Interactive interpretation of 2D seismic data

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Abstract: Interactive interpretation first became possible for 3D data because of the regular closely-spaced array of data points which a 3D survey provides. Now the 2D interpreter can also enjoy the benefits of an interactive system. He can select the desired lines from a prospect basemap, display the sections in colour for optimum dynamic range, cut, fold and shift to establish correlations and automatically track the horizons of interest. Mapping includes fault connection, manual contouring, automatic contouring, amplitude mapping and superimposition of final displays for interpretive synthesis.

THE SYSTEM

Seismic Interactive Data Interpretation System, SIDIS, (Fig. 1) has been developed specifically for 2D data. Based on experience with GSI's experimental 3D interactive interpretation system, SIDIS now incorporates full 3D data capabilities.

SIDIS operates on one of the VAX* family of computers, on a MicroVAX* II computer or on a TIMAP+ IV system as part of a GSI service centre.

USER-FRIENDLY MENUS

The whole SIDIS system is menu-operated and easy to use. Each menu is divided into four regions (Fig. 2). The main menu options controlling the majority of functions appear across the top of the terminal screen. Each has a brief explanation in the documentation on the left. If the name of a map or horizon is being selected, it appears on the scrollable list. Standard menu options which are used repeatedly, such as zoom and scroll, appear across the bottom of the terminal screen.

TRAVERSE SELECTION

One of the two colour monitors is for maps, the other for seismic data. A 2D basemap (Fig. 3) is used for traverse selection by indicating the line segments required with the cursor. This traverse displayed on the data screen (Fig. 4) indicates the three line segments selected and the intersection points with other lines. The basemap always indicates the extent of the data visible on the data screen. The section zoom (Fig. 5) is only part of Line 18 as indicated by the dashed line (Fig. 6).

SECTION CORRELATION

The interpreter assesses data correlations, for example across faults, by a cut-fold-shift operation. First he chooses a cut line (CDP 450) and then a fold point (CDP 358). After the fold point is folded to the cut line, the data segment on the right may be shifted up and down by any chosen amount (Fig. 7) until correlation is established. The shift in milliseconds may then be read from the bottom of the screen. A similar approach is used to measure misties at intersections.
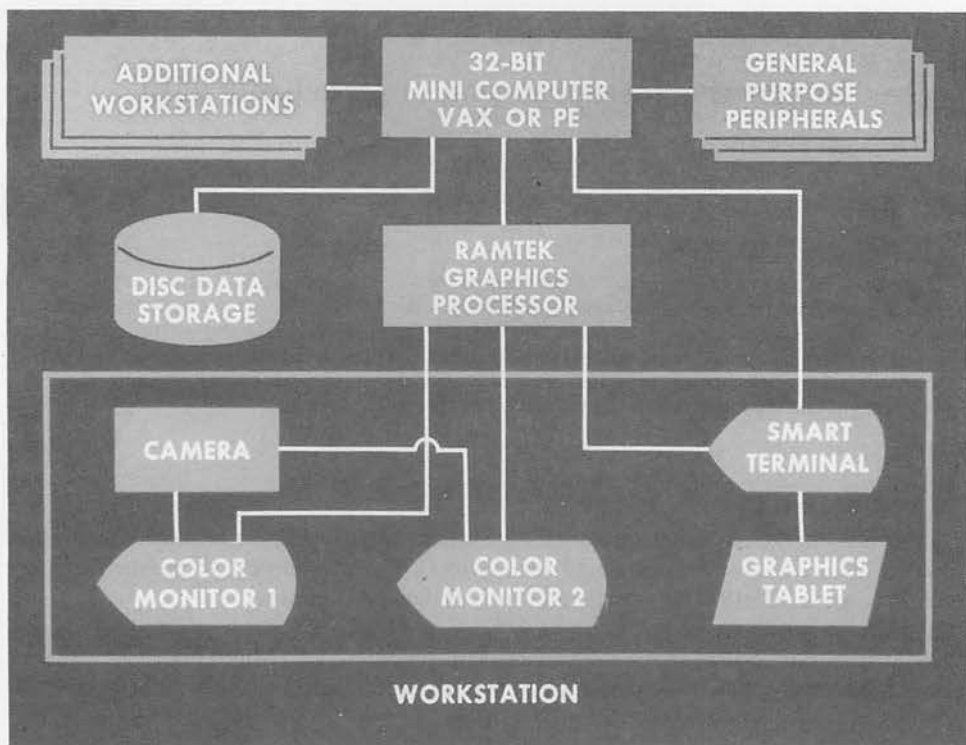
Fig. 1.   The Seismic Interactive Data Interpretation System, SIDIS.
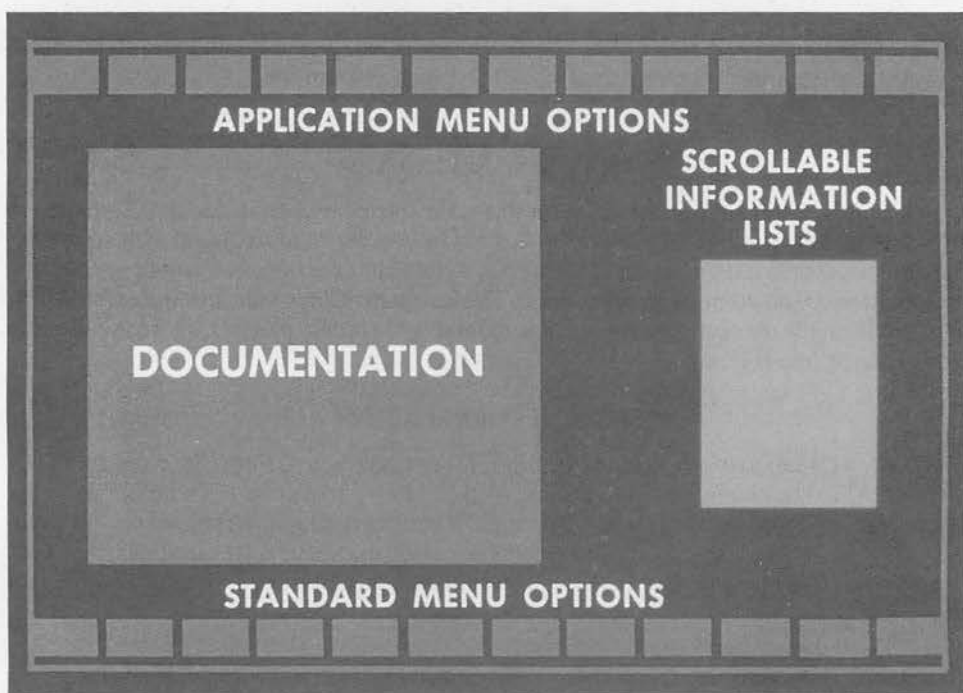

