# INTERBASE*

TECHNICAL SUMMARY
4 - 402
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The main purpose of computer assisted seismic interpretation is to produce the contourings required by the geophysical interpreter. Interbase, CGG's scientific data base management system, provides a means of generating such contouring.

With Interbase, the geophysicist interacts on all phases of the contouring process on a graphic terminal. Designed to operate on Control Data Cyber series computers, this software manages previously interpreted data such as reflectors picked on seismic sections or velocity derived from velocity analyses. This data is described and stored in such a way as to be easily accessible to the interpreter when generating contourings he requires.

Several different contourings can be generated:

- time contours taking into account faults and tectonic directions,
- isopachs,
- velocity contours with optional filtering such as RMS velocities, interval or average velocities,
- depth constructions derived from isochrons and velocity maps,
- time and depth migrations.

The use of an interactive terminal allows the interpreter to obtain an almost immediate response to any modification in the fault scheme and to guide the contouring program in the vicinity of the faults.

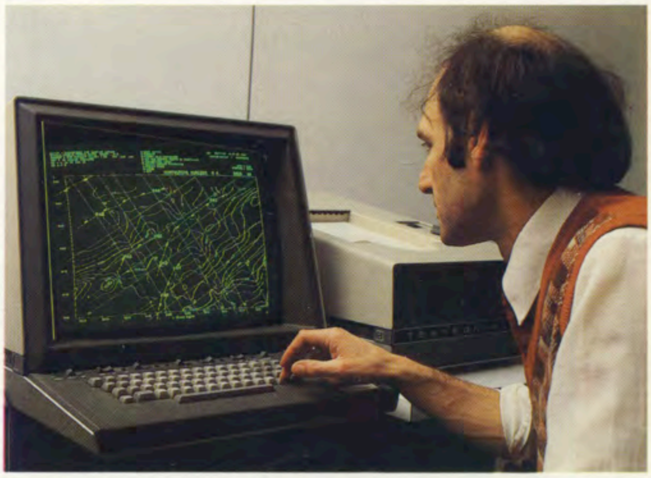

*Fig.2: Interbase's interactive terminal*

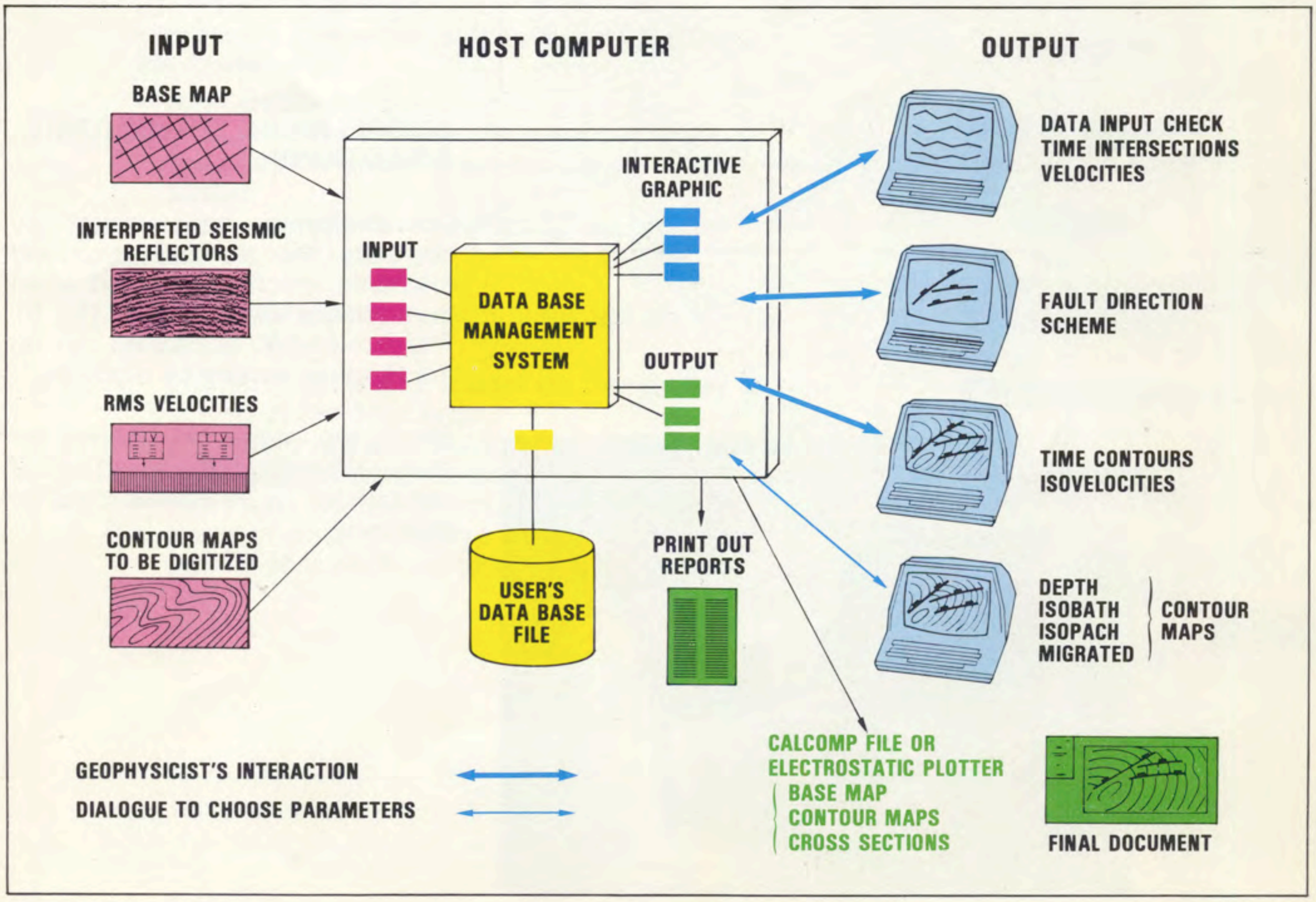


*Fig.1: General diagram*

* CGG trademark

## GENERAL DESCRIPTION OF THE LOGIC STRUCTURE OF THE DATA BASE MANAGEMENT SYSTEM

Interbase's data base management system was developed by CGG to resolve problems involved in managing scientific data. First, a logical system of describing or cataloguing the data was devised.

All data is described on three levels regardless of the processing to be carried out:

– an internal level in which the data is described as stored in the file,
