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STANFORD GEOTHERMAL WORKSHOPS: THE FIRST SIX YEARS

Ian G. Donaldson* and Paul Kruger

Stanford Geothermal Program
Stanford University
Stanford, CA 94305

Introduction The First Stanford Geothermal Reservoir Engineering Workshop was convened in December, 1975. Its success in compiling the scattered information on geothermal reservoir engineering resulted in its establishment as an annual event of the Stanford Geothermal Program. In this seventh Workshop, it is appropriate to look back over the efforts of the past *six* years and to evaluate the overall results. Three questions may be raised: (1) Are the Workshops achieving the same aims and objectives of the initial meeting?; (2) What progress in geothermal reservoir engineering has been achieved over these six years?; and (3) Have the Workshops developed any special values of their own that distinguish them from other geothermal meetings?.

The development of the Stanford Geothermal Engineering Workshops is well recorded in its Proceedings. At the first Workshop, some 50 papers were presented over a three-day period. These papers, including two overviews, covered the following general areas of geothermal engineering:

(1) Reservoir Physics - studies to evaluate the physical processes occurring in geothermal reservoirs
(2) Well Testing - techniques used in specific and generic fields to determine volumetric and extractive characteristics of a reservoir
(3) Field Development - methods for optimum commercialization of producing fields
(4) Well Stimulation - techniques for improving energy and fluid recovery from geothermal resources
(5) Modeling - mathematical methods to study geothermal reservoirs.

During the ensuing five Workshops, the weighting given to these general areas have changed; different areas were introduced at various times, for example the area of well testing was expanded to include reservoir testing and formation evaluation; and special sessions were added for topics such as production engineering, geopressured systems, and risk analysis. The three-day format of the Workshop has been retained; and in 1977, a major change in program content occurred with the introduction of a panel session. The panel session is now an integral part of the workshop program; the specific theme for each workshop is chosen to reflect a topic most appropriate to the state of geothermal reservoir engineering at that time. The topics discussed at the four prior annual workshops are listed in Table I.

The development of geothermal reservoir engineering is also reflected in the changes in sponsorship of the Stanford Geothermal Program, indicating the general change in government support of geothermal energy research and. development over this time period. The sponsorship of the workshop program is listed in Table 11.

Aims and Objectives During the past *six* years of the Workshop, the aims and objectives have been kept rather constant. In the Introduction to the Proceedings of the First Workshop, they were clearly defined:

"The purpose of the Workshop convened here at Stanford this December, 1975, is two-fold. First, the Workshop was designed to bring together researchers active in the various physical and mathematical branches of this newly-emerging field so that the participants could learn about the very many studies underway and share experiences through an exchange of research results. The second purpose was to prepare these Proceedings of the Workshop so that the integrated information could be disseminated to the geothermal community responsible for the development, utilization, and regulation aspects of the industry."

These purposes may be contrasted to the objectives as stated in the Introduction to the Proceedings of the Sixth Workshop in 1980:

"The objectives of the Workshop, the bringing together of researchers, engineers, and managers involved in geothermal reservoir study and development and the provision of a forum for the prompt and open reporting of progress and for the exchange of ideas, continue to be met."

In retrospect, the stated objectives of the Workshop have been constant, but have they indeed been met? This can best be answered by looking at three aspects of the Workshop:

* current address: DSIR, New Zealand

Table I

SGP Workshop Panel Discussion Topics

Workshop	Year	Topic Theme
Third	1977	Definitions of Geothermal Reserves
Fourth	1978	Geochemistry
Fifth	1979	Reservoir Models--Simulation vs. Reality
Sixth	1980	Numerical Model Intercomparison Study

Table II

Sponsors of the SGP Geothermal Workshops

Workshop	Year	Sponsor
First	1975	National Science Foundation: RANN Program
Second	1976	{National Science Foundation: RA" Program Energy Res. and Dev. Adm.: Div. Geoth. En.
Third	1977	Dept. of Energy: Div. Geoth. En. (thru LBL)
Fourth	1978	Dept. of Energy: Div. Geoth. En. (thru LBL)
Fifth	1979	Dept. of Energy: Div. Geoth. En. (thru LBL)
Sixth	1980	Dept. of Energy: Div. Geoth. En. (thru SF00)

(1) the people who participate by presenting papers and attending the sessions, (2) the coverage of the papers offered, and (3) the status of the Proceedings.

Throughout the six years, Workshop participants have come from a wide spectrum of research and development groups--from government agencies (such as the Department of Energy and the U.S. Geological Survey), from the universities, from the National Laboratories, and from the many sectors of the industry (developers, utilities, and consultants). In addition, there has been considerable input and participation from abroad. For example, 21 attendees from 11 foreign countries participated in the 1979 Workshop; 18 attendees from 6 nations participated in the 1980 Workshop. This 20% attendance from abroad indicates a strong international nature of the Workshop. A significant feature is that these participants keep coming back.

Progress in Geothermal Reservoir Engineering

During the six annual Workshops, the distribution of general topics covered has become discernable. Table III shows the number of papers by the headings that have been used in the Proceedings' programs for the six Workshops. The totals for the last three also include panel discussion papers. The averages indicate a program of 2 overview papers, 9 reservoir science papers, 10 field evaluation papers, 9 field development papers, 3 stimulation papers, and 11 modeling papers. By decision, a feature of the Workshops is a balance between theoretical and practical papers; one that has been maintained through the six years.

