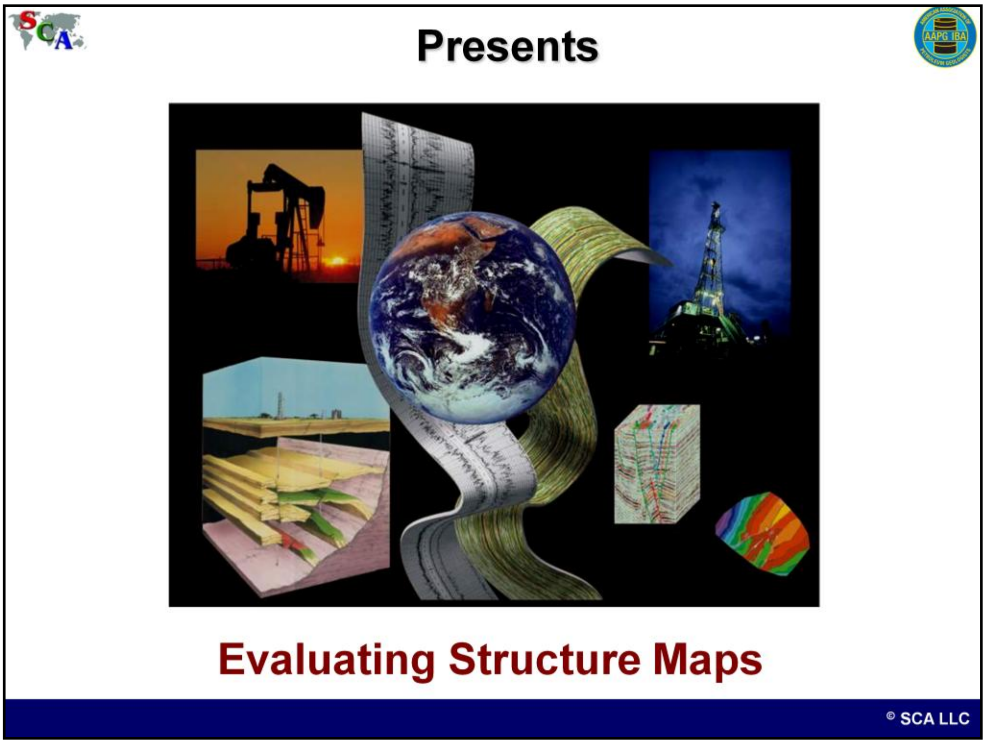
This webinar has been put together by the Imperial Barrel Committee, in conjunction with the American Association Petroleum Geologists and the AAPG Division of Professional Affairs to help you improve your final prospect maps..

The techniques and methods discussed in this presentation will not only help you in the competition, but in your career as well.

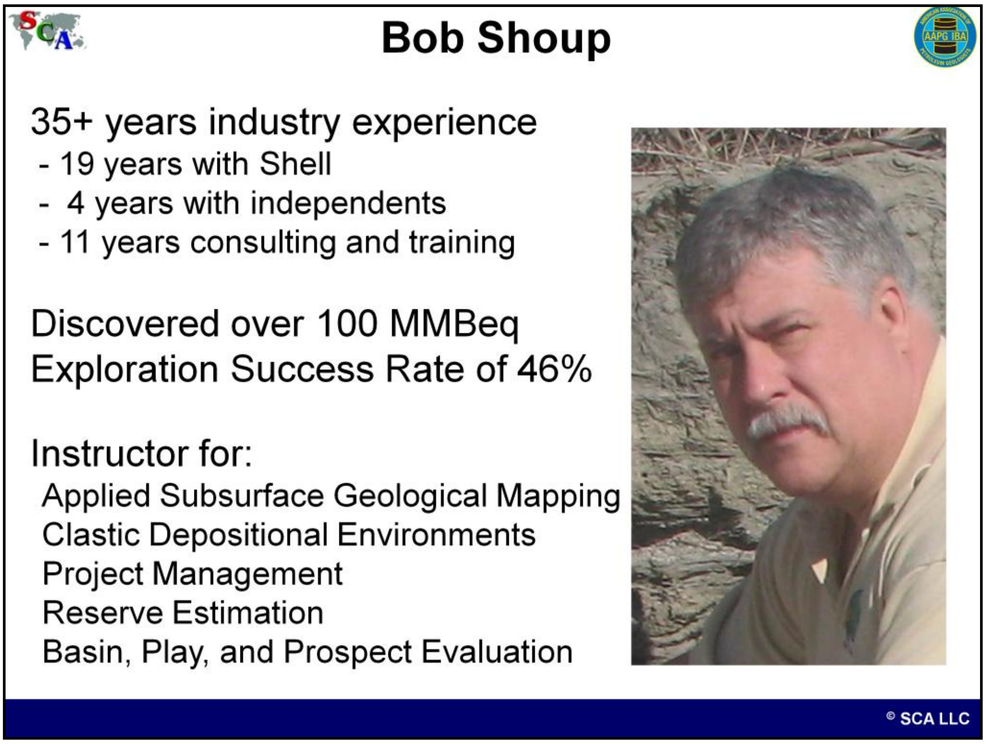


Since it is essential that we get resource and reserve estimates as accurately as possible, it is important to have our maps as accurate as possible.

Maps generated in the workstation are almost always wrong. So you need to be aware of some of the many methods you can use to review and correct your maps.

This class has been put together by Subsurface Consultants & Associated LLC. SCA is an international petroleum consulting and training company. They offer an essential array of services to clients in the upstream oil and gas industry.

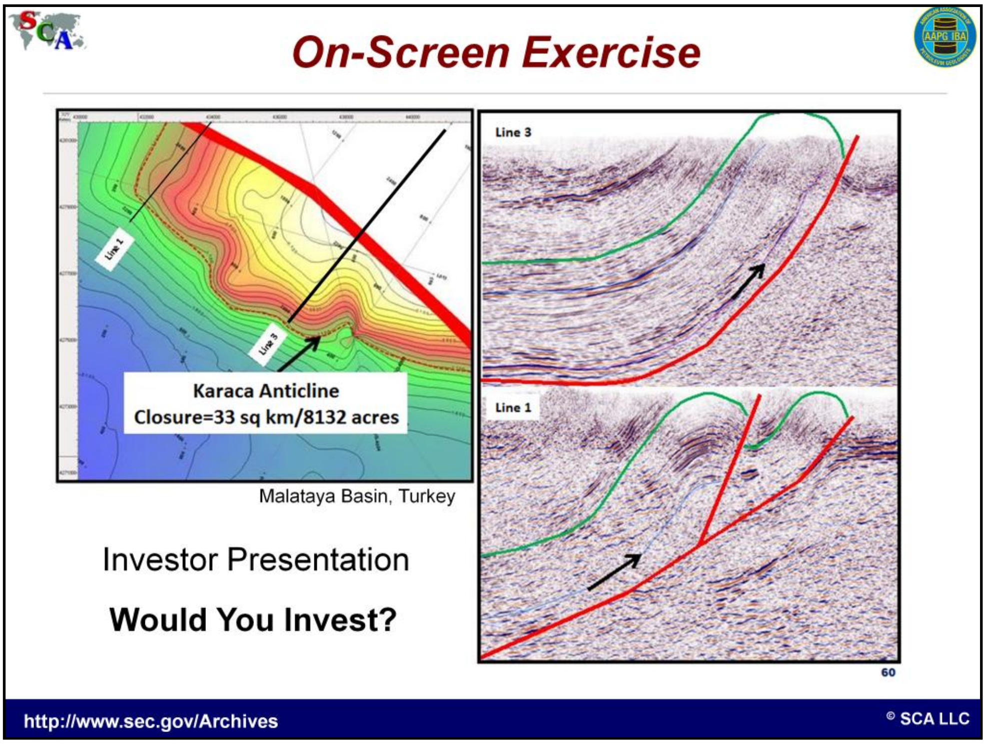
We encourage you to visit SCA's website at www.scacompanies.com.



The instructor for this webinar is Bob Shoup. He has over 35 years of industry experience in regional studies, prospect generation, reserve evaluation, well planning, and project management. He is considered an expert in interpreting clastic depositional environments, syndepositional structural systems, and rift basins.

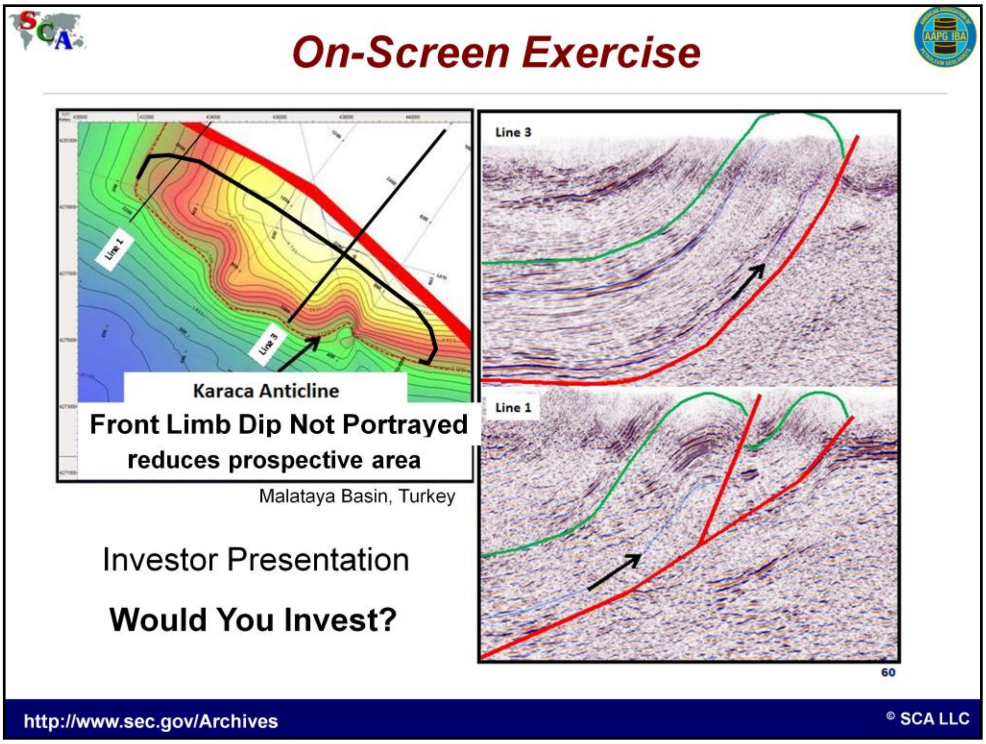
He has drilled, or caused to be drilled 26 prospects resulting in 12 commercial discoveries totaling more than 100 million barrels equivalent.

Mr. Shoup is an instructor for a number of courses for Subsurface Consultants & Associates, including their signature class Applied Subsurface Geological Mapping.

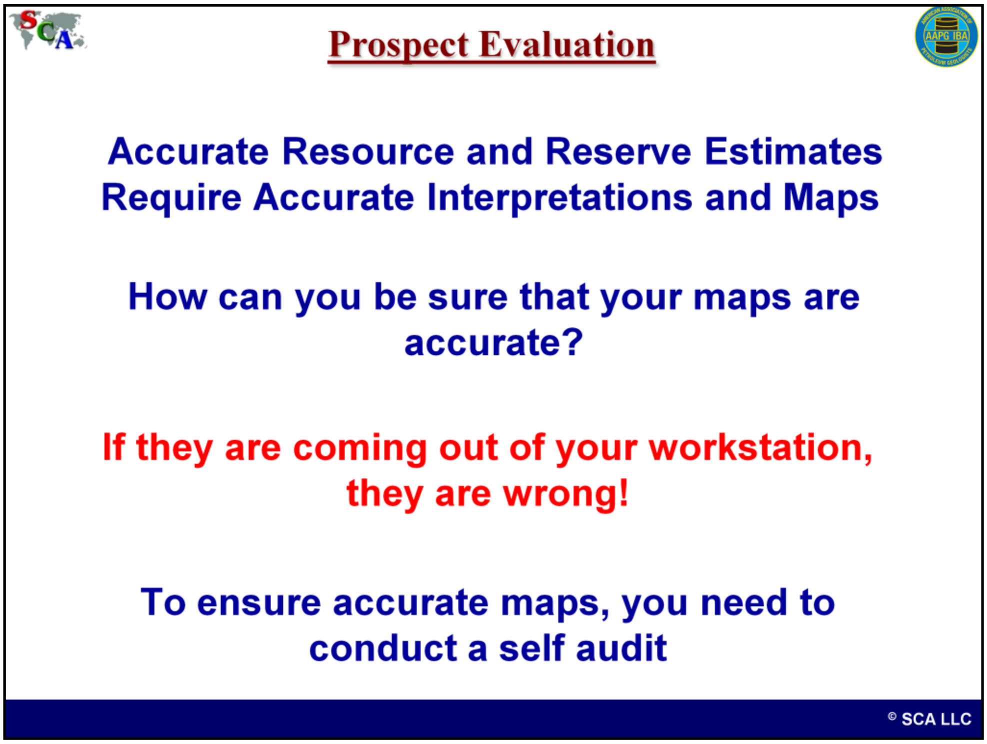


Look at this investor presentation. The seismic shows us that we are looking at a fault propagation fold. Would you allow your company to invest in this prospect?

You should not make investment decisions based on incorrect maps. So the real question becomes "Is this map correct?"



We can quickly see that the structure map does not show any dip on the front limb of the fold. The map IS wrong, and so is the area of closure determined from the map. The area is significantly over-estimated, and so would the volumes determined from this map.



We tend to accept what comes out of our workstations as correct. is wrong.

Unfortunately, almost every map generated and contoured in the workstation is wrong. You need to know how to review and correct your maps before you consider them as final. It is better for you to find the errors on the map before your boss, or the IBA judging Committee; or before you drill a dry hole.

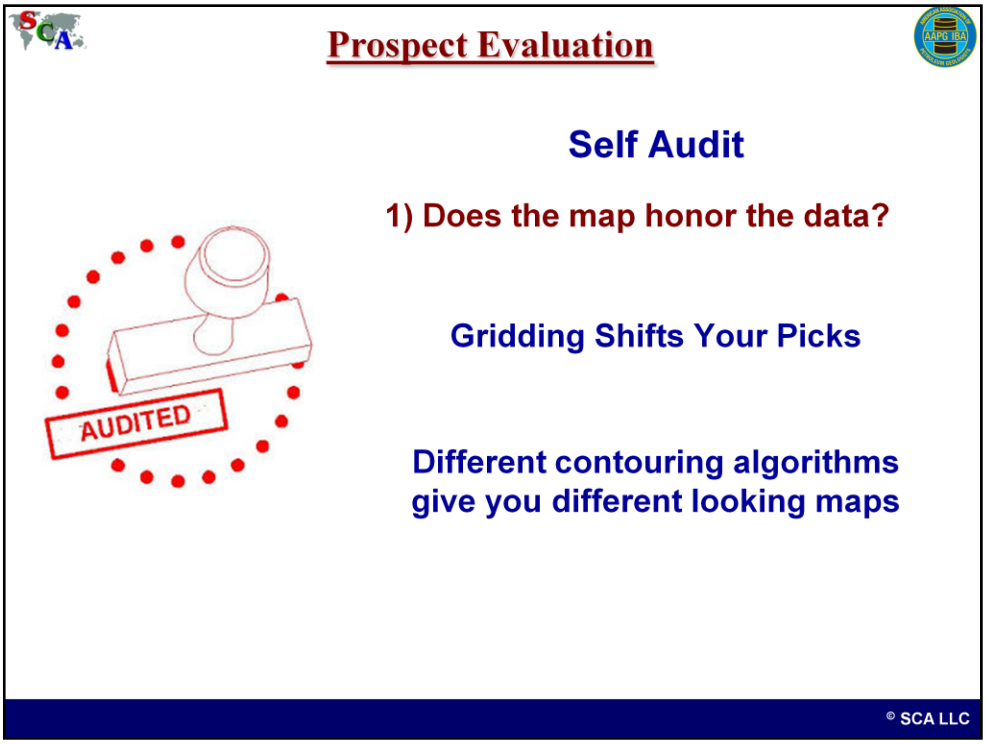
The process of reviewing your map is a self audit.

Prospect Evaluation

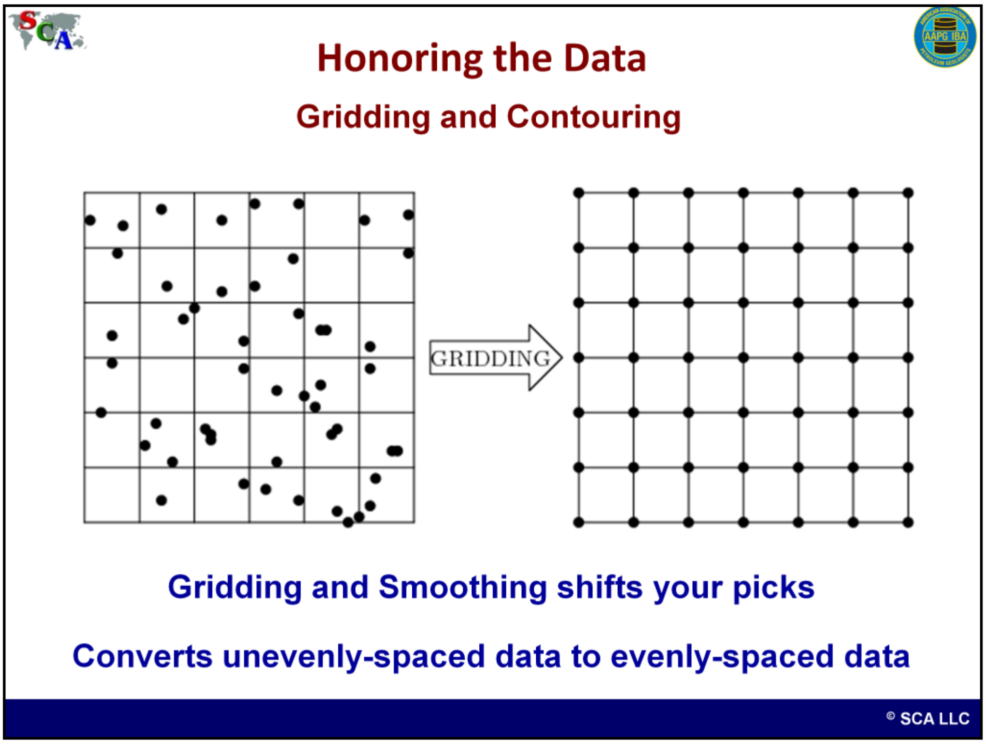
Self Audit

1) Does the map honor the data?
2) Do the contours exhibit contour compatibility?
3) Do the contours honor vertical separation?
4) Does the map match the seismic?
5) Are the fault traces properly positioned?
6) Does the map honor the geology?

Self Audits are a process you can follow to determine if your maps are accurate, and if not, help you to fix them. The self audit consists of eight steps



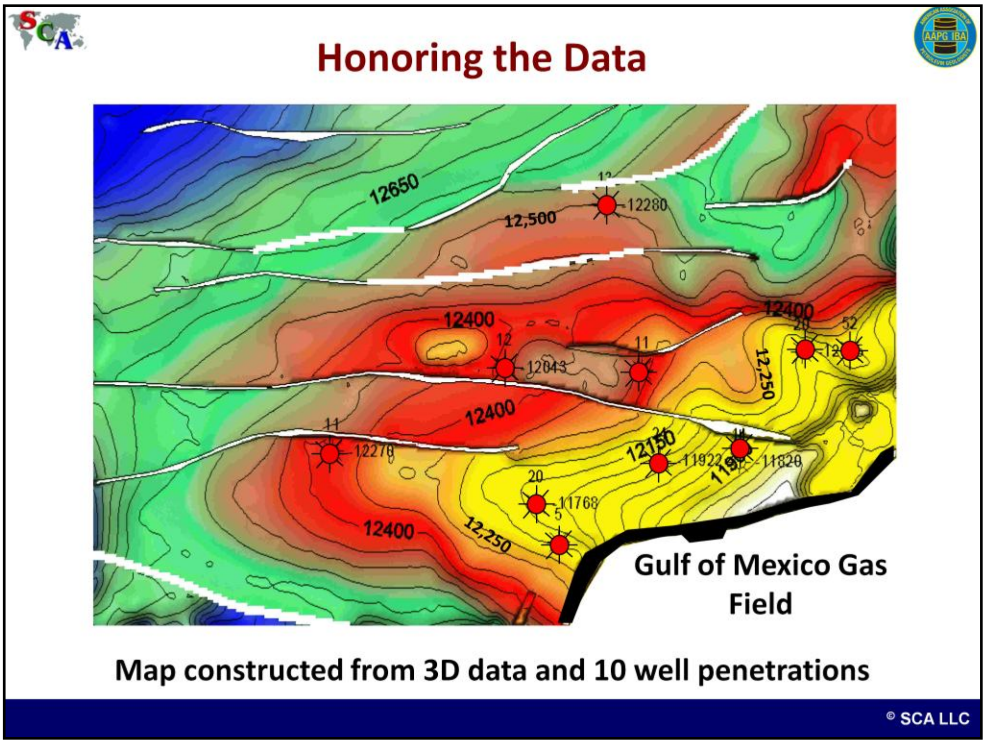
The first step in a self audit is to look at the contours and ensure that they match the wells. The gridding process will shift your picks, often considerably. Once the map has been gridded, the map is contoured. There are many different contouring algorithms. Different contouring algorithms will give you very different looking maps from the same data. So the contouring process can further shift your picks.



Gridding will take your unevenly distributed interpretation or picks and move them to create a regularly distributed grid. How much the process shifts your interpreted picks is a function of the original distribution of data or picks and the size of the grid cell.

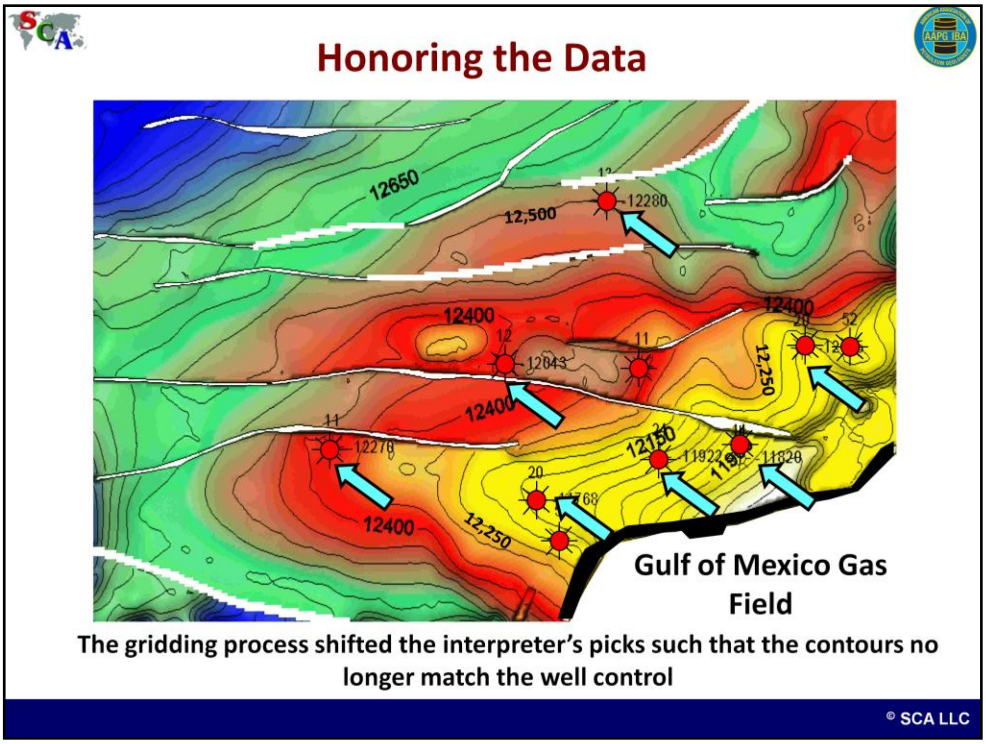
Once the picks have been moved into the new grid cells, your original picks are ignored. If you smooth the data, or the contours, the gridded data can be shifted even more.

The data points in the grid may vary by hundreds of feet from your original picks.

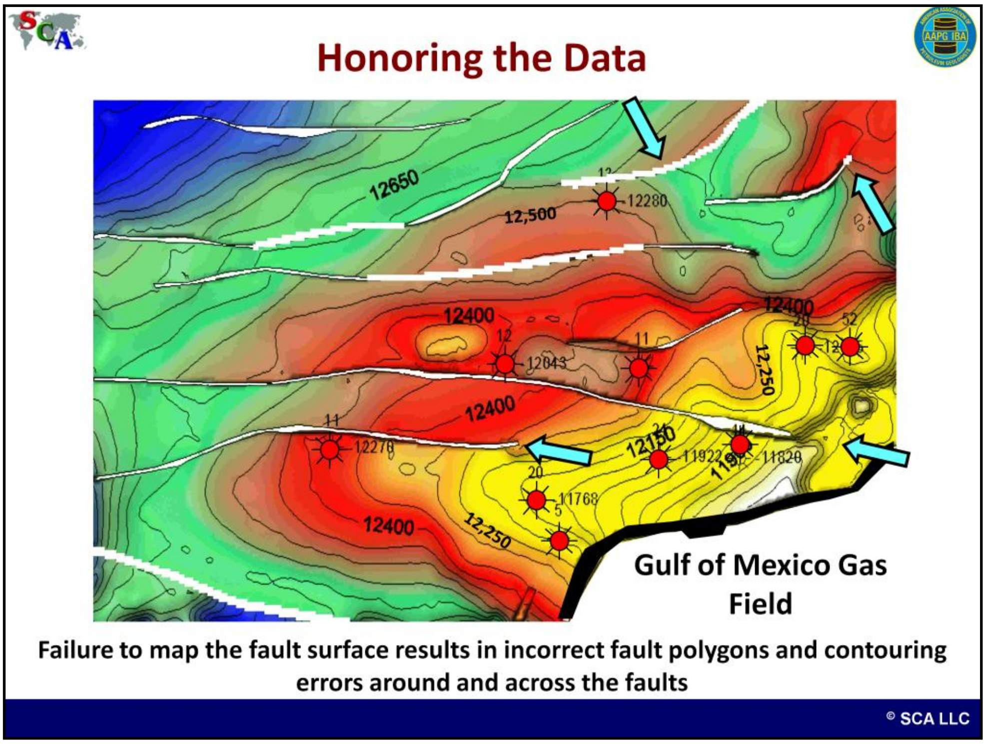


This slide shows a portion of a map over a gas field in the Gulf of Mexico. This producing horizon consists of an upthrown fault closure with several fault compartments.

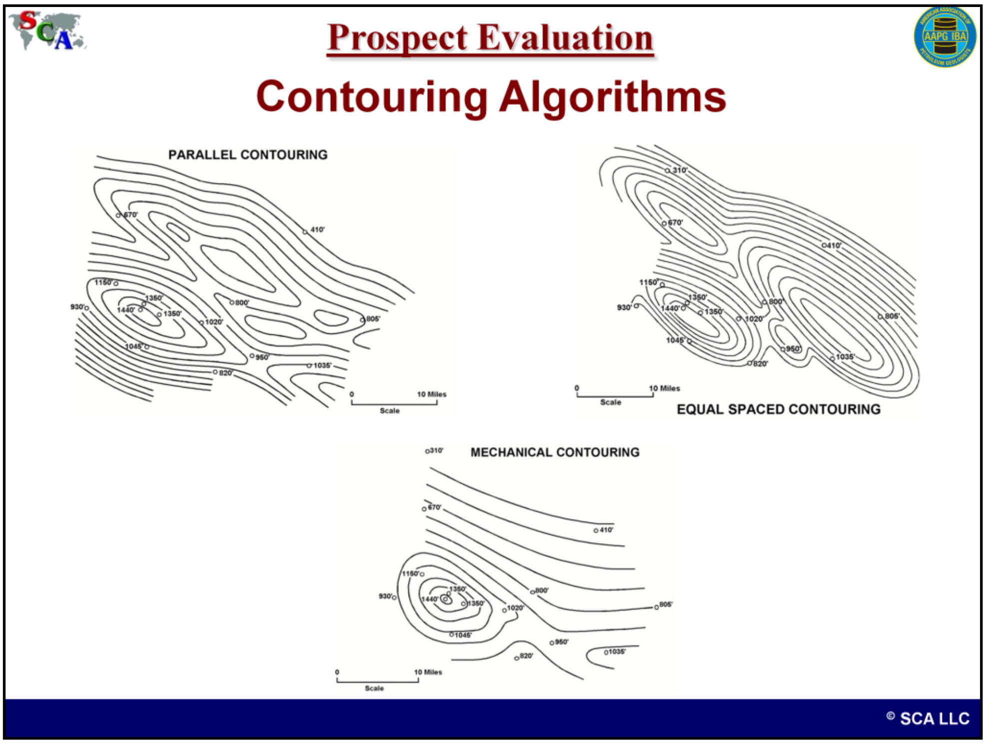
The map was constructed from 3D data and 10 well penetrations.



