PRAKLA-SEISMOS INFORMATION No. 38

COMAI
Computer Aided 3-D Seismic Interpretation

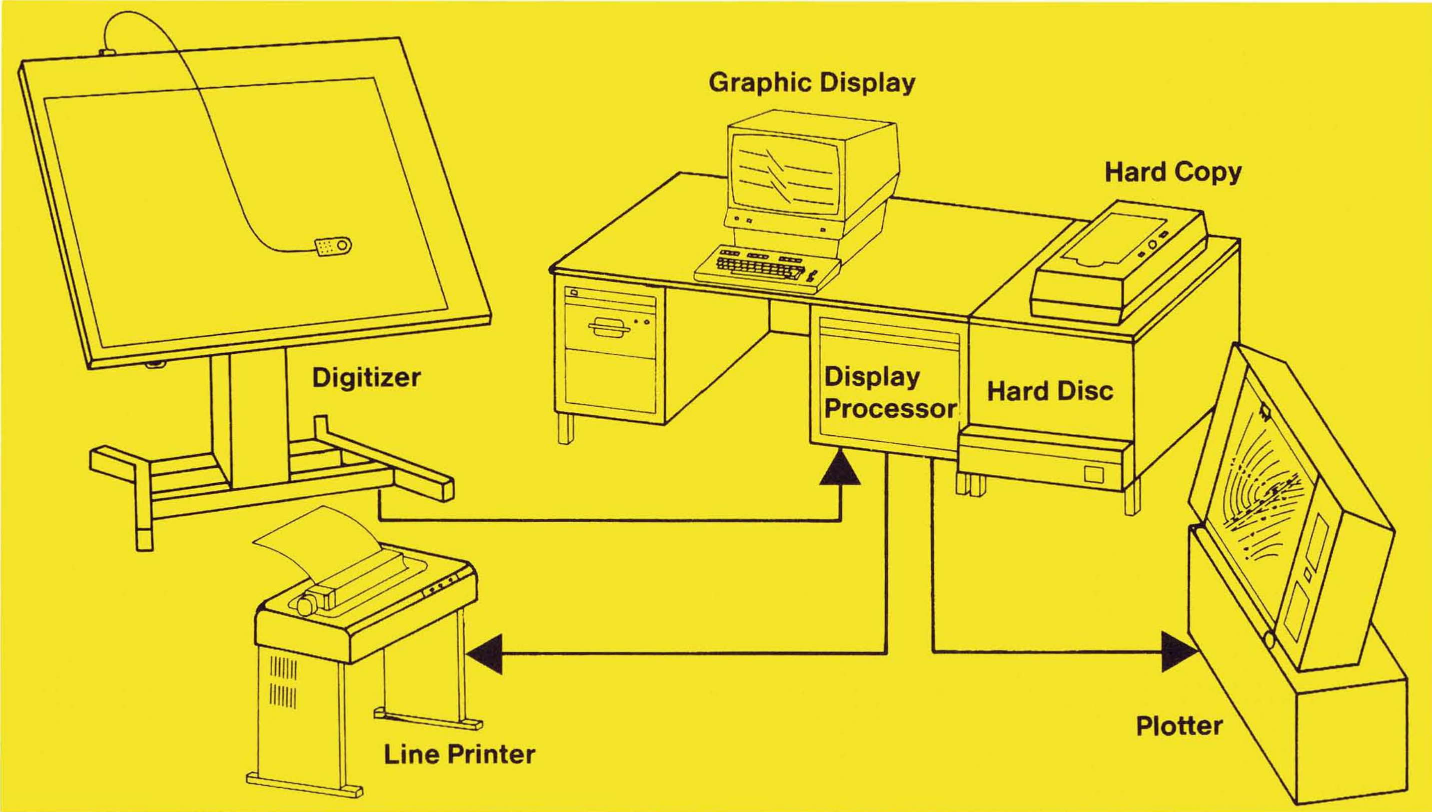


Fig. 1: Hardware

The interpretation of reflection seismic data from 3-D surveys generally implies the processing of extremely large amounts of information. Since 1979, the reduction of routine work (e.g. tie-ins, plotting of time and depth maps, contouring etc.) has been a substantial part of the PRAKLA-SEISMOS Computer Aided 3-D Seismic Interpretation (COMAI) concept. On the other hand this concept retains the traditional manual methods of horizon and fault picking and their correlation with well and mining data.

Hardware

The hardware consists of the Tektronix 4081 interactive graphic system combined with a digitizing table, plotter, hard copy module and line printer (fig. 1). The 48 cm monitor uses the vector principle in both refresh and storage mode, the resolution is 2048 x 1536 points. The necessary processing operations for the system are run and controlled by a display processor contained in the Tektronix 4081 (working storage capacity 64 K Byte). This allows work without dependence on a host computer.

