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# Graph Types

**Standard Plots**    These plots are used to report ground behavior.

- Cumulative Displacement
- Incremental Displacement
- Displacement vs Time

**Diagnostic Plots**    These plots are used to determine the potential for systematic errors and to help calculate corrections.

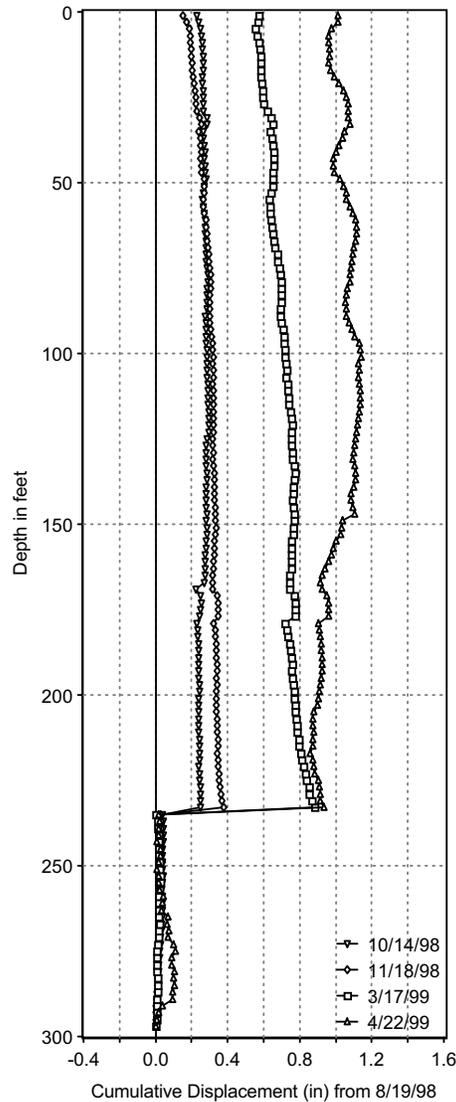
- Cumulative Deviation
- Incremental Deviation
- Checksums and Difference Checksum

## Cumulative Displacement Plot

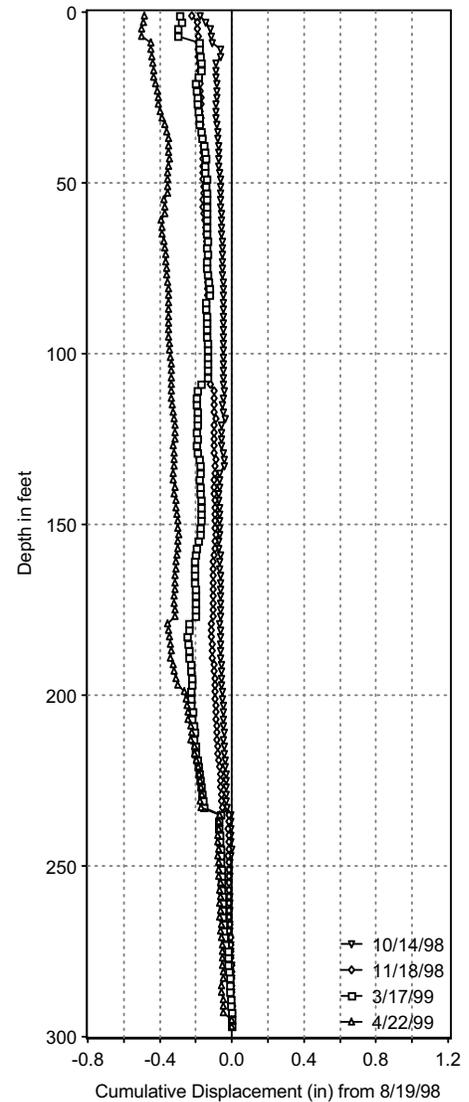
This is a plot of movement. Displacements appear abrupt because the horizontal scale is not proportional to the vertical scale. However, this allows us to identify displacements easily.