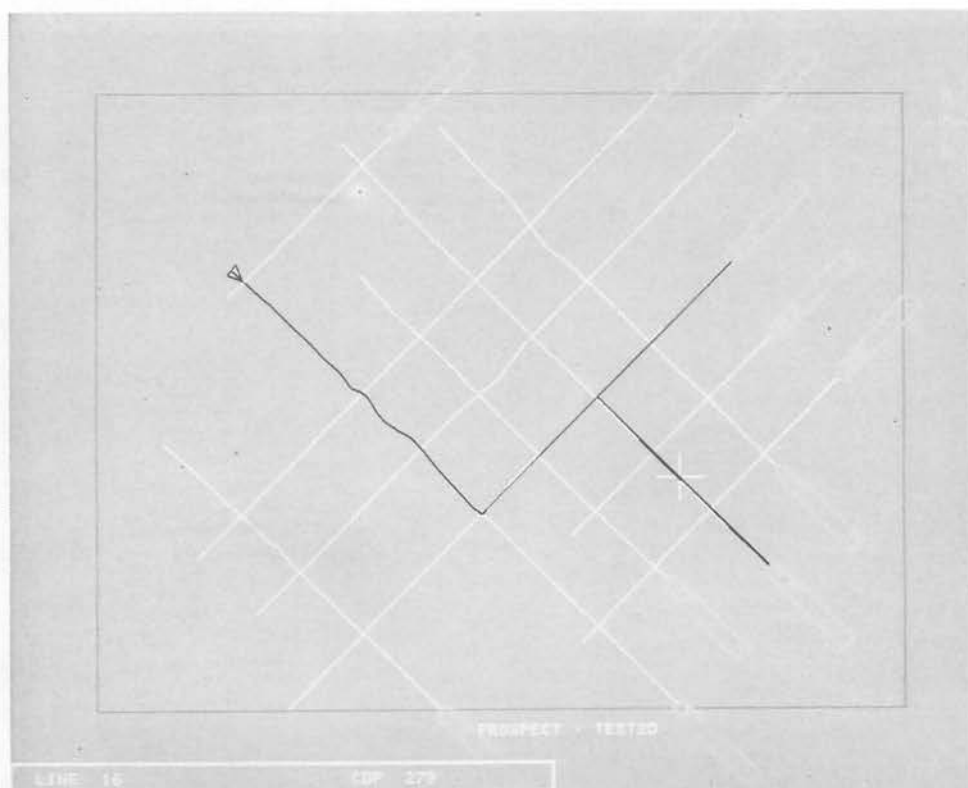Fig. 2.   Each menu is divided into four regions.

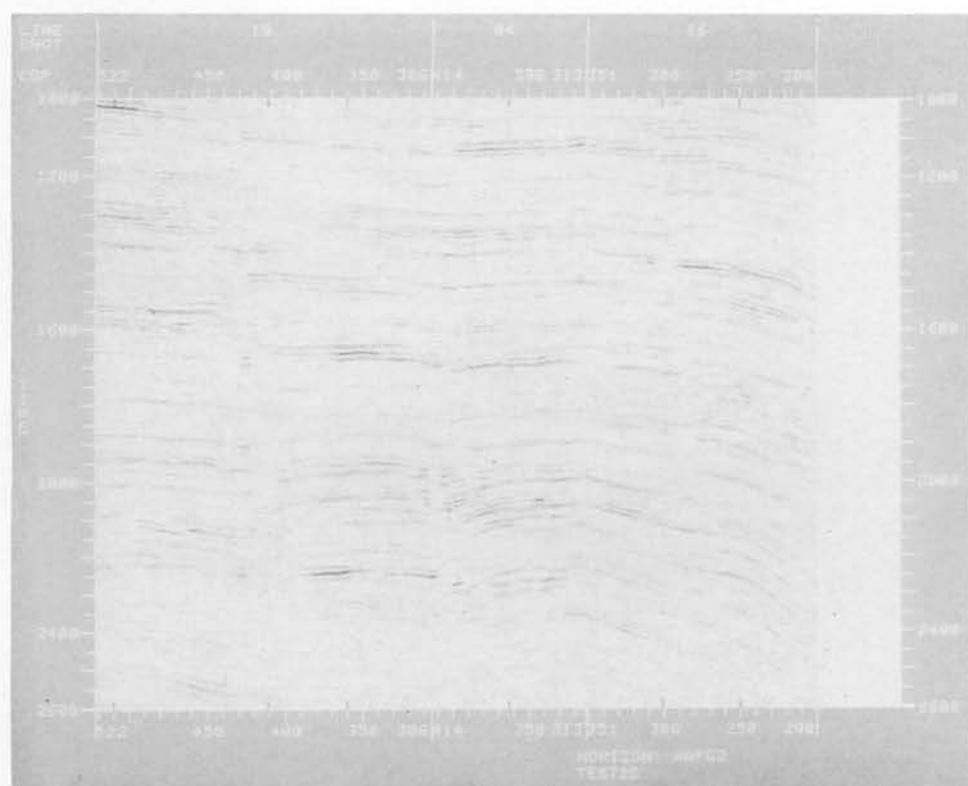Fig. 3. A 2D basemap is used for traverse selection on one colour monitor.

