VELOCITY ANALYSIS

This Processing Sheet reviews the basic velocity analysis techniques developed or used by CGG in order to accommodate the many situations confronting geophysicists. It does not review special methods such as seismic trace inversion or modeling.

CONSTANT VELOCITY SCANNING: "VSCAN"'

The velocity scan technique stacks traces from a certain number of consecutive CDPs (at least 24), after moveout using a succession of constant velocities.

This approach is more qualitative than quantitative; it allows the interpreter to identify primary and multiple reflections and to select an approximate velocity function for further analysis by a more detailed method.

Velocity scans may also be very useful when the signal-to-noise ratio is low, as they make it easier to visualize the overall structural picture for various stacking velocities. This technique is also appropriate in complex geological situations, where travel path anomalies may result in conflicting velocity values at the same point.

ANVIT type velocity analysis picking (see next page).

VARIABLE VELOCITY SCANNING: "ANVIT"

The ANVIT program starts from a reference velocity function selected from the best available geological and/or geophysical information. It then generates a set of different velocity functions by adding or subtracting a given time increment to or from the reference function.

The traces from the selected CDP are NMO corrected for each velocity function and stacked. The program then calculates the RMS amplitude as a function of time for each stack trace and samples the results to generate a matrix showing the RMS amplitude as a function of time and stacking velocity.

Matrices from several consecutive CDPs may be added without deterioration of the results, even in the case of dipping interfaces, as the operations at this stage involve absolute values rather than algebraic numbers.

Finally, a two-dimensional operator is applied to the spectrum in order to emphasize the relative maxima which show up reflecting events. The basic ANVIT display shows the RMS amplitude spectrum with a 25 ms time interval; see the left part of the two opposite displays. Both logarithmic and linear velocity scales are available.

The bar graph on the right-hand side of the spectrum represents the maximum value of each section of the matrix before it is normalized for the display. This maximum value is also printed on the left-hand side of the display together with the corresponding velocity. The second highest value and associated velocity are also printed for the same section, so that interpreters can then compare the relative weights of primary and multiple reflections more easily.

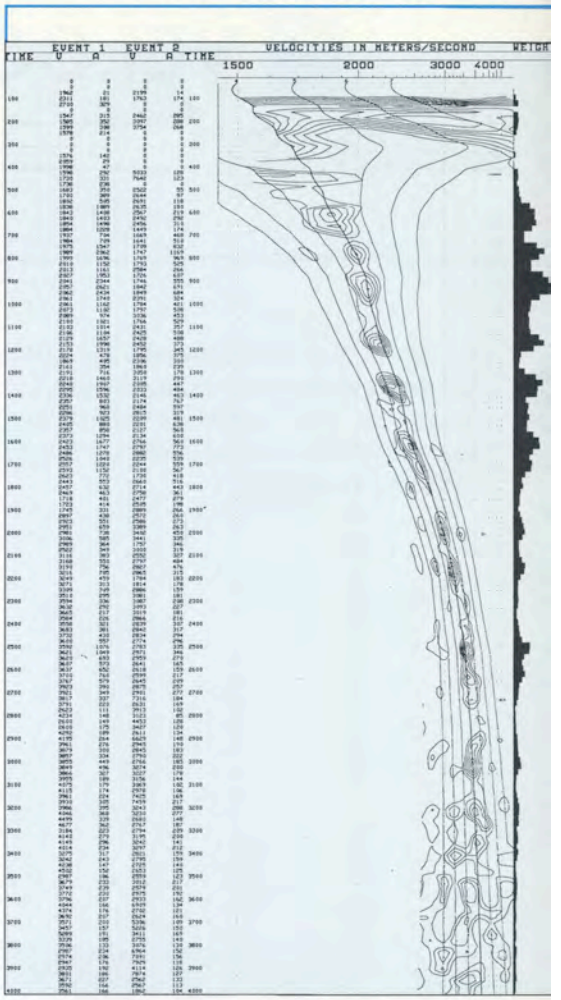
Velocity interpretation can be performed using either paper documents or interactive computer facilities.

