Data bases in oil and gas exploration : an overview

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Data bases in oil and gas exploration: an overview [1]

by G. E. GORIN[2]

with 13 figs.

Zusammenfassung

Computerbasierte Datensysteme sind heutzutage ein unverzichtbares Bindeglied zwischen der Datenaquisitionsphase und der Modellierungsphase, die zu einer Explorationsbohrung führt. Hauptsächlich zwei Motive führen zum verstärkten Einsatz von Datenbasen: a) grosse Datenmengen, das wertvollste «Guthaben» einer Explorationsgesellschaft, zu lagern und zu zentralisieren; b) technische und managementmässige Entscheidungen zu unterstützen und zu beschleunigen.

Fünf Hauptkategorien von Datenbasen sind zu unterscheiden: geologische, seismische, geophysikalische (ausser seismische), allgemeine (Topographie, Konzessionen, usw.) und Referenz-Datenbasen (Fallstudien, allgemeine Statistik). Die ersten beiden Kategorien werden in allen Stadien eines Explorationsprogramms am meisten benutzt. Die geologische Datenbasis hat den kompliziertesten Aufbau. Die seismische Datenbasis ist zwar umfangreich, aber einfacher aufgebaut.

Die Hauptanwendungen von geologischen und seismischen Datenbasen dienen der integrierten Interpretation unter Einsatz aller verfügbaren Daten. Applikationsprogramme sorgen für graphische Displays (Karten, Profile, Diagramme). Der Gebrauch von interaktiven graphischen Systemen gekoppelt mit Explorationsdatenbasen nimmt rasch zu.

Zwei Typen von Datenbasen werden in der Exploration angewandt: a) das einfache, billige und leicht zu bedienende «sequentielle» Filesystem auf Magnetband; b) das komplizierter aufgebaute und teurere «random access» Filesystem auf Magnetplatten. Letzteres erfordert ein angemessenes Datenbasen-Management. Hauptkriterien für die Wahl des richtigen Typs sind: Grösse der Datenbasis, Häufigkeit des Gebrauchs, verfügbare Computersysteme und Finanzmittel, Art der Daten.

Welches System auch immer gewählt wird, sein Nutzen ist von folgenden Faktoren abhängig: ausreichende Anleitung der Benutzer, Zusammenarbeit zwischen Explorationspersonal und Datenbasenexperten, sowie fortgesetzte finanzielle Unterstützung für das System.

Résumé

Les banques de données dans l'exploration pétrolière forment un lien indispensable entre la phase d'acquisition des données et la phase de forage. Leur fonction est double: a) elles permettent la préservation et la centralisation d'informations qui constituent le plus précieux capital d'une compagnie; b) elles facilitent les décisions techniques et de gestion.

On distingue cinq grandes catégories: les banques de données géologiques, sismiques, géophysiques (gravité, magnétisme, etc.), cartographiques (topographie, concessions, etc.) et historiques (exemples de structures pétrolières testées par forage, statistiques pétrolières, etc.). Les plus utilisées sont les banques de données géologiques (les plus complexes) et sismiques (simples, mais volumineuses). Leurs applications sont essentiellement graphiques (cartes, sections, graphes). L'utilisation de systèmes graphiques interactifs associés aux banques de données se généralise.

Deux types de fichiers sont utilisés: a) les fichiers séquentiels sur bandes magnétiques, bon marché et simples à utiliser; b) les fichiers à accès aléatoire sur disques, plus complexes, coûteux et exigeant l'utilisation de techniques

[1] This paper was originally presented in a seminar entitled «Data bases in the Earth Sciences» organised by the Geological Department of the University of Geneva, Switzerland, on 20th - 22nd October 1982. This seminar was part of the post-graduate program of studies organised by the French-speaking Swiss Universities.

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spéciales d'administration de données. Les critères déterminant le choix du type de fichier sont les suivants: quantité d'information à stocker, fréquence d'utilisation, moyens informatiques et financiers disponibles, nature des données.

Finalement, indépendamment du type de fichier choisi, l'efficacité d'une banque de données dépendra des facteurs suivants: qualité de l'information, instruction des utilisateurs, collaboration entre les géologues/géophysiciens et les experts informaticiens, soutien financier au système choisi.

Abstract

Computer-based data systems provide nowadays an indispensable link between the data acquisition stage and the modelling stage leading to exploration drilling. The incentive to use data bases is twofold: a) to preserve and centralise large amounts of data which are the most valuable asset of an exploration company; b) to help and speed up technical and management decisions.

Five main categories of data bases are distinguished: geological, seismic, geophysical (non-seismic), general (topography, concessions, etc.) and reference (case histories, general statistics) data bases. The first two types are the most commonly used at all stages of an exploration program. The geological data base is the most complex one. The seismic data base, although voluminous, has a simpler framework.

The main applications of geological and seismic data bases are oriented towards integrated interpretation employing all data. Application programs are geared towards graphic displays (maps, sections, graphs). The use of interactive graphic systems coupled with exploration data bases is spreading rapidly.

Two types of data base systems are used: a) the simple, cheap and easy-to-run sequential files on magnetic tapes; b) the more complex and more expensive random access files on discs, which require proper data base management. The main criteria for choosing the right type are: size of the data base, frequency of use, computer facilities and finances available, type and nature of the data.

Finally, whatever the data base system chosen, its effectiveness will be dependent upon the following: proper education of the users' community, collaboration between explorationists and data base experts, continued financial support to the system.

1. Introduction

Nearly all petroleum exploration and production are dependent on historical data. Computer-based data systems designed expressly for storage and retrieval of geological data were first used around 1960 in oil and gas exploration (Stauft, 1972). At the same time, the rapid development of digital computers resulted in the rapid growth of seismic digital processing. Multinational companies with worldwide operations became increasingly concerned with the preservation and centralisation of huge amounts of data (Fig. 1), which became impossible without the use of computer-assisted files.

But computer geology is expensive. It is staff consuming and requires user-education (namely computer-oriented explorationists). Moreover, it has to be used on an extensive scale to be justified (Robinson, 1972). Therefore an exploration data base system can not be limited to the classification and storage of exploration data; it has to be practically oriented towards «integrated interpretation employing all geophysical data and all geological data» (Rockwell and Roberts, 1973). Such an ideal system must be:

- user-oriented;
- providing easy data access and rapid retrieval;
- flexible and expandable;
- conveniently updated;
- compatible with a broad spectrum of applications and display programs.

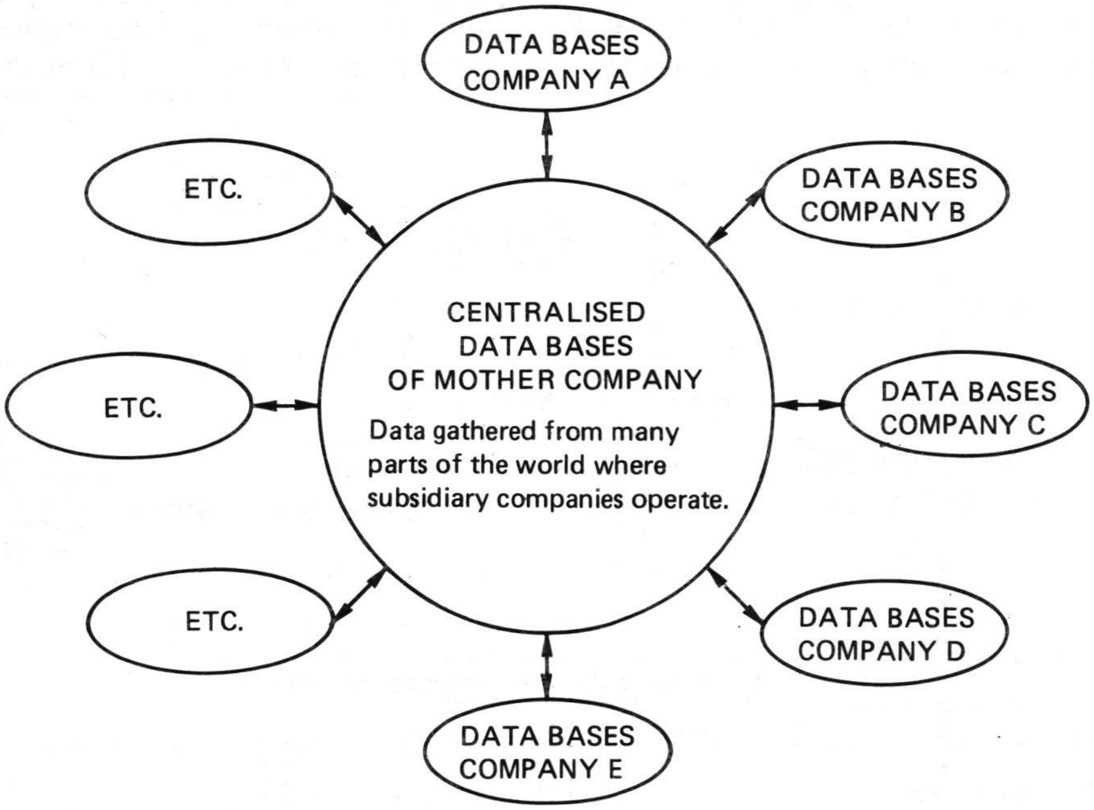


Fig. 1 A major concern: centralisation of data generated by worldwide activities.

