Note on QC and reprocessing of Exp319 FMI imaging

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Summary

- Data QC and reprocessing of the FMI borehole image data are made by CDEX LSS. Optimized parameters and limitation of processing are indicated.
- Big amount of stick and slip of the FMI tool distort the image. The image is improved by processing with optimized parameters.
- Washout and rugous borehole blur the image. It is out of improvement of processing.

Introduction and background

CDEX LSS made pre-processing of FMI borehole image data during exp 319 cruise. The best results were provided the on-board science party in limited time, but there were some blurry images in several intervals. CDEX LSS made detail QC and optimize the processing parameters after cruise. The causes, results and limitation are reported in this note.

The depth in this note is mBRT (meter below the rig floor) original wireline record, because the plot here is purpose of data quality check. You need subtract 2081.1m for meter below the sea floor. Pre-processing in this note is carried out with Schlumberger GeoFrame 4.4.

FMI tool and image pre-processing

FMI (Fullbore Formation microimager, trademark of Schulumberger) scans inside a borehole wall and generates electrical images. 24 button electrodes are mounted on each pad and flap like Figure 1. The four arms push the four pads and flaps against the borehole wall, and the resistivity is measured with pulling up the tool continuously. The two pair of arms measures hole diameters simultaneously. FMI is aligned with GPIT (General Purpose Inclinometry Tool, trademark of Schulumberger), which has three component accelerometers and magnetometers to calculate tool inclination, dip and orientation.

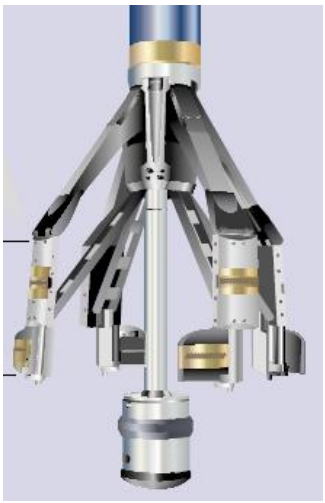

Figure 1 After Schulumberger's FMI brochure

The FMI and GPTI data are made data QC and pre-processing (speed correction, scaling, and generating dynamic/static image) with GeoFrame or other third party software, then scientists make geological interpretion. Logging winch continuously winds cable to raise wireline logging tools from the bottom of hole, but rugous or sticky borehole wall make the tools stick and slip motion. It results in incorrect depth and distorting images. "Speed correction" processing corrects images with taking account of the tool motion. GeoFrame and third party software provide several algorithms to correct. The pads and flaps are required to touch borehole wall smoothly. Washout and rugousness of borehole blur the image.

Tool motion and speed correction

Tool motion (tool velocity, cable speed, acceleration on z axis, tool acceleration, and tool head tension) are plotted in Figure 2. The depth shift to be applied to the data (correction to true tool position) is calculated from the tool motion. Tool motion and depth shift below 3365mBRT are larger than above. It is consistent with the unit IV, interpretation in the 319 expedition report.

