



**McMULLENOLAN**

## NED KELLY HATS

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LAND SURVEY  
HYDROGRAPHIC SURVEY  
3D LASER SCANNING  
3D VISUALISATION  
MAPPING  
SOLID TERRAIN MODELS  
CARTOGRAPHICS  
GIS





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## 1.0 INTRODUCTION

In July 2008 Ned Kelly hats were incorporated into the automated slope monitoring system across Mt Whaleback mine site. The hats are designed to sit on top of the survey instrument to protect them from rain and dust, consisting of a light weight carbon shell with small panes of glass inserted either side for line of sight for the survey instrument. After the introduction of the hats changes in the graphing of slope distance was noticed across these monitoring stations. The survey team at Mt Whaleback then conducted a number of small trials to isolate and eliminate this problem from the slope monitoring system.

## 2.0 INITIAL OBSERVATIONS

Of the four automated slope monitoring stations using Ned Kelly hats at Mt Whaleback, changes to the graphing were different at each station, although the change it self was typically a 5-10mm jump or step in the graph of an affected prism. In two of the four automated pillars 55 and 91 only select prisms from each monitoring group seemed to be affected by this step. Of the two other pillars all prisms seemed to be affected at 91 and no prisms affected at 87. (See *Chart1*)

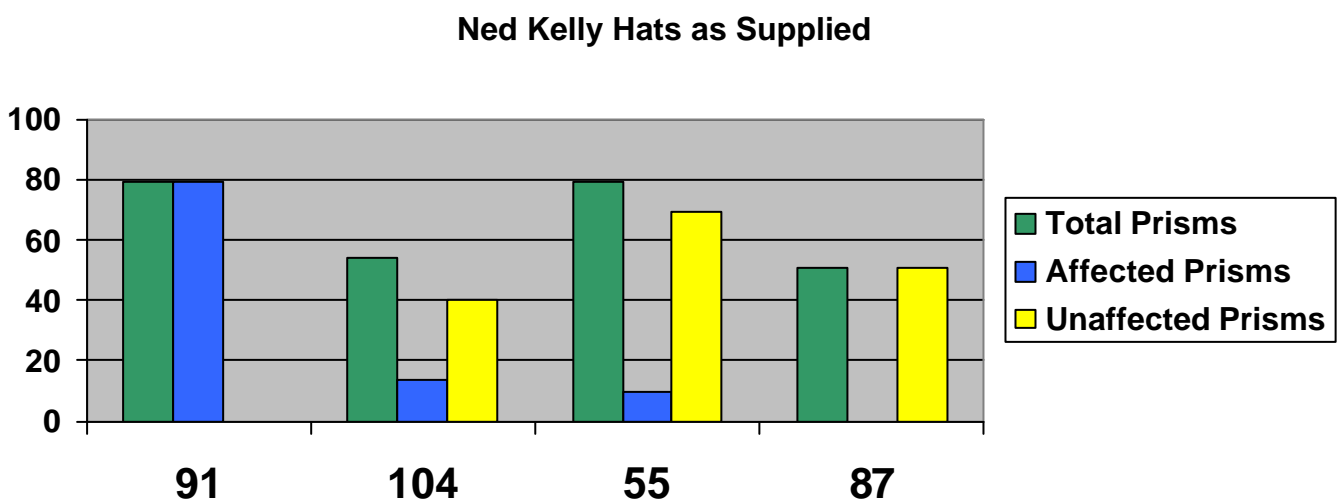
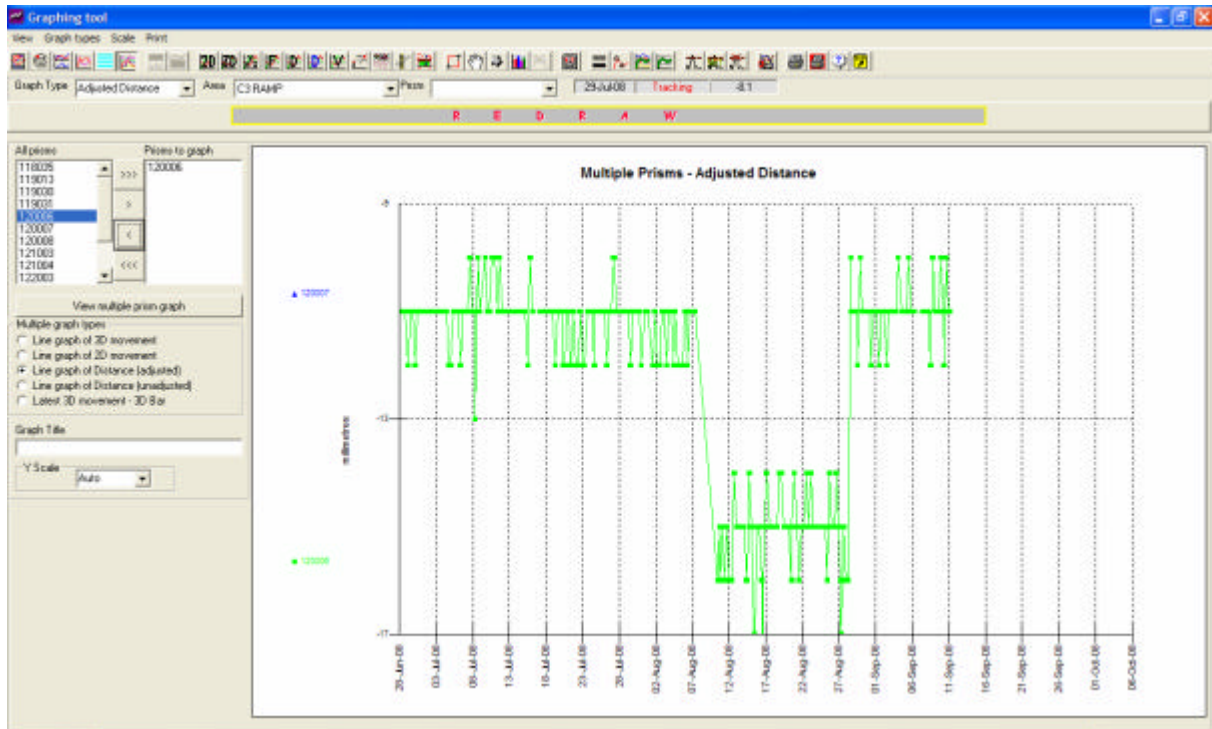
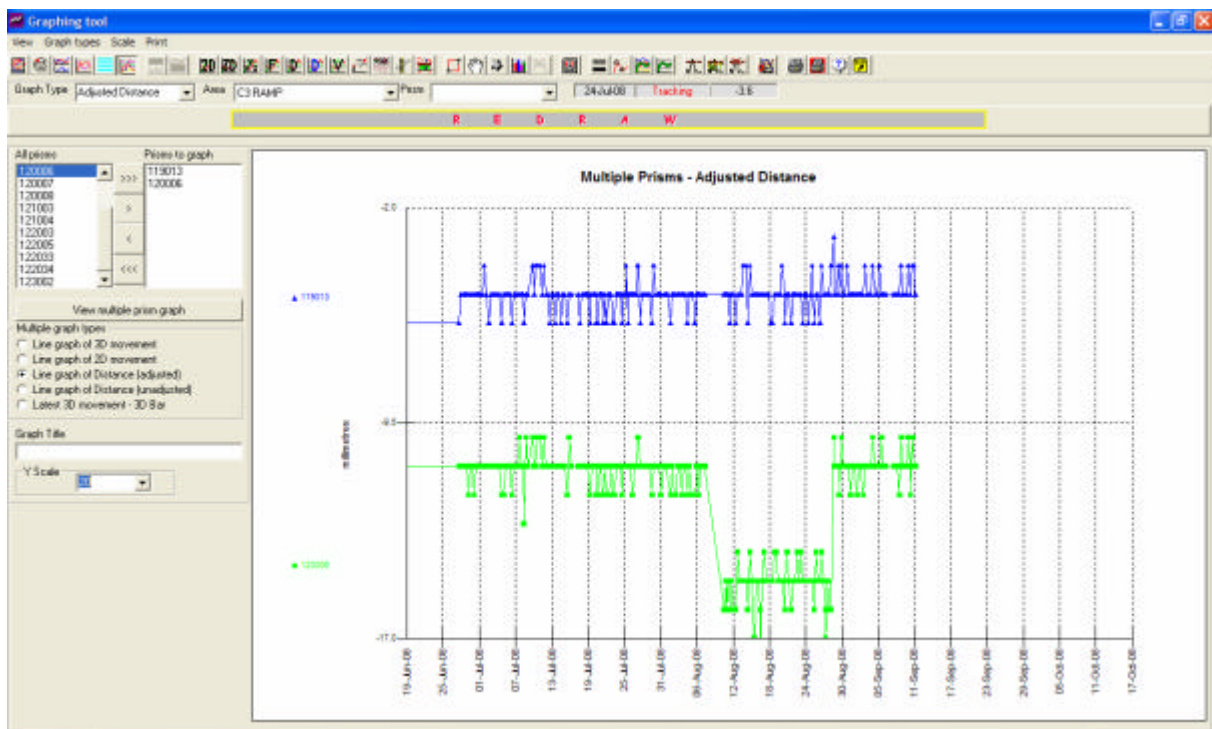


Chart 1

In *Picture 1* the step created in the graph is apparent of affected prisms. In *Picture 2* we see a clear difference between affected and unaffected prisms during the same conditions and time period from the same pillar with the hat on.



