How Workstations Cause Dry Holes*

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Abstract

Geophysical workstations add efficiency to the exploration and development workflow. With workstations, companies can achieve more with less. At the same time, workstations often cause dry holes. More correctly, over-reliance on workstations causes dry holes. We are seeing that the workstation is doing to geologic skills what the calculator has done to math skills.

One principal cause for this problem is the technology trap. Most of today's interpreters have grown up using computers. Since they do not have the inherent skepticism of previous generations regarding computers, they have a tendency to accept computer models as real and not numeric simulations. We refer to this phenomena as the "technology trap" One must remember, however, that not only are computer models and interpretations based on a number of known formulas, they also include a number of assumptions. If the assumptions are flawed, then the models are flawed.

Over-reliance on computer models and technology is not isolated to the oil and gas industry. Dogmatic over-reliance on computer models by climate scientists causes them to insist the CO_2 causes temperatures to rise, even though temperatures have not increased for the last sixteen years even though CO_2 levels have increased. Flawed computer models were also instrumental in helping cause the recent collapse resulting from the U.S. housing bubble. In addition, they cause dry holes to be drilled on geologically improbable and even geometrically impossible prospects.

The Technology Trap and Climate Change

The hypothesis of anthropogenic global warming is based heavily on global circulation climate models. These are extremely robust computer models that provide a great deal of insight into the workings of the climate system. However, they also require a great many assumptions, many of which are based on climate interactions that are poorly understood, or not understood at all. Most global circulation models have built in assumptions that CO_2 is a climate driver, yet do not account for the influence of water vapor, a much more prevalent green house gas. As such, global circulation models should not be used for making predictions. Yet for the last twenty years, these computer models have been used to make dire predictions regarding climate change. Yet examination of the predicted temperature trends versus actual measured temperatures (Figure 1) shows that reality does not match the model predictions.

In spite of the obvious difference between the model-predicted temperatures and the observed temperatures, many climate scientists doggedly refuse to question the validity of the models, choosing instead to challenge the observations. They have fallen into the technology trap.

The Technology Trap and the 2006-2007 Financial Collapse

Financial investment firms used to research individual companies, review their stock reports and financial data before developing a buy or sell opinion for their investment clients. Today, stock trading is handled by computers. The computers have been programmed to look for trends and then act on them. For example, if the computer notices that a certain stock price is moving downward, then it can order a sell-off of that stock, even though it does not know why the stock price is falling. Then other computers notice the sell off, and order their own sell-off. This sell order can travel around the globe quickly, and could end up destroying the value of that companies stock. Usually before that happens, some brokerage firm's computer eventually recognizes that the stock is priced below market and begins buying that stock. And around it goes again (Smalley, pers. comm., 2014)

The creation of incredibly complex risk models by Wall Street analysts, and the almost total reliance by trading houses on those models turned what could have been just another housing bubble into a global disaster (Sperling, 2009). These models included several poor assumptions, largely regarding human behavior. So when the housing prices started to fall, the computers went into action; and the rest is history. In short, financial analysts have fallen into the technology trap. More importantly, they are still stuck in the trap, so invest carefully.

The Technology Trap and Dry Holes

Drilling and development decisions represent investments of tens to hundreds of millions of dollars. These decisions require geologically valid and geometrically possible interpretations and maps. Yet many of the maps that come out of a geologic workstation are wrong to some degree. The computer will shift the interpreter's picks during the gridding process. Different contouring algorithms will contour the same data differently, sometimes significantly differently. Finally, there is virtually no computer contouring software packages that can properly cross contour across faults. These errors combine to make most geologic maps wrong, some so wrong that they are no longer geologically valid and occasionally geometrically impossible.

The more sophisticated the workstations become, the less sophisticated the interpreters have become. Many interpreters we have attending our Applied Subsurface Geological Mapping Class (Tearpock and Bischke, 2003) have never contoured a map or made a cross section. Of our last 100 students from many countries and companies, less than 20 have hand-contoured a map and less than 25 have made a geologic cross section. Almost 90% of the students did not know what the various contouring algorithms did to their data, and many did not know there were multiple contouring algorithms available to them. They assume that the products generated by the workstation are correct, when in fact, those products need some level of correction. In short, they have fallen into the technology trap.

To make matters worse, many interpreters today are using auto-picking software to allow the computer to actually interpret the data for them. It is important to understand that computers cannot make geologic interpretations; they can only make mathematical correlations. Look at Figure 2. A geoscientist should be able to recognize that they are looking at a seismic line crossing a rift basin. Moreover, they should also be able to recognize that the basin underwent inversion between the magenta and purple events. All of this information is important to making a sound geologic interpretation of the basins petroleum system.

