

Technical Management Document #1
Department of Energy - Division of Geothermal Energy
Western States Cooperative Direct Heat Geothermal Program

by

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INTRODUCTION

The purpose of this document is to provide a better understanding of the Department of Energy's Western States Cooperative Direct-Heat Geothermal Program, and of the responsibility of each participating organization. The State Cooperative Program is one of several programs being conducted by the Division of Geothermal Energy of DOE, whose mission is to stimulate development of geothermal energy as an economic, reliable, operationally safe and environmentally acceptable energy alternative. Emphasis in this document is on Phase I of the Program.

SUMMARY DESCRIPTION OF THE STATE COOPERATIVE PROGRAM

The objectives of the State Cooperative Program are 1) to assist the U.S. Geological Survey in extending the inventory of geothermal resources in the United States to include the low temperature ($\pm 20^{\circ}\text{C} < T < 90^{\circ}\text{C}$) reservoirs most suitable for direct heat application¹, and, 2) to stimulate reservoir confirmation studies at sites with an apparent but unquantified potential for direct heat application development. It is the belief of the program participants that development of direct heat geothermal resources will have a significant near-term impact by helping to fulfill U.S. energy requirements.

The Program will be carried out separately but concurrently in each of about 15 western states by interdisciplinary working groups of people from Federal and State agencies and from other organizations. Each State Project will be carried out in two phases, which may or may not operate concurrently:

¹The presently existing geothermal resource inventory published in U.S. Geological Survey Circular 726 tabulates resources where $T \geq 90^{\circ}\text{C}$.

- Phase I:
1. Compilation of available data and possibly collection of new data on temperature, temperature gradient, water quality, aquifer productivity, and related peripheral geoscience items as specified further below;
 2. Submission of certain items of the basic data from (1) above for inclusion in USGS computer file GEOTHERM;
 3. Publication of a preliminary map and report based on interpretation of the above data compilation;
 4. Publication of a final map and report based on detailed interpretation of the above data compilation.

- Phase II:
1. Selection, by use of the Phase I data base, of specific sites for detailed testing;
 2. Geoscience investigations of the above specific sites to select drill-test locations;
 3. Drill testing for reservoir confirmation and assessment;
 4. Publication of site-specific results, including distribution of maps and reports to potential developers of direct-heat geothermal resources.

Each of the State Projects will be initiated by five-way agreements among 1) DOE-Division of Geothermal Energy (DGE), 2) an appropriate state agency, academic institution, or other geoscience group within the state, 3) the U.S. Geological Survey (USGS), 4) the Bureau of Land Management (BLM), and 5) the U.S. Forest Service (USFS). The basic responsibilities of each of these organizations will be as follows:

- DGE:
1. Technical and administrative management of contracts between the state agency and DGE (contact John Griffith or Maggie Widmayer, U.S. Dept. of Energy, 550 2nd Street, Idaho Falls, Idaho 83401: (208) 526-1668);
 2. Programmatic liaison with the USGS;
 3. Interfacing with other DGE programs;
 4. Environmental reviews necessitated by Federal participation in projects on non-Federal land; and
 5. Funding and technical support for site-specific environmental studies.

- State Agency:
1. Project management of state agency work funded by DGE;
 2. Coordination of various State and Federal agencies and other organizations participating in the project;
 3. Liaison and coordination between the State Project and other ongoing Federal and State-supported geothermal projects in the state;
 4. Preparation of a preliminary report and map (if needed) showing location and extent of direct heat geothermal reservoirs in the state (with possible help from NOAA);
 5. Supplying the USGS with data generated by this project for inclusion in the GEOTHERM data base;
 6. Preparation of a final report summarizing the known distribution of direct heat geothermal resources in the state (final map to be prepared by NOAA);

7. Contracting for environmental studies leading to the preparation of environmental reports on specific test sites; and
8. Coordination of site-specific geoscience studies and subcontracting for drill testing.

