# Computer-Aided Net Pay Mapping*

Alan Cherry[1]

Search and Discovery Article #120014 (2009)
Posted November 20, 2009

*Adapted from presentation at AAPG Geoscience Technology Workshop, "Geological Aspects of Estimating Resources and Reserves," Houston, Texas, September 9-11, 2009

[1]Subsurface Consultants & Associates, LLC, Houston, TX (cherry_alan@hotmail.com)

## Abstract

Computer applications have revolutionized the way we handle complex geologic and engineering data. Activities like seismic interpretation and well log analysis, for example, used to be very labor intensive, and are now routinely performed on a computer workstation. Net pay isochore mapping, however, is largely still done the "old fashioned way" by hand. There are many reasons for this; one being that existing software packages do not have a pre-built workflow to generate net pay maps; the other is that this work has routinely been performed by in-house reservoir engineers or 3rd party consultants who do not have access to the workstation containing the data.

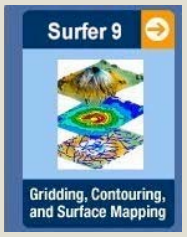
Once someone has learned and applied the principles of making net pay isochore maps by hand, they should be able to move into the computer realm. Net pay isochore maps can be generated on the computer that rival or exceed the accuracy of those done by hand and can be performed on most existing workstation software or other inexpensive (or free) tools. Once generated, these maps can be efficiently updated and maintained.

The steps to build net pay isochore maps from existing data are discussed using an edge water reservoir as an example. A computer-aided methodology for handling the complexity associated with an uneven vertical distribution of reservoir quality rock within the wedge is presented.

Copyright © AAPG. Serial rights given by author. For all other rights contact author directly.

# COMPUTER AIDED NET PAY MAPPING

## By Alan Cherry




*SURFER, From Golden Software was used to build this model*


©SCA

# Traditional Net Pay Mapping

- ***Net pay mapping to this day continues to be primarily performed by "hand" by development geologists and reservoir engineers.***
- ***We seem to do everything else on the computer; why not net pay mapping?***
- ***High-End Workstation software tends to be designed around "canned" workflows.***
- ***Workflows for computer-aided net pay mapping tends to have been overlooked.***
- ***This can be overcome with applying what we already do by "hand" to our existing maps and data present within our workstations.***


©SCA

# What software is needed?

- ***If your geologic workstation software contains grid math functions, such as add, subtract, multiply, divide, Min, Max, etc., then this should suffice.***

- ***If your software does not have this capability (or you are doing an outside evaluation), then you can download the freely available SURFER Demo to create maps and calculate areas and volumes.***

# What software is needed?

- *Well Logs*
- *Structure Map in depth over the area of interest.*
- *Gross Interval Thickness data (TVT area wide)*
- *Net Sand Thickness data (TVT area wide)*
- *Net Pay (TVT) for each well in the area of interest*
- *Fluid Contact values*
- *Optional Fault Surface Maps*

Microsoft Excel - Wells.xls

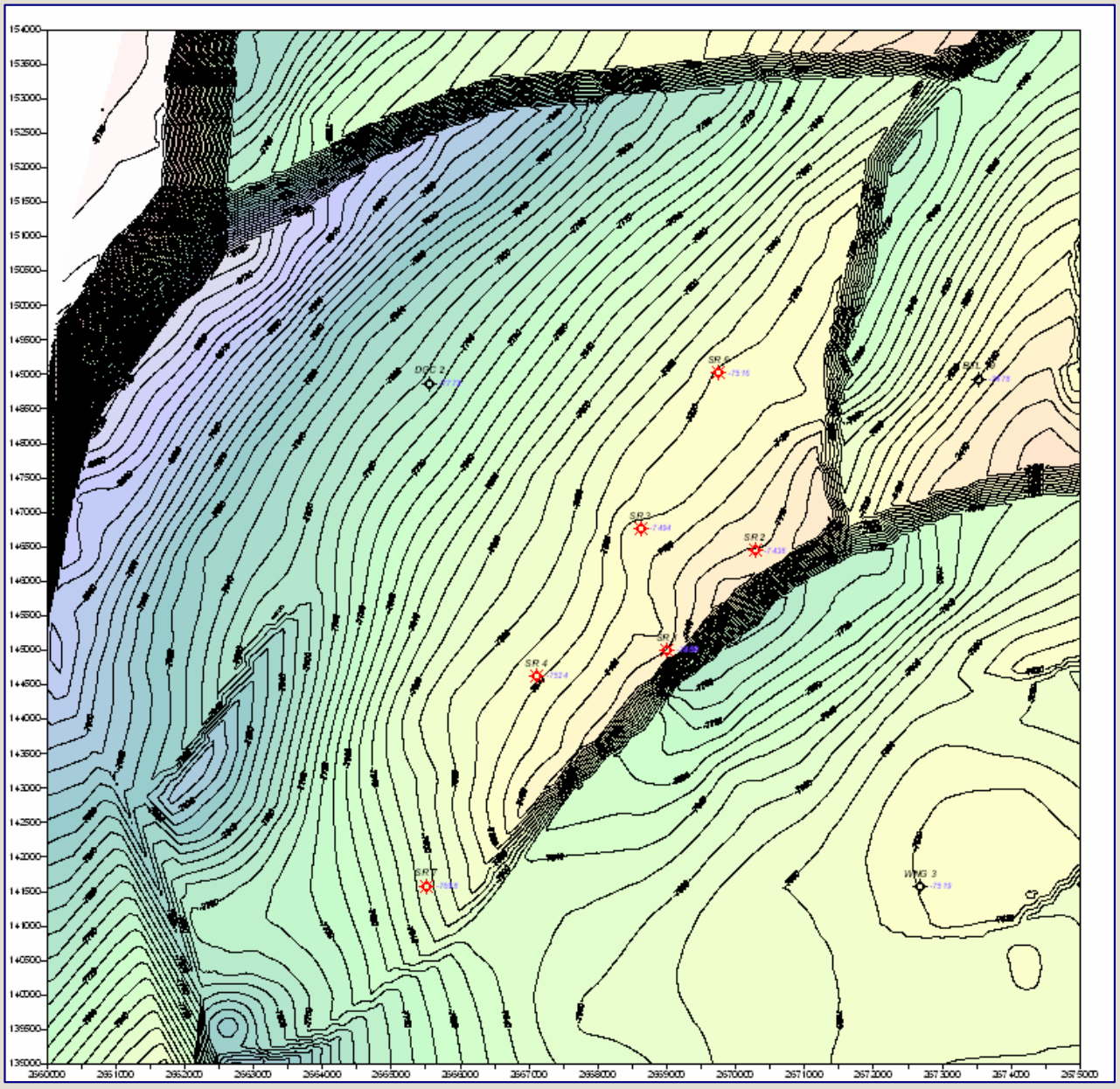
File Edit View Insert Format Tools Data Window Help