Look at Figure 3. This is how your computer sees the same line. You may be able to make out the rift basin, but can you see the inversion structure? Neither does the computer. Your computer cannot evaluate the basins history or understand the petroleum system.

Technology Trap Pitfalls and How They Cause Dry Holes

There are a number of pitfalls inherent in our technology-based workflow and interpreters need to be aware of them. One of the most common pitfalls is found in the gridding process. When the computer grids your interpretation, it often moves your picks to place them into a regular grid. Often, the picks are shifted enough to make the final maps geometrically impossible. Two maps are shown in Figure 4. The maps were constructed from a 3D data set, then gridded and contoured. However, if you look at the cross section shown in Figure 5, you can see that in the process of gridding the data, the workstation shifted the picks of both horizons, such that the deeper horizon crosses the shallower horizon, a geometrically impossible interpretation.

Another significant workstation pitfall is using an inappropriate contouring algorithm. Different contouring algorithms manipulate the data differently, and can create radically different maps from the same data. Three different maps are shown in Figure 6. All three maps were contoured from the same data set. The map on the far left was contoured using a mechanical contouring method. The middle map was contoured using the equal-spaced method, and the map on the right was contoured with a parallel contouring method.

One of the most common pitfalls in the workstation workflow is to interpret faults by picking and connecting fault sticks as opposed to making fault surface maps. This often leads to aliasing faults, that is, connecting two or more faults as one (Figure 7). Wells drilled on maps with these errors are usually dry holes (Figure 8).

Avoiding the Technology Trap and Dry Holes

Avoiding the technology trap can reduce the number of dry holes you or your company drill. So how does one avoid the “technology trap”? Since we find oil and gas in geologic traps, we must return to our geologic roots.

1. Interpreters must use the workstation as a tool to help them make geologically valid interpretations, not as a platform for interpreting the data and generating maps. They must also be fully aware of what the computer does to the data and to their interpretations.
2. Interpreters must have a classical education in geology, and have a thorough knowledge of the tectonic and depositional environments for the area in which they are working.

3. Interpreters must understand that almost all computer-generated maps are, to some degree, incorrect. They have a responsibility to correct those maps using their understanding of geology.
4. Interpreters must use all of the data and ensure that their seismic and well log correlations are accurate and loop-tied.

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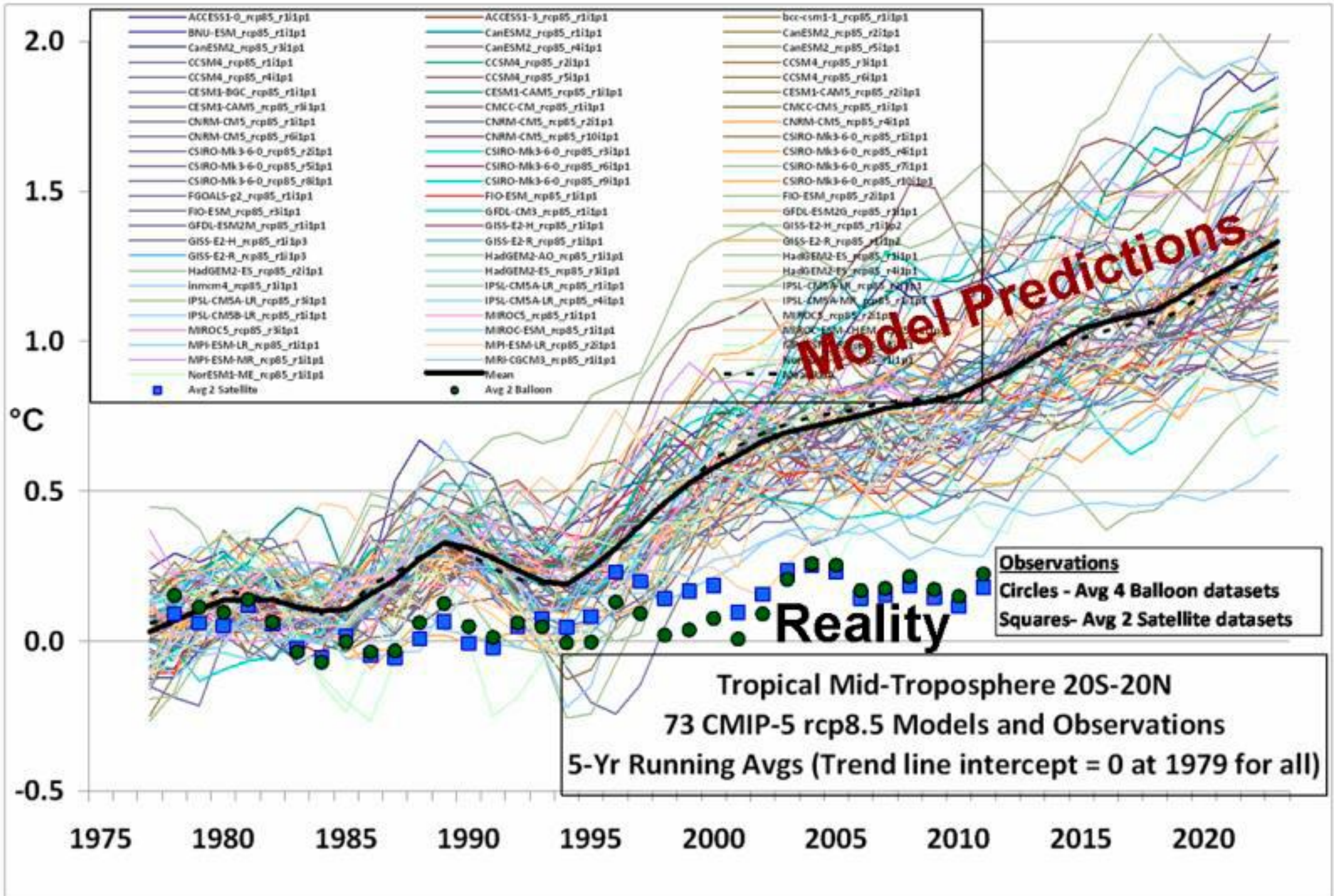