Picture 1



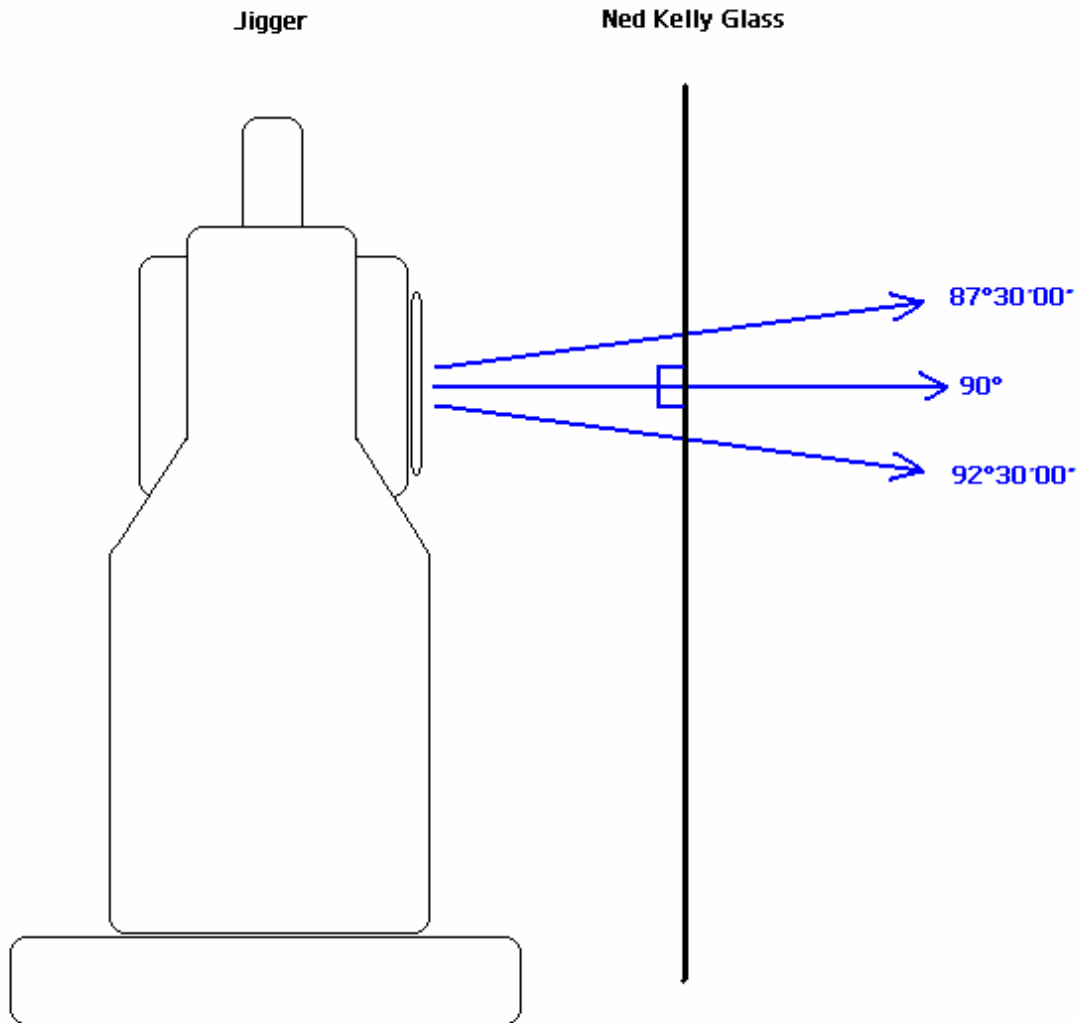
Picture 2

### 3.0 INVESTIGATION RESULTS

After the initial observations with the graphing, Ned Kelly hats were removed from the three pillars showing steps. All graphs returned to trends observed previous to the hats being introduced into the automated slope monitoring as in *Picture 1*. Due to the fact that observations from pillar 87 seemed unaffected by the addition of the Ned Kelly hat, monitoring continued with the hat attached. Again no step or jump was observed during this period

After a week of consistent results without issue three separate trials were conducted. One pillar was left without a Ned Kelly hat attached, while a Ned Kelly Hat with no glass was fitted to the second pillar. A Ned Kelly hat, as supplied by the manufacturer, was fitted to the third. Of these three pillars only the pillar using the Ned Kelly hat as supplied by the manufacturer showed a jump or step in the graphs, isolating the problem to the glass fitted to the Ned Kelly hats.