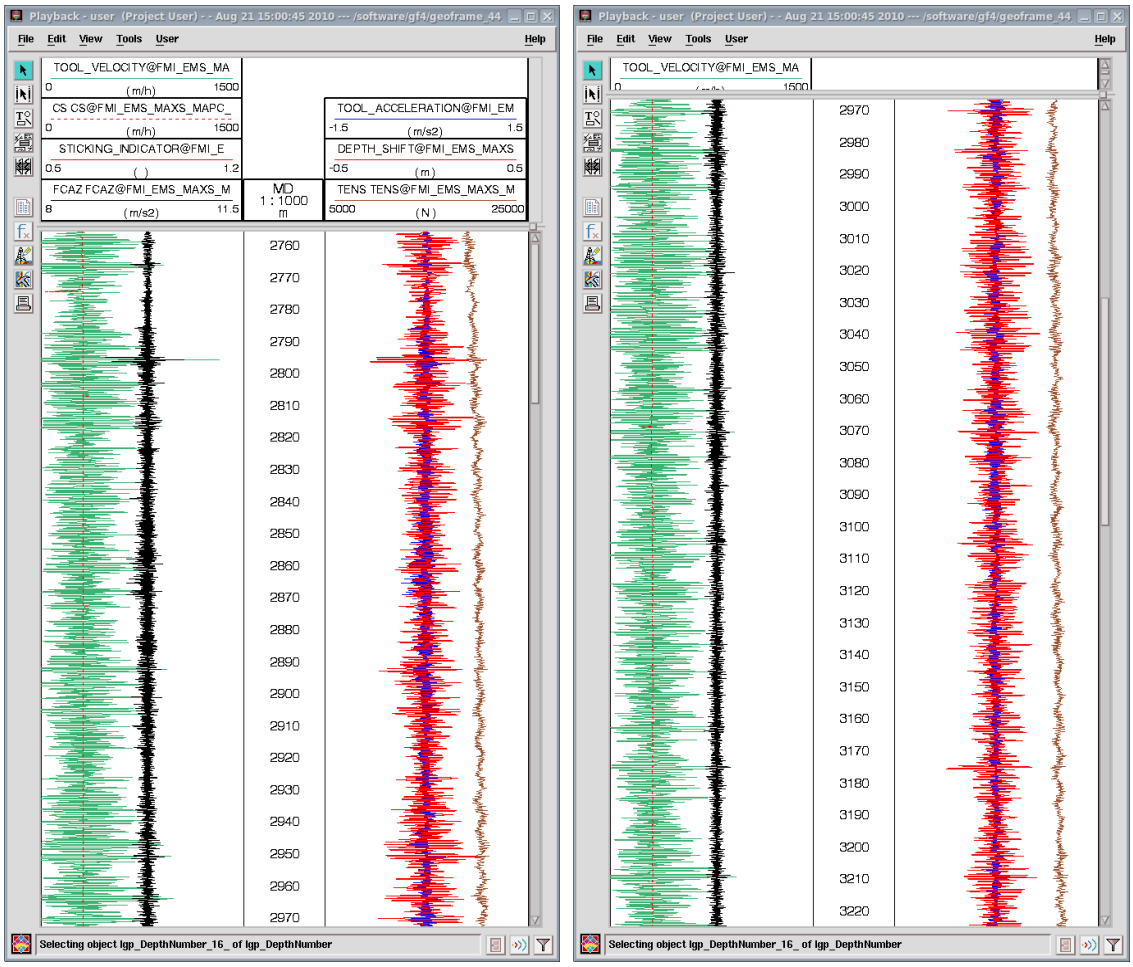

Figure 2 (a) left and (b) right: tool velocity, CS (cable speed), FCAZ (acceleration on z axis), tool acceleration, depth shift to be applied, tool head tension. STICKING_INDICATOR is not plotted, because “Sticking Detection” option is not used.