The last point is in fact the «raison d'être» of the entire system, because geology and geophysics are essentially visual techniques requiring mainly maps, sections, logs, graphs, etc. (Rockwell and Roberts, 1973; Russel et al., 1975; Townsend, 1979).

Exploration data bases consist of many smaller bases (or data sets) which cover several disciplines; often the various sources of information are the domain of different departments and are documented in many divergent forms (Townsend, 1979). The development of Data Base Management Systems (= DBMS, see Martin, 1976 and Deen, 1977) has provided an efficient way of integrating data stored on different files. The objective of these systems is to provide the basic software for maintaining a base of common data, allowing data retrieval as required for a variety of different applications. The structure of such systems is based on logical relations between data and each data item is stored only once.

No total system yet exists. Although various Data Base Management Systems exist on the market (Collins, 1981), they are not meant especially for petroleum exploration and they must be complemented with specially designed input, applications and display software. For instance, the latest developments in interactive graphic systems, which can be combined with exploration data bases, are an asset to better data display.

The purpose of this paper is to give an overview of the type of data generated in oil and gas exploration, how conceptually the two main types of exploration data bases may be organised and, finally, what are their main applications. Although this paper is intentionally referring to the exploration side of the oil and gas business, it is obvious that the same principles are directly applicable to oil and gas production.

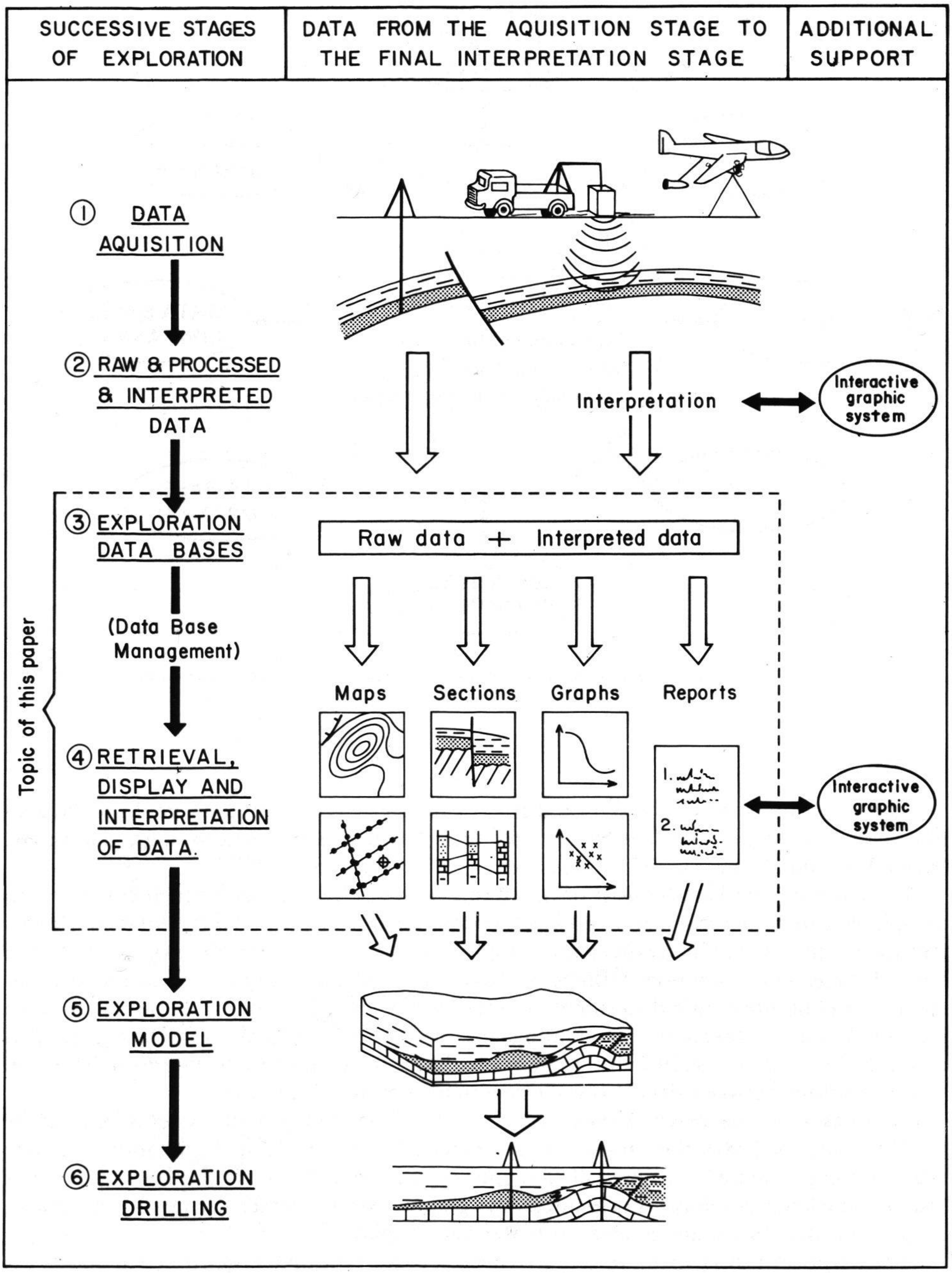


Fig. 2 The role of data bases in the different stages of oil and gas exploration.

2. Data bases

2.1 Main types of data bases

In an exploration campaign, data bases and their applications form a vital link between the acquisition stage and the development of an exploration model, which will help geologists and geophysicists to generate their own plays and prospects (Fig. 2).

Generally speaking, exploration data bases may be subdivided into five main categories (Fig. 3):

- Geological data base: It is the most complex one, because of the extremely wide range of information it may contain. It constitutes the most valuable asset of an exploration company. Information obtained from an exploration well will never become obsolete, and consequently a geological data base may grow indefinitely.

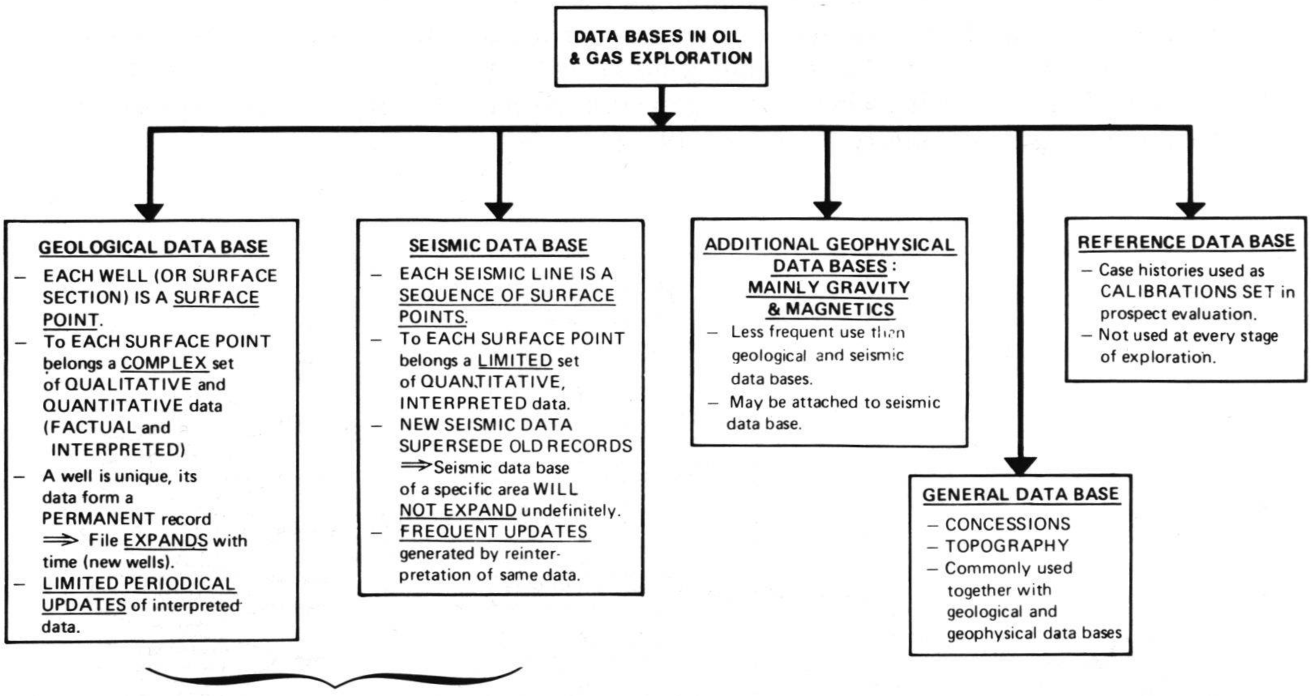


Fig. 3 Types of data bases in oil and gas exploration.