Fig. 4. The traverse selected is displayed on the data screen indicating the three line segments selected and the intersection points with other lines.
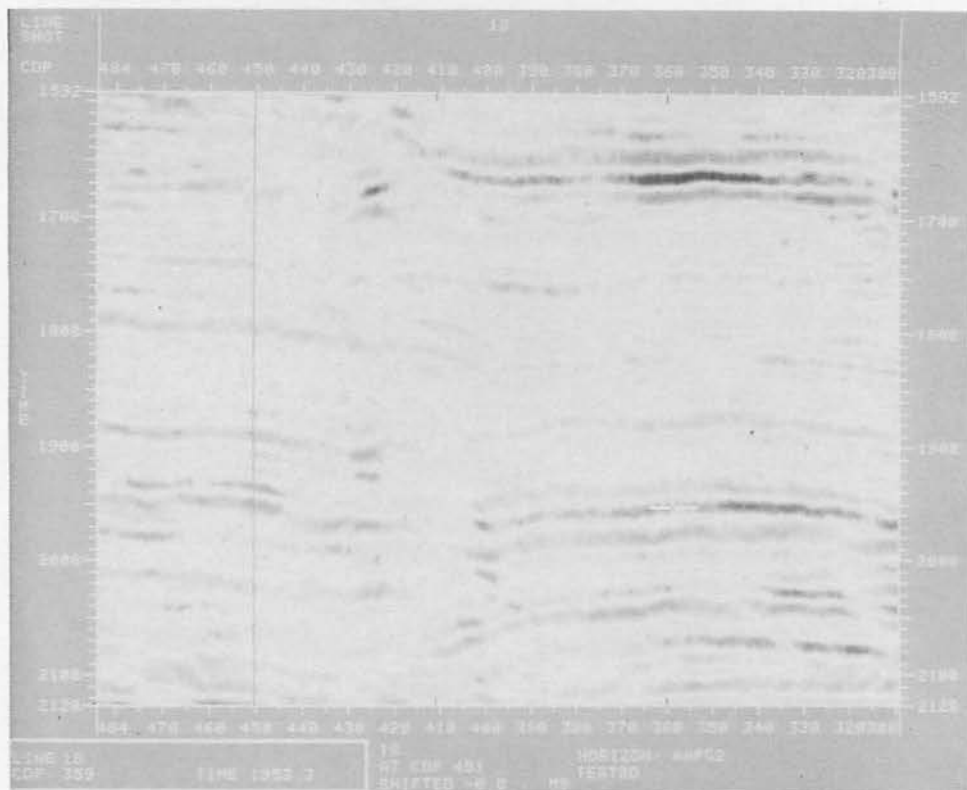
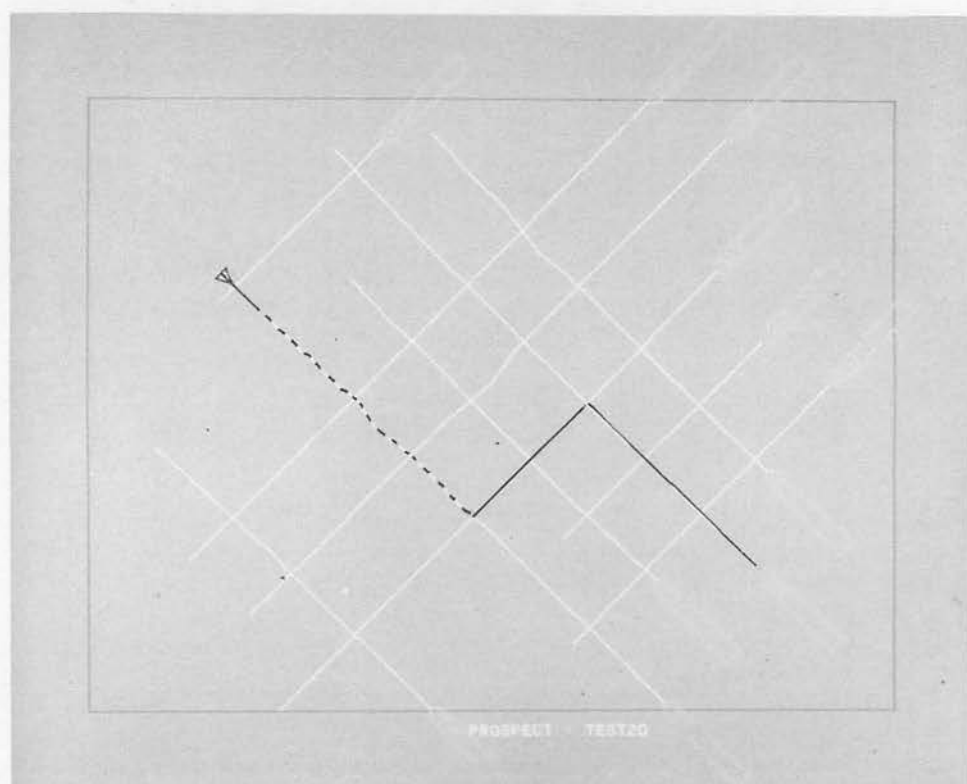Fig. 5.   The section zoom of part of a Line indicated by the dashed lines in Fig. 6.

Fig. 6.   Part of a Line, indicated by the dashed line, showing the section zoom location in Fig. 5.

FLEXIBLE DISPLAY AND COLOUR

As well as control over display scales and gain, the interpreter can select several display modes. He may use variable area/wiggle trace (Fig. 8), wiggle trace only, dual polarity variable area or, in order to maximize dynamic range, full colour. The default colour scheme is gradational blue for peaks and gradational red for troughs (Fig. 5) but the interpreter may select his own scheme for personal preference or special purpose (Fig. 9). He selects from a colour palette (Fig. 10) and may interpolate between selected colours to complete the scheme.

HORIZON AND FAULT TRACKING

A horizon may be tracked either automatically or manually. Automatic tracking follows optionally the crest of a peak, the crest of a trough (Fig. 11) or a zero crossing. Time and amplitude are simultaneously stored in the database for each depth point tracked.

When a section is zoomed, pixels are interpolated to retain the smooth appearance of the data (Fig. 12). The irregularity of the track indicates that it is following the maximum amplitude in the waveform. The crosses on or adjacent to the horizon track indicate the track intersections from other lines. At CDP 250 there is a small mistie.

Faults are tracked manually. Each fault is given a name and a distinctive colour and is stored separately in the database.

FAULT MAPPING

The first stage of 2D data mapping is fault connection. The horizon times are posted along the lines in colour according to the legend at the top of screen (Fig. 13). The faults are indicated in black with the tick at the upthrown end. When one fault indicator is selected with the cursor, all other fault indicators stored in the database with the same name flash; this tells the interpreter how he thought they should be connected when he tracked the sections. After the upthrown and downthrown edges of a fault have been connected, the area between them is commonly filled in black to indicate the fault zone (Fig. 14).