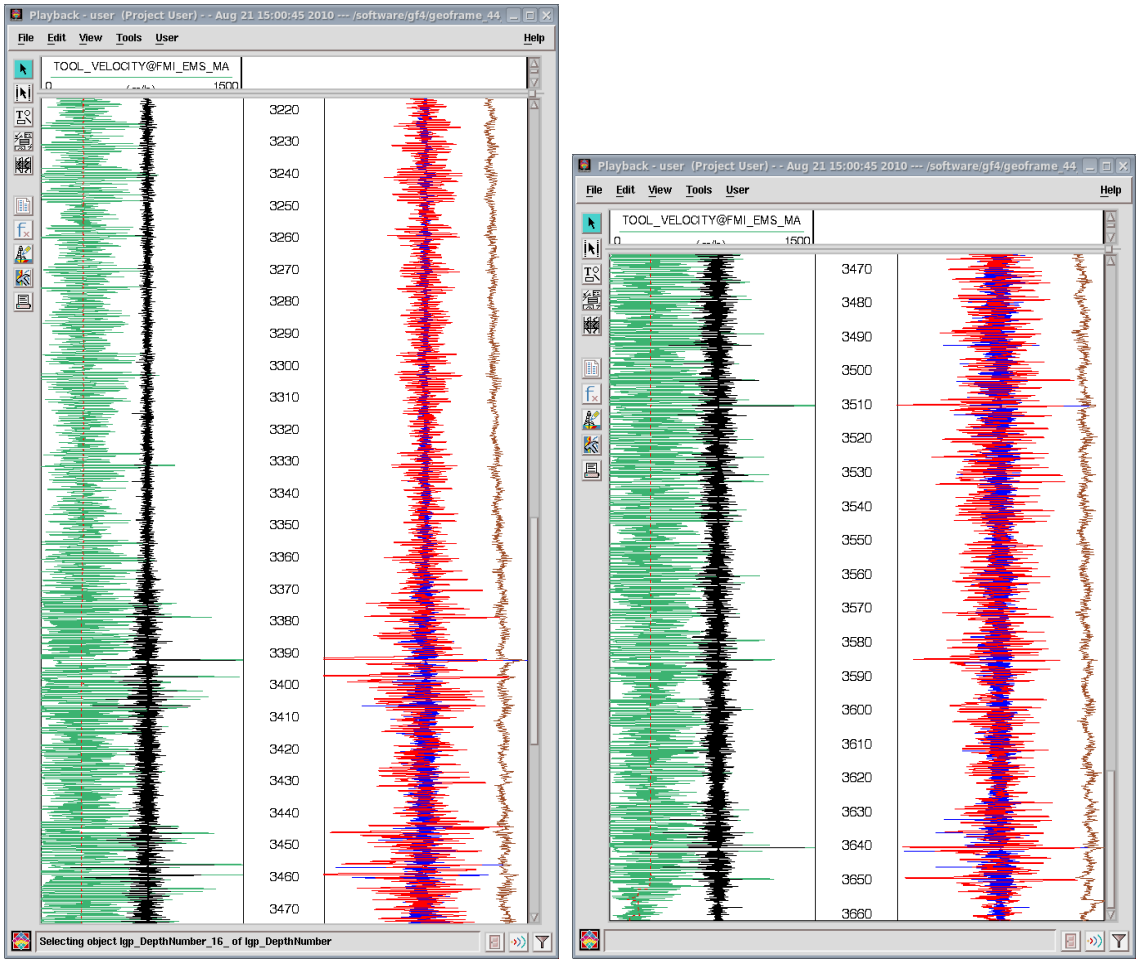

Figure 2 (c) left and (d) right: tool motion and depth shift.

"Sticking Detection" is appried as Figure 3. This option is toggled off as default setting. "Detection Threshould (m/s2)" and "Recovery Speed Factor" are carefully optimised to 0.0025 and 3.0, respectively.

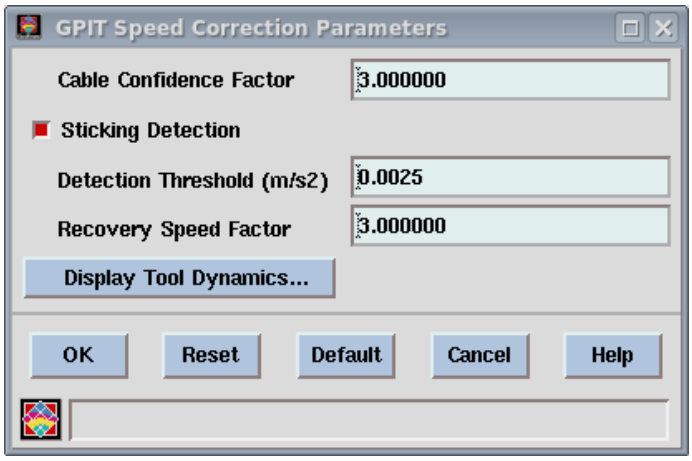

Figure 3: Speed correction parameters for this data.

Many “STICKING_IDENTICATOR” are flagged in sticking intervals (below 3375mBRT), and depth shift are recalculated in Figure 4.

