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Why 3D Seismic Data ?

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3D seismic data is significantly more expensive than 2D seismic data. What do we obtain for the extra expense? 2D data assumes no out-of-plane structure where surface locations of the 2D data define the “plane”. In other words, 2D data assumes no lateral variation in the reflectors perpendicular to the 2D plane. 3D data does not have that restrictive assumption, providing a more accurate subsurface image.

So much for the theory, what are the practical ramifications? The following experiment uses 3D data to investigate the ramifications. Figure 1 shows a 2D line extracted along a straight line from the original 3D data. This data has not yet been migrated to create an image. Notice the dominant, anticline feature in the lower 2/3rds of the data.

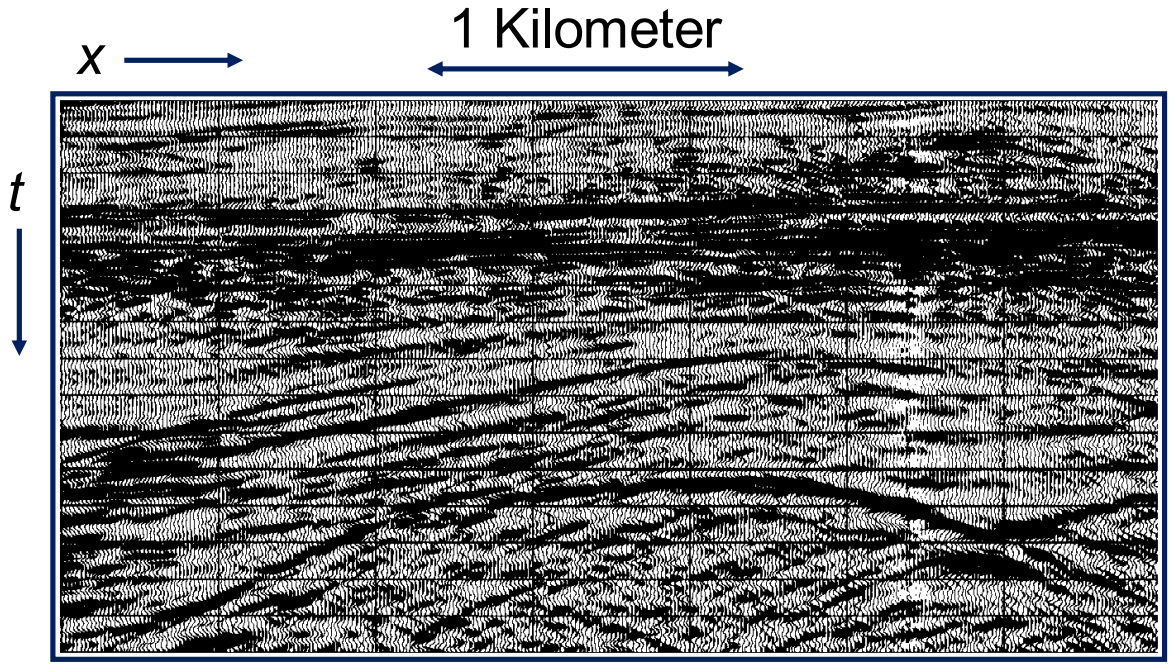

Figure 1: 2D Seismic data before migration

Figure 2 illustrates the same data, but after 2D seismic migration. The migration used knowledge of the interval velocities and, for seismic data, only Figure 1's 2D data. As visible in Figure 2, the migration algorithm decreased the lateral extent of the large anticline.