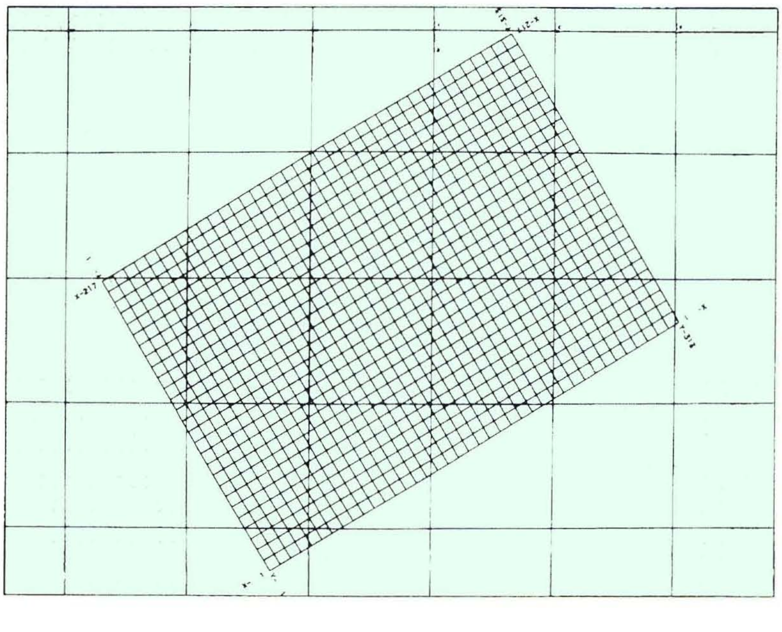


Fig. 2: Location Map for 3-D Interpretation

Software

The COMAI software package was internally developed and programmed in Standard Fortran. The simplified flow chart is shown in fig. 3.

Prerequisites

COMAI requires 3-D migrated sections and a rectangular, equidistant line grid. Up to a maximum of 8200 grid points and 16 separately coded horizons per interpretation area can be handled.
After the input of general information via keyboard (e.g. user, survey area, client, scale, line spacing etc.) 4 corner points each for the coordinate grid and the line grid are defined. Control displays of the location map (fig. 2) and other general data can be seen on the monitor.
The horizons and faults manually picked in the seismogram sections can now be digitized.