Figure 1. Climate model 5-year mean model-predicted versus observed temperatures (Spencer, 2013).

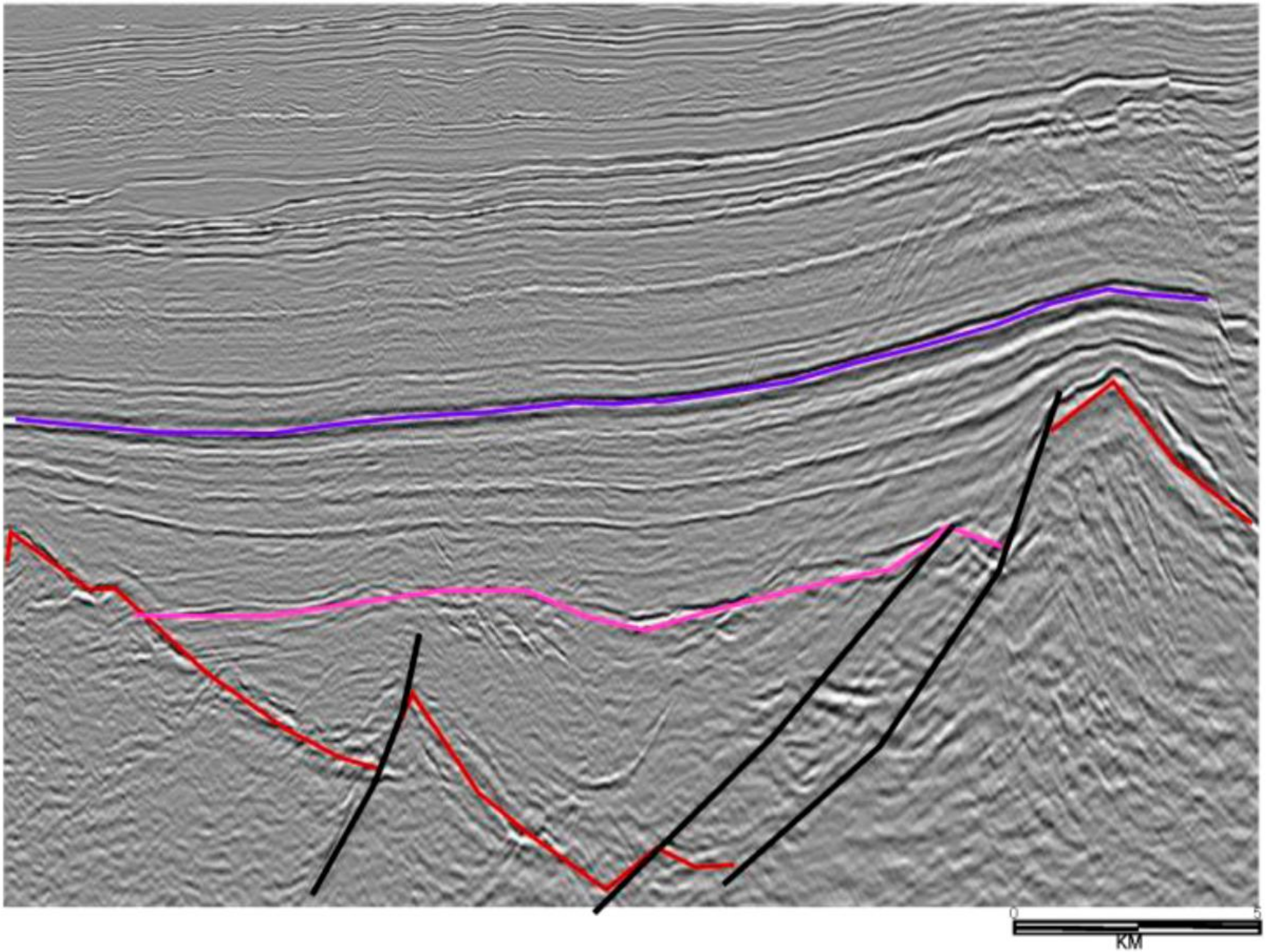

Figure 2. Seismic profile across a rift