

We conclude from these results (Fig. 2) that in our sampled sites, the fraction finer than 50% of bed material is being moved by rather common floods having a 0.8 probability of occurrence. These results are in accord

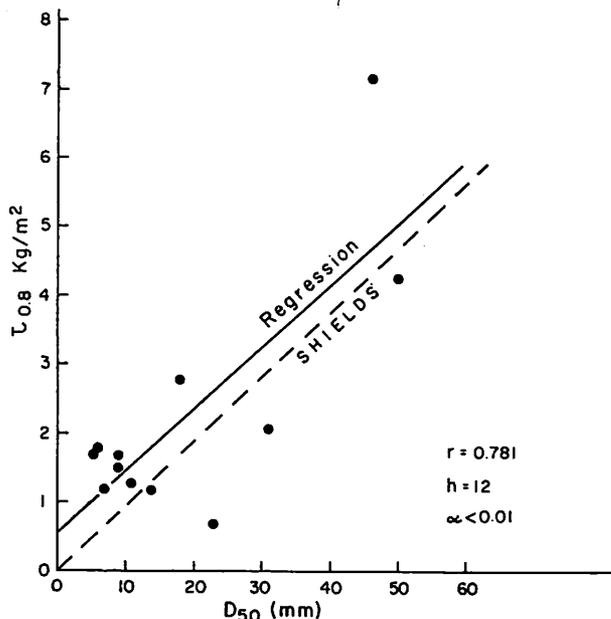


Fig. 2. Correlation between median grain size, and the shear stress which occurs in three streams at a probability of 0.8.

with the estimate of Brush (1961) that the 2.3-year flood moves 80-90% of bed material in headwaters, and are also in accord with Andrews' (1980) results, that a bankfull discharge is almost identical with the modal sediment-transporting discharge.

This study is at a preliminary stage and more measurements are definitely needed before reliable conclusions can be drawn. However, the early results are promising and it is hoped that this approach will shed light on the frequency of bed material movement, and will also permit the extrapolation of the results, in order to construct discharge-frequency curves for ungaged streams in the Negev.

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## SYNOPSIS OF THE ISRAEL WELL DATA SYSTEM

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### Introduction

Boreholes are an indispensable source of information for all types of subsurface geological investigations. The amount of information which can be obtained from each borehole is not only large but it can cover a wide range of subject matter including among others stratigraphy, paleontology and petrography; the composition, pressure and level of fluids; petrophysical - log measurements; and technical aspects of the drilling operations. Commonly, the various types of data are assembled by different agencies, each emphasizing the collection of those special data which are most pertinent to its field of interest. Each agency usually employs a different validation and registration standard and filling proce-

cedure. These practices lead to a situation in which the scattered data become practically inaccessible to the general user or, at best, its collation is prohibitively inefficient and expensive. Thus, the advantages and importance of creating a centrally coordinated comprehensive data base system which will contain all the information cannot be overemphasized. However, it is important to realize that due to various constraints, such a major program is often not practicable, and can certainly not be accomplished in a short time. Under these circumstances the comprehensiveness of the system should be compromised in favour of practicality and effort should be concentrated on developing an interim solution which is useful yet feasible.

A well inventory including basic items of information is a common need of all potential users, regardless of their particular speciality. Such a compilation is manageable with restricted means and can be accomplished within a reasonably short time period. In addition to providing a useful service in itself, such an inventory is a foundation on which any future expansion can be built. Based on these considerations, it was decided to limit the scope of the compilation to the following basic data: Well identification number (new); Well name (all synonyms of well names are retained); Location coordinates; Reference elevation of the well head; Topographic elevation of the well site; Total depth; Source of information (serves as a reference for further information); Identification numbers (according to the Mekorot Water Company and the Electrical Company); Well cuttings sample number (Geological Survey of Israel archive); Availability of petrophysical logs (yes/no); Identification of producing aquifer in water wells; Date of completion. These data were assembled for about 7500 boreholes which are of stratigraphic significance. These include oil, gas and water wells, wildcats, structural holes and the deeper geophysical and geotechnical boreholes. The data were collected from the archives of the Oil and Water Divisions, Geological Survey of Israel, Tahal Water Planning for Israel Co., and the Hydrological Service of the Ministry of Agriculture. In order to make the compilation accessible to the general user for quick manual referral, the entire contents of the data base and the various retrieval directories were published (Gill, 1972).