- Seismic data base: depending on the grid of data available in a specific area, such a file can expand considerably. But new, better resolution seismic data will sooner or later overlap and supersede older data. Therefore, in the longer term, the seismic data base covering an extensively explored basin has a voluminous, but finite size. This, together with the rather limited set of data attached to each seismic line make the conception of a seismic data base simpler than that of a geological data base over the same area.

- Other geophysical data bases: There are some specific aspects of petroleum exploration in which non-seismic methods can be used (mainly magnetics, gravity, electrical methods and remote sensing, Sarocchi and Royer, 1983). The generation of a specific data base for this type of information will be a function of how extensively it is used and how the data have been collected. If non-seismic methods are integrated with seismic surveys (e. g. gravity recorded with seismic data), it may be preferable to incorporate these data in an extended version of the seismic data base (Russel et al., 1975).

- General data base: it incorporates all information not directly connected with well or geophysical data, such as concession boundaries, topography, pipelines, etc. (also referred to as «cartographic data», Farmer, 1981 or «geographic data», Nelson, 1982). These data will be commonly used within the overall data base system, mainly when displaying seismic and geological maps.
- Reference data base: because of the very large sums of money involved in modern exploration investment decisions, quantitative prospect appraisal has become an extremely valuable technique to improve the investor's risk assessment. Large companies with world-wide access to extensive geological information have been able to establish a large reference data base from case histories of well-documented oil and gas fields and conclusively-tested dry traps in various exploration ventures. This reference data base can then be used as a calibration set for the evaluation of a specific exploration prospect (Nederlof, 1979; Sluyk and Nederlof, 1984) or of an exploration play as a whole (Baker et al., 1984).
  The reference data base may also contain general petroleum statistics, i. e. exploration licenses, exploration efforts (seismic and drilling), reserves and production, etc., which can be used in decision-making when assessing the risks associated with petroleum exploration in a specific basin or country (Coustau, 1977).

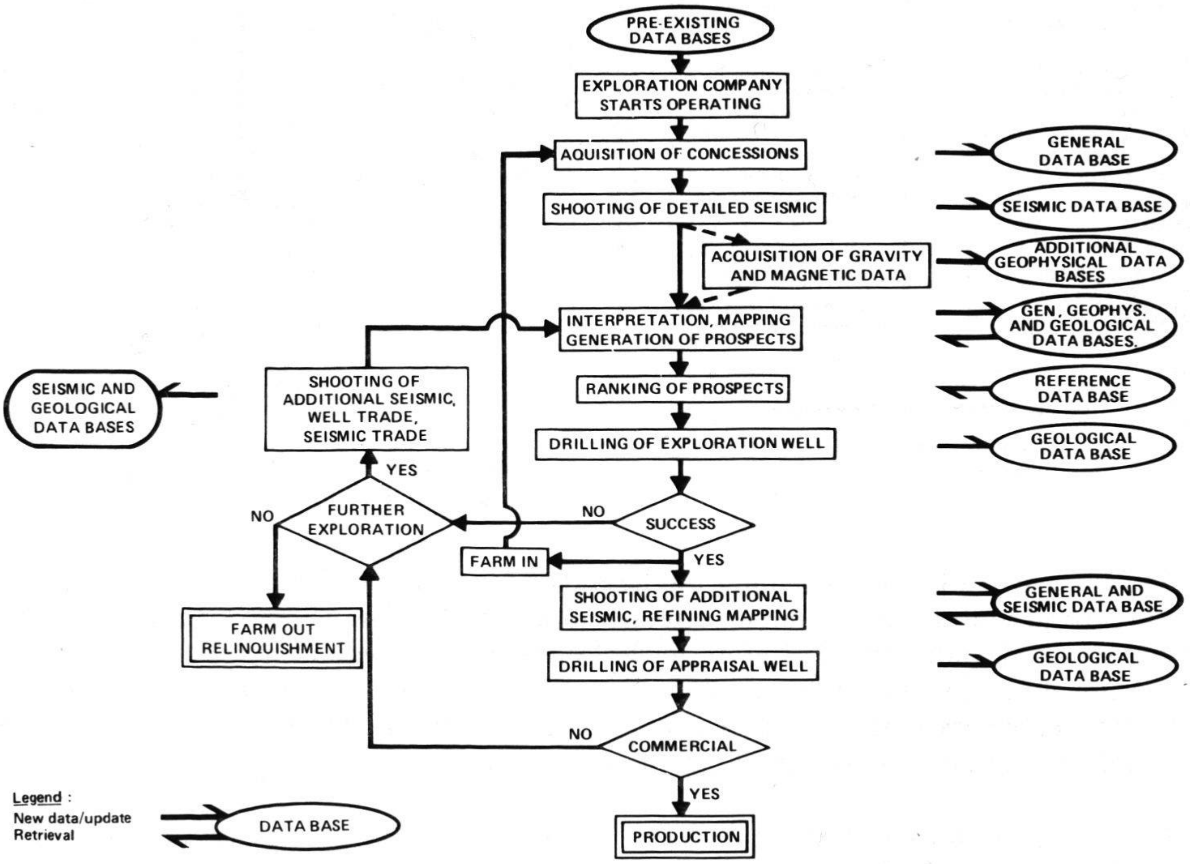


Fig. 4 Generation and use of data bases in oil and gas exploration.

The five types of data bases described above are used for storage or retrieval purposes at different stages of an exploration program (Fig. 4). The geological and the seismic data bases are the most commonly used (often in conjunction with the general data base). We will therefore describe in more detail the framework of these two files.

2.2 Geological data base

The source of geological data comes from wells and surface sections. For each of these surface points, one has to store a complex set of both factual and interpreted, and both qualitative and quantitative data (Fig. 5). This informations covers different disciplines and is collected by people of various technical backgrounds. The introduction of standard input forms (GILL et al., 1977, MARSH et al., 1981) facilitates the recording of data and decreases the possibilities of error. Validation programmes make the quality of the information even more

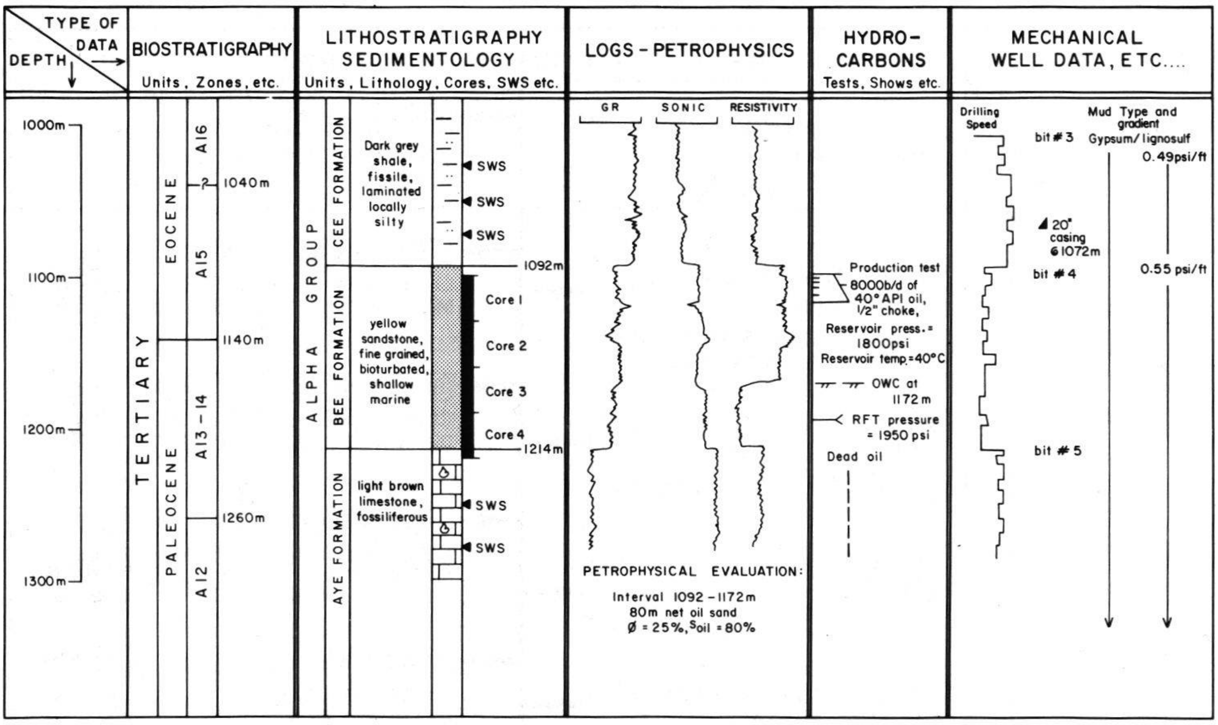


Fig. 5 Schematic example of a well completion log showing the variety and complexity of information to be stored on a geological data base for one surface point.

