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DATA COLLECTION AND ORGANIZATION FOR THE DEVELOPMENT OF HDR / EGS SYSTEMS - A SUBTASK WITHIN THE HOT DRY ROCK ANNEX OF THE NEW IEA-GIA (GEOTHERMAL IMPLEMENTING AGREEMENT)

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1. ABSTRACT

Annex III of the new IEA Geothermal Implementing Agreement (GIA) deals with Enhanced Geothermal Systems / Hot Dry Rock (EGS/HDR). Subtask C of this Annex was set up to provide a framework of information for the construction of the coming first generation of HDR/EGS energy producing plants, including project planning and availability of special tools and services.

The subtask is entitled Data Acquisition and Processing. The initial intention is to document for future use the information already gained at all the major HDR research and development projects world-wide over the past 25 years. These include in particular those at Soultz-sous-Forêts in Alsace, France, at Rosemanowes Quarry, Cornwall, UK, at Fenton Hill in New Mexico, USA, at Fjällbacka in Sweden and at both Hijiori and Ogachi in Japan. All of these projects will be overviewed as far as possible in this subtask. An English-language handbook for a newly developed database, created for indexing data and literature generated at each project, and details of data archiving techniques have already been produced.

Further efforts are directed towards the collection of information on literature, equipment, services, tools and techniques suitable for use during the design and construction of an HDR power plant. These are linked to the development of a generic project development and construction plan, which will also be introduced.

2. AIMS OF THIS WORK

An accumulation of data and documents characterizes every major R & D project. In an emergent technology like Hot Dry Rock geothermal energy, which tends to involve long timescales, generations of scientific staff and often work by many organizations, it is especially characteristic.

Switzerland's technical contribution to the GIA consists principally of organizing and leading one subtask within Annex III (the EGS/HDR programme). The formal title of this subtask is "Data acquisition and processing". In practice this title is slightly misleading, because the majority of the effort is directed at finding, collecting and organizing information.

The overall aim of the subtask is to provide aid in planning the development of future HDR projects, first by pinpointing data requirements for the successive project phases and then by locating the sources of those data. It is intended to create a framework for the construction of a commercial HDR plant - including project planning, availability of special tools and services - and (through lists of reports and publications with their abstracts) an overview of existing data, of data analyses and of experiences gained at the major HDR projects world-wide. This is held to be most valuable at the present phase of development of Enhanced Geothermal Systems or HDR resources as we move from the purely research phase into the early operational phase.

Work started in the course of 1997. In the first year, effort was concentrated in two main directions: first towards setting up the working framework and secondly towards creating some of the tools for the subtask.

Over the past three to five years it has become apparent that soon a number of EGS pilot plants will be built and soon after that the concept will become commercial. There is, therefore, an urgent need to secure and organize the relevant detailed information, measurements and experiences acquired over some 25 years of research at a total cost equivalent to some US$ 400 million world-wide. This task was approached first, therefore, after setting up a matrix framework for project information requirements.

A concept exists now for the stable archiving of project activities, data acquired and literature generated and for identifying the location and availability of those items typically occurring in the developing and testing of an HDR reservoir. The various aspects of these techniques have been tested on the two large European projects: Rosemanowes Quarry in England, now completed, and the presently active site at Soultz-sous-Forêts in eastern France. The corresponding database application and archiving principles were distributed to international collaborating project teams at the end of 1997 or the start of 1998.

3. COLLECTING AND ARCHIVING DATA

The Soultz project has now been in active existence for some 12 years. The Rosemanowes and the Fenton Hill projects were active for 15 and 17 years respectively and work has been going on at the Hijiori site since 1984. As long as we are still learning about reservoir creation and development in differing conditions, there will continue to be a need to re-analyse measurements and observations from past experiments. This consideration is behind the data collection, archiving and cataloguing for the Soultz project, which started in 1996.