The Israel Well Data System may serve as an example of a task oriented record management system of the kind discussed in Gill *et al.* (1977). The main characteristics of such systems are: subject - specific information; sequential file organization of fixed-formatted records; simple software; predictable search criteria, and a provision for manual access by means of published documentation of the data base and its retrieval directories. The following is a brief review of the design of the system and its software components. It may serve as a general reference and guide for the construction of similar systems for other applications.

### Review of system components

A generalized flow diagram of the system is presented in Figure 1. The system consists of ten programs (shown in the diagrams by sequentially numbered rectangular boxes) which operate on and generate a number of permanent and intermediate working files (shown by circles) and print a number of messages and reports (shown by the torn page symbol). The prog-

rams are written in COBOL. Sorting operations required at various stages are carried out by the sorting utility program of the operating system (rectangular boxes labeled 'SORT'). The software system can be divided into five functional components (Fig. 1):

1. Data input and validation - The input stream can contain three types of transactions, new wells, modifications and deletions. Any card order is permissible. The cards are read by the Input Validation program. The program detects input errors by performing logical checks on the individual fields of the input records according to validation tests and permissible codes prescribed for each type of transaction in internally stored tables. Erroneous records are listed in the error report and rejected from further processing. Valid transactions are retained (file T-1) and sorted according to well and card number to produce file T-2, whose order now parallels that of the current master file (K-1).

2. Update - The Update program performs three main functions: a. It carries out several additional input-validation tests (which could not be performed by the input validation program) and lists and rejects the erroneous records. b. It applies the valid update transaction changes to the existing current master file (K-1) to produce a new master file (K-2). c. It writes the valid update transactions on a separate file (T-3). This file is sorted according to transaction and well / card identification number to produce file T-4 from which the update report appendix is prepared (see below).

3. Master list printing - Program Report 1 edits the data and prints either the new master file (K-2) to produce the master well list or the update transactions file (T-4), to produce the update report. The printing, reproduction and distribution of the entire master file, a very costly endeavour, is done only when a new edition of the master file and its directories is to be published. Appendices to the master list, documenting only the changes made in each updating run, are printed more often, whenever justified by the number of update transactions.

4. File manipulation - The Record merger program performs some file manipulations in preparation for certain subsequent operations. The master file (K-2) is separated into two files, one containing the well-names in Hebrew (A-1) and one in English (B-1). In each file all the data for a specific well is compiled into a single record in order to facilitate subsequent data handling (primarily sorting). The English file (B-1) serves the multiple attribute, general purpose retrieval application (following section (6)). It also serves other data systems involving subsurface well information, such as the Israel Paleontological Analyses Data System. All retrieval directories of the Hebrew master file are prepared from the A-1 file.