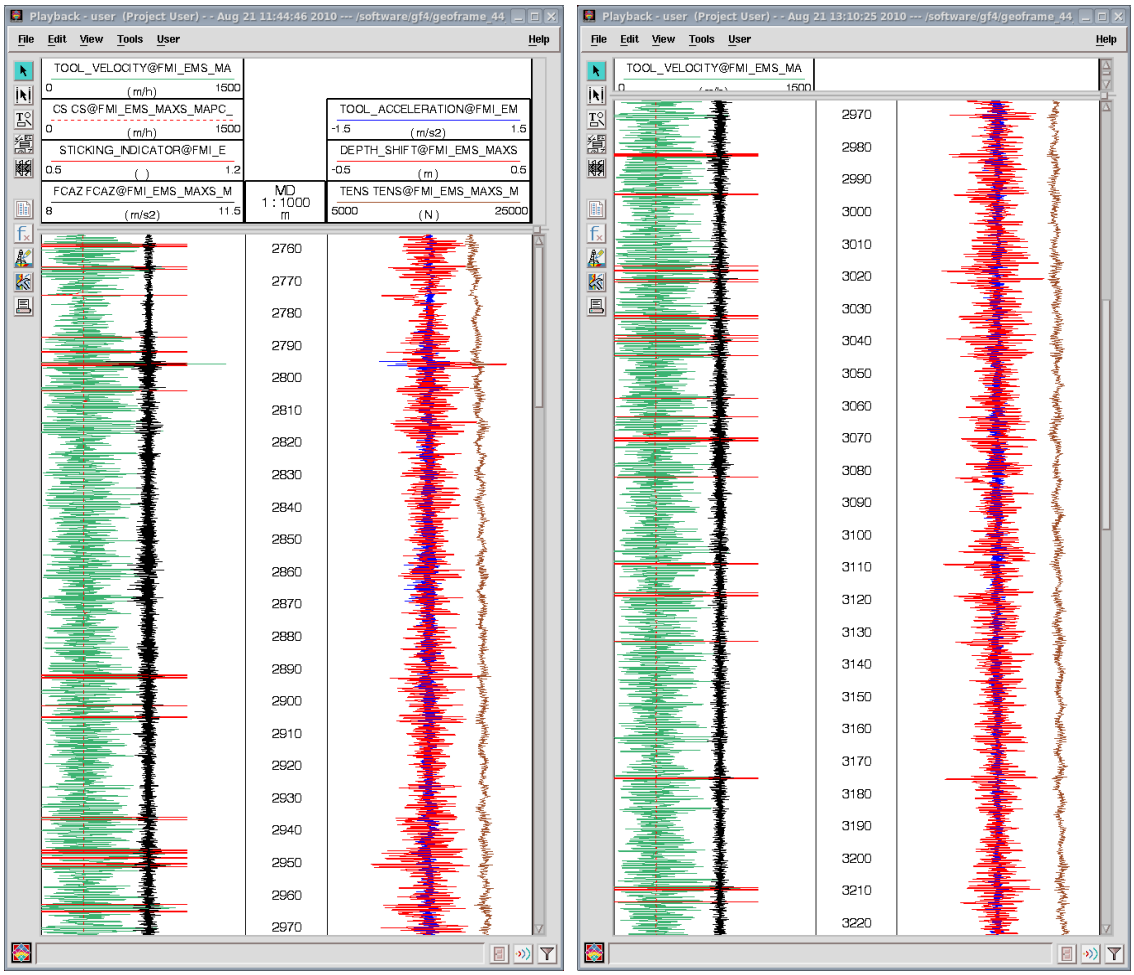

Figure 4 (a) left and (b) right: tool motion, STICKING_INDICATOR, depth shift to be applied.