There are a number of criteria to be fulfilled by any data management scheme in the present context:

- Archiving should be on stable media with at least one basic version of each set of stored information produced, with text and numerical data in codes and formats which are internationally standardized as far as possible.
- Although re-study and re-analysis of data will no doubt continue over many years (even decades), only a small number of people really need to have copies of the *data*.
- Many more people will want to know what has been done and to read *interpretations* of the events and results of work.

Consequently the following approach has been adopted for use on the European HDR projects at Soultz and Rosemanowes. The same approach is being recommended also for use by other projects co-operating in the GIA. The essential features are:

1. physical separation of archived data from the data catalogue system;
2. adoption of a data storage approach which in general enables location by data and by subject (for the moment, raw microseismic data are an exception);
3. creation of a data catalogue, named the Project Index Database, which documents the project history and links activities with data, reports and publications.

This two-component concept is illustrated in Figure 1. It has the advantage of permitting complete, efficient and, if necessary, decentralized archiving.

3.1 Archives

Archiving in the broad sense concerns not only the quantitative data but also comment and interpretation and results in the form of reports and publications. Both sets of information must be collected, but we concentrate in this section on the first item - quantitative data.

The first principle adopted is to convert data from field or laboratory measurements into ASCII files on the most stable medium. At present, Compact Discs offer the best maintenance-free solution, requiring at the same time a minimum of physical storage space compared with other media. This principle will ensure the most reliable and uncomplicated access to the data over longer periods.

We can expect continuing improvements in durability and levels of standardization of storage media, so the need for periodic updating of electronic archives will have to be met.

The second principle is the arrangement of quantitative data both by calendar date and by subject. This is illustrated by the diagram in Figure 2. Data are archived according to the month during which a measurement series or recording activity commenced.

Data files are identified more precisely by file name and header and may be identified and located from the Index Database (see section 3.2 below). A consistent system for filenames is naturally preferred and helps to avoid mistakes in indexing or accessing them but is not, strictly speaking, absolutely necessary.

Whereas publications can always be located using conventional library access techniques, archiving and accessing project reports requires particular care. Double storage of reports and technical notes, that is to say, the maintenance of both paper and electronic archive originals is the approach adopted here.

3.2 The Project Data Index

The Project Index Database is designed to enable quantitative and qualitative data - resulting from experiments, investigations, measurements and reports - to be catalogued and linked. The quantitative data are located by file and storage medium names, but are not directly integrated in the database. Literature objects (reports and publications) are also not integrated. These are however referenced by title and publication reference, authors and, wherever available, abstracts.

To meet this requirement a general relational database has been developed, capable of being applied to any similar field projects. The database gives output in list or graphical forms designed to enable a simplified overview of the chronological sequence of operations and the progress of the project. The linked data may be accessed from three viewpoints, which represent the grouping of the information, as follows:

Activity: types of activity on site, dates, available data sets, locations;

Literature: types, titles, authors, abstracts, locations;

Organization: firms or institutions responsible and the contact points.

Searches for specific activities or literature may be initiated via keyword. Each type of access enables cross-reference to the other two information groups.

The Index Database contains also a brief historical overview of the project and enables a further perspective of the project by means of graphical chart outputs of activities.

A widely available, economical and widely used database system was sought for the Index Database. The choice fell on Microsoft ACCESS, version '97. A "runtime" version of a completed database can be created and made available for distribution without the end user being required to buy a version of the core program.

4. A GENERIC PROJECT - A YARDSTICK

The application of the Index Database concept together with careful archiving of all relevant information will ensure easy availability of existing data collected over the past decades.

In order to help define which existing information and also what additional data will be needed and when it might be needed during the construction of at least the first few pilot plants, the experience of building a pilot plant should really already be available. Unfortunately this is not yet the case, so it has been decided to use the experience gained in planning and executing one of the first projects of this nature and generalizing and extrapolating from that basis.

The project being used for this use is the Deep Heat Mining project in Switzerland, where currently a project is being developed in the city of Basel. The project is still in its very early stages but has generated already a great deal of planning work with detailed long term considerations of data

requirements, techniques to be used, particular services needed, logistics and co-ordination tasks.

