This is the complete TVD welltie document.

TVD Welltie Procedures for use with Geolog 6

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Introduction:

The welltie process requires checkshot data and also a DT sonic log. The Geolog 6 software is setup to use vertical well data, which lacks any deviation along the track of the borehole. The original Kilauea data I was given is referenced to MD (measured depths from the KB 'Kelly Bushing'). The problem is all of the Kilauea wells are deviated so there are some extra steps which need to be taken in order to make a proper welltie from the recorded checkshot data and sonic log. These instructions will go over the exact proceedure I used to make a welltie for the Tex 2 deviated well.

Methodology:

1. I started with the following 'sets' already existing in Geolog for this Tex #2 well: CHECKSHOT\_NK\_MD, DIRECTIONAL, REFERENCE, WIRE\_NK\_REF\_MD, XTRAC\_TRACE\_MD. At this point the xtracted trace set and the directional set are not used. The directional set was created from a directional survey so that MD values could be converted to TVD values (True Vertical Depth). Originally, a welltie was run using the wireline data referneced to MD and also using the checkshot referenced to MD values. Upon scrutiny from Mincom, this NEW method using TVD references was developed. The TWTIME values from the checkshot data table and the MD values matched after running through the standard welltie proceedure. The problem is the calculated drift values were too high. Mincom recomends a max. of ~52 instead of my 180. The new process of using TVD referenced data instead of MD will(should) fix this.

2. Because of space considerations and speed problems, I decided to remove the CHECKSHOT\_MD and WELLTIE\_MD sets to make room for the new and improved sets referenced to TVD values. I have been experiencing speed problems with saving the well so maybe by shrinking the number of sets in the well, things will speed up.

3. The first step of the new process is to read in the checkshot data referenced to TVD. In the past I have read in both TVD and MD values and also OWTIME (one-way time) and TWTIME (two-way time). I do not have complete understanding of the internal Geolog code, so I now only read in the exact data I need; in this case its the OWTIME and corresponding TVD values. In the past I explicitly referenced TVD and still the software used the MD values in calculations. By eliminating any MD values in the checkshot set, this should be avoided

4. I set up a template to load the checkshot data called CHECHSHOT\_NK\_TVD The columns of the data read in are TVD, OWTIME, and TWTIME.

5. Next, we need to take the original WIRE\_NK\_MD dataset (all wireline curves) and duplicate the entire set. This is done using: tools->utility

->log duplicate. An inherent feature of 'log duplicate' is the ability to rereference the data which will allow us to take the entire wire set and go from MD values to the interpolated TVD values. I believe this introduces an error of approx. 0.4-0.5 feet at the bottom of the hole. A copy of the TVD curve from the deviation survey must be copied into the original WIRE\_NK\_MD set.

Since this set is referenced to MD, the first row in the set is depth. My copied TVD curve shows up around row #38 due to the alphabetical ordering. Confirm the total depth (TD) of the hole in the MD and TVD curves. For Tex#2, the MD bottoms out at 12706.0 Feet and the TVD terminates at 11499.879 Feet.

6. Now that the input set has a copy of the TVD curve, we can run the set through the log duplicate module in geolog. I set up a template titled 'rereference\_MD2TVD' so that future wells could be processed quickly as well. The Input set is the original wireline data, WIRE\_NK\_REF\_MD. The newly created output set will be 'WIRE\_NK\_REF\_TVD'. For the new reference top and bottom values, I viewed the TVD curve and used the first and last values of 0 and 11499.879. The second step in log duplicate is to fill in line 3, the input for a reference log to use when creating a new output set. We want to go from MD to TVD so I chose WIRE\_NK\_REF\_MD.TVD\_0. The blank window can be highlighted so that a choice of options appears. Choose the TVD curve found in the input wire set being processed.

7. The fourth line which needs to be filled out is the input logs to copy or the ones to be processed into a new rereferenced dataset. I clicked on the window for options and since I wanted all logs except the TVD curve, I held down the 'control' key and selected all curves needed with the mouse. I then saved the template and hit the 'OK' button to initiate the calculations. Upon finishing, go into the view text window to look at the new TVD referenced wireline set of curve. Line #1 should be the TVD curve and line #2 for me was MD. The bottom hole values for each were preserved.