In addition to the basic ANVIT display, the VELCOM option provides:

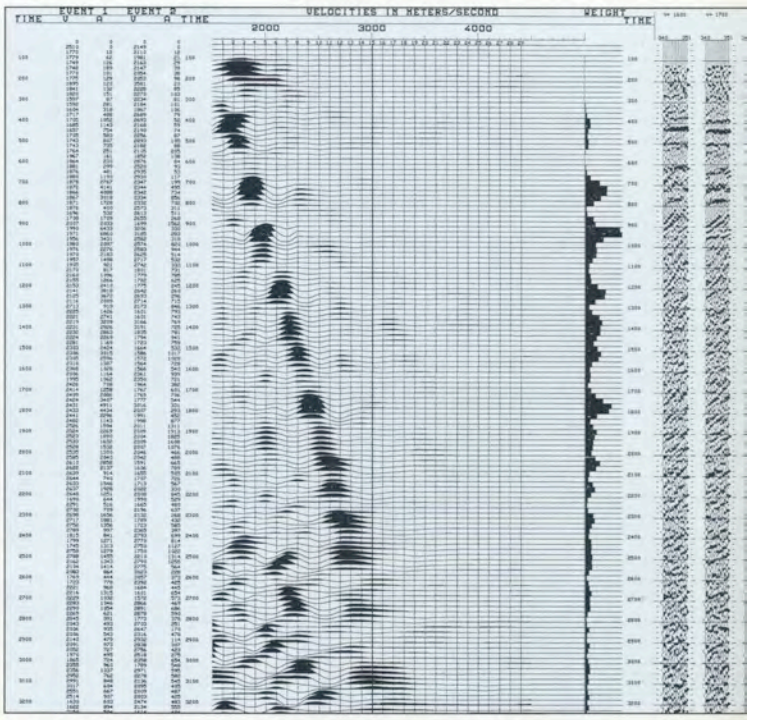
- a mini-stack of several consecutive CDPs corrected with some of the velocity functions (7 in the example). These displays make it easier to visualize the overall effect on reflection continuity of velocity functions defined and applied at discrete locations. Mini-stacks are particularly useful for dealing with complex structural situations.
- a CDP gather: the single traces corresponding to the central CDP of each "mini-stack" are NMO corrected for the same velocity functions and displayed before stacking. This display is highly accurate when the signal-to-noise ratio is good.

The VELAN option (below right) is based on the same principle as VELCOM but uses constant velocity functions instead of time-dependent velocity functions.

