# An update of MATLAB-EOM for converted wave data

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## ABSTRACT

The MATLAB code for equivalent offset migration has been updated to include the processing of converted wave data. This new procedure estimates a converted wave velocity that is then used to estimate a shear wave velocity. The compressional and shear velocities are then used in the double-square-root equation to compute traveltimes.

Parameter options are defined. Some of the new parameters define a limited offset and spatial range during the gathering process to form converted wave gathers with one converted-wave velocity.

## PROCESSING OUTLINE

### Basics

The equivalent offset (EO) processing of the converted wave data requires two runs between the MATLAB code and commercial processing software such as VISTA or PROMAX. The gathers that are produced use the equivalent offset concept to align the converted wave data into hyperbolic paths that may be processed as regular P-P data with one converted wave velocity $V_c$. These gathers are referred to as common conversion scatterpoint (CCSP) gathers.

An <u>initial run</u> of the MATLAB code will produce a few limited range CCSP gathers (LCCSP). These LCCSP gathers are formed with the compressional (or primary) wave velocity $V_p$, and a fixed value for $\gamma$, which is the ratio of the primary and shear wave velocities $V_p/V_s$. This is typically set to $\gamma = 2.0$. A converted wave velocity $V_{c1}$ is computed to create a few LCCSP gathers. These LCCSP gathers are output as a SEGY file.

The LCCSP gathers are read by commercial processing software to estimate a new $V_{c2}$. One trace of these new velocities $V_{c2}$, at each time sample, is converted into a text file that can be read by a second pass of the MATLAB code.

A <u>second run</u> of the MATLAB code reads the text file of $V_{c2}$ velocities, and with the $V_p$ velocities estimates the shear velocities $V_s$. The $V_p$ and $V_s$ velocities are then used to create the full CCSP gathers that are output to a SEGY file for additional processing. (However, the MATLAB code can use the text-file $V_{c2}$'s to apply moveout correction and stack for initial viewing of the migrated data).

After the second run, the SEGY file of CCSP gathers is read by processing software for a refined picking of the converted wave velocities $V_{c3}$, which are then used for moveout correction and stacking to complete the prestack migration.

### Input data

It is assumed that the input data to the MATLAB code has been preprocessed to a horizontal datum. All noise removal, and static corrections for both the source and

receivers have been applied. It is further assumed that the trace reversal for the radial wave has been applied. The one processing step not included is moveout correction. This data must be in a SEGY file.

Input SEGY file of the P velocities at the location of each migrated trace.

Text file containing the $V_{c2}$ velocities, created after the first MATLAB run.

New parameters.

## Input parameters

Most of the input parameters remain the same as for P-P wave processing, but a number of new parameters have been included for the processing the converted wave data. The four lines of parameters are:

```
ConvertedWave 1      % Converted wave data: 1 = use gamma for Vc, 2 = use text file for Vc
Gamma         2.2    % Gamma parameter for Vp/Vs
XmaxOffCW     5000   % Maximum offset for the X parameter (MP to CSP)
HmaxOffCW     2000   % Maximum offset for the H parameter (Half source-receiver distances)
```

ConvertedWave: Set to 1 or 2 for converted wave data.
  If 0, conventional P-P data. (This is the same as not including the line).
  If 1, this directs the code to use $V_{c1}$ estimated from the gamma value.
  If 2, this directs the code to read a text file containing refined values of $V_{c2}$.

Gamma: $V_p/V_s$ ratio. Used with $V_p$ to form only a few limited CCSP gathers. The P velocities are scaled in amplitude and time to produce converted wave velocities $V_{c1}$. These velocities are used to form <u>limited range</u> CCP gathers. A new $V_{c2}$ is extracted from these gathers.

XmaxOffCW: The parameter defines a maximum range of the data in CMP locations that can be included in the formation of the CCP gathers. Initially, for limited range gathers, this should be set to something like 100 m, or when forming the full CCP gather should be set to match the migration aperture.

HmaxOffCW: This parameter allows the offset to be limited and should typically be set to the maximum source-receiver offset. If set to a low number such as 50 m, and XmaxOffCW was large, it would allow examination of the near offset traces in a CCP gather.

## Output data

The output from the MATLAB code are LCCSP or CCSP gathers in SEGY format.

## DATA EXAMPLE

The following data are taken from the Hassar project, and show the compressional and converted wave data from a three-component receiver.  The P-P data are from the vertical receiver and the P-S data are from the radial component.



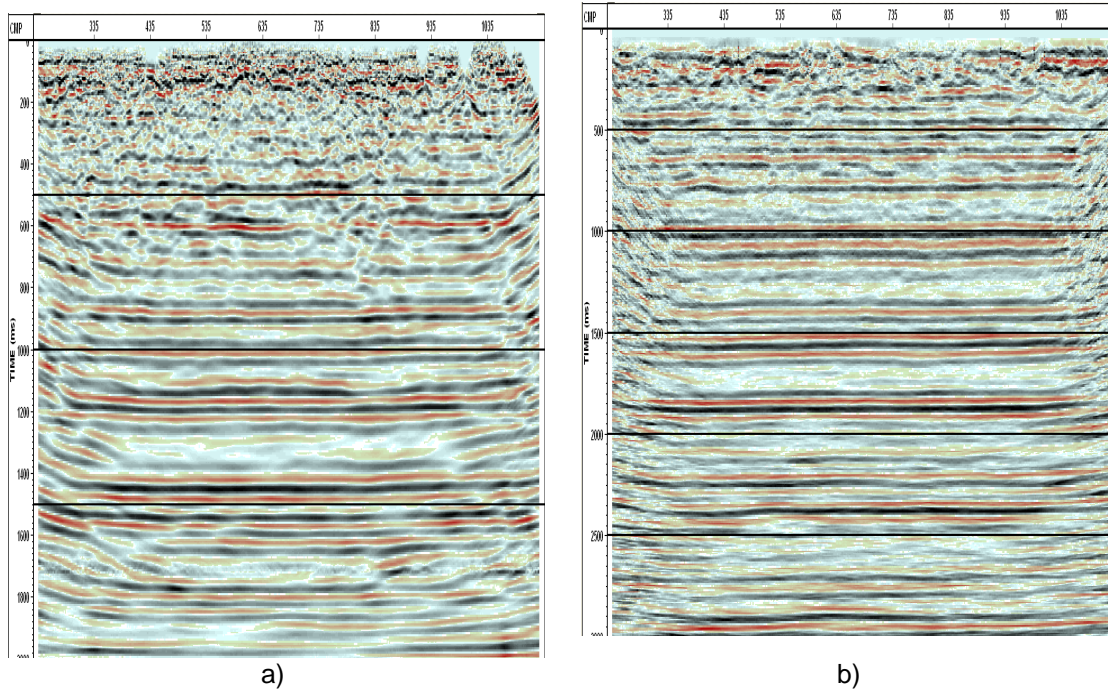a)                                                        b)

FIG 1: An example of the EOM processing for a) P-P data and b) P-S data.  The P-P data ranges from 0 to 2 seconds and the P-S data from 0 to 3 seconds.

## COMMENTS AND CONCLUSIONS

The converted wave processing using the MATLAB code is quite clumsy and requires a few passes of the code between it and commercial code.

Converted wave EOM requires a more accurate starting velocity than conventional P-P data.  The method described was quite successful in estimating an initial S velocity and produced reasonable results with one iteration of estimating $V_{c2}$.

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