– a conceptual level, in which the structure of the data without regard to its storage is described along with the constraints and procedures the data should follow,
– an external level in which the data is described as it is seen by the application modules.

A diagram of the design shows branching parallel structures with three hierarchical levels. The unit element identified by this system is a data table. The Seismic Interpretation Data Base (SIDB) diagram predefined in Interbase consists of four structures (fig. 3):

- the POSITION domain which includes all the data necessary for the plotting of a location map (coordinates of lines, definition of the map projection, cultural information);
- the HORIZON domain which includes all the data associated with the reflectors: line by line picking of velocities and times, the grid of values containing all data necessary for interpretation maps, coordinates of the tectonic directions correlated by the interpreter;
- the VELOCITY domain which includes all data from velocity analyses for each station along the line;
- the WELL domain which contains data concerning wells: geologic, well logs, deviation, etc.

The use of a data base offers the interpreter the following advantages:

– data is centralized and the base is completed progressively as operations advance without the interpreter having to bother about the order of the data input;
– data updating is simplified and as with any data base management system, emphasis is placed on the reliability of the data to be respected;
– a variety of selection criteria is available;
– several data bases can be merged to form a single one, for surveys carried out in the same zone for example;
– the use of a data base system guarantees that future changes in software will be compatible with data bases already created;
– in this specific software, several images of the data can exist simultaneously enabling the user to edit or carry out trial tests before final validation, or to stop the trial and consequently return to the previous version.