BASIC ANVIT DISPLAY

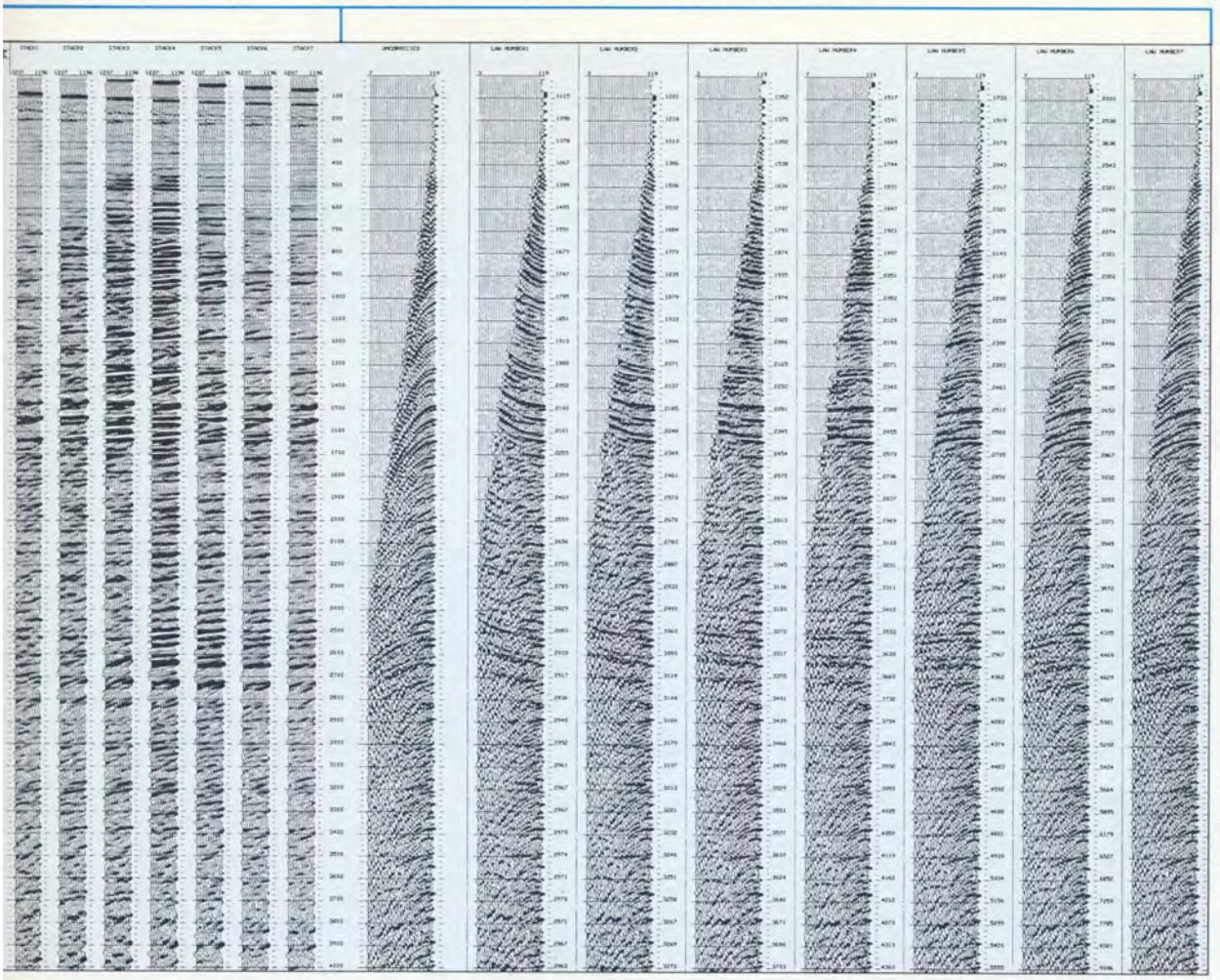


*The **VELCOM** display: three ways to evaluate time-*

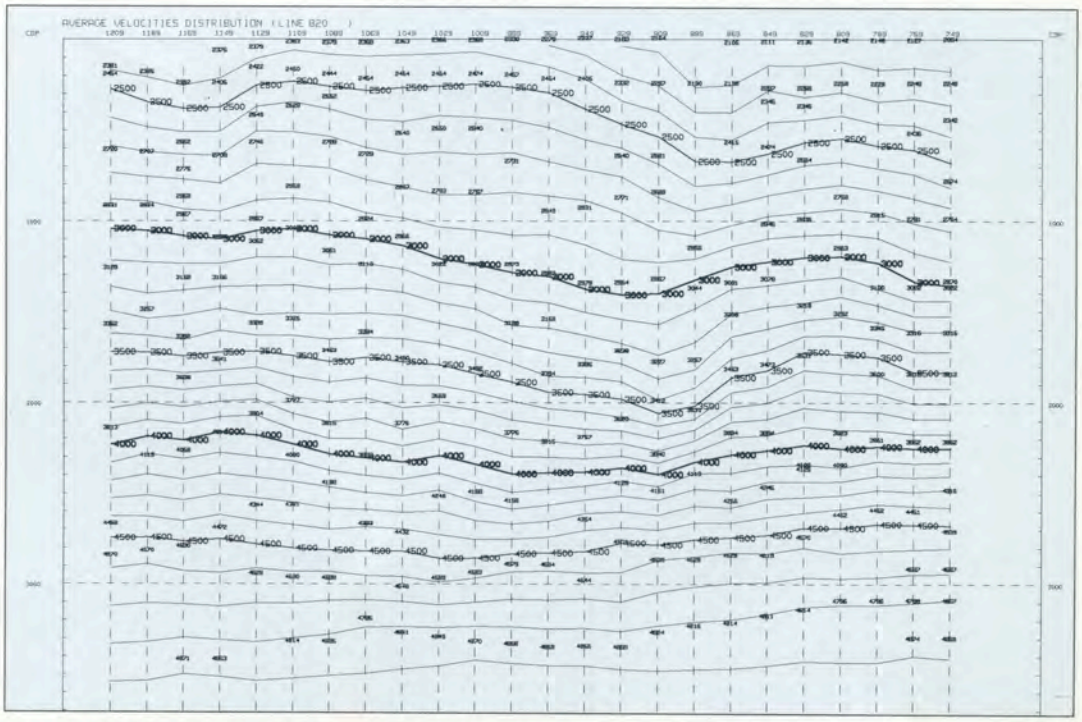


*The **VELAN** option uses constant velocity functions.*

MINI STACK **CDP GATHERS**



ɔendent velocity functions.



The isovelocity display gives the geophysicist an overview of the velocity field along the line.

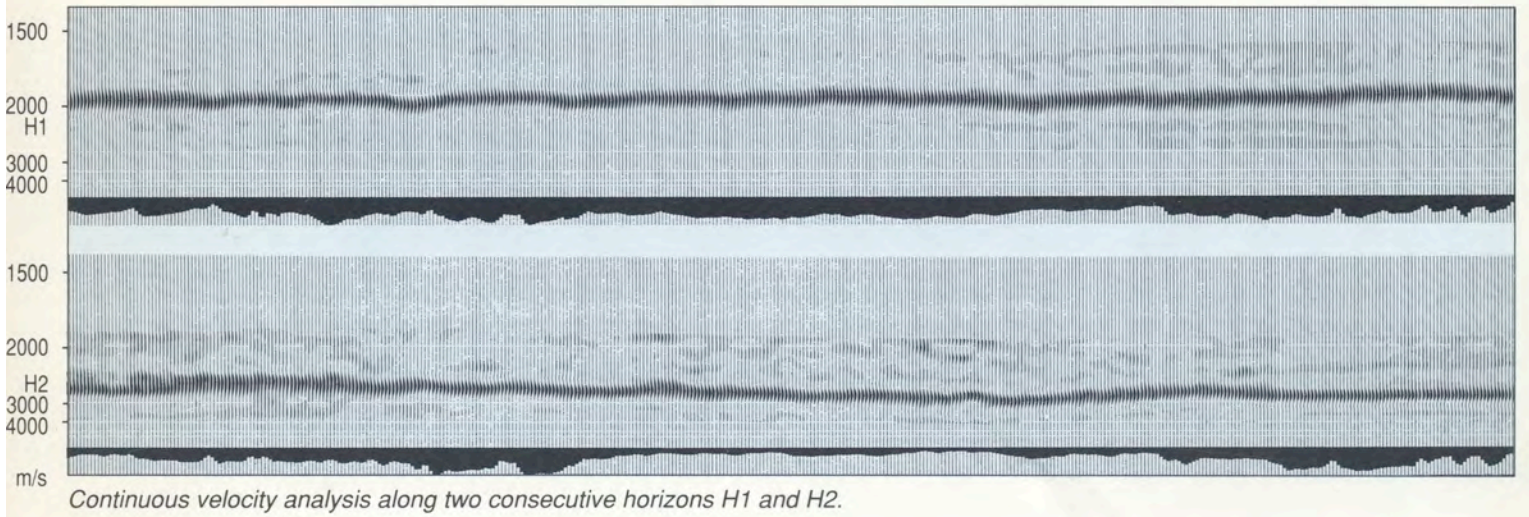
CONTINUOUS VELOCITY ANALYSIS ALONG A GIVEN REFLECTOR

In order to study the variations in stacking velocity along a given reflector, an ANVIT analysis is carried out at each CDP along the line, or at least once every two or three CDPs, to produce a display called a "velocity horizon". The ANVIT matrix values are then extracted at the time of the selected horizon and displayed for all CDPs along the line, as shown below.