The cumulative displacement plot makes shear displacements easy to identify. If there is no shear plane and the plot shows an overall tilt or distributed strain, then interpretation is more difficult. In some cases, systematic accumulating error could be responsible for the tilt.

Displacement plots become cluttered and difficult to analyze when too many datasets are included. It is better to plot fewer rather than more datasets.



Cumulative Displacement, A-Axis

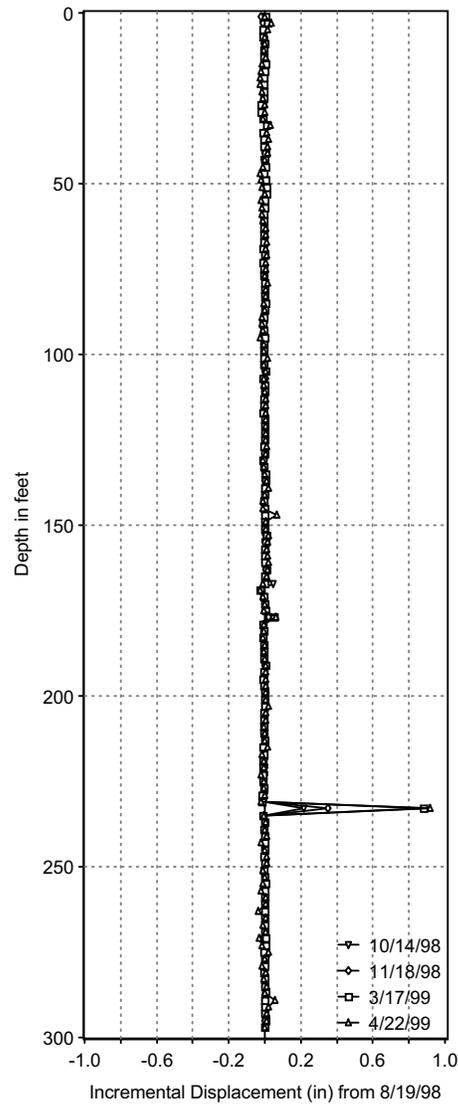


Cumulative Displacement, B-Axis

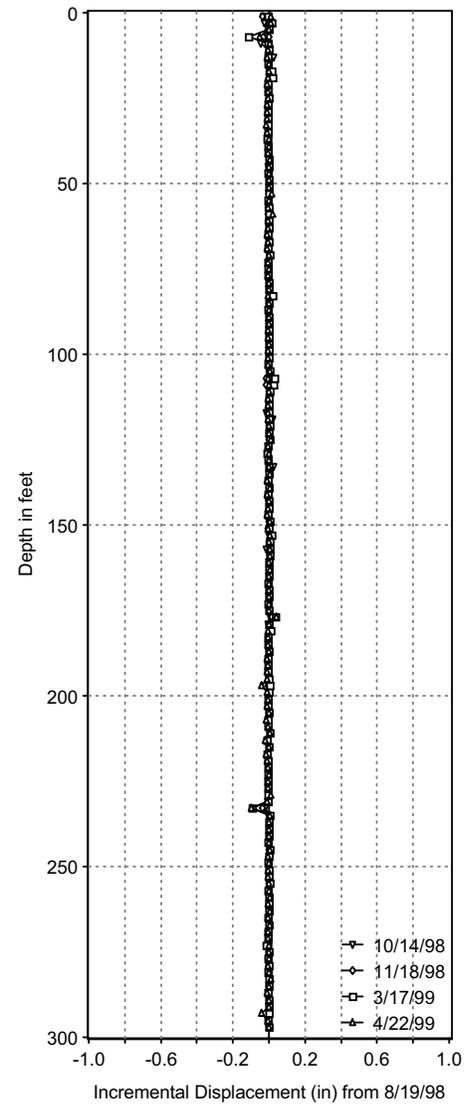
## Incremental Displacement Plots

This is a plot of movement at each reading interval. A spike indicates significant movement. Growth in the spike indicates continued movement. This can be seen in the spike at 234 feet.