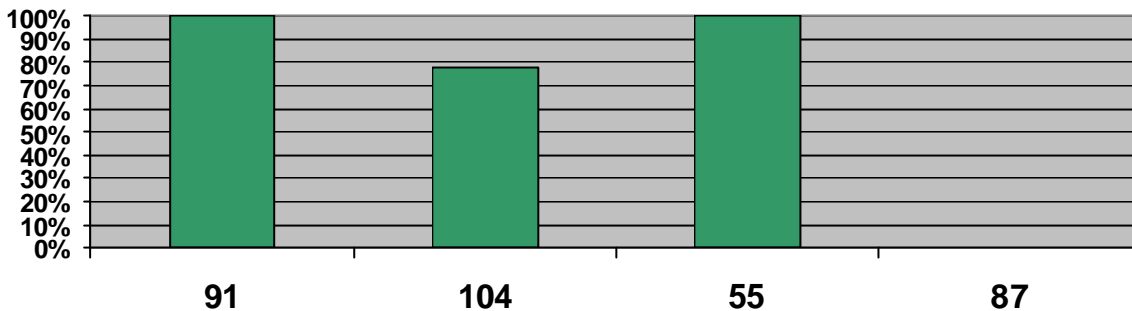
Following the results of the trials, data was reviewed across all monitoring groups from time periods affected by the Ned Kelly hats. It was found that where prisms showed a jump or step in their graphs, the vertical angle observed from the survey instrument was consistently between  $87^{\circ}30'00''$  and  $92^{\circ}30'00''$  or close to perpendicular to the glass fitted into the Ned Kelly hats. After consultation with MAPS Survey Team Leader Greg English, it was suggested that at this angle,  $87^{\circ}30'00''$  to  $92^{\circ}30'00''$ , the EDM may be reflecting or partially reflecting off the glass and back into the EDM causing interference. *Picture 3* illustrates the angle from the jigger or survey instrument at which a jump or step in the graph occurs.



Picture 3

Prisms showing a step in the graphs that were measured with a vertical angle greater than  $87^{\circ}30'00''$  and less than  $92^{\circ}30'00''$  across all monitoring groups are represented below in *Chart 2*. Most interesting results arose at 104 were 78% of affected prisms were within this range and 100% at 55.

**Affected Prisms within Vertical Angle Range**



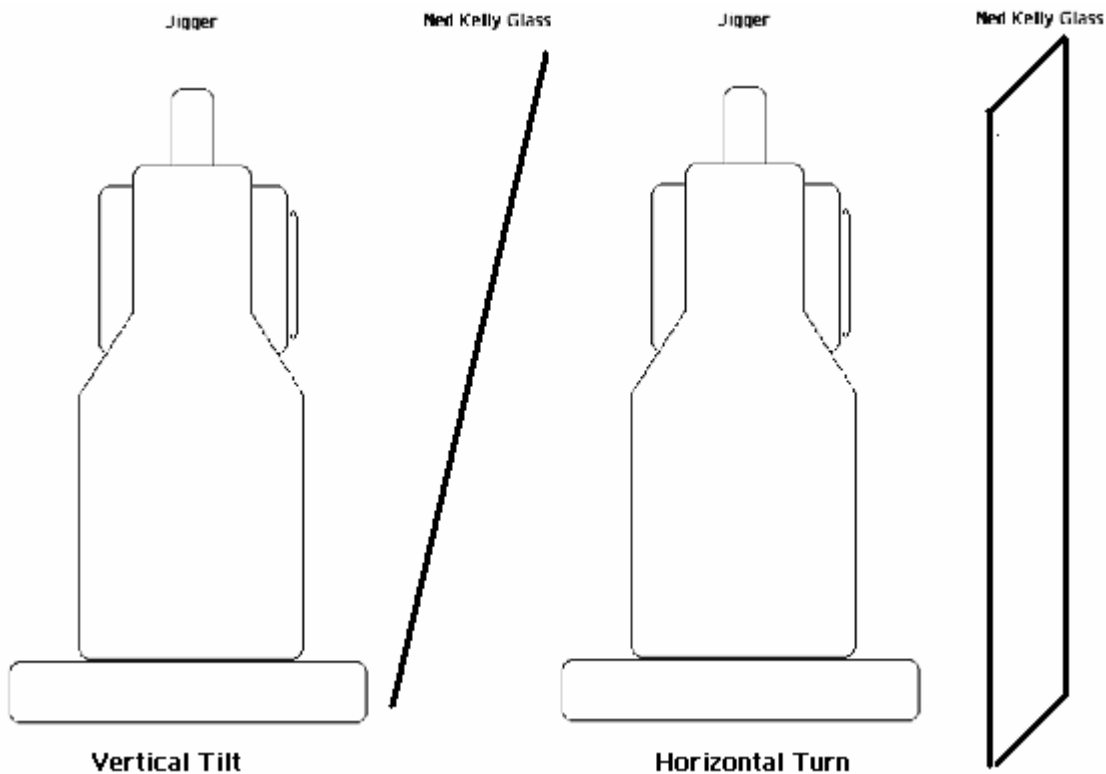
*Chart 2*

This finding also explained why we had conflicting results from pillars 91 & 87. Firstly pillar 87 is elevated above all prisms and reference objects it monitors, hence the survey instrument is always measuring a vertical angle greater than  $93^\circ$  with no interference. This is confirmed with the graphs from 87 showing no change with or without a Ned Kelly hat fitted.

In *Chart 1* we see pillar 91 with 79 total prisms and 79 affected prisms. After analysis of the data from 91 it was found that the RO or Reference Object from which the survey instrument calibrates its measurements, had a vertical angle of  $90^\circ 05'$ . Given the interference observed with other prisms in this vertical angle range it would explain that the affected measurement taken at the RO was then propagated through out the entire monitoring group in the form of an adjustment, which is as per the design of the software to reduce one variable in the solution.