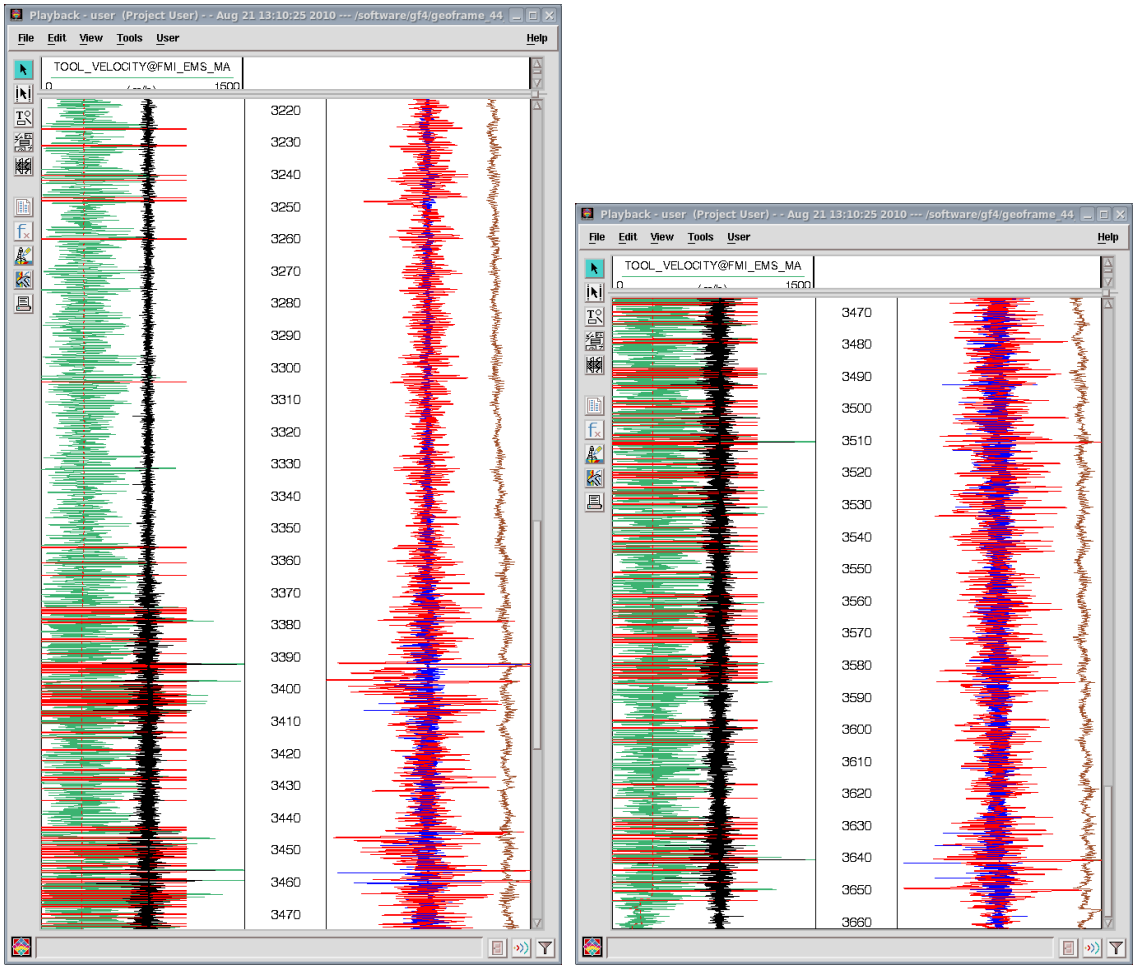

Figure 4 (c) left and (d) right: tool motion, STICKING_INDICATOR, depth shift to be applied.

The minute images are created as in Figure 5. The image with and without “Sticking Detection” does not make difference in this interval, because the sticking is not detected.