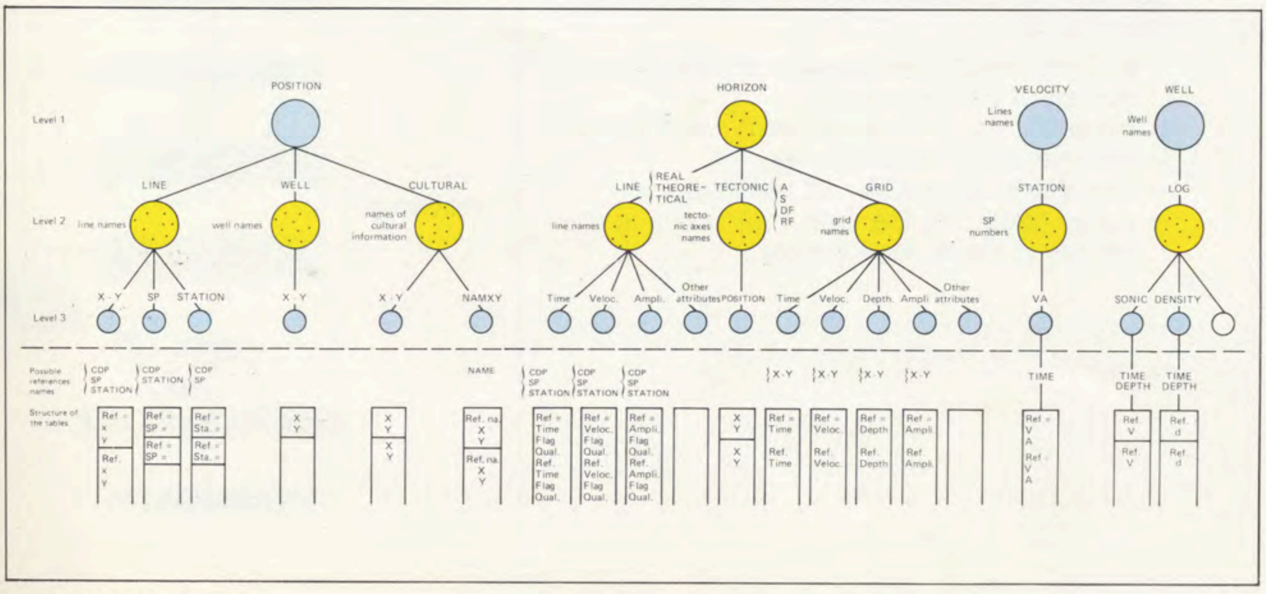


*Fig.3: Data base diagram*

## DATA INPUT

Inputting line position, horizon times and interpreted velocities may be performed in either of two modes:

- batch mode for all data on supports such as magnetic tapes (radionavigation tapes for example) or punched cards (interpreted velocities from seismic processing or off-line digitizing of reflectors);
- on-line digitizing mode by using a graphic tablet (fig. 4) for rapid input of data from documents available to the interpreter: location maps, picked seismic sections, velocity analyses. If requested, the digitizing program can eliminate the effect of paper stretch by inputting a sufficient number of calibration points.

Moreover, Interbase application modules can be introduced into seismic processing jobs to select seismic features near picked horizons such as amplitudes, instantaneous frequencies, etc., which would be of interest to map.

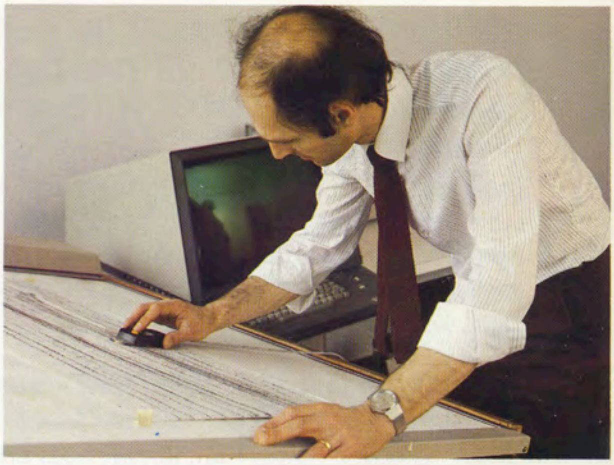

*Fig.4: Digitizing seismic data*

## INTERACTIVITY OF THE SYSTEM

Interbase's interactive software provides the interpreter with:

- easy and direct operation. Options may be chosen from a key letter menu or in certain cases by the use of a question and answer format;
- a considerable time savings in map production.

Seismic interpretation main steps are as follows (fig. 5):

- a direct check and update on the display screen of the data input;
- a selection of the work zones by digitization;
- correlation of tectonic axes;
- trial maps using different parameters;
- a way of guiding the time contouring, in the vicinity of faults for example.