I13

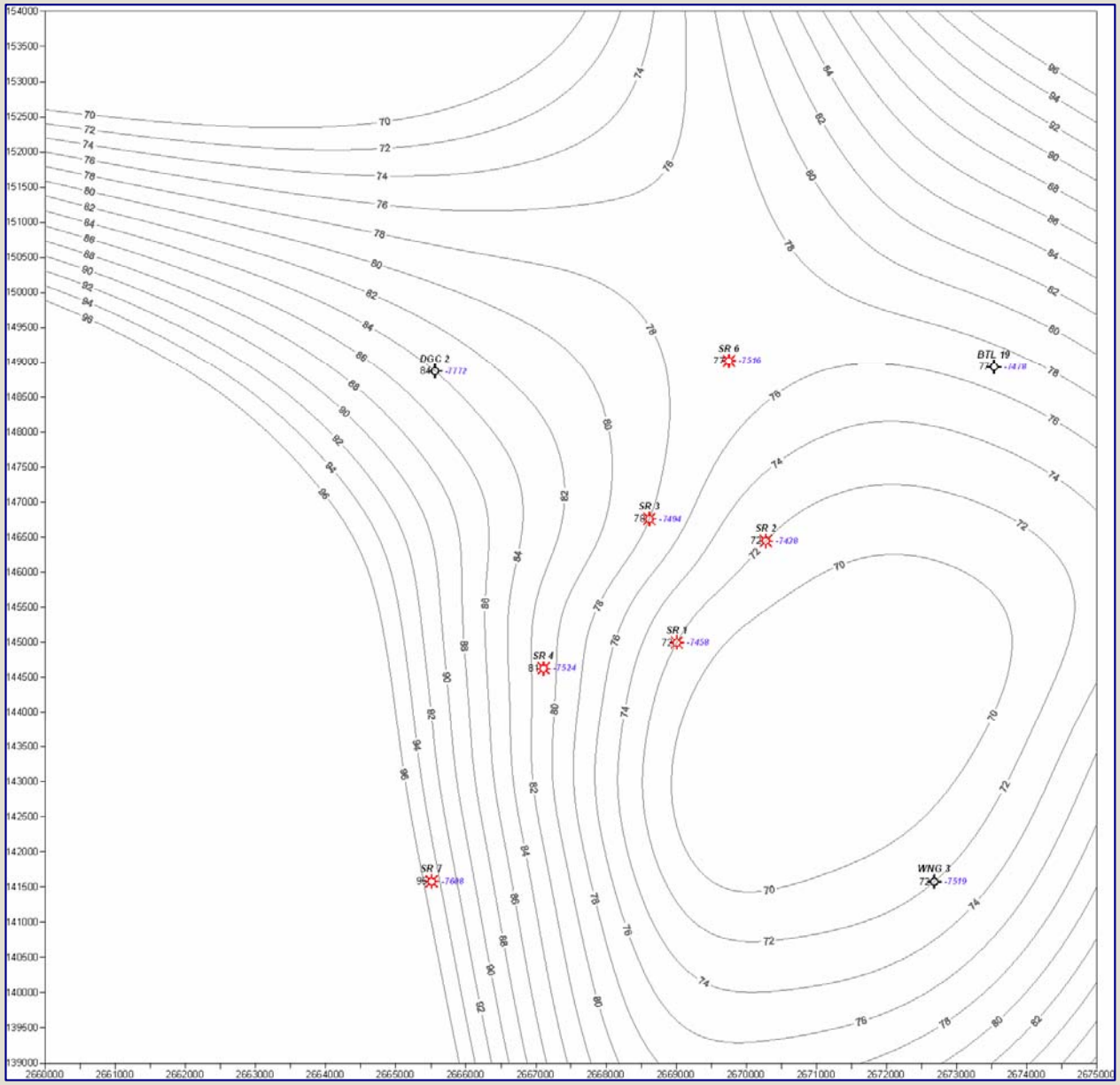
| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | x | y | Well# | SS | Gross_Sand | Net Sand Ratio | Net Pay | |
| 2 | 3314.08 | 2465.2 | 12 | -6015 | 75 | 0.5 | 37.5 | |
| 3 | 5666.37 | 2661.23 | 7 | | | | | |
| 4 | 4483.69 | 2393.33 | 11 | -6375 | 120 | 0.7 | 84 | |
| 5 | 5333.13 | 1916.34 | 9 | -6650 | 150 | 0.45 | | |
| 6 | 4058.97 | 792.462 | 4 | -6700 | 130 | 0.6 | | |
| 7 | 3124.58 | 831.668 | 1 | -6665 | 125 | 0.6 | | |
| 8 | 2647.59 | 2027.42 | 14 | -6105 | 90 | 0.65 | 24 | |
| 9 | 2307.82 | 2850.72 | 2 | -6300 | 20 | 0.1 | 2 | |
| 10 | 1954.97 | 3752.43 | 3 | -6345 | 30 | 0.2 | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |