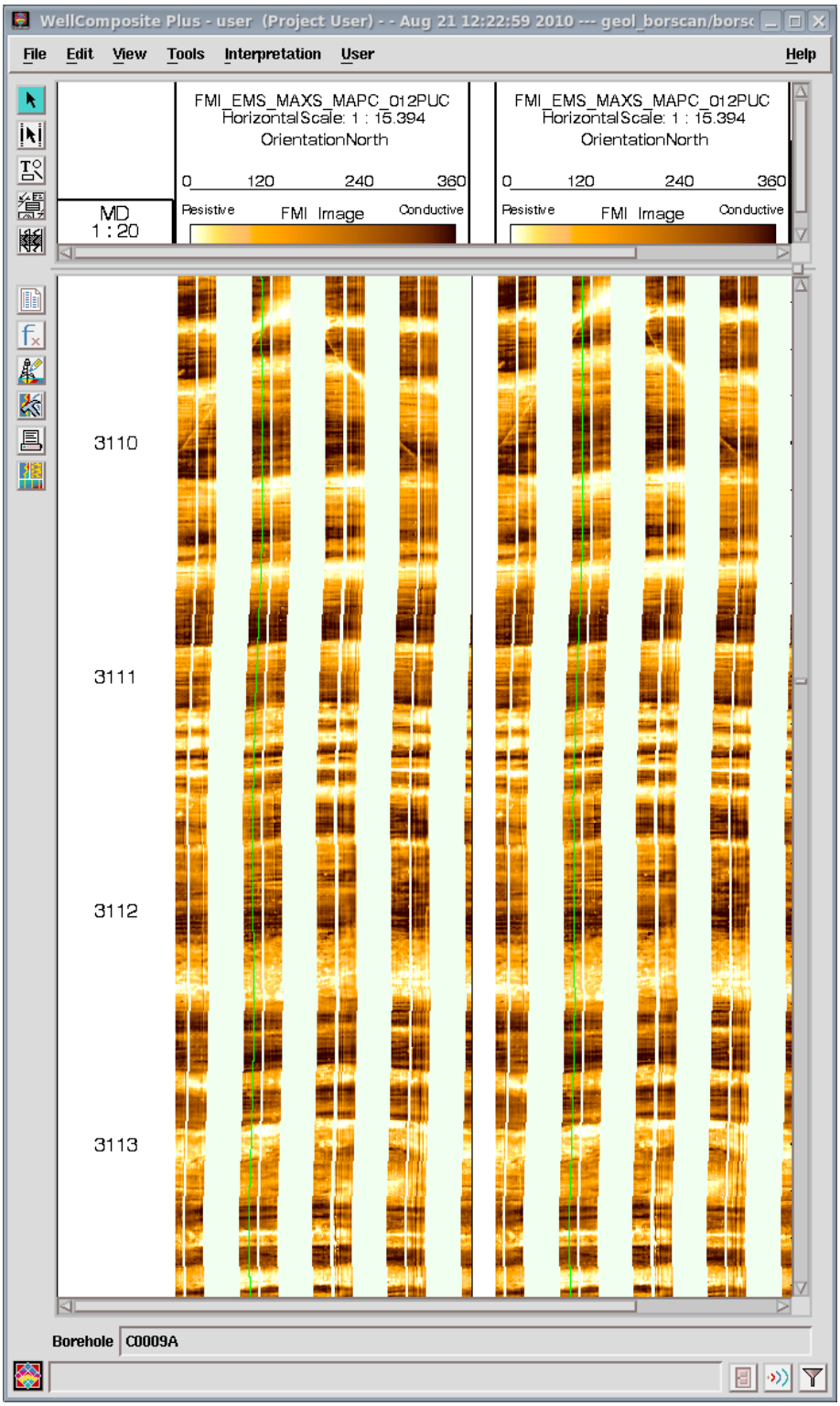

Figure 5: Left is the images without “Stick Detection”. Right is the image with “Stick Detection” in 3110-3113mBRT.

The stretching by tool slip are shown in 3455.5-346.5mBRT (highlighted with blue

rectangular) in the left of Figure 6 and 7. The position and distortion are corrected by applying with “Stick Detection” in red circles in the right of Figure 6 and 7.

Figure 6: Left is the images without “Stick Detection”. Right is the image with “Stick Detection” in 3454-3457mBRT.

Figure 7: Left is the images without “Stick Detection”. Right is the image with “Stick Detection” in 3456-3460mBRT.

Effect of hole diameters

Image processed with “Stick Detection” and orthogonal hole diameters are shown in

Figure 8. C1 and C2 are hole diameters measured Pad 1 and Pad 3, and Pad 2 and Pad 4, respectively. The diameter of drill bit in this hole is 12-1/4 inch. The hole condition is good, because the hole diameters are almost same as that of the bit. Detail of formation texture and small fractures are imaged clearly.

