Japan, 2000.
- c. Complete sets of the following: *Geothermal Resource Council Transactions*, *Geothermal Resources Council Bulletin*, *Stanford Annual Geothermal Reservoir Workshop* volumes, and the journal *Geothermics*.
- d. If working on geothermal direct use and/or ground source heat pumps, various materials from the OIT GeoHeat Center and the International Ground Source Heat Pump Association (IGSPA) are valuable.
- e. Those interested in the history of DOE support for geothermal research and development should try to find copies of the *Transactions of the DOE Geothermal Annual Review* and the relatively recent *DOE Geothermal Research Update* reports.
- f. The U.S.G.S. Circulars on Geothermal resource assessment. Geothermal energy is very specific to regions and sites, and the U.S.G.S. reports provide the entry points to that information. U.S.G.S. Circular 790, 1978, is particularly important, since its contents provide the basis for most discussions and arguments about the amount of useful geothermal energy in the continental U.S..
- g. State-based publications, particularly the *Geothermal Hot Line* reports from California often provide historical and functional insights that other publications do not.
- h. Many of the technical details of geothermal research conducted at the National Laboratories and university groups and funded by the DOE Geothermal Program were published as stand-alone reports by the National Laboratories prior to about 1985. Since then, a great deal of the same type of information has been published primarily in the *Geothermal Resource Council Transactions*, *Stanford Annual Geothermal Reservoir Workshop*, *Geothermics*, *Transactions of the DOE Geothermal Annual Review*, and *DOE Geothermal Research Update* reports. In some cases, researchers mentioned still work at the Labs, or can be reached by those still working there.

3.0 DETAILS ABOUT REFERENCE SITES

3.1 Libraries Closely Related to the DOE Geothermal Energy Program

DOE HQ - Geothermal Energy Program Home Page(s)

These pages are the entry site for the Department of Energy Geothermal Energy Program. These pages are hosted at "EREN". The home page, at the URL below, has pointers to four pages: What is Geothermal Energy, About the Program, Web Resources, and Press Room. Together these pages constitute a brief introduction to geothermal energy and DOE involvement therewith.

The Web Resources page is one of the more comprehensive of such pages for geothermal energy sites. The pointer to INEEL points to the DOE Geothermal Technical Web site housed there. That should be relabeled and the INEEL pointer redirected to the URL for the Geothermal Research Group at INEEL.

There is a "Search" button at the left on each of the four subsidiary screens. "Geothermal" there produced 70 items, mostly WWWeb sites. "Geothermal AND exploration" produced 17 items.

This site contains some of the best introductory pages to the geothermal energy and the DOE Geothermal Research program. This page would be much improved if it provided relatively uniformed users some roadmaps to getting to more sophisticated information. Something like a technical textbook, with many links.

URL: www.eren.doe.gov/geothermal/
Dates: 3/19, 3/20

EREN - DOE Energy Efficiency and Renewable Energy Database

Things get very confusing at this site, but there is a lot of power here. You can get to this site by more than one URL, and each produces different results. That situation should be cleaned up, because any user, naive or not, could conclude that the DOE EREN Geothermal "site" accesses 31,653 relevant items, 6,419 items, or only 70 items. Or that the DOE Geothermal Energy Program has produced a total of only 70 reports in 25 years. The author believes that the middle ground, that which is at the "RE" site, is the most reasonable and useful.

URL 1: www.eren.doe.gov/
Dates: 2/13, 2/21, 3/19

"Geothermal" produced 31,653 items. But only 16,367 have "geothermal" as a keyword.

- The difference between the 31,000 and 16,000 items is because EREN uses a graded retrieval system, where partial matches, i.g., to "geo" and "thermal" would be included

as keys to items that rank low in the grading system.

- The items hit included many WWWeb sites, and many pages indexed by NREL and other National Labs. So it is reasonable to conclude that much of what is here are secondary references, rather than pointers to items held by EREN.
- Dates of publication are not shown, especially to references at the DOE Geothermal Program Technical Site (INEEL-2).

"Geothermal exploration" produced 7,035 items.

- Keyword "exploration" is indexed to 1,297 items.
- Only about the top 50 or so of the hits seemed to be relevant technical reports. Most of those hits were from the DOE Geothermal Research Program Technical site at INEEL.

URL 2: www.eren.doe.gov/RE/geothermal.html

Dates: 3/20

"Geothermal" produced 6,419 items. "Geothermal exploration" produced 485 items.

Many of those hits (in the exploration search) were from the DOE Geothermal Research Program Technical site at INEEL. So this site, with the "RE" in the URL, in fact provides the need and very useful search engine into the DOE Geothermal Technical Site at INEEL. This needs to be made clearer at more places in the network of DOE sponsored sites. There is no search engine at the INEEL site. The INEEL site should reference this site as the search engine to use for the Research Summaries.