reliable. Each well (or surface section) corresponds to a wide range of information that can be grouped into different data sets or «blocks» (Fig. 6). Geographical coordinates are the only common reference of these data sets and the data base will hinge upon the quality of the cartographic information (TOWNSEND, 1979; MARSH et al., 1981). Within each of the «blocks», data are classified according to the depth of occurrence in the well or section. For example, in the «geological block» one will find the different lithologies encountered between depth markers which indicate the top or base of a lithological unit; the «palaeontological block» will contain the depth of first occurrences of fossils, the depths of the interpreted biozones, etc. For some time, data such as well logs have been recorded directly onto magnetic tape. This type of computer-compatible information has in fact provided an important incentive for the addition of other factual and interpretative data types into a formal data base (FARMER, 1981).

To summarise, a geological data base contains a sequential set of surface points classified by their geographical coordinates. Within each surface point, data is organised hierarchically per subject («block») and then per depth.

SALIENT FEATURES

— EACH WELL (OR SURFACE SECTION) IS A SURFACE POINT IDENTIFIED BY ITS GEOGRAPHICAL COORDINATES.

— EACH SURFACE POINT CORRESPONDS TO A COMPLEX SEQUENCE OF FACTUAL AND INTERPRETED DATA (QUALITATIVE OR QUANTITATIVE) THAT MAY BE STORED INTO SEPARATE BLOCKS.

— INTERPRETED DATA ARE SUBJECT TO UPDATES.

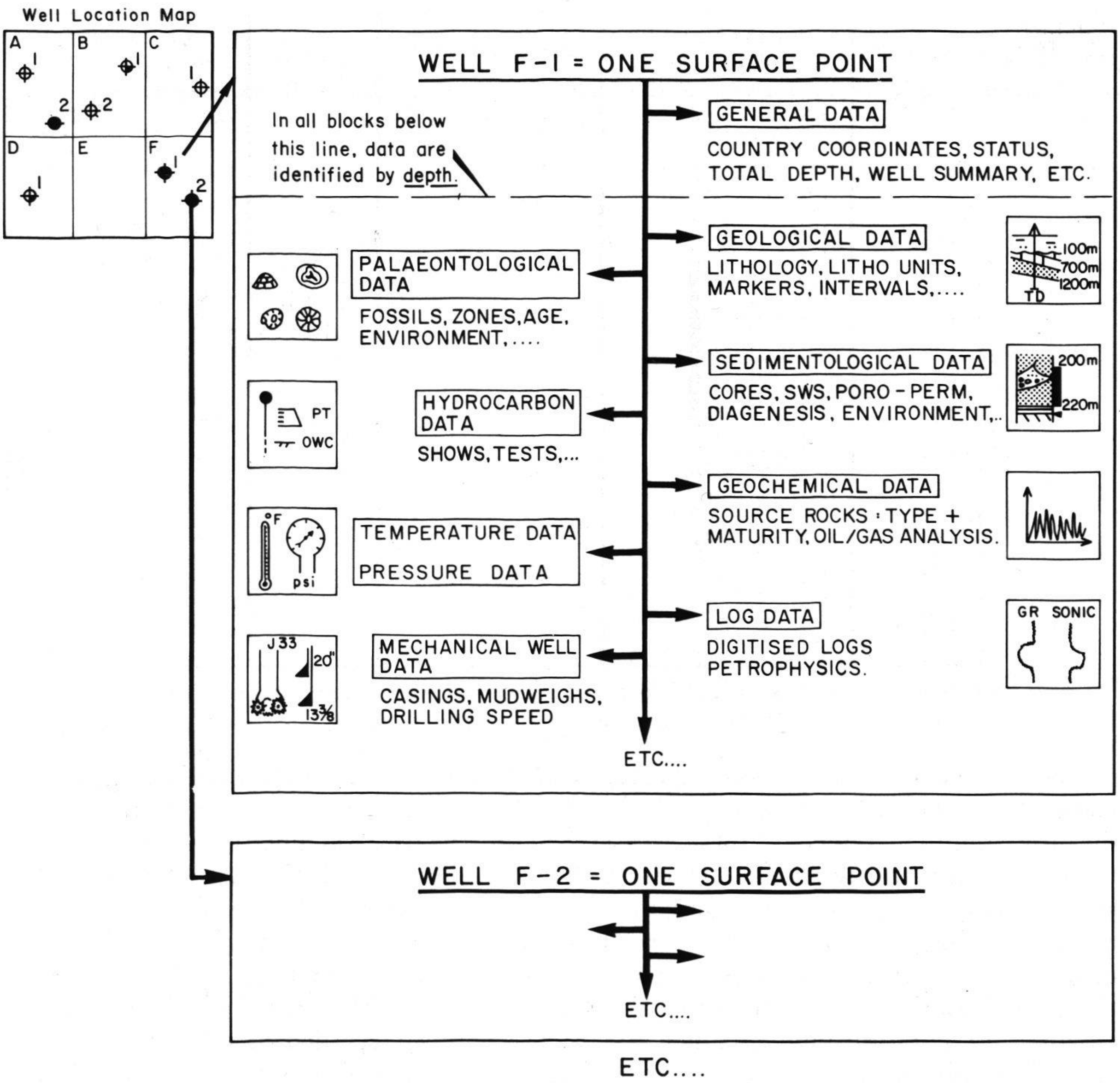


Fig. 6 Schematic organisation of a geological data base.

The organisation of such a file will be very much dependant on its size; the increase in the amount of blocks to be stored for each surface point will rapidly lead to a need for more advanced data management techniques (see section 2.4).

Finally, easy updating facilities should be provided for those blocks which contain interpreted data. When compared with seismic data, well data require much less updates; once they are thoroughly interpreted, updates are relatively rare.

2.3 Seismic data base

A seismic line is formed by a sequence of surface points called shotpoints, each of them corresponding to a specific seismic record of the subsurface (Fig. 7). The first step in the generation of a seismic data base is the recording of the location of each line where shotpoints are identified by their geographical coordinates. The quality of the seismic data base will therefore hinge on the accuracy of the positional data relating to seismic surveys (Townsend, 1979; Nelson, 1982). Since the mid-1970's most of this data has been routinely recorded by contractors on magnetic tape and provided a strong incentive to develop formal seismic data bases by addition of interpretative data.

The bulk of the interpretative data on a seismic data base is voluminous but simple: it consists essentially of seismic horizons digitised from interpreted seismic sections (Fig. 7). For each shotpoint a set of two-way reflection times will be stored (Fig. 8). For sake of simplification it is common practice to digitise horizons only every few shotpoints. Stacking velocities can also be stored for each seismic line. Other types of velocity functions to be used for depth conversion may be preferentially stored on the geological data base because they are usually derived from well data or regional geological trends.

A number of seismic surveys are often run over the same area at different times, and the importance of an effective indexing system is obvious in the retrieval phase (Farmer, 1981). A seismic line is usually identified by its coordinates and the year during which it was shot (Fig. 8): the latter information can usually be directly «translated» into data quality and allows easy retrieval of the most recent, usually better quality, seismic surveys. A seismic data base may become rapidly difficult to handle because of its sheer volume (in extensively explored areas, 3-D coverage is not uncommon and usually supersedes pre-existing seismic grids). Keeping all data in an active «on-file» form is unrealistic: the creation of selected working project files at the scale of a sedimentary basin (see part 2.4) is a good approach to solving this problem.

To summarise, the basic organisation of a seismic file is dependent upon two parameters, geographical location of the lines and their year of shooting, which form the backbone of the seismic line index. Each line is then broken down into a sequential set of surface points, each of which contains a limited amount of data organised sequentially per increasing two-way travel time.

Finally, major updates are quite frequent in seismic data bases: each new interpretation of a seismic grid leads to extensive updates if it is to supersede the former interpretation in the data base. Therefore, routine updating procedures play an important role in maintaining an optimally efficient seismic data base.