8. The next step is to take the TVD log and resample it. Both the checkshot TVD depth values and the TVD curve values must be regularly sampled. It is recommended by Mincom to have all depth values end with 0 or .5. Since the TVD values for the checkshot data already ended with XX.0, I only needed to resample the TVD log. This was done in: tools->utility->regular. The input set was WIRE\_NK\_REF\_TVD and the output set is TVD\_RESAMPLED. The inputs are begining and ending values; I used 0 and 11500 Feet. The sample rate increment used was 0.5 and the units are Feet. The description is just a reminder of what you did, I specified 'resample TVD curve to 0.5' and the output was named TVD\_RESAMPLED. This generates the new set called 'TVD\_RESAMPLED'. I then needed to copy all of the logs from the WIRE\_NK \_REF\_TVD set into this new resampled TVD set. Once this is done, the intermediate set called WIRE\_NK\_REF\_TVD is erased and the resampled TVD set is renamed as appropriate. In this set I have the TVD\_RESAMPLED curve as the reference and also an MD cuvre which can be plotted as an alternative scale for comparisons. Originally the TD depth in MD was 12706 and now its 12705.58 due to the rereference and regularly sampled TVD curve. This is where I came up with the 0.4 Feet induced error in the data.

9. The welltie can now be addressed using the TVD referenced DT curve and the TVD referenced checkshot data. The input set is the WIRE\_NK\_REF\_TVD which was just renamed and has the regularly sampled TVD curve as the reference curve. The welltie is under: Geophysics->adjusted sonic. Line 3 is the KB height. Seismic reference datum was set to 0 because we had checkshot data referenced to a seismic datum of sea level. Line 5,reference log, is the TVD\_RESAMPLED. Line 6 uses the edited DT sonic. This has been previously edited to removed anomalous spikes in the data and also fill in skips in the log curve which cause the calculations to bomb. The output set from this module is named 'WELLTIE\_REF\_TVD'. Some of the important outputs are TWTIME\_REF\_TVD curve which shows the relationship between TVD depth and TWTIME which would apply to 2-D or 3-D seismic data. Another output curve I am interested in is line 13, the Drift. Mincom recomends max. drift values of 52 although my data has a 55 msec drift. One important note here is that although I read in the checkshot data properly, Mincom is now agreeing with my idea of adding in one extra 'bogus' checkshot data point in order to get interval velocity calculations down to the max depth of the checkshot data. For The Kilauea data, the checkshot data ends at 8500 Feet TVD. I put in a bogus 9000 Foot TVD value so that the calculated Interval Velocity Curve for the Checkshot would extend to 8500 Feet TVD. Without the bogus value, the curves end at 8000 Feet. Mincom is aware of this and agrees the extra extrapolated checkshot point is necessary in this version.

10. The last step is to take a copy of the TWTIME curve produced from the WELLTIE-Adjusted Sonic module and copy it into the reference set. This will allow the TWTIME scale to be plotted and also the extracted seismic data wont show up without the TWTIME curve in the reference set. I also put a copy of the TVD curve in the WELLTIE\_NK set so that the data table could be viewed in the Text window and the MD versus TVD depths and TWIMES could be compared. I find that after all is said and done, the final product looks reasonable. In the WELLTIE set, the TWTIME for my TVD value of 8500 Feet is 2.4181 seconds and according to my initial checkshot input, it should be just 2.4180 seconds. An error of 0.0001 secs is very acceptable. Another note is that the two curves produced in WELLTIE called SRD\_DEPTH\_to\_CHECKSHOT or Reference both turn out to be TVDSS logs (true vert. depth subsea). This should always be confirmed against a TVD and MD log though before plotting.

Conclusions:

One thing remaining unclear is the tie between the plotted seismic amplitudes and TWTIME. It doesn't matter which TWTIME curve you chose, be it the one generated from a MD WELLTIE or a TVD WELLTIE. This is because both will have the same corrections applied for the wells deviation. I chose to copy the TWTIME\_TVD into the reference set as TWTIME. Because of the large well-bore deviation, I would expect the plotted extracted trace would only be comparable to the wireline data where the seismic trace and borehole intersect. Zones outside of this intersection would have data from two different sources (active 3-D seismic and downhole wire logs) comparing two different areas of geology. Even so, the extracted trace does not match the wireline data very well. I expected drops in the GR log to indicate large seismic impedance drops as well, but this is not readily observed. The bottom line is the 'drift' value is indicating a reasonable tie between checkshot and wireline DT data, but I need to explore the accuracy of yanking extracted traces out of Landmark and how one goes about identifying the exact TRACE and LINE number in Landmark to specify for the exporting of time and amplitude values. This will be looked into after synthetic trace generation is finished.