GPR_VELA

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Description: **GPR_VELA.EXE** calculates constant-velocity normal moveout (NMO) for a single GPR common-midpoint (CMP) file. The velocity spectrum is calculated from the NMOs. The input to this program is a "CMD" file, an ASCII text file containing keywords (or commands) which are discussed in a section below. Only the GSSI SIR-10A, SIR-2, SIR-2000, or RADAN binary "DZT" format is supported at this time. Only one channel is used from multiple-channel DZT files. There is no graphic display of the data. To display the output data, use programs such as GPR_DISP.EXE or FIELDVEW.EXE.

NMO CORRECTION AND THE VELOCITY SPECTRUM

For a subsurface model that consists of constant-velocity, horizontal layers, the travel-time curve (from the transmitting antenna to a layer and back to the receiving antenna) as a function of offset (which is the distance between antennas) is a hyperbola. The difference in travel time between zero offset and some other offset is called the normal moveout (NMO). The NMO correction is the subtraction of the appropriate NMO time from every sample in a trace.

A common midpoint (CMP) GPR record is required to perform the NMO correction. A GPR CMP record is one in which the each trace in the file is from two antennas that are positioned equally and oppositely from a central point at uniformly increasing distances.

Usually a range of velocities is selected in order to determine the best NMO time (or velocity) for a particular layer. When the correct NMO velocity is used, the hyperbolic shape of a horizontal reflector in a CMP record turns into a flat reflector. See Yilmaz (1987) for details.

The velocity spectrum consists of a set of traces where each trace is the result of stacking (or averaging) the results of one NMO. The number of traces equals the number of velocities selected for NMO corrections. The highest amplitudes in the velocity spectrum occur for the best NMO velocity selections for each layer represented in the CMP.

Here is the general algorithm used to perform the NMO correction.

- For every velocity (m/ns)
  - Square the velocity; [V^2]
  - For every trace in a file
    - Calculate the offset (meters) of that trace; [X]
    - Square the offset and divide by the square of the velocity; [X^2/V^2]
    - For every sample in a trace
      - Calculate the travel time (ns) at the sample and square the value; T^2
      - Calculate the NMO time, Tnmo = SQRT($T^2 + X^2/V^2$)
      - Get the amplitude values for the samples on either side of the NMO time
      - Linearly interpolate to the get the amplitude for the NMO time; AMPnmo
      - Change AMPnmo to the median value if > the mute limit = [(Tnmo-T) / T]
      - Assign the AMPnmo to the current sample
    - If every sample has been muted then give a special mark to trace

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THE KEYWORDS

Following is the list of keywords and their default values. The documentation format is:
"KEYWORD: **keyword** = default value".
Look at GPR_VELA.CMD as an example command file with correct usage and default keyword values. The file GPR_VELA.CMD has most comments stripped out, and GPR_VELA.CM_ has all comments removed.

****************************** PROGRAM CONTROL ********************************
KEYWORD: **batch** = "FALSE"
Place program in batch mode (no pauses) if "TRUE". If set to "FALSE", the program will pause after the keyword values are displayed and ask if you want to continue. After the data are processed, the program will end automatically.

KEYWORD: **display_none** = "FALSE"
Set to "TRUE" to suppress displaying keyword values when program starts up.

****************** SPECIFICATION OF INPUT AND OUTPUT DATA *********************
One input data file and one output data file must be specified. The data storage format is determined by inspecting the file. Only the GSSI "DZT" format is supported at this time.

KEYWORD: **dzt_infilename** = ""
This is the input GPR binary data file name.

KEYWORD: **dzt_outfilename** = ""
This is the output GPR binary data file name that will contain the results of velocity analysis. This file contains several "groups" of GPR data.
group 1 = original CMP data (from the input file).
group 2 = gained CMP data (whether gained or not).
group 3 = the NMO sub-groups, one for every velocity selected; each sub-group has the same number of traces as in the CMP.
group 4 = the velocity spectrum (number of traces is the number of velocities selected).
The comment string in the file header notes how many traces are in each group. It also notes the time-zero sample, the mute, and other information. GPR_RHDR will list the information in the file header.

KEYWORD: **channel** = 1
This is the channel to use in multi-channel data sets. GSSI data can have up to 4 channels (channel = 1, 2, 3, or 4). This keyword applies to multi-channel GSSI DZT files only. Note that output files are single-channel only.

KEYWORD: **trace_first** = 0
This is the first trace to use from the file. Traces are indexed from 0 (that is, the first trace is trace 0).

KEYWORD: **trace_last** = 0
This is the last trace to use from the file. If equal to 0 then the last trace in the file is used.

KEYWORD: **samp_first** = 0
This is the sample number that represents time-zero, or the sample at which the transmitter fired. Samples are indexed from 0 (that is, the first sample at the start of the trace is sample 0).

KEYWORD: **pos_start** = 0
This is the distance in meters that separate the antennas for the first trace that is used from the file.

KEYWORD: **pos_step** = 0
This is the uniform distance in meters the antenna separation is increased between traces.

******************** SPECIFICATION OF NMO PARAMETERS ***********************
KEYWORD: **vel_start** = 0.0
This is the first NMO velocity in meters per nanosecond (m/ns). The valid range is 0.01 to 0.30 m/ns.

KEYWORD: **vel_step** = 0.0
This is the velocity increment between NMOs in m/ns.

KEYWORD: **vel_num** = 0
This is the number of NMOs to calculate.

KEYWORD: **mute** = 0.0
This is the stretch percentage where muting starts (that is, all samples in the trace are assigned the median value). The stretch is defined as (Tnmo-To)/To.
Example: mute = 50 means the maximum stretch allowed is 0.5.

********************** SPECIFICATION OF RANGE GAIN ************************
Because signal strength is often greatly reduced at longer offsets between antennas, it is useful to increase the gain of the traces. The gain below is applied to only a subset of the traces and their samples. The gain is given as decibels. Sometimes it is useful to have the bottom gain (rg_on[1]) less than the top gain (rg_on[0]). The gained block of samples can also be slid down each trace to mimic the moveout.

KEYWORD: **rg_start_trace** = 0
Start the gain at this trace (goes to last trace).

KEYWORD: **rg_start_samp** = 0
Start the gain at this sample on first trace.

KEYWORD: **rg_stop_samp** = 0
Stop the gain at this sample on first trace.

KEYWORD: **rg_step** = 0
Move start and stop samples down by this much for every trace after the start trace.

KEYWORD: **rg_num_on** = 0
Only 0 (no gain) or 2 (gain) are allowed.

KEYWORD: **rg_on[0]** = 0
This is the gain for the top sample in the block (**rg_start_samp**). The value is in decibels (dB); 6 dB = 2X; 12 dB = 4X; etc.

KEYWORD: **rg_on[1]** = 0
This is the gain for the bottom sample in the block (**rg_stop_samp**). The value is in decibels (dB).

Usage: `GPR_VELA cmd_filename`

Required command line arguments:

cmd_filename - The name of the keyword file.

Optional command line arguments (do not include brackets): none

Examples:

```
gpr_vela vfile1.cmd
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