

2D Velocity Mis-ties and Their Resolution

WHAT IS A MIS-TIE?

In a large 2D seismic processing project lines often intersect. Depending on the shooting direction, these intersections mostly involve strike and dip lines. Depending on horizon dip, the ray paths will vary, so given this group of intersections, we often find in practice that the processed seismic data from one line does not “tie” with the data from another line. Mis-ties within a single survey can be due to the result of recording in both the dip and strike directions. The strike direction records data parallel to the dip, which is the shortest distance between shot/receiver and the reflector, thus the reflectors come in at an earlier time than the ones recorded in the dip direction.

The tie problems that we have defined in the above paragraph are within a single survey of the same vintage and are due to the inherent geophysics of the recording. At the same time, we are not limited to a 2D survey of a single vintage. This can produce mis-ties due to different sources, receivers, or recording instruments, rather than the geology and geophysics seen in the survey. Regardless of the source of the mis-tie, it is important that we understand what a “tie” actually means.

When defining the tie, we need to define the attributes that do not match. The most typical trace attributes that we would expect to tie on the seismic section are phase and amplitude of the seismic traces. The structural attributes that we would expect to tie on a seismic section are the number and location of the horizons in either depth or time. In addition to seismic attributes, we expect the velocity data to tie as well. In this case, that is both the RMS and the interval velocity should be well behaved no matter the line from which the data was acquired. Of course when dealing with the real earth, we expect that there may be anisotropy, and this means that velocity fields may still be well behaved, thus “tie”, and yet not have a numerical match at a given location.

For purposes of this discussion, we will be limiting ourselves to the velocity fields, and the structural aspects of the line ties. The attributes of phase and amplitude are best resolved by a deriving an amplitude/phase matching operator, and these tools are typically well known. In order to present a correct velocity field in a 2D data processing project, the velocities at line intersections must tie. The process of tying the intersecting velocities is one that takes a strong understanding of both geophysics and geology. It is not enough to merely force the ties to have the same velocity profile at a single location. Simply forcing the tie at the intersection without respecting the geology can lead to a situation where the migrated images may not make geologic sense. The main goal of this tying process is to generate a combined velocity field that will honor the geology, including any anisotropy.

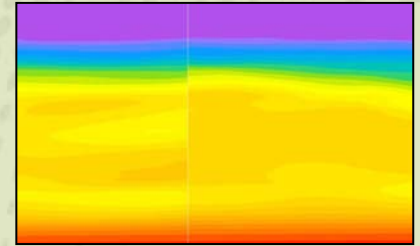


Figure 1

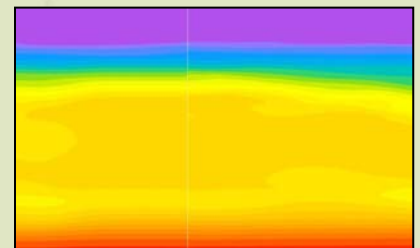


Figure 2

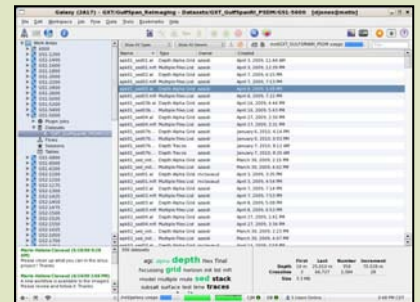


Figure 3

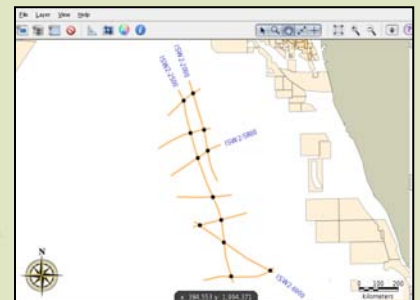


Figure 4

Figure 1 (on the previous page) shows two lines that have a velocity mis-tie. The magenta and blue velocities in the shallow section show that this shallow section ties. From about 4000 meters and deeper, we see the velocity mis-tie. Figure 2 shows that this velocity field can be corrected and made to tie correctly. ION's GXT Technology (GXT) group has developed a workflow to resolve velocity mis-ties. This flow centers around being able to easily access both the seismic and velocity data that go into the individual 2D lines, editing those velocity fields, and then migrating the data. Figure 3 shows a Galaxy project with a whole suite of 2D lines. From this straightforward user interface, we can display an intersection map like the one in Figure 4, and then from the main Galaxy interface get to any of the associated data, and even launch our migration runs without having to leave the interface. Figures 5 shows a seismic section with a mis-tie and Figure 6 shows the mis-tie repaired.

WORKFLOW SUMMARY

Identify the mis-tie

In this case, we are looking for velocity mis-ties between two lines. The velocity profile for each line is selected, in our Galaxy package, and then opened for viewing in Multiviewer. If a mis-tie is found, then the workflow (shown at left) is followed.

Pick a "top horizon for mis-tie"

The velocity file is opened with the Sirius package for horizon picking. The suite of horizon picking tools from automated picking to fully manual picking are available, and based on his or her experience, the geophysicist will:

Try to tie the velocity by:

- Creating a velocity grid from a velocity function that matches both lines or several lines in the area from inside the linked Sirius gridding package
- Update the velocity by manual picking so that it ties with other lines
- Merge the original velocity with updated/tie velocity at the "top horizon for mis-tie"

Re-migrate

In most cases, the original migration was run via a Galaxy plugin, and that is then accessed, the necessary migration parameters, including the updated velocity file, are changed, and the migration is rerun.

QC the migrated gathers/stack

At this point the quality of the stacks and gathers is evaluated. If updates are needed, iterate over the workflow.

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Workflow

1. Identify the mis-tie
2. Pick a "top horizon for mis-tie"
3. Try to tie the velocity by
 - Creating a velocity grid from a velocity function that matches both lines or several lines in the area
 - Updating the velocity by manual picking so that it ties with other line(s)
4. Merge the original velocity with updated/tie velocity at the "top horizon for mis-tie"
5. Re-migrate
6. QC the migrated gathers/stack

Iterate steps 1-6 until:

- Both velocity and stack tie reasonably well
- Quality of migrated gathers/stack is acceptable

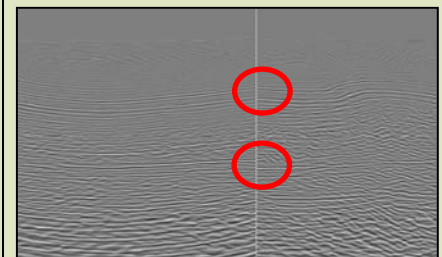


Figure 5

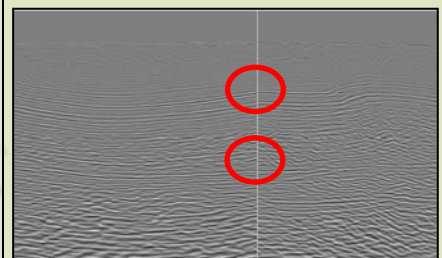


Figure 6