The incremental displacement plot minimizes any systematic error, because each plotted point contains only one instance of the error.



Incremental Displacement, A-Axis

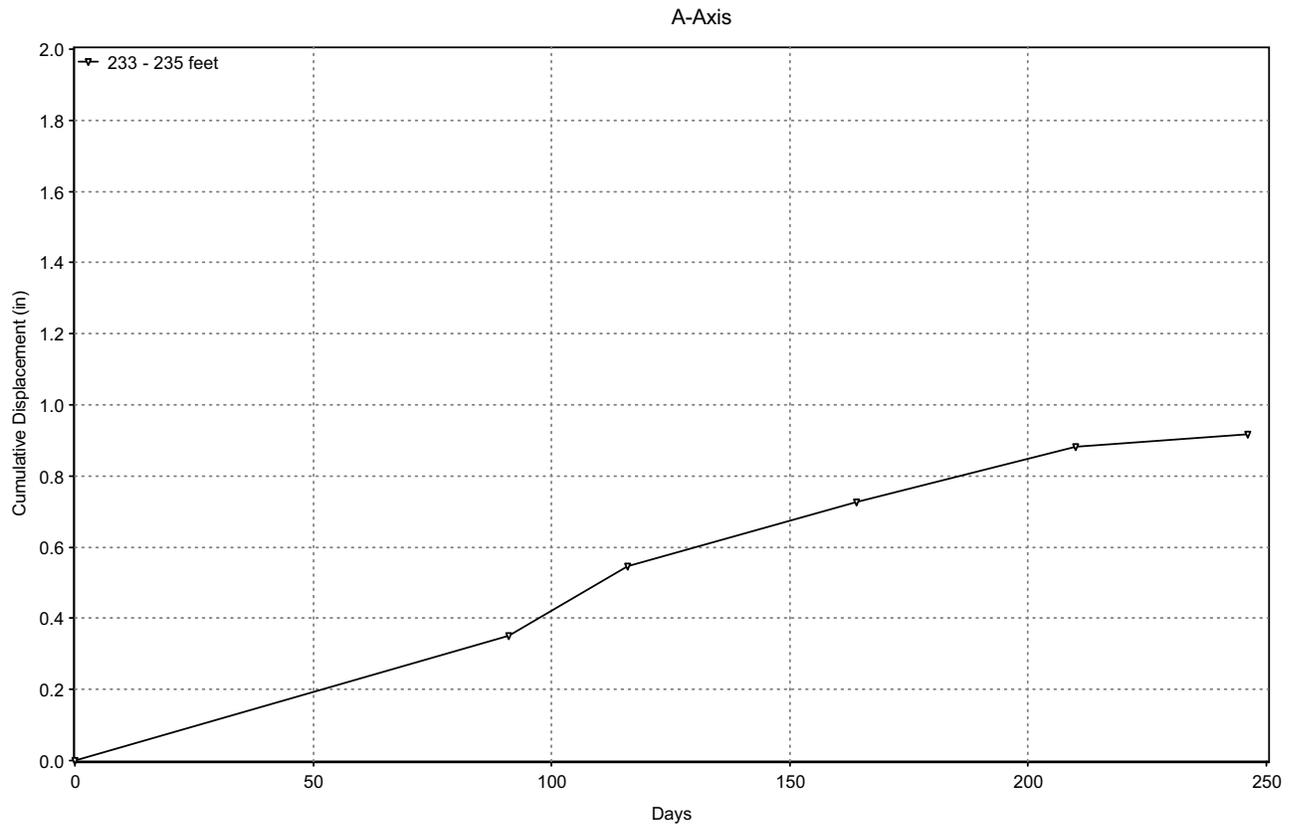


Incremental Displacement, B-Axis

## Time Plot

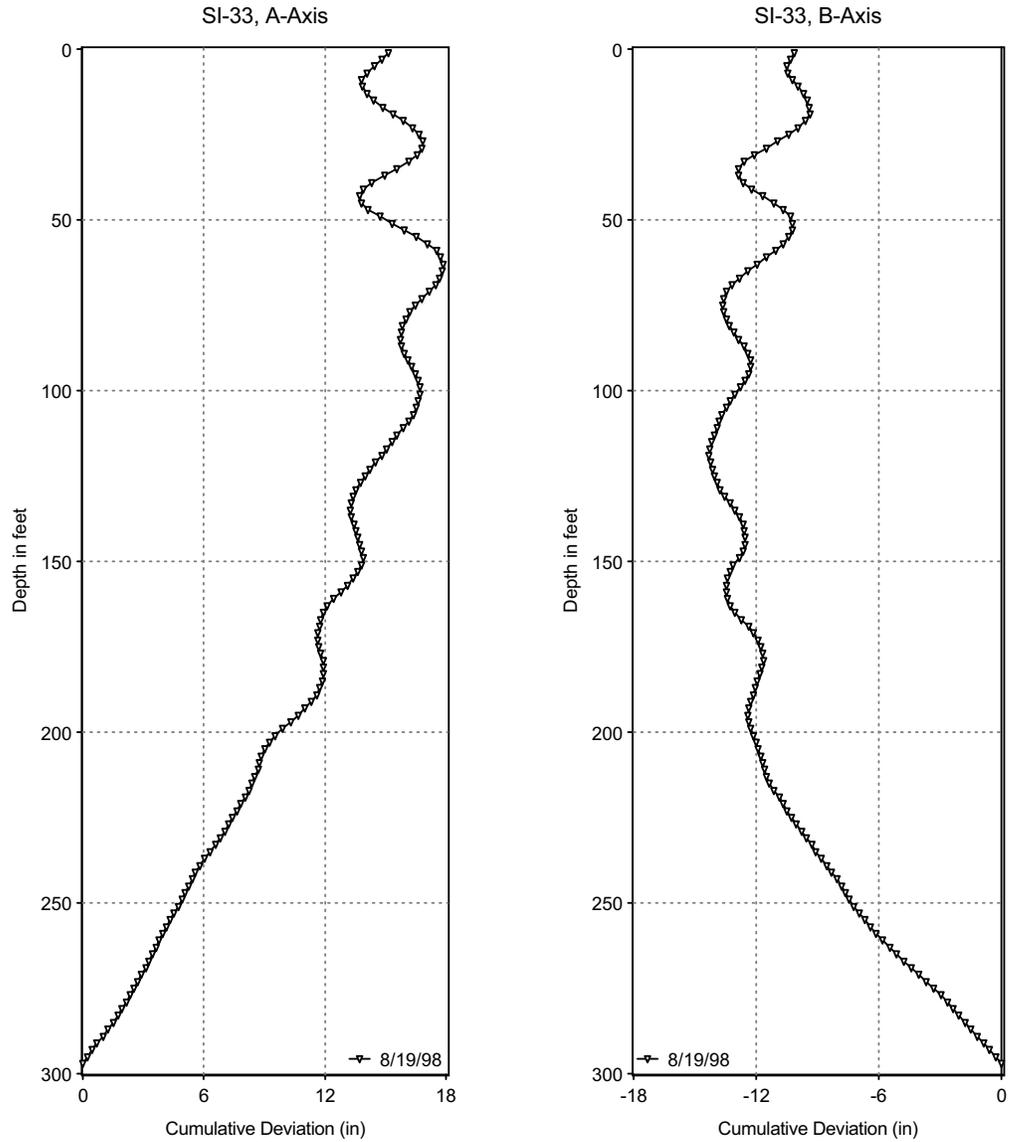
This plot shows the rate of movement. A steepening slope shows accelerating movement. The rate of displacement can be correlated with other time-based parameters in slope stability assessment.

Start using time-displacement plots as soon as you have identified a zone of displacement. In this type of plot, use as many datasets as possible, since this will improve the definition of the displacement rate. As with the incremental displacement plot, the time-displacement plot minimizes systematic errors.