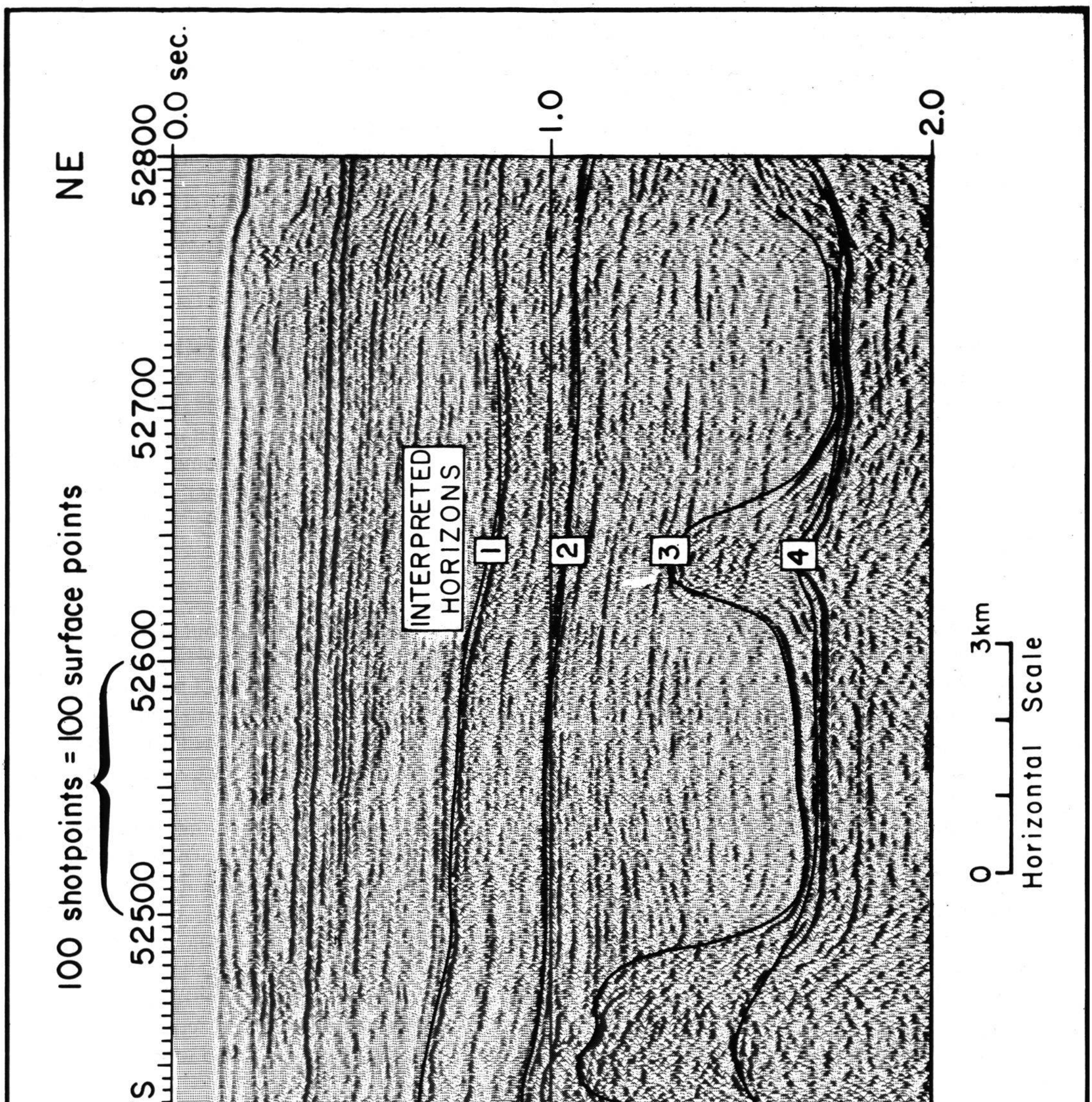


Fig. 7 Example of a seismic section: each shotpoint is a surface point for which a set of measurements (i. e. two-way travel time down to interpreted horizons) will be stored on the seismic data base.

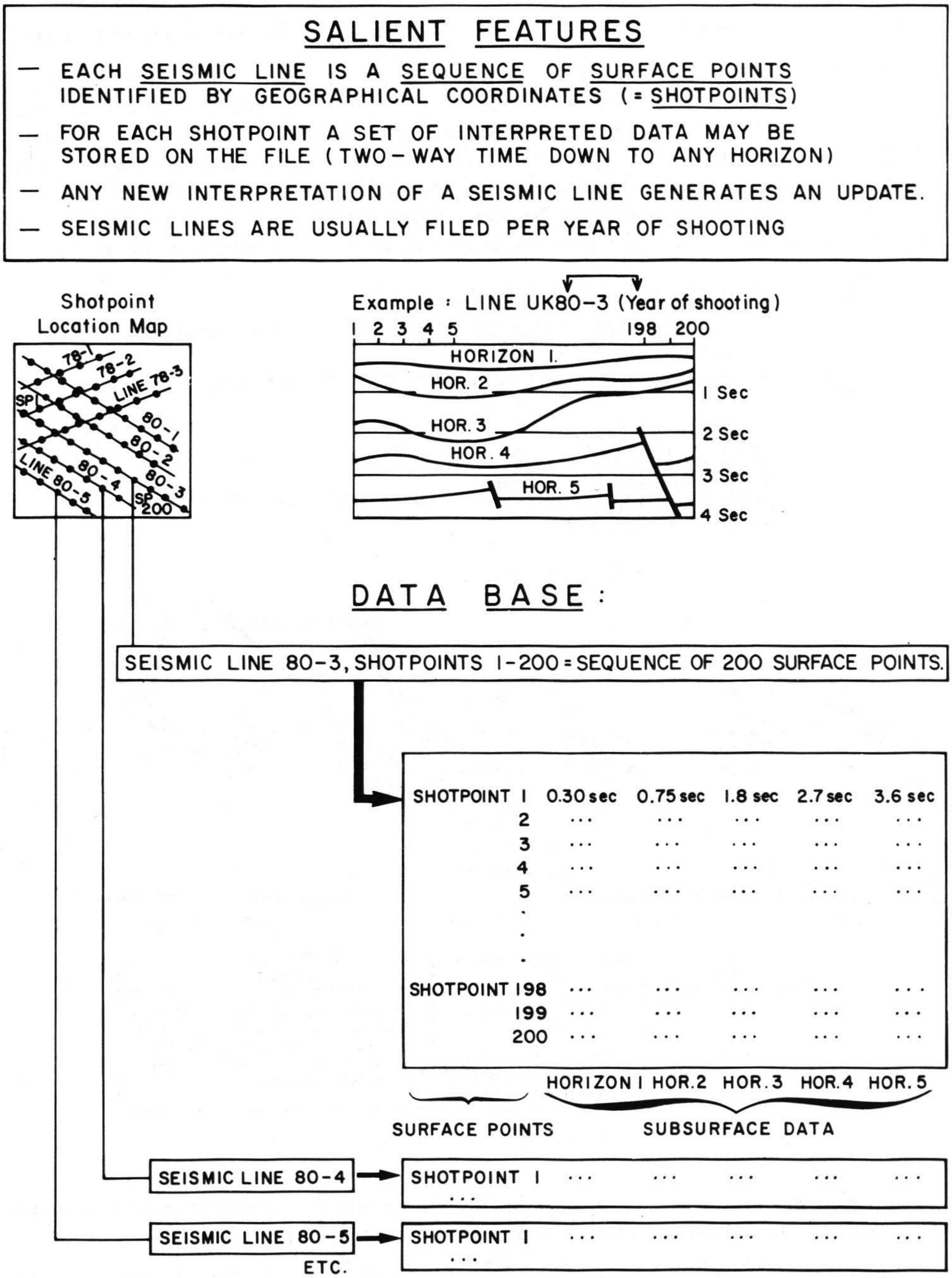


Fig. 8 Schematic organisation of a seismic data base.