Note that the contours do not match the well data for 6 of the wells. This is the result of the gridding process shifting the interpreted picks to fit the grid.

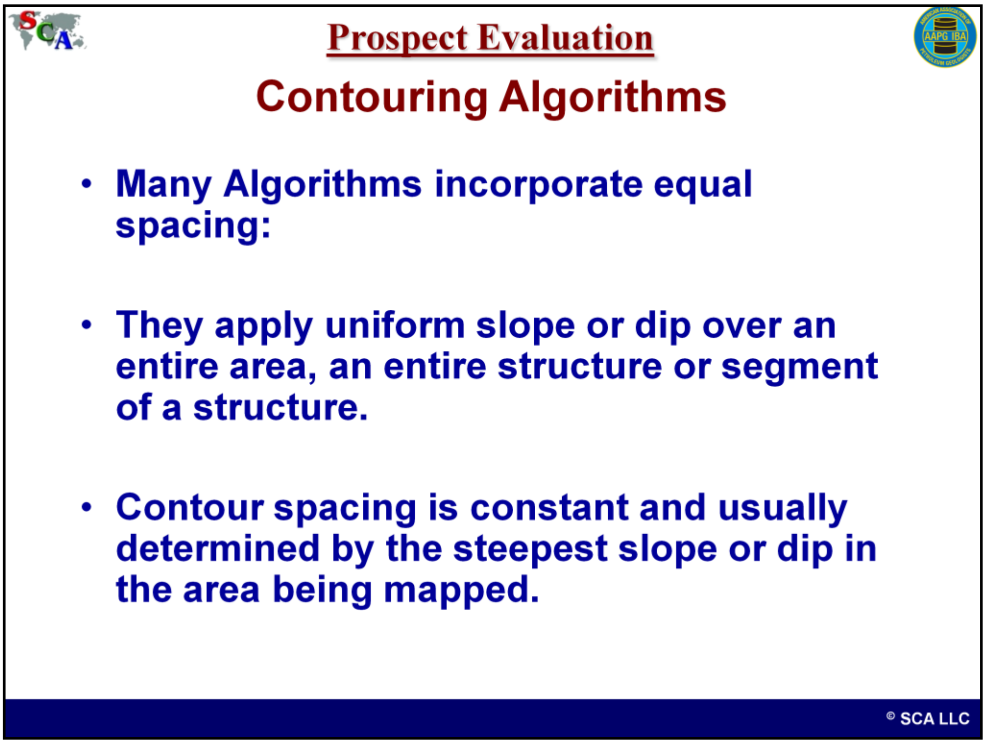


There are also numerous contouring errors observed on this map, especially around and across faults. Additionally, the fault polygons are not correct as the interpreter failed to map the fault surface and integrate it with the horizon

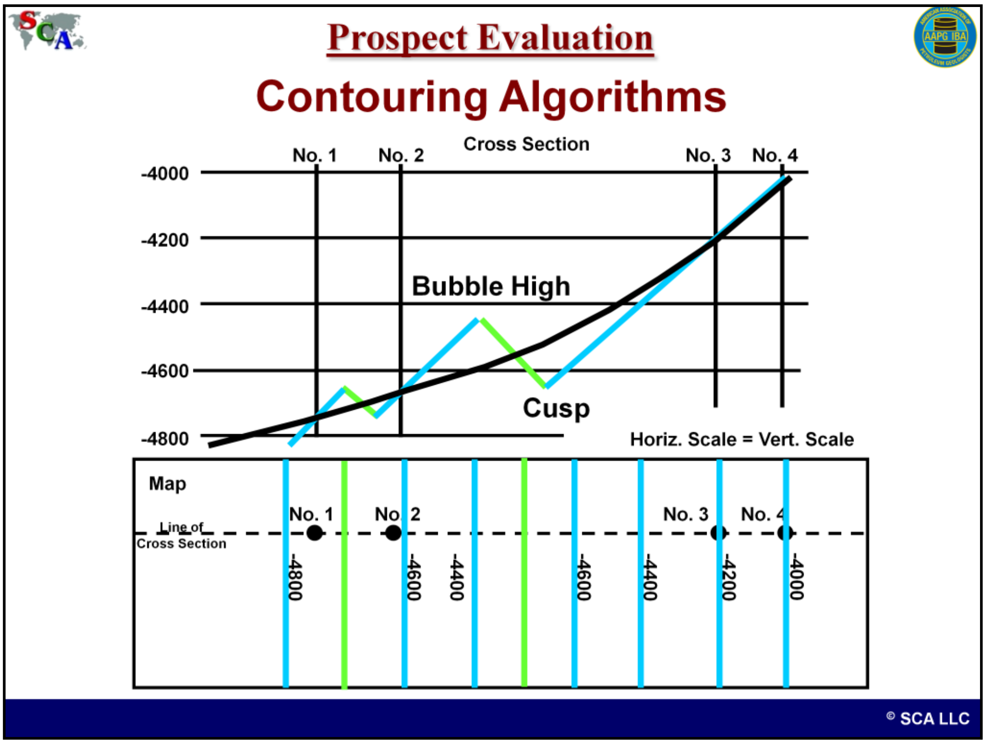


As mentioned, there are numerous contouring algorithms. Different contouring algorithms can give you radically different looking maps from the same data set.

The three maps shown here show a data set that was contoured with three different contouring methods. The map at the bottom of the slide is the closest to being the correct portrayal of this fault bend fold. Notice that the two upper maps have closed highs that are not geologically real but artifacts of the contouring methods.

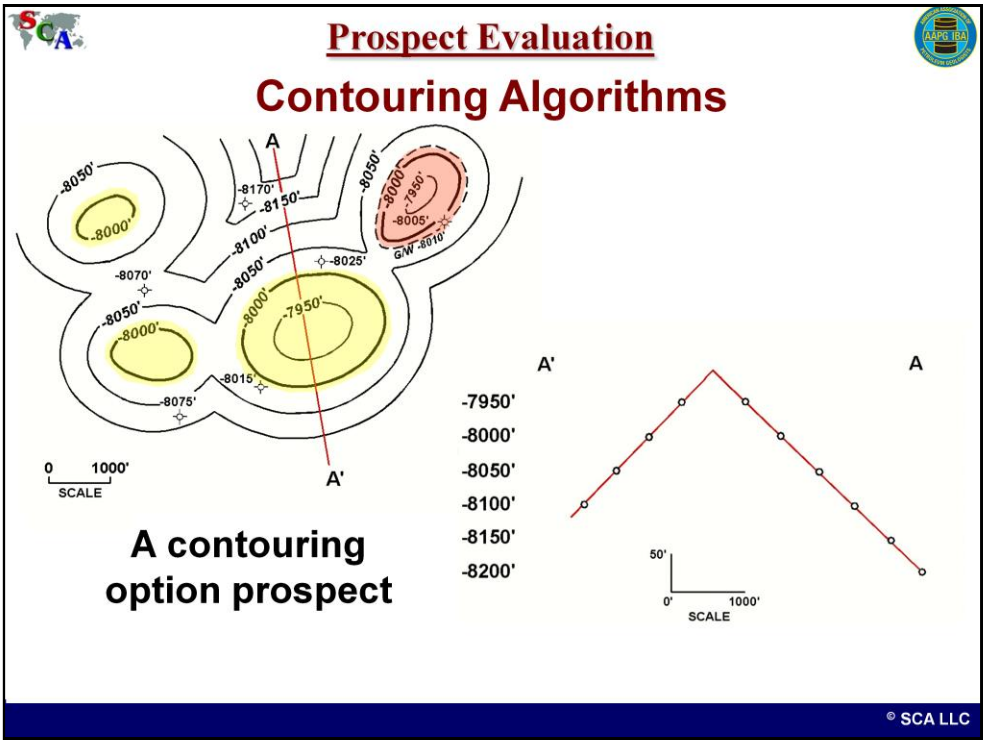


The equal-spaced contouring method often shifts your picks in order to maintain constant dip across structures that do not have constant dip

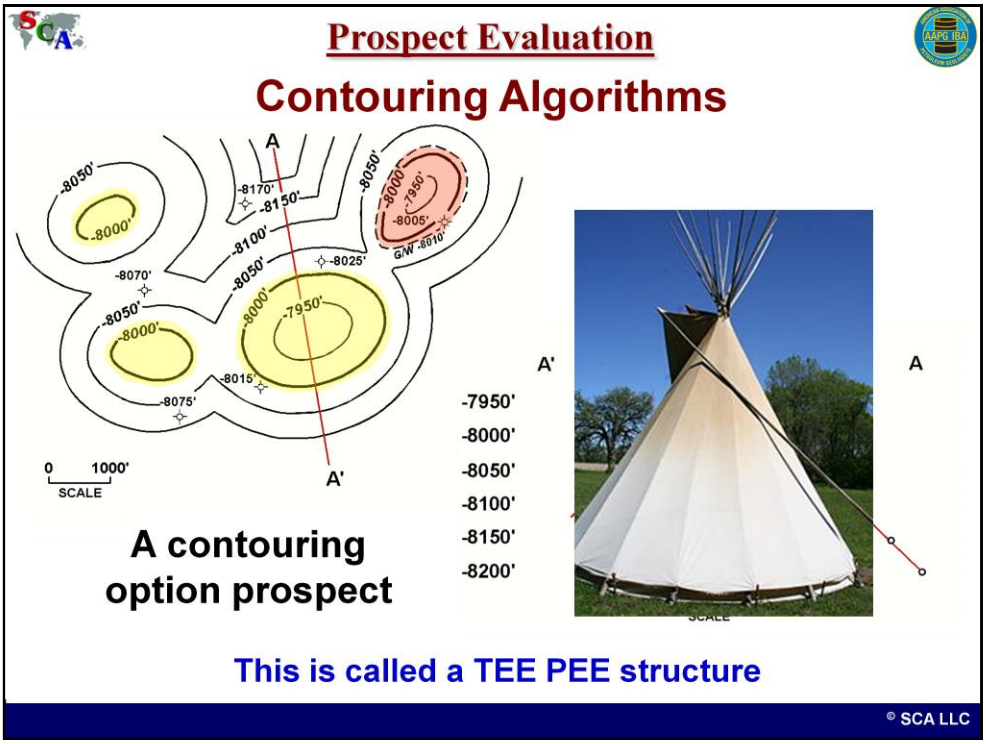


We can see how this happens by looking at this cross section. We see four wells penetrating a surface that has a curvilinear geometry. The surface is steeper at wells 3 & 4 than it is at wells 1 and 2.

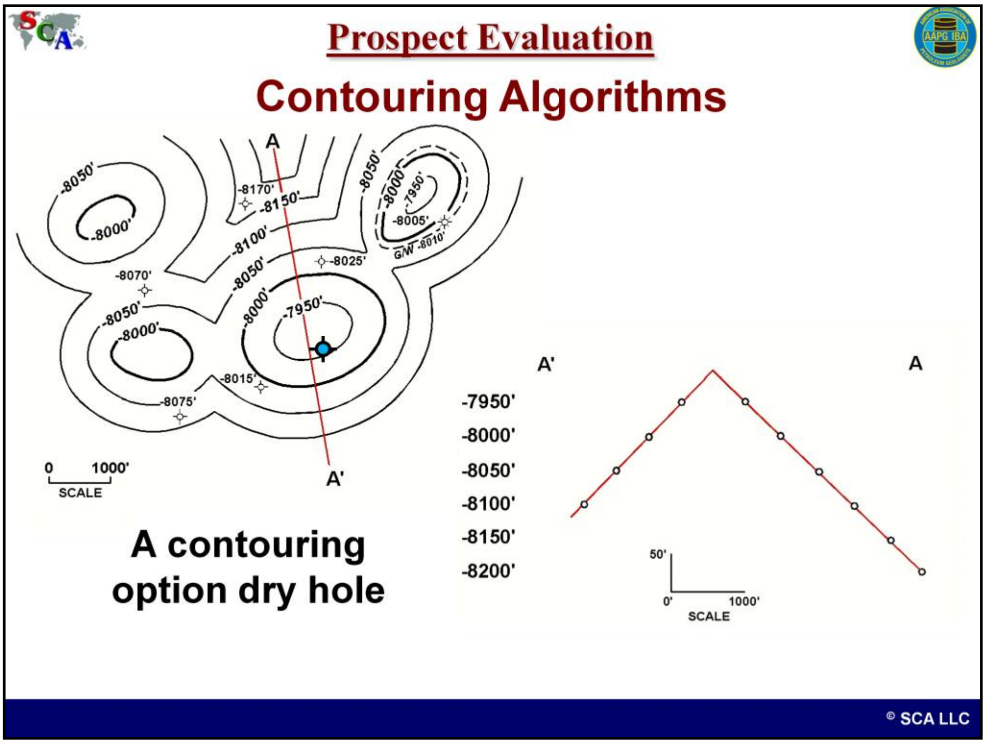
The contouring algorithm establishes the slope or dip rate at wells 3 and 4. The algorithm will then maintain that same slope through wells 1 and 2. However, that slope is too steep for wells 1 and 2, so the algorithm will reverse the dip direction to connect these slopes, resulting in contour cusps and bubble highs.



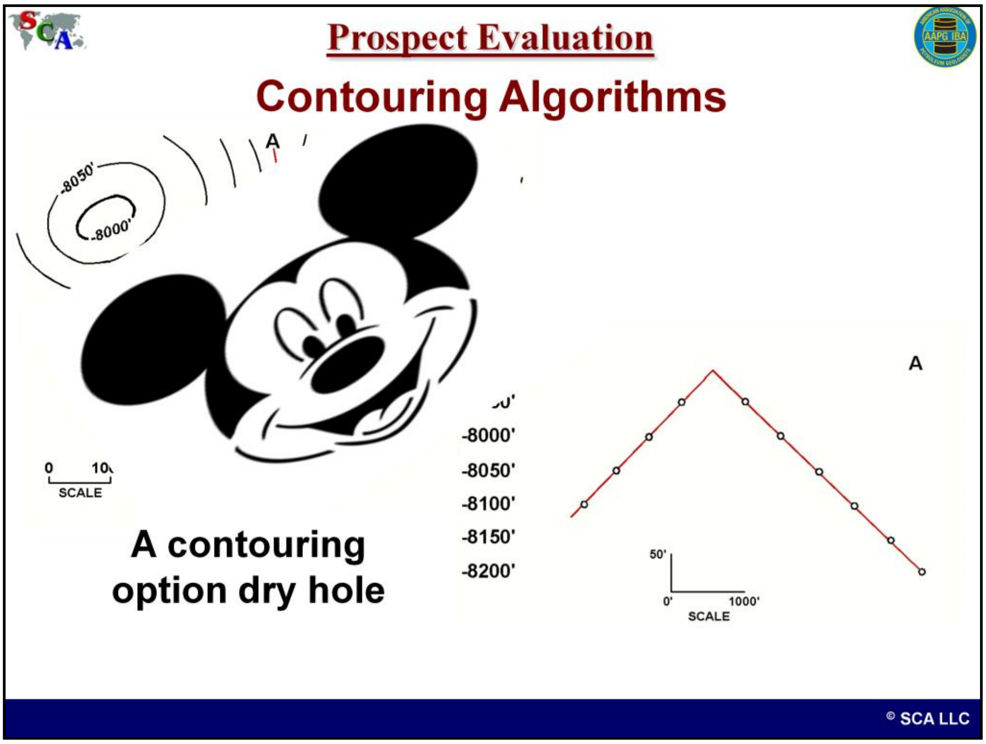
In this structure map, we several closures adjacent to a gas discovery. We can see from the cross section across the center of the map that the structure was contoured using an equal spaced algorithm. As such the prospective structures seen on the map are very likely to be bubble highs. That is, prospects resulting only from the contouring option we selected.



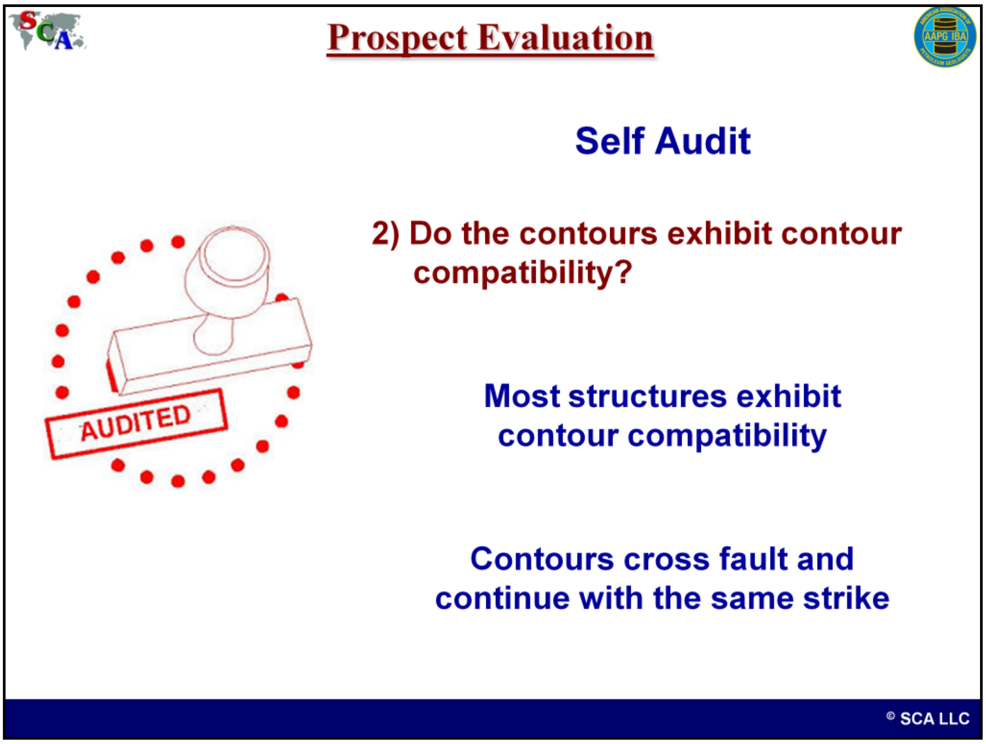
We call these types of structures teepee structures as the cross section resembles the tepees used by many American Indian Tribes.



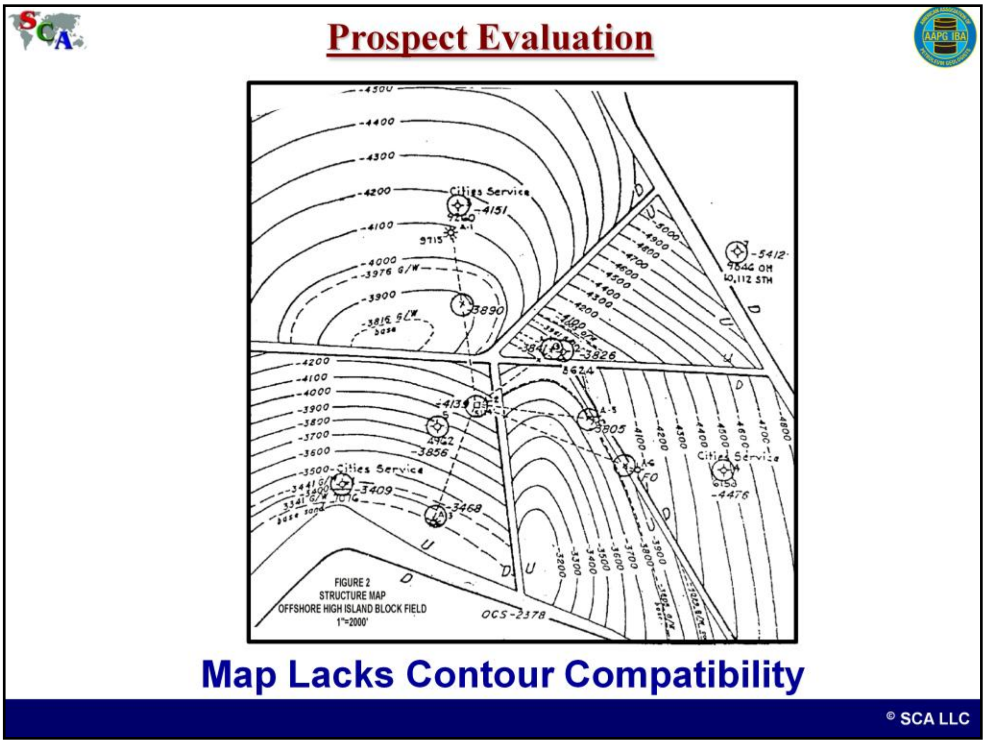
The largest of the prospective structures was drilled, resulting in a dry hole. The well was a dry hole because …



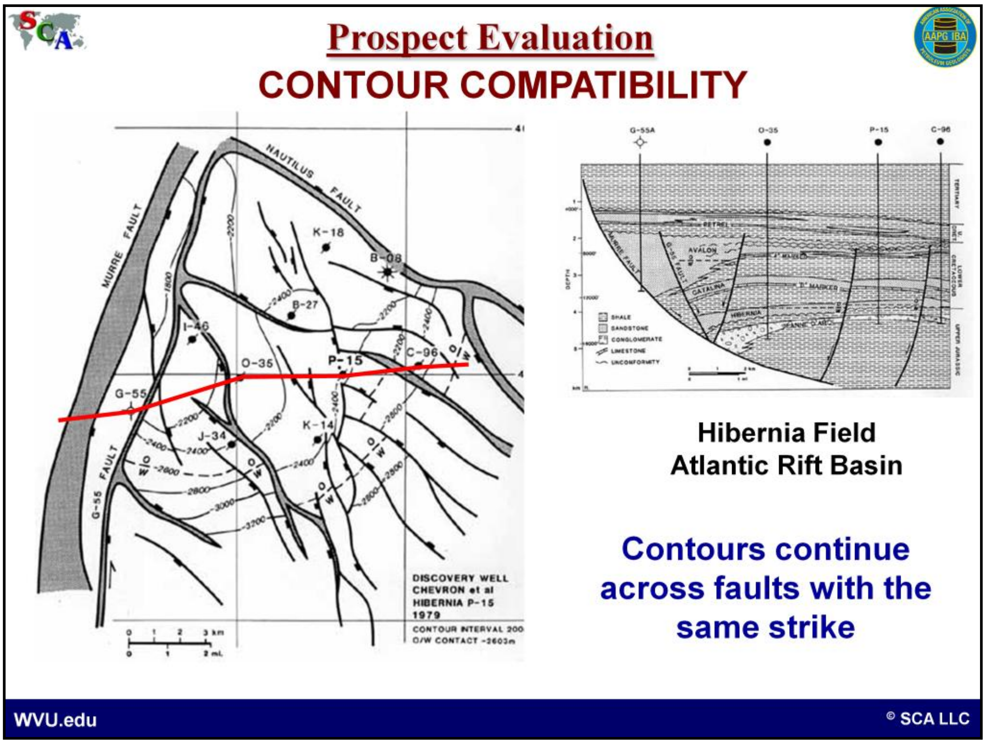
… it was a Mickey mouse map, more fantasy than reality.



Continuing on with our self audit, we want to look at the contours to see if the contours exhibit contour compatibility across the faults.



This map does not exhibit contour compatibility. Hopefully you will see that the map does not look geologically correct. That is because each fault block was contoured independently. Your workstation also contours each block independently.



Here is a structure map across the synrift section of the Hibernia Field in the North Atlantic. Note that the contours cross the faults with the same strike, showing contour compatibility.

Prospect Evaluation

EXCEPTIONS TO CONTOUR COMPATIBILITY ACROSS FAULTS

- Large growth normal faults
- Large thrust or reverse faults
- Intermediate or late-stage strike-slip faults
- Ramps related to dying faults
- Areas with Multi-phase deformation

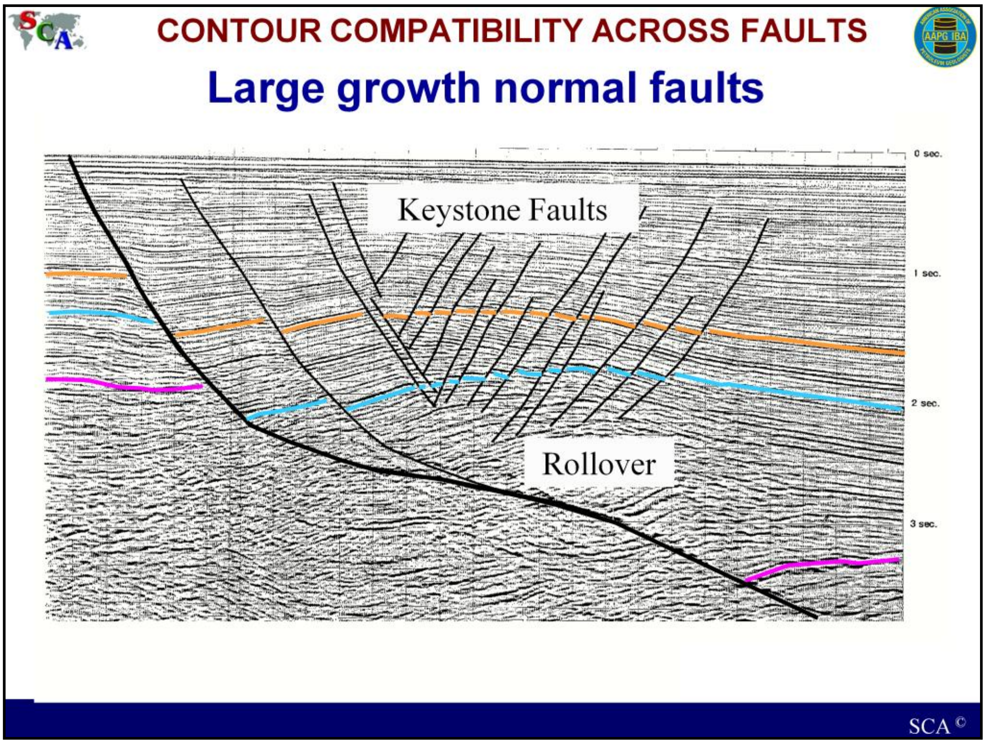
Most structures exhibit contour compatibility, so much so, that it is easier to list the exceptions to the rule.

Very Large Growth Faults

Large Thrust Faults

Ramps related to dying faults:

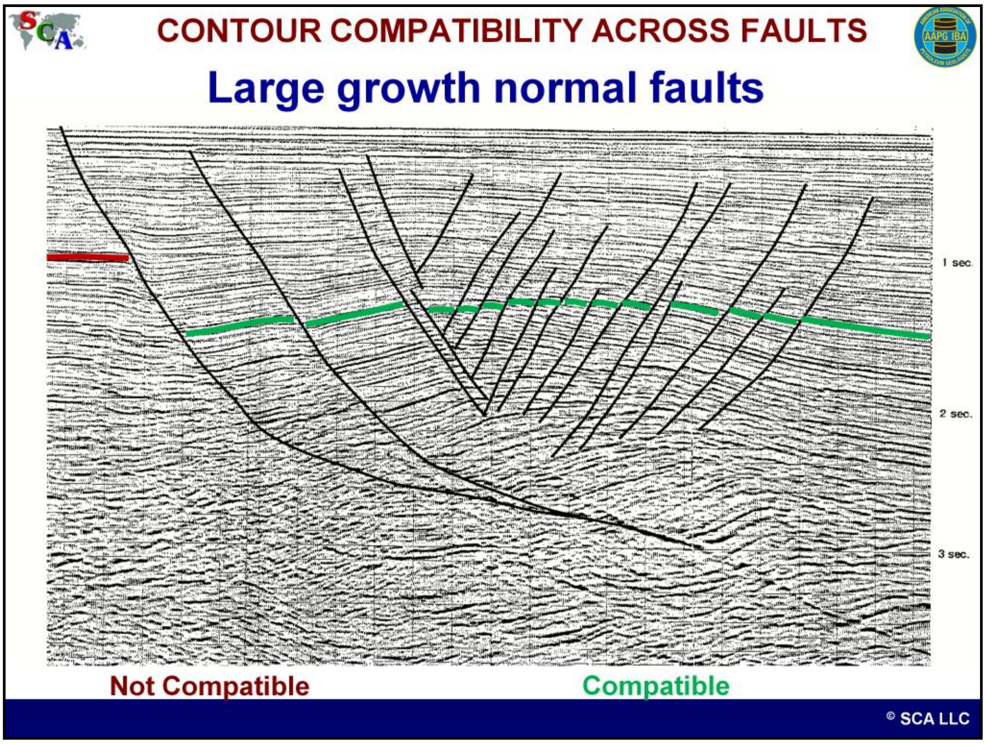
Multi phase deformation.



