Interbed Multiple Attenuation (IMA)

ION’s GX Technology (GXT) group has created several techniques, including Interbed Multiple Attenuation (IMA), to address multiples in data acquired in both land and marine environments. IMA is an extension of the 3D SRME (Surface Related Multiple Elimination) methodology which can be used to attenuate surface multiples, and then remaining interbed multiples are attenuated by IMA. GXT’s multiple attenuation approach involves signal processing, then a processing sequence to attenuate surface multiples with SRME, and an additional step to attenuate the remaining interbed multiples using IMA.

Problematic interbed multiples are frequently associated with a generating event with a strong reflectivity coefficient. Most significant interbed multiples have their two bottom bounces on a common anomalously bright event, and that event ends up acting as a mirror for the events above. Common examples of bright events are top of salt, carbonates, volcanic, and coal layers. The generator is an important input to the IMA removal process as it is needed to help build the prediction. Identifying such an event therefore is required for efficient implementation of IMA.

INTERBED MULTIPLE ATTENUATION

We can think of a seismic trace from surface point A to surface point B as a sum of primary events, surface-related multiples, and interbed multiples. Figure 1 (a) illustrates an SRME multiple candidate raypath. This primary data set still contains interbed multiples which, following SRME, can be attenuated by IMA. Two traces from the SRME results which do not share a surface location are convolved, giving a trace with raypaths like the one illustrated in Figure 1 (b). The correlation removes the nonphysical raypaths, creating an interbed multiple model trace with a reflection point on a subsurface event such as in Figures 1 (c) and 1 (d). IMA generates approximations to the actual interbed multiple requiring the use of adaptive subtraction to give a primary data set with attenuated interbed multiples.
WESTERN DESERT

The Western Desert in Egypt has an interbed problem similar to many onshore areas. The shallow sediments, typically consisting of sand and shale layers, are easy to image. Around 1600 ms into the data, there is a high-reflectivity layer of carbonates. The high reflectivity of this layer reflects much of the seismic energy, leaving the events below to be illuminated by only a fraction of the source wavefield. The high-reflectivity event also acts as a mirror for the events above. The resulting section is doubly difficult to interpret because the primary reflections are weak, the interbed multiples are strong, and there is not much dip difference between the two. The similarity of the dip of primary and multiple events can raise the question of whether the correct events are removed. Figures 2 (a) and (b) represent an example of Egyptian desert data. Figures 2 (a) contains a blue and red overlay that shows a primary-only synthetic trace derived from a well log. With little dip discrimination between primaries and multiples, well-log synthetic data are useful in verifying that the multiples are being attenuated while the primaries are being preserved. Figures 2 (b) shows the data with multiples attenuated. The events attenuated by IMA do not match events on this synthetic, while those that remain show good agreement with the well.

Figure 2 (a) Egyptian Western Desert data with well synthetic.

Figure 2 (b) Egyptian Western Desert data with interbed multiples attenuated.
GULF OF MEXICO

The Gulf of Mexico has large areas of tabular salt. The high reflectivity of the salt boundaries is conducive to interbed multiple generation. Figure 3 (a) shows an example of tabular salt and its interbed multiples. The generator in this case is the top of salt which acts as a mirror to the sediments above the salt. These interbed multiples interfere with the interpretation of the base of salt as well as mimicking subsalt reflectors. Removing salt-generated multiples also clarifies the presence or absence of entrenched sediment in the salt bodies and the presence of “dirty salt.” Figure 3 (b) shows the data with attenuated internal multiples.

Figure 3 (a) Gulf of Mexico Data Showing Interbed Multiples Off the Top of Salt.

Figure 3 (b) Gulf of Mexico Data With Interbed Multiples Attenuated.