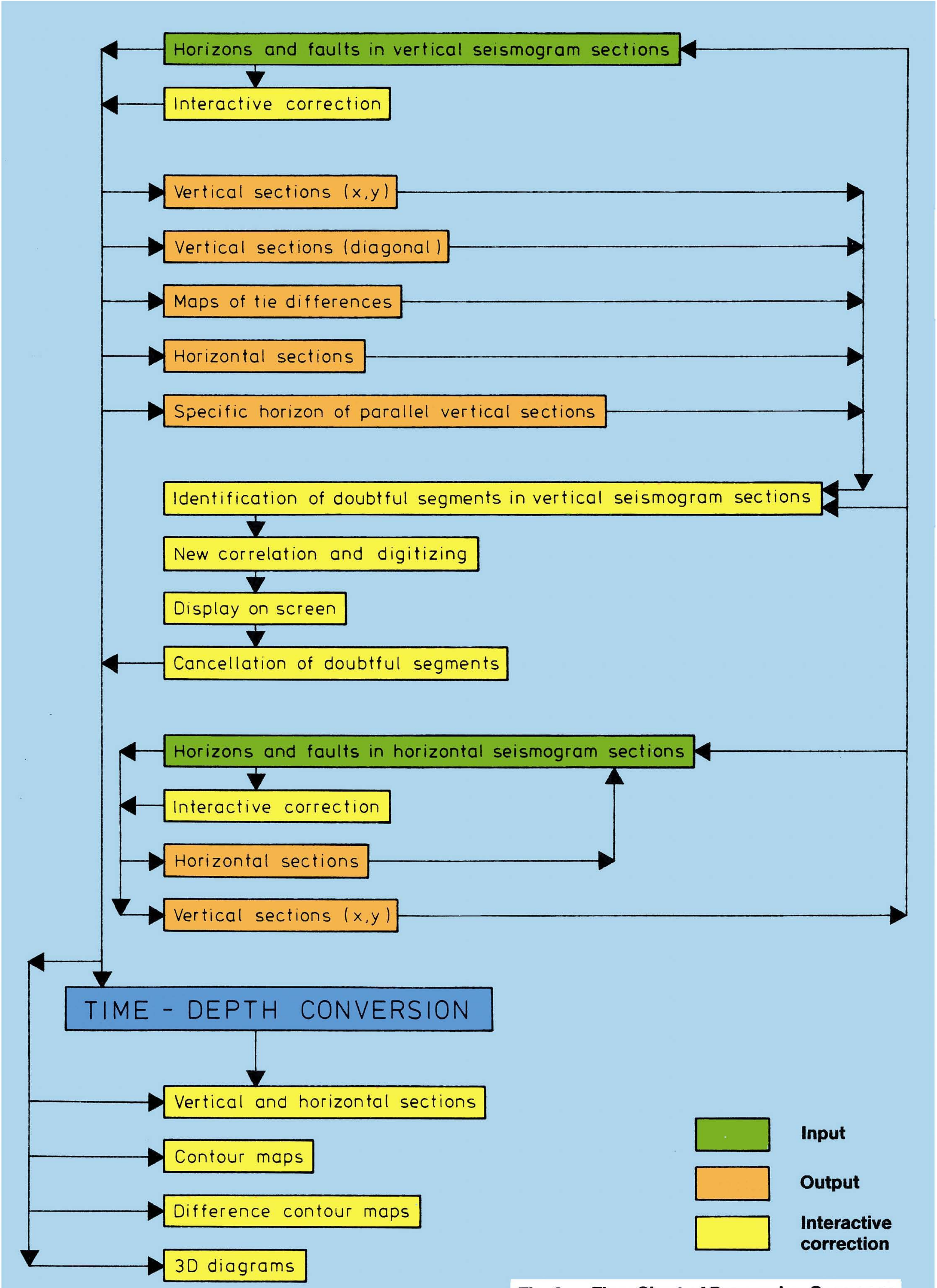


Fig. 3: Flow Chart of Processing Sequence

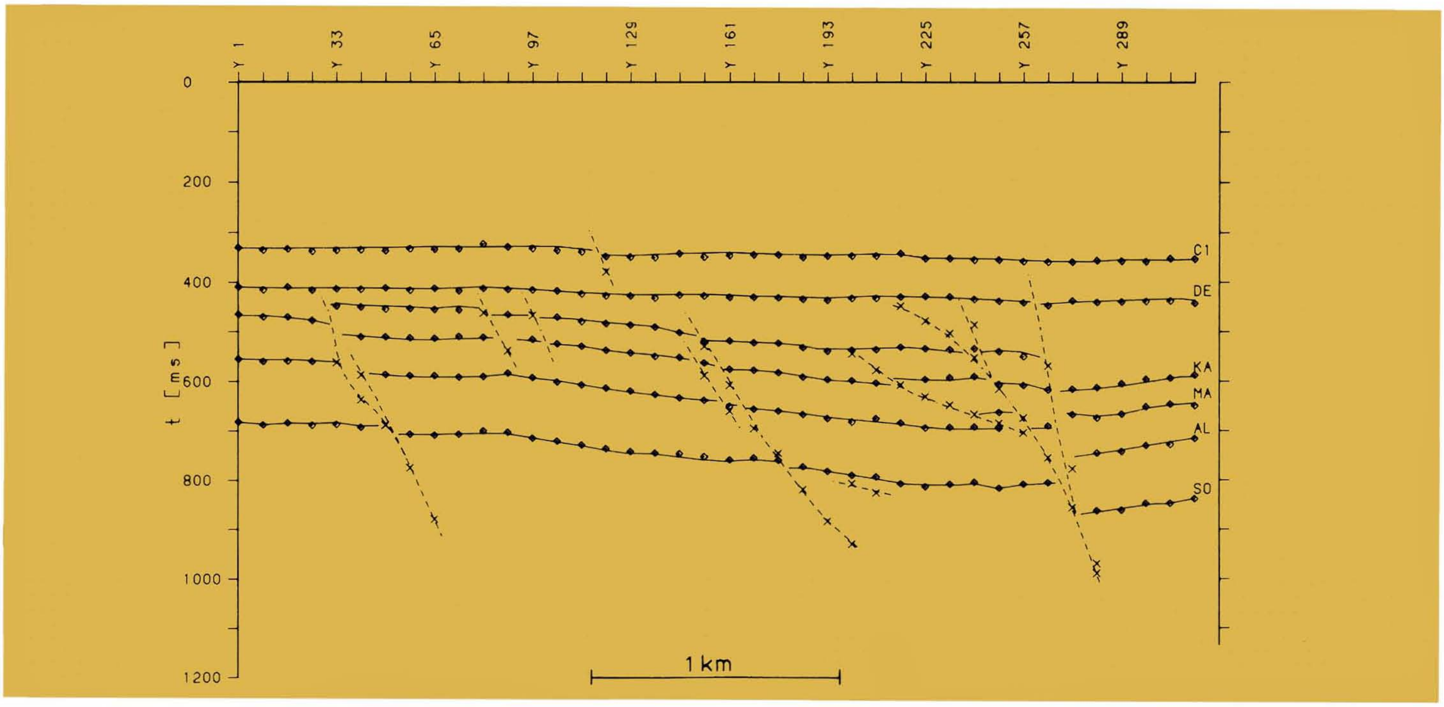


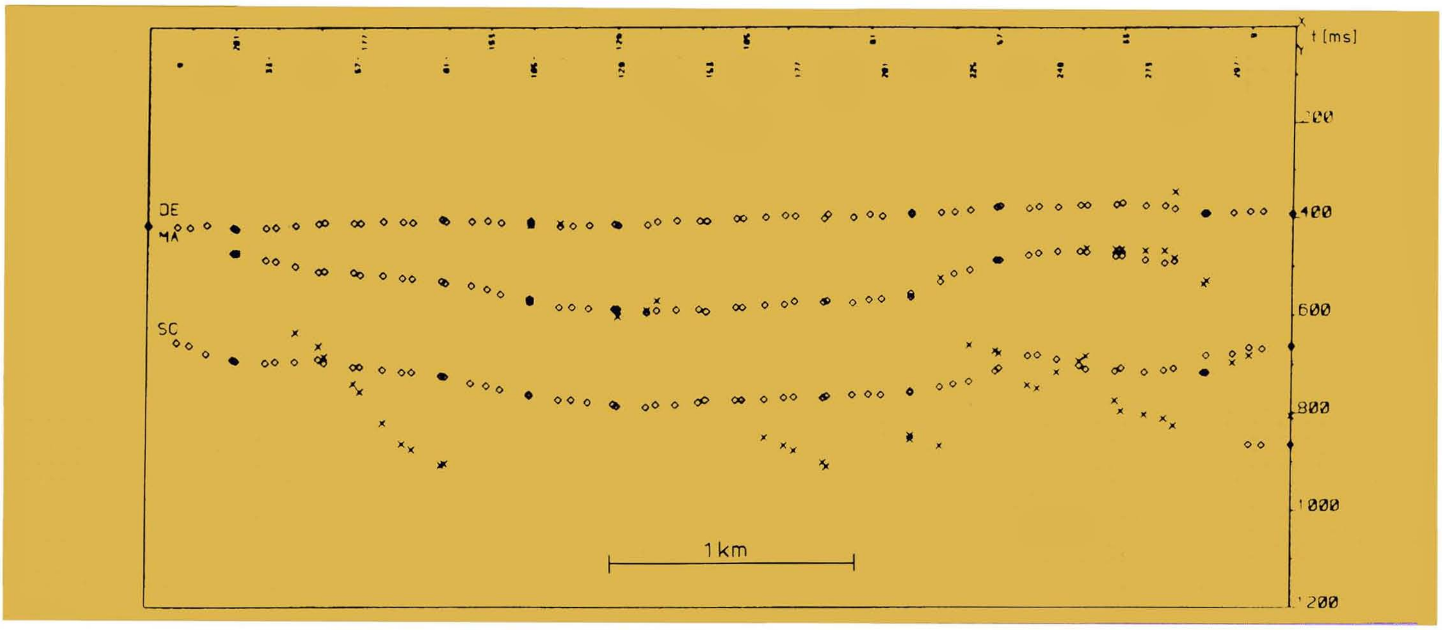
Fig. 4: Vertical x Time Section

Interpretation Sequence: Vertical Plane

After digitizing, vertical x and y sections can be output on screen or plotter. **These sections contain all automatically transformed ties with all cross lines.** The tie data of horizons are rhombic symbols, faults are shown as slanted crosses (fig. 4). Irregularities at this stage should be eliminated interactively with a special correction process. Doubtful segments in the seismogram sections are pin-pointed on the digitizer using the cross-hair cursor. For final decision purposes the updated interpretation is displayed together, with the previous interpretation on the monitor.

Tie errors can be checked by selecting arbitrary diagonal sections which contain projected tie information from x and y lines (fig. 5).
A **map of differences** at each gridpoint for the horizon in question can also be used for checking interpretation.