basin. Note inversion structure just left of the center of the line.

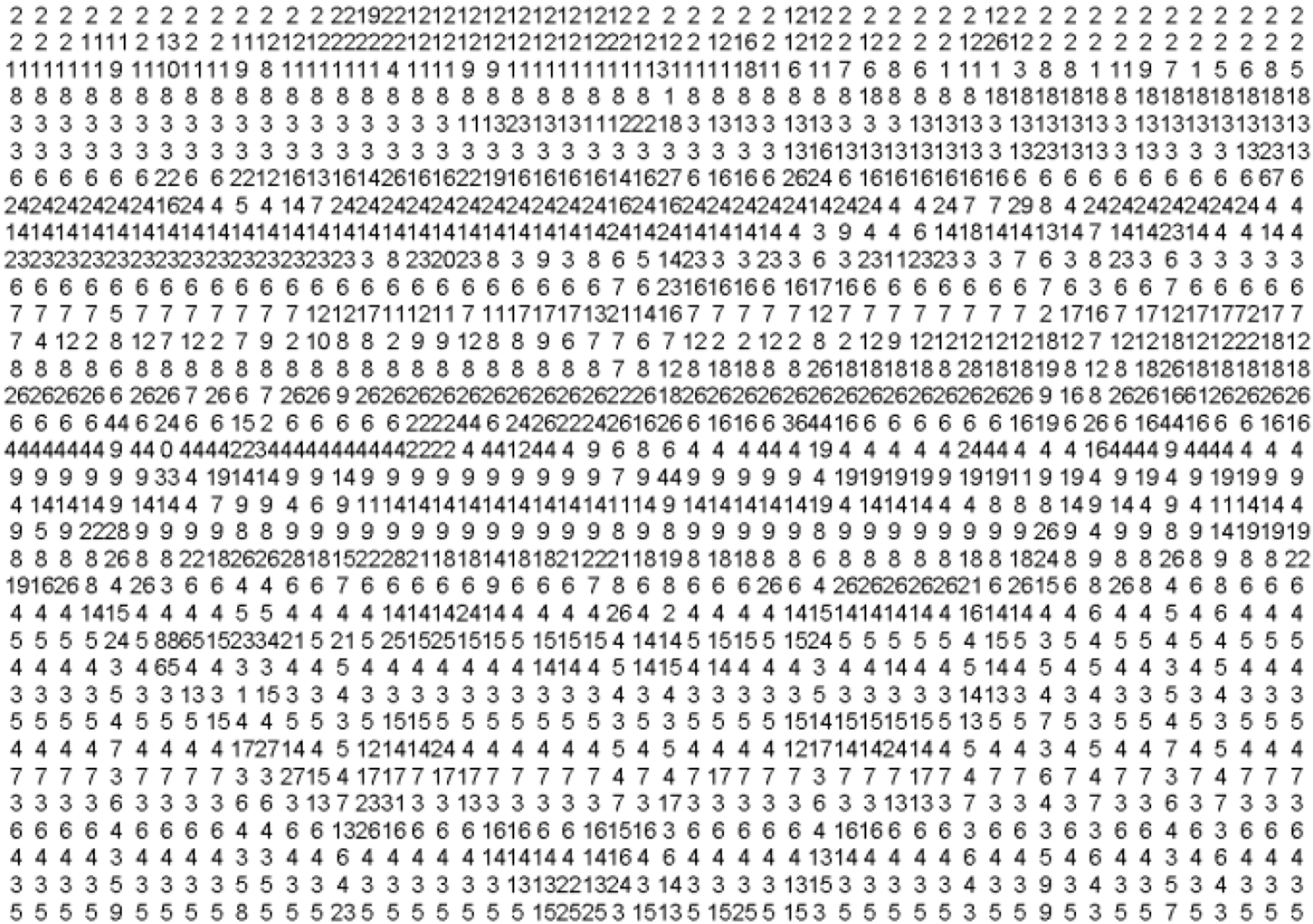

Figure 3. Seismic profile across a rift basin as seen by the computer.