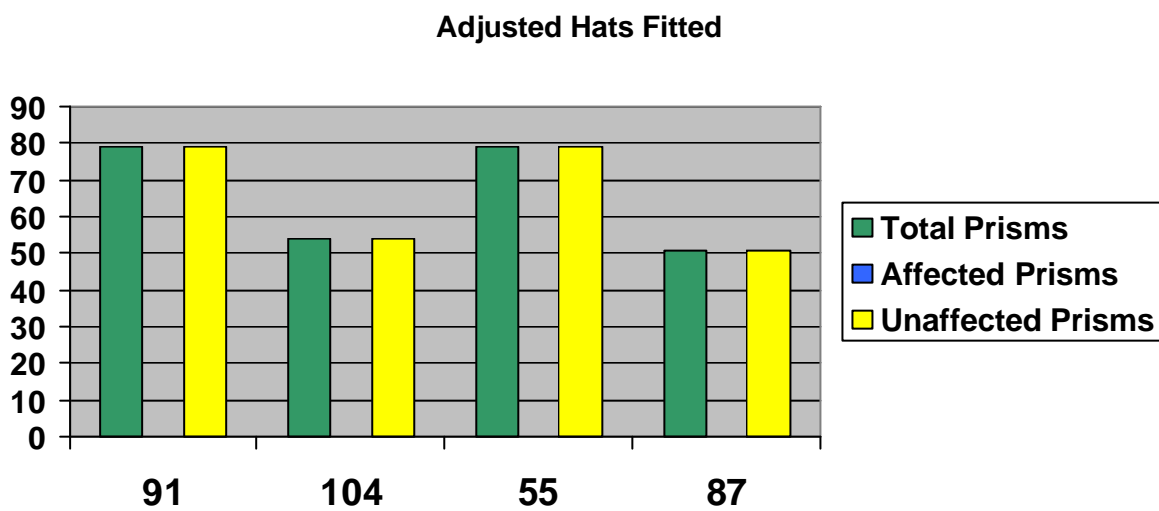
#### 4.0 SOLUTION

After reviewing results from the three trials conducted with Ned Kelly hats it was determined that tilting or turning the glass in the Ned Kelly hats would stop the interference by deflecting the glass reflected EDM signal away from the survey instrument. The glass on either side of the Ned Kelly hats was turned horizontally (Horizontal Turn) due to the fact that the survey instrument and Ned Kelly hats turn on the same horizontal axis but while the hat stays still the survey instrument rotates on a vertical axis. If the glass was tilted backward or forward (Vertical Tilt) this would allow for the same interference to occur at a different vertical angle. See *Picture 4*. To create this twist in the glass a spacer was placed in one side of the glass.



Picture 4

After implementing this solution, trends in the graphs in all monitoring groups returned to those prior to the introduction of Ned Kelly hats at Mt Whaleback as seen in *Chart 3*.



*Chart 3*

## 5.0 RECOMMENDATIONS

Currently the device holding the glass in place is a plastic ring binder with masking tape. Should this glass turned solution be adopted, a more permanent and professional adjustment should be fitted to the Ned Kelly hats to ensure the glass does not turn or slip out. Another option would be to remove the glass from the Ned Kelly hats eliminating interference completely, however this would defeat the real purpose of the hat, which was to assist in keeping dust and rain from the instrument.

## 6.0 CONCLUSION

After observing errors in the graphing across monitoring groups during the introduction of Ned Kelly hats at Mt Whaleback three comprehensive trials were conducted to isolate the problem. It was found that when the survey instrument measured a vertical angle between  $87^{\circ}30'00''$  and  $92^{\circ}30'00''$  with the glass from the Ned Kelly hat in place, a 5-10 mm step or jump in the graph was visible for most prisms. When the Reference Object is within this vertical angle range, the error is propagated through out the group of monitored prisms, as designed within the parameters of the algorithm.

When the glass panel of the Ned Kelly hat, in front of the survey instrument is tilted or rotated, so that it is no longer perpendicular to the line of sight or direction of the emitted EDM from the survey instrument, the step in the graphing of the prisms is no longer visible, confirming our theory that portion of the emitted EDM ray is reflecting back into the instrument and effecting the distance observed.

## 7.0 APENDIX

- A Ned Kelly hat in use
- B Adjustment made to Ned Kelly hat
- C Ned Kelly hat with glass turned
- D Initial Observations at 91
- E Initial Observations at 104
- F Observations after adjusted Ned Kelly hat fitted at 91
- G Observations after adjusted Ned Kelly hat fitted at 104