Fig. 5: Vertical Diagonal Time Section



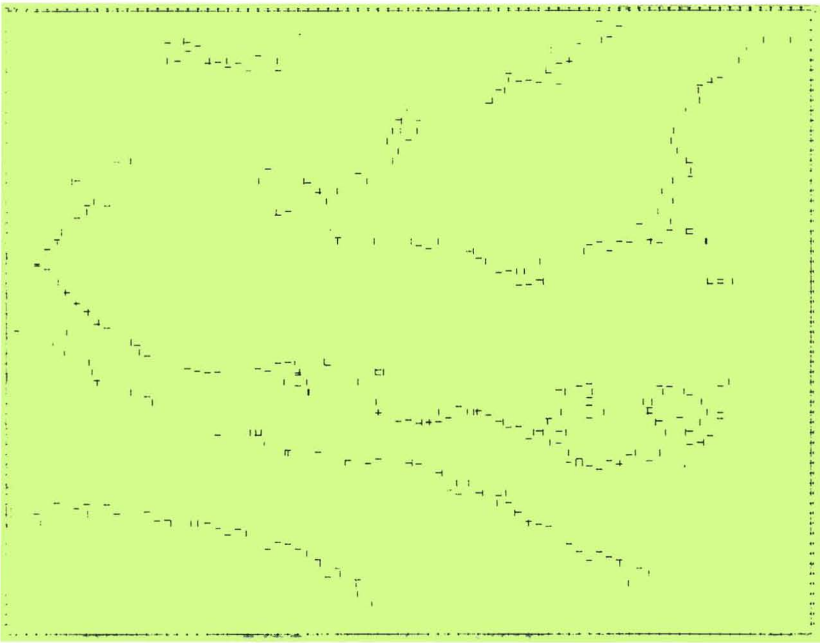


Fig. 6: Horizontal Section with Horizon Penetration Points, 1532 ms

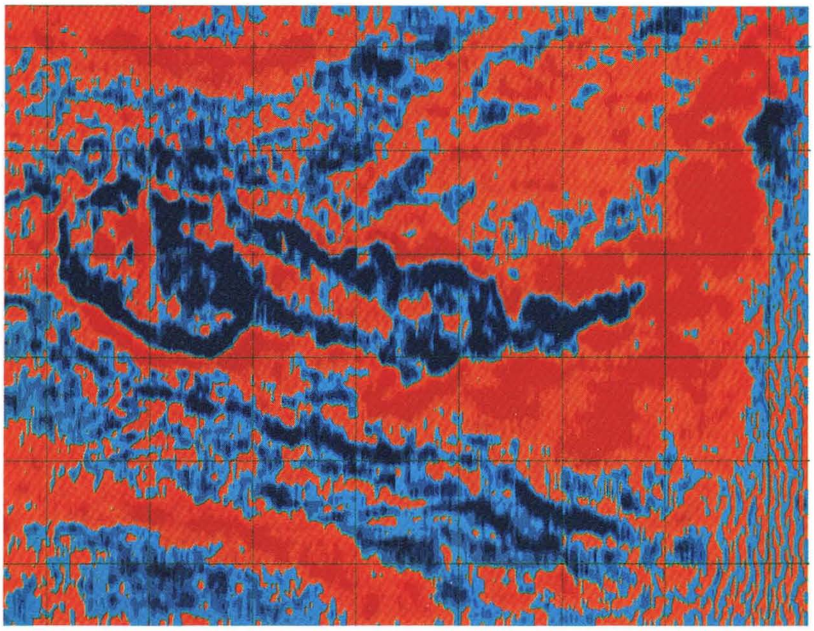


Fig. 7: Horizontal Seismogram Section, 1532 ms

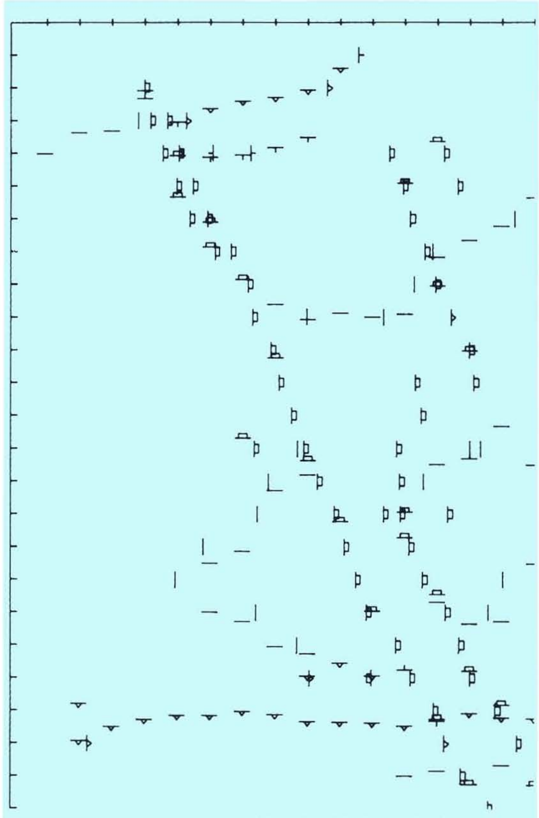


Fig. 8: Horizontal Section with Horizon and Fault Penetration Points, 540 ms

Fig. 9: Horizontal Seismogram Section, 540 ms

Horizontal sections containing the automatically determined penetration points of horizons and faults from vertical sections have also proved to be useful (figs. 6, 7, 8, 9). The computer checks not only the exact location of such points but whether a normal fault ⊓, an overthrust △ or an non-definable fault ⊥ is present. These plots are used as overlays for horizontal seismogram sections at the same scale and "stabilize" the interpretation.

By selecting a particular horizon from parallel vertical sections the **structural pattern can be checked.** This is realized on the monitor with up to 10 sections in refresh-mode. Additionally a plot of the selected horizon through all x or y sections can be produced (fig. 10, spacing 75 ms).

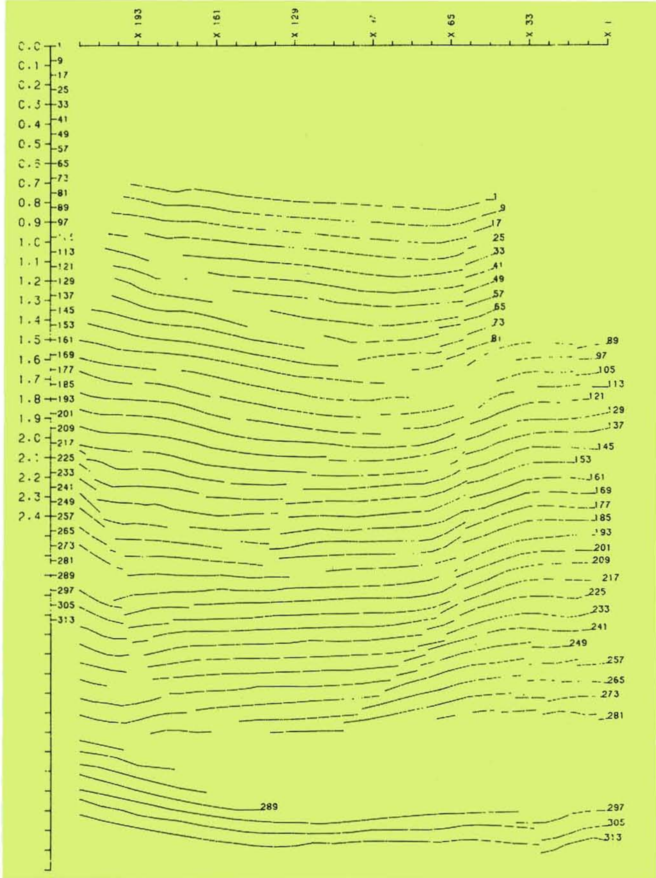


Fig. 10: Plot of a Selected Horizon through all y-Time Sections ▶

Interpretation Sequence: Horizontal Plane

The simplified flow chart (fig. 3) shows that the interpretation results of horizontal seismogram sections can also be used. The digitized segments can be output for one or more horizontal sections (fig. 11). A transformation of these segments into selectable x or y sections leads to penetration points in a similar way to those obtained from vertical sections (fig. 12). Thus an additional interpretation tool for the corresponding vertical seismogram sections is made available to the interpreter.