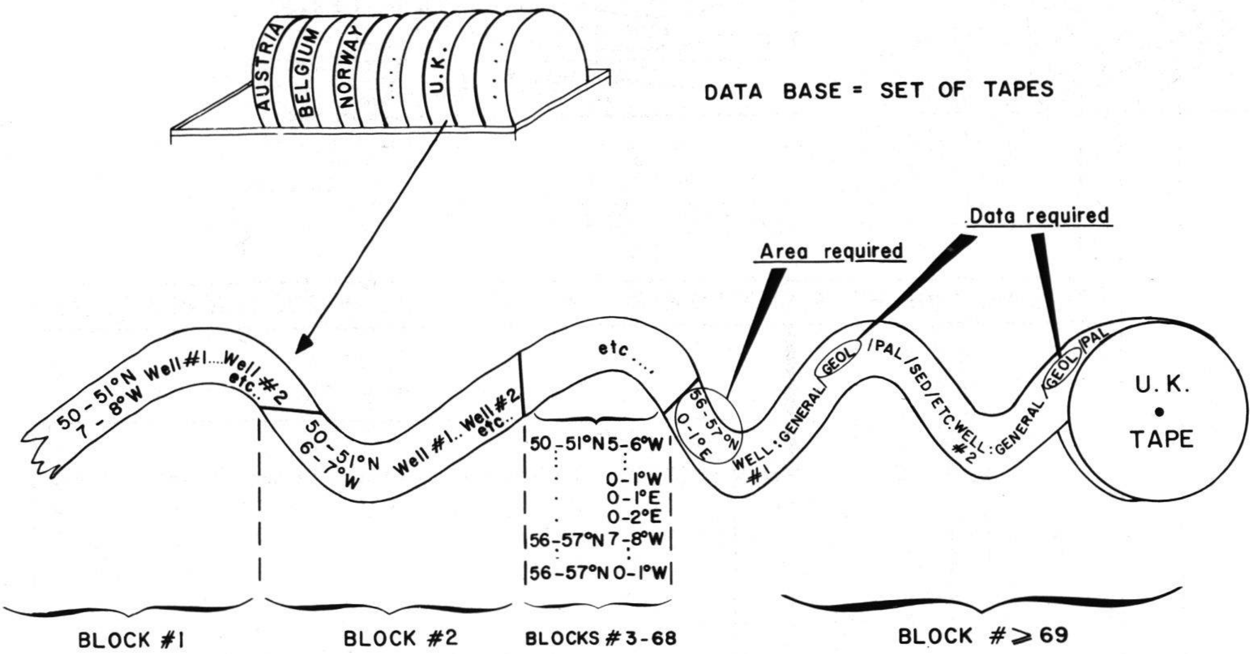
2.4 Data base organisation: sequential files vs. random access files and associated problems

From the early days of computer development, the most common and cheapest form of physical data storage is the magnetic tape. Consequently all early data bases were sequential files (Fig. 9), which, for companies with large data sets, developed rapidly into sizeable tape libraries! As the complexity of exploration problems increased, it became necessary to relate and analyse all relevant data. This could be best achieved by using proper index files (Fig. 10), which were an essential element of the data base management systems with random access on discs that appeared in the 1970's (ROCKWELL and ROBERTS, 1973; RUSSEL et al., 1975).

GIVEN : GEOLOGICAL DATA BASE OF EUROPE.

PROBLEM : TO RETRIEVE GEOLOGICAL DATA OF ALL U.K. WELLS LOCATED WITHIN 56-57°N AND 0-2°E.

SOLUTION : SELECT THE RIGHT TAPE AND READ IT THROUGH



PROS	CONS	REMARK
– Cheap (tapes) – Adequate for a local company.	– Tape handling and storage – The whole file has to be read → retrieval of data is a slow process.	– If data base becomes too large it can be subdivided into sub-files stored on separate tapes → the first stage of retrieval becomes a manual operation.

Fig. 9 A conceptual example of a sequential geological file.

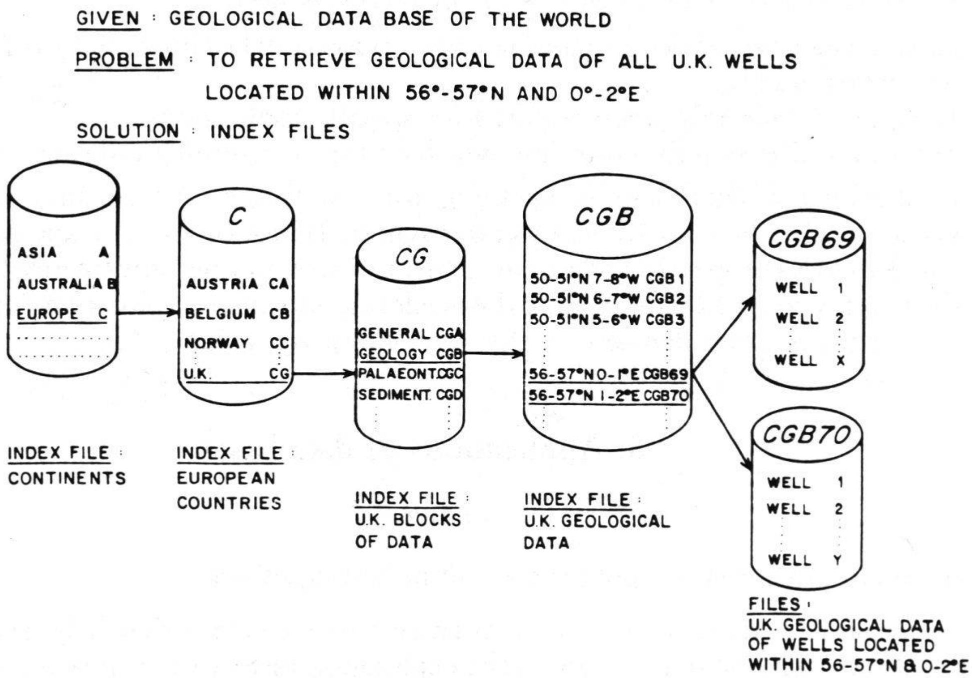
It is not the purpose of this paper to describe the technicalities of these two types of files. Nevertheless, the following general comments can be made:

a) Both types are presently used in oil and gas exploration. Sequential files are quite suited for small companies or organisations with relatively limited data sets (e. g. the Israel well data system, with only basic well data, GILL, 1981). Sequential files are quite adequate when retrieval speed is not critical and when computer facilities are limited. But, above all, they provide a cheap way of storing easily accessible data, and their existence does not have to be justified by a frequent use.

When a company or organisation is experiencing delays directly associated with data storage and retrieval, it is time to think of using random access files. The need for a frequent, regular use of exploration files may have to be demonstrated! In the United Kingdom, organisations like Britoil (FARMER, 1981) and the Institute of Geological Sciences (HORDER, 1981) have chosen to use data base management systems.

b) Irrespective of the type of data base chosen, a critical review of the data sets should be performed regularly in order to remove from the «active files» (stored either on discs or on tapes in the computer room) data which are too old, or not relevant any more or of little use in day-to-day operations. This data will then be transferred onto tapes to be archived (BOTBOL, 1981), thereby avoiding overcrowding of the main data base. This procedure is commonly applicable to seismic files where old seismic surveys are often superseded by data of more recent vintage.

c) The type and nature of the data may help in selecting the right type of storage: for example, a geological data base is quite adequate for random access facilities. It is formed by various types of data often collected by different departments in all sorts of formats. Most of the files are used on a regular basis. On the contrary, a seismic data base contains more homogeneous data and is by nature sequential, the data being classified by year of shooting. For practical and financial reasons, there is no need for random access to the whole seismic data base. Mapping projects are usually undertaken over limited areas and require only some vintages of data. After retrieval from the main sequential data base, this selected information may be stored on specific, random access project files. A large company with worldwide interests may also wish to keep on a random access file a basic framework of regional lines for reference purposes.



PROS	CONS	REMARKS
Very fast retrieval of data. Allows storage of data on a worldwide scale.	Expensive (discs) Justified only by extensive use of the system.	Cost of such an exploration data base may be justified when integrated within a larger Data Base Management System (DBMS) shared with other departments of same company.

Fig. 10 A conceptual example of a random access geological file.

d) A random access data base should not be an instant and rigid creation, but should be evolutionary along a user-defined route. This flexibility is critical because data bases are never static for long (TOWNSEND, 1979; NELSON, 1982).
Smooth development of a data base is best achieved when hardware and software are sufficiently modular to allow growth of the system when required. When the original «modular» files (with mainly sequential access methods, FARMER, 1981) become too big to be efficiently used, it is then time to integrate them into a formal data base management system. Structuring the large data sets to allow fast retrievals becomes one of the key considerations when converting them to random access files: in order to do so, an essential data analysis will reveal the logical inter-relationships existing between relevant data components originating from different sources. In particular, geographical location is a common basis for cross-referencing of seismic or geological data.

e) The establishment, use and maintenance of data bases in petroleum exploration are associated with a few problems, which are well described in the literature (TOWNSEND, 1979; BOTBOL, 1981; HORDER, 1981). These can be summarised as follows:
   - An effective data base can be maintained only if adequate resources are available. It requires a full-time data base administrator with well-defined responsibilities, which should include, among others, file updating, editing and verification.
   - One must ensure the compatibility of the data. For example, the introduction of a standard coding system among subsidiary companies will facilitate centralisation of data by the mother company (Fig. 1).
   - Data must be relevant and adequately qualified: this implies a close cooperation between the specialist scientists and the data base experts. To achieve this, proper education of the users' community is needed.
   - After a data base has been established, two options can be chosen to load the backlog of information:
     1) input of data only when required for specific applications;
     2) input of all data at the same time, which is a time-consuming and expensive operation.
   - Establishing a data base is planning for the future and requires continued financial support for many years to come. Transition from inexpensive sequential data bases to a proper data base management system may become financially attractive if the latter is designed so as to serve the needs not only of an exploration department, but also of many other divisions in the same company.