# Top Porosity Map

***This map can often be exported into a an XYZ text file from a workstation.***

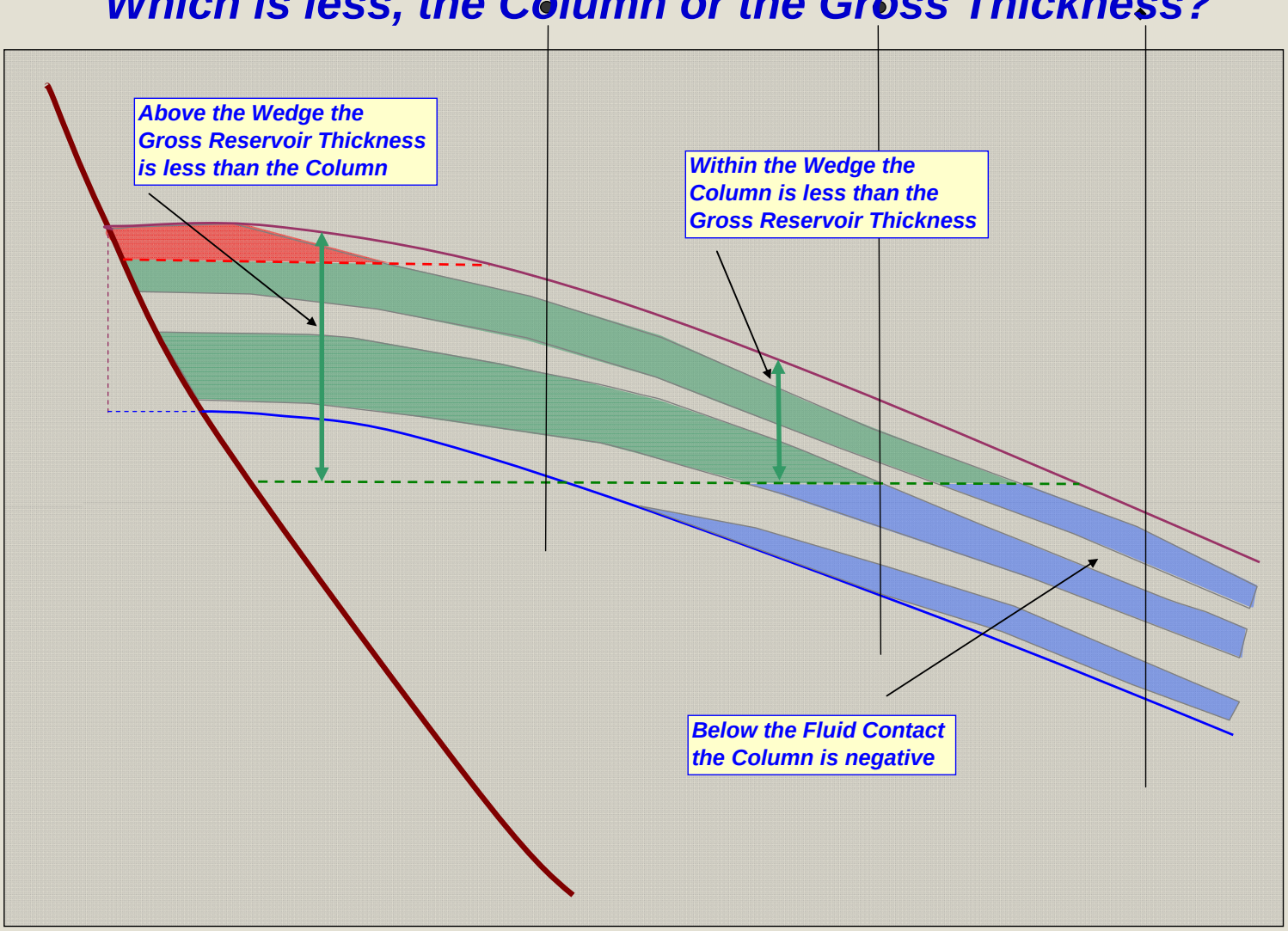


# Gross Thickness Map



# Computing Net Pay in the Wedge

***Which is less, the Column or the Gross Thickness?***

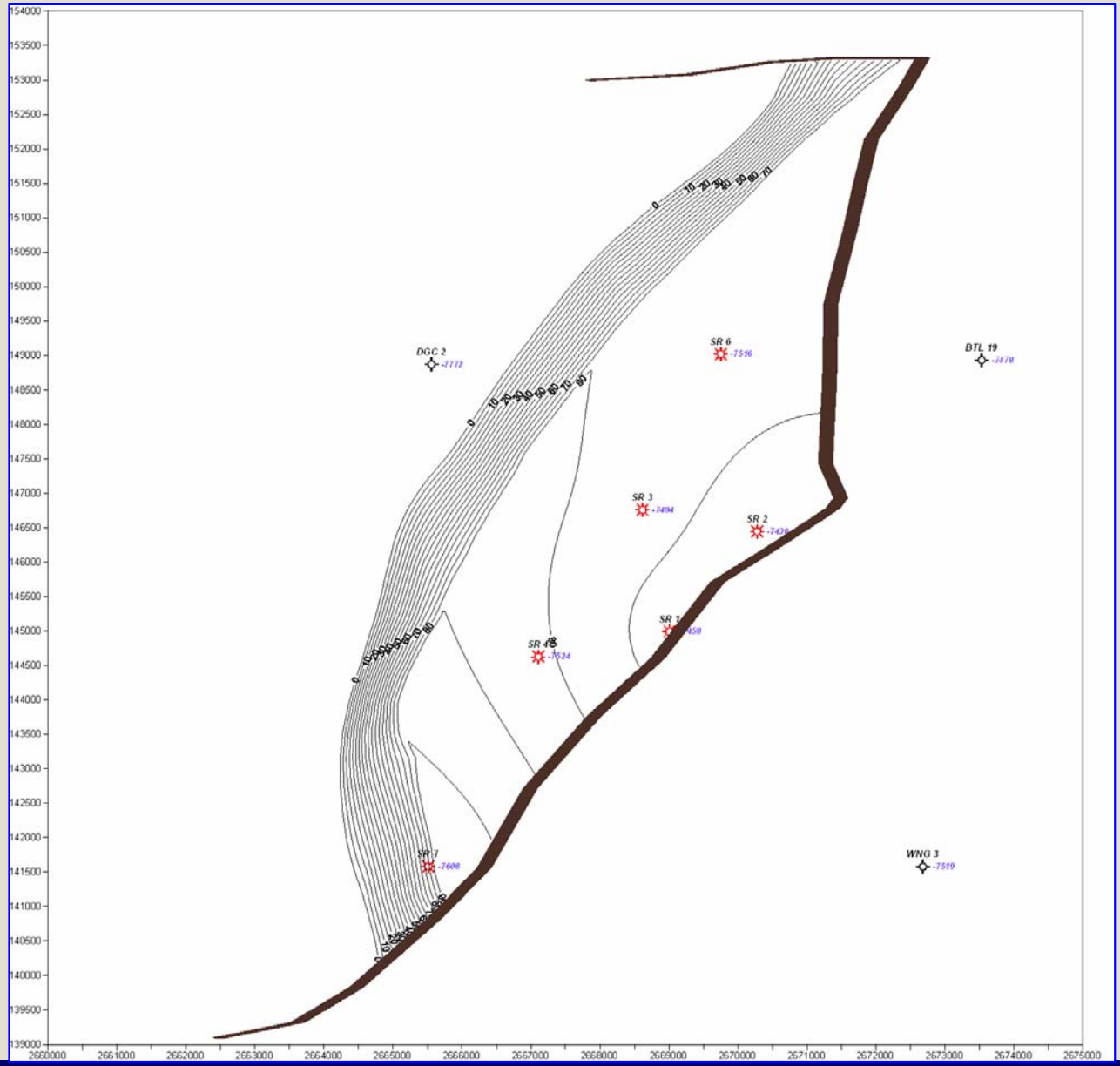




©SCA

# Gross Hydrocarbons Map

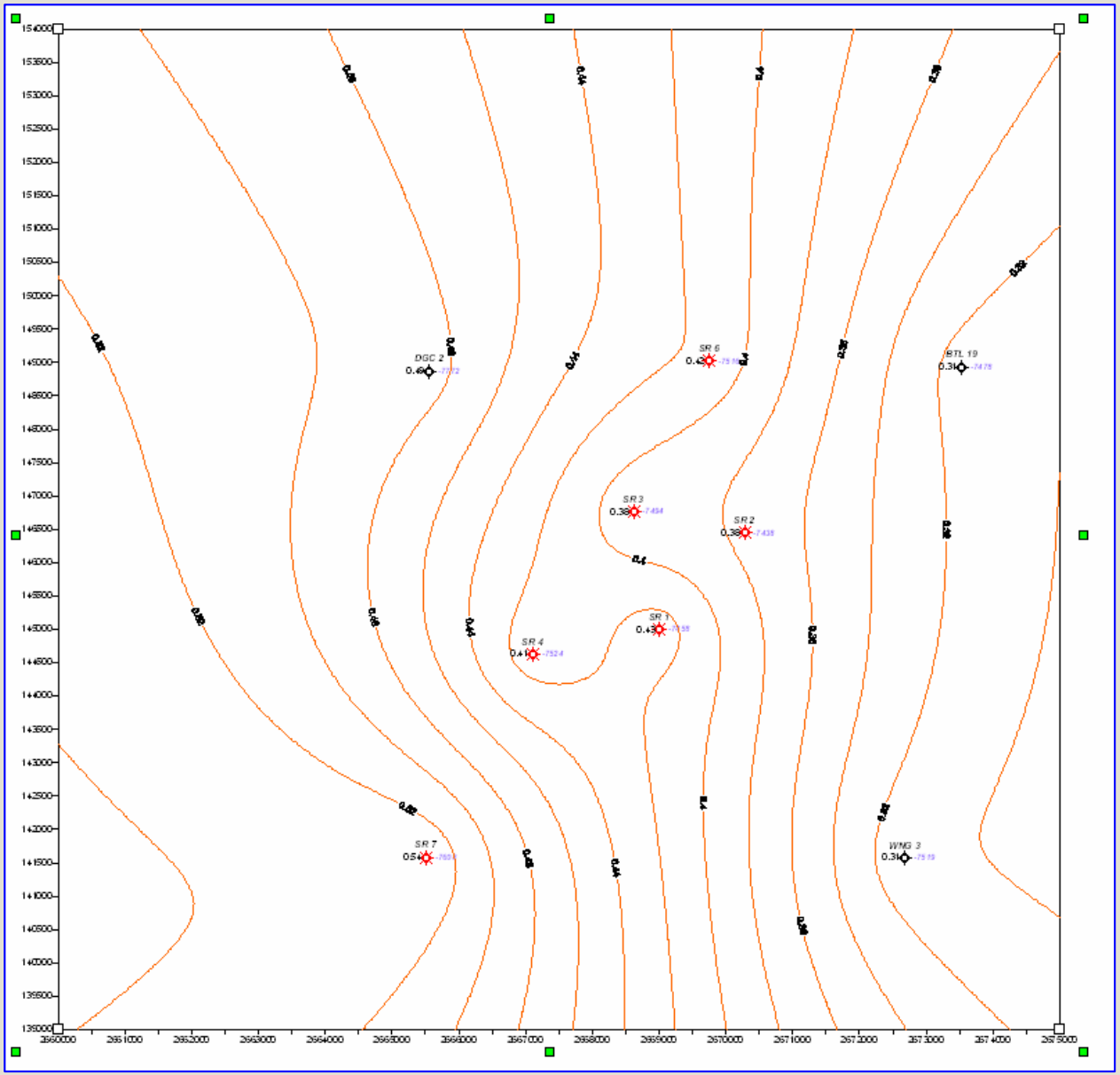
- ***Formula: Minimum (Hydrocarbon Column or the Gross Interval).***
- ***Hydrocarbon Column = Structure Map – Fluid Contact.***
- ***Values below the contact will be negative.***
- ***You can blank (0) the negative values in the formula by: Max(Min(Column,Gross), 0)***



# Net/Gross Ratio Map

- ***If you already have separate Gross Sand and Net Sand Maps, then just divide NS/GS.***

- ***From Net sand data, generate a Net Sand Map using a smooth type algorithm.***