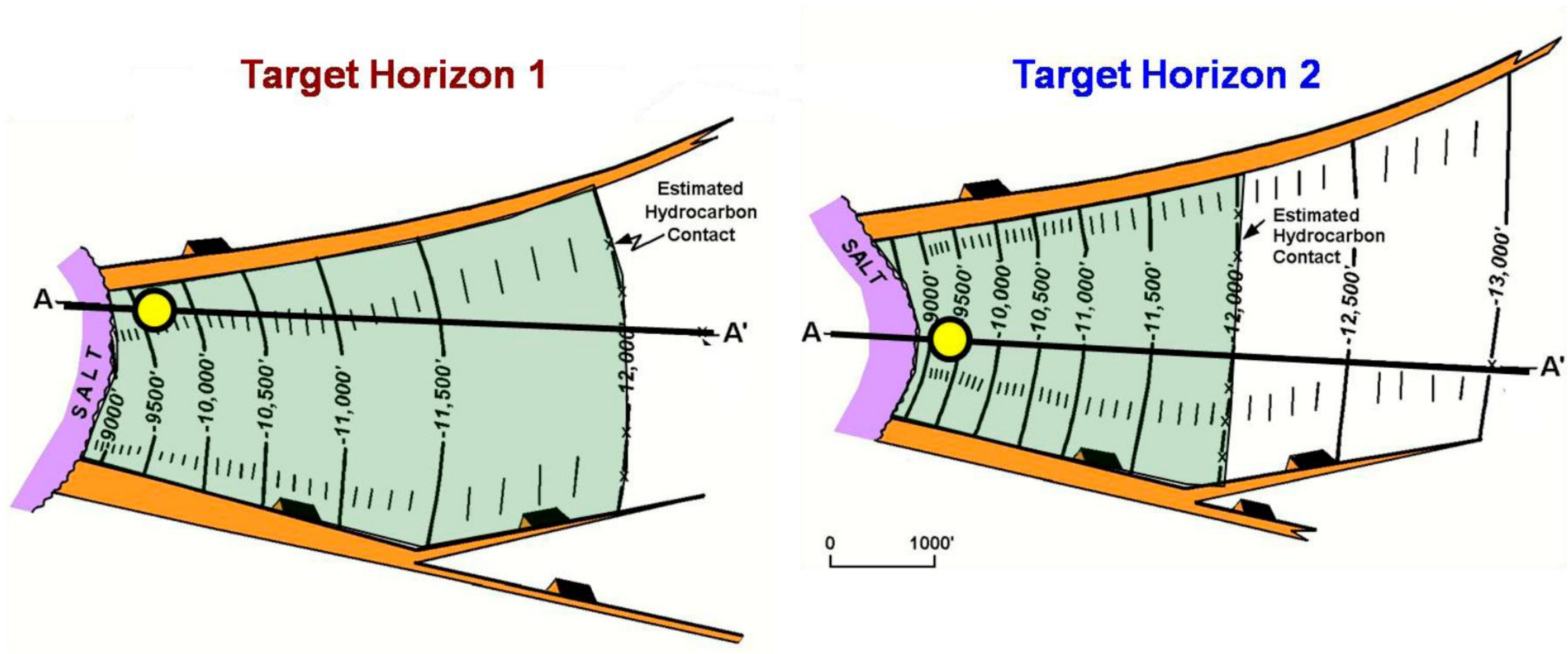

Figure 4. Final structure contour maps of two horizons interpreted from 3D data.