3. Applications of data bases

3.1 General

Two main categories of applications can be distinguished:

a) Exploration data bases as a management tool: they help decision-making by providing general statistics about the exploration history of an area or country (CHEW and STEPHENSON, 1983), often leading to the decision of opening a new venture or closing an old venture (COUSTEAU, 1977). For this type of application, most of the data will be retrieved from the reference data base (see section 2.1).

b) Exploration data bases as a technical tool: technical support is the main «raison d'être» of the data bases. They are used mainly for direct prospect definition, prospect appraisal, regional mapping and regional geological studies leading to exploration modelling.

As data storage and retrieval systems evolved, so did the applications of exploration data bases. Their development has been geared towards improving visual displays (HODGSON, 1982), from simple listings of basic information, through posted and automatically contoured maps to sophisticated plots such as 3-D seismic correlations on interactive graphic systems. We shall examine shortly the main technical applications of geological and seismic data bases.

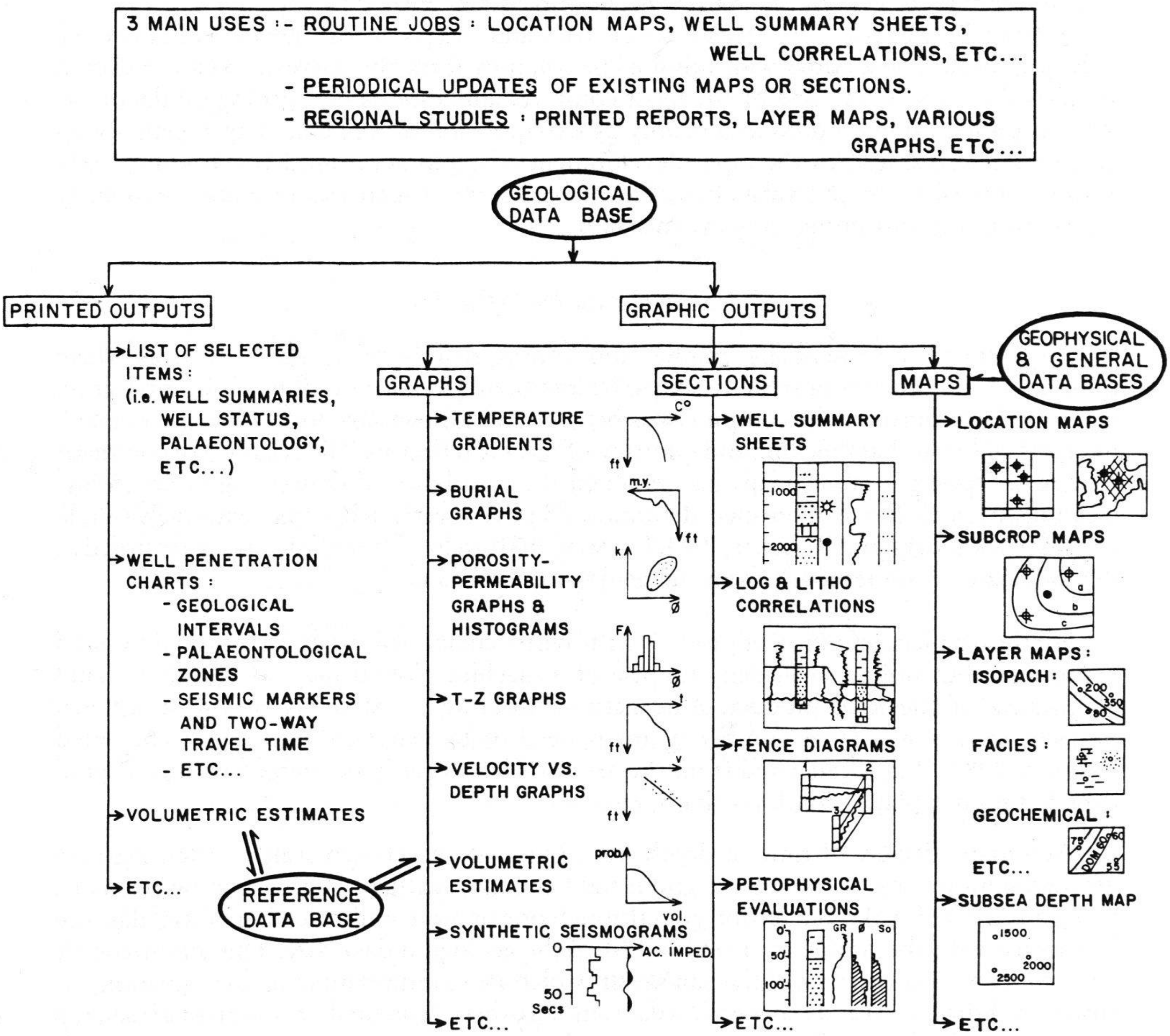


Fig. 11 Applications of geological data bases in oil and gas exploration.

3.2 Geological data base (Fig. 11)

A comprehensive set of routine application programs is a prerequisite for an effective, full use of the data base. The explorationist must be confident that he can get without delay the maximum technical support, «at his fingertips», which will allow him to substantiate his proposals to management of drilling locations in a known exploration play.

When a more regional, comprehensive study is undertaken, usually with the aim of defining new exploration plays, special software may be needed to provide original «ad hoc» types of retrievals and displays. This is when the collaboration between explorationists and data base experts is critical. Because of the amount of data to be dealt with, computer geology is most effective on large and regional projects.

Data retrieved from a geological data base will be mainly displayed in a graphic form for sake of conveniency. However, printed outputs are still very much in use for specific purposes (WIGLEY, 1983). For instance, listing of well summaries in a basin under study may help to identify at an early stage the critical wells in this area.

Among the graphic outputs, sections and maps are the most commonly used. Well log displays associated with lithological columns form the basis for well correlation sections (NELSON, 1982), one of the most common applications of a geological data base. Various geological maps produced mainly by extrapolation of well data may, together with geophysical maps, lead to the rapid development of exploration models (HORDER, 1981). Without a reliable computer data base, the establishment of such a set of maps is extremely time-consuming and prone to many mistakes.

3.3 Seismic data base (Fig. 12)

Applications are essentially graphic and consist mainly of maps. In areas where thousands of kilometers of seismic have to be interpreted to meet deadlines (e. g. application in a round of licensing), the computer has become an indispensable tool, which saves many weeks of laborious handpicking and -plotting of seismic reflectors. The accuracy of computer plotted shotpoint location maps has removed the possibility of draughting errors in line locations, a critical factor in prospect definition. Depth conversion becomes extremely simple and fast (ROCKWELL and ROBERTS, 1973; FARMER, 1981): velocity functions are either stored in the data base or are retrieved from the geological data base.

For the detailed definition of prospects, the best accuracy will always be achieved by hand contouring, but nobody will deny the use of a machine-plotted map as a guide in hand contouring of the final product. Automatic contouring is extremely useful in regional projects, mainly if a large number of maps need to be generated and depth converted (NELSON, 1982). Maps generated from the seismic file can easily be merged with geological data to produce play maps, layer maps, etc.

Automatic display of time or depth sections at any chosen scale is often used for geological modelling. If the seismic grid is tight enough, synthetic profiles can be generated along any desired strike. If a section goes through one or more wells, plotting of well data can be merged with the profile after retrieval from the geological data base. This automatically combines on a section some of the parameters which are so important in basin evaluation, i. e. structural, lithological and geochemical data among others. Structural evolution of a basin can be addressed by using palinspastic reconstructions from sections.

Applications of seismic data bases are an evolutionary process. The steadily improving computer display systems nowadays allow direct linkage of seismic data bases with various interactive interpretation systems available on the market. The gain in time and efficiency is considerable, especially as exploration is looking more and more to 3-D seismic as a practical working tool.