URL 3: www.eren.doe.gov/geothermal/

Dates: 3/19, 3/20

Getting into this site from the DOE Geothermal Energy Program home pages brought up a search engine that found only 70 items for "geothermal" and 17 for "geothermal AND exploration." That gives an impression that the Program has produced only a very few reports.

BNL - Brookhaven National Laboratory

The BNL geothermal research team focusses on developing materials for geothermal systems. This site lists about 20 references. There is no search engine.

URL: www.bnl.doe.gov/est/MEA/htm

Dates: 3/20

INEEL - Idaho National Engineering and Environmental Laboratory

INEEL.1 - Laboratory Home Page

This was evaluated from the home page of INEEL. A search engine there produced 45 items from "geothermal". Most of the items were not relevant to Geothermal Research. About 10 were relevant and about 5 could be construed as related to "geothermal exploration."

It seems clear that INEEL does not maintain a WWWeb-accessible database of most of its copious technical output.

INEEL.2 - DOE Geothermal Research Program Technical Site

This covers DOE Geothermal Program Research Summaries from FY-95 through FY-99.

The summary pages from FY-95 through FY-97 appear to be based on an HTML format that provides a Table of Contents only for each major section, and no Index (although there were indexes in the paper versions of these reports). For FY-98 and FY-99, the pages are based on Adobe (.pdf files) and provide a good Table of Contents and an Index. The FY-99 format is by far the best overall.

The FY-2000 Research Summaries were distributed on CD ROM at the 2001 GRC annual meeting (August, San Diego). Those summaries need to be added to this site.

One big problem with the research summaries is that the individual pages are not tagged by year. So you can find one of these pages from an external search engine (e.g., Google), and not be able to tell the recency of the report.

We did not count the items in these five references explicitly. There are about 100 items per year, and about 15 exploration items per year. So this site scores about 500 geothermal items and about 75 exploration items.

INEEL.3 - Geothermal Technical Library

The Geothermal Research Program at INEEL has built up a substantial collection of DOE Geothermal Research Program related reports. The information here is from an interview of Joel Renner, the manager of that program.

The core of the INEEL technical reports database consists of reports originating from DOE technical research and from western state energy and geology agencies. This collection is important because it is the primary documentation for at least the following research either conducted at INEEL or managed by the DOE-Idaho field office:

- a. Direct Utilization research in the early programmatic years, when many sites were evaluated and many concept designs for industrial uses of geothermal heat were developed.
- b. The field research for the Raft River, Idaho, 10 MW binary electric demonstration project.

This project included a number of reservoir stimulation experiments.

- c. Research in the latter half of the DOE geopressed-geothermal energy program.
- d. Much research on reservoir numerical simulation methods, especially the modeling of dual-porosity media.

The initial collection at INEEL consists of about 1,200 reports. Many of these are technical reports of geothermal research sponsored by the DOE since about 1975. This initial part of the INEEL collection is databased using Microsoft Access. INEEL staff believe its files can be translated to the files needed by the databasing system that GRC uses for Geothermal Resources Council Library, "DB/Textworks," by InMagic, Inc.

In 1999 and 2000 two substantial Geothermal Technical Report libraries maintained in the Washington, D.C., area were transferred to the INEEL geothermal group. The first had originated at the MITRE Corporation, McLean, VA in the 1970s, and most recently had been maintained at Princeton Economic Research, Inc. (PERI, now named Princeton Energy Resources International, LLC), in Rockville, MD. There were about 3,000 reports in this set. This set was supported by its own manual indexing system, so it will be the last to be entered into the INEEL Geothermal Group's technical library.

The second set was maintained most recently by BCS, Inc., Columbia, MD. BCS received that from the Geothermal Energy Association, Alexandria, VA, and no one knows who originated that collection. That set contained about 1,100 reports. These are slowly being integrated into the INEEL geothermal group library using the DB/Textworks software.

Among these three collections, our current rough estimate is there are 3,500 individual reports, of which at least 700 contain detailed information useful to geothermal exploration work.

Additional reports from LBNL are being sent to INEEL for retention. Three boxes of data on Valles Caldera, NM have arrived, and much additional data on Heber will be sent soon.

INEEL receives about five requests for information per month. Two thirds of these are technical questions about Geothermal Heat Pumps, and Renner refers these questions to Kevin Rafferty at the Oregon Institute of Technology, DOE's center of expertise for Geothermal Direct Use resources and technology. Over the past five years, INEEL has received on the order of eight requests for detailed information about characteristics of potentially commercial geothermal resource sites.