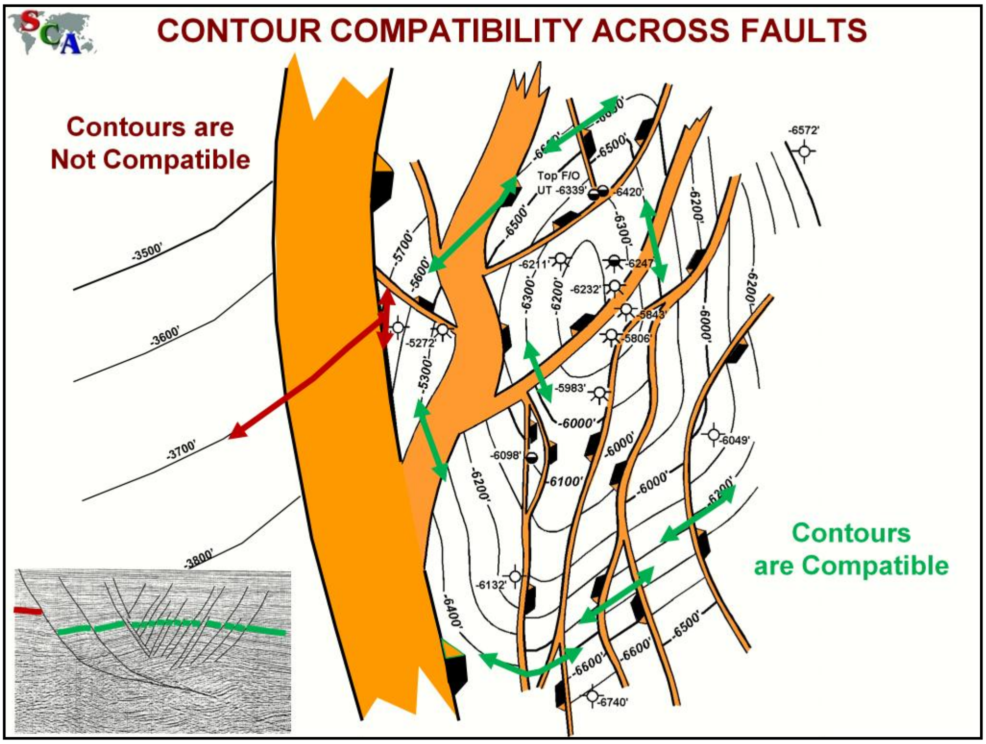
Here is an example of a very large growth fault, the Corsair Fault in the Gulf of Mexico.

The orange event is in the Late Miocene, the blue event is near the Middle Miocene, and the purple event is in the Early Miocene

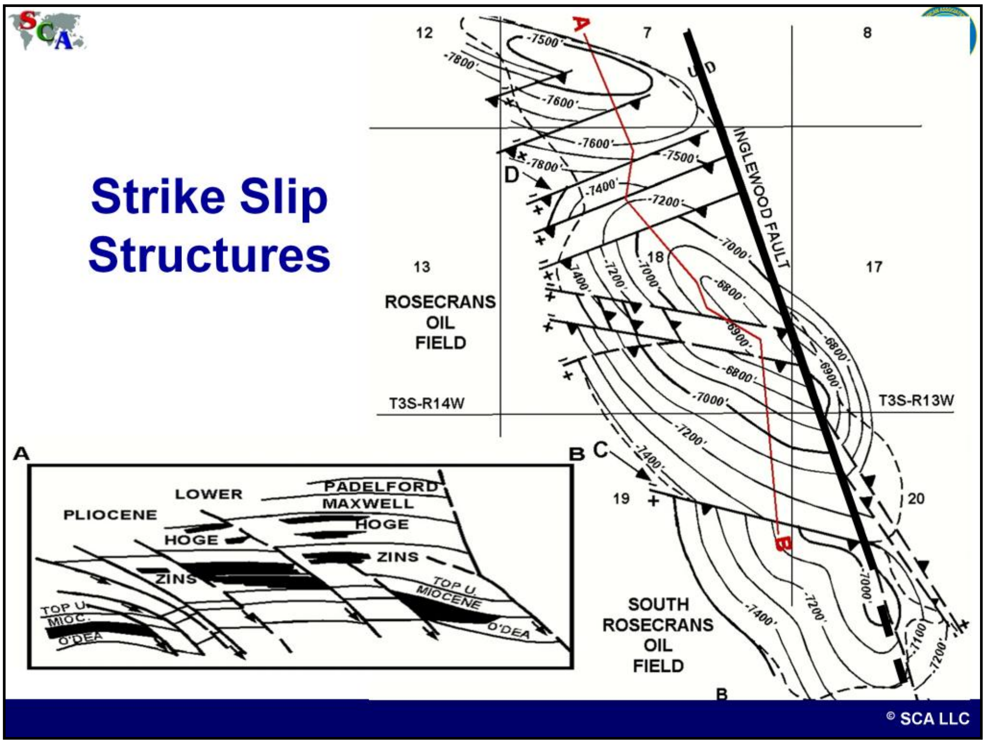
The conjugate faults observed over the rollover anticline are called keystone faults, as the crestal block resembles the keystone of a Roman Arch



The beds across the large Corsair fault do not exhibit compatibility. However, the beds crossing the keystone faults do exhibit compatibility.

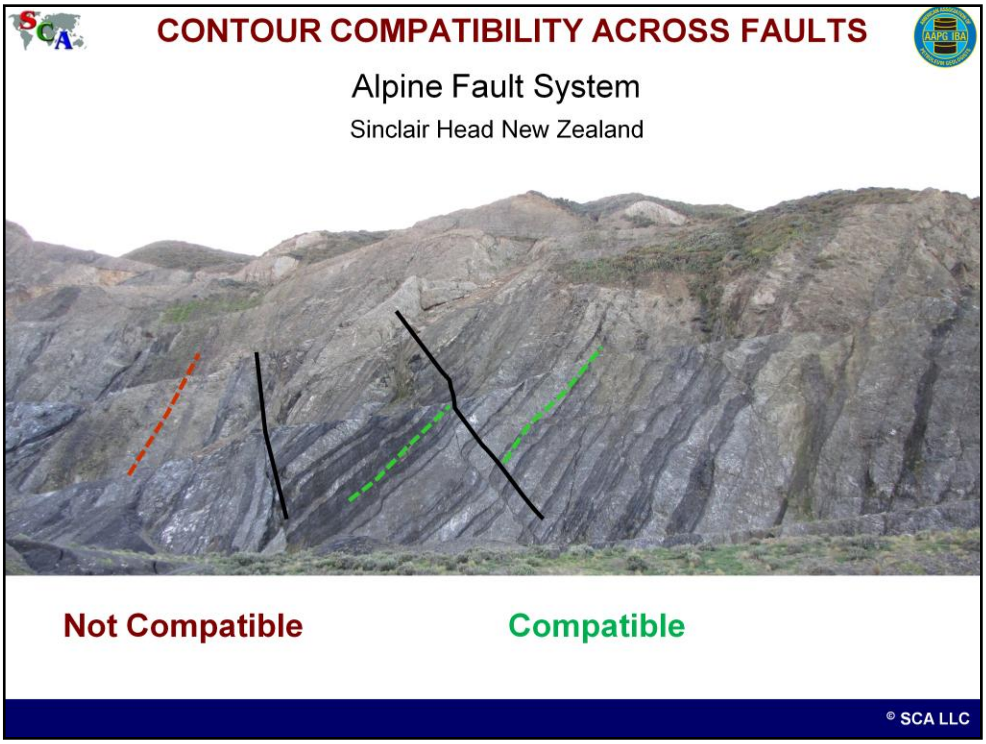


Note that the contours across the large fault ‘intersect’ with high angles, showing a lack of compatibility. The contours within the rollover structure cross the keystone faults with the same strike, thereby showing compatibility.

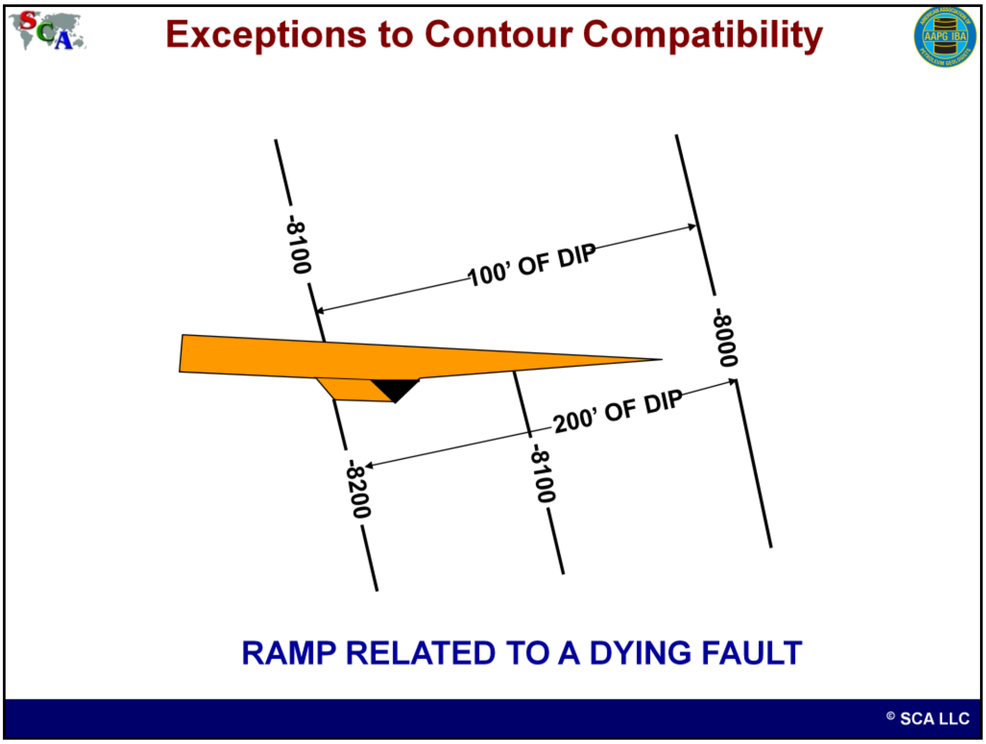


This is a structure map for a key producing horizon in the Inglewood CA, Rosecrans field, which is formed by a major strike slip fault.

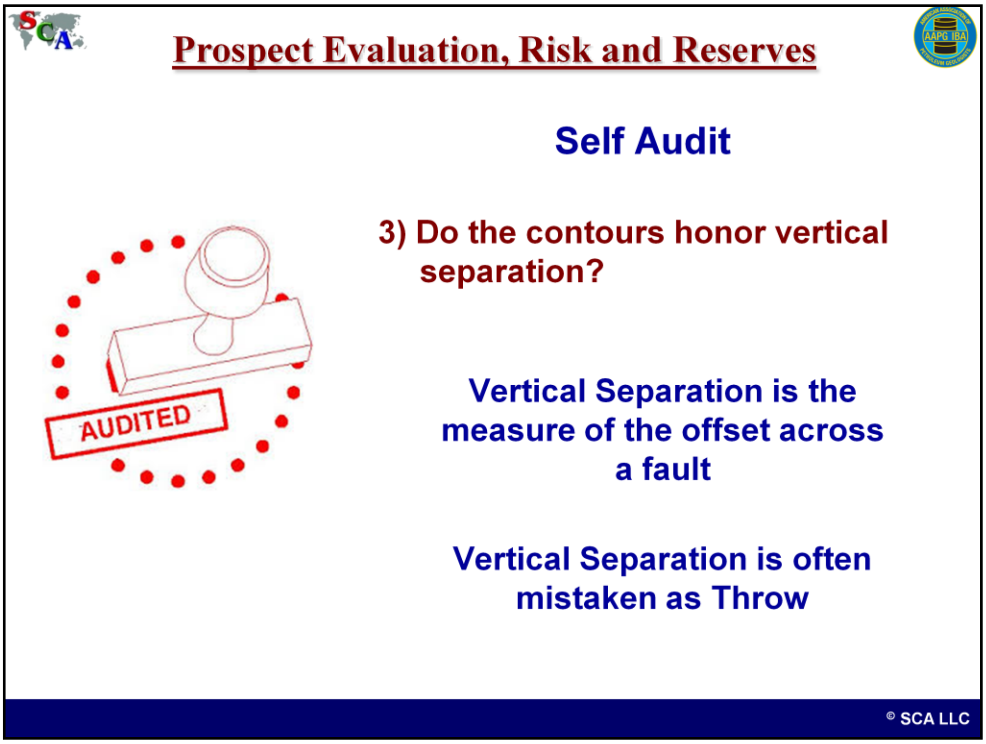
Note that there is no compatibility across the Inglewood fault. On the west (left) side of the Inglewood Fault, several fault blocks exhibit compatibility, others do not.



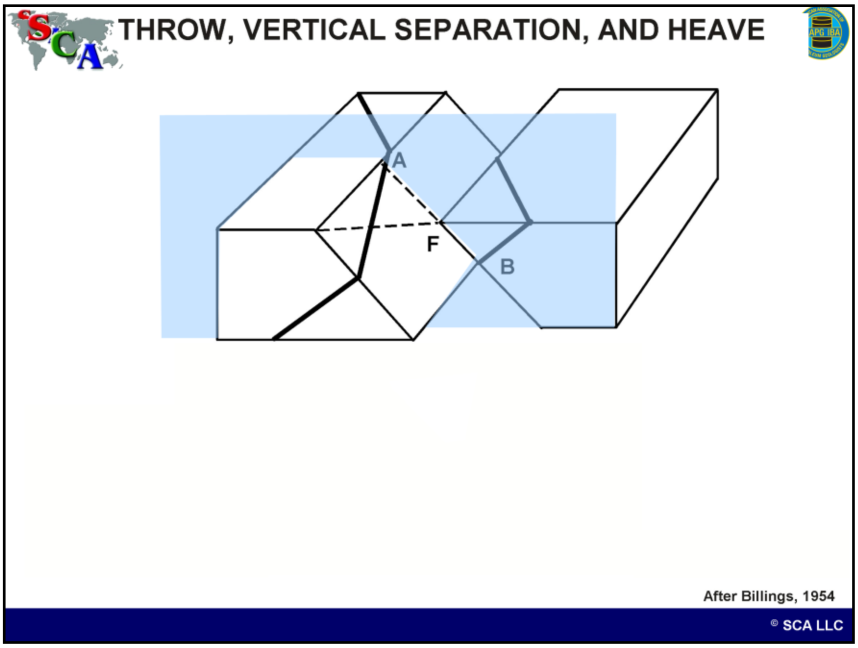
We see a similar situation along the Alpine Fault in New Zealand. The beds are compatible across the fault near the middle of the outcrop, They are not compatible across the fault to the left.



At the ramp associated with a fault tip, there is a lack of compatibility as the downthrown side of the fault will have a higher dip rate than the upthrown side.

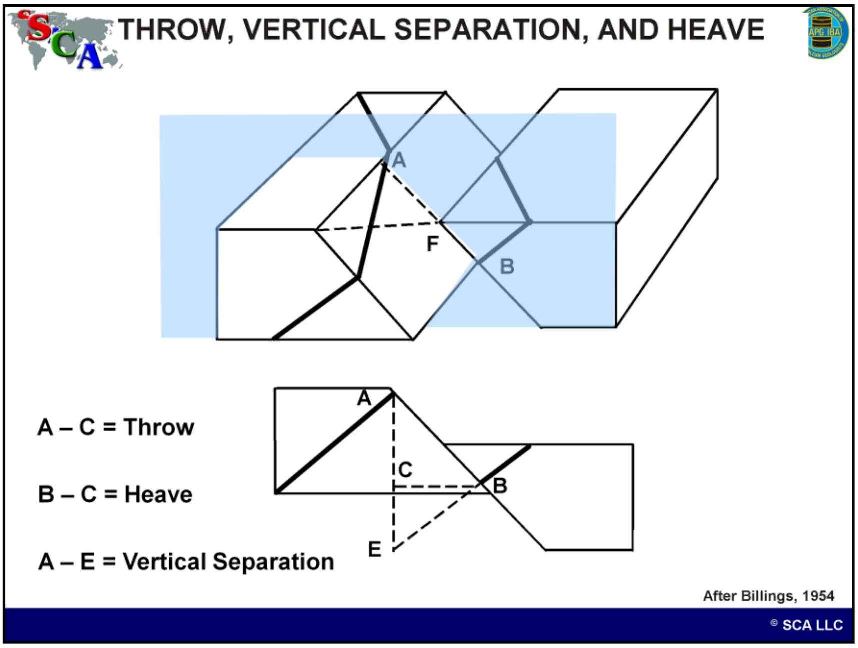


Now that the contours exhibit contour compatibility, we need to make sure that they also honor the vertical separation.



Billings – in 1954 commented that many petroleum geologists confuse the terms throw and vertical separation.

We can see this by looking at this block diagram of a faulted structure. If we construct a cross section perpendicular to the fault, we can see the relation of the horizon to the fault.



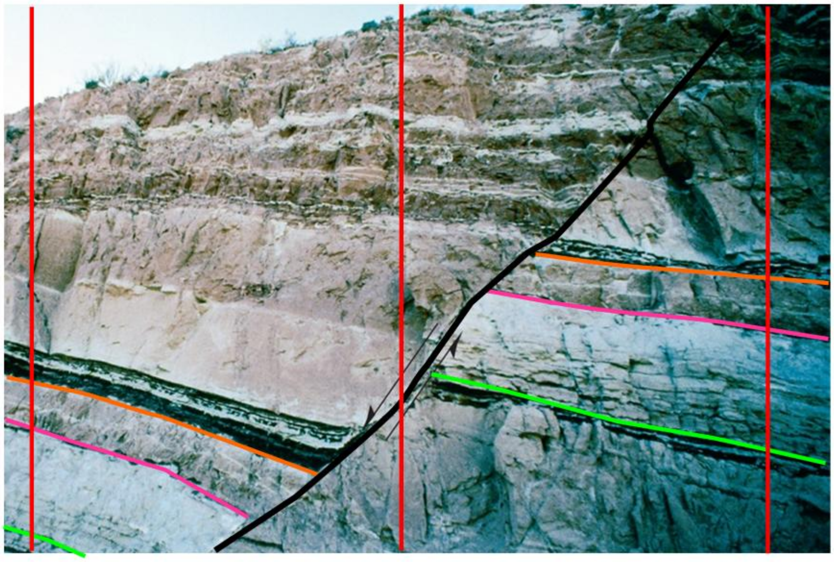
Throw (A – C) is the depth of intersection of the upthrown block at the fault minus the depth of the intersection of the downthrown block at the fault. It must be measured perpendicular to the fault surface.

Heave (B – C) is the horizontal distance from the intersection of the upthrown block at the fault to the intersection of the downthrown block with the fault. It must be measured perpendicular to the fault.

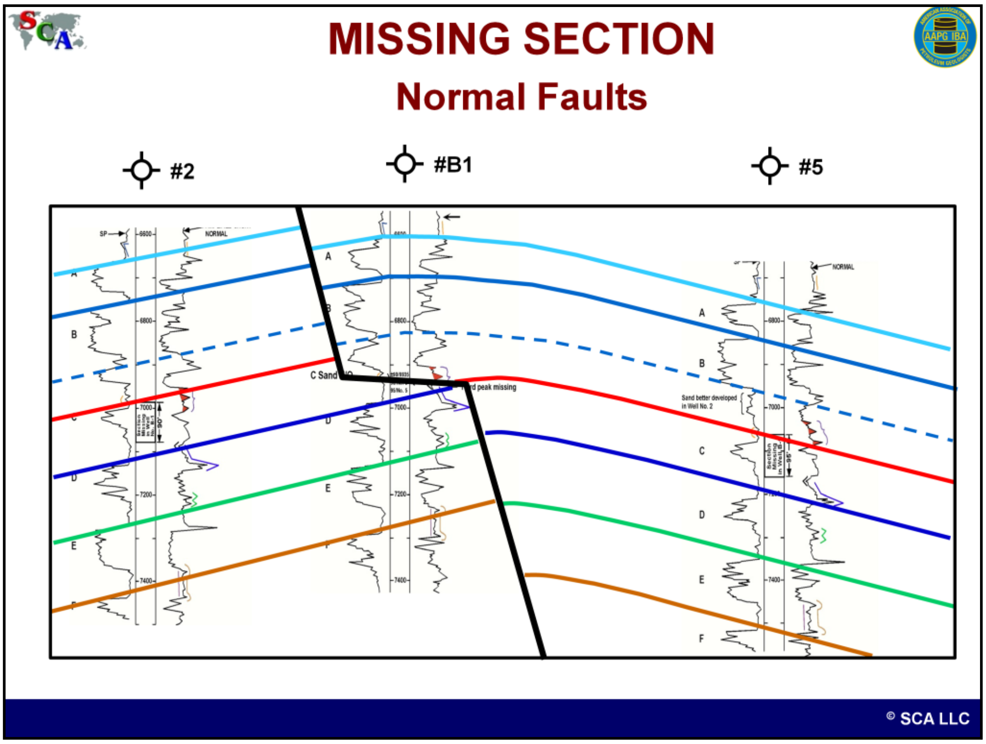
Vertical Separation (A – E) is the depth of intersection of the upthrown block at the fault minus the depth of the intersection of the downthrown block projected with the same dip across the fault to a position below the upthrown intersection. It is equal to the missing section and can be measured at any angle to the fault.

MISSING SECTION

Normal Faults

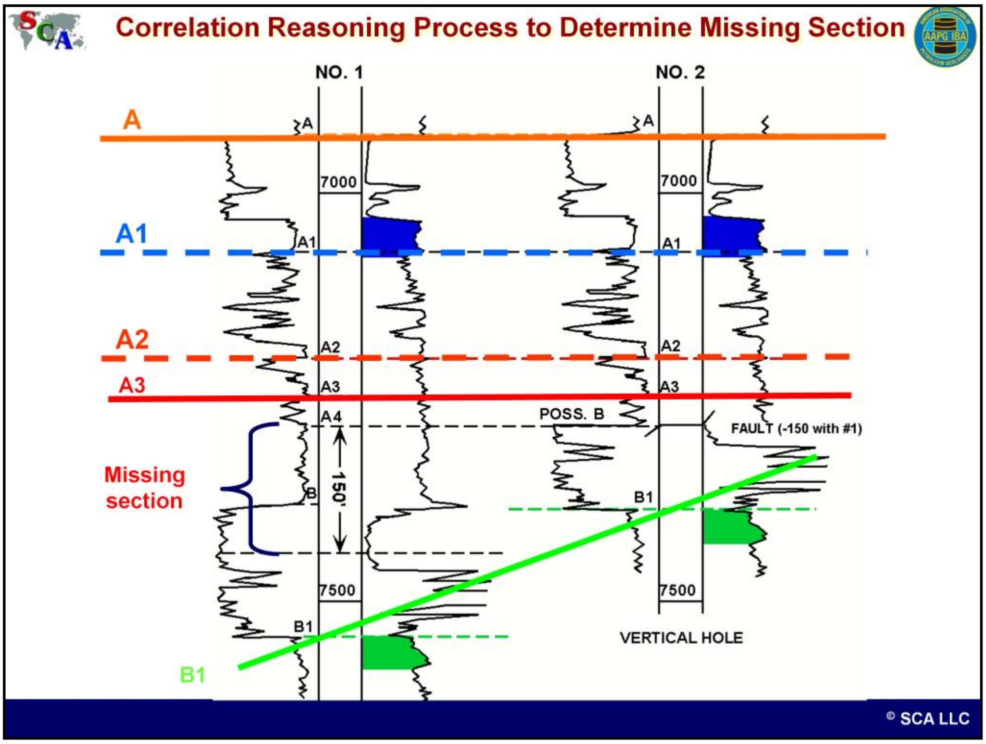


We can see in this outcrop of a normal fault that the horizons seen in the upthrown and the downthrown blocks would be missing in the middle well which was drilled in the fault gap of the three horizons.



We see the same thing in this cross section across a fault. The red horizon is missing in the middle well as the well crosses from the downthrown block into the upthrown block.

The missing section in the well is the vertical separation, NOT the throw.

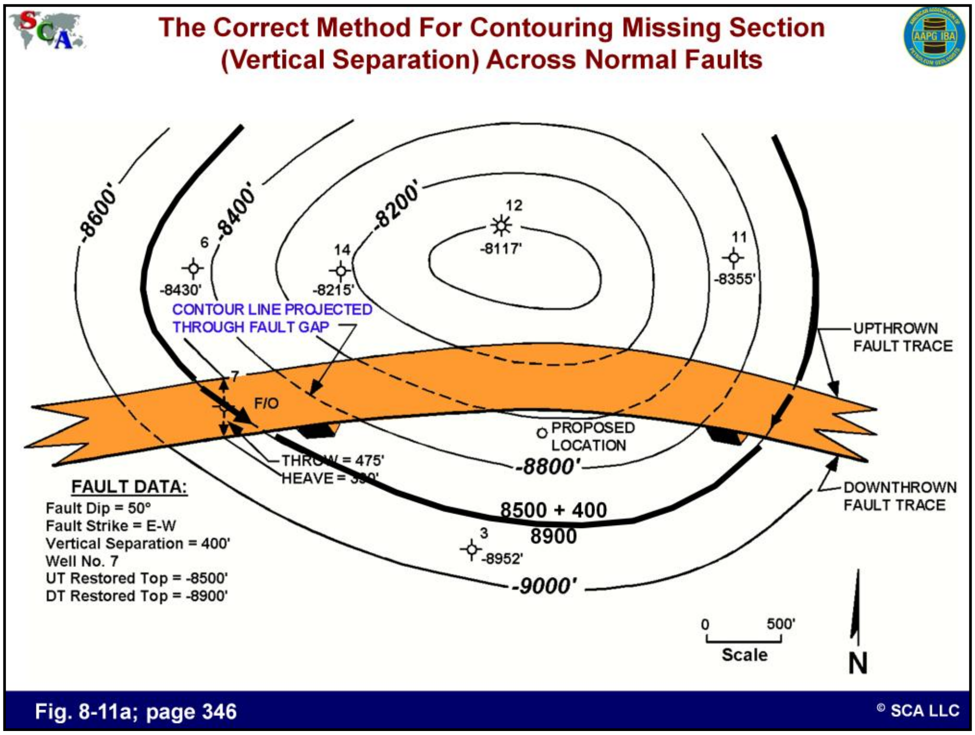


To identify the missing section when correlating wells, we correlate the wells until we reach a place in the wells where we lose correlation. In this case, just below the A3 marker, well 2 encounters a sand whereas well 1 is still in shale.

We annotate both wells, well 1 showing a fault (or unconformity) and well 2 is annotated to indicate the top of the missing section.

Correlation is re-established below the fault, marker B1 in this example. Then the correlations are worked back up the wells until you get to the fault observed in well 1. At the corresponding point in well 2, we annotate this as the base of the missing section.

The difference in the depth of the top and base of the missing section gives us the vertical separation.