In order to create an overview of the data requirements the generic project has been structured into five phases as shown in Figure 3. This is similar in some ways to the breakdown of an oil industry project, which is not surprising since we are considering here heat mining on a local scale, even though in general a regional resource can be considered as sustainable. In this diagram, the data needed by the project developer, or later the operator, have been divided into seven rather general categories. Within these categories there are naturally finer divisions and lists of individual of information to be made.

Naturally the detailed lists of items will vary from site to site and from country to country. To be helpful for the planning groups over the next few years or decades it is felt that it will be useful to produce guidelines for the truly generic questions to be answered and at the same time relate the exact experiences of a particular case. This always allows case-to-case, country-to-country and site-to-site comparisons to be drawn.

5. STATE OF THE WORK

The planning of the Index Database and all programming work has been completed. A user manual is now available (Hopkirk & Mégel, 1998).

Within Europe the techniques sketched out above are being applied to the current EU project at Soultz-sous-Forêts in Alsace, and also to the British Rosemanowes Quarry project in Cornwall (also partly financed by EU funds) which has provided so much valuable experience. The state of data archiving and organization was very different in the two projects. Because of the generally excellent availability of information on activities, data sets and reporting of the project, it was decided to use Rosemanowes as a base for testing the Index Database concept. A trial version with the information collected from the archive store at Rosemanowes with the help of CSMA in the course of 1997 has been produced and is now available for demonstration.

At the time of writing (autumn 1999) most of the quantitative data and literature pertaining to the Soultz project to date has been identified and located. Archiving is being undertaken and rationalized and a large amount of information has been entered into the Project Data Index. Some CD's with data sets have been produced, although much work remains to be done before a truly current state can be achieved. Reports on the field activities and data collections of some of the institutions involved are beginning to appear in print (e.g. Genter, 1999; Pribnow & Jung, 1999).

Both Japan and the United States of America are active partners in subtask C. In both countries similar project documentation and data archiving campaigns are under way. In Japan, much of the quantitative data and literature from the Hijiori research site has been collected and an Index Database is being built up. This work is being carried out at NIRE (National Institute for Resources and Environment). Work is also starting on the Ogachi project.

In the United States, the huge amount of data and literature generated during the Fenton Hill project is being sorted and indexed in the manner suggested here. Of very great value too are the history, the lessons learned and the consequences of the research work. These are being reviewed and documented (GeothermEx Inc, 1998a ,b).

Progress on generic project analysis has covered now the pre-construction and strategic planning stages. At present efforts are being undertaken to establish the consequences for the necessary data flows of deciding on one procedure or another.

6. ACKNOWLEDGEMENTS

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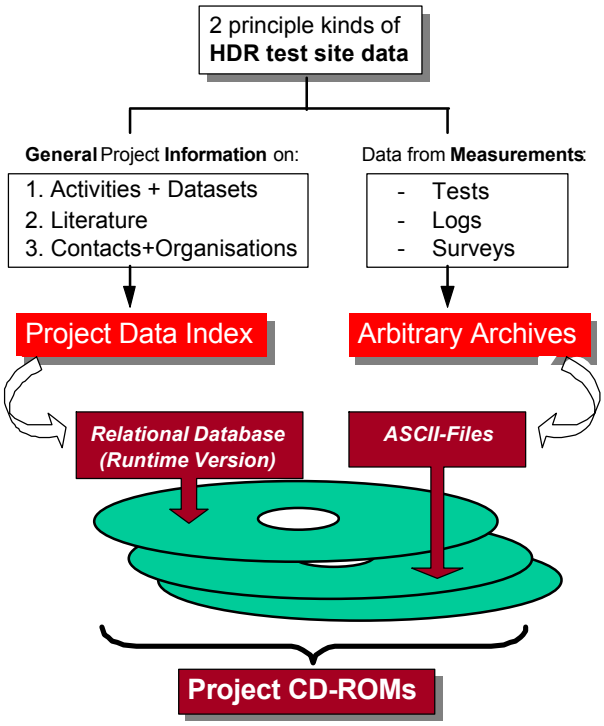