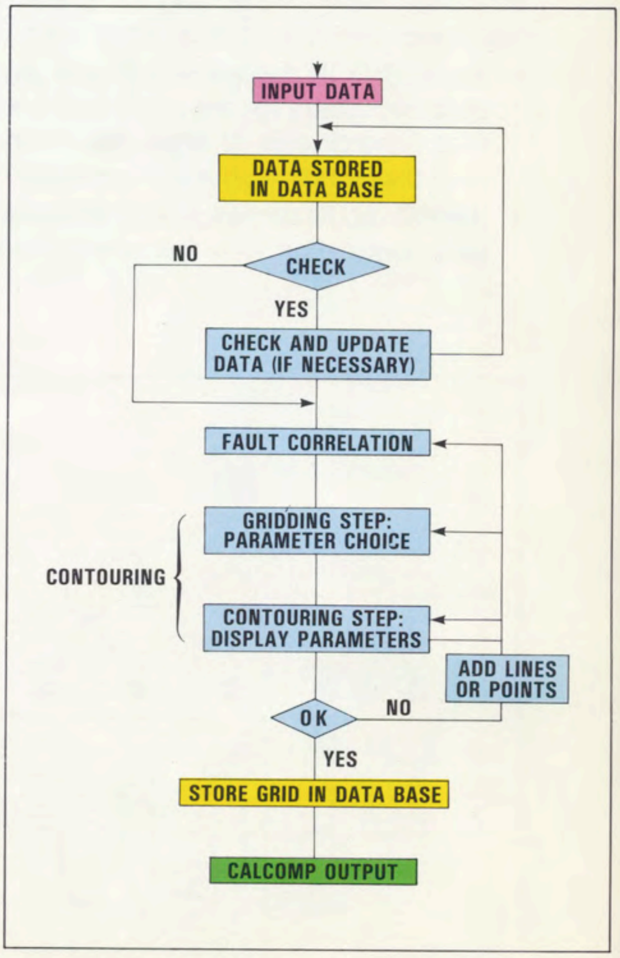


*Fig.5: Flow chart for isochron generation*

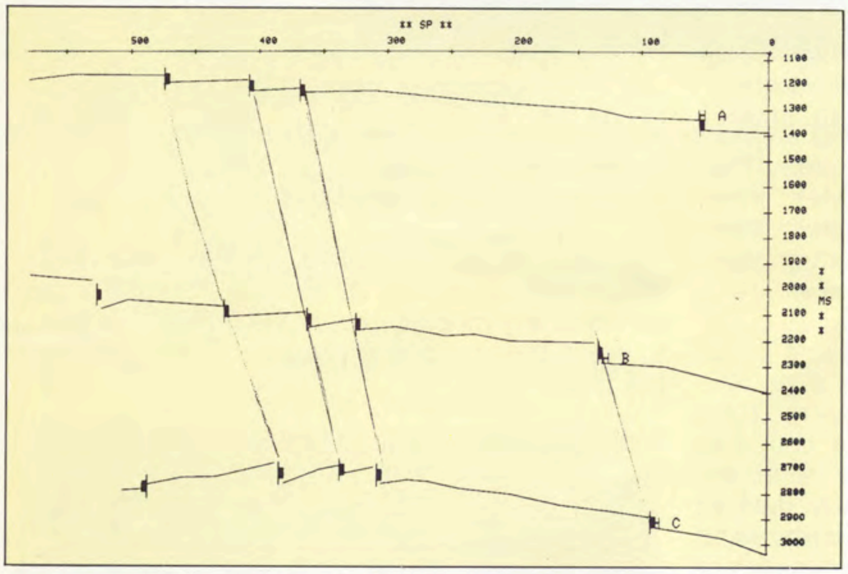


*Fig.6: Time section with fault indicators*

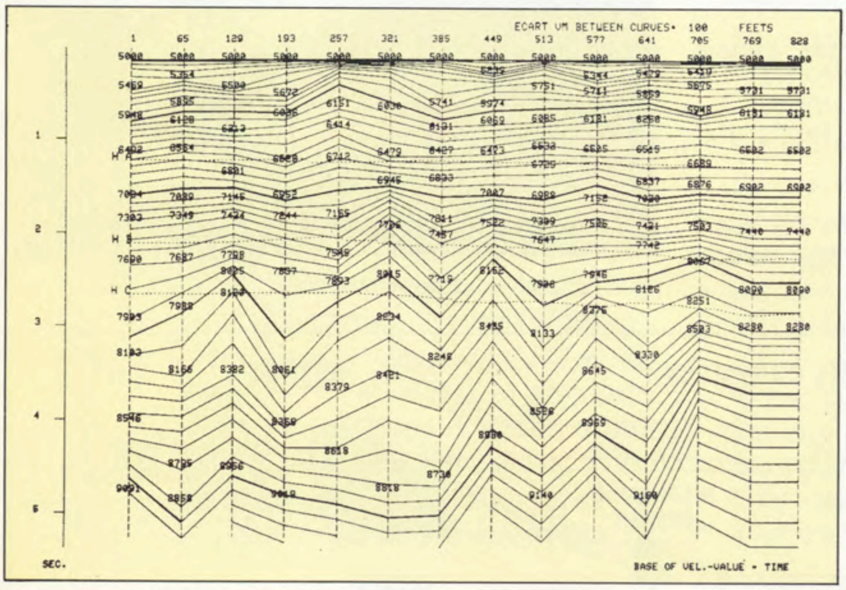


*Fig.7: Checking and editing of RMS velocities*

*Fig.8: Correlation of faults by the interpreter*

## CHECKING AND EDITING DATA

- On a graphic display screen, the input time and velocity data are controlled and positioned on a location map.
- Time horizon intersections are checked line by line:
  - either in batch mode by means of a printout;
  - or, in interactive mode displaying the intersection points of a reference line with the intersecting profiles. The user can correct the picking of a time horizon either at a particular point, or by shifting an entire horizon (to recalibrate the picking of different surveys for example).
- Faults indicators or tectonics along the time horizons are checked and edited directly on the screen by digitizing (fig. 6).
- Interval, average or RMS velocities (fig. 7) can be edited and displayed on the screen line by line. Plotting of time horizons may be superimposed over velocity functions.