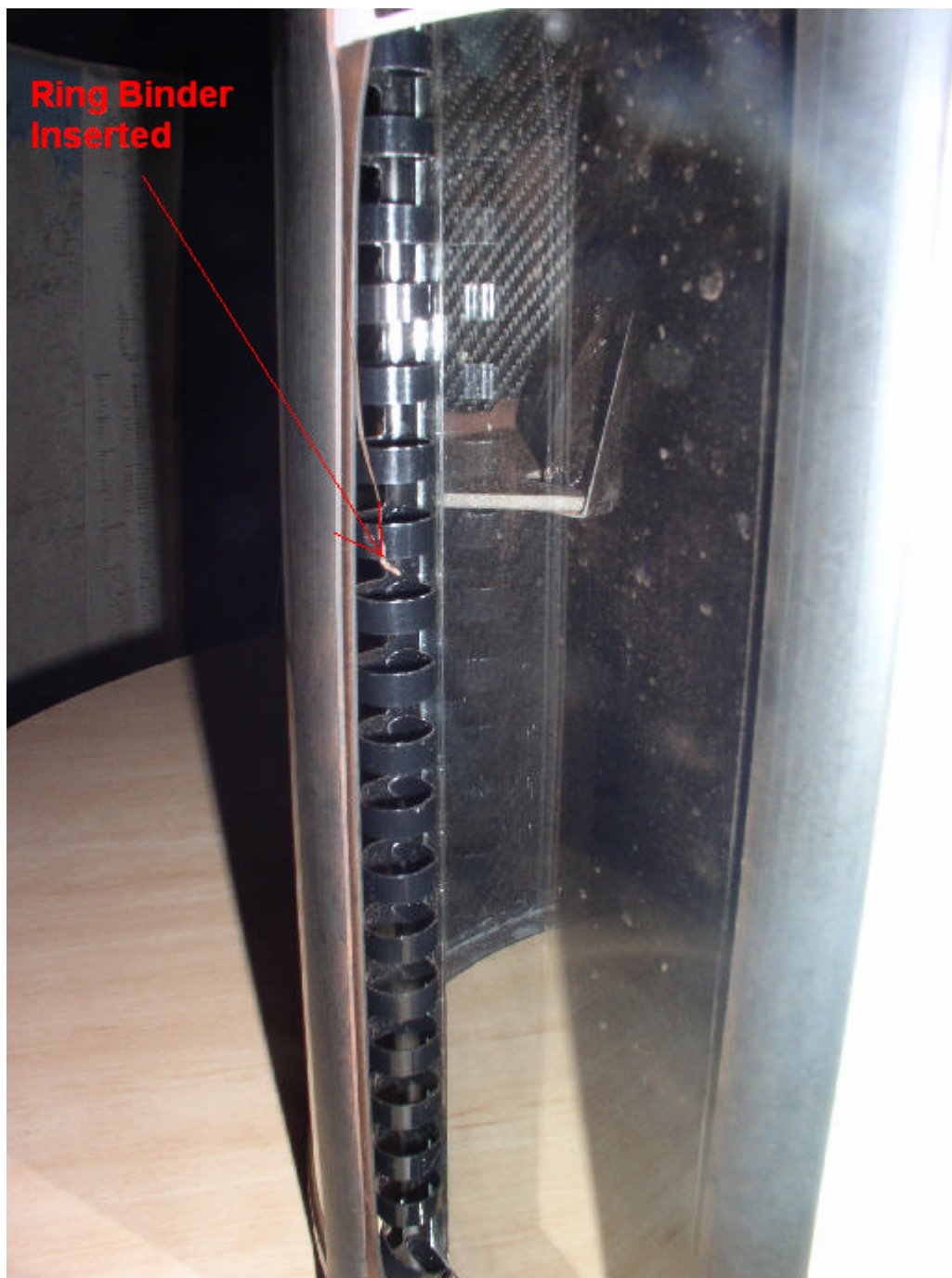


A





**B**