Figure 1: The generalised archiving and indexing concept

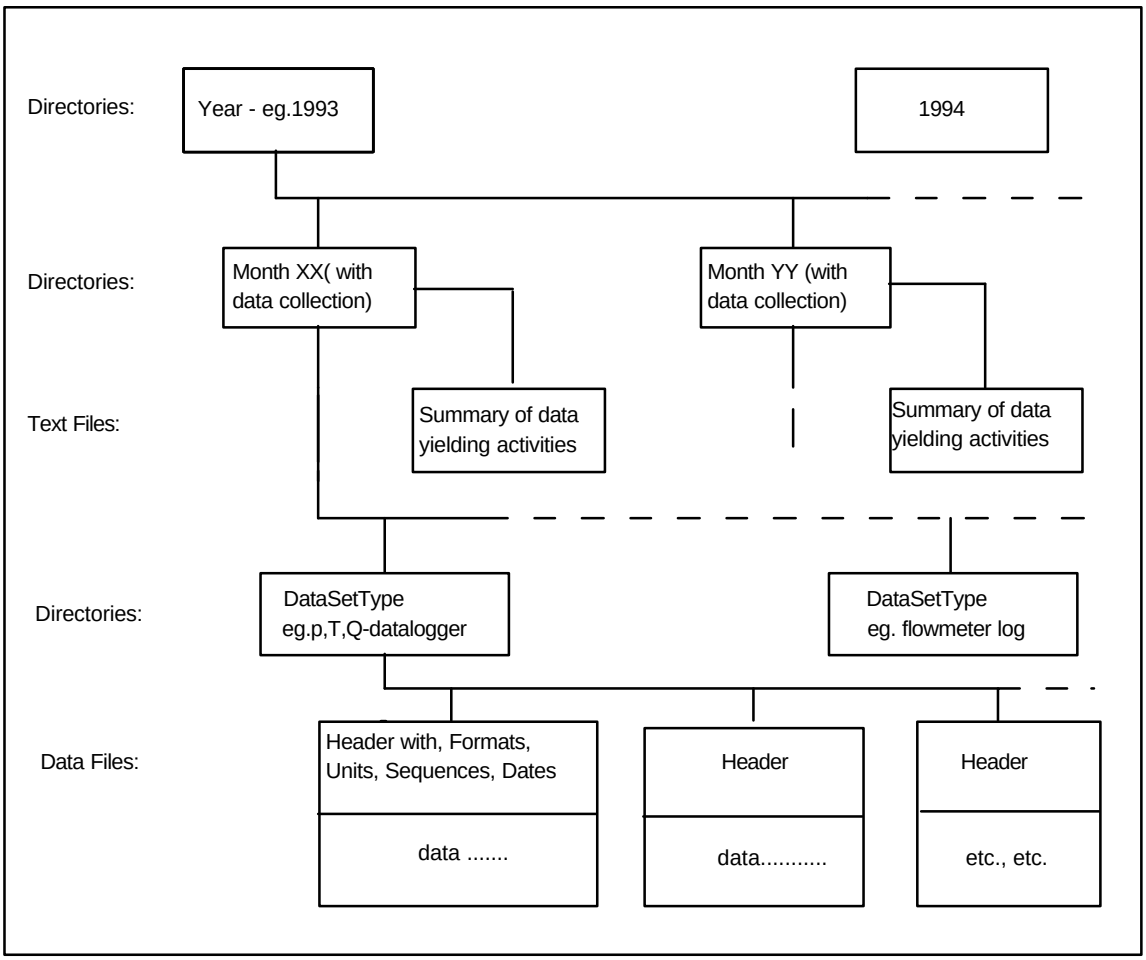

Figure 2: archiving quantitative data by date and by subject