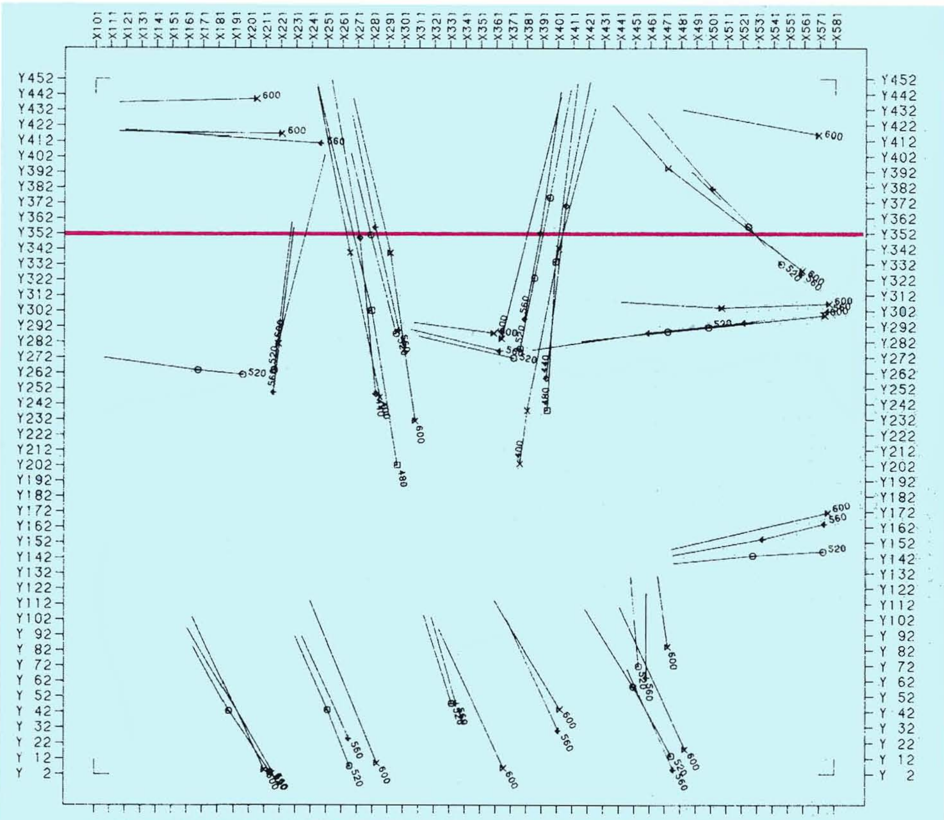


Fig. 11: Plot of Fault Segments, digitized in Horizontal Seismogram Sections ▶

Time/Depth Conversion

The time/depth conversion is carried out using the **TEUF program.** This is a depth distention in the vertical as the input data are 3-D migrated time sections. Various velocity functions can be applied between up to 16 reference horizons (e.g. $v = const.$ $v = v_0 + az$, $v = k\sqrt[n]{z}$, $v = \sqrt[n]{v_0^n + v_1^n z}$), lateral variations can also be considered.

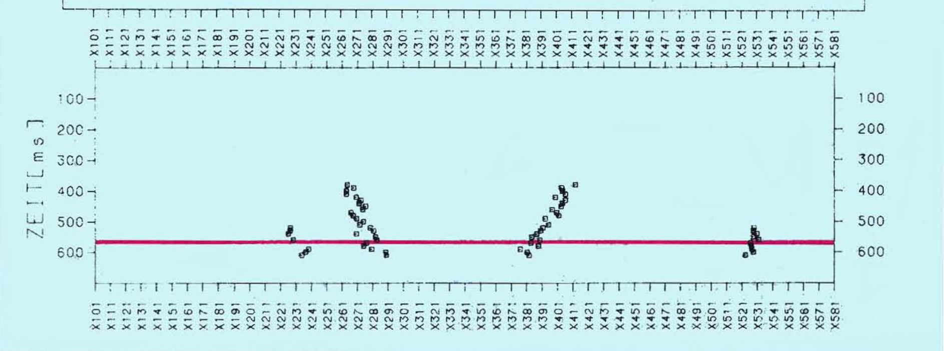


Fig. 12: Vertical Time Section with Fault Penetration Points ▶

Presentation of Results

The final displays show quite impressively the time saved and the elimination of routine work.

The plotter program can be utilized for the transfer of the interpretation into the seismogram sections (even film sections). Hereby the suppression of symbols (e.g. horizon- and fault-ties etc.) is possible.

Contour maps can be made by connection of horizon penetration points, the contour spacing being identical to the spacing of available horizontal sections.

Contour lines can also be calculated and plotted by the **ISO program.** Numerous parameters influence the calculation of contours. The optimum choice of parameters allows the production of isoline maps which are equal in quality to, or even better than, manually contoured maps. Fig. 13 shows an automatically contoured depth map of an offshore area in which the numerous relatively small normal faults were neglected, in contrast to fig. 14, an example of coal exploration. All faults affecting the horizon are plotted in the contour map as red symbols: normal faults ⊓, overthrusts △ and general fault planes ⊥.