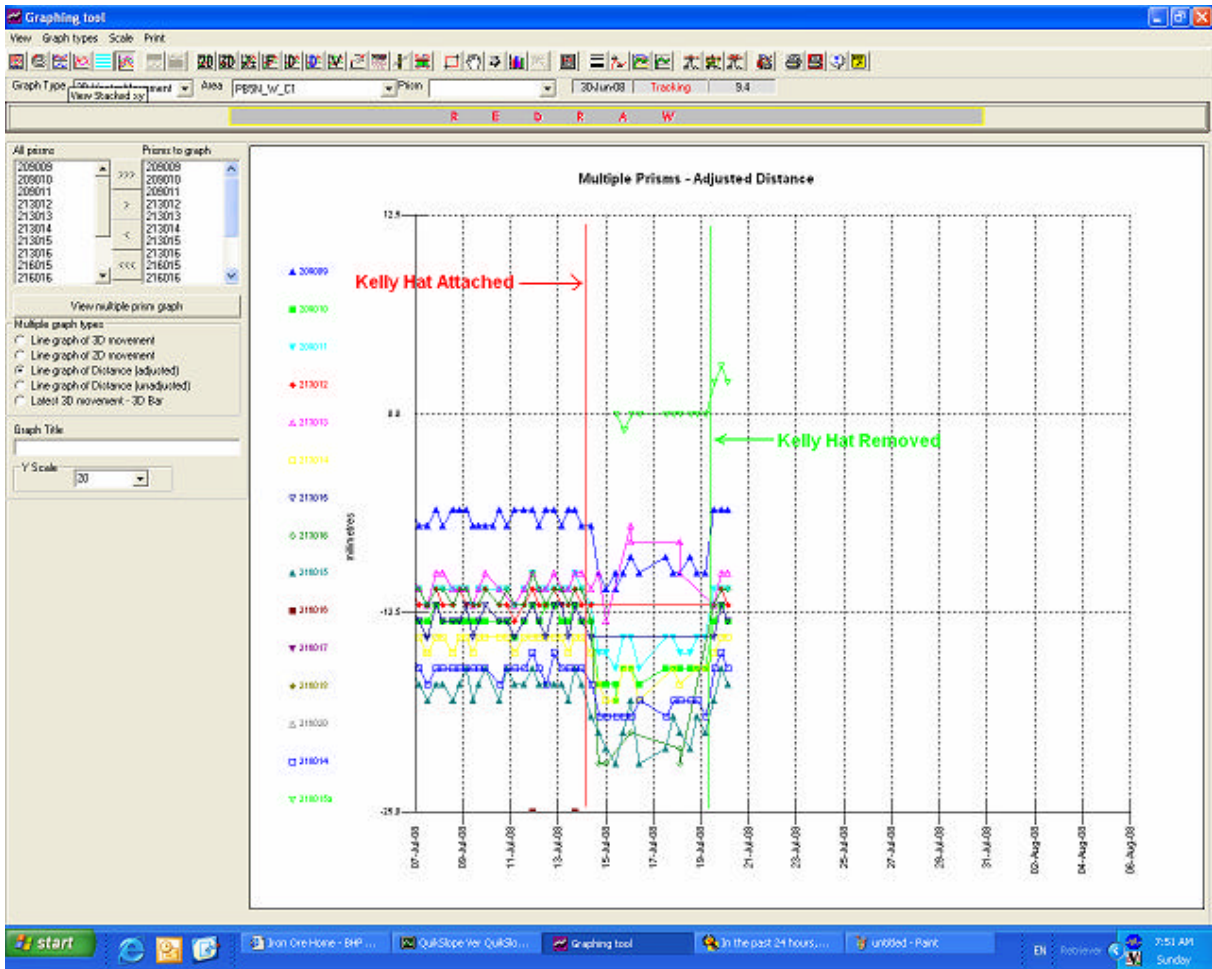




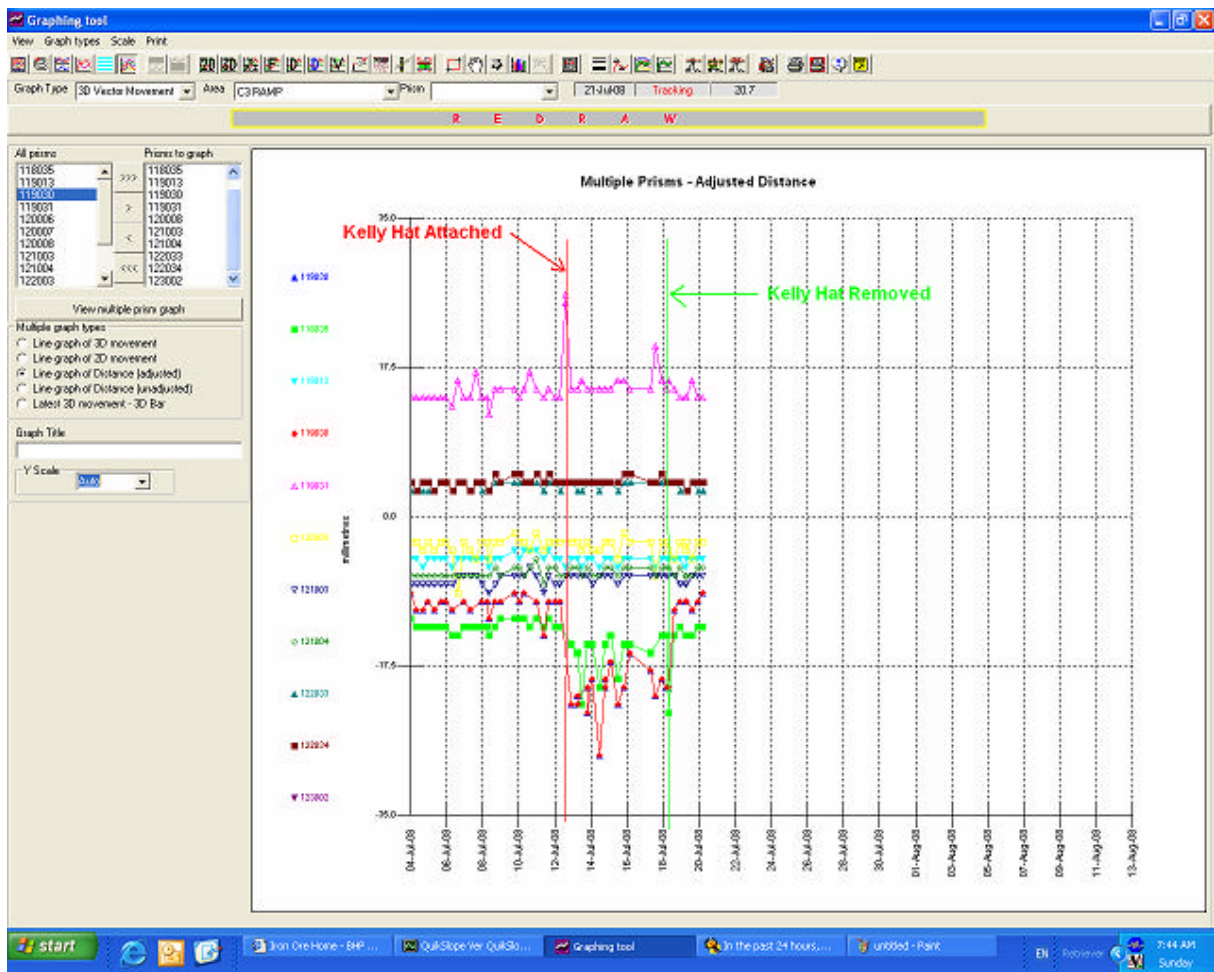