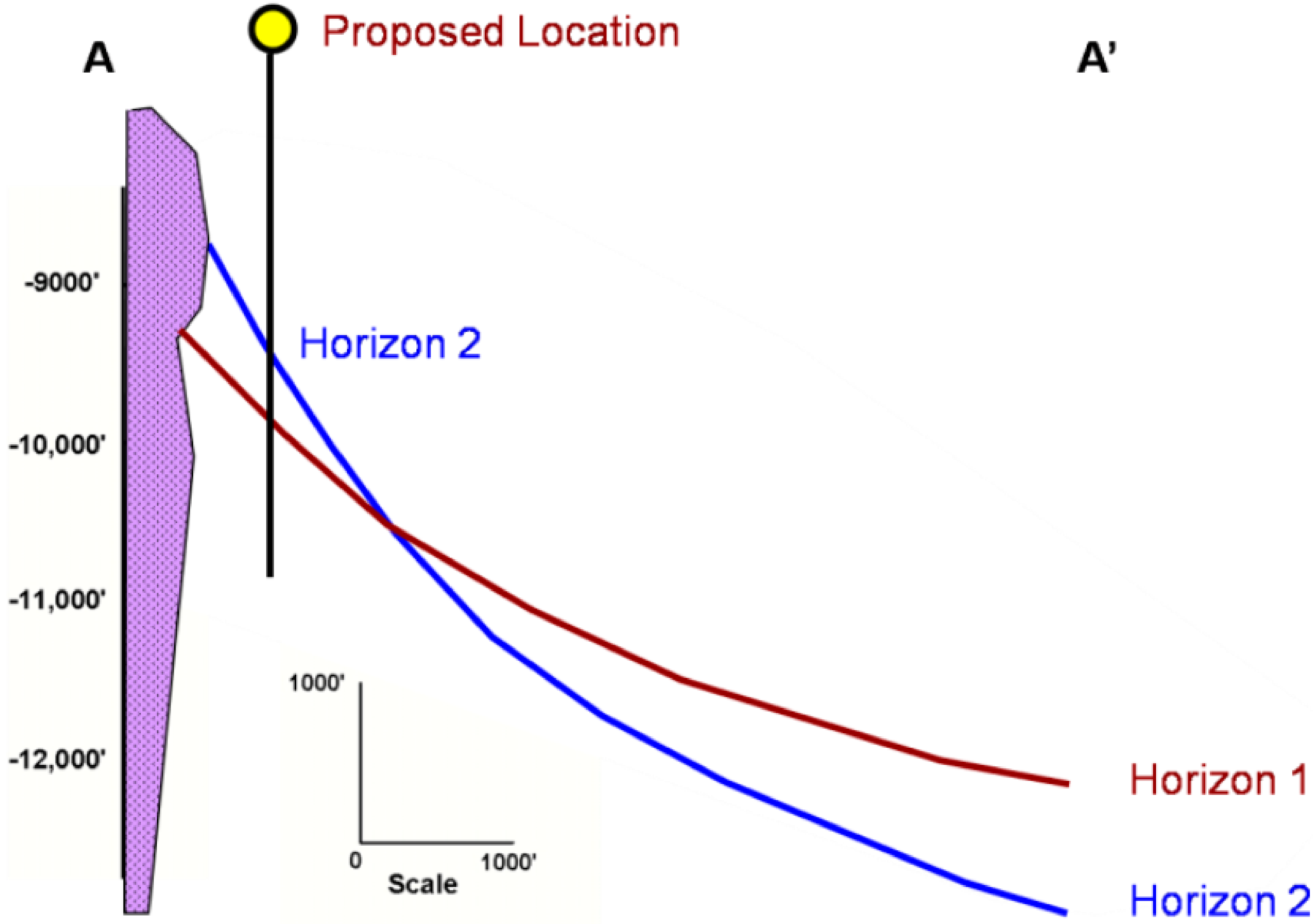

Figure 5. Cross section across the maps in Figure 4. Note that the gridding process has shifted the horizons.