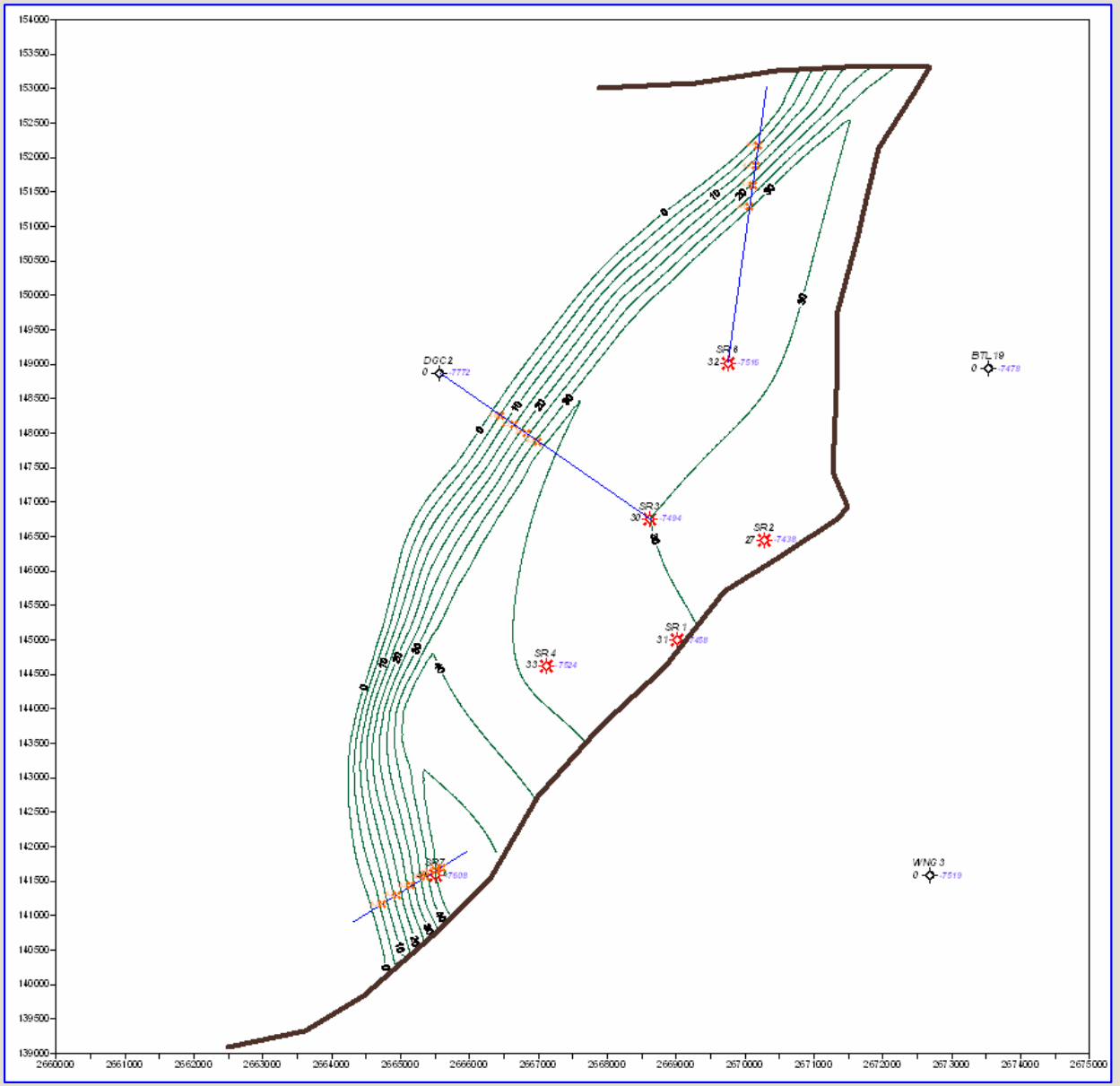




©SCA

# Initial Net Pay Map

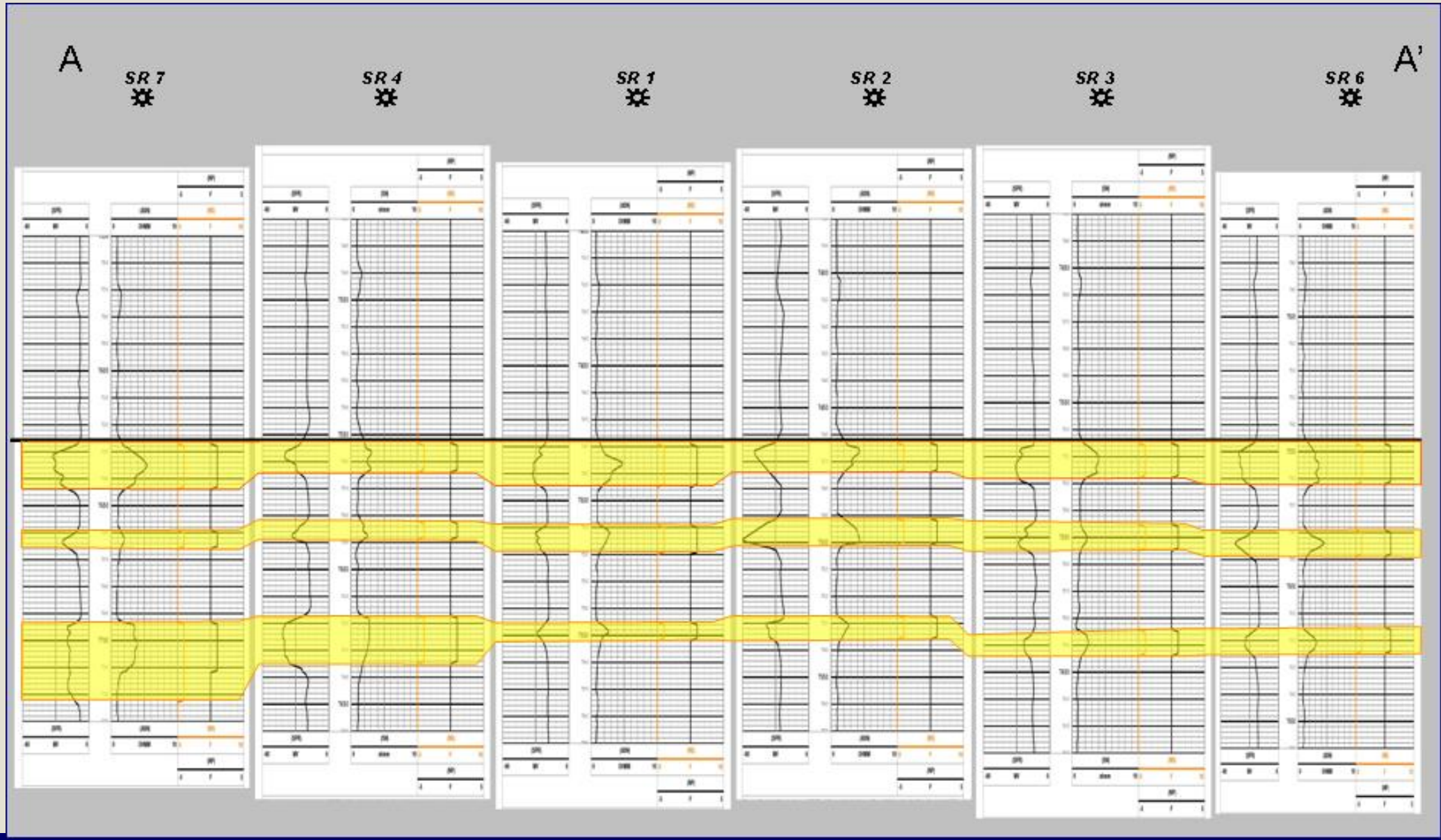
- ***Using Grid Math Multiply the Gross Hydrocarbons Map x the Net/Gross Ratio Map***.