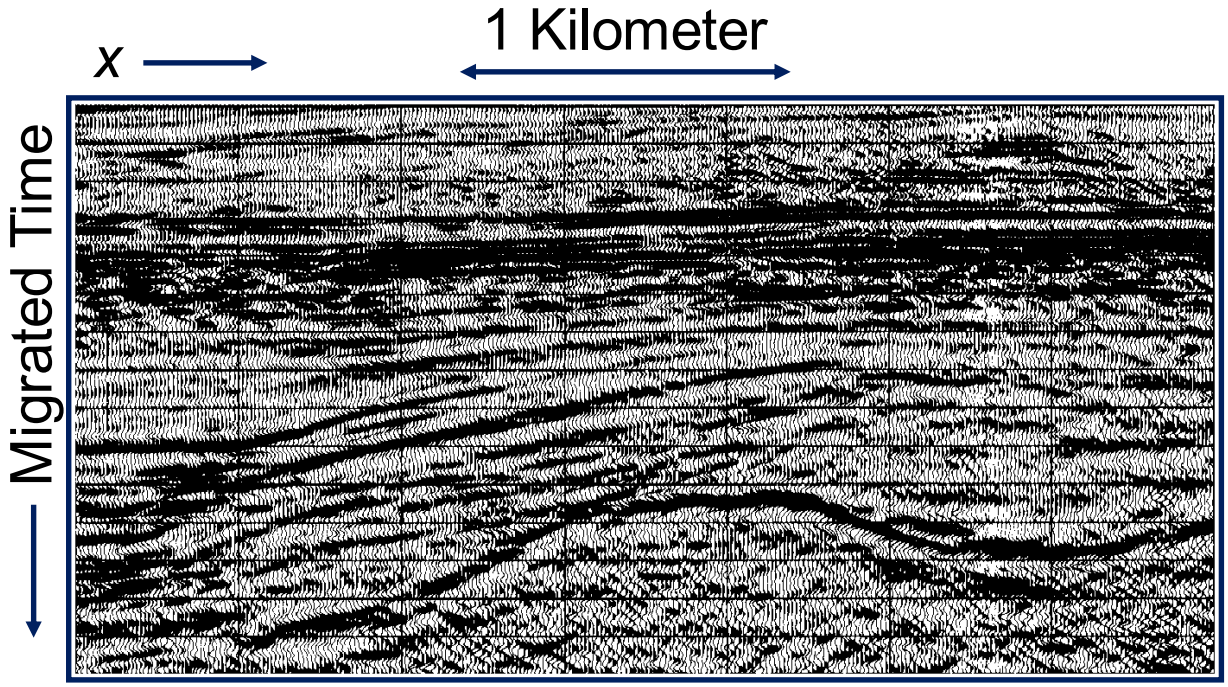

Figure 2: 2D seismic data after 2D migration.

Figure 3's seismic data is beneath the same surface location as the previous figure's, but after the application of a 3D seismic migration algorithm. 3D migration removed the large anticline from the location of this 2D slice of the 3D migrated data.

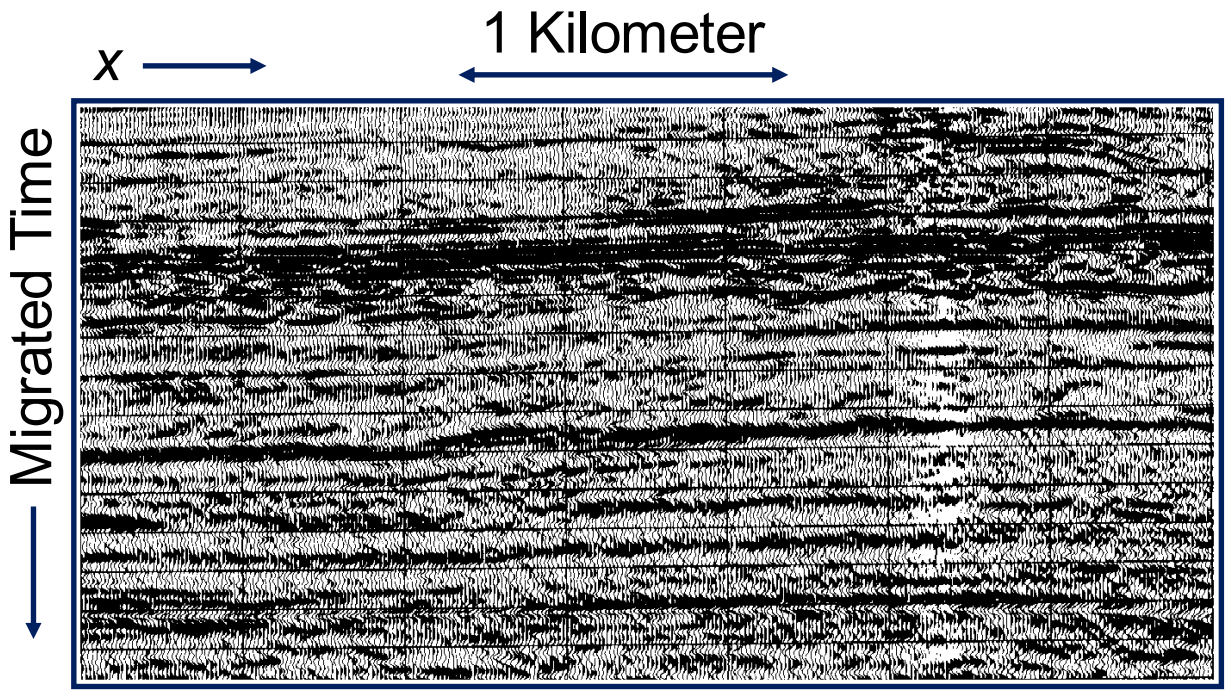

Figure 3: A 2D slice of a migrated 3D data volume.

Figure 2's migration used only the seismic data acquired along a single, 2D surface line. By contrast, Figure 3's migration used all of the data from the entire 3D seismic survey. The large anticline exists outside of the plane of this seismic line. Thus, the subsurface violated 2D migration's assumption of no lateral variations perpendicular to the seismic line. 3D migration appropriately imaged the anticline to a new position, laterally displaced from the location of this 2D seismic line, hence, invisible at Figure 3's slice of the 3D migrated volume.

Many "2D versus 3D" examples are less dramatic than this example. However, in all cases, 2D migration of 2D data assumes no lateral variation in the subsurface reflectors in the direction perpendicular to the 2D line. The subsurface rarely meets this stringent assumption. Unfortunately for the accountants, the more accurate 3D migration requires 3D data and not the less expensive 2D data.