## CORRELATION OF TECTONIC DIRECTIONS

The interpreter can interactively correlate the various structural elements which were noted when the horizons were digitized (fig. 8). The correlation is carried out on the terminal screen by digitizing.

Should the interpreter request the fault pattern be considered in the contouring, the directions must be digitized.

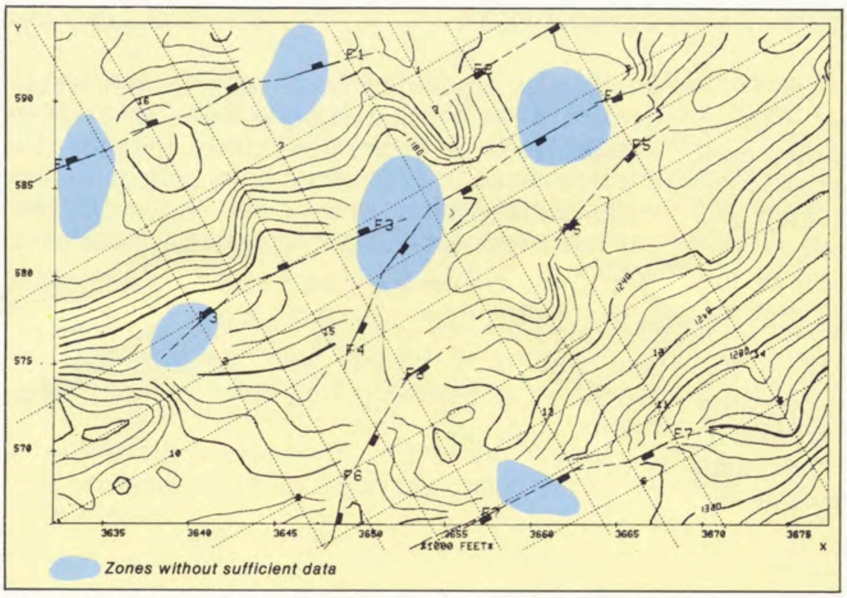


*Fig.9: Isochron contouring*

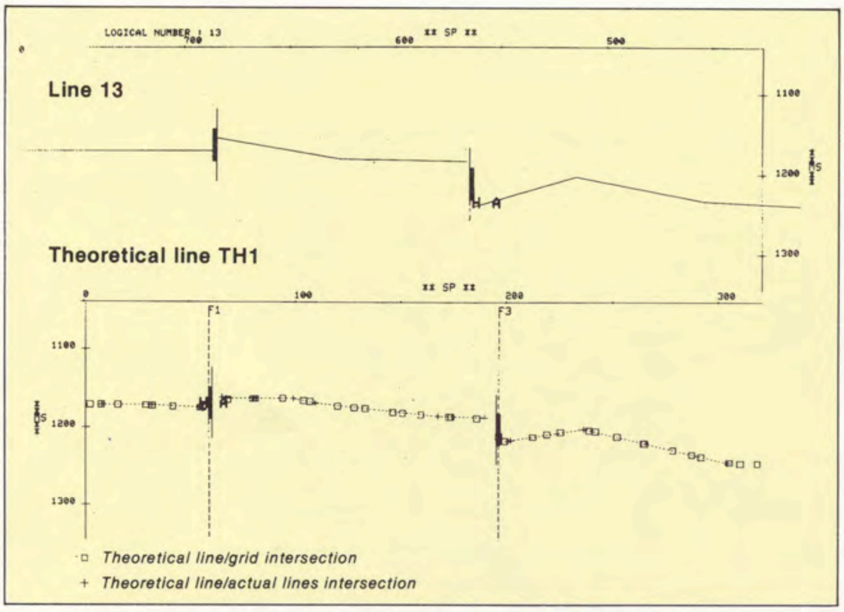


*Fig.10: Time sections of a theoretical line and line 13 parallel to it*

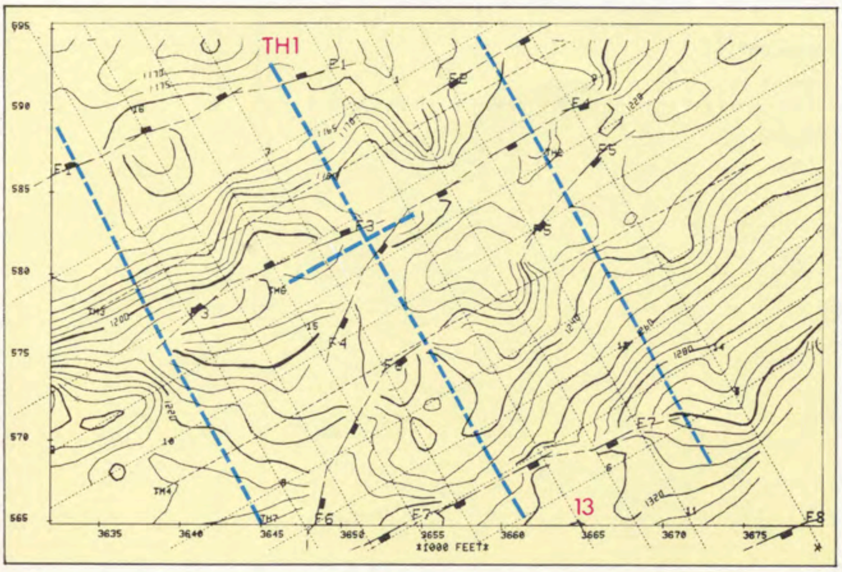


*Fig.11: Influence of a theoretical line on the contouring*

## GENERATING CONTOURS

The automatic contouring program can be guided by the user. When a heavily faulted zone is surveyed (fig. 9) the program does not have sufficient data to compute the values at the grid intersections, thus the contour mapping leaves certain parts blank.

Interbase resolves this problem by allowing the interpreter to digitize theoretical lines, along faults for example, in order to examine the seismic section of a theoretical line (fig. 10 and 11). Time horizons are computed at the points of intersection with the profiles and for the horizon studied at the intersections with the previously computed grid. The interpreter can modify them and recommence generating grids or validate the grid if the contouring proves to be satisfactory.

Another possibility is available to the interpreter who can modify the contour maps by inserting, by means of digitizing, new control points assigned a value. The grid computation is begun again with these additional points. This is a way of guiding the program in those zones where there is little data.

## PRINCIPLE AND ALGORITHM OF GRID GENERATING

The contouring program may be used for line oriented surveys as well as for random surveys, to map any parameter such as time, RMS velocities or interval velocities. A preliminary gridding program generates a regular grid of values starting from the irregular pattern (X, Y) of observed values (Z).

The gridded value ZG at each grid intersection, XG, YG, is computed as the Z coordinate of a second order surface F (X, Y, Z) = 0 defined to best fit the sets of observed X, Y and Z. The incidence of each data point is weighted by a $1/D^4$ function, D being the distance between the grid point and the data point in the XY plane.

Two parameters must be given for the computation:

- the grid spacing (fig. 12),
- the radius of a circle marking the boundary of the zone used for computing each point of the grid.

The program considers:

- faults. When computing the grid, faults must be taken into account for interpolating the times of the different horizons, but may be ignored for velocities computation;
- a direction to be favored (optional), for example anticlinal and synclinal axes for time contours (fig. 13).

After viewing and validating the contour map computed from the grid information, the interpreter may then store the grid in the data base file.