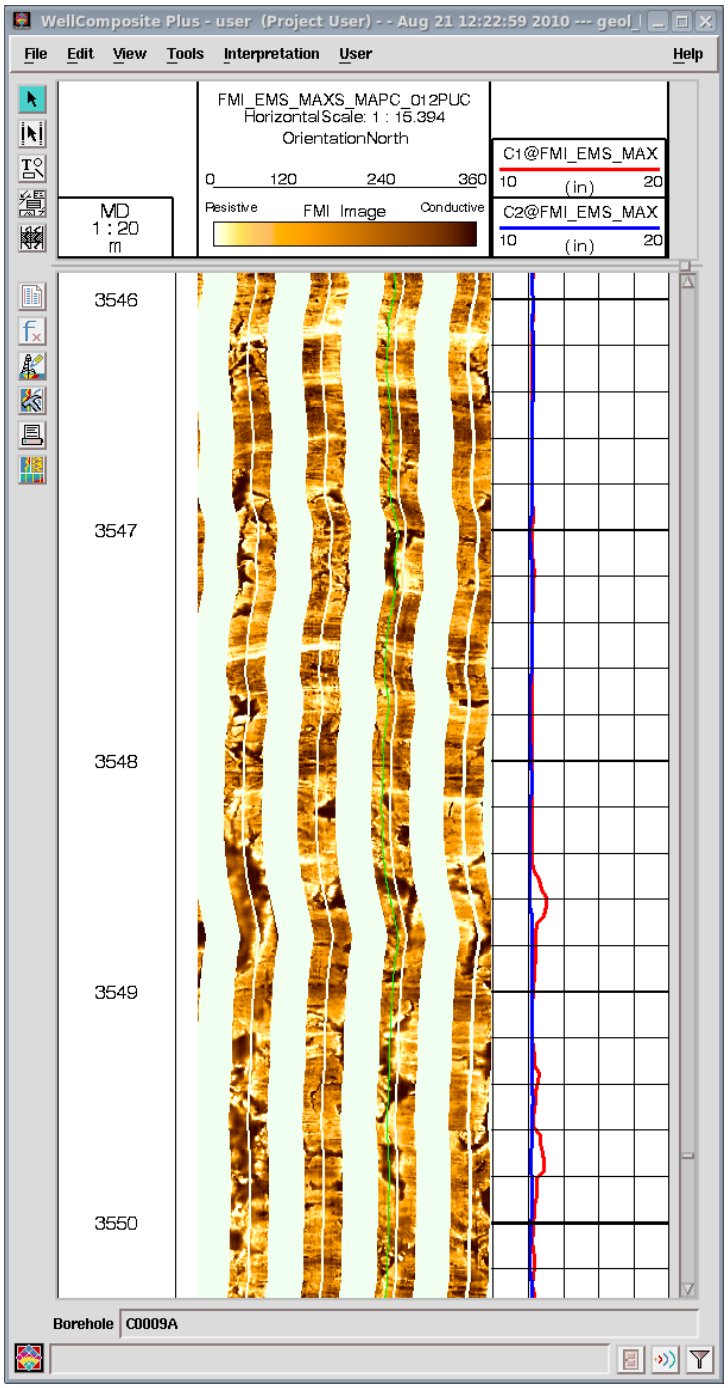

Figure 8: Image processed and orthogonal hole diameters (C1 and C2) in 3546-3550mBRT.

Image processed and orthogonal hole diameters (C1 and C2) in 3442-3446mBRT are shown in Figure 9. The images above 3444mBRT with good hole condition are very clear, but those below with large washout (hole diameter) are unfocused.

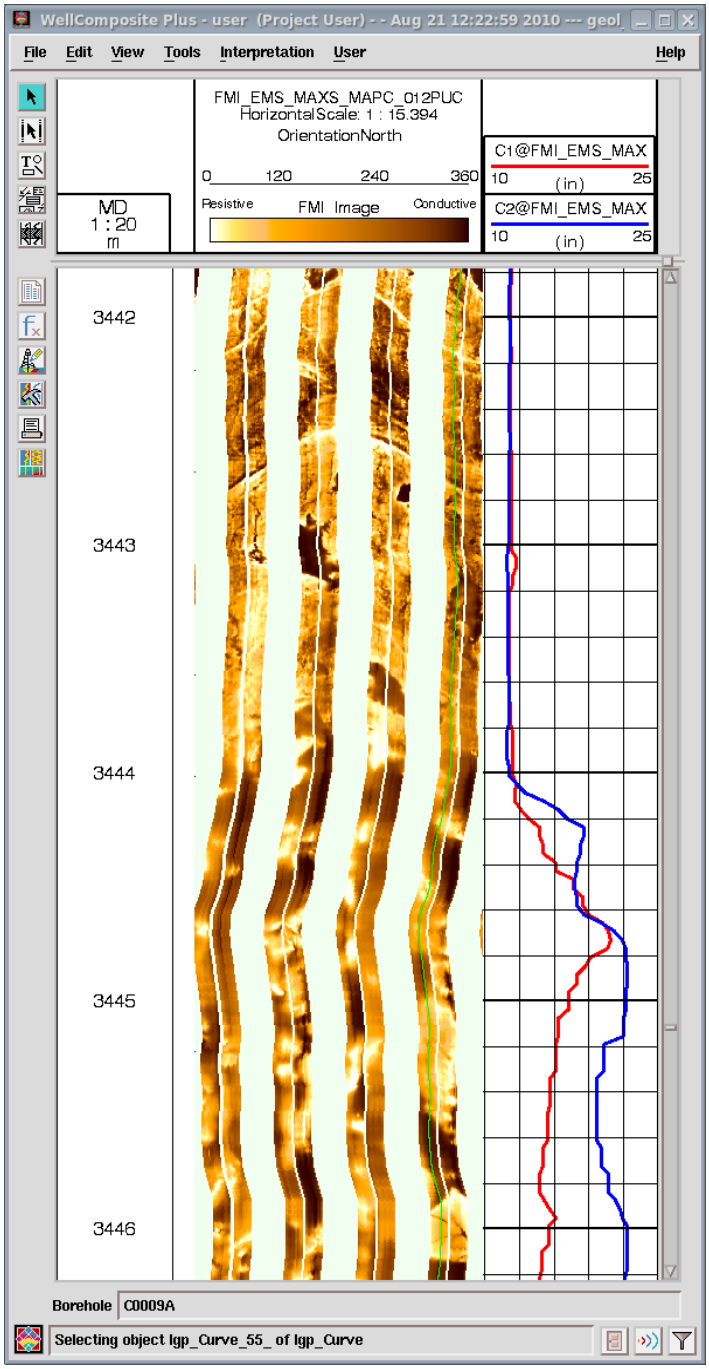

Figure 9: Image processed and orthogonal hole diameters (C1 and C2) in 3442-3446mBRT.