MANUAL CONTOURING

A horizon structure map may be contoured either manually or automatically. In the manual mode the data is colour posted with the desired contour interval. The interpreter then manually connects the colour junctions in a manner very similar to the traditional approach with which he is familiar (Fig. 15). He then fills the areas between the contour lines with colour according to the legend (Fig. 16). Labelling may be added to complete the map.

AUTOMATIC CONTOURING

In the automatic contouring mode the interpreter may select all the mapping parameters to suit his data. In the example (Fig. 17) contours with a 50 msec interval are in red and annotated, contours with a 10 msec interval are in white. The black dots indicate the data points on which the map is based. The contouring procedure honours the faults but also needs an external boundary to limit the contouring to the area of the data (Fig. 18). The map may then be finalized with colour and annotation as before.
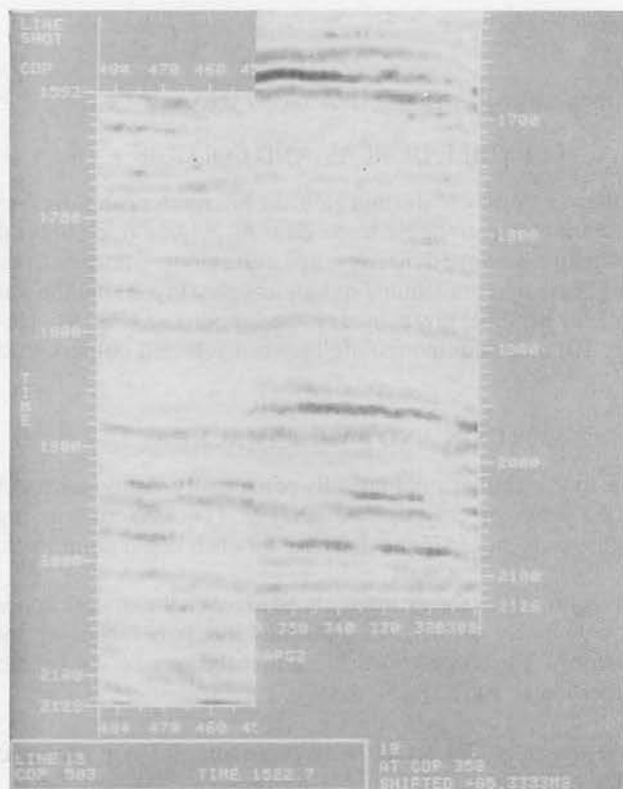
Fig. 7. After the fold point is folded to the cut line, the data segment on the right may be shifted up and down by any chosen amount until correlation is established.
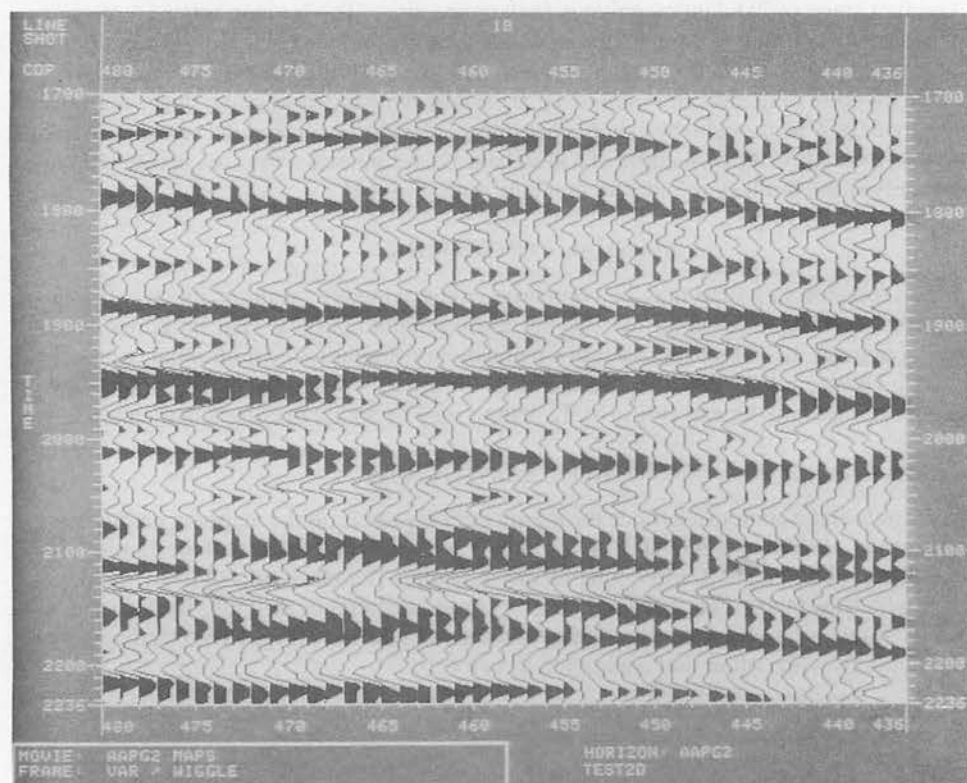