USGS:¹

1. Technical advice to each State Project Manager;
2. Making available to the State Project Manager any existing geologic, hydrologic, chemical, or geophysical data that are pertinent to the project objectives, and planning in consultation with the State Project Manager additional data gathering activities by the USGS that are mutually desired for the project;
3. Assistance in the transfer of data from the Project to the GEOTHERM file (contact James R. Swanson, US Geological Survey, Mail Stop 84, 345 Middlefield Road, Menlo Park, CA 94025; (415) 323-8111);
4. Delivery to NOAA of final digital tapes from GEOTHERM file containing point temperature and water quality data for production of preliminary and/or final maps;
5. Assistance in interpretation of point geothermal and water quality data in terms of geothermal resources;

¹The USGS is the lead Federal agency in assessment of geothermal resources in the United States. The State Cooperative Program is assisting in a new USGS resource assessment through direct funding and through integration of this Program with USGS resource assessment activities.

6. Coordination by the USGS Geothermal Research Program management and the appropriate District Chief of the Water Resources Division with the State Project Manager of ongoing and planned USGS geothermal studies within the state;
7. Participation in selection of specific sites for reservoir studies (Phase II), and, where desired and appropriate, cooperation in the execution of these studies.

USFS:

1. Coordination as necessary for surface activities, environmental assessment and use regulations on land managed by this agency. (Contact local USFS office in each region.)

BLM:

1. Same as USFS above, except BLM operates geographically by state in the western U.S.

In addition to the above, other organizations will be involved in several aspects of the Program as follows:

Earth Science Laboratory, University of Utah Research Institute (ESL/UURI):
(contact Phillip M. Wright or Duncan Foley, Earth Science Laboratory, 391-A Chipeta Way, Salt Lake City, Utah 84108: (801) 581-5283)

1. Advice in preparation of proposals to DGE by the state agency and in formulation of state projects;
2. Technical advice to DGE on each state project;

3. Geoscience technical advice and help to the state agency in data compilation, verification, interpretation, documentation, and in report writing;
4. Coordination of transfer of data among the state agency, the USGS and NOAA for production of the final maps;
5. Participation in selection of specific sites for Phase II reservoir studies;
6. Geoscience technical advice and help to the state agency during evaluation and testing of specific sites.

National Geophysical and Solar-Terrestrial Data Center, National Oceanic and Atmospheric Administration (NOAA): (contact Paul J. Grim, NOAA, Code D62/NOAA/EDS, Boulder, Colorado 80302: (303) 499-1000, x-6418)

1. Advice to DGE and to the State Project Manager on compilation and publication of preliminary and final state maps;
2. Plotting and publishing final state maps;
3. Help in peripheral data compilation, plotting and digitizing for final state map preparation.

Topographic Division, USGS (TD)

1. Compiling and digitizing base map information for final state maps;
2. Delivery of digital tape containing base information to NOAA.

Los Alamos Scientific Laboratory (LASL): (contact A. William Laughlin or Francis West, Los Alamos Scientific Laboratory, P.O. Box 1663, Los Alamos, New Mexico 87545; 505-667-4255)

For the states of Arizona and New Mexico:

1. Advice in preparation of proposals to DGE by the state agency and in formulation of state projects;
2. Technical advice to DGE on the Arizona and New Mexico projects;
3. Geoscience technical advice and help to the state agency in data compilation, verification, interpretation, documentation, and in report writing;
4. Participation in selection of specific sites for Phase II reservoir studies;
5. Geoscience technical advice and help to the state agency during evaluation and testing of specific sites.

RELATIONSHIP TO THE 1978 USGS

RESOURCE ASSESSMENT PROGRAM

During 1978, the USGS is reassessing the geothermal resources of the United States. This effort is being coordinated by Patrick Muffler in the Menlo Park office. It is expected to culminate in the publication in early 1979 of a report, complete with maps, which will represent an update of USGS Circular 726. The portion of this effort concerned with assesment of low- and moderate-temperature resources is being coordinated by Ed Sammel, who is working directly under Muffler. Much of the data base that will be required by Sammel will be generated by the State Cooperative Program and close liaison with Sammel's project will be maintained.