INEEL.4 - Library of Geothermal Resources International

The INEEL Geothermal Group has recently acquired the entire technical library of one of the most active U.S. geothermal exploration firms, Geothermal Resources International, also known as GRI and GEO. This library is being indexed using the GRC-compatible databasing system. Mr. Renner estimates that the total cost to shelf and index the information will fall between \$50,000 and \$75,000.

The GEO information consists of the following. The "boxes" referred to are bankers boxes, each of which can typically hold about 40 3/4 inch thick reports.

1. GEO Exploration Data:
 - a. California: 38 boxes (Much is about The Geysers.)
 - b. New Mexico: 15 boxes (Much is about Valles Caldera.)
 - c. NV and ID: 21 boxes (Most is about Nevada.)
 - d. OR, WA, & UT: 22 boxes
 - e. USGS folded maps: 14 boxes, at about 100 maps/box
 - f. Pallet of rolled up maps: 15 boxes with about 30 maps per box.
(These have lots of site detail penciled in or printed out on them.)

2. General Publications:
 - a. Geothermal info: 40 boxes
 - b. Foreign pubs: 4 boxes
 - c. General geology and other earth sciences, not geothermal: 35 linear feet of shelved materials.

The GEO collection is one of the most significant collections of industry-collected exploration data.

LANL - Los Alamos National Laboratory

LANL was the primary lab for the Department of Energy's Hot Dry Rock geothermal resources and technology program, which lasted for about 18 years.

LANL's General Geothermal Collection

The URL is [lib-www.lanl.gov/]. This get you to the {library catalog}. Searching there within the category {All Words} gave the following results:

- geothermal: 4,876
- geothermal AND exploration: 381

If "Los Alamos National" is placed in the {Institution} category, then the results are:

- geothermal: 291
- geothermal AND exploration: 21

To find references to LANL Hot Dry Rock Publications:

1. Google Advanced Search -> "LANL AND Library"
get: LANL Library Home Page.
 2. -> Library Catalog
get: Catalog search page
 3. Use the bottom part of search page, with its three rows for entries.
- 3a. Find LANL Hot Dry Rock reports:

Select Index Search For Words Relationship

Select Index	Search for Words	Relationship
All Words	hot dry rock	or
All Words	HDR	and
Institution	Alamos	

-> [Submit]

- This returns 282 items. In 1999, all of these could be downloaded to your computer as .PDF (Adobe) files. In February 2002, they were not downloadable. It is likely that one could contact the LANL Website master to get them loaded up for temporary access.
- Omitting the <Institution> "Alamos" term returned 491 items. This indicates at least references to about 200 citations of non Los Alamos reports on HDR.

Dates: 2/13, 2/26

LLNL - Lawrence Livermore National Laboratory

The search here at the LLNL Library WEBCAT page showed 86 hits for "geothermal" and only 2 hits for "geothermal AND exploration." A number of the 86 hits are for journals.

Looking at the specific items found produced essentially no information except the title and year or years of publication.

From this site you can also get to the California Digital Library, which is a digital catalog that integrates information at some, but not all, of the University of California campuses. CDL produced the following indications of hits on "geothermal":

UC San Diego: 708
UC Riverside: 581

Periodical Titles: 101.

It is noteworthy that UC San Diego and UC Riverside are campuses where significant research sponsored by the DOE Geothermal Research Program has been funded, and therefore we are not surprised by a modest geothermal collection at each site. We did not search the CDL site for information more detailed than that shown immediately above.

NREL - National Renewable Energy Laboratory

This is the research results site for the Geothermal Group at NREL, not the main DOE HQ sites maintained by NREL under the "EREN" brand name. The research here is mostly about power conversion cycles and subsystems, and one recent study on institutional issues. About 10 long abstracts are available here. None of them are about exploration. There is a link to an NREL publications search engine, which shows you references to 81 NREL geothermal publications.

URL: www.nrel.gov/geothermal/
Date: 3/19

SNL - Sandia National Laboratories

The Sandia Geothermal Research Program concentrates on geothermal drilling technology. The search engine at this site produced 45 items for "geothermal". For "geothermal AND exploration" it produced 7 items, most of which are related to slim hole drilling. At the Sandia NL main library (infoserve.sandia.gov/collections/collection.html), "geothermal" returned 645 items, while "geothermal AND exploration" returned 10 items.

URL: www.sandia.gov/geothermal/
Dates: 3/19, 3/21

3.2 Other Government Libraries and Bibliographies

LOC - Library of Congress

This is located in Washington, D.C. You can access the LOC card catalog from the WWWeb. Search found 874 geothermal items, 28 of which were also keyed to "exploration". Many items here are collections, like the magazine "Geothermal Energy" that was published from 1973 through 1986. Unless you can visit Washington, you should use this mainly as a source of references to historical documents. One interesting set of reports cited here is the Inter-American Development Bank handbooks on how to conduct geothermal feasibility studies, 1994.