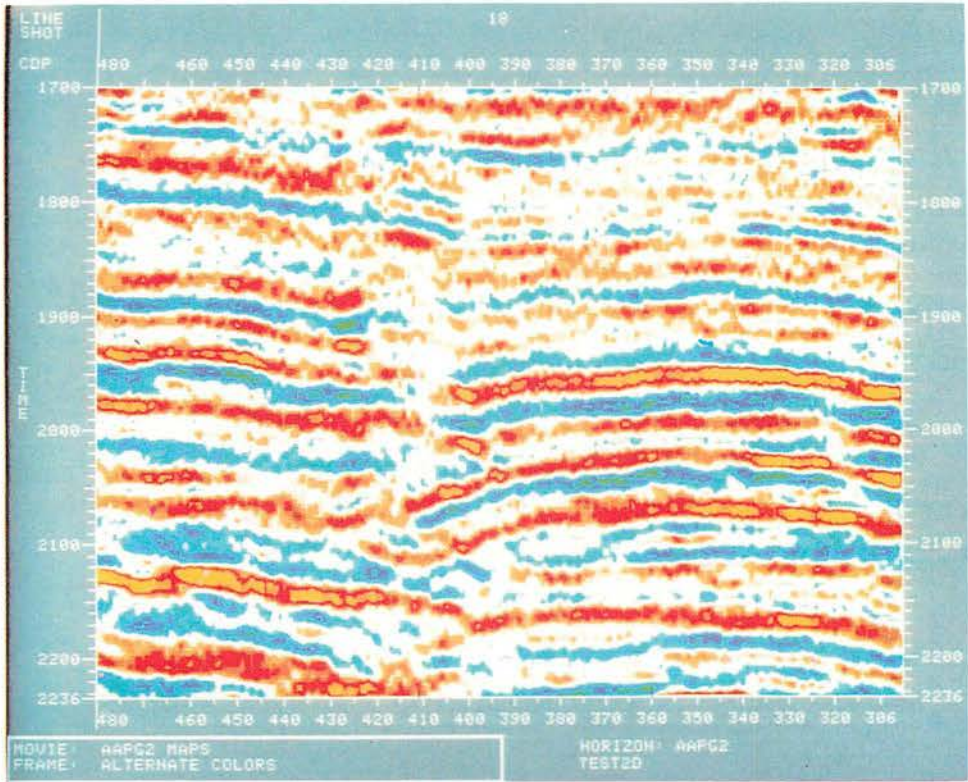Fig. 8. The variable area/wiggle trace display mode.

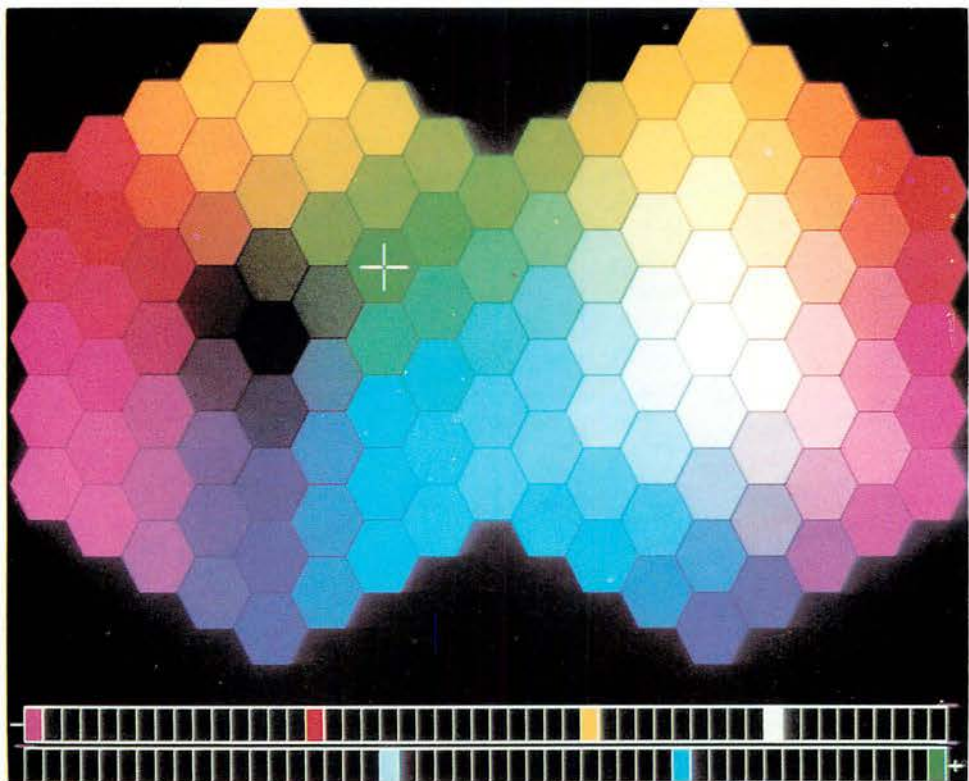Fig. 9. The interpreter can select his own full colour display scheme.

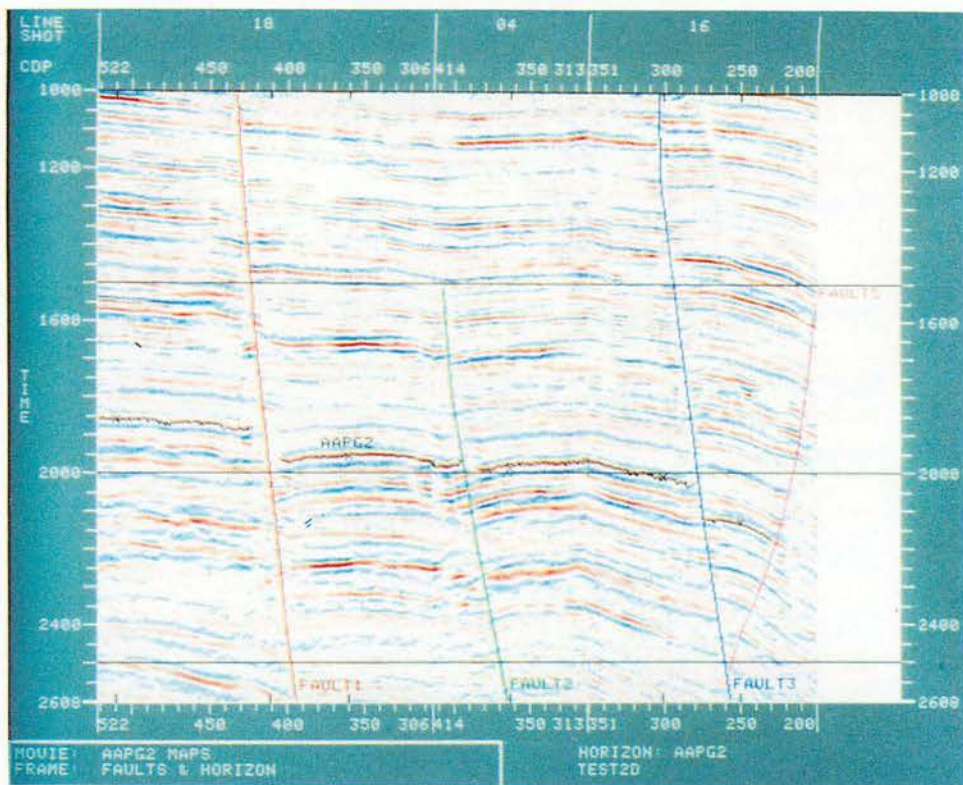Fig. 10. A colour palette for colour selection or interpolation.