DETAILED DESCRIPTION OF PHASE I

Phase I of the State Cooperative Program will require close cooperation and interaction of the participating groups. In order to assure appropriate uniformity and to facilitate timely publication of individual state reports and maps, certain requirements for data compilation, verification and interpretation, as well as for data flow, must be established. These requirements are discussed below.

It is presently planned that NOAA may print two final maps for each state. The first map will be intended for the general public and the second map will be intended for the geoscience community. In terms of stimulating private sector development of geothermal energy, the "public" map may prove to be the more important. Although much data applicable to a study of direct heat geothermal energy resources have been published already, there generally exist no compilations and interpretations of such data which are useful to non-geoscience-oriented potential developers. Such compilations and interpretations are necessary to stimulate broad-based development of direct heat applications.

One guiding principle of the Phase I reports and "public" maps, therefore, is that they must be easily understandable and useful to the general public. In this way the greatest benefit is expected in terms of rapid development of low- and moderate-temperature geothermal resources for direct heat applications.

The "geoscience" map will generally be more complex and will include geoscience data that will not be printed on the "public" map. The final state report may or may not discuss the geoscience map.

It is important to present geothermal energy data in map form because it is anticipated that this will be one of the principal methods of promoting the use of this alternate form of energy. It is planned to have final multicolored maps of each state prepared by NOAA. These final maps will be at the USGS state base scale (1:500,000, except for Alaska) and projection (Lambert Conformal conic), and the method of presenting data will be approximately the same for all states. Present plans call for NOAA to undertake immediately production of "public" and "geoscience" maps for the State of Idaho as a trial. This trial will serve to establish a working system for production of other state maps. Idaho was selected because the Phase I study is well along and because the USGS - Topographic Division already has much of the base data digitized from recent maps.

The preliminary state map and report referred to above will be directed to the non-geoscience public and will include only a selection of the total data package to be compiled in order to facilitate publication at an early date. The final state map(s) will be more comprehensive.

Data Compilation

The data to be compiled under Phase I are classified as 1) geoscience data, 2) base data, or 3) operations research data. Data types specified below are for discussion purposes. The data package ultimately compiled

should be the subject of very careful consideration by each state project working group.

Geoscience Data

1. Location, temperature and depths of temperature measurement(s) for geothermal wells and springs where measured $T > 20^{\circ}\text{C}$. The actual cutoff temperature will vary from area to area and should be chosen at roughly 5°C above mean annual air temperature. Obviously depth to water at the cutoff temperature is important and should be considered on an area-by-area basis;
2. Location, temperatures and depths of wells where geothermal gradient data are available even though $T < 20^{\circ}\text{C}$;
3. Water quality and productivity data and other hydrologic data for geothermal wells and springs and for areas where a low-temperature geothermal resource is predicted to exist;
4. Subsurface temperature estimates from chemical and isotopic geothermometers;
5. Location, extent, and ages of young volcanism and intrusion;
6. Location and nature of geothermally deposited spring deposits;
7. Locations of known faults and/or lineaments thought to have a bearing on geothermal resources;
8. Distribution of mineral deposits and/or other geochemical indicators of geothermally deposited elements, such as Hg or U prospects;

9. Locations of known earthquake epicenters.

The basic geoscience data for the State Cooperative Program are groundwater temperature and water quality. Most low temperature reservoirs will be economically exploitable only if they are shallower than approximately 2,000 feet, and it is compilation and interpretation of these shallow data that should be emphasized. Where geothermal gradient data are available they should be compiled, even though measured temperatures are below $\pm 200^{\circ}\text{C}$, because gradient data may give an approximate idea of how deep a usable low-temperature resource might be.

Water quality data are important for at least two reasons. First, determination of low-temperature heat exchanger specifications requires water quality data. Some geothermal fluids may require special treatment before passing through a heat exchanger. Second, some ions may cause contamination of the environment if the geothermal fluid is not disposed of properly. Anomalously large amounts of F, B, Hg, As, H_2S and other such substances thus should be noted.