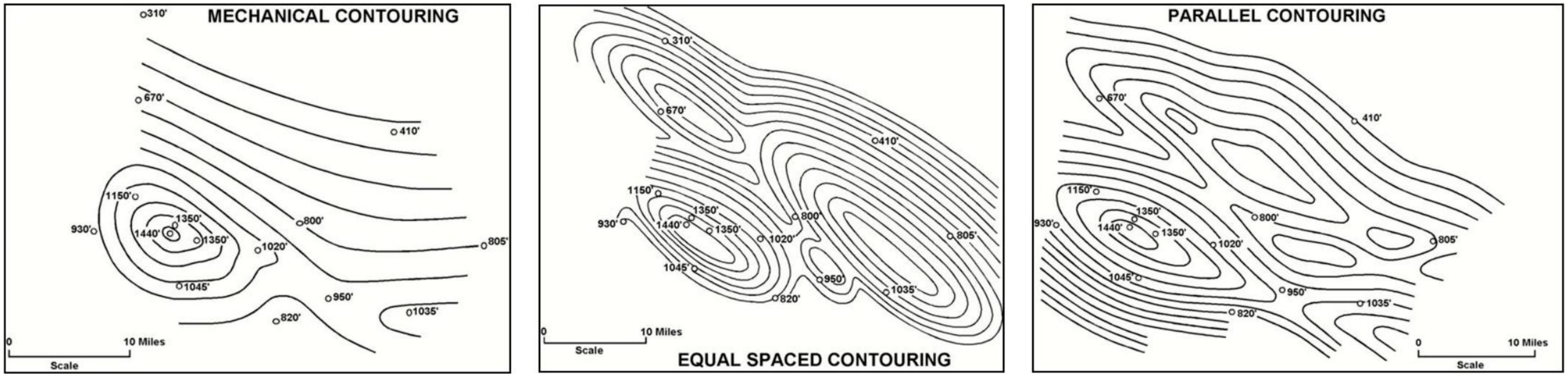

Figure 6. Comparison of a data set contoured with three different contouring methods.

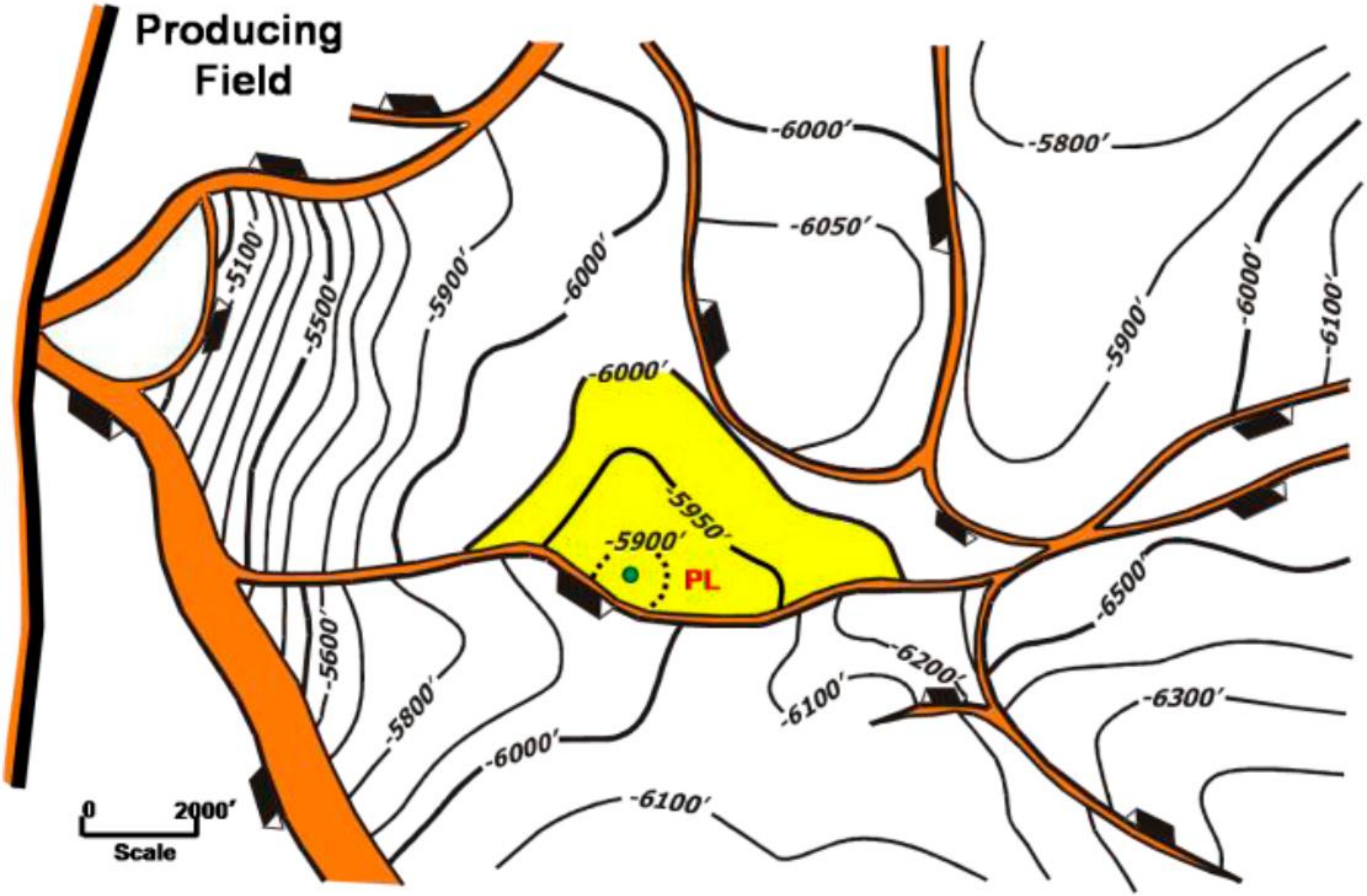

Figure 7. Structure contour map with the trapping fault interpreted as a single fault.