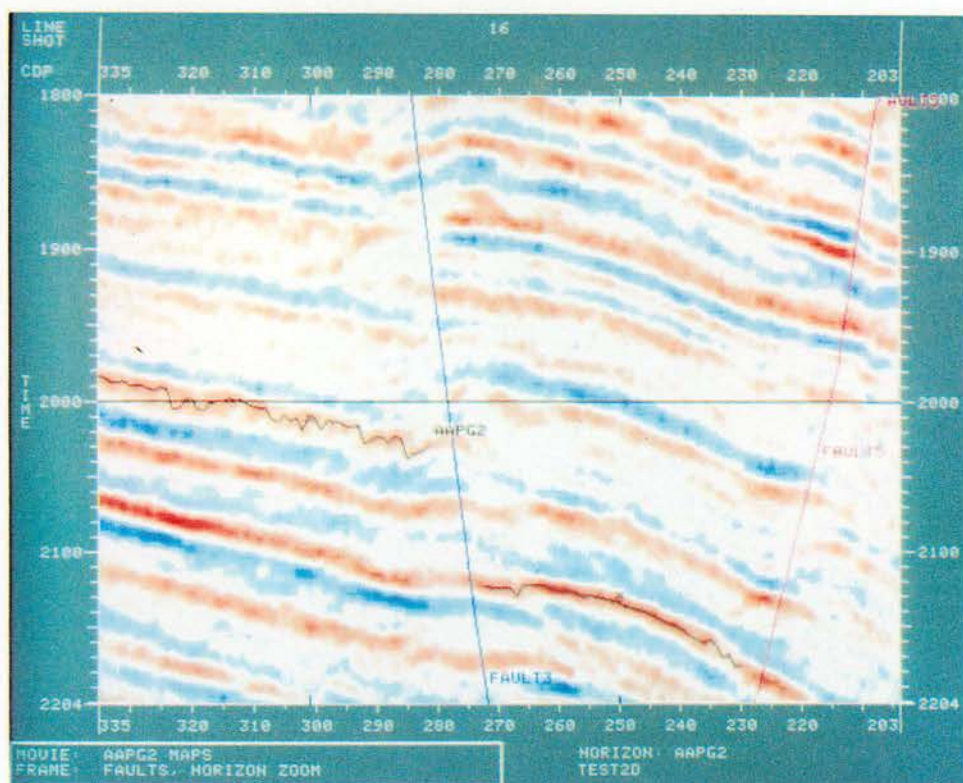Fig. 11.   Automatic tracking of the crest of a trough.

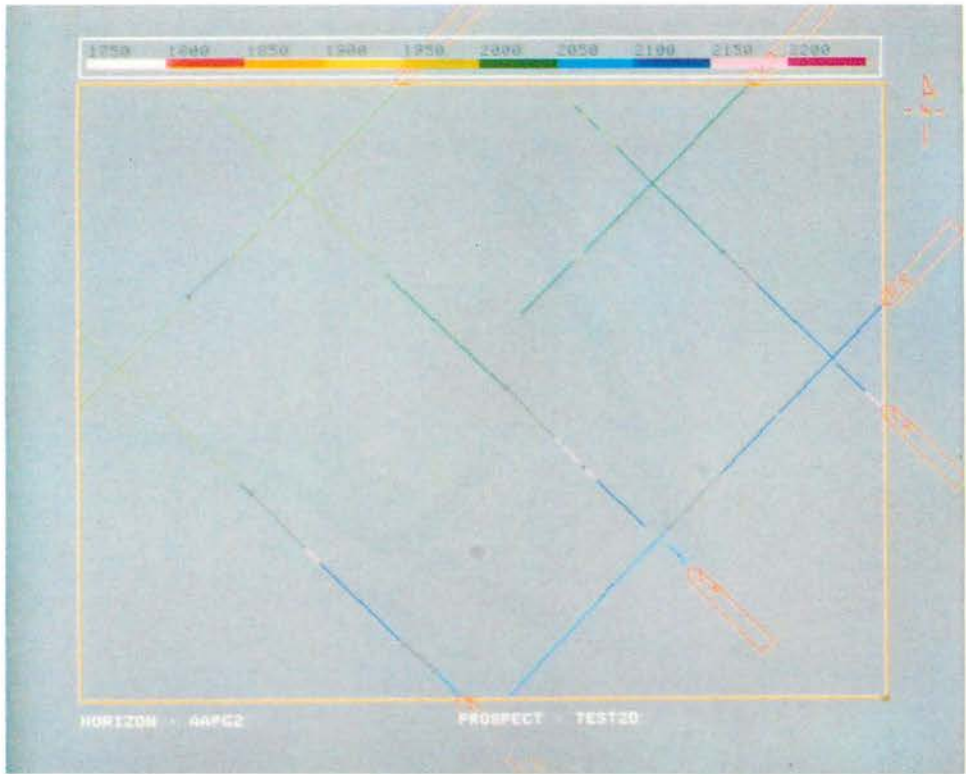Fig. 12.   When a section is zoomed, pixels are interpolated to retain the smooth appearance of the data.