The productivity of geothermal wells and springs should be noted if available. Otherwise generalizations should be included on the typical productivity of certain aquifers not necessarily within the resource but which are interpreted to be characteristic of the resource.

One idea for display of water quality and productivity data is to include a 1:1,000,000 scale map either as an inset or on the back of the 1:500,000 scale map.

Estimates of subsurface temperature from chemical or isotope geothermometers likely will not be incorporated directly into the final interpretation of locations and extent of geothermal resources. Considerable question remains about the application of these geothermometers to lower temperature resources. The value of compiling such data will lie in pointing out areas in need of more data collection. Verification of anomalous geothermometer temperature by actual temperature measurements would be in order. If the prediction of geothermal waters can not be verified, the chemical geothermometer data for purposes of this project should be downgraded. It is appropriate to indicate areas of anomalous geochemical thermometry data on state maps, but these areas should not be shown as established geothermal resources.

Peripheral geoscience data listed in items (5)-(9) are of value as a result of their association with geothermal resources. They will aid in interpretation of the point geothermal data in terms of predicted total areal extent of a geothermal reservoir.

Base Data

1. Boundaries: State; County; National Park, Monument, Forest; State Park, Monument, Forest; Indian Reservation; Military Reservations; Physiographic Provinces; KGRA's.
2. Location; township and range; latitude and longitude; UTM grid tics.
3. Highways and roads
4. Railroads

5. Drainages and water bodies
6. Populated places
7. Land ownership

Operations Research Data

1. Electric power transmission lines
2. Gas and oil pipelines
3. Population density
4. Others

Preliminary State Map and Report

It is anticipated that a preliminary map and report showing distribution of known low- and moderate-temperature direct-heat geothermal resources may be desirable. The purpose of this preliminary publication is quickly to disseminate resource data to interested individuals and organizations in the public and private sector. The need for preliminary publications will be determined by DGE after consultation with the State Agency, the USGS, UURI, NOAA and others. The map will contain the primary information, whereas the report should be a useful but very brief description of the data and of the resource. The text of the report could be printed on the back of the map. Recommended map specifications are:

Scale: 1:500,000

Projection: Lambert Conformal conic

Base Data: County boundaries, cities and towns, highways and roads,
railroads, township and range, latitude and longitude.

Geoscience Data: Point Data--temperatures of geothermal wells and springs, depth(s) of temperature measurement(s), temperature gradients where available, water quality of producing aquifers in ppm total dissolved solids with potential contaminants noted, expected aquifer production;

Interpretation--areal extent of each low temperature reservoir.

Operations Research Data: None.

The Earth Science Laboratory-UURI will provide help and technical advice where needed during data compilation, verification, and interpretation and during map and report preparation. The USGS-Water Resources Division also can be asked by the State Project Manager to help with data verification and interpretation. The USGS-Office of Resource Analysis may also participate in interpretation if desirable. If a preliminary map is to be produced, the method of preparing it may vary from state to state. The map may be made by the state agency, by NOAA, or by the state agency with assistance from NOAA.

Final State Map(s) and Report(s)

The final state map(s) will be published by the National Geophysical and Solar-Terrestrial Data Center of NOAA in Boulder, Colorado. NOAA has facilities for producing a high quality map product at minimum cost and time. Uniformity will be assured by having each state map published by the same facility.

NOAA will make extensive use of computer plotting during preparation of the map separates. Digital magnetic tapes containing information to be included on each map will be furnished to NOAA by several organizations:

1. The base data as listed above will be provided to NOAA by the Topographic Division of the USGS in Reston, VA;
2. The point geothermal data and some water quality data will be provided to NOAA from USGS computer file GEOTHERM.

The interfacing needed to guarantee delivery of a product useful to NOAA will be carried out directly between NOAA and the organization providing the digital data, with help from UURI if needed.

NOAA will require other data in addition to those listed above for final map production:

1. A final interpretation of the areas containing low temperature resources. This interpretation will be made on the basis of the point geothermal data and existing information on hydrology and geology. The state agency will be responsible for this interpretation, but use of expertise from the USGS Geothermal Research Program and District offices of the Water Resources Division (WRD) and from ESL/UURI will be encouraged by DGE. The interpretation will be provided to NOAA in map form, and NOAA may or may not digitize the data.