One lasting feature of the Workshops has been the set of Proceedings that have become an important part of the literature on geothermal reservoir engineering. From the start, copies have been in demand to such an extent that reprintings have been required for some and increased first printings are now essential. Papers in the Proceedings are regularly cited in the professional literature as well as in review articles and in books. The Proceedings are often the only public source of information relating to some research and to some aspects of field development.

In reviewing the Proceedings, a major observation becomes readily apparent. In each of the topic areas, the context of the papers shows a marked transition from reports on "research intent" to reports of "significant achievements." This is especially true in the topics of field evaluation and field development, where successes (and problems) in bringing new fields on line have been shared among the participants. The sessions on modeling also show a rapid acceleration from "How to" papers to analysis of complex fields. A special part of the 1980 Workshop Proceedings (SGP-TR-42) was issued separately on the code intercomparison study sponsored by the Department of Energy in which it was noted that six independently constructed simulators could arrive at reasonable agreement of results given the same input information.

Table III

Distribution of Papers by Topics in the SGP Annual Workshop Proceedings

Topic	Workshop First	Second	Third	Fourth	Fifth	Sixth	Total	Average
Overviews	2	3	2	4	1	1	13	2.2
Reservoir Physics	9	8	8	7	4	12	48	8.1
Reservoir Chemistry						4	4	
Well Testing	10	5				3	18	
Well & Reservoir Testing			12				12	10.0
Well Test & Formation Eval.				15			15	
Pressure Transient Analysis					15		15	
Field Development	9	9		4	7	9	38	
Geopressured Systems						4	4	9.0
Production Engineering					6	6	12	
Well Stimulation	6	6		6			18	3.0
Modeling	14	13	11	9	10	9	66	11.0
Risk Analysis						2	2	0.3
Totals	50	44	33	45	43	50	265	44.2

The Special Values of the Workshops In contrast to the many overall meetings on geothermal research and development, the SGP Workshops might be classified as relatively small and specialized. The result has been a set of Workshops in which all participants are able to be involved over the whole meeting. With an average of about 100 attendees, the meetings are informal, with much cross-discussions of issues raised during the presentations. Over the three-day period, the participants can get to know or renew acquaintance with a large proportion of the attendees. A large amount of information transfer and exchange of ideas occurs through this open structure.

Although centered about the engineering aspects of the geothermal reservoir, the Workshop is still broad enough to attract papers from a wide spectrum of disciplines: social, economic, environmental. The balance between theoretical and practical aspects of geothermal reservoir developments allows a wide degree of perspective to each participant.

A second special value feature of the Workshops is the panel discussion. To date the panels have had excellent support from both the audience and the panelists. Fortunately, there has been little difficulty so far in finding topics appropriate to the research and development climate existing at the time of each Workshop. With the nation's energy picture still not in sharp focus, this situation is likely to remain yet for some time.

The third special value feature of the Workshops are the meeting preprints and the Workshop Proceedings. These have proved an excellent means of circulating recent research findings and field development information quickly to the many scientists, engineers, and managers responsible for the development of geothermal energy. This year, the advent of the "camera-ready" copy for preprints and Proceedings should result in even faster communication of results to the geothermal community.

A basic principle of the SGP Workshops is that all papers accepted for the Workshop be published in the Proceedings. This is now especially important today in that not all papers offered can be presented orally at the sessions. Although this principle could lead to publication of ideas that might not be accepted for publication in archival journals with full reviewing process, the publication in the Workshop Proceedings puts them on record. Like the Workshop itself, the Proceedings are a forum for discussion and hence new or alternative viewpoints should continue to be acceptable.

Achievements of the Workshops The Stanford Geothermal Reservoir Workshops have made "significant achievements" in their short lifetime. They certainly have brought together those interested in geothermal reservoir research and development and provided the participants with a forum for expression and exchange of ideas and results. Through the Proceedings, these ideas and results are maintained for later reference.

Another significant achievement results from the informality and openness of the meeting. The Workshop has become accepted as the medium for reporting new research ideas and development information--well in advance of more formal publication, if any. Several research themes have continued through several workshops, indicating a feedback mechanism from exposure and discussion of ideas to development into research programs and results. A major case in point was the panel discussion of the Fifth Workshop in 1979, "Geothermal Reservoir Models--Simulation vs. Reality," which in effect set the stage for the Department of Energy sponsored numerical modeling intercomparison study carried out over the next year and reviewed in the panel discussion of the Sixth Workshop in 1980.

Summary The Stanford Geothermal Reservoir Workshops are now firmly established as an international forum for those interested in the geothermal reservoir, its study, and its development. The industry is yet in its infancy with respect to its future potential in meeting the nation's energy requirements. Thus, the problems of geothermal reservoir engineering need to be investigated for some time yet. New appropriate topics for future workshops will not be in short supply. The Proceedings of the Workshops have become an important part of the baseline of current knowledge of geothermal reservoirs. However, the distribution to date has been rather limited. With wider references to them appearing in the general literature, their availability should be expanded. The avenues for wider circulation to technical libraries and other geothermal reference systems are being examined.

The Stanford Geothermal Reservoir Engineering Workshops have played a significant role in the current development of geothermal energy. The momentum is forward, and maintaining a perspective of the growth of geothermal exploitation will be an interesting part of future Stanford Geothermal Workshops.

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