URL: www.loc.gov/catalog/
Date: 2/27/02

NTIS - National Technical Information System

The NTIS is located in Springfield, VA, about 8 miles south of the Pentagon. It has been a repository of paper copies of technical documents published by the U.S. government since at least 1980, and probably earlier. NTIS is operated by the Technology Administration of the U.S. Department of Commerce.

If you ascertain you want a document that NTIS has, you send NTIS money, and they send you a paper copy of the document. Prices are neither cheap nor exorbitant, perhaps 10 cents a page plus a small handling fee. (In most instances, DOE contractors can get the same reports free from OSTI (see OSTI, below) for free.)

Their electronic catalog includes all documents NTIS has received since 1990. The URL is [www.ntis.gov/search.htm]. You are allowed to see at most 300 titles from a search. On the key "geothermal" the NTIS search produced the following results:

Last 2 years:	77 reports
Last 5 years:	141 reports
Since 1990:	300 reports (the maximum return allowed).

For the "Last 2 years" search (when done in November 2001), most of the items had publication dates of 1998 or 1999. A few reports in that list were dated 1996 or 1997, suggesting the search date specifies an NTIS accession or data entry date.

On February 26, the NTIS search site was down, so we could not do the "geothermal AND exploration" search.

We contacted NTIS staff on 2/26. Their energy specialist was off at a conference, and has not returned three calls, so we are not sure of some details. One marketing staff person indicated that changes are being made. Most reports since 1997 are stored as full report .PDF files. By April or May (2002)

users will be able to find and download those for free.

NTIS, along with GPO (Government Printing Office) are responsible for disseminating copies of many of these reports to "depository libraries" for free.

OSTI - Information Bridge

OSTI is the DOE Office of Science and Technology Information. It was associated originally with Oak Ridge National Laboratory in Tennessee. URL: [www.osti.gov/bridge].

OSTI is DOE's main mechanism for referencing and disseminating DOE technical reports. Much of this is called "Gray Literature." Those are reports published by the Department of Energy itself and/or its Field Offices and Laboratories. These reports may or may not have been published in scientific, technical, or trade journals and magazines; most clearly were not.

DOE contractors can get report from OSTI free. Your DOE client must submit a form to enable this.

If you start at the above URL and then select OSTI Home Page, other valuable information resources appear. The OSTI site is in perpetual development, and promises to be increasingly important in the near future, particularly since non-contractors (everyone) can now access many full text reports here.

OSTI.1 - The Information Bridge Itself

The Energy Citations Database contains an unspecified number of citations, from 1948 to the present. Some of reports are full text documents, but most of the geothermal citations we sampled had informative abstracts but not full text.

The search specification is a bit klunky, in that each term must be entered in a separate field, as at the Los Alamos site (see above). The term "geothermal" alone produced 14,853 items when search in the field {**Bibliographic Information**}, but zero citations in the field {**Full Text**}. Most of these reports do not have full text associated with them, and are not searchable in that way. The search "geothermal" AND "exploration" produced 4,137 items.

Those numbers of citations are very similar to the numbers found from the GRC database, but most of the documents in the two sets are different from each other. Of the 16,000 reports in the GRC database, the U.S. Dept. of Energy was listed as the source for 2,066, and U.S. National Laboratories were listed as the source for 1,970, or about 4,000 reports taken together. The author would expect that most of those 4,000 reports would be included in set of 14,850 reports cited by OSTI for "geothermal." That leaves more than 10,000 reports on "geothermal" published by the federal government that are listed at OSTI - Information Bridge but are not cataloged at the GRC. For example, at the Information Bridge, "Sandia" AND "geothermal" produced 496 items, compared to the 202 Sandia citations listed in the GRC database.

Searching on "geothermal" AND "explor" in an attempt to broaden the search to a combination of exploration, exploring, explore, etc. returned only 14 items. Information Bridge, unlike many other

search engines, does not like partial words.

Some of the Information Bridge citations are for papers stated to be presented at a GRC meeting or other GRC report. The combination "geothermal" AND "resources" AND "council" AND "meeting" produced 443 items. That does not mean that all of those are from the "Geothermal Resources Council." Some of these items had "Council" as a term for an entity other than the GRC.

In many searches, terms you concatenate with "geothermal" will produce items that have very little to do with the arena of geothermal energy. For example "geothermal" AND "materials" produced 1,944 items (seemed like a gold mine) but by far most of those reports had little or nothing to do with geothermal energy.