2. Peripheral geoscience data.

Each final state map will show a selection of geoscience, base, and operations research data discussed above. Other map specifications are presently planned to be as follows:

Scale: 1:500,000

Projection: Lambert Conformal conic

Special Features: 1) Summary of report text on back of map
2) Geothermal site descriptions as insets
on map

The final State Report for Phase I will be a concise, comprehensive discussion of the data portrayed by the map. It should be useable by the public at large as well as by earth science specialists.

Data Flow

The following Figures 1, 2, 3, and 4 are self-explanatory. They indicate in skeletal outline one system of data flow for Phase I of the State Cooperative Program. The exact data flow system for each state should be individually tailored to state needs.

PROGRAM FUNDING

DGE plans separately to fund or partially fund a number of organizations:

1. State Agency;

2. USGS Office of Resource Analysis (Geothermal Research Program, computer file GEOTHERM);
3. USGS - Topographic Division;
4. USFS;
5. National Geophysical and Solar-Terrestrial Data Center (NOAA);
6. Earth Science Laboratory, University of Utah Research Institute (ESL/UURI).
7. Los Alamos Scientific Laboratory (LASL).

Each State Agency should request sufficient funds in their proposals to DGE to discharge successfully their responsibilities. The other separately funded organizations should be used by the State Project Manager as specified herein and for additional tasks as necessary. Separate funding is provided for these organizations by DGE in order to encourage their use.