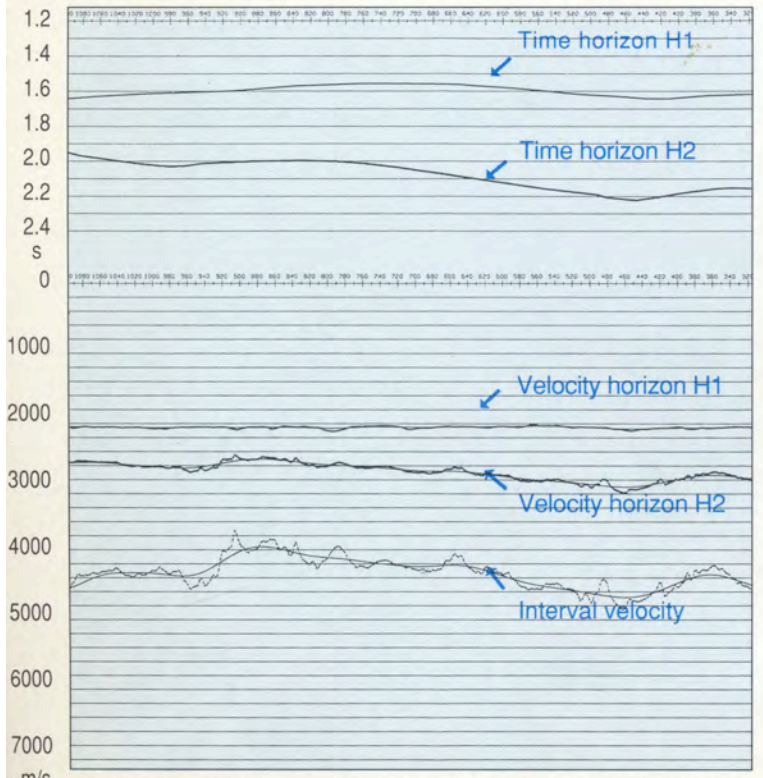
The horizontal scale represents the X coordinate along the line and the vertical scale the stacking velocity. The matrix rows are displayed after a ninety degree rotation with respect to the basic ANVIT display. The bar graphs represent the maximum amplitude before normalization.

The selected time horizon can also be plotted on a time-distance scale in order to facilitate correlation between the velocity horizon and the time horizon on the stack section.

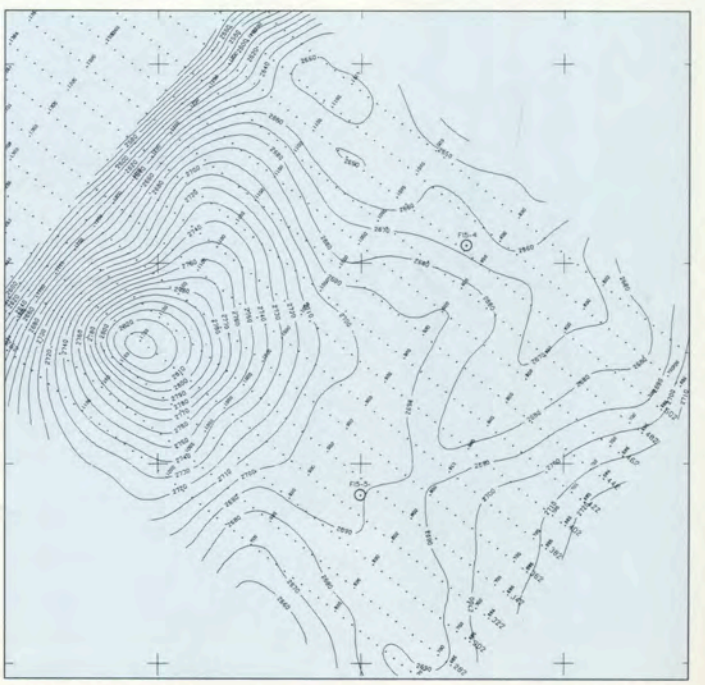
Various smoothing or space averaging options can be applied to a velocity horizon in order to attenuate the effect of any local irregularities and to emphasize the broader trends. Interval velocities can also be calculated and mapped for use at the migration stage.



Continuous velocity analysis along two consecutive horizons H1 and H2.



Continuous velocity analysis is used for interval velocity calculation.



Interval velocity mapping on a 3D survey from the Interbase® interactive system.