One more interesting aspect of the Information Bridge is that it will show you 78 items keyed on "geothermal" and "plowshare". More than half of the items are citations to reports related to early work of the Atomic Energy Commission on the potential of using underground nuclear explosions as primary sources of heat for electric power plants. It is clear from these citations that the original conceptual work on "very hot dry rocks" was done at Lawrence Livermore National Laboratory (then the University of California Radiation Laboratory at Livermore, CA, Battelle Pacific Northwest Lab (at Richland/Hanford, WA) and the U.S. Geological Survey.

OSTI.2 - Other Search Engines

At least two other collections at OSTI are important to geothermal researchers. These are the "Gray Literature" database and the "Preprint Network" database. You can get to these resources from the Information Bridge by from the Bridge to the OSTI home page.

The "Gray Literature" database contains full text of over 60,000 searchable reports. Of those, 1,771 contain the term "geothermal". This database allows retrieval of only 250 items per search, so to survey most of the 1,771 you would have to break a search into parts like "geothermal AND exploration", "geothermal AND drilling"; "geothermal AND power"; etc. (The search engine for this database accepts Boolean terms.) The reports are in Adobe (.PDF) format.

The "Preprint Network" search engine lets you search across a number of collections containing about 400,000 preprints. A search on "geothermal" produced 264 items, with date ranging from 1974 to 2000. Most are fairly current.

OSTI.3 - How Technical Reports Get to OSTI

The author is aware that at one time that the Labs or Headquarters sent geothermal reports here, and then they were disseminated to other Labs and other relevant groups. Reports were sent free to DOE contractors. In the 1970's and 1980's, geothermal reports were being received by Geothermal R&D Program support contractors under this program. That dissemination had to be approved by the Department of Energy.

It appears from the contents of the "DOE Gray Literature" database that program is still in place. However, it seems that at least some of the geothermal technical reports being produced by the

National Laboratories are not being sent to OSTI. The author contacted Ray Fortuna of the DOE HQ Geothermal Program staff, and he was not aware of the status of this activity by the geothermal groups at the National Laboratories. The degree to which the various Labs are sending reports here should be checked out, especially since all recent reports are being placed online as PDF files.

USGS - U.S. Geological Survey

This site is important because U.S.G.S. staff did a lot of exploration and resource assessment work in the 1970's through mid-1980's. Although the Survey shut down most of its formal geothermal work in the mid-1980's, a few staff continued the effort. Many of their reports are indexed here. "Geothermal" produced 617 items, some of which are reports in the *GRC Transactions* and the *OIT GeoHeat Center Quarterly Bulletin*. "Geothermal AND exploration" produced 103 items. In some instances, links here let you get to full text at other sources.

URL: library.usgs.gov/
Date: 3/19

3.3 Other Important Geothermal Energy Libraries

GHC at OIT - Geothermal Heat Center at Oregon Institute of Technology

The GeoHeat Center is at the Oregon Institute of Technology, Klamath Falls. This group has been DOE's main provider of technical assistance and technology transfer for non-electrical applications of geothermal for many years. This collection focuses on applications of direct use of geothermal energy as heat, including materials on ground source heat pumps.

Much of the following information was drawn from the GHC fourth quarter 2001 report to the Department of Energy.

During the quarter, the GHC web site received an average of 1,031 users per day, and 6,678 hits per day (it takes a number of hits to find one or two reports). 70,265 files were downloaded by site users during the quarter. 216 requested paper publications were sent to individuals. For the last two months of 2001 (the October records were lost) the total number of users was 63,000, of whom 48,000 were from U.S., 4,600 from other countries, and 10,500 not identifiable re country.

The topics of the 70,000 downloaded files covered the gamut of materials available at OIT, including direct use, heat pumps, and geothermal power plant design and performance. At the end of 2001, there were 5,749 cataloged "volumes" in the GHC paper reports library.

A scan of the GHC Web site indicated there were about 300 reports available for downloading, in a mix of formats. Of those, 5 seemed to deal with exploration.

URL: geoheat.oit.edu/
Date: March 14, 2002

GRC - Geothermal Resources Council Library

The Geothermal Resources Council is the main geothermal energy trade association in the U.S. It defines itself as "a tax-exempt, non-profit, educational association (501(c)(3)). The GRC is a bit more than twenty years old. During most of its history has been building up a library of materials of its own making and of donated reports and data sets.

The materials here are based on searches of the GRC online database, and an interview of Mrs. Estella Smith of the GRC on February 26, 2002. Smith has been responsible for most of the GRC Library and its databases over the past decade.