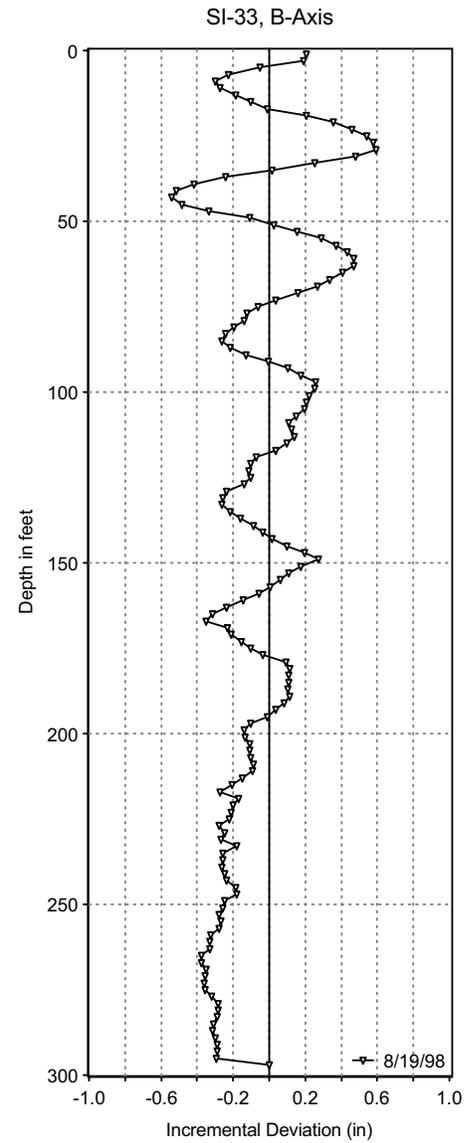
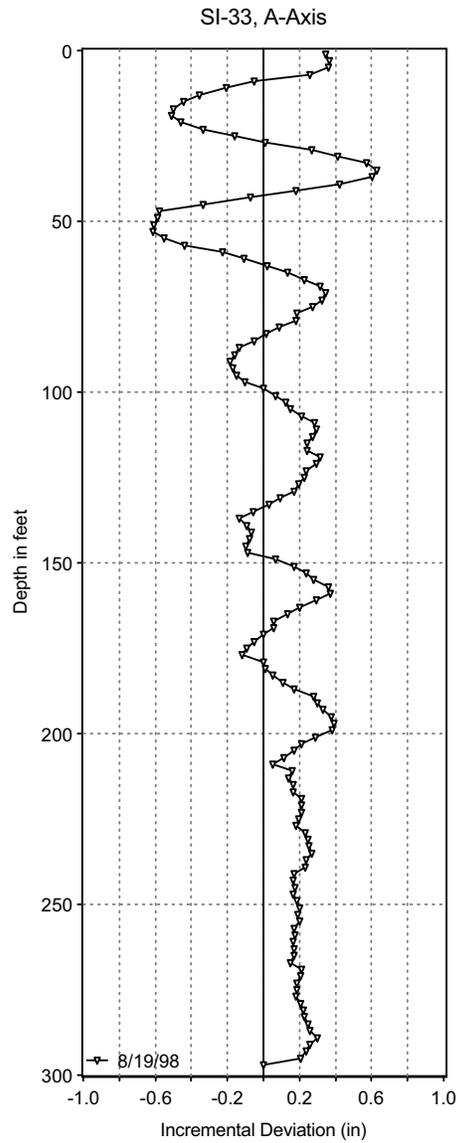
## Cumulative Deviation Plot

This plot shows the profile of the casing relative to vertical. Since inclination of the casing can contribute to error, the cumulative deviation plot is useful for diagnosing and correcting “rotation” errors.



## Incremental Deviation Plot

This is a simple plot of the readings converted to lateral offset at each reading interval. The more change in the readings with depth the more curves in the casing. Ideally, the casing should be installed as straight as possible. Change in the readings or curvature in the casing sets up a potential for displacement error due to changes in the depth positioning of the probe. Therefore these plots are useful in detecting depth error.