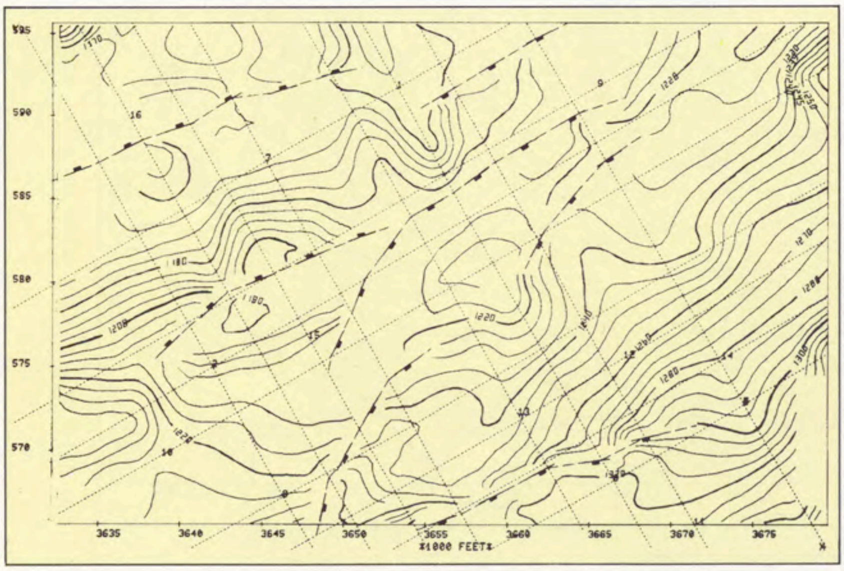

*Fig.12: Influence of the grid spacing on the contouring (smoothing effect)*

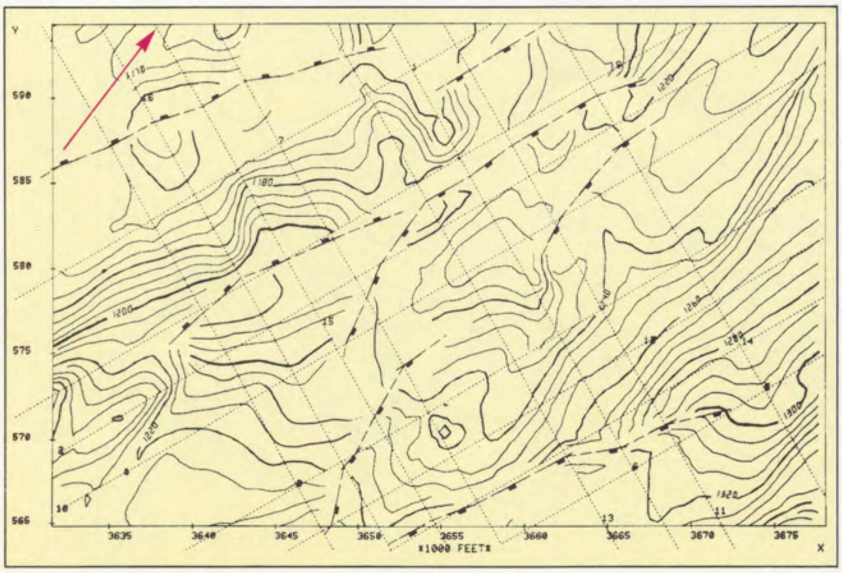

*Fig.13: Influence of a direction to be favored on the grid spacing (↗)*

## MISCELLANEOUS

- Arithmetical mean velocities for all the interfaces chosen by the geophysicist are computed from interval velocity grids and time grids.
- Some parameters may be smoothed and an appropriate filter chosen by the interpreter.
- Depths are computed from time grids and average velocity grids (fig. 14 and 15).
- Isopachs are plotted from the difference in time grids for two given reflectors, the isobaths from the depth grids.
- Arithmetic operations such as adding a constant, a percentage, etc. may be performed.

## FINAL DOCUMENT DISPLAY

According to the size of the survey, the grid may cover the entire surveyed area or a section at a time. In the latter case, Interbase's interactive operation allows different partial grids already validated to be merged to reconstitute a grid covering the entire surveyed area.

From a validated grid in the data base file, and by means of an application module, any contour map with its location map can be output by an electrostatic plotter or calcomp.