C



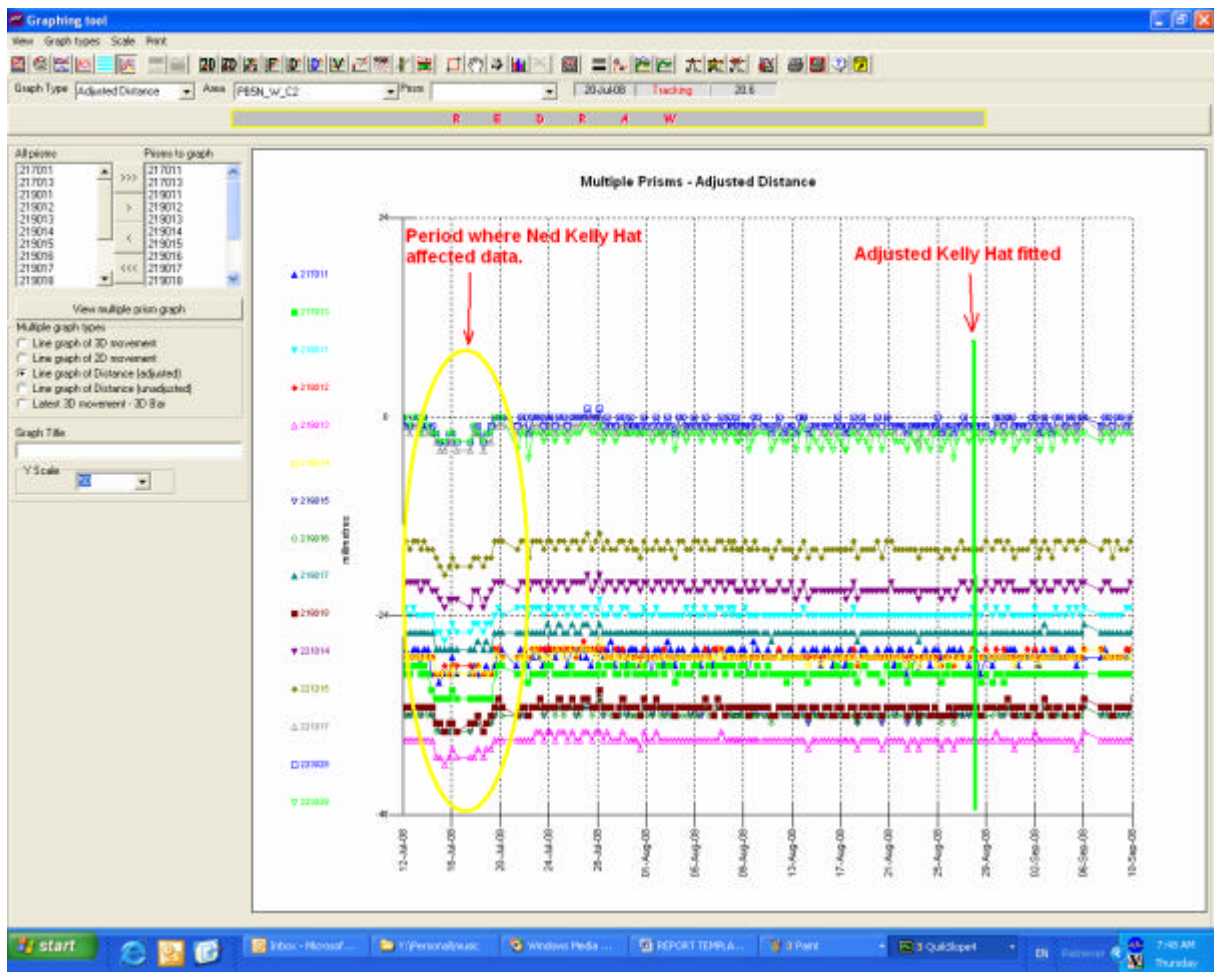
# D



# E



# F



G