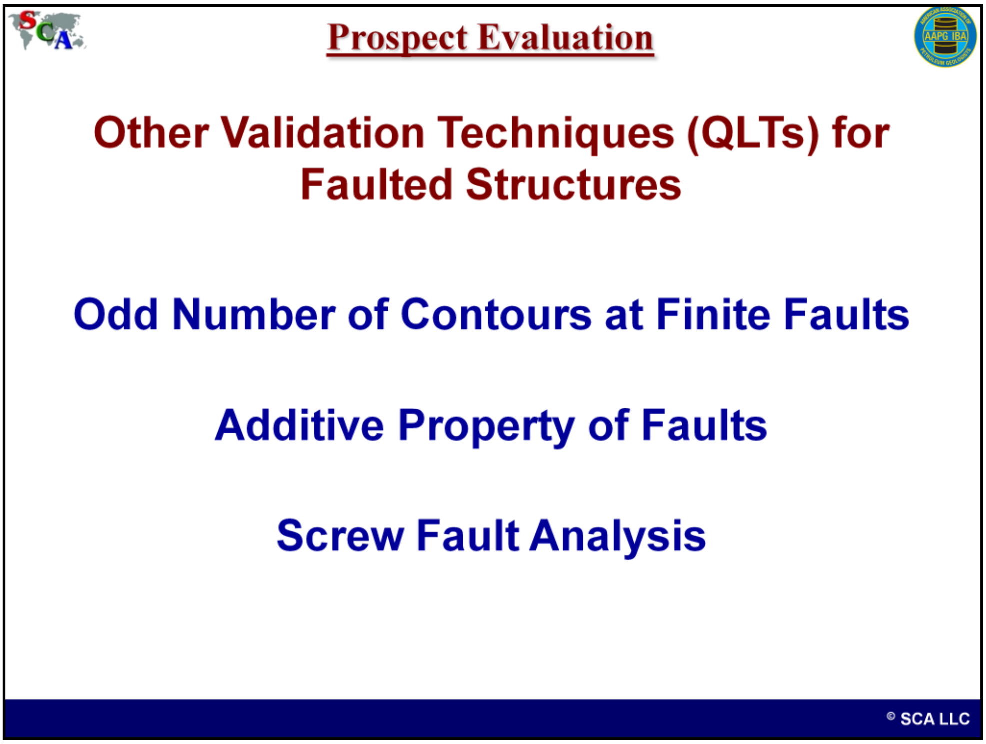


When mapping faulted structures we want to make sure that the map honors the vertical separation measured as the missing section in those wells that cross the fault.

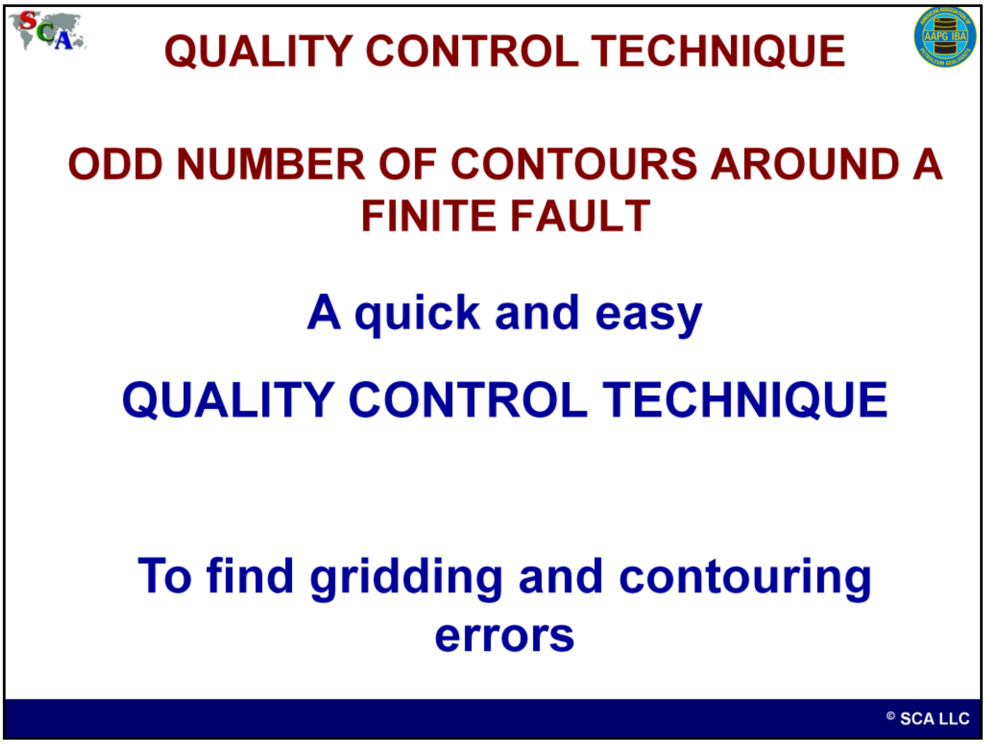
As we cross a fault from one side to the other, we carry the contours across with the same strike to ensure that we have contour compatibility.

Once the contour crosses the fault, we either add or subtract the vertical separation, depending on whether we are going from upthrown to downthrown, or downthrown to upthrown..

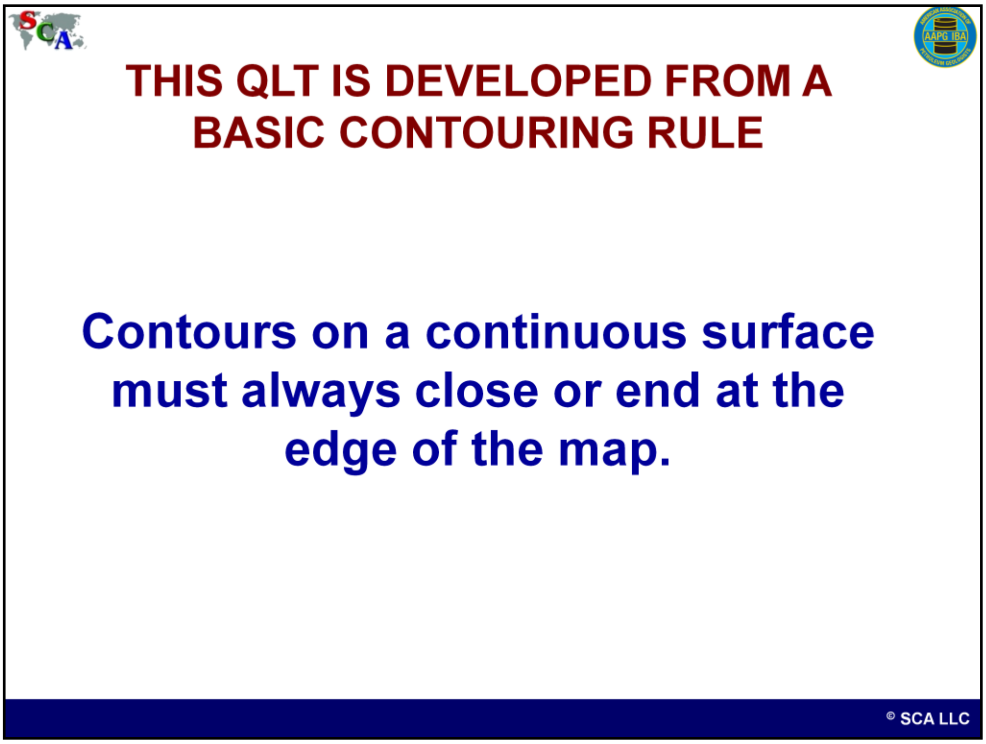
In this example, we have a faulted structure with a fault that has 400 feet of vertical separation. So when the 8500 contour reaches the fault, we carry it across with the same strike, and add 400 feet. The downthrown contour, therefore, has a value of 8900.



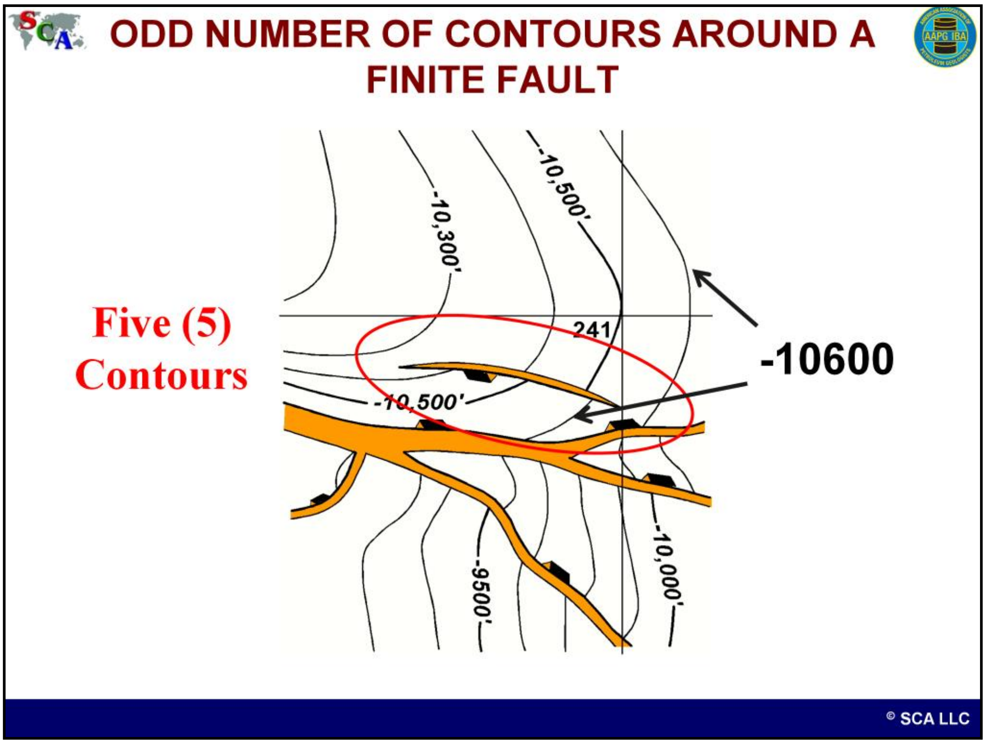
There are several other quick look techniques for validating that the structure map generated in the workstation is correct.



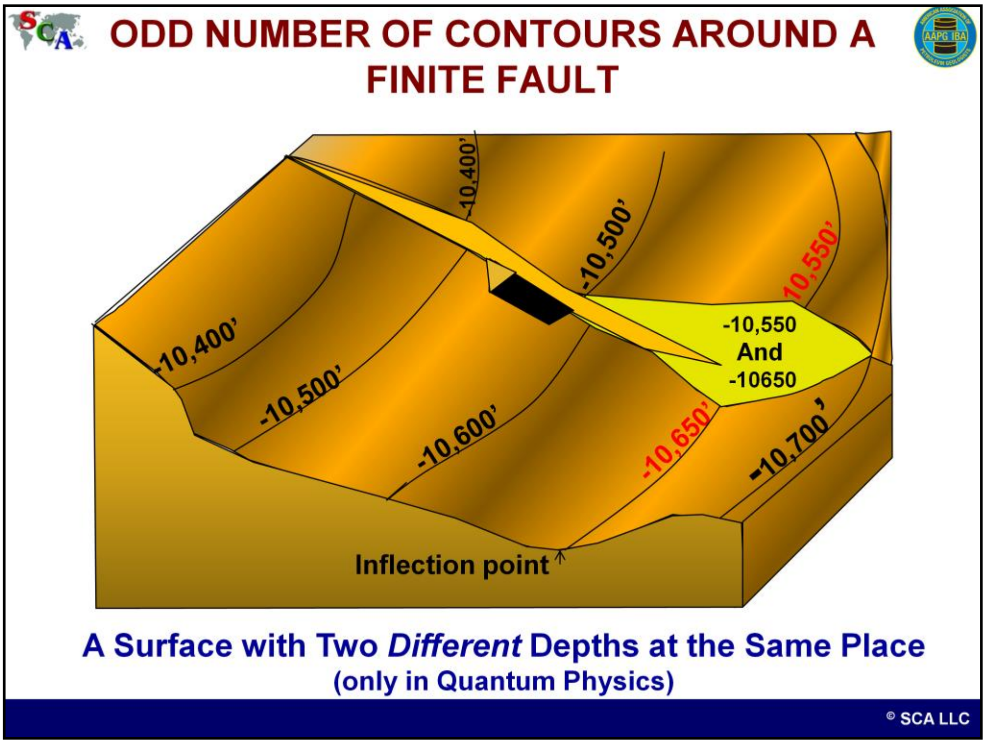
Another quick and easy to apply validation method is to count the number of contours intersecting a finite fault. For the map to be valid, there must be an even number of contours intersecting the fault.



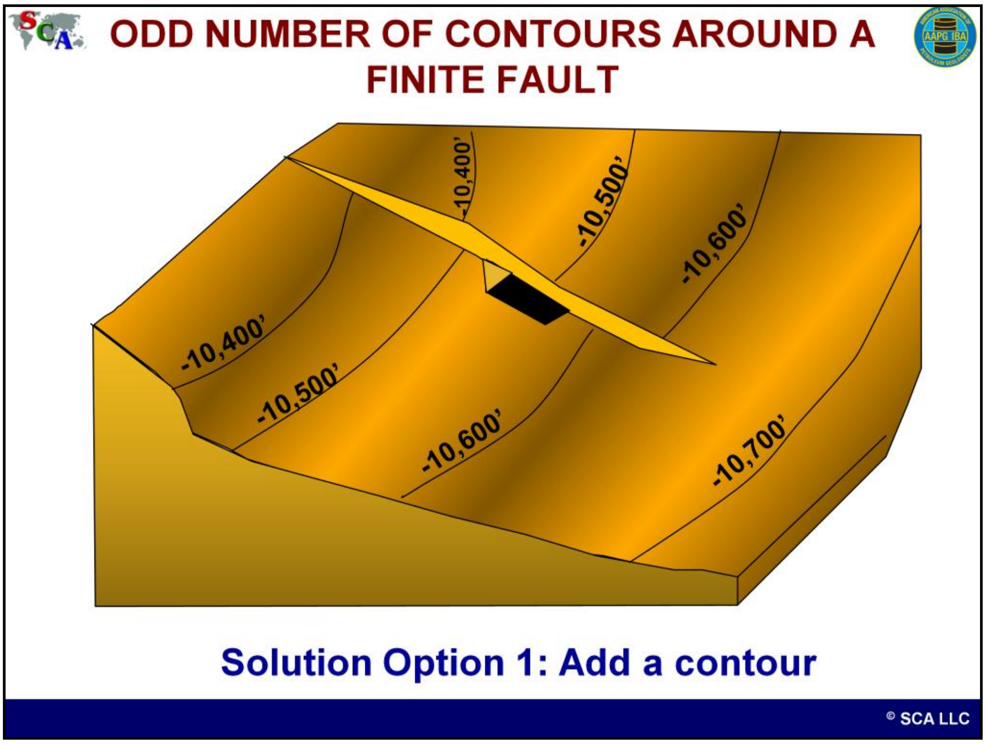
This technique comes from the basic contouring rule that contours on a continuous surface must close or extend to the end of the map



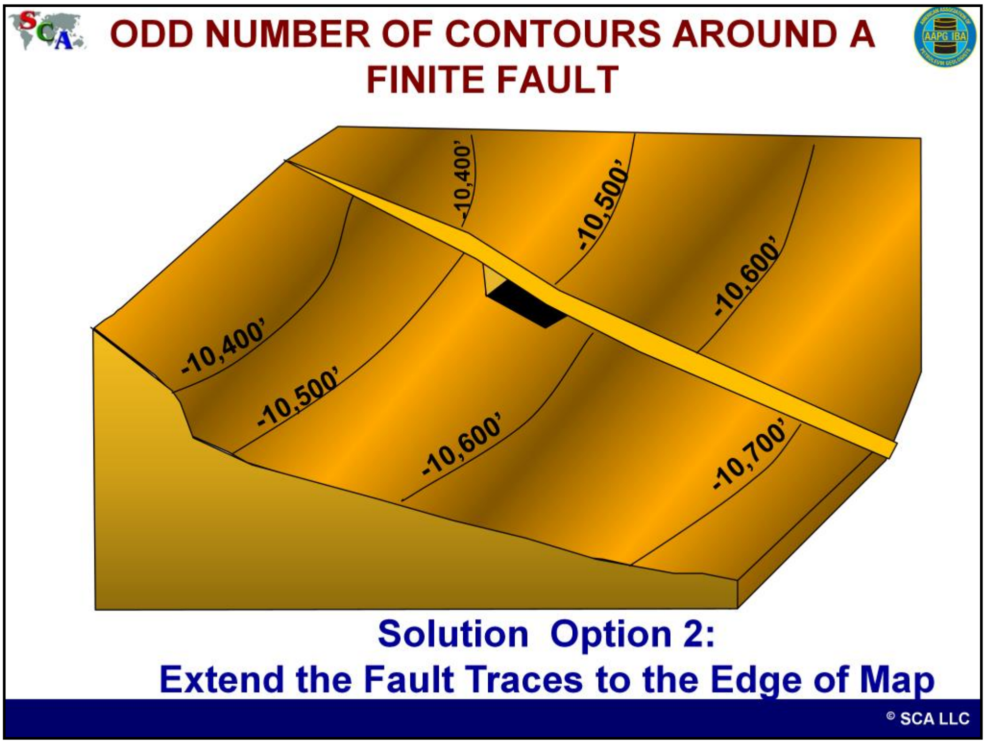
In this map, we see a finite fault, that is a fault that has both tips seen in the map,. We can quickly determine that there are 5 contours intersecting that fault, which is geometrically impossible as it makes two contours have a value of -10,600 feet.



It may be possible for a surface to have two different values in the same place in quantum physics, but it is not possible in the earth.



If your map has an odd number of contours intersecting a finite fault, you can add a contour to the map.



Or, if the data allows, you can extend the fault traces to the end of the map or to a fault intersection.

QUALITY CONTROL TECHNIQUE

THE ADDITIVE PROPERTY OF FAULTS

A quick and easy

QUALITY CONTROL TECHNIQUE

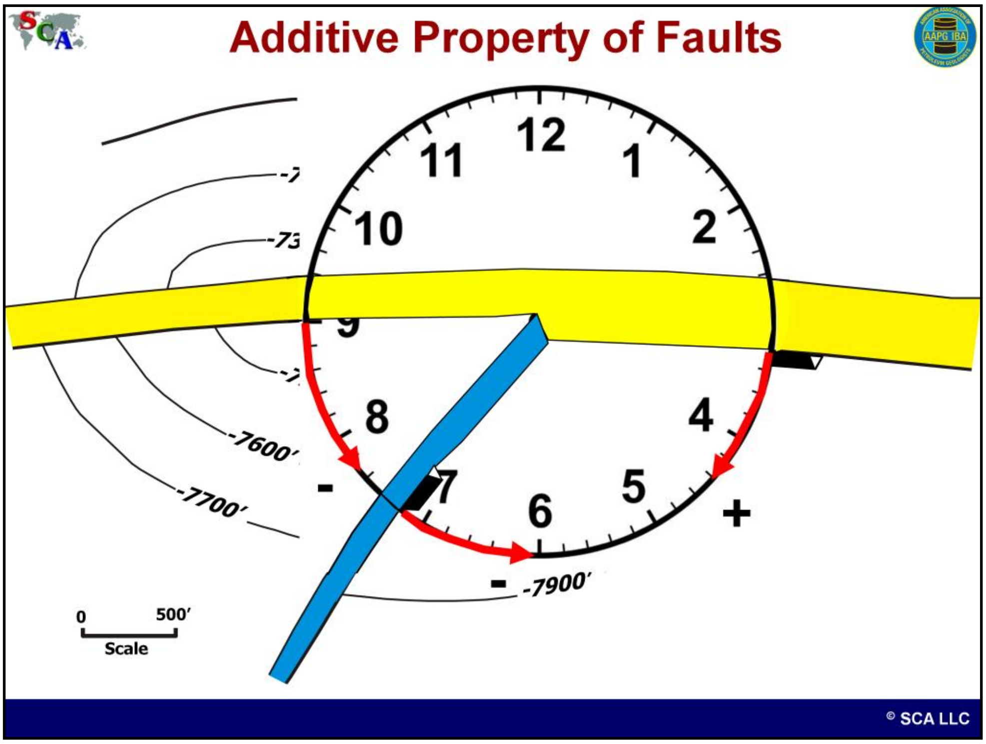
To validate that vertical separation was applied where faults join

Here is another simple to apply technique to validate your maps; sum the vertical separation at fault intersections.

ADDITIVE PROPERTY OF FAULTS

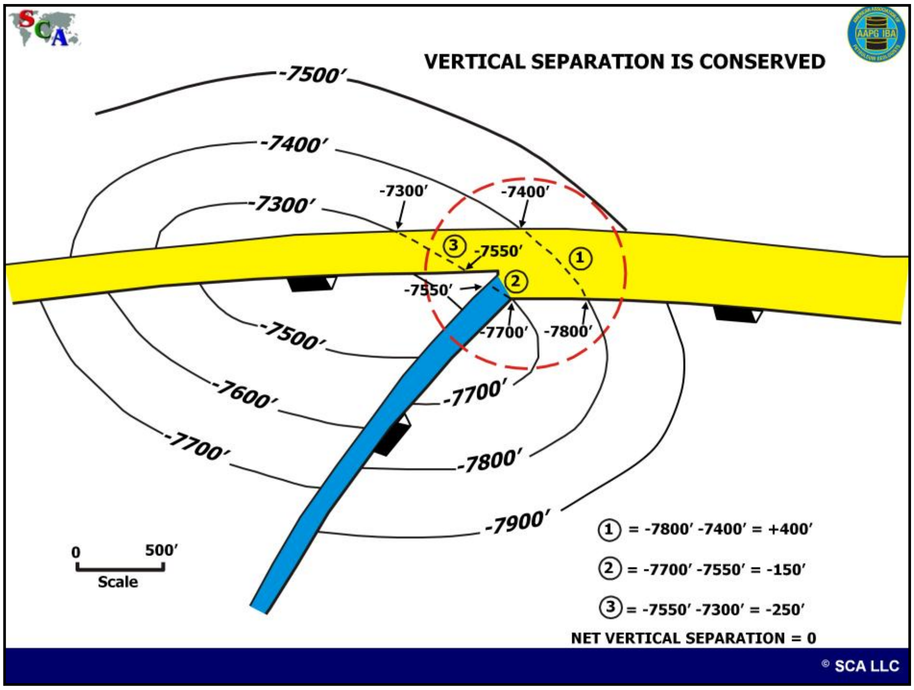
The additive property of faults, simply defined, states that in areas where two or more faults have an intersecting relationship, the algebraic sum of the vertical separations must equal zero at the intersection.

The additive property of faults states that the algebraic sum of the vertical separation at fault intersections must equal 0..



For faults that move in a clockwise direction make the displacements positive

For faults that move in a counter clockwise direction make the displacements negative



Looking at this faulted structure we see it is cut by two intersecting faults. We can look at the vertical separation at the intersection to see if the map is valid.

Crossing from UT to DT at point 1 we get 7800 – 7400 = 400 feet.

The offset across the fault is clockwise, so we make it + 400

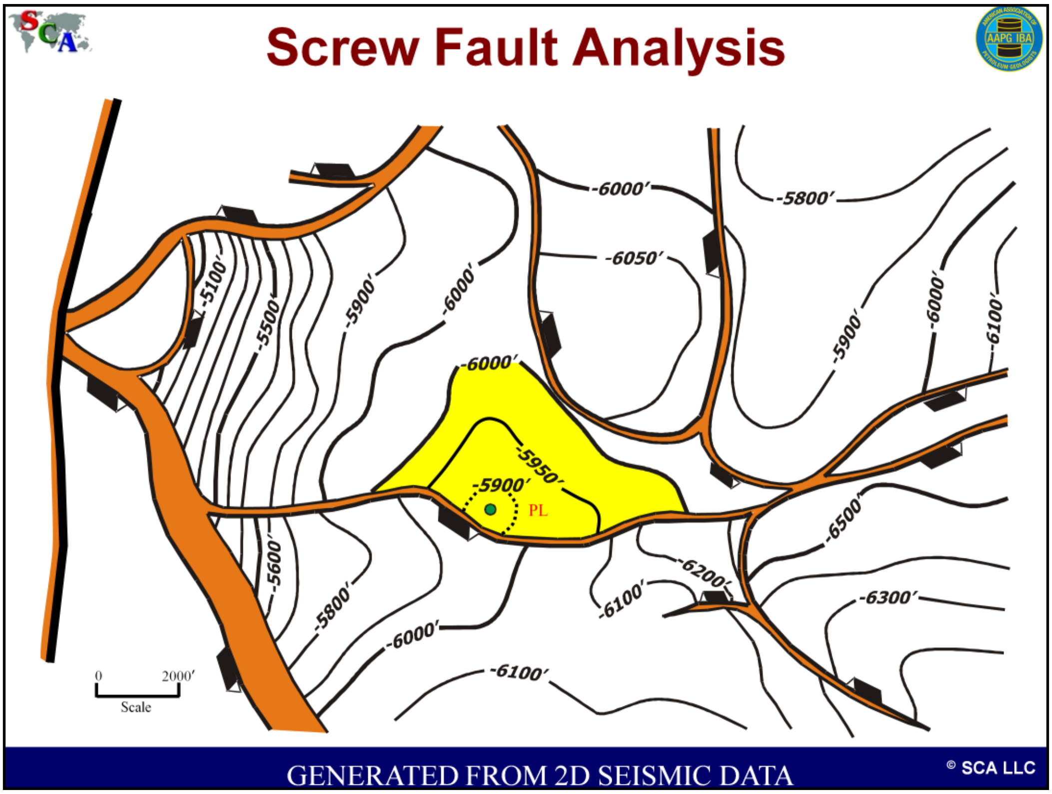
Crossing from UT to DT at point 2 we get 7700 – 7550 = 150 feet

The offset across the fault there is counter clockwise, so we make it - 150

Crossing from UT to DT at point 3 we get 7550 – 7300 = 250 feet
The offset across the fault there is also counter clockwise, so we make it -250

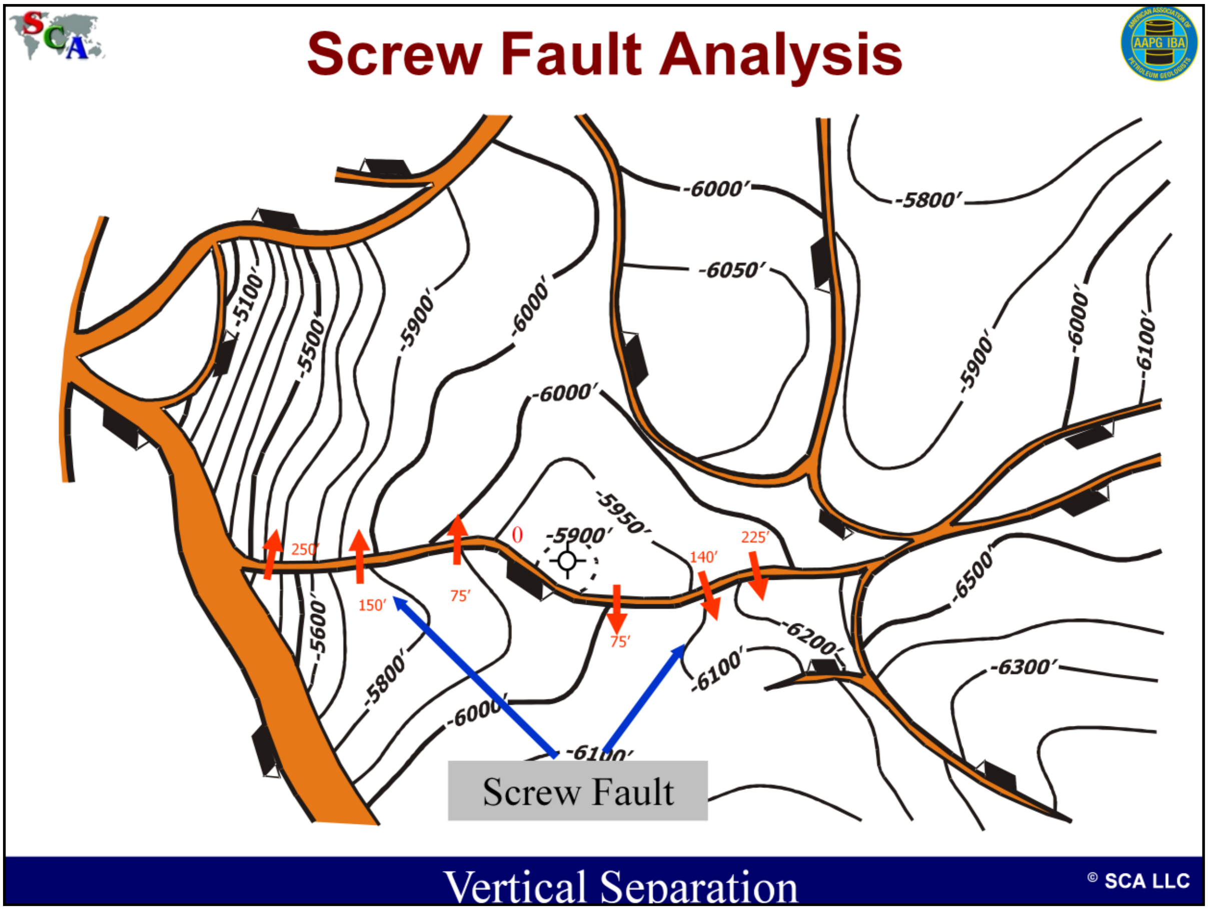
400 – 150 – 250 = 0 so we know that the contours at the fault intersection are valid

Looking at the vertical separation across key trapping faults to determine if they are screw faults is another simple technique to validate your map and prospect.