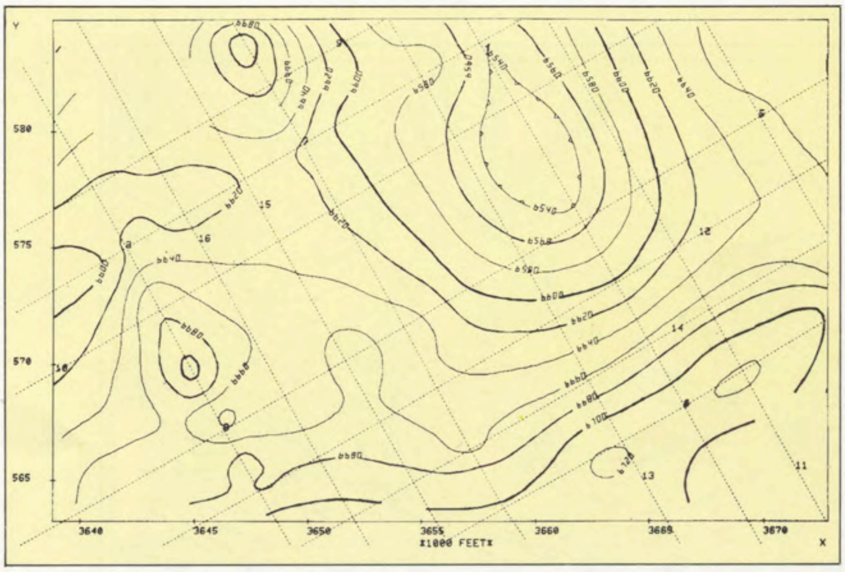


*Fig.14: Contouring of velocities*

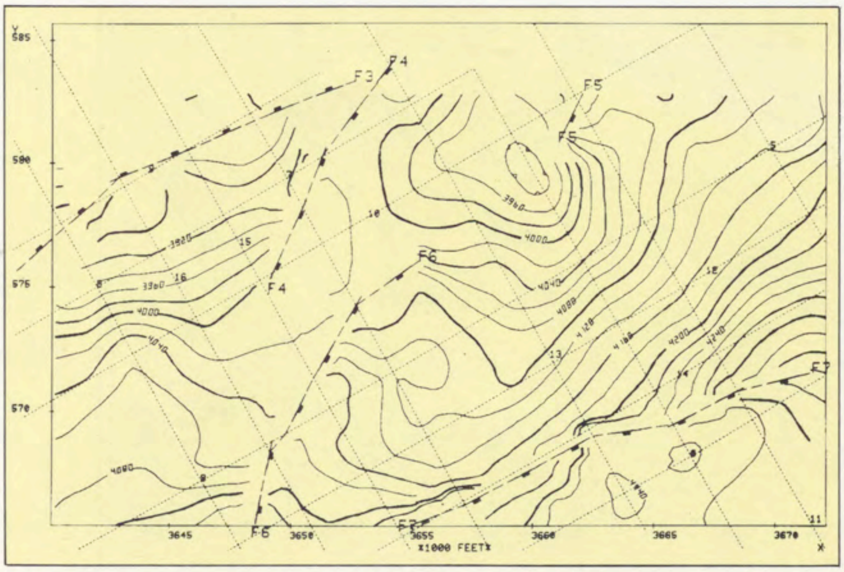


*Fig.15: Non-migrated depth contouring*

## DEPTH MIGRATION

PRINCIPLE:

Assuming that the time of the horizon n to be migrated, the depths of the already migrated horizons n - 1 and the interval velocities are defined at the intersections of grids already computed and stored in the data base, for each intersection ($X_o$, $Y_o$) the program computes the position of the migrated intersection (x, y, z) by ray path tracing.

Thus, a set of points is obtained from which the grid of the depths of the horizon to be migrated and mapped may be computed. If the horizon to be migrated is faulted, the traces of the faults defined on the time horizon are themselves migrated (fig. 16).

## CONCLUSION

Interbase's application modules and data management system significantly improve seismic interpretation through their ability to add new information such as geologic or logging data from wells. Either interactively or not, the interpreter can superimpose this data onto data from seismic sections.

Designed for use in today's 2D and 3D surveys, Interbase is a flexible and efficient tool for managing and working with the numerous documents.

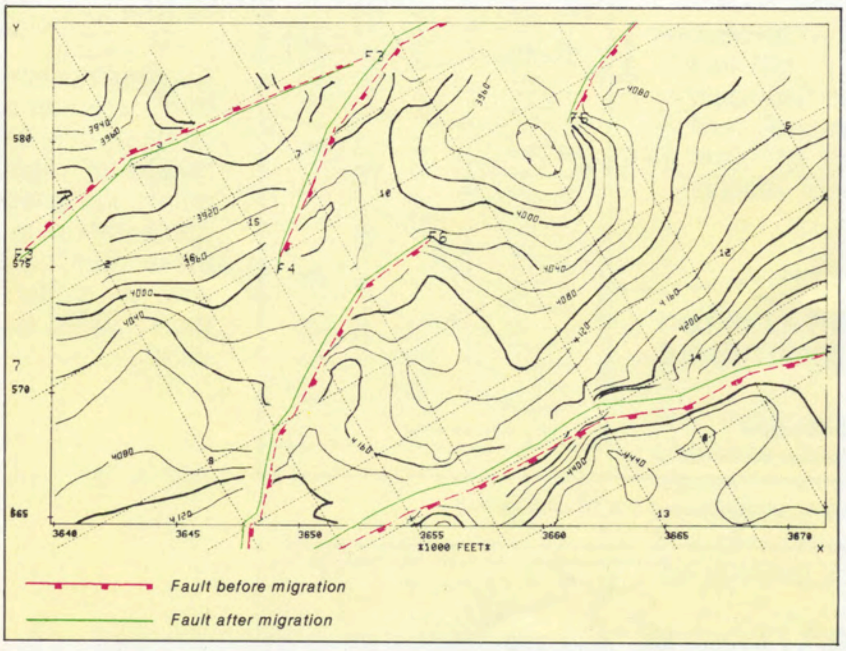


*Fig.16: Depth migrated contouring*

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