Figure 1. Flow Diagram for Geothermal Data

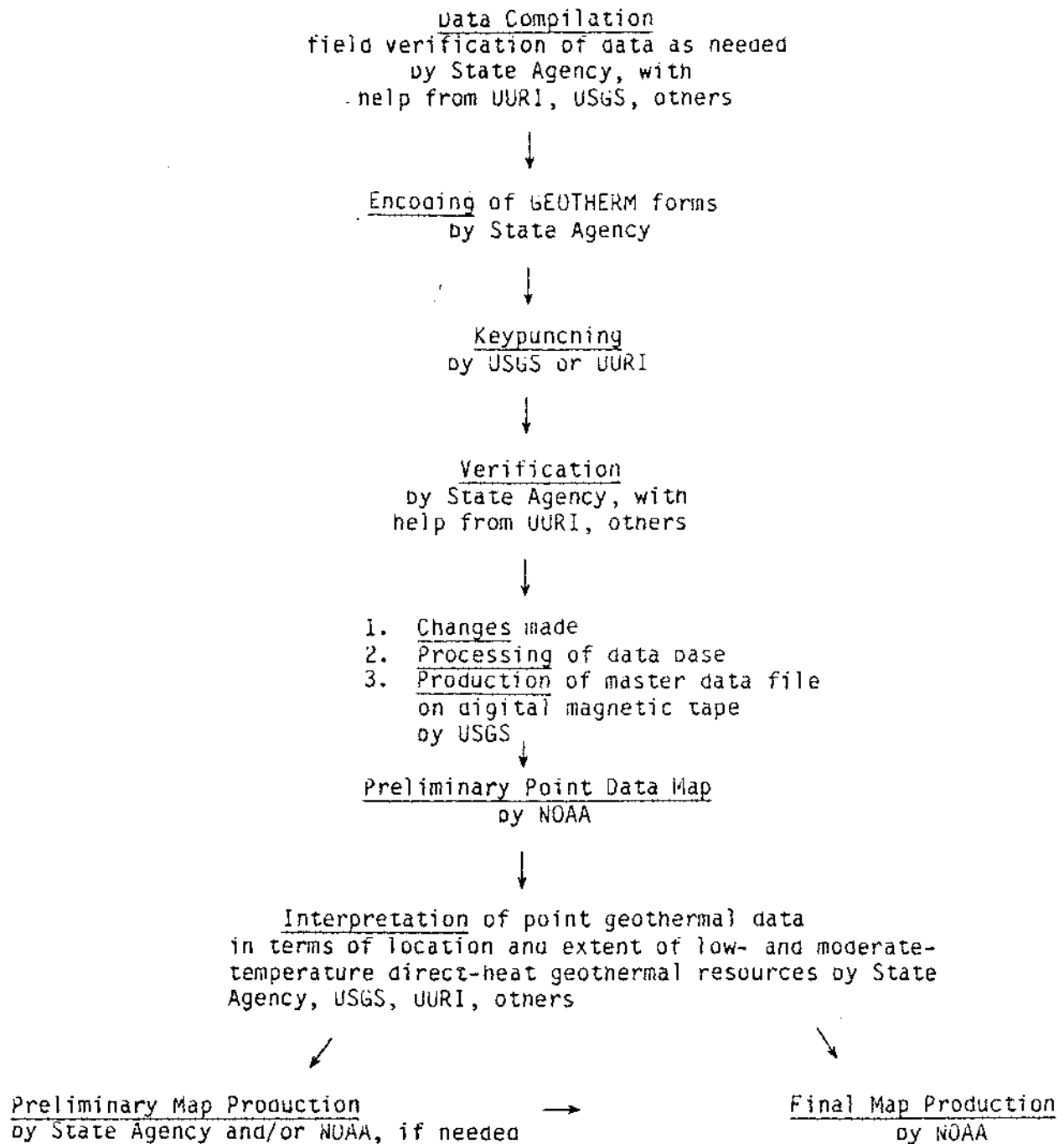


Figure 2. Flow Diagram for Peripheral Geoscience Data

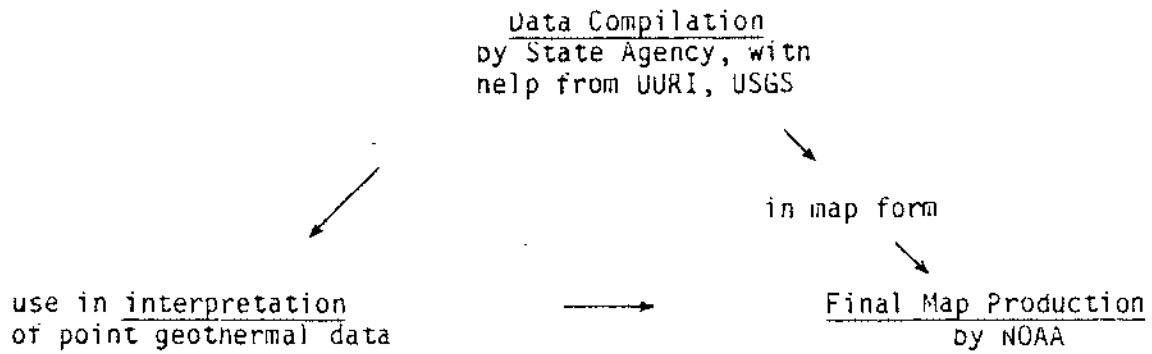


Figure 3. Flow Diagram for Base Data Compilation

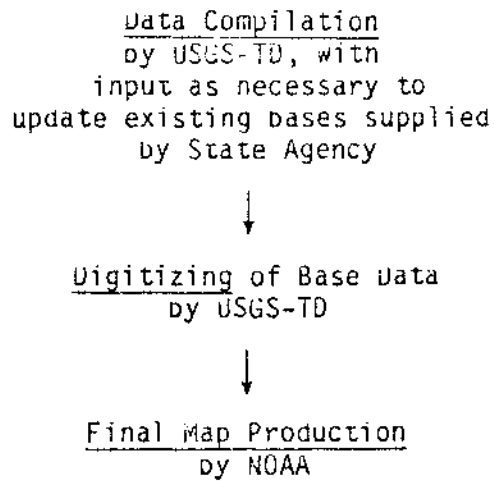


Figure 4. Flow Diagram for Operations Research Data

Compilation of OR Data
by NOAA with
help from State Agency, UURI, USGS



Digitizing OR Data
by NOAA



Final Map Production
by NOAA