Here is a structure contour map generated with tight grid of 2D seismic for a prospect in the Gulf of Mexico, a passive margin characterized by extensional faults. Is this map geometrically valid?

Since we are dealing with a 2 dimensional map that is portraying a 3 dimensional surface, it takes more understanding, investigation and analysis to identify geometric problems.

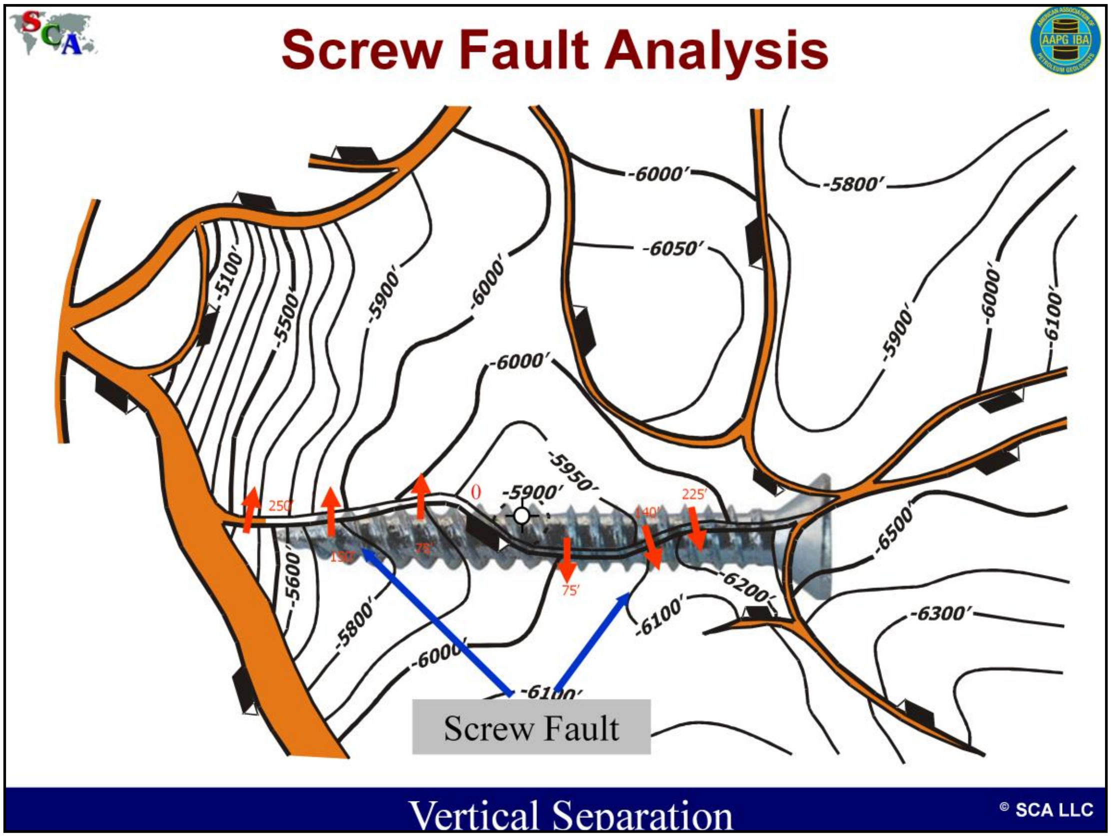


The prospect was drilled and the result was a dry hole

Let's examine the trapping fault

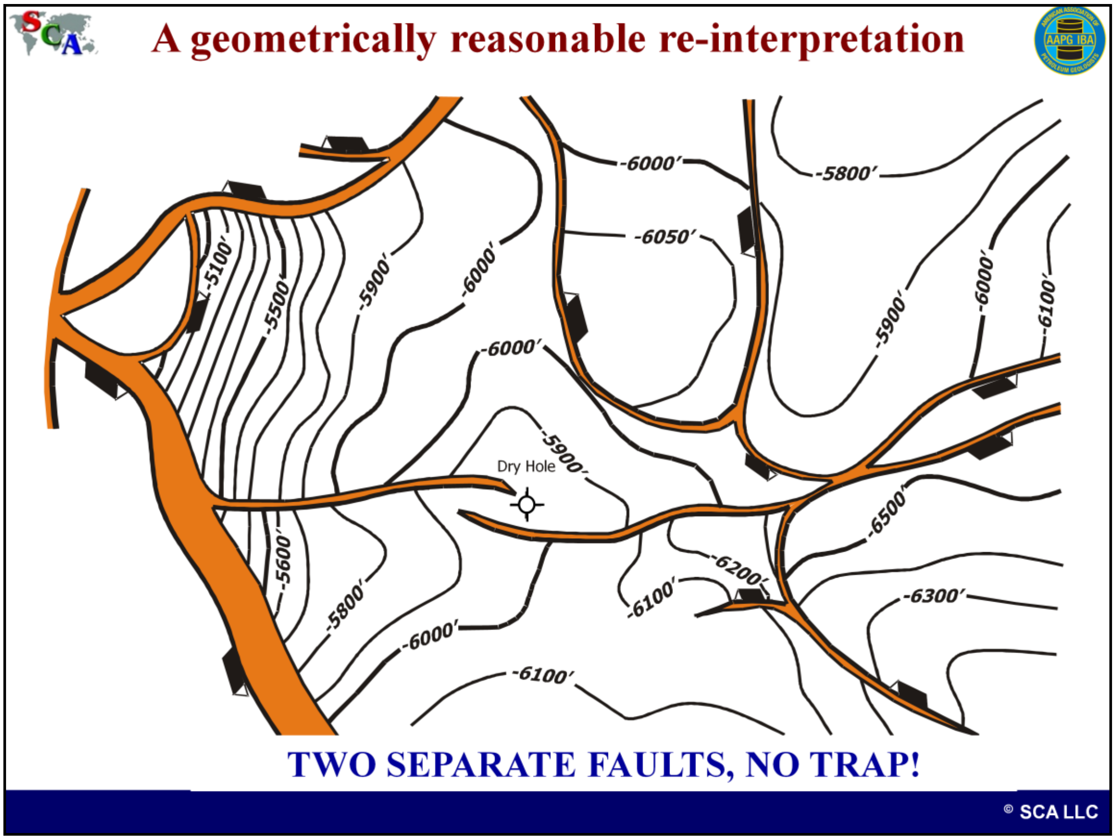
The amount of offset along the trapping fault decreases from east to west. The offset then increases again but the sense of throw is to the north, or up-thrown direction. There is almost no offset at the well location

This is a screw fault.



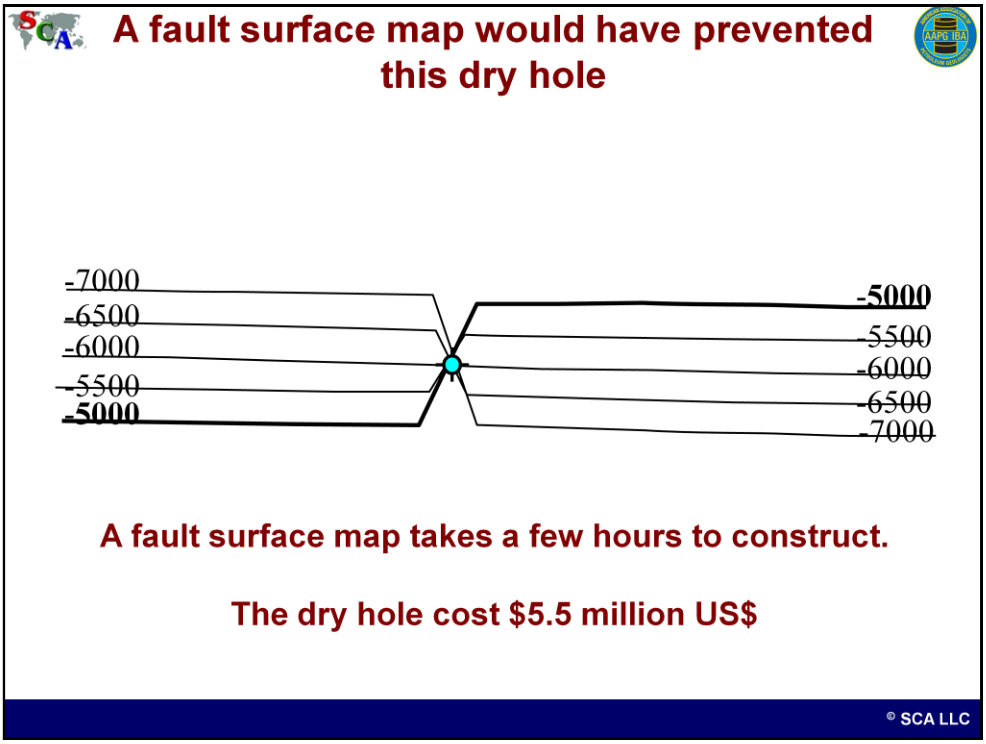
Screw faults CANNOT occur in compressional or extensional settings. Scissors faults can occur with strike-slip faults, but those faults are also nearly vertical.

We call these screw faults because the change in dip gives the fault the appearance of “screwing: through the map. Also, if you drill a fault closure defined by a screw fault, you are screwed.



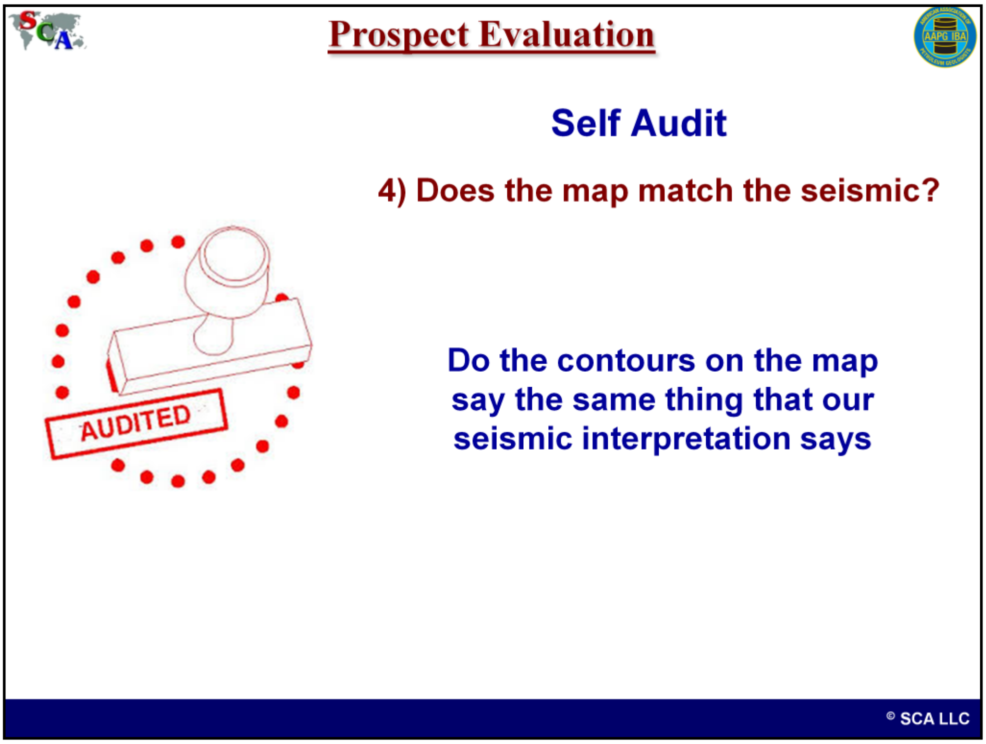
Screw Faults indicate 2 faults have been mapped as 1 fault.

This mistake is the result of picking fault sticks as opposed to mapping the fault surface.

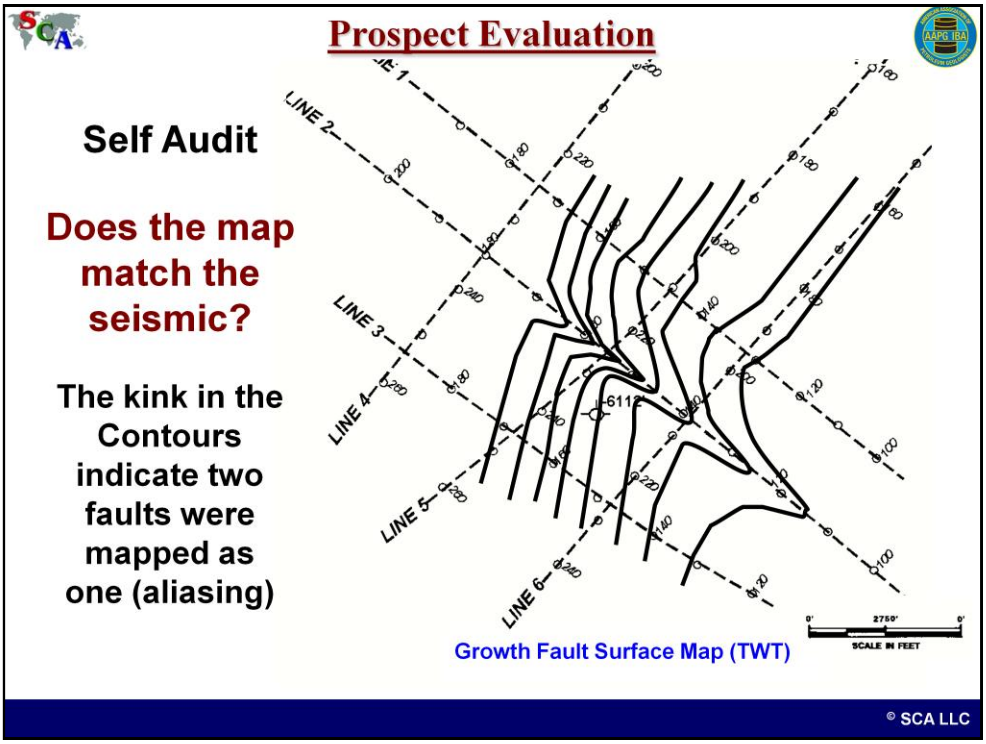


So, this $5.5 million dollar dry hole could have been avoided had the interpreter taken a few hours to contour the fault picks.

Making fault surface maps for any structure that is impacted by faults is essential to ensure that the maps are accurate.

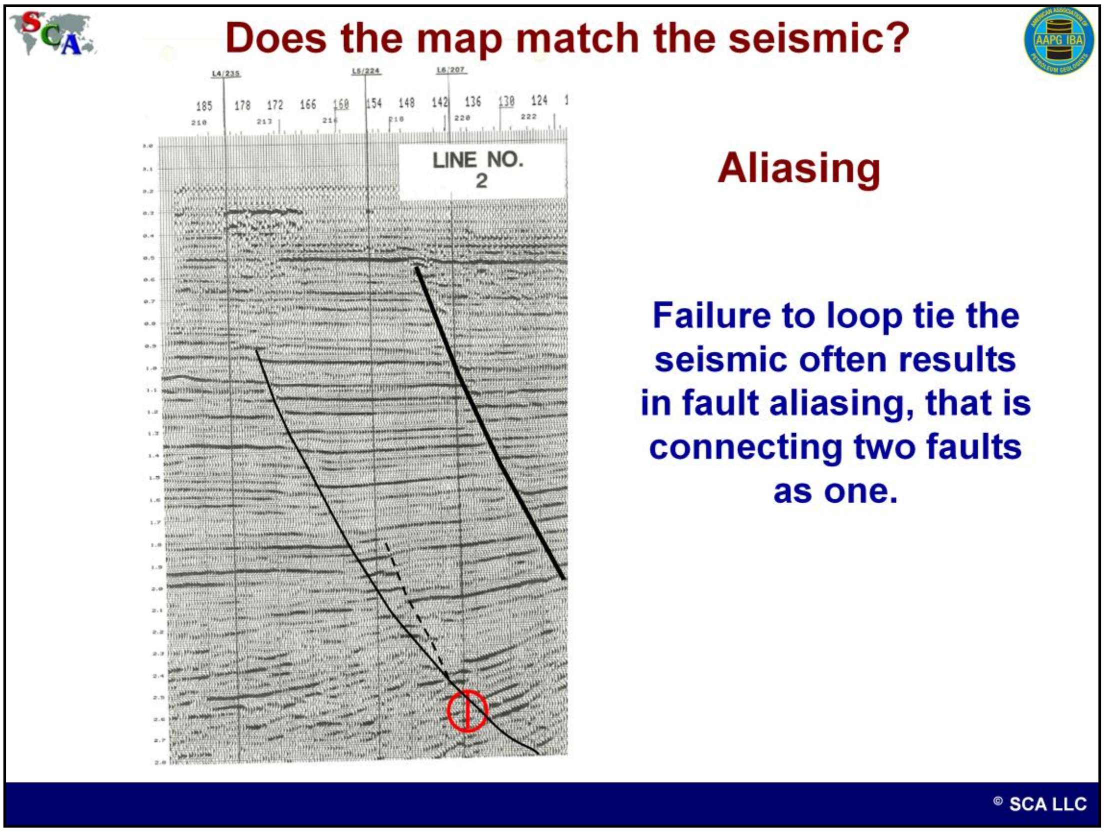


Now that we know that the map has been properly gridded and contoured, and that it exhibits contour compatibility and properly honors the vertical separation, we need to be sure that the final map matches our seismic interpretation.

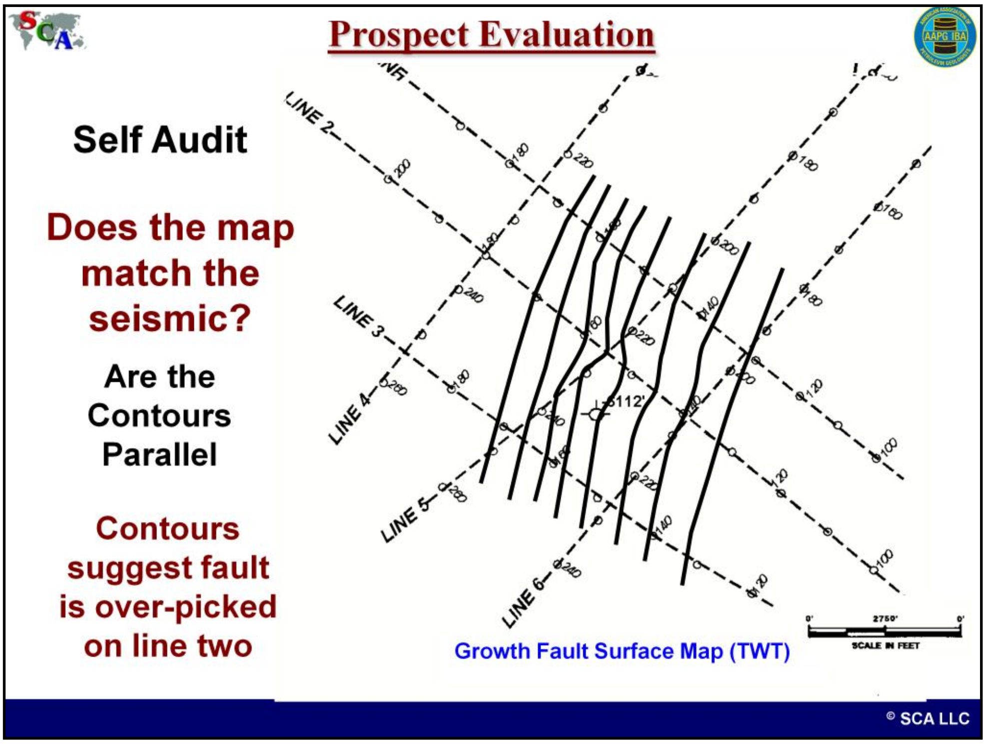


Here is a fault surface map for a growth fault. The kink in the contours at line 2 indicate that two faults were mapped as one. We call that fault aliasing.

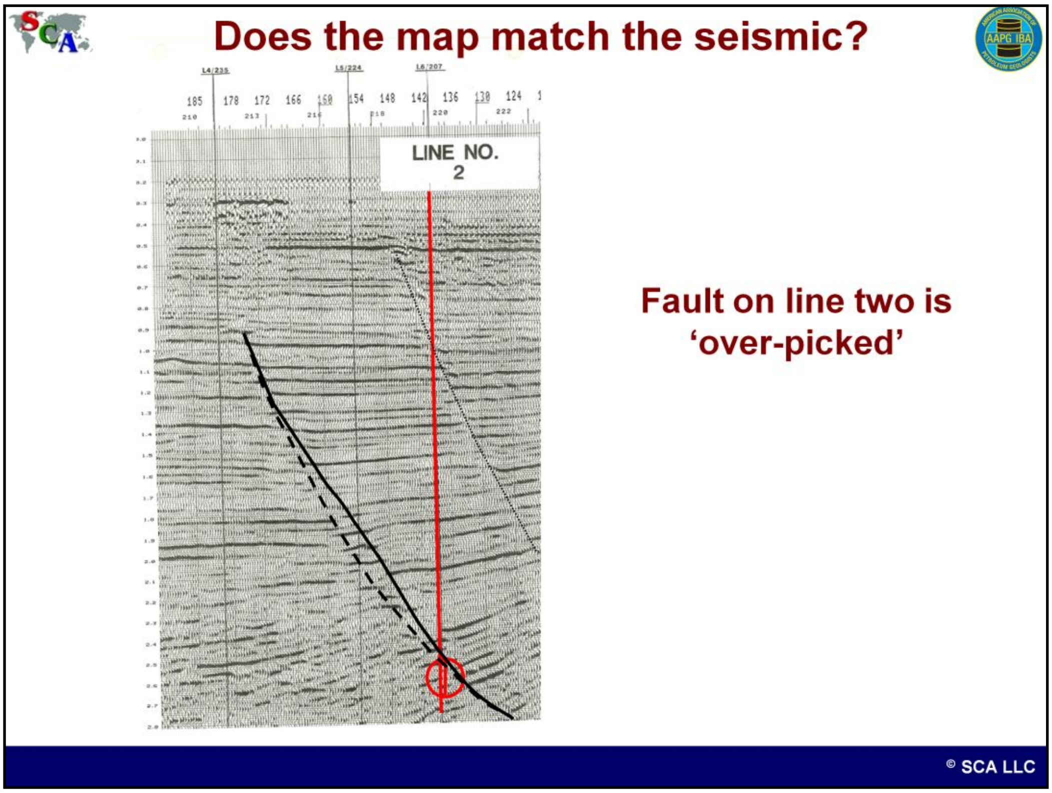
Having the fault surface map allows us to quickly see that we have incorrectly connected two faults as one.



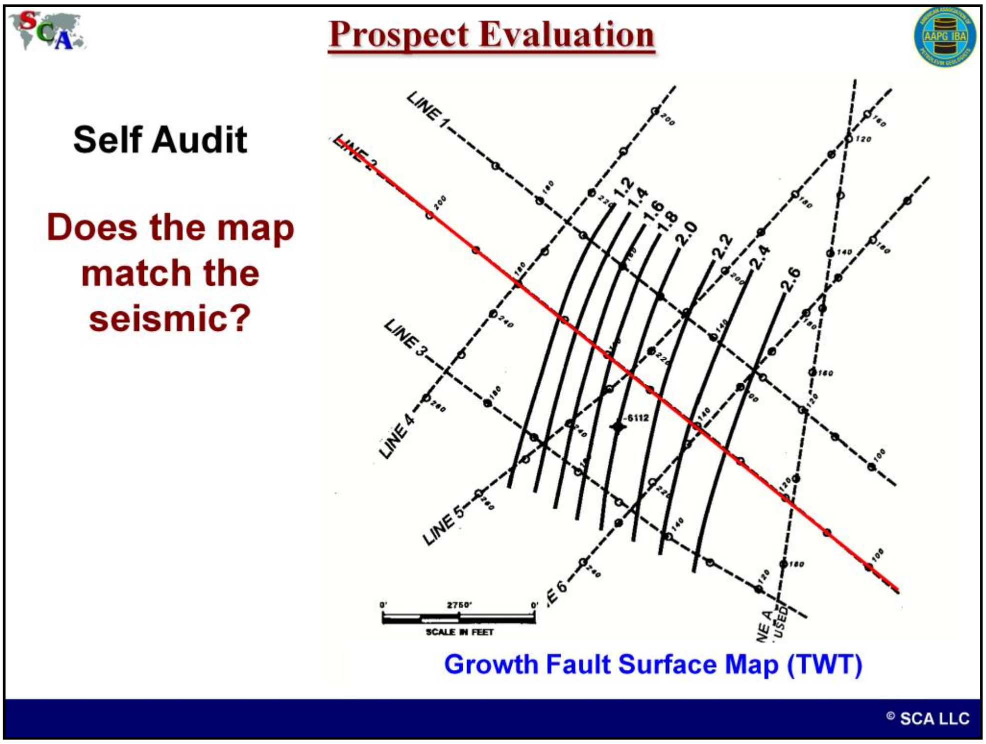
Failure to loop tie the seismic often results in fault aliasing, that is connecting two faults as one. The map shows that on line 2, we assigned the shallower fault observed on the line to the fault we are mapping, which is actually the deeper fault as indicated by the red circle used to show the tie to another seismic line.



In this example, we can see a small bend in the contours at line 2. This suggests that fault is over-picked on line two.



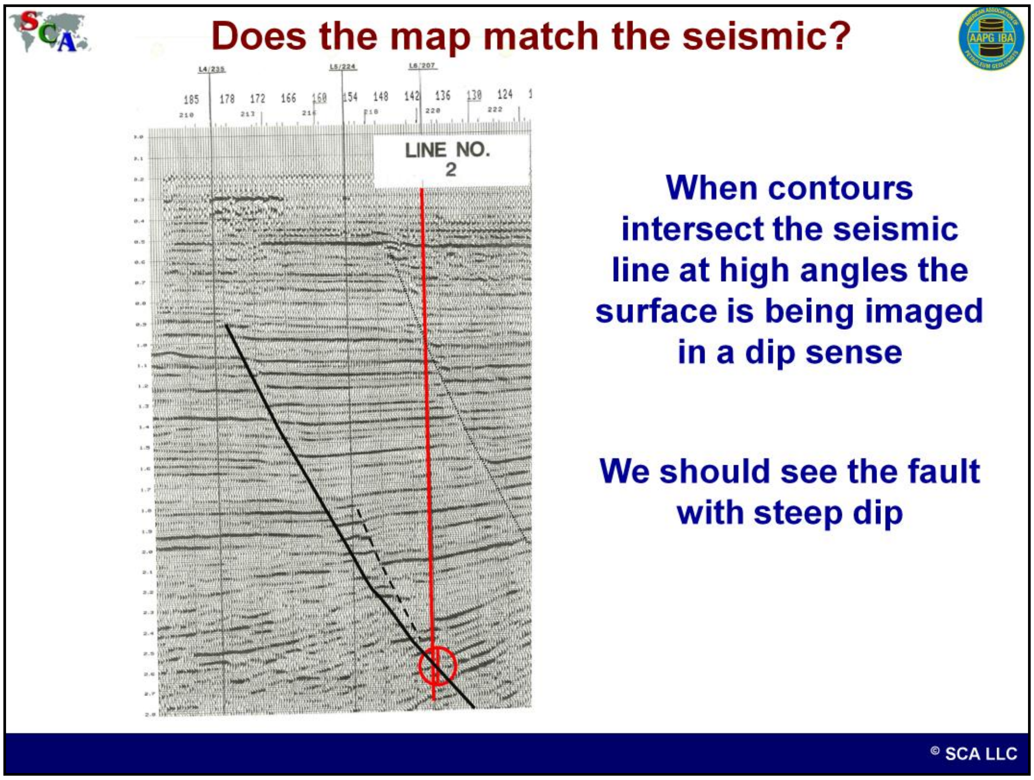
To make the contours better, we can reexamine line 2 and see that we can move our fault pick back to the dashed line.