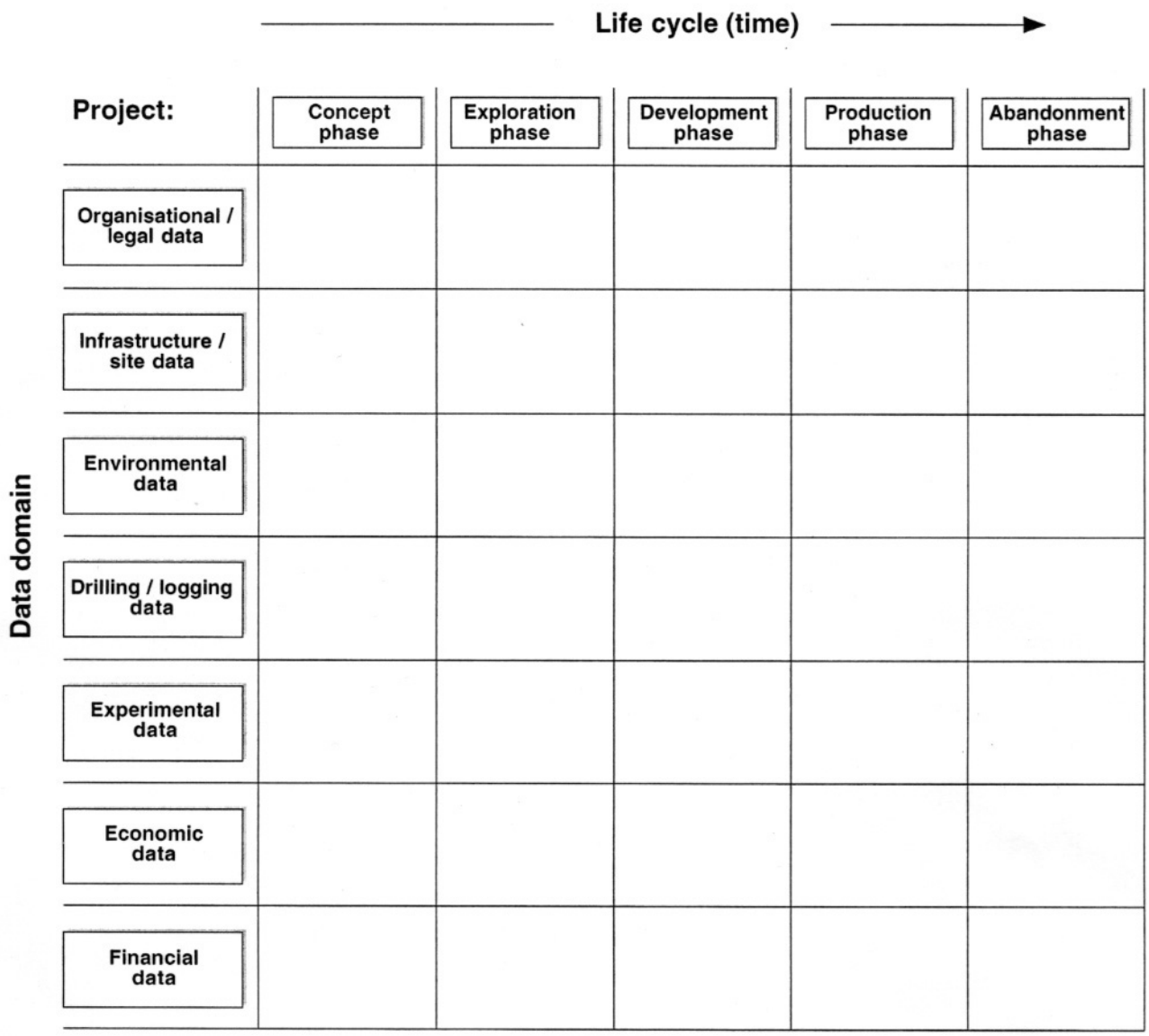

Figure 3: The project data matrix - classification system used for data required for the generic plant during the five phases of its lifetime.