GRC.1 - GRC Library WWWeb Database

The URL is: [www.geothermal.org/database.html]. Portions of the GRC Library have been databased since 1994. As of February 2002, only about one third of the shelved GRC holdings has been entered in the database. The database is limited to reference citations, and does not include abstracts or full text. All of reports cited can be ordered from the GRC for a reasonable fee.

As of mid-February 2002, the GRC Library electronic database included the following components:

a.	General Geothermal Information	16,000 citations
b.	GRC Bulletin Articles	3,700 citations
c.	GeoHeat Center Articles	300 citations
	Total:	20,700 citations.

The General Geothermal Information database includes the following numbers of citations from the listed Source:

1.	GRC Transactions:	3,060
2.	U.S. Dept. of Energy:	2,066
3.	U.S. National Labs:	1,970
4.	CA Dept. of Conservation	1,219
5.	New Zealand GTh Workshops	1,024
6.	Stanford GTh Workshops	1,100
7.	Geothermics (Journal):	1,100
8.	Japanese Geoth. Journals:	640
9.	Other journals	0
10.	International GTh Congress	562
11.	EPRI	460

These eleven sources account for about 13,200 of the 16,000 items in the GRC General database. The *Geothermal Resources Council Transactions* consists of the technical papers presented at the GRC annual meetings. EPRI is the Electric Power Research Institute, which sponsored many studies of geothermal energy systems in the 1970s and 1980s.

There are very few publications in which the name of a major U.S. geothermal energy firm appears as the Source. This includes no hits from searches on: Unocal, Shell, PG&E, and Edison. Smith confirmed that most reports from industry sources have not been cataloged yet.

The software platform for the GRC Library databases is Inmagic Plus, a DOS-based product of Crew Noble, Inc. Smith would prefer to use the stronger Windows-based version of this software, DB-Text, but GRC can not afford the \$2,500 or so it would take for a new Windows compatible computer and the upgraded DB-Text software. The files from Inmagic Plus can be converted automatically to DB-Text files when GRC gets a Windows capable computer. Smith also noted that the INEEL Geothermal Technical Library is using DB-Text to ensure its compatibility with the GRC database. The INEEL database technicians are in frequent contact with Smith to ensure compatibility is maintained.

GRC.2 - Usage of GRC Library Resources

Smith provided detailed information about usage of the GRC WWWeb Library Database and the Library in general. The GRC Library is hosted on a server operated by Solar Host, which provides certain detailed statistics on usage. For example, in October 2001, the GRC Library site served more than 29,000 (yes, twenty seven thousand) "successful server requests" from 3,484 "distinct hosts."

A "distinct host" is a Internet Service Provider (ISP) that serves as few as one but as many as thousands of users. For example, Smith said that in the Solar Host statistics Yahoo.com is a "distinct host" that originated many requests. So the number of users in that month was almost certainly greater than 3,484. During the seven days preceding February 26, 2002, the site had served 1,013 distinct hosts. By contrast, in 1994, the GRC Library had about 200 users per month.

A "successful server request" would consist of access to a single web page at the GRC site. So when the author of this report was checking out how many GRC Library items included "exploration" as a key word or "Department of Energy" as a Source entry, each of those probes was a single server request. We used perhaps 100 of those to get statistics for this report.

Smith believes, from conversations with many users, that the GRC Library database is being used by many as an important tool for finding references to much of the geothermal technical literature. The immediate uses seem to be mainly writing reports on technology development and seeking detailed information about specific geothermal site for potential commercial development. Most of this usage does not result in direct requests to the GRC Library for copies of reports.

In a typical month, GRC receives about 10 requests for reports from students in grades K-8; these are referred to the Geothermal Education Office, which has special materials for those levels. About 10 requests come from high schools. For these GRC has standard level-appropriate materials, which it sends out directly. Another 10 or so requests arise from college research projects, and the responses to these are tailored to more specific topics.

During 2001 the GRC received about 200 requests for copies of technical reports from the geothermal community (industry, DOE laboratories, universities). GRC mailed out copies of between 3 and 20 papers to service each of these request. The total number of reports mailed out was on the order of 1,500. Hot topics during 2001 were:

- Amount of geothermal power generated in the U.S.
- Geothermal resources in eastern states.
- Geothermal information relevant to India. This included many requests from Indian firms for contacts with U.S. geothermal development firms.

So to repeat -- in conclusion -- the GRC Library database, besides helping users gain access to paper copies of reports held at GRC, is helping a very large number of users find references to materials that they themselves hold. The author of this report has used the GRC Library database himself for that purpose many times in the past two years. But he is amazed to find that 2,500 to 3,000 people are doing that routinely in each of the recent past months.