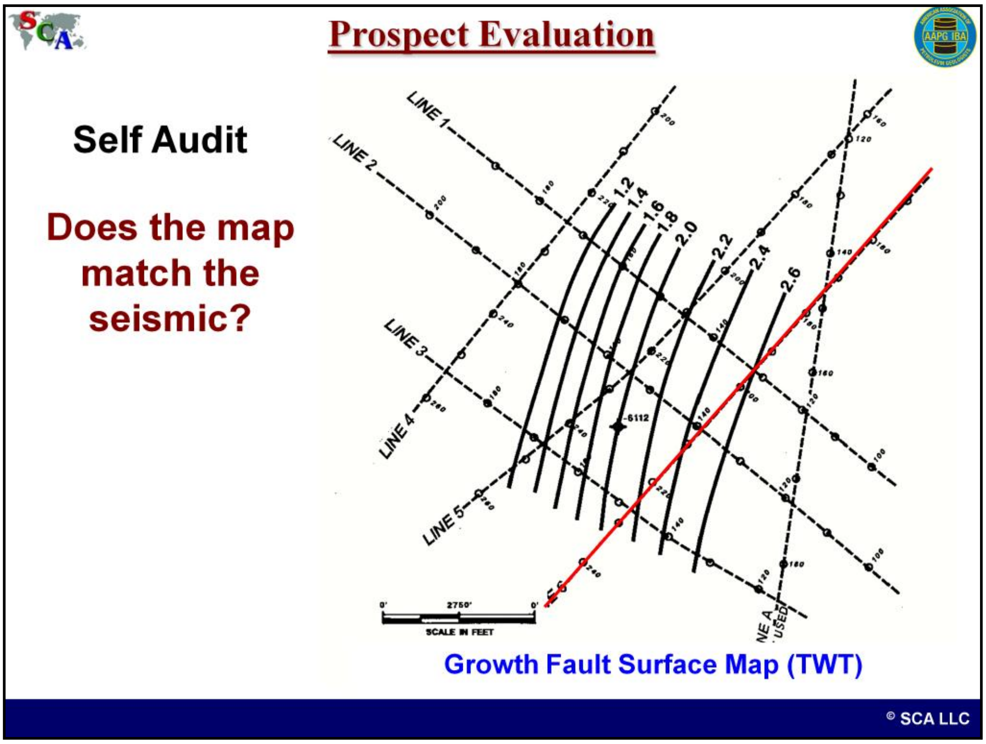
Now the map shows parallel contours, so the map looks reasonable, We still need to be sure that the map and the seismic 'tell the same story'.

Looking at line 2, we can see that the fault surface contours intersect the line at near right angles. Therefore, on line 2, the fault should be steeply dipping.

Since the contour spacing increases with depth, the fault should also appear listric.

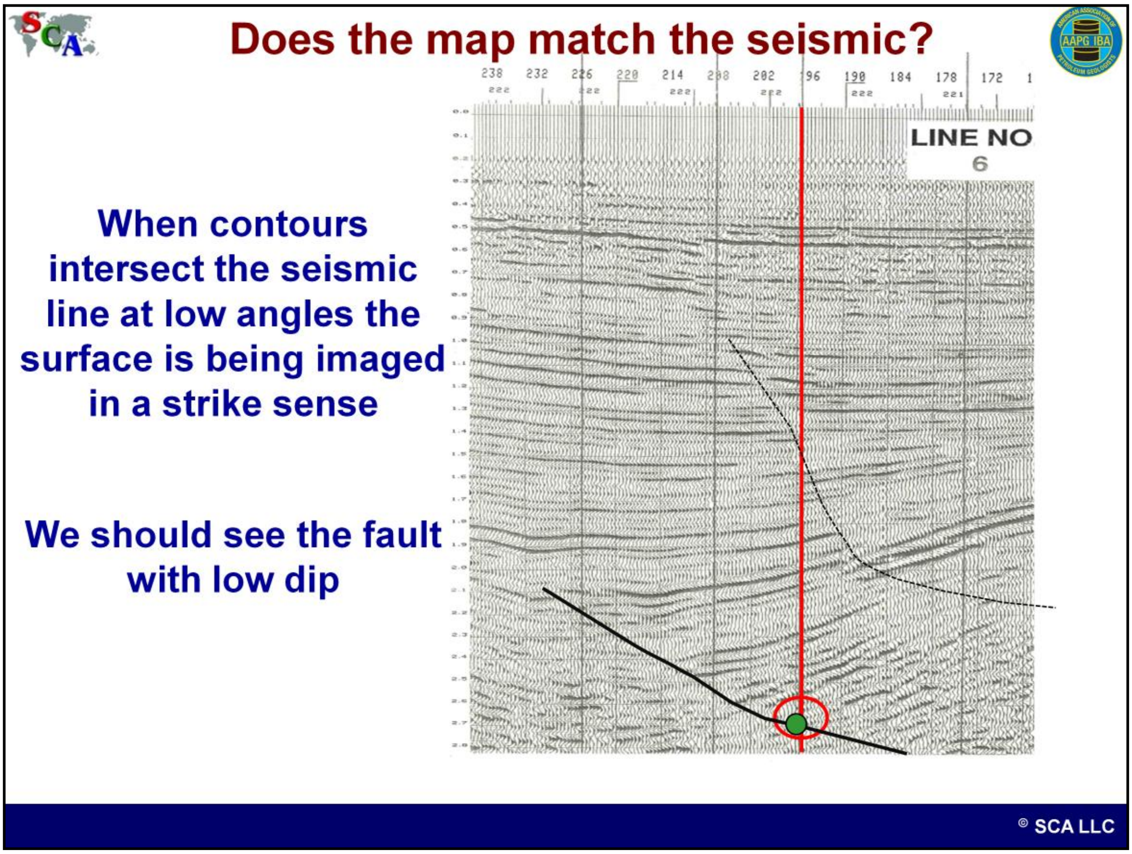


Looking at line 2, we can see that the fault is steeply dipping and that the fault has a listric geometry. Therefore, the map and line two are telling the same story.

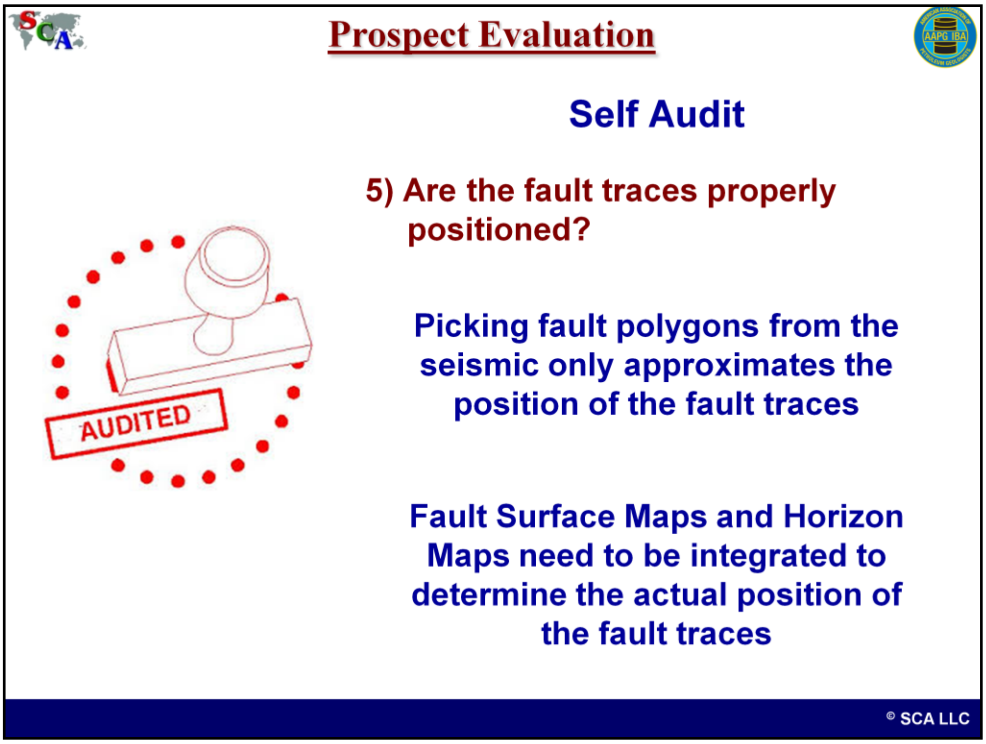


Looking at line 6, we can see that the fault surface contours intersect the line at near an oblique angle. Therefore, on line 6, the fault should be gently dipping.

Since the contour spacing increases with depth, the fault should also appear listric.



Looking at line 6, we can see that the fault is gently dipping and that the fault has a listric geometry. Therefore, the map and line six are telling the same story.



Self audit step 5 is a critical audit step. If fault surface maps were not constructed and integrated with the horizon map, then the fault traces are not in there correct position.

Industry has spend many hundreds of millions of dollars drilling wells into fault gaps because the fault traces were not shown in their proper position.

Integrating Fault Surface Maps And Horizon Maps

So lets look at the process for integrating fault surface maps with horizon maps

FAULT / STRUCTURE MAP INTEGRATION

Step 1: Construct Fault Surface Map

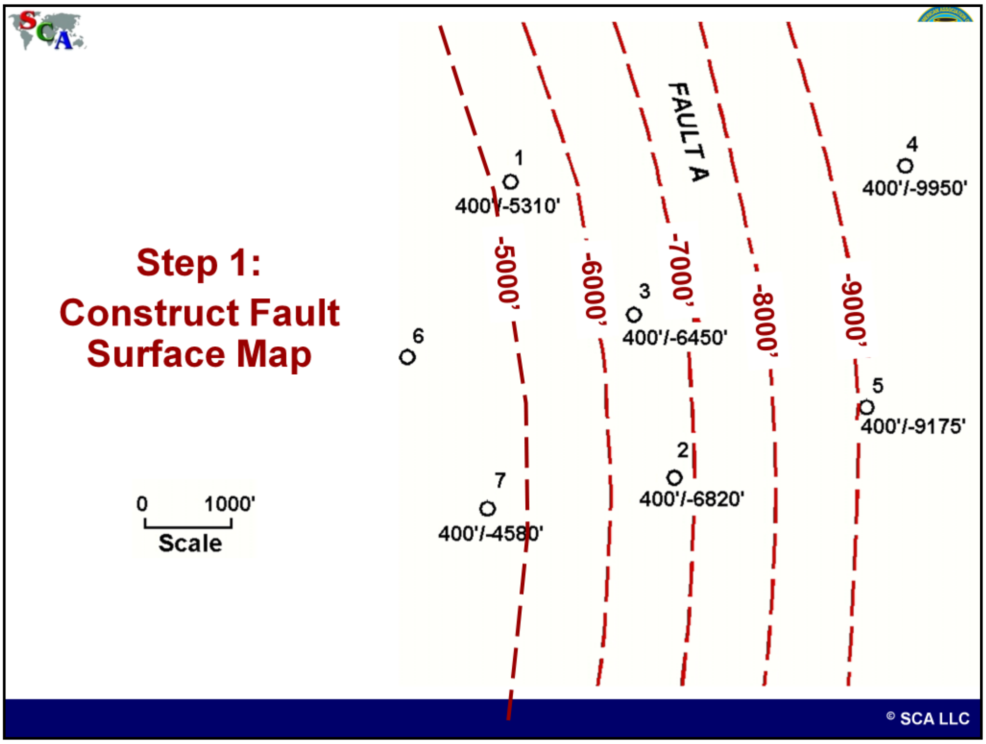
Step 2: Contour the Fault Block with the Most Data

Step 3: Integrate the Contour Map with the Fault Surface Map to define the Fault Trace for the Contoured Block

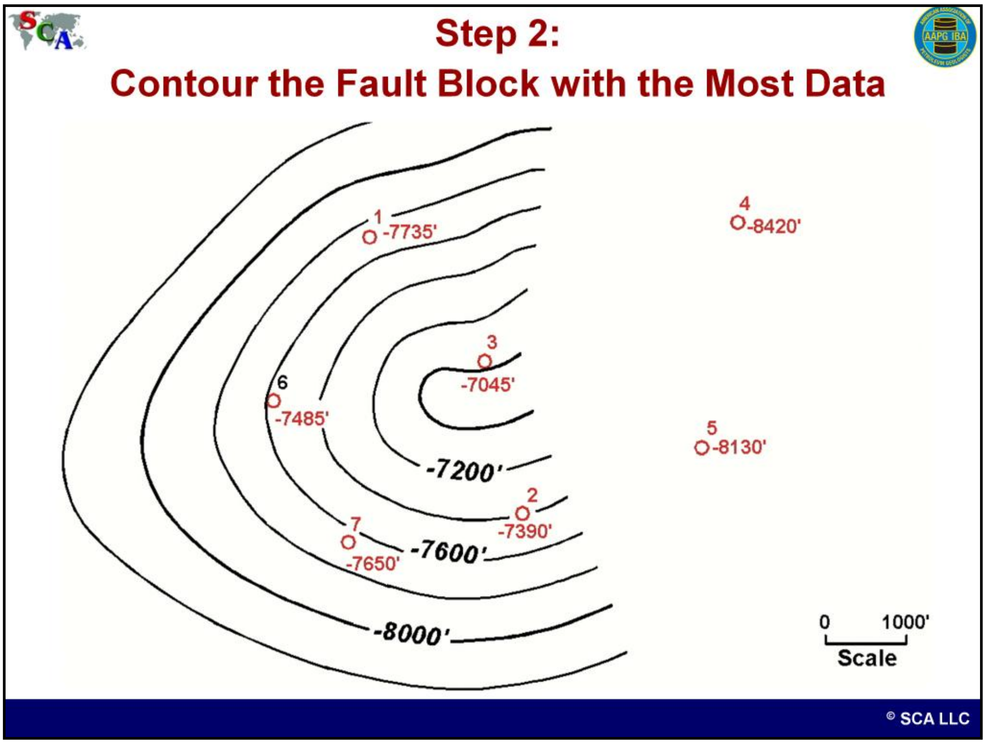
Step 4: Apply Missing Section and Structural Compatibility to Contour the remaining Fault Block

Step 5: Integrate the Contour Map with the Fault Surface Map to define the Fault Trace for the newly Contoured Block

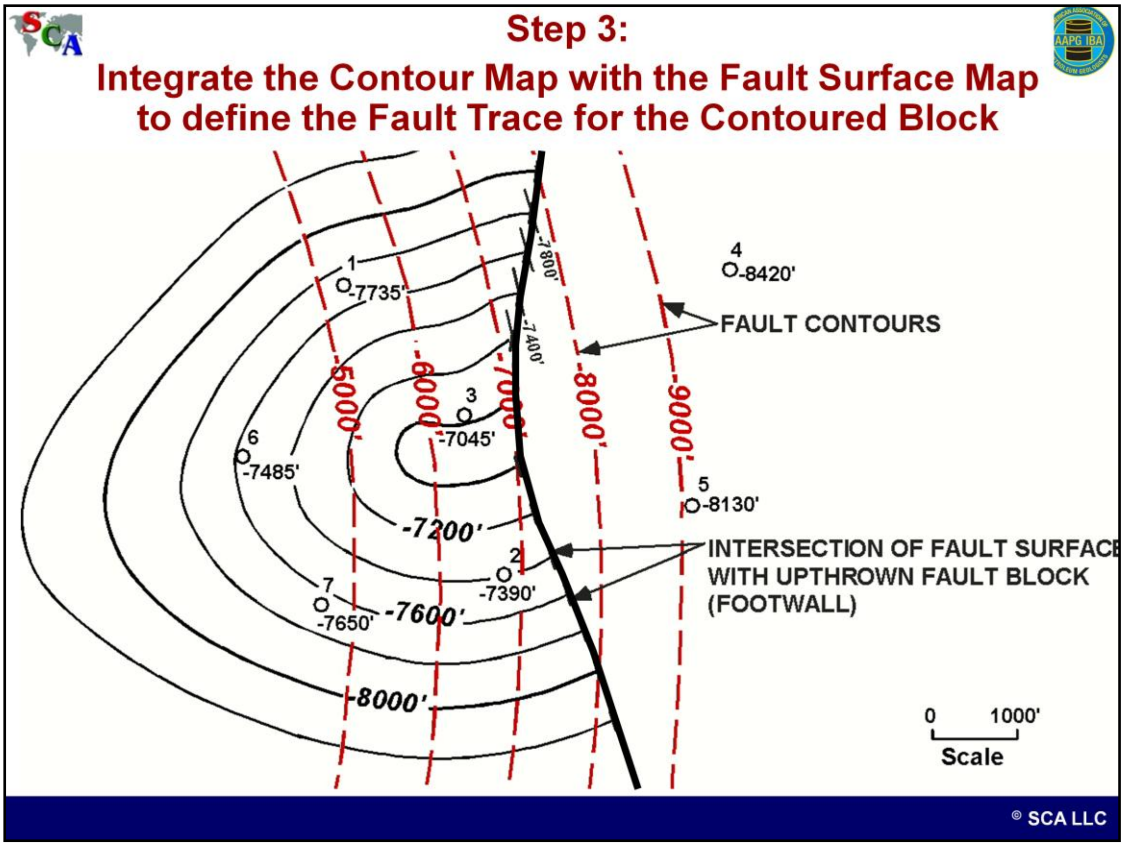
There are 5 steps to the process



Step 1: Construct a contour map of the fault surface



Step 2 Contour the fault block with the most data

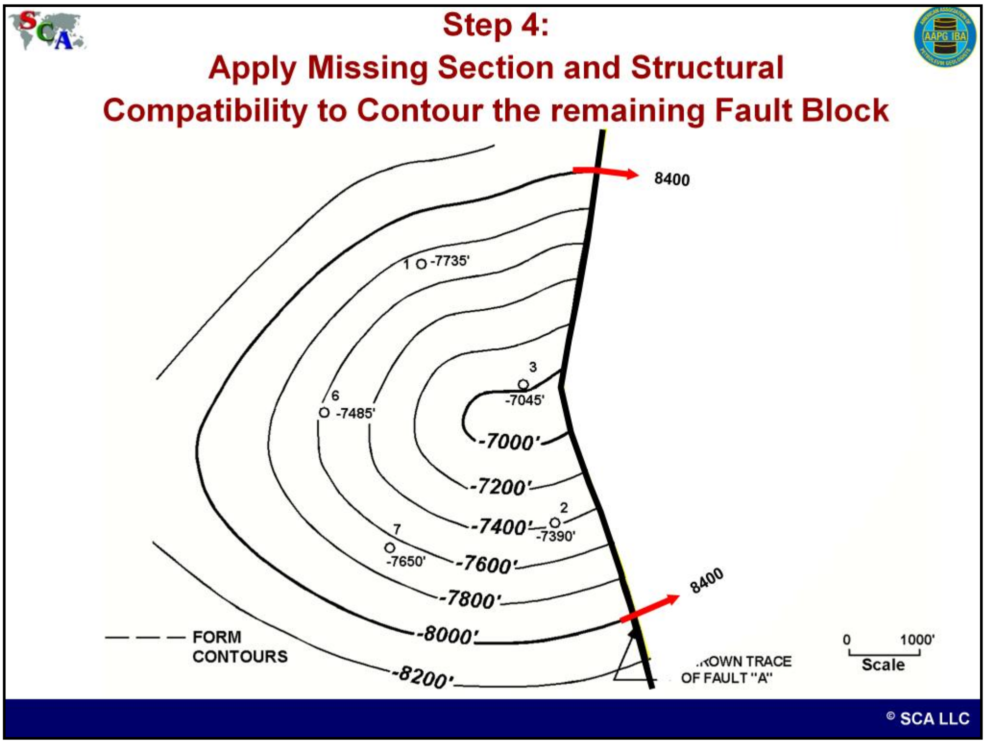


Step 3 Integrate the contour map with the fault surface by marking the position where contours of the horizon intersect contours of the same value on the fault surface.

For this example, we have marked where the 7000, 7200, 7400, 7600, 7800, and 8000 foot contours intersect the fault surface contours of the same value on the north flank of the structure. We did the same for the south flank of the structure.

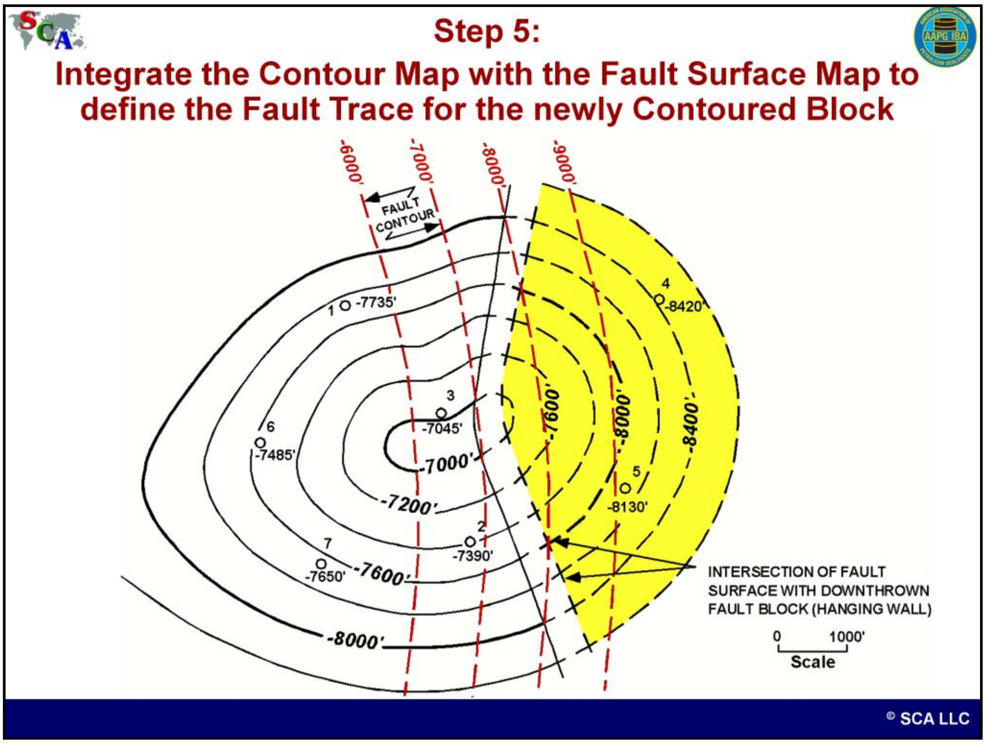
We then connect the marks to define the UT fault Trace

Note, the fault trace bends to the east whereas the fault surface (red contours) strikes north northwest. That is because the fault surface contours are lines of equal depth for the fault. The fault trace represents the intersection of the fault surface contours with the horizon contours, such that the depth of the fault trace varies across the map/

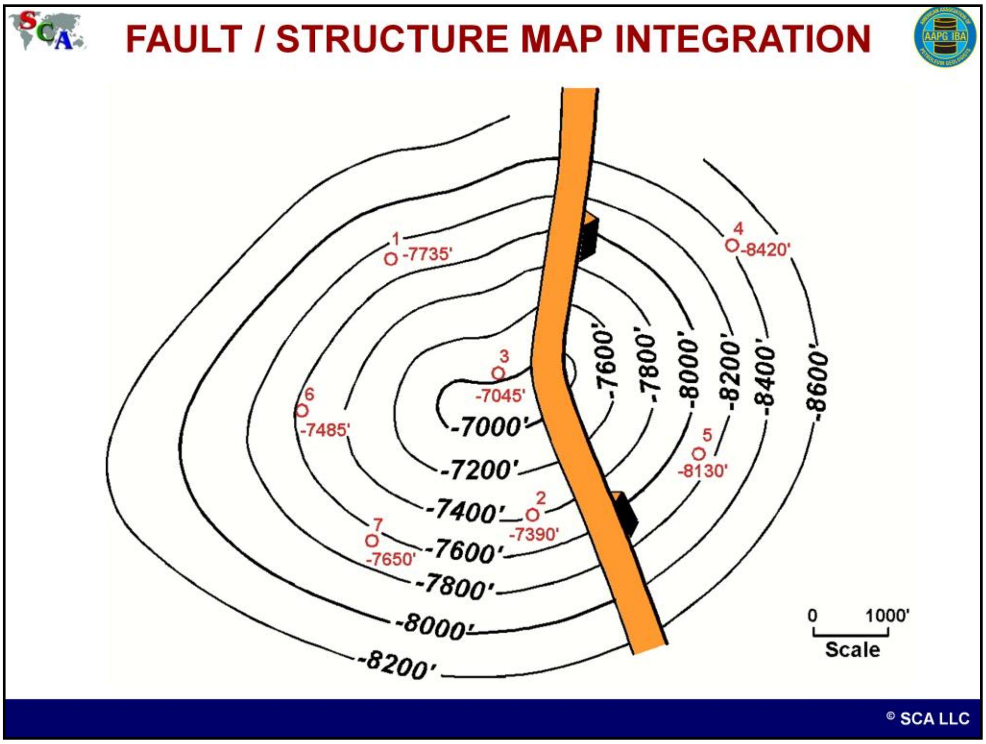


Next you project the contours across the fault with the same strike they have at the fault (contour compatibility)

Add (or subtract) the missing section to the contour value and contour the remaining fault block

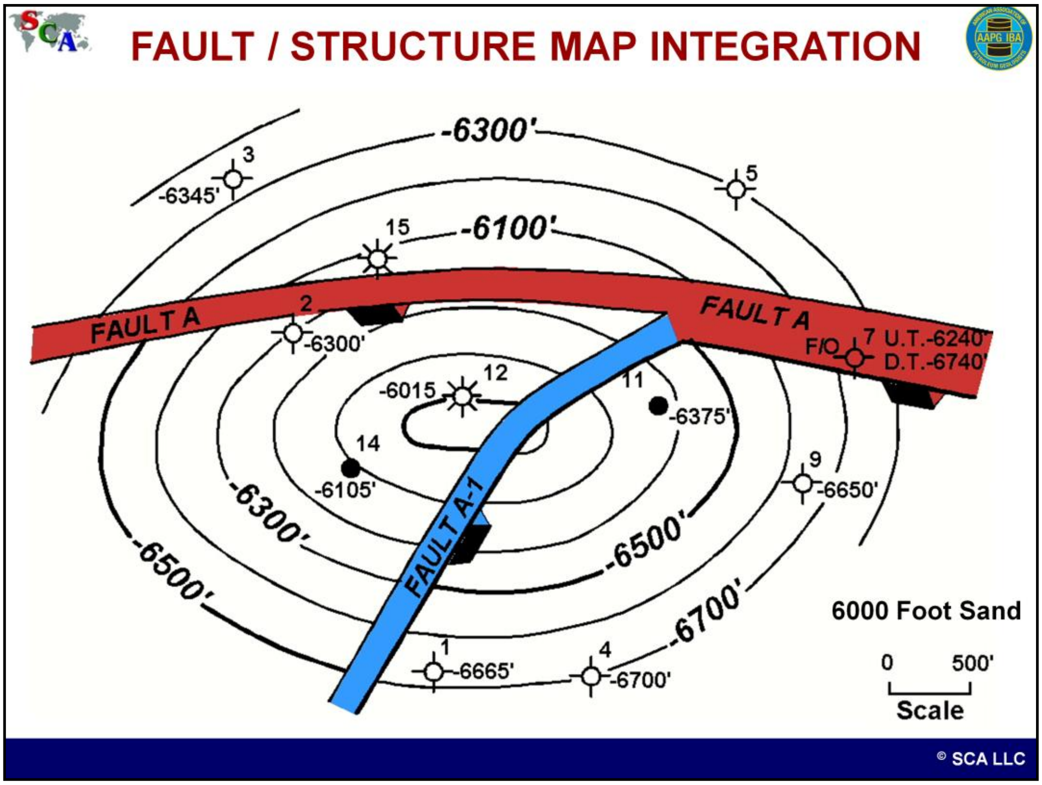


Integrate the newly contoured block with the fault surface map to map the fault trace for that fault block



The upthrown and the downthrown fault traces are now exactly where they are supposed to be based on our interpretation.