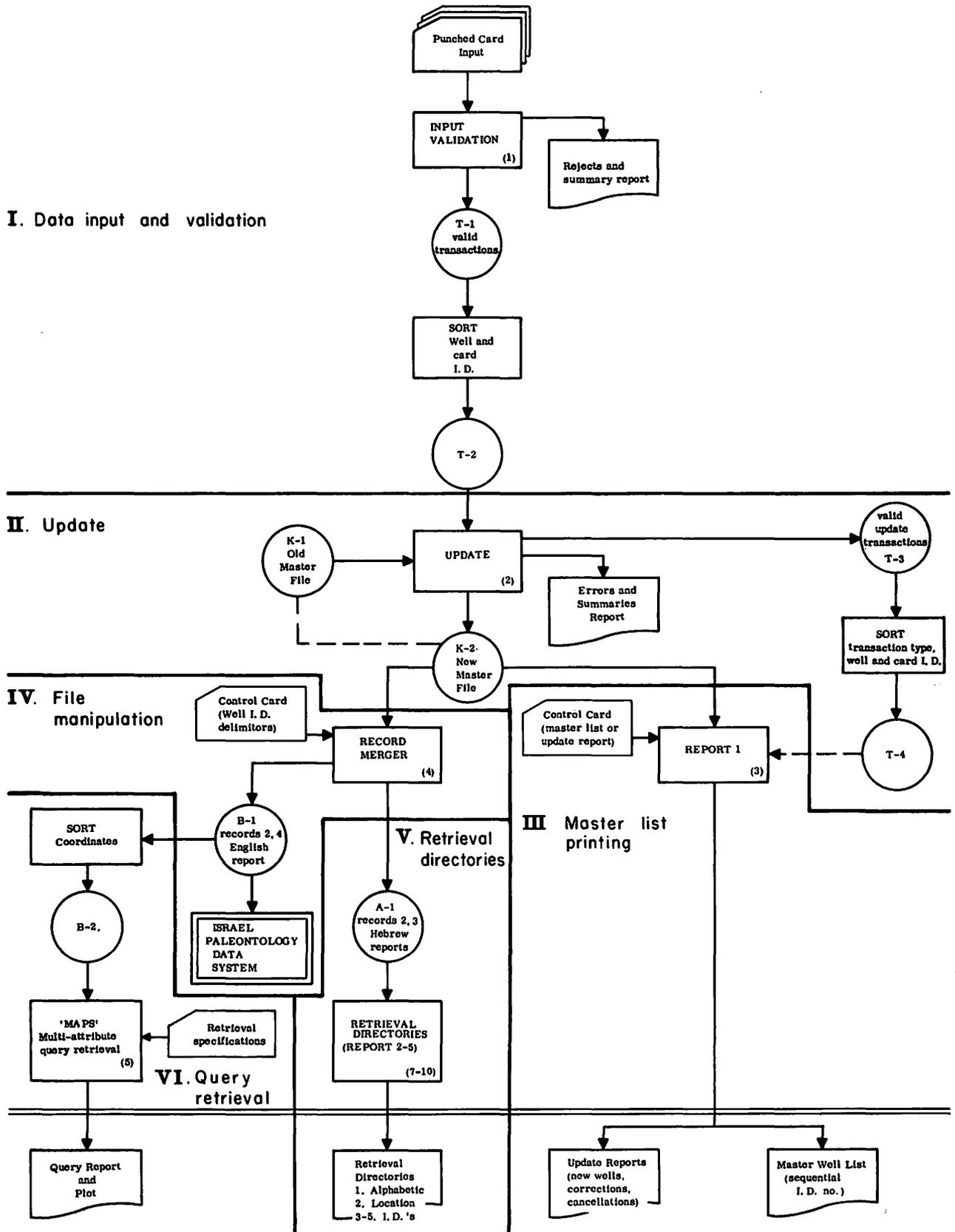


Fig. 1. Flow chart of the Israel Well Data System.