The application of the **DREID program** to the data grid of a horizon produces 3-D block diagrams. An important factor for such diagrams is the location of the viewpoint (zooming, fig. 15).

We would like to thank Bergbau AG Westfalen, Dortmund, West Germany, and Empresa Nacional del Petroleo (ENAP), Magallanes, Chile, for their kind permission to reproduce the results.

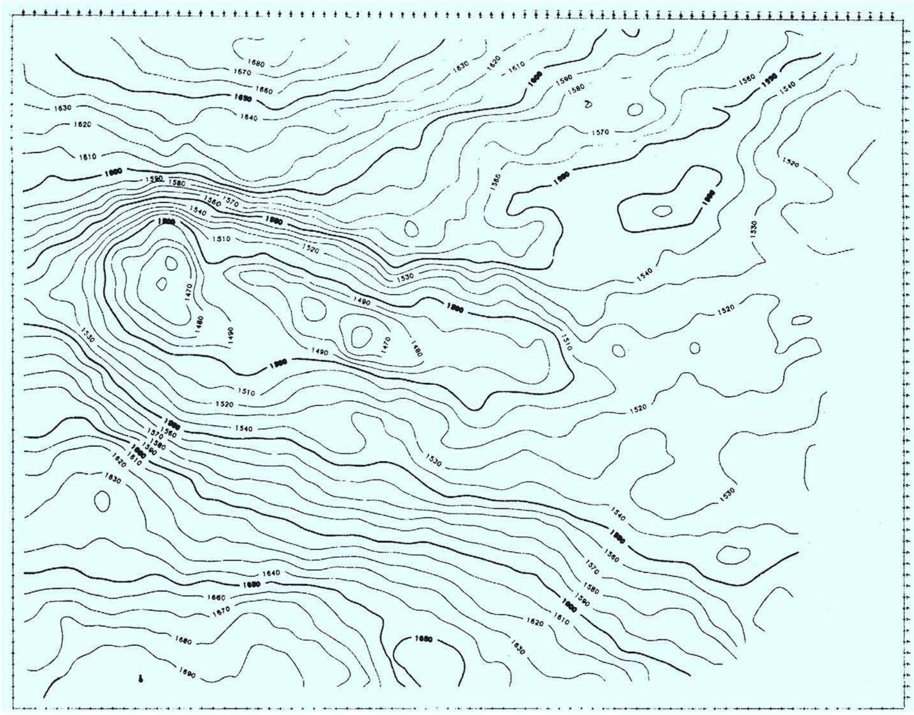


Fig. 13: Depth Map of an Offshore Survey, Faults neglected

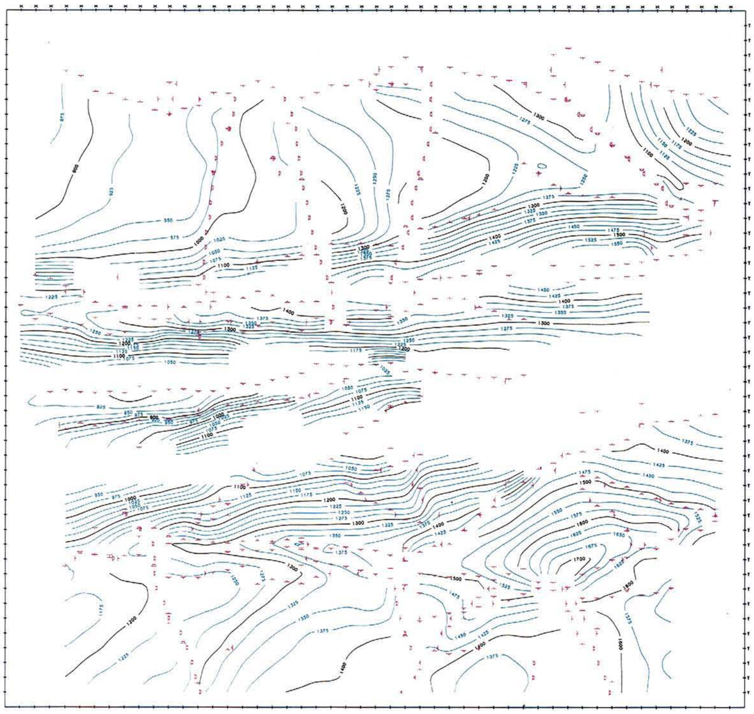
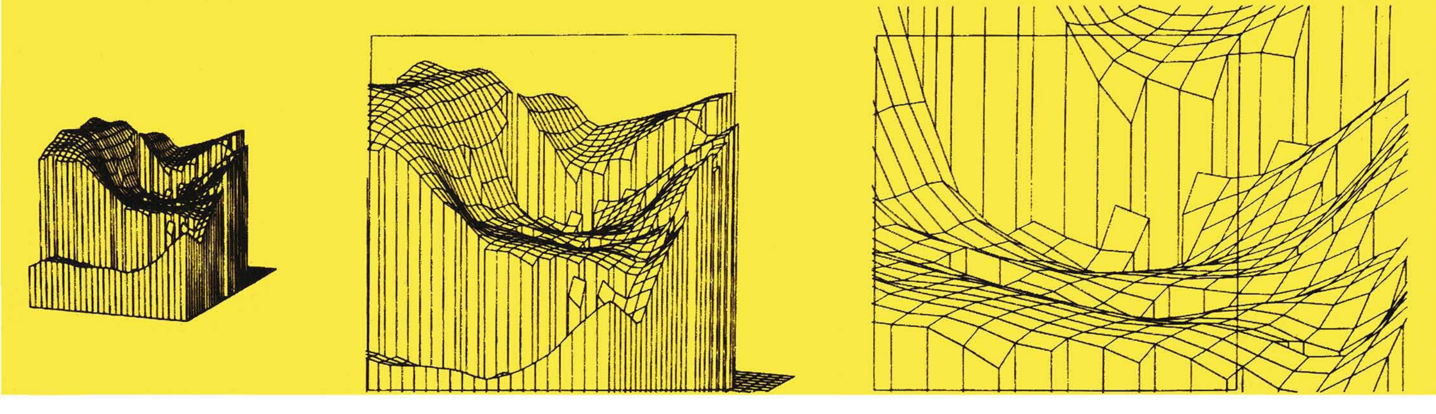
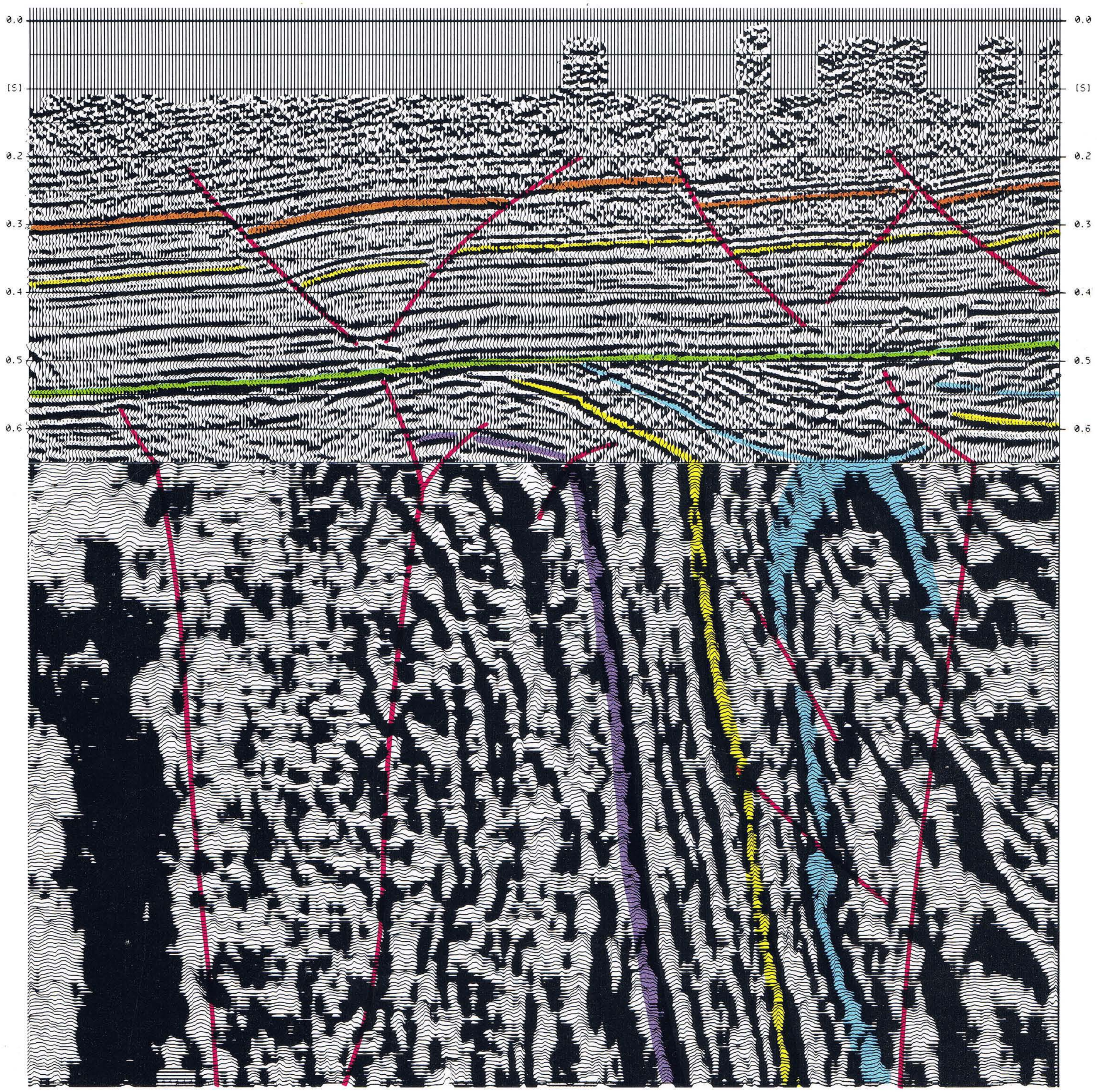


Fig. 14: Depth Map of a Coal Survey, including Fault Penetration Points

Fig. 15: Zooming of 3-D Block Diagrams





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