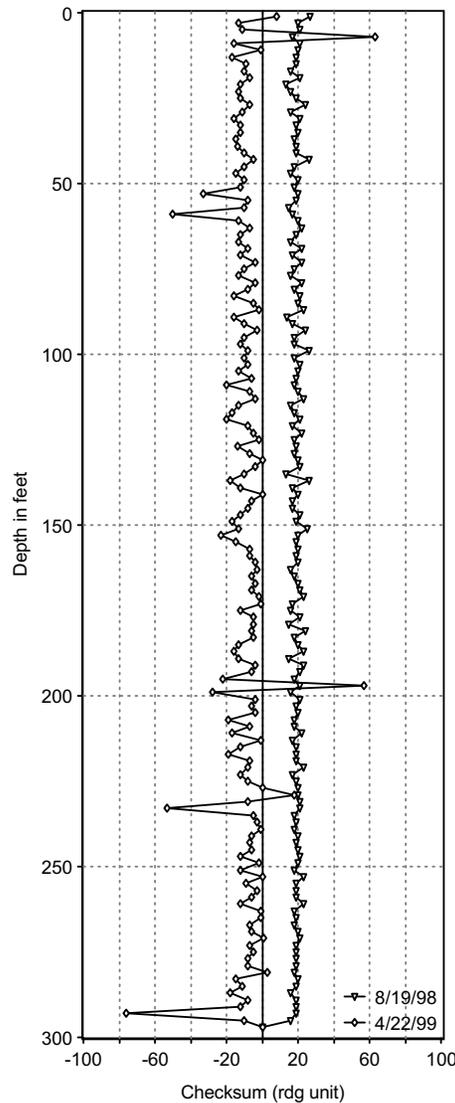


## Checksum Plot

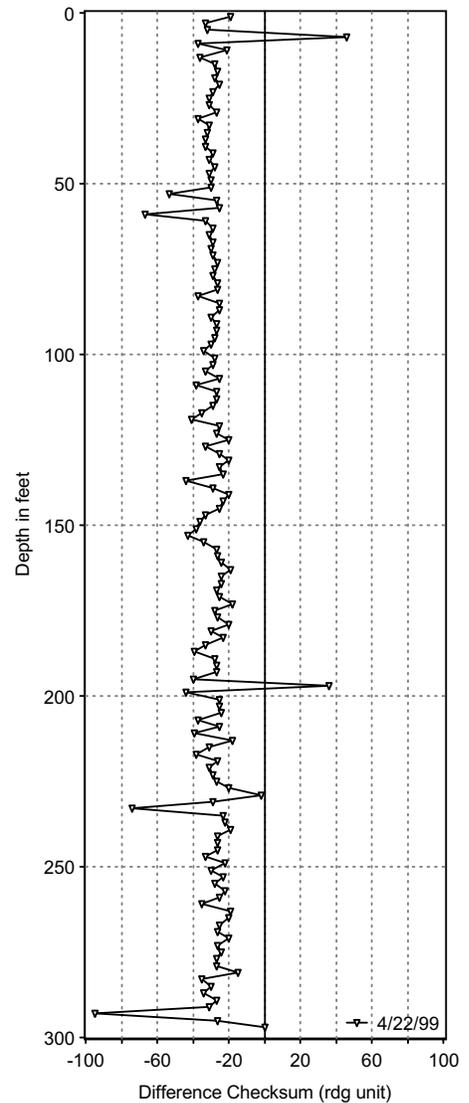
This graph shows checksums for each data set and can be used to evaluate the quality of the datasets. Spikes in the plot may indicate bad readings or they may be a characteristic of the casing.

Since the bias of the probe changes from time to time, checksum plots will not always overlay each other. Frequent shifts may indicate a weak probe and the potential for bias-shift errors. A tilting checksum plot indicates a drifting sensor.

The difference-checksum plot compares checksums for subsequent datasets against checksums for an initial set. This eliminates casing signatures and reveals only changes in checksums.