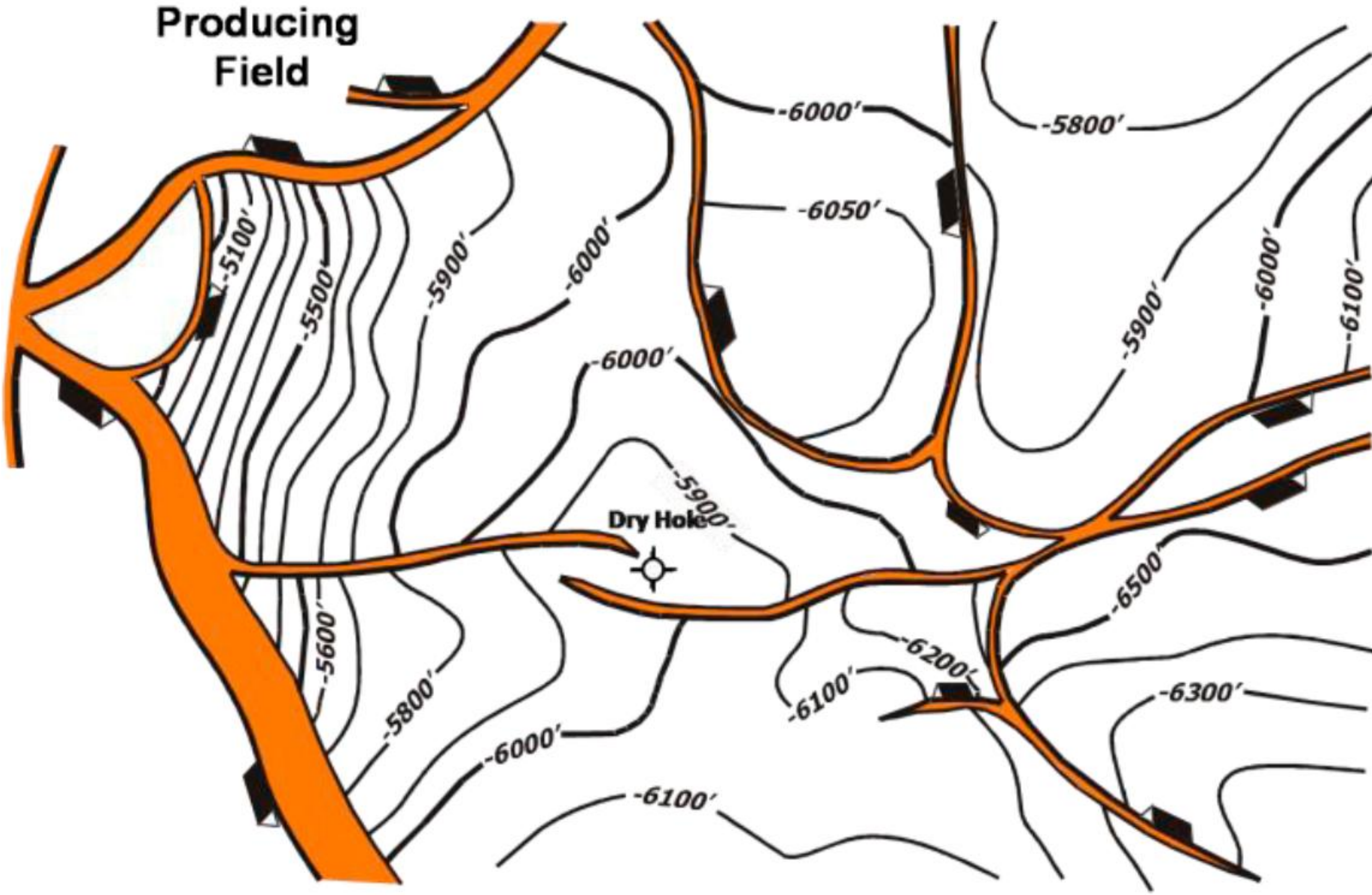

Figure 8. Dry hole post-mortem revealed that the trapping fault is actually two non-connected faults.