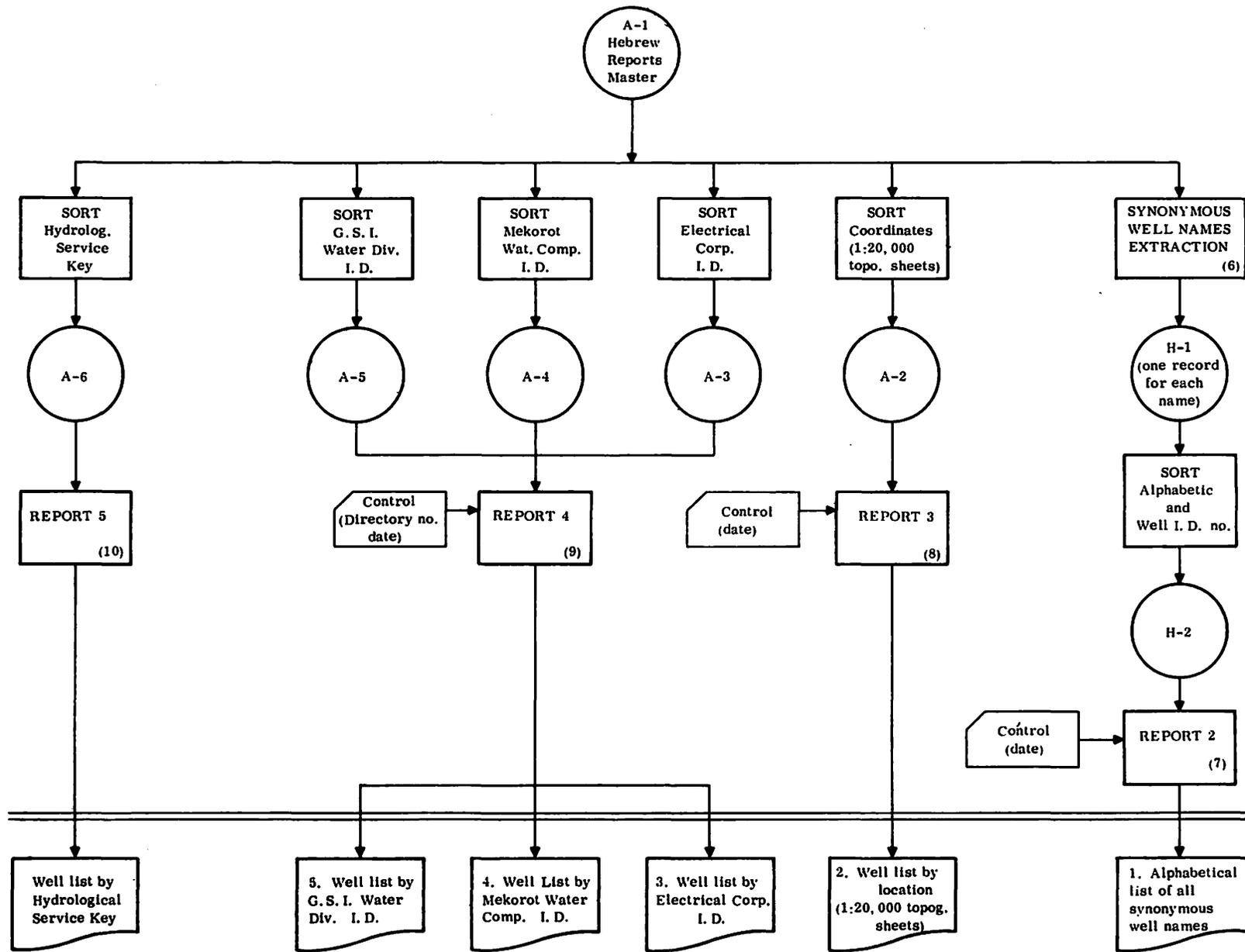


Fig. 2. Flow chart of the Israel Well Data System: preparation of retrieval directories.

RETRIEVAL DIRECTORIES

5. Preparation of Retrieval Directories - As indicated above, a provision for manual access to the entire data base is one of the main design elements of the system. In addition to the master well list, which documents the entire contents of the file listed according to sequential access numbers (3) above, the user is also provided with a number of retrieval aids. The retrieval directories consist of condensed inverted lists, cross referencing the attribute according to which the directory is sorted with the master list. The attributes selected for cross-referencing are a few, useful keys according to which the file is most likely to be searched. The keys selected for this application are the well name(s), location coordinates and four additional well identification numbers by which the wells are listed by other institutions. A detailed flow chart of the programs, operations and intermediate files involved in this stage is shown in Figure 2. The retrieval directories produced during this phase appear along the bottom of the chart. The unified file (A-1) serves as the source for all consequent directories. This file is sorted according to each one of the desired keys and the resultant sorted files (A-2 to A-6) are edited and printed (programs 8, 9, 10, Fig. 2). The production of the alphabetical directory of well names (Fig. 2, right column) requires some additional treatment due to the fact that each well may possess more than one name. The synonymous well names stored in file A-1 are extracted, and for each name a complete well record is compiled (program 6, file H-1). This operation ensures that the directory will contain an entry for each of the synonymous well names and facilitates their alphabetical sorting. The sorted file (H-2) is then edited and listed (program 7) to produce the alphabetical well name directory.

6. Multi-attribute query retrieval - In a complex search involving a large number of boreholes and / or the union or intersection of several attributes, use of the directories can become rather tedious and time consuming. Program 'MAPS' (Fig. 1) provides such a flexible, general purpose retrieval capability. The user submits his request for retrieval in the form of a matching function using Boolean operators to define the relations between individual or sets of attributes. The program retrieves the pertinent boreholes meeting the prescribed specifications, lists them and, on request, can also produce a base-map plot of the distribution of the wells to any desired scale. Since most searches are confined to a certain geographic area, file B-1 is first sorted by coordinates and the resultant file B-2 serves as a source for the retrieval program.

### Summary

The Israel well data system consists of a sequential fixed-format-record data base and a series of integrated

programs for input validation, file update and maintenance, report generation and flexible multi-attribute query retrieval with optional base map plotting. For easy manual retrieval, the general user is provided with a master list of wells and three directories of wells listed alphabetically, by location and by various identification numbers.

The data base contains only fundamental identification and related data (13 items) from approximately 7500 boreholes of stratigraphic importance including oil, wildcat, structure, water and the deeper geophysical and geotechnical boreholes. During the data collection phase, special emphasis was placed on assembling and validating the information from all data sources available and on the preservation of all known synonyms of well names. The information assembled in the present data base will be shared in the future by other national geological information systems of stratigraphic, paleontologic and geochemical data which are currently under construction. The flow of operations and the various software components and required intermediate files has been reviewed. This system may serve as a model for the construction of simple, task oriented record management systems of limited scope, which are relatively easy and inexpensive to implement.

### Acknowledgements

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