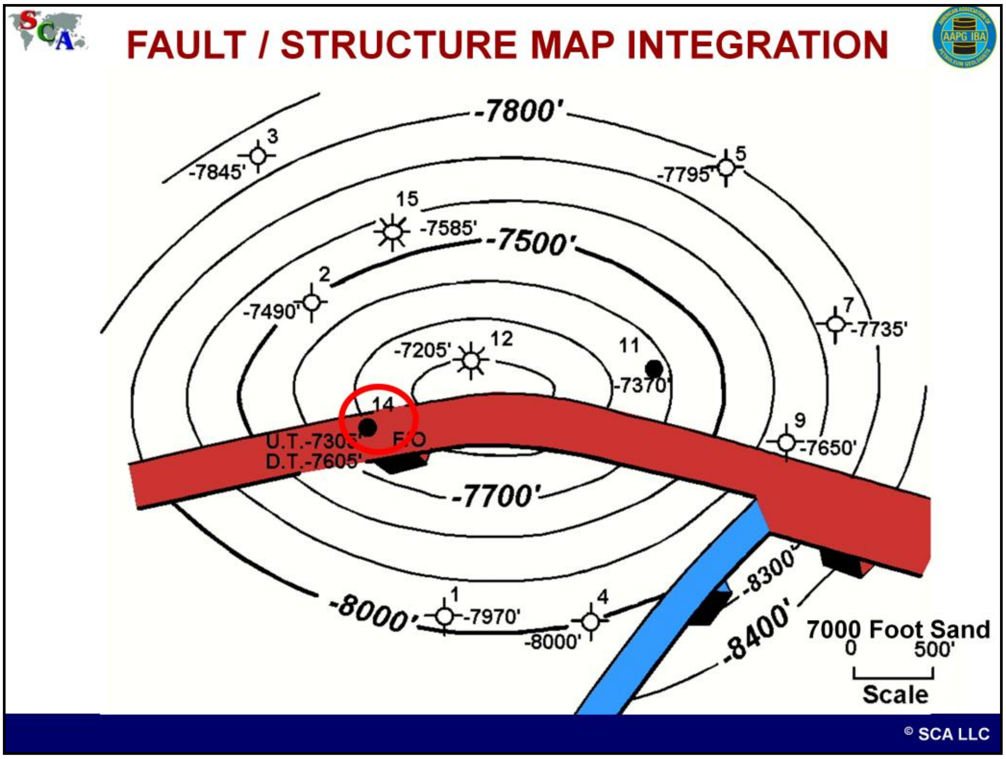
The fault gap is also the proper width



Here is a structure map for the "6000 Foot Sand". It shows a faulted anticline with two faults that intersect in a bifurcating pattern. The blue fault has a vertical separation of 200 feet. To the left of the intersection with the blue fault, the red fault has a vertical separation of 300 feet. The width of the red fault gap changes at the intersection with the blue fault and to the right of the intersection, the red fault has the combined vertical separation of the two faults, or 500 feet.

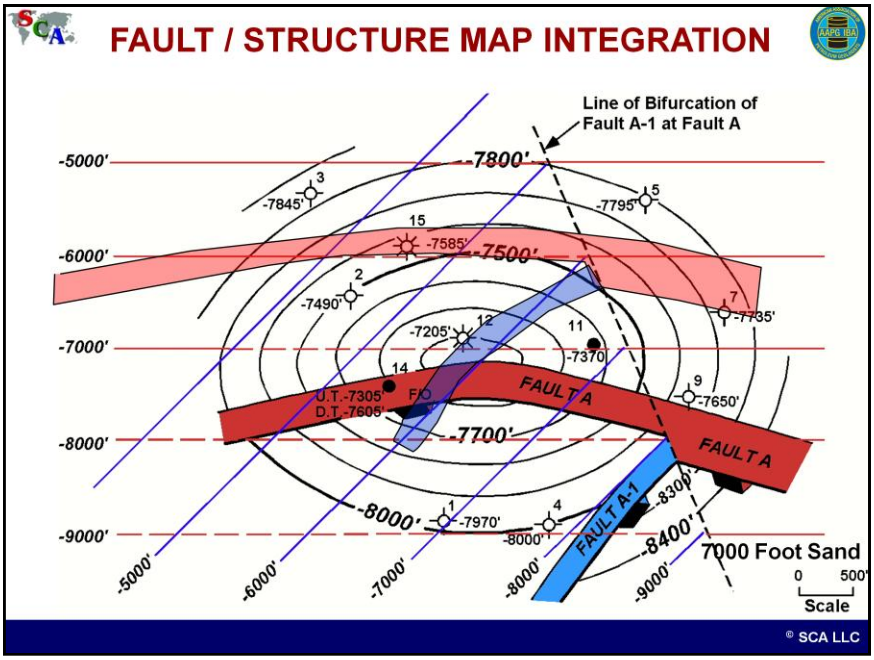
Fault surface maps were constructed for both faults and integrated with the horizon to generate the upthrown and downthrown fault traces You will notice that the fault trace for the blue fault is more curved than for the red fault. The blue fault is crossing the structure, going from 650' to 6000' then back down structure. The fault curves at the crest

The red fault is relatively straight as it is trending parallel to the strike of the fold.



Here is the structure map for the “7000 Foot Sand” without the fault surface contours for the red and blue faults. So we have moved ~1000’ deeper in the subsurface than the previous map.

Note that well 14 was drilled in the fault gap. That is due to the fact that the interpreter simply took the fault polygons generated for the 6000 Foot Sand and shifted them to the 7000 Foot Sand level instead of integrating the fault surface maps with the horizon maps.

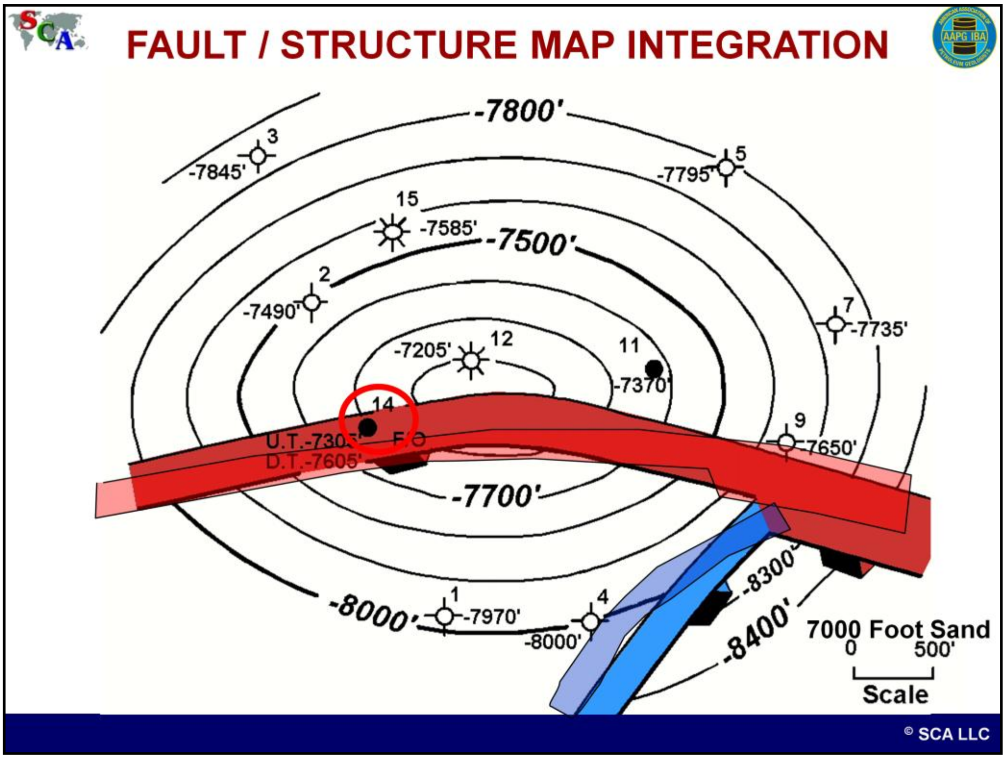


Here is a structure map for the “7000 Foot Sand” with the contours of the fault surfaces overlain. The east-west trending lines are the fault surface contours for the red fault. The blue lines are the fault surface contours for the blue fault.

The lighted shaded fault is the position of the fault traces for the 6000 Foot Sand. Note that the intersection of the two faults migrates from the shallower level to the deeper level along the line of bifurcation defined by the fault intersection.

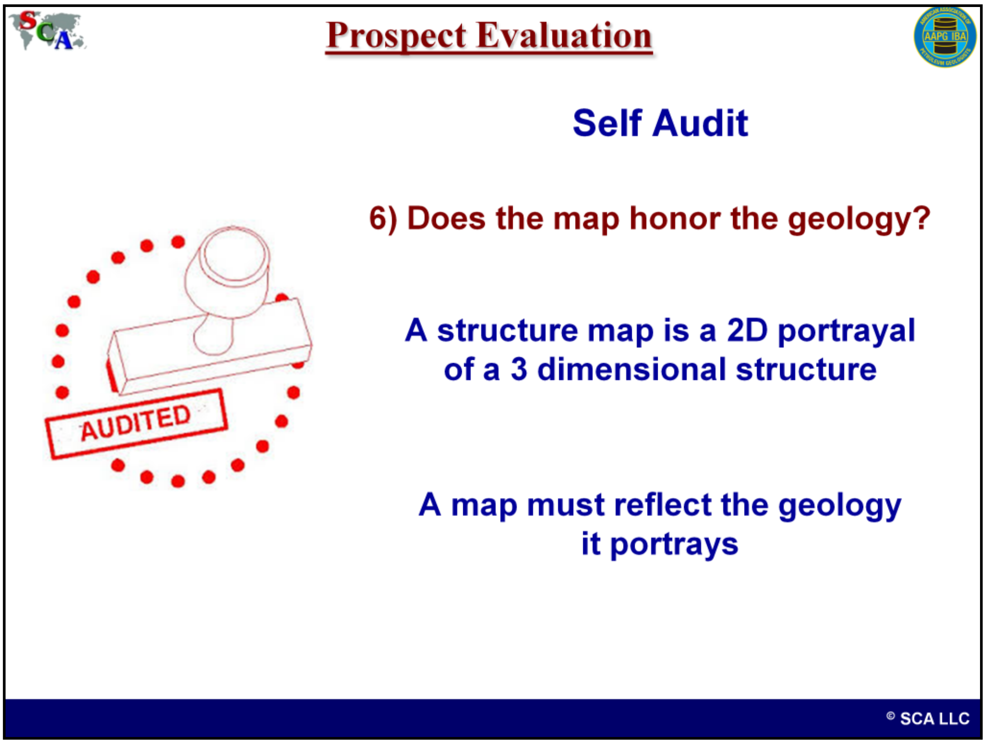
You will notice that the fault trace for the blue fault has less curvature at the 7000 foot level than it did at the 6000 foot level.

The red fault has more curvature at the 7000 foot level than it did at the 6000 foot level. This is because at the 7000 foot level, the fault crosses more structural relief across the anticline.

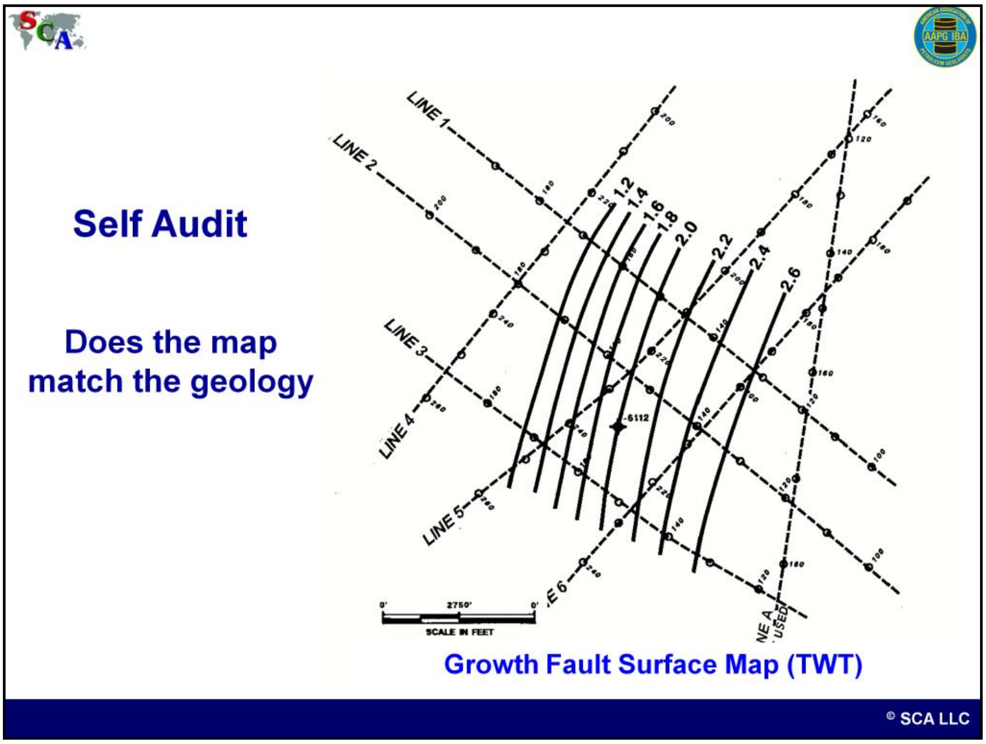


Here is the structure map for the "7000 Foot Sand" without the fault surface contours for the red and blue faults. The pastel shaded fault traces are the position of the fault polygons shifted from their position at the "6000 Foot Sand" level

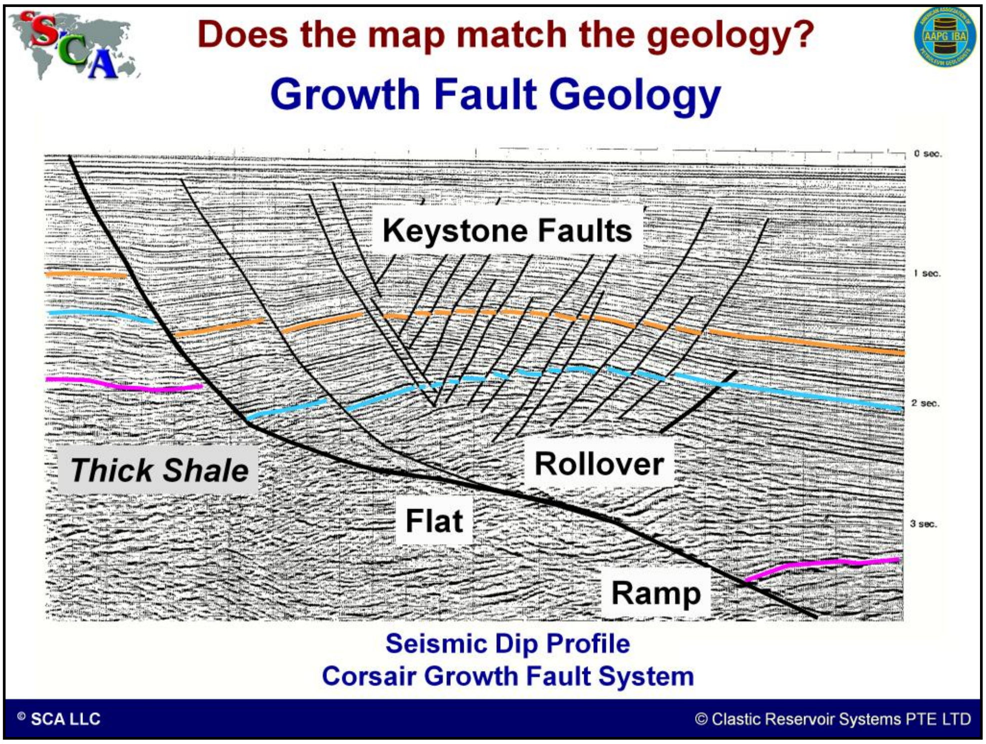
Note that well 14 was drilled in the fault gap. As mentioned, that is due to the fact that the interpreter simply took the fault polygons generated for the "6000 Foot Sand" and shifted them to the "7000 Foot Sand" level instead of integrating the fault surface maps with the horizon maps.



The final step in your self audit is to review that map and the interpretation to see if it matches the geology.

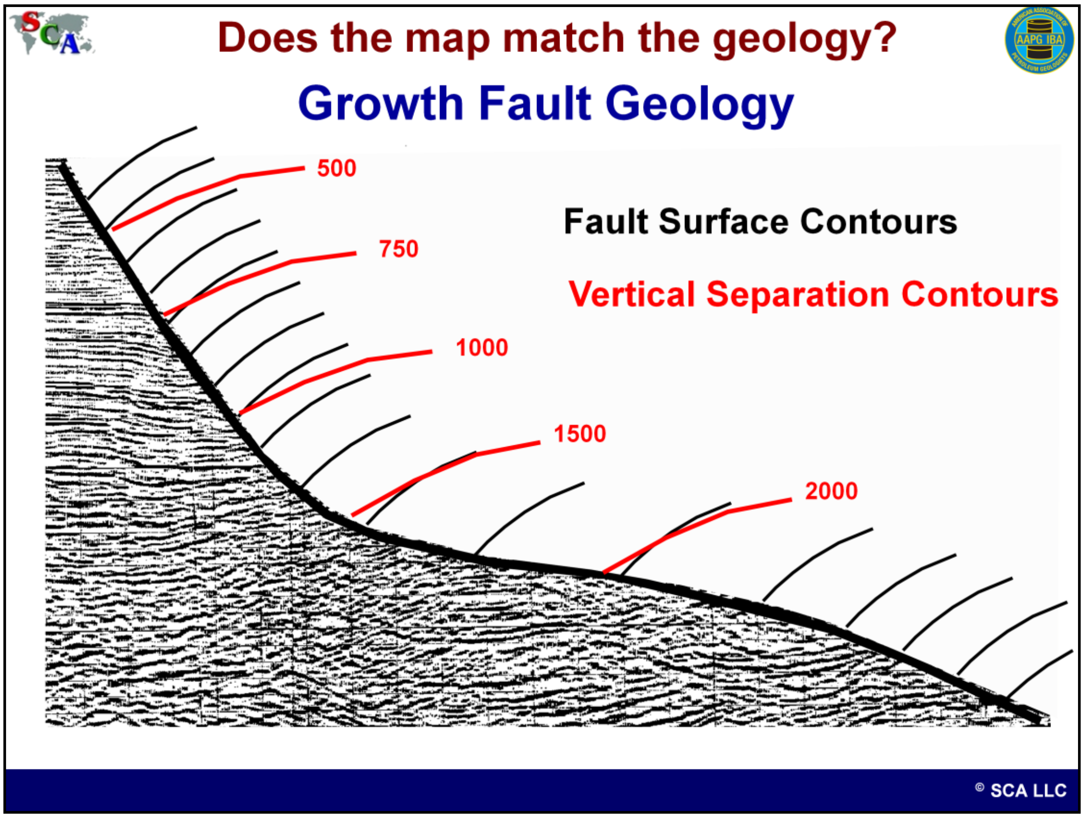


We looked at this map earlier. It is a fault surface map for a growth fault. The contour spacing for a growth fault should increase with depth to reflect the faults listric geometry.



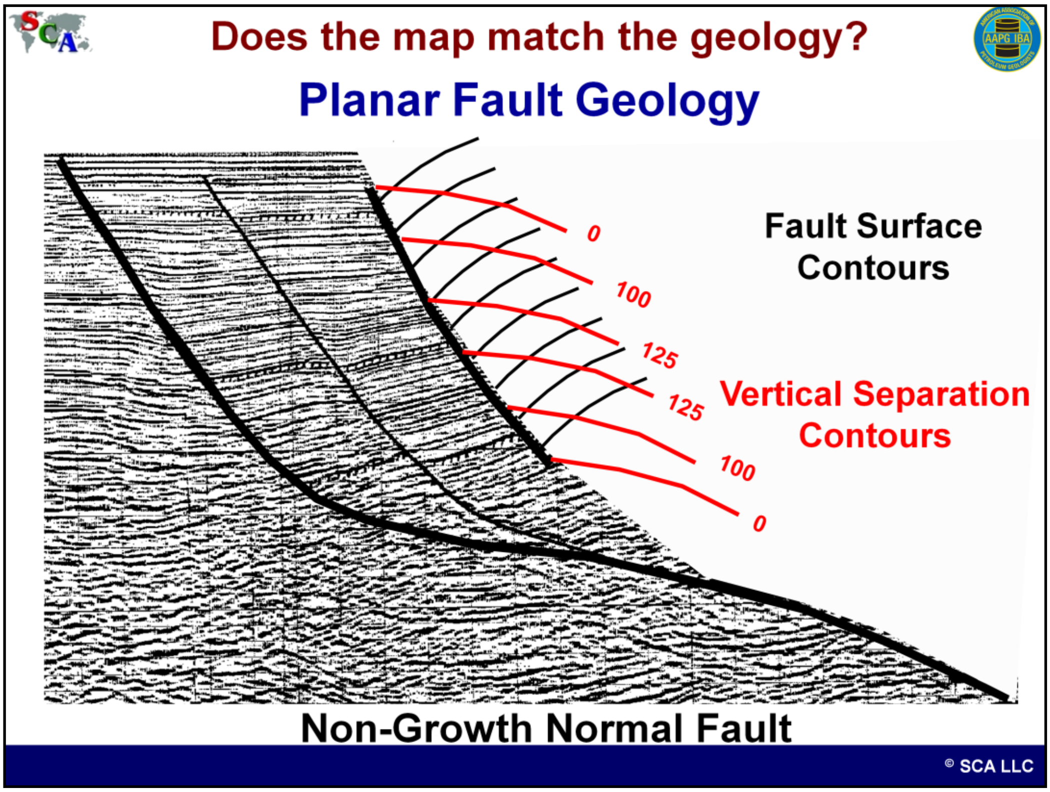
If you are mapping prospects in regions with growth faults, you need to know the geology of a growth fault system.

This seismic profile crosses the rollover fold associated with the Corsair Fault, a Middle Miocene Fault in the Gulf of Mexico.



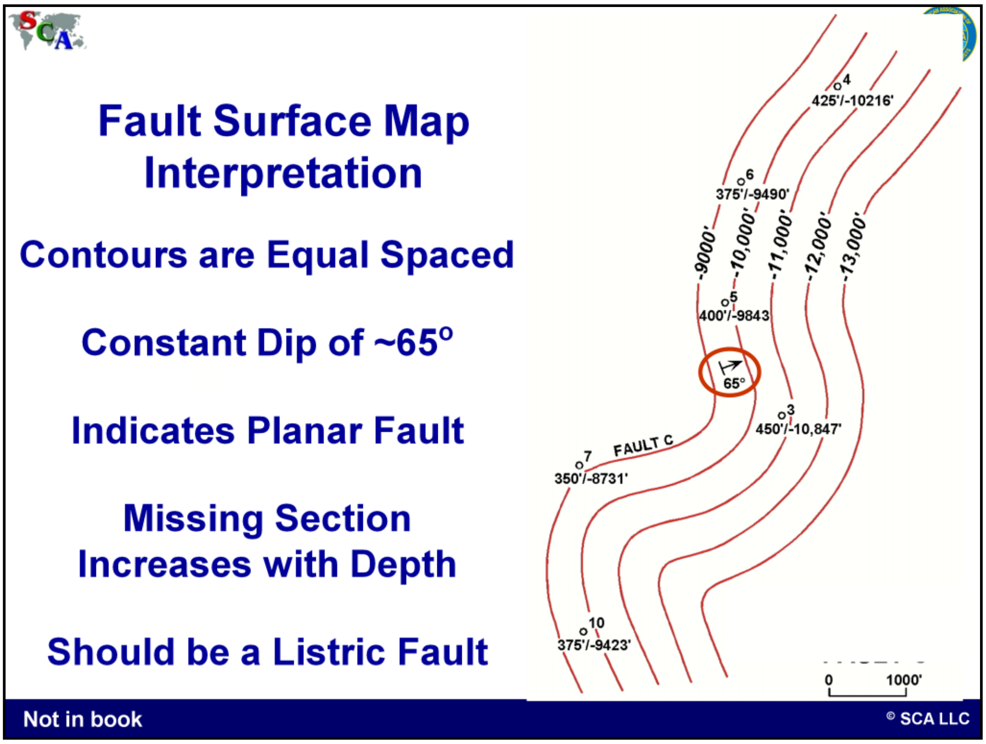
Growth faults are listric, that is concave upward. As such, the fault surface depth contours will be parallel. For the shallow part of the fault, the contours will be closely spaced reflecting the steep dip of the fault (60 – 80^{o}). The contour spacing will increase with depth as the dip of the fault decreases. The Corsair Fault has a ramp and flat profile, so the contour spacing will get closer together again in the lower ramp.

The Vertical Separation Contours: will be generally parallel to sub-parallel to the fault surface contours, The amount of vertical separation will increase with depth.



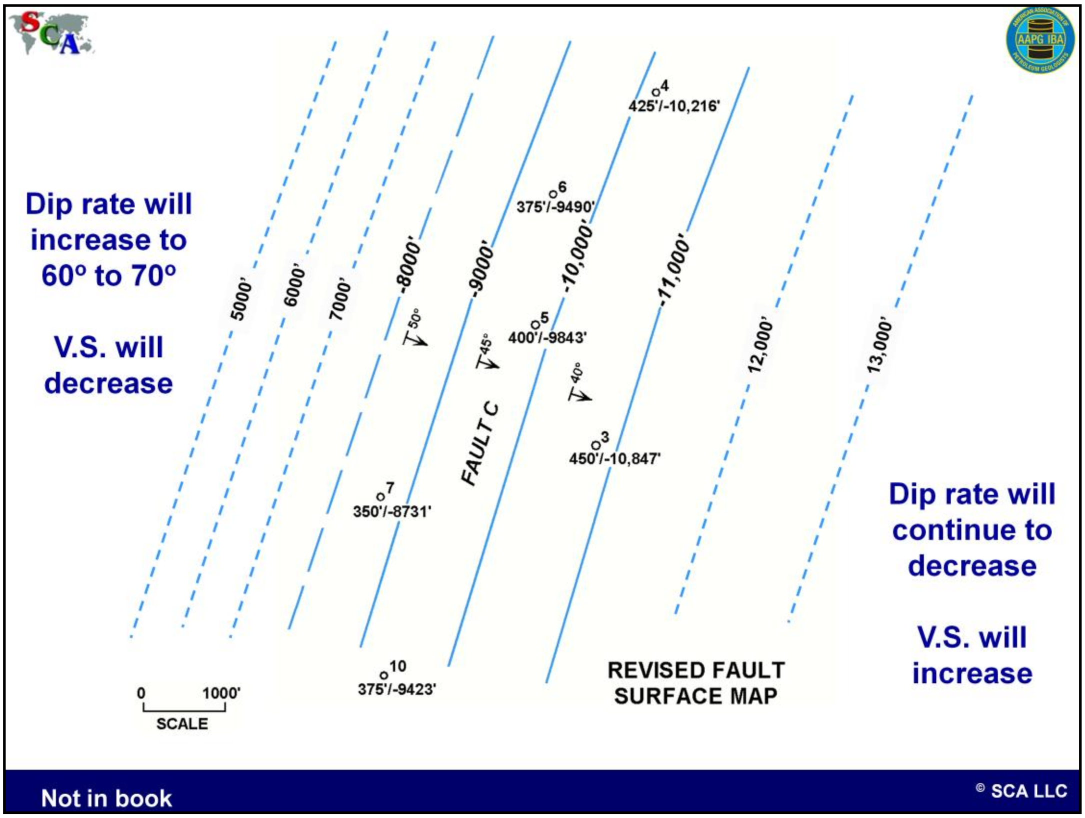
The keystone, or conjugate faults are more planar. The fault surface depth contours will be close to equally spaced.

The Vertical Separation Contours: will be generally perpendicular to the fault surface contours, The amount of vertical separation will be greatest in the middle section o the fault.



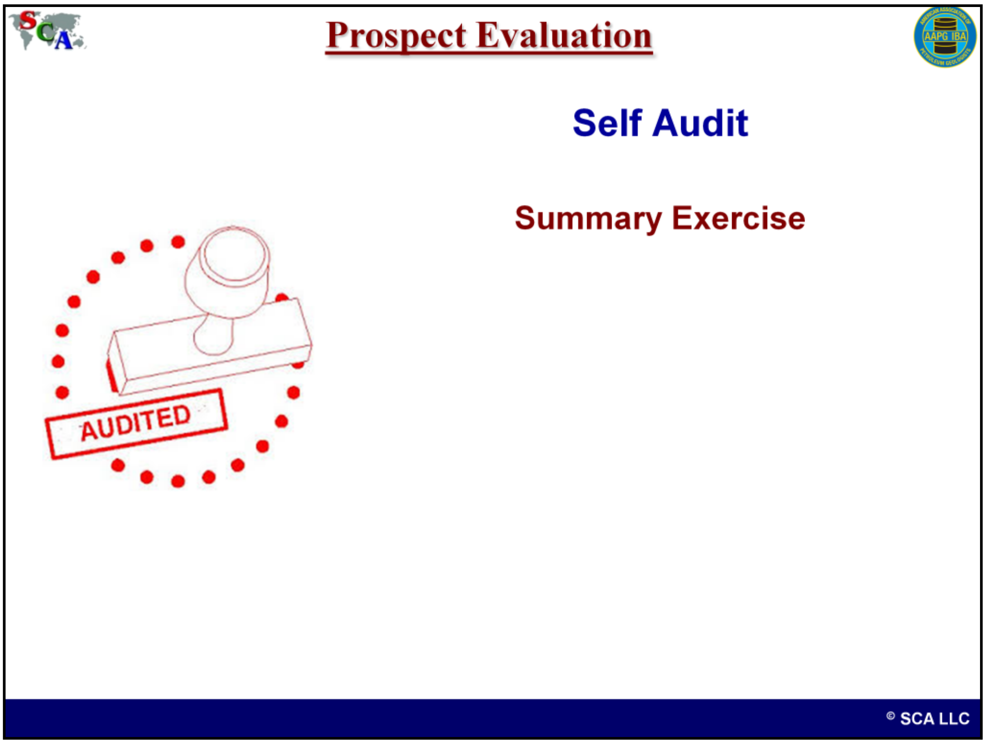
If we examine this fault surface map, we see a fault that has equally-spaced contours indicating a planar fault with a dip of 65°.