GRC.3 - Other Materials in GRC Library

Other materials in the GRC Library collection consist of:

- a. About 40,000 items of shelved reports and other materials that GRC has not yet cataloged in the database.
- b. The following U.S. industrial and public sector library collections. These materials have not been opened or indexed because GRC does not have the funds to do so.
 1. B.C. McCabe Library - 8 boxes. McCabe was the founder of Magma Power Corp., and was the pioneer of modern geothermal energy development at The Geysers, CA, and of numerous exploration and development efforts in the U.S. This library might reveal much about early geothermal exploration in the U.S.
 2. The Pat Muffler Library - 10 boxes. Patrick Muffler was one of geothermal pioneers of the geothermal resource assessments conducted by the U.S. Geological Survey. These materials could provide useful inputs to contemporary geothermal resource assessments.
 3. The Tsvi Meidav Library - 25 boxes. Dr. Meidav, President of Trans-Pacific Geothermal, Inc., has been one of the leading U.S. geothermal industry explorers since the 1960s. He discovered a number of fields in the U.S. and elsewhere.
 4. Materials from the California Energy Commission - 25 plus boxes. These materials consist in part of management and technical files of geothermal projects, mostly for direct utilization, supported by CEC funding over the years.
- c. The Giancarlo Facca Geothermal Library - 15 file cabinets (yes, cabinets). Facca was a geothermal pioneer in Italy. These materials contain information mostly about geothermal resources in Italy, but also some information about work by Italy's geothermists in other countries and regions, presumably East Africa and Central America. Mr. Franco Tonani, of Italy, has been visiting U.S. geothermal laboratories this year, and has spent a fair amount of time organizing the Facca collection.

SMU - Geothermal Heat Mapping Lab at Southern Methodist University

This is most important because of the work of Professor David Blackwell and associates (e.g., Ken Wisian and Maria Richards) on mapping data on U.G. geothermal heat flow. Most of the information available at this site is related to databases of thermal gradient wells and heat flow maps by state and U.S. regions. We include this library because it is mostly geothermal-specific and much of Dr. Blackwell's research support has come from the DOE geothermal research program.

At the site, we found a master list of references to reports on geothermal exploration and regional interpretation from Dr. Blackwell's laboratory. Dr. Blackwell confirmed that this is the main bibliography

for the reports in his library, and that it is updated every two or three months. The URL for that is shown below. This bibliography is alphabetized by states, then geothermal sites. It represents a pretty complete bibliography of which exploration team did what where. This is the master list against which all other geothermal lists of exploration reports should be compared.

URL: MAIN: www.smu.edu/-geothermal/
URL: REF LIST: www2.smu.edu/geothermal/georeou/refhots2.doc
Date: 2/21

VTGDB - Virginia Tech Geothermal Database WWW Home Page

This site is a good example of a well-organized presentation of information from geothermal exploration wells, mostly thermal gradient wells. There is a page for each of seven mid-Atlantic states, from Georgia to New Jersey. Each page shows maps with well locations. Selecting a well location brings you to data from that well. There are links to other geothermal pages here. There is not much specialized detail except for the well data, so we rated this as 7, 7.

URL: rglsun1.geol.vt.edu/
Date: 3/19

WDC-CON - Washington, D.C. area DOE HQ Contractors

Various support and technical contractors to the DOE HQ Geothermal Energy Program built up technical libraries over the years. The largest of these originated at MITRE Corp. in about 1974 migrated to Meridian Corporation in about 1985 and to Princeton Energy Resources International (PERI) in 1995. Most of this, perhaps 3,000 reports was shipped to INEEL in 2000. A library of about 1,000 items labeled "Geothermal Energy Association library" (possibly from when the GEA was in Alexandria, VA) was relocated to BCS consulting, Columbia, MD, in 1999 and shipped to INEEL in 2001.

Currently PERI holds about 1,000 reports. Most of these are secondary-level references about DOE sponsored research on geothermal technology development in the areas of exploration through conversion equipment and environmental and social issues. Many of the others are related to DOE Geothermal Programmatic materials issued over the years, including program plans, most of the *Transactions of the DOE Geothermal Annual Program Review* (about 15 volumes), and the *Geothermal Progress Monitor Reports* (20 items). PERI has a complete set of the *GRC Transactions*, many of the *GRC Bulletins* and *OIT GHC Quarterly Reports*, and the *California Geothermal Hot Line* reports. International symposia are well represented.

In 1999, PERI indexed most of the LANL Fenton Hill Hot Dry Rock technical reports on a CD ROM under its work on the DOE Enhanced Geothermal Systems (EGS) R&D program. At that time PERI downloaded many of the LANL HDR technical report .PDF files (before the LANL library moved them off line).