Fig. 13. For fault mapping the horizon times are posted along the lines in colour according to the legend at the top of the screen.
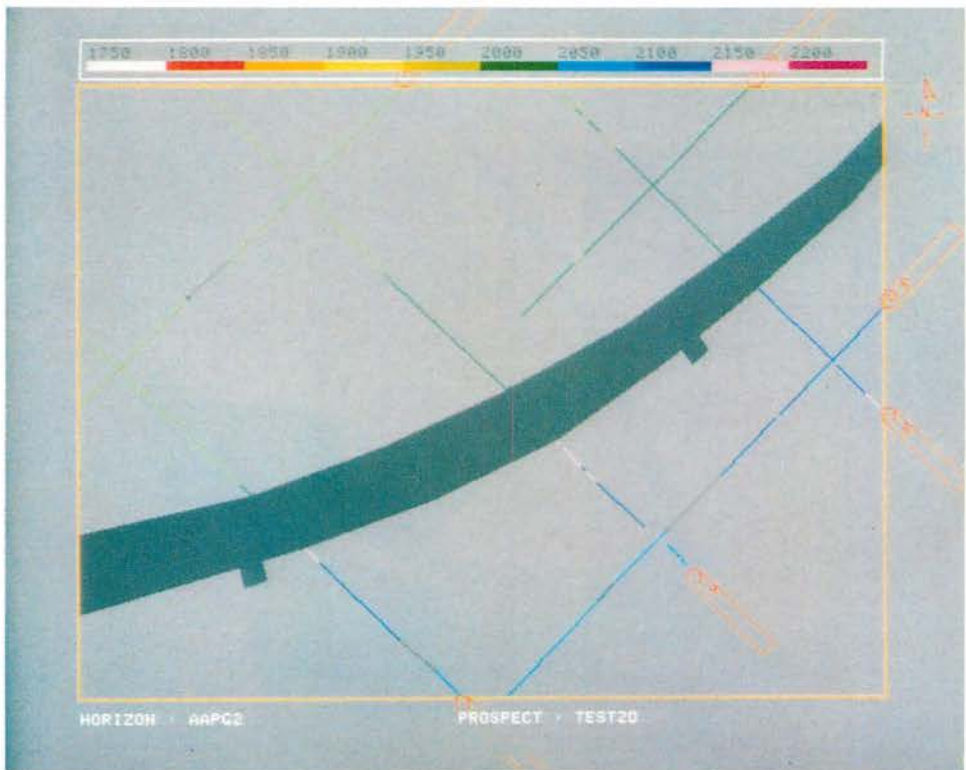

Fig. 14. After the upthrown and downthrown edges of a fault zone have been connected, the area between them is commonly filled in black to indicate the fault zone.
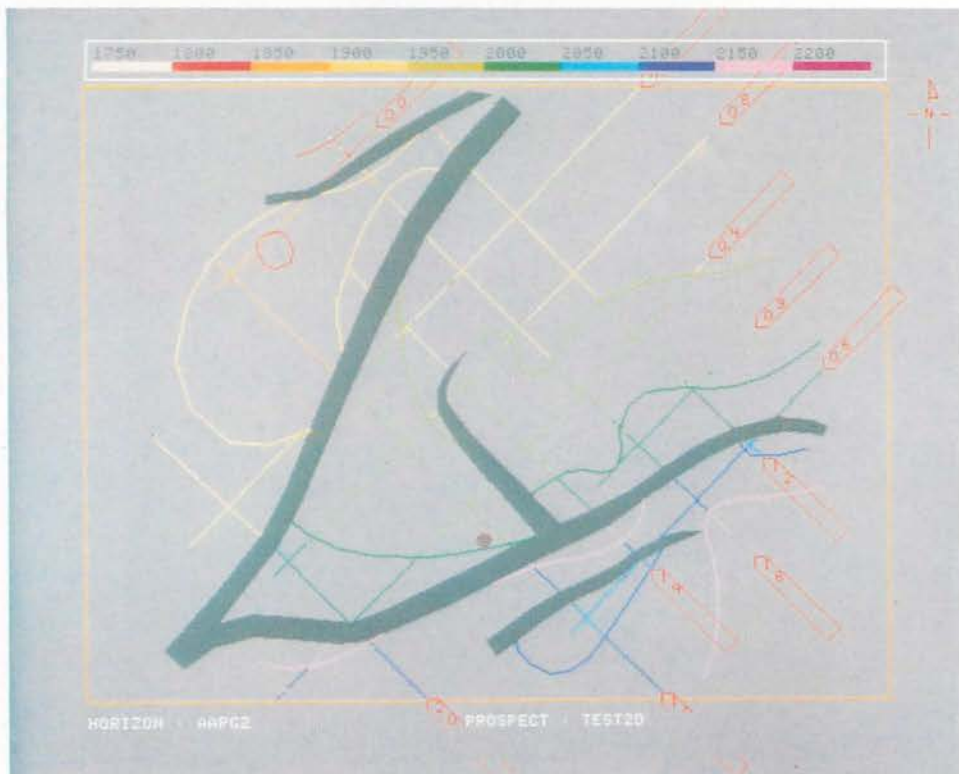
Fig. 15.   In manual contouring, the interpreter manually connects the colour junctions.
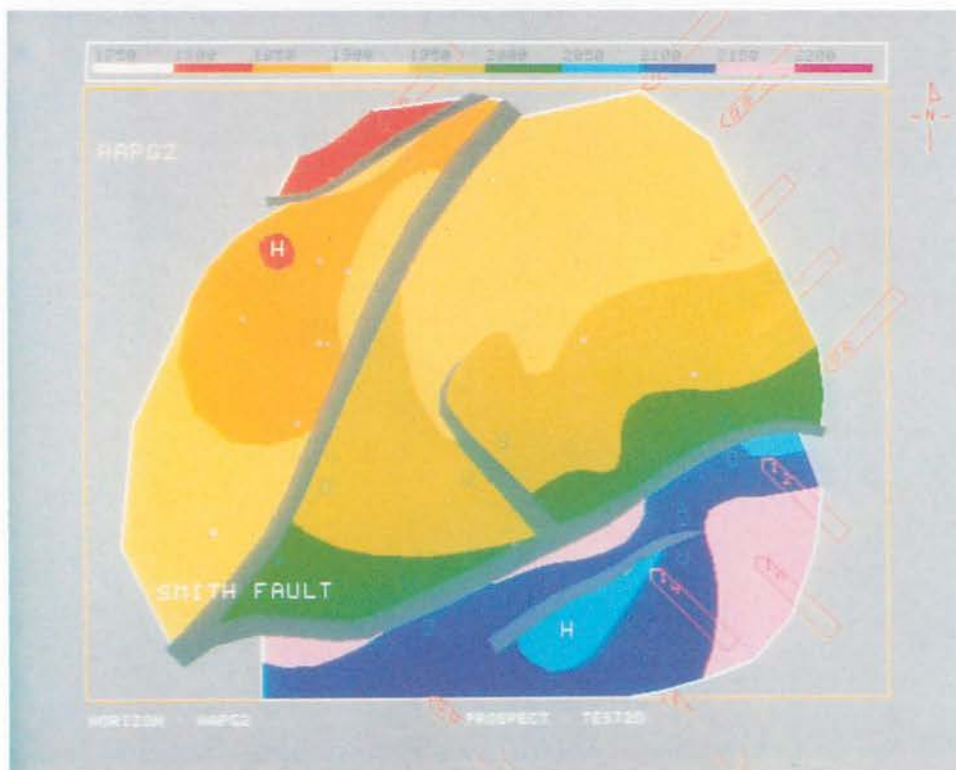