If we examine the data, we can see that the fault is a growth fault. Therefore the contour spacing should increase with depth. This fault surface map does not match the geology as it was contoured with an equal spaced contouring algorithm.

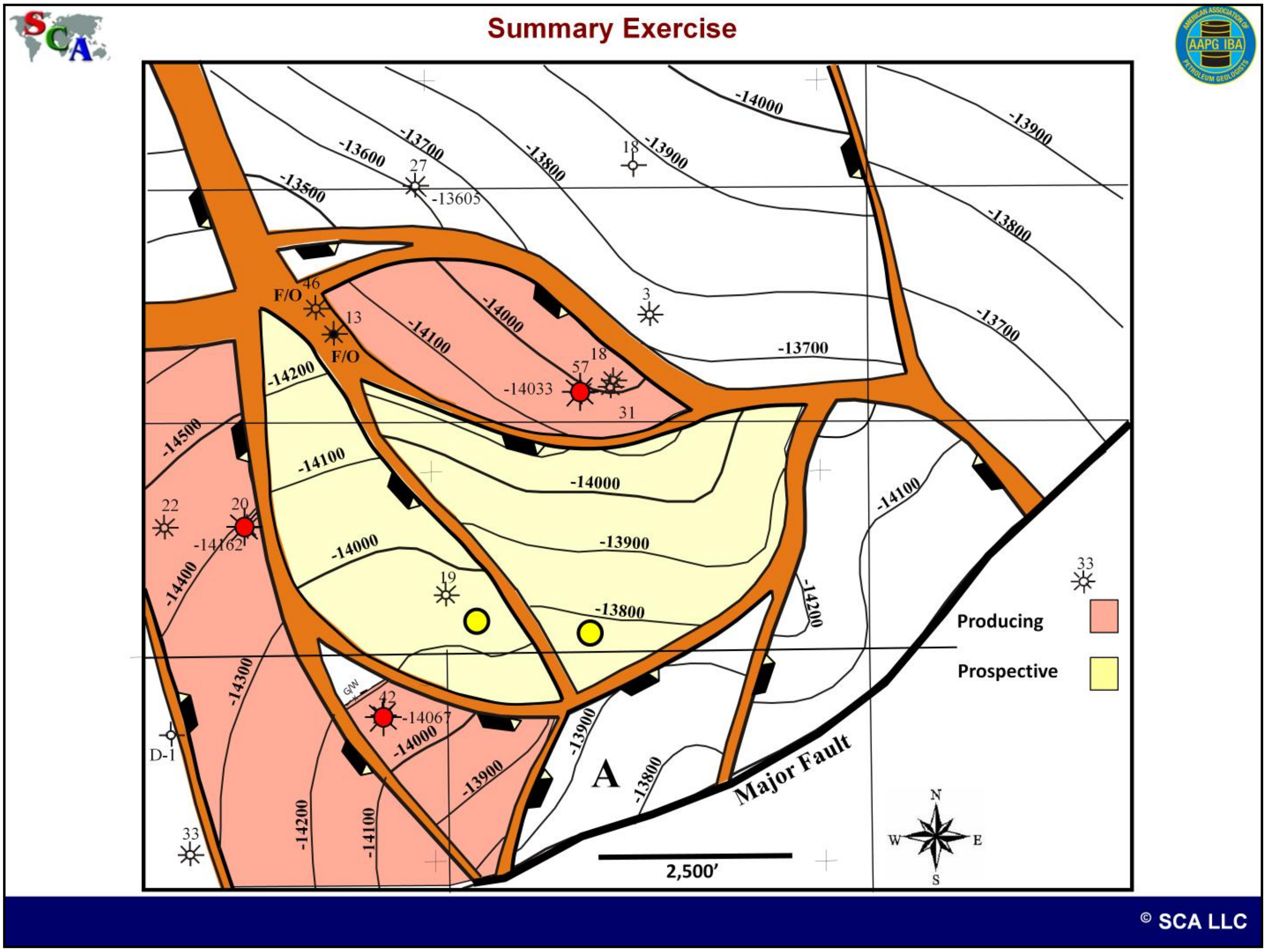


Here is the corrected fault surface map. We can now see that the contour spacing increases with depth.

We can use our understanding of growth faults to extend contours away from the data. Shallower contours will be more closely spaced to reflect the steeper dip. Deeper contours will be more widely spaced due t the lower dip rate.



So now that you know the steps to conduct a self audit, lets conduct a self audit on the following map.

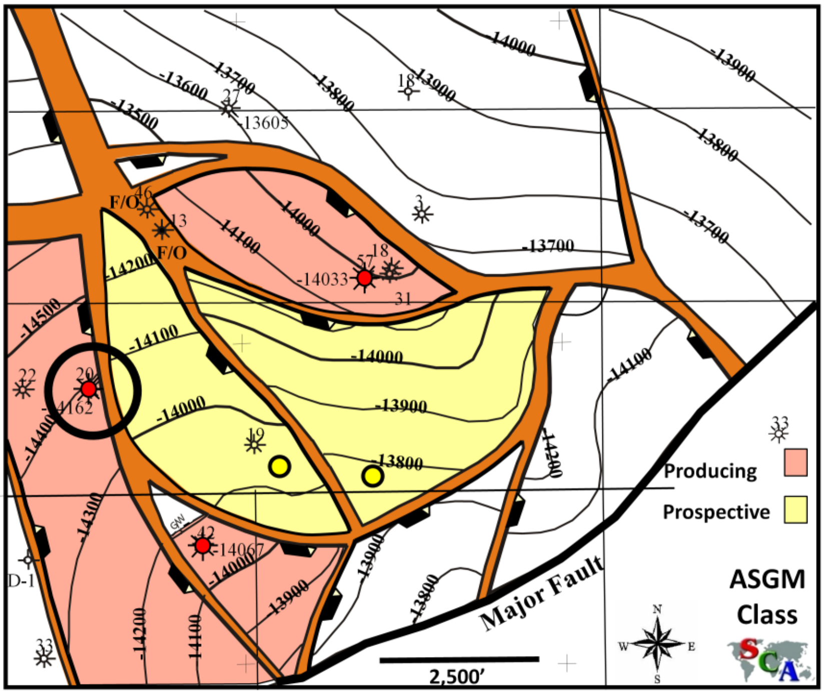


Here is a structure map for a producing field in the Gulf of Mexico. It was generated from 3D seismic, there is also well control and reservoir engineering data available to the interpreter.

Several fault blocks are producing with a depletion drive mechanism. Two locations have been proposed to drain the two fault blocks that do not have producing wells in them (Well 19 had pay at this level, but is producing from a deeper level).

The company assigned the chance of success for these wells at 85%. Do you approve these locations? Is the map 3 dimensionally valid? Can you find 3 things wrong with this map?

Summary Exercise

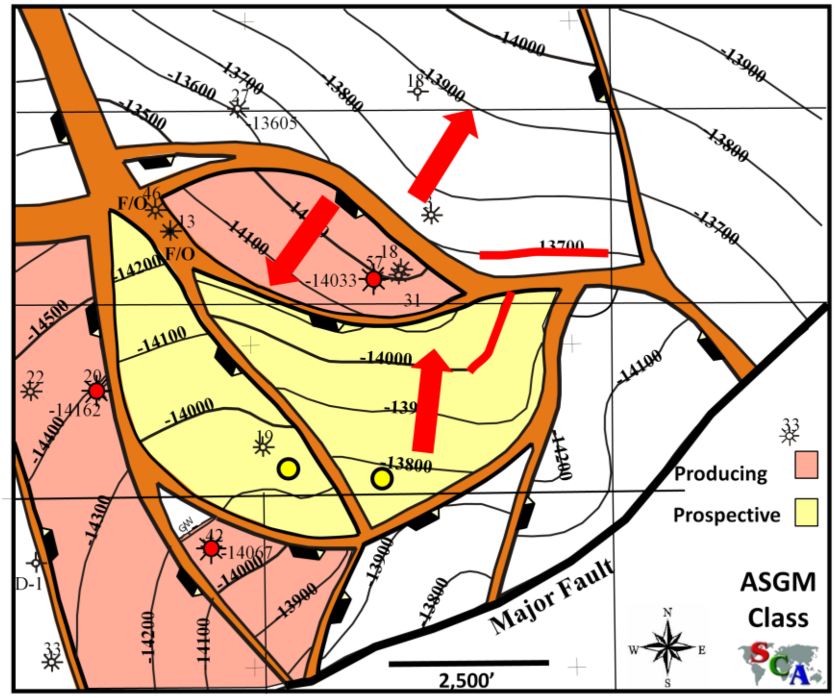


Contour does not honor the well control

Does Not Honor the data

Although most of the contours honor the well data, one fault block does not.

Summary Exercise



Dip of one fault block is toward the southwest.

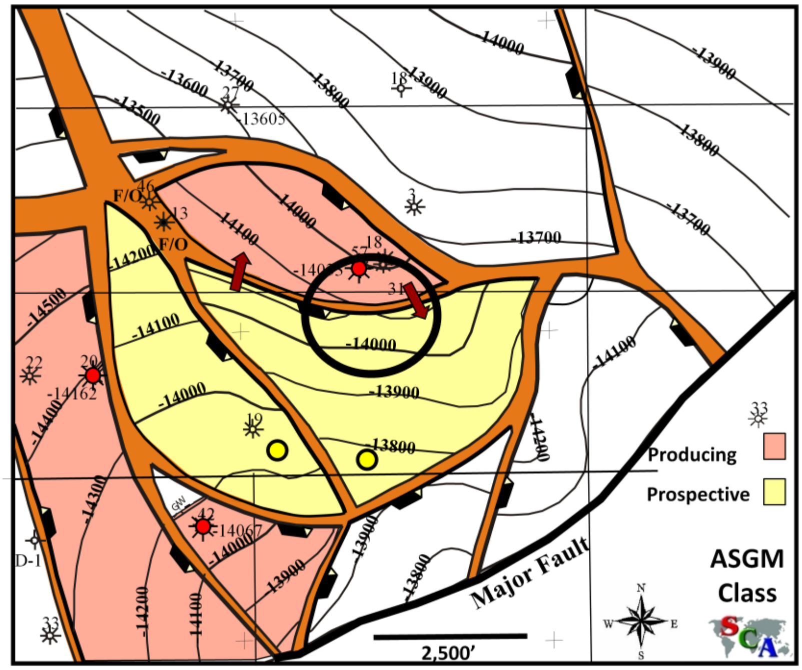
Dip of all of the other fault blocks are generally to the north

The south-dipping fault block does not honor contour compatibility

Lacks Contour Compatibility

Several fault blocks do not exhibit contour compatibility

Summary Exercise



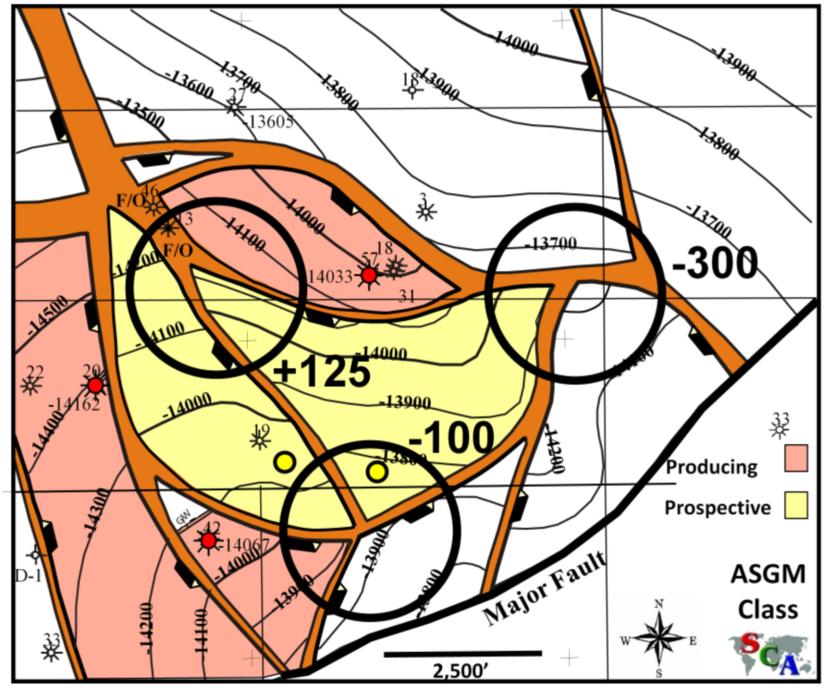
Examination of fault offsets indicates that a key fault has a portion of the fault trace where there is 0 offset

Key Fault is a Screw Fault

Screw Fault Analysis

Screw fault analysis, looking at the vertical separation across key faults would have shown that a key fault separating one of the prospective blocks from a producing well is a screw fault and that at the critical point along the fault trace, the vertical separation is 0.

Summary Exercise

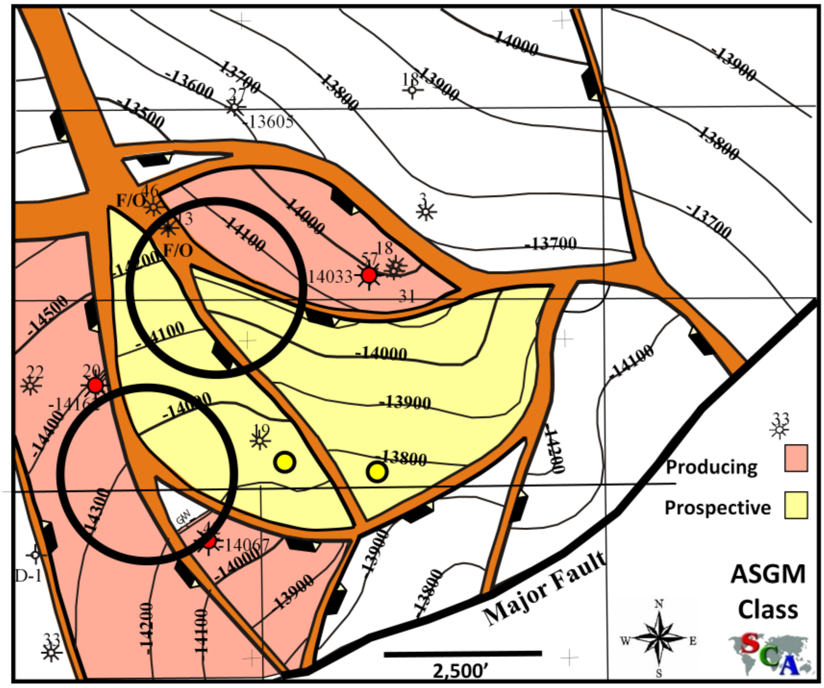


Fault Intersections are not correct

Looking at the algebraic sum of the vertical separations at key fault intersections, we see that the sums are not equal to 0

Looking at the fault intersections for the key faults, we can see that the algebraic sum of the vertical separations at the intersections are not zero.

Summary Exercise

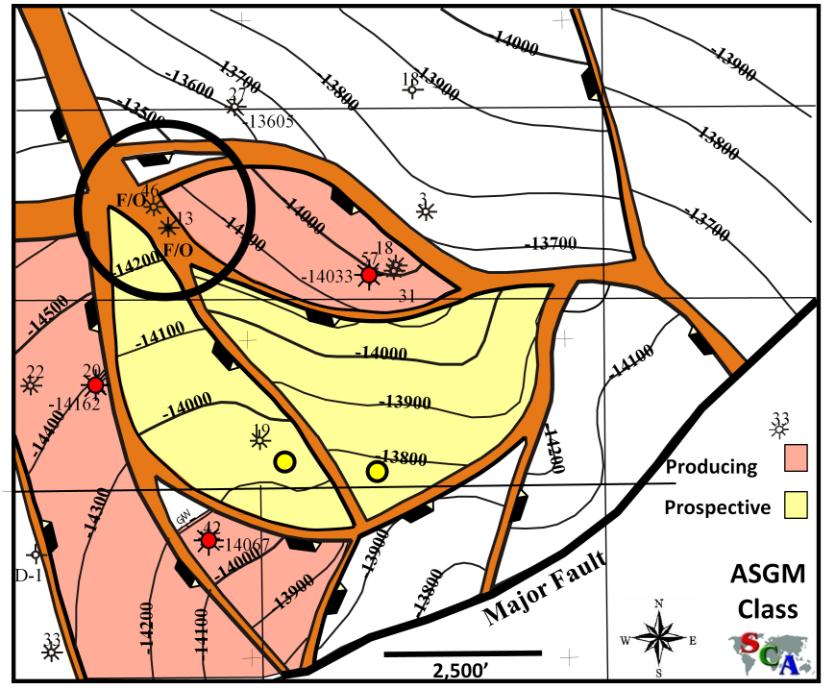


Interpreter used fault polygons and did not map the fault surface and integrate the fault surface with the horizon

Fault Traces are not correct

Looking at the intersection patterns of several faults, we can also see that the patterns are not correct. This indicates that the interpreter did not map the fault surface and integrate it with the horizon. Rather, he picked faults and made a fault polygon.

Summary Exercise

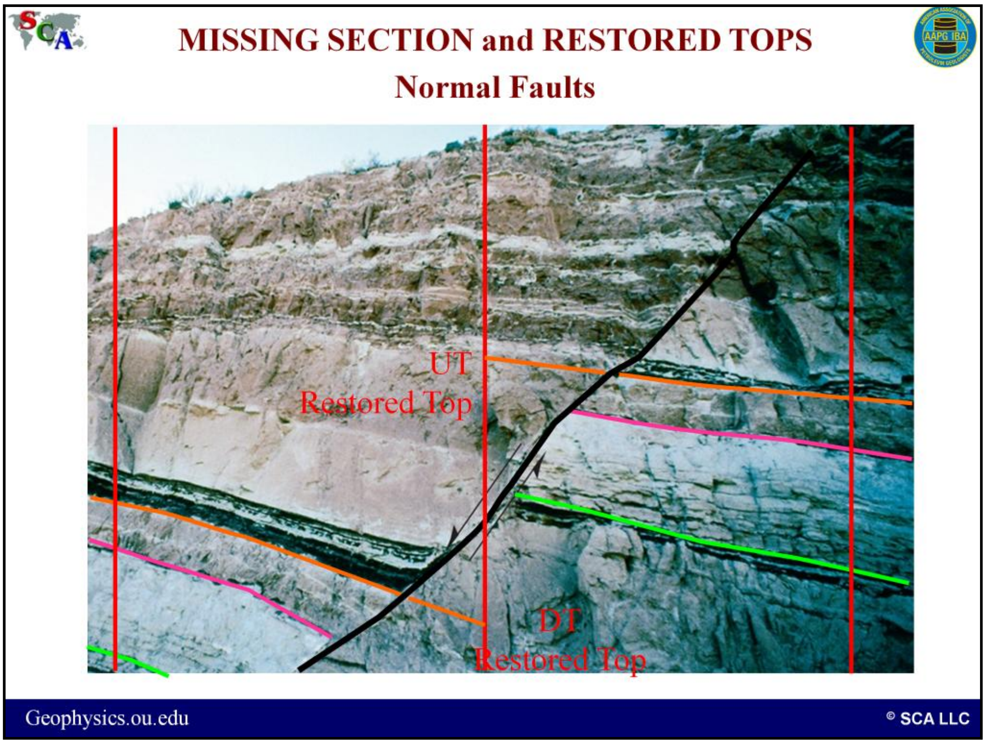


Note the well in the fault gap

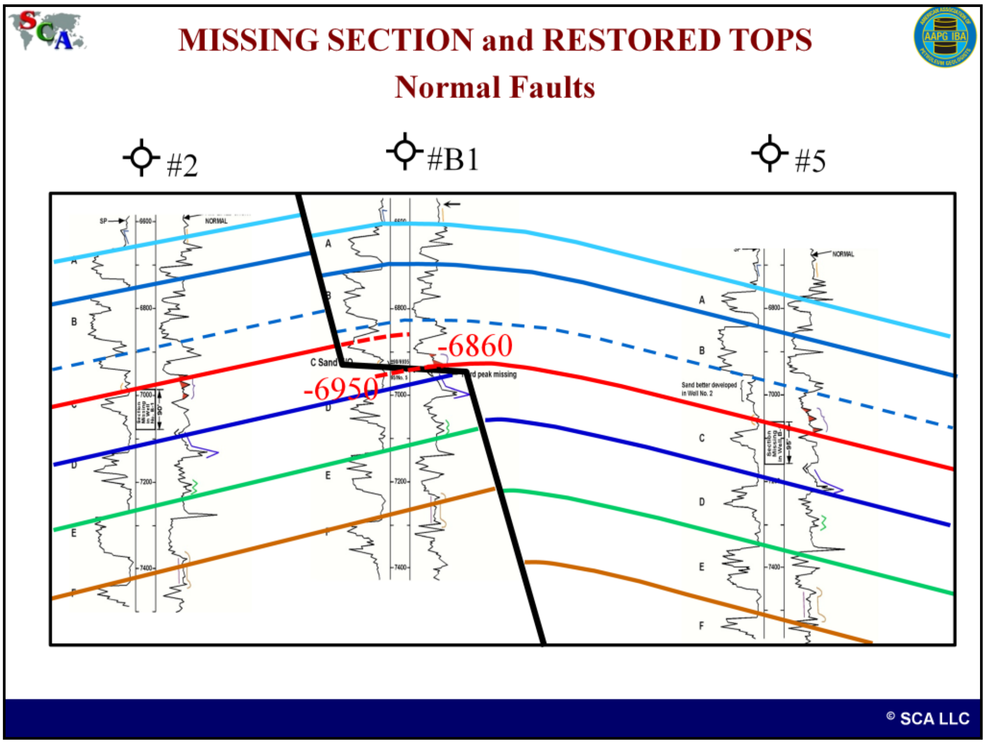
Restored tops were not calculated

Failure to use all of the data

There are wells in the fault gap. The interpreters failed to calculate and use restored tops. Had they done so, they would have seen that the contours were incorrect.



Restored tops are the position in a faulted well where a horizon would be encountered if there were no fault. There are two restored tops, the upthrown restored top and the downthrown restored top.

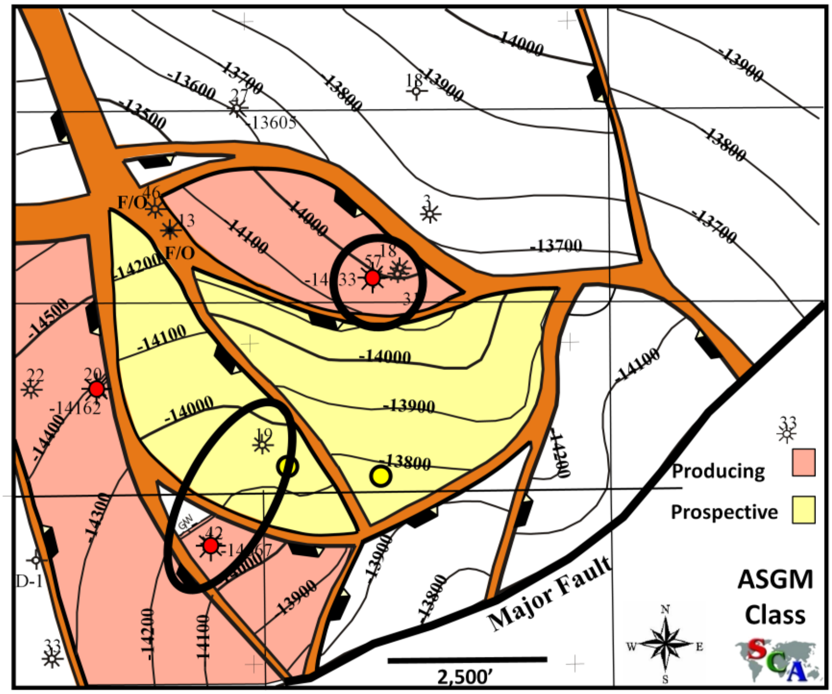


We can see on this cross section how to determine restored tops. The C sand (red horizon) is faulted out of well B1 at a depth of 6930 feet.

If the fault seen in well B1 were not present, the C sand in the upthrown block would be seen in the well at a depth of 6860 feet.

Likewise, if the fault seen in well B1 were not present, the C sand in the downthrown block would be seen in the well at a depth of 6850 feet.

Summary Exercise



More significantly, the interpreters failed to talk to the engineers

Well 19 is in pressure communication with well 42

Well 18 has produced 150% of the mapped reserves for that fault block

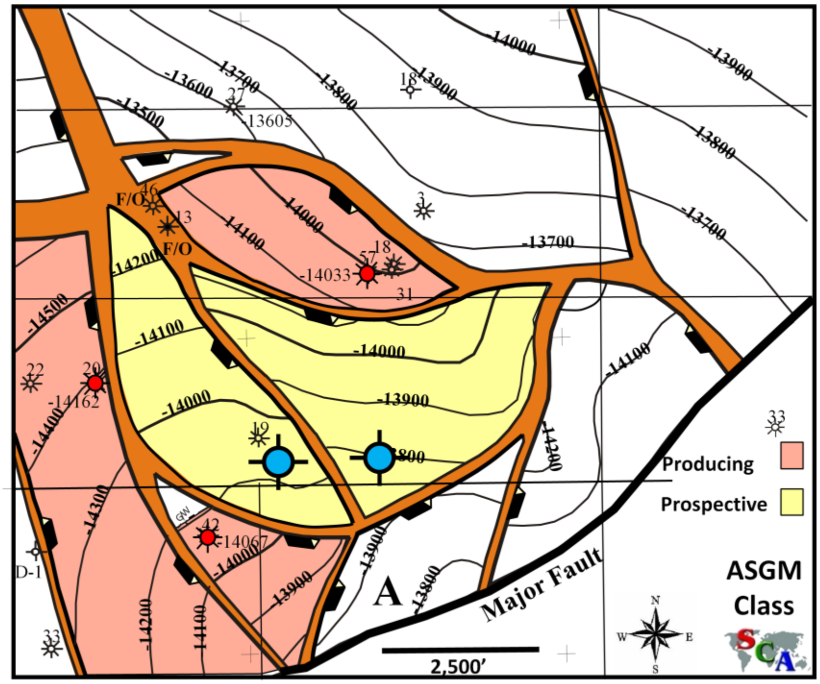
Map does not fit with the Reservoir Engineering Data

Most significantly, the interpreters failed to review their interpretations with the reservoir engineers. Had they done so, they would have learned that both of their proposed locations were almost certainly depleted.

Well 19 was known to be in pressure communication with well 42, so well 42 was draining the fault block targeted by one of the two wells.

Well 18 has produced 150% of the reserves of its fault block as determined from this map, indicating that the map is wrong and the compartments have not been properly defined. Given that the fault that defines that compartment is a screw fault, it is safe to assume that the fault block with well 18 is connected to the block targeted by the other well.

Summary Exercise



The failure to apply pre-drill QLT's caused them to drill 2 cement storage facilities, costing their investors more than $10 million

Two needless cement storage facilities?

The two wells were drilled, and the reservoirs wee depleted, so the wells were plugged and abandoned. This map is one of the worst maps we have ever seen. Had the interpreters made geologically valid maps using all of the data, or if management had critically reviewed this map using Quick Look Techniques, the company would not have wasted $10 million dollars.

Prospect Evaluation

The maps coming out of your workstation will be wrong. Before you make any decisions based on those maps, conduct a Self Audit

1) Does the map honor the data?
2) Do the contours exhibit contour compatibility?
3) Do the contours honor vertical separation?
4) Does the map match the seismic?
5) Are the fault traces properly positioned?
6) Does the map honor the geology?

Self Audits are a process you can follow to determine if your maps are accurate, and if not, help you to fix them.

You can find more information on making better interpretations and maps by going to SCA's website and checking out the 10 Habits of Highly Successful Oil Finders which can be found in our blog section.

On behalf of Subsurface Consultants & Associates, the American Association of Petroleum Geologists Division of Professional Affairs, and the AAPG Imperial Barrel Committee, we would like to wish you the best of luck in the competition.