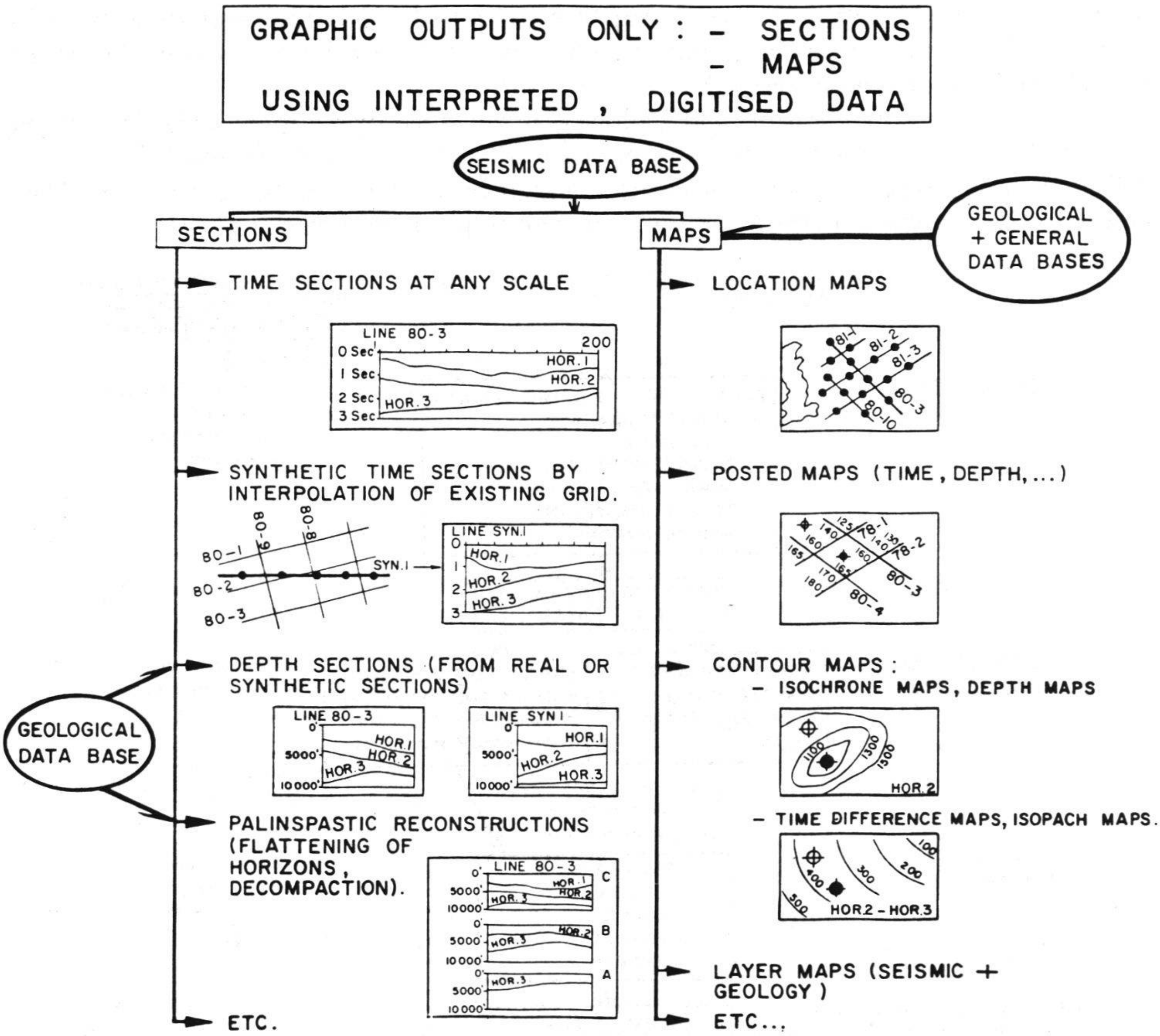


Fig. 12 Applications of seismic data bases in oil and gas exploration.

4. Conclusions

Computerised data bases are nowadays an indispensable tool in the search for oil and gas. The main steps in the generation and use of exploration data bases are summarised on Fig. 13.

The main reasons for using data bases are self-explanatory. Data bases help and speed up technical and management decisions: the simple decrease in time required to make these critical exploration decisions will provide enough pay-back alone to justify the initial investment of planning, hardware and software.

The designing of an exploration data system and its applications are an evolutionary process. The system has to be adapted to the initial needs and size of a company, but it must be flexible enough to accommodate new requirements at any time. For instance, the decision to go from sequential files to random access files may be taken at any stage.

Right from the beginning a strong commitment must be made to financially support the system throughout its development. The efficiency of a data base system is a direct function of the data quality. Continued financial support is required to provide adequate software in the retrieval and application phases and enough training to the explorationists enabling them to make full use of the system.

The integration of all seismic and geological data owned by companies leads to proper basin analysis. Data synthesis is the basis for major advances in exploration modelling, which will allow the testing of new plays and ensure companies maintain their competitiveness. Data bases in oil and gas exploration are a way of investing for the future!

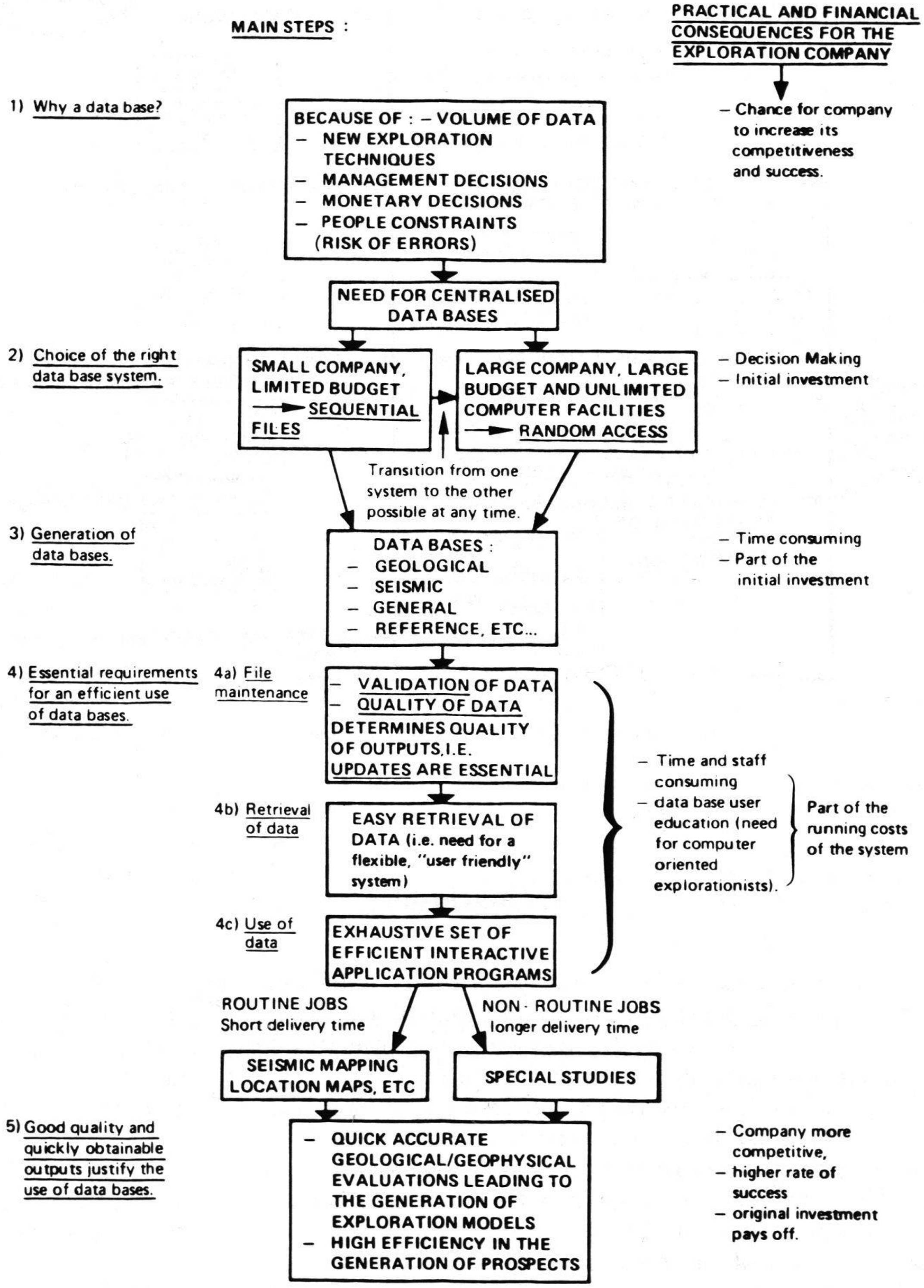


Fig. 13 Data bases in oil and gas exploration: the main steps in the generation and use of an efficient system.

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