Fig. 16.   The interpreter then fills the areas between the contour lines with colour according to the legend.
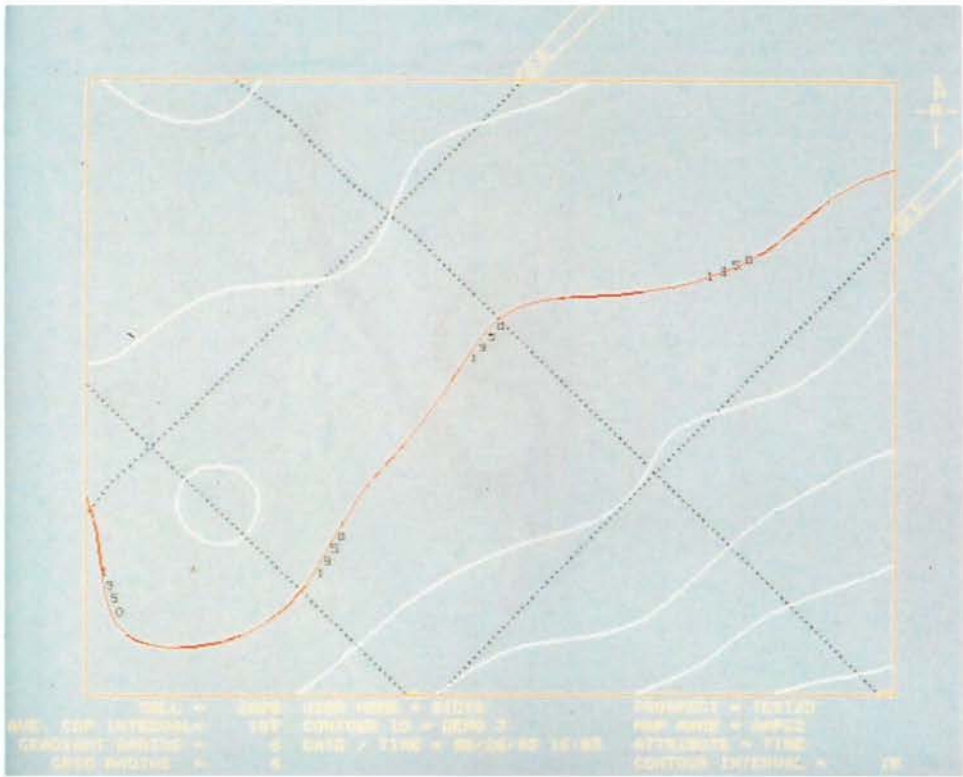
Fig. 17.   In automatic contouring mode the 50 msec interval is in red and annotated, contours with a 10 msec interval area in white.

Fig. 18.   Map by automatic contouring and finalized with colour and annotation.

Fig. 19.   Amplitude may be posted in colour in the same way as time.
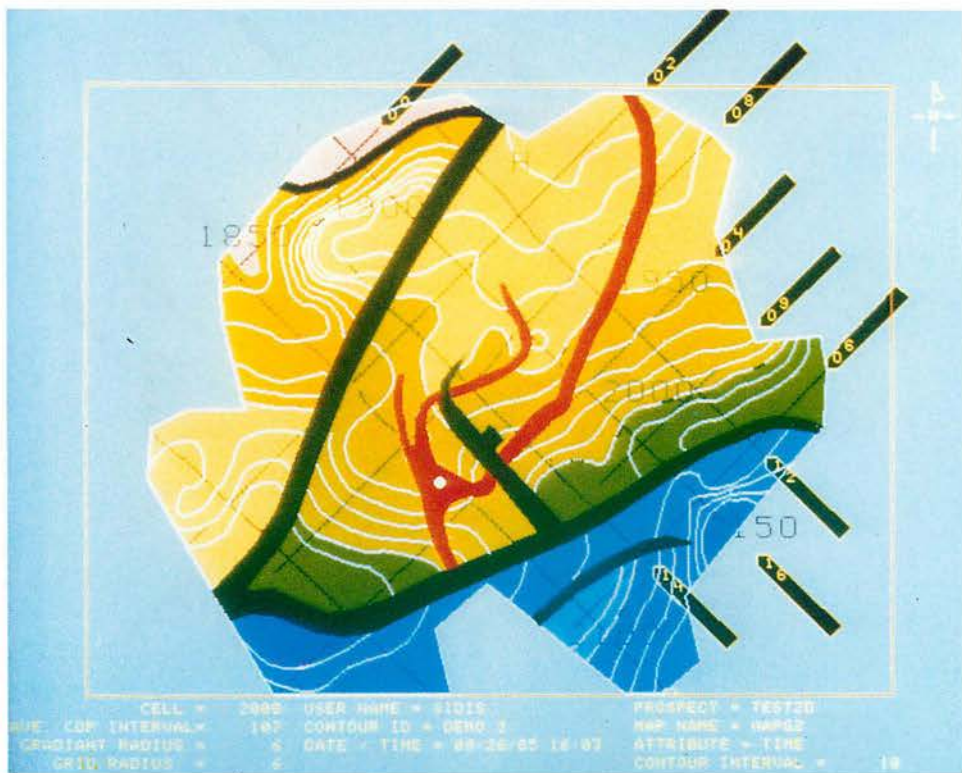

Fig. 20.   Superimposition of the amplitude and time maps.

AMPLITUDE

Horizon amplitude is important in stratigraphic interpretation and may be incorporated into a final map product. Amplitude may be posted in colour in the same way as time (Fig. 19). Here only three colours are used from the legend. The high amplitudes in red are interpretively connected to yield an amplitude map indicating a branching channel. By superimposing the amplitude and time maps (Fig. 20) the inferred channel may be seen in the presence of the structure now affecting it. The white dot is a possible location in the channel, at the updip end of the block and the upthrown side of the fault.

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