©SCA

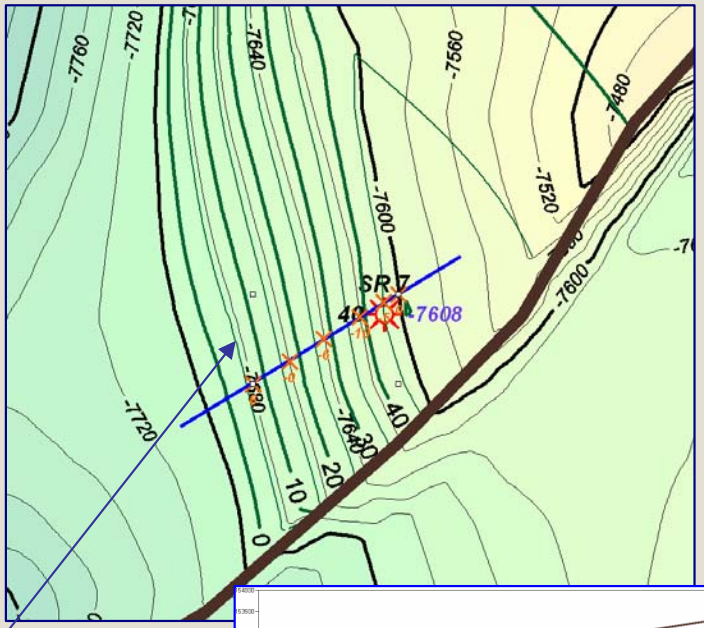
# Does the Net Sand Vary Vertically?

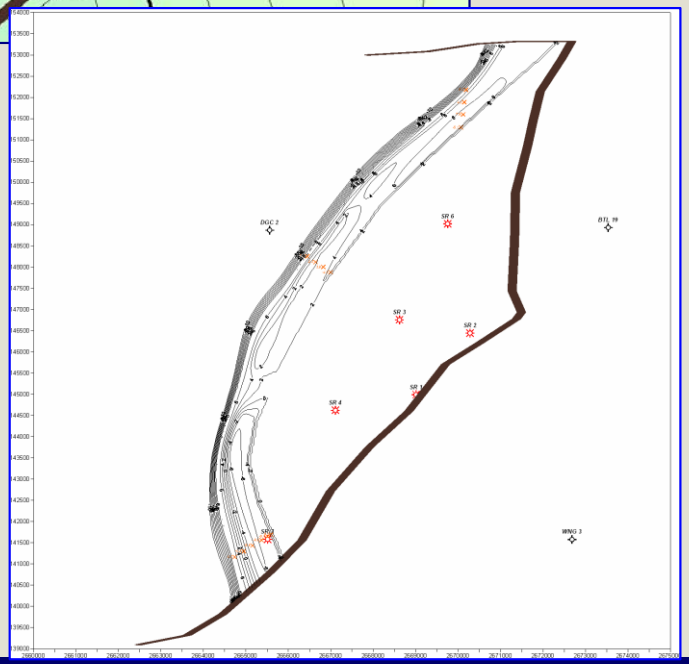


# Downdip Wedge Net Pay Errors

***Differences can be "fixed" by adding a simple error map using an inverse distance algorithm interpolating the thickness errors at the well to a Zero value at the top of the wedge.***

***Or just edit the contours where errors have been identified.***



***A more accurate approach would be to digitize points to "walk" the well(s) updip.***


©SCA

# Net Pay Map w/corrected Wedge

Surfer - Net Pay Volumes Final.rtf

File Edit

Wed Jul 22 09:34:38 2009

## Upper Surface

| | |
|---|---|
| Grid File Name: | C:\Data\Net Pay Mapping\Surfer\Net Pay Final Blank.grd |
| Grid Size: | 400 rows x 400 columns |
| X Minimum: | 2660000 |
| X Maximum: | 2675000 |
| X Spacing: | 37.593984962406 |
| Y Minimum: | 139000 |
| Y Maximum: | 154000 |
| Y Spacing: | 37.593984962406 |
| Z Minimum: | -305.03048327983 |
| Z Maximum: | 49.746871097372 |