WWWeb Sites with Specialized Geothermal Links

There are a few important sites from which to find other geothermal WWWeb sites. These include EREN (DOE), NREL, GRC, and IGA (International Geothermal Association). These are described as URL (Uniform Resource Locator) Lists or Lists of Links.

Interestingly, the most comprehensive of these lists is at a site in China:

[www.dhm.ch/geothermlinks.html].

That page can be saved, and is a good resource for links to many other significant pages.

4.0 CONCLUSIONS

The "system" that currently holds the products of 25 years of geothermal research and exploration is loose knit. It appears that most of key parts of the DOE-HQ sponsored geothermal technical library collections (except for the OWGT web sites at NREL and INEEL, including the EREN sites) were configured many years ago. The main federal sites for archiving federally sponsored technical reports (OSTI and NTIS) seem to be in process of being actively adapted to the WWWeb.

Some of the DOE-HQ-Geothermal sponsored collections are being adapted to the WWWeb, some not.

Many libraries at the National Labs and primary contractors (e.g., EGI) are not databased or even well categorized. This means we are likely, soon, to lose the ability to recall even what was done, let alone be able to locate a copy of certain important reports.

The main recommendations are in the Summary Section.

5.0 REFERENCES

1. Bechert, Heinz, "'To be a Burmese is to be a Buddhist': Buddhism in Burma," in *The World of Buddhism*, H. Bechert and R. Robrichh, eds, Thames and Hudson, Ltd., New York, 1991, p. 157.

Appendix A. Details: GRC Library Database

Review of Contents of GRC Library Database

The GRC Library database is perhaps the most significant geothermal reference database of non-government reports in the U.S. The version probed in February 2002 was updated last in March 2001. The author probed that database to gain a rough idea of the extent of coverage on a number of geothermal technical areas. The results are shown here

GRC Main Reference Database:

Total number of references: 16,700.

Hits based on Source of reference:

GRC Transactions	3,064
Geothermics	1,010
Gth Science & Technology	4
U.S. Dept. of Energy:	2,066
DOE National Laboratories: [a]	
Brookhaven	64
Sandia	202
Idaho	3
LANL	306
Lawrence Berkeley	1,346
Lawrence Livermore	0
Pacific Northwest	59
Argonne	0
Oak Ridge	13
U.S. Dept. of Interior	1 [c]
USGS	? [b]
Geological Survey	187
Geological Survey of Japan	184
United Nations, Total	778
UN, 1970 Symposium	208
UN, 1975 Symposium	311
UN, Remaining [d]	~550

References to articles in other GRC separate databases.

GRC Bulletin: 3,700 items.
OIT GeoHeat Center: 300 items.

Number of hits for some terms:

<u>Term in Keyword Field</u>	<u>Hits</u>
geothermal	1697
thermal	2962
exploration	4472
lease or leasing	174
geology	1046
chemistry	1285
geochemistry	779
geophysics	467
seismic	467
seism	508 [e]
reservoir	3829
simulation	442 [f]
drilling	1155
well	1435
wells	372
completion	164
stimulation	118
power	1689
power plant	377
direct use	870
direct heat	25

DOE Programmatic Areas in Keywords:

Hydrothermal	371	(But this is the default area for most reports.)
Hot Dry Rock	588	(Many HDR items are reports on foreign projects.)
Geopressured	132	
Magma Energy	13	(All are reports of Sandia activities.)

Country in Keywords:

Americas

Canada	51
Costa Rico	33
El Salvador	59
Guatemala	25
Mexico	400
Nicaragua	23

Asia

Japan	615
Philippine(s)	151
Indonesia	91
New Zealand	397

Europe

France	106
Italy	302
Iceland	206
United Kingdom	30

U.S. Major Geothermal Resource Areas (in Keyword field)

The Geysers	434
East Mesa	126
Heber	96
Salton Sea	155
Coso	74
Imperial Valley	145
Imperial	174

States of the U.S. (in Keyword field)

Arizona	27
California	1,295
Colorado	45
Dakota(s)	17
Idaho	114
Montana	18
Nevada	175
New Mexico	161 (Many HDR reports key on New Mexico.)
Oregon	127
Utah	87
Washington	40
Wyoming	17

Notes about the GRC Library:

- [a] Search for these without using term "National". LANL was at times LASL. Lawrence Lawrence Berkeley Laboratory did not use the term "national" in most of the references.
- [b] Search engine did not find USGS, or U.S.G.S. or U. S. G. S. The engine seems to not want to process single letters with periods, at least in the "Source" field.
- [c] Search: Department of *the* Interior.
- [d] Mostly about the UN training programs.
- [e] "Seism" will hit both "seismic" and "seismology".
- [f] Could include wellbore simulation.