Image processed and orthogonal hole diameters (C1 and C2) in 3563-3567mBRT are shown in Figure 10. The hole diameter by Pad 2 and Pad 4 (C2) is almost same as that of the bit size. The images of Pad 2 and Pad 4 are very fine. But the hole diameter by Pad 1 and Pad 3 (C1) is larger than that of the bit size because of washout or hole collation. The images of Pad 1 and Pad 3 are not focused.

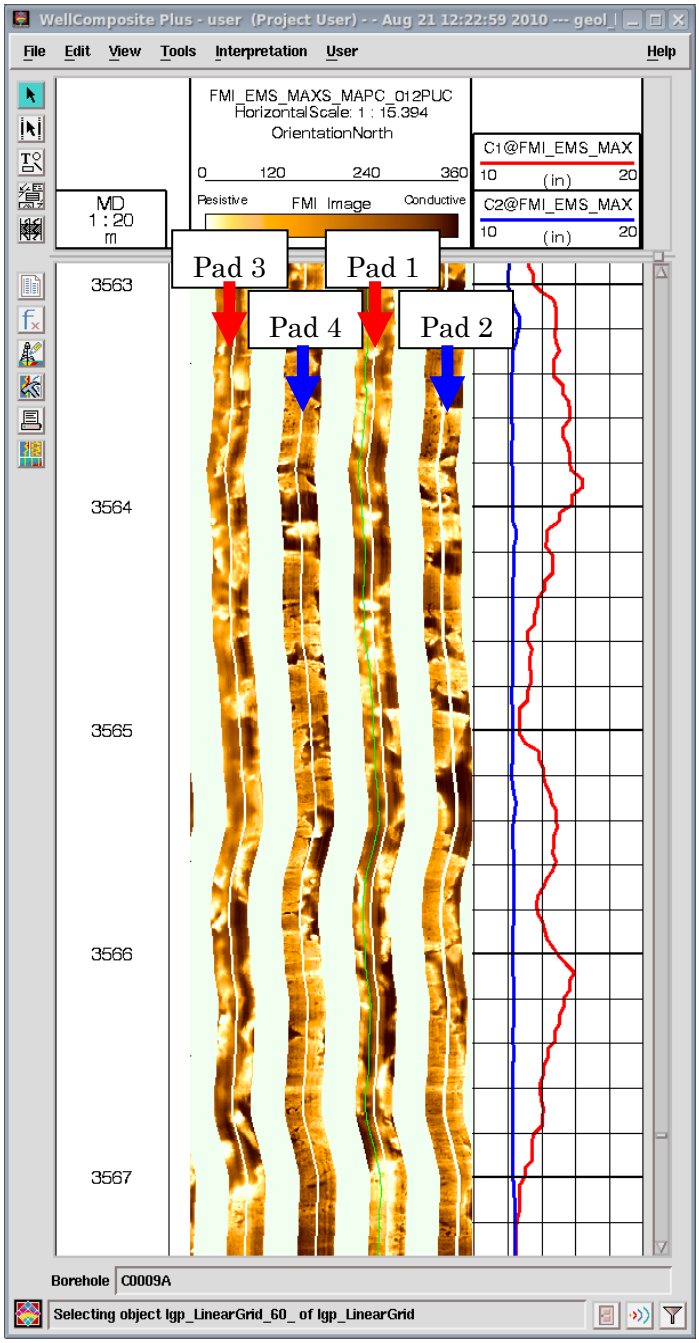

Figure 10: Image processed and orthogonal hole diameters (C1 and C2) in 3563-3567mBRT.

Results and discussions

Big amount of stick and slip of the FMI tool distort the image. The image is improved by processing with optimized parameters. Default parameters of speed correction processing in GeoFrame or other third party software usually work well in normal conditions. But the data affected strong sticky formation like the Nankai area is required careful parameter optimization. Washout and rugous borehole blur the image. It is out of range of improvement of data processing, because it is results from the measurement condition. The author hopes this note would help for the image processing of the data measured in similar condition.

Acknowledgement

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References

- Schlumberger's web site, http://www.slb.com/services/evaluation/wireline_open_hole/geology/fullbore_formation_microimager.aspx
- "BorEID User's Guide" in GeoFrame, Shulumberger.