## Lower Surface

Level Surface defined by Z = 0

## Volumes

| | |
|---|---|
| Z Scale Factor: | 1 |

**Total Volumes by:**

| | |
|---|---|
| Trapezoidal Rule: | -4682974776.0375 |
| Simpson's Rule: | -4681891634.6719 |
| Simpson's 3/8 Rule: | -4683319920.5968 |

**Cut & Fill Volumes**

| | |
|---|---|
| Positive Volume [Cut]: | 1335829959.7462 |
| Negative Volume [Fill]: | 6018804735.7837 |
| Net Volume [Cut-Fill]: | -4682974776.0375 |

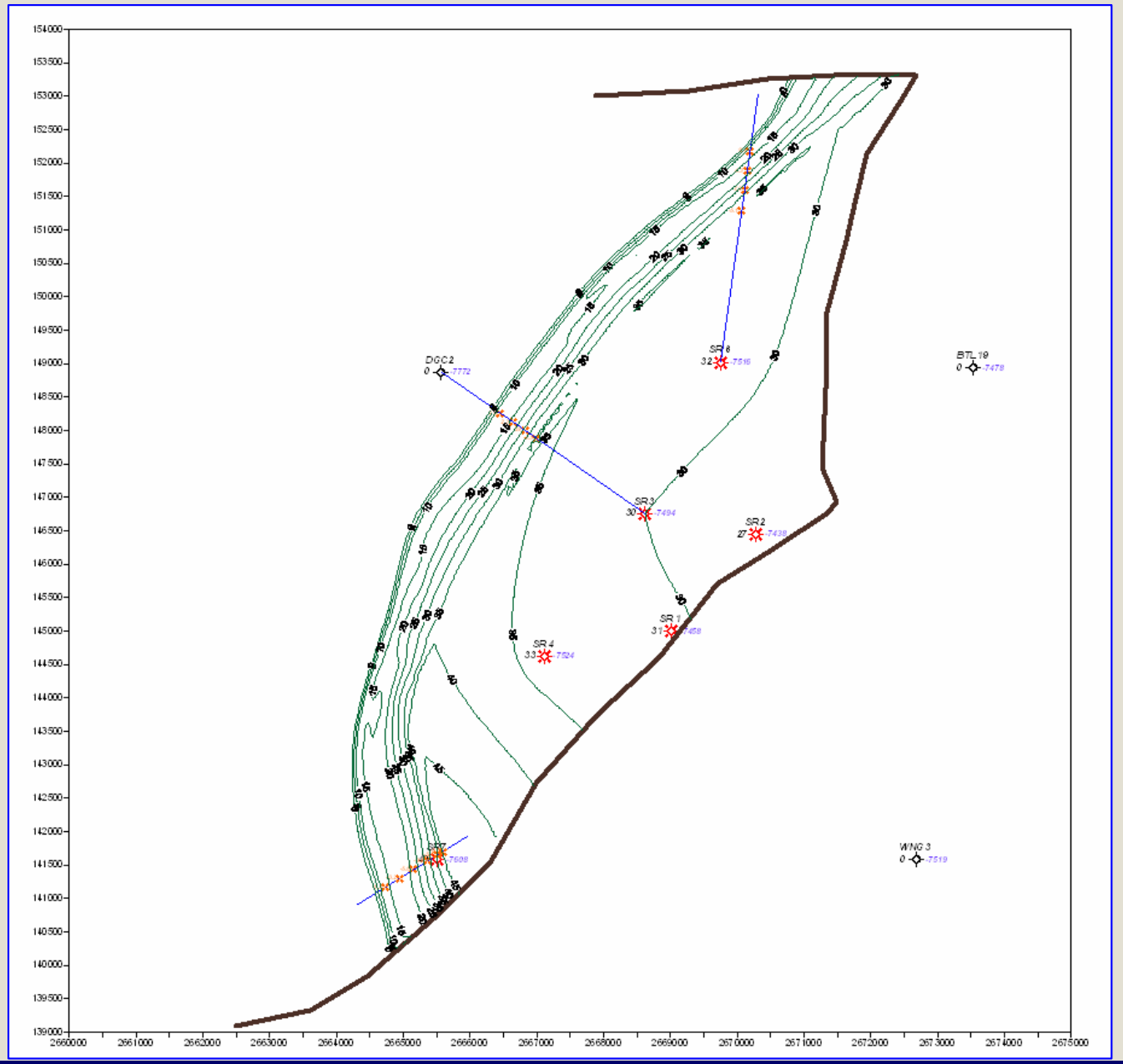
## Areas

**Planar Areas**

| | |
|---|---|
| Positive Planar Area [Cut]: | 45471895.070982 |
| Negative Planar Area [Fill]: | 56197221.329041 |
| Blanked Planar Area: | 123330883.59998 |
| Total Planar Area: | 225000000 |

**Surface Areas**

| | |
|---|---|
| Positive Surface Area [Cut]: | 45485462.259982 |
| Negative Surface Area [Fill]: | 56325650.668951 |



# To Complete the Volumetric Calculations Integrate Porosity and Water Saturation Maps