Checksum Plot



Difference Checksum Plot

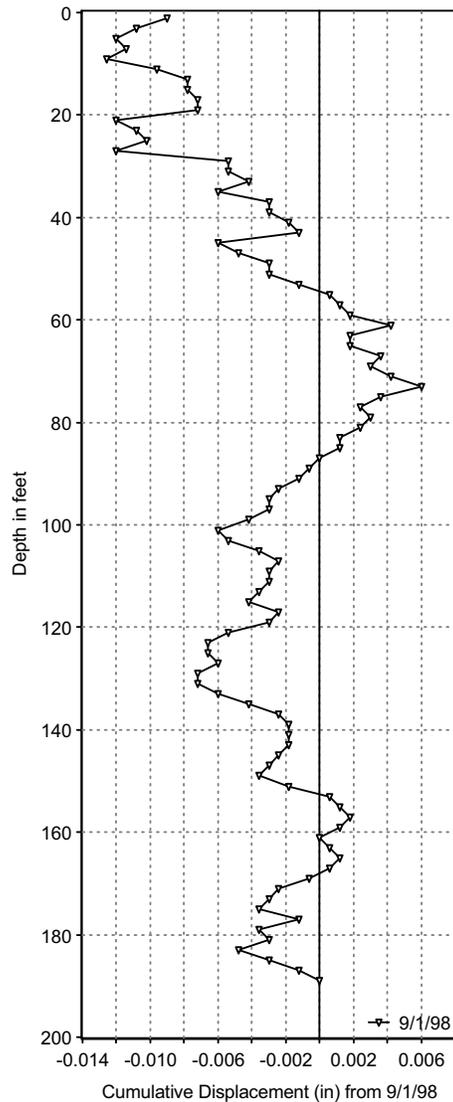
**Presentation:  
Horizontal  
Scales**

Graphing programs automatically apply scales to match the minimum and maximum values in a data series.

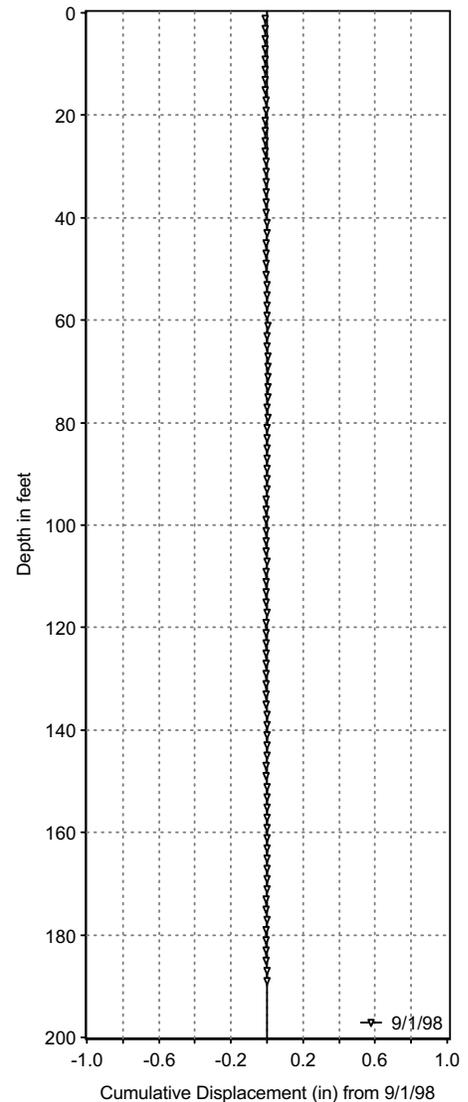
The graph on the left is auto-scaled. It is difficult to interpret. Is there movement? Is there a problem with the probe? Was the survey conducted carelessly?

No. The readings are very good. The auto-scaling is the problem. The standard accuracy for an inclinometer survey is  $\pm 0.3$  inch per hundred feet. The maximum value in this plot is only 0.014 inches and the depth is almost 200 feet. The plot is showing 100% noise.

The graph on the right shows the same data plotted with an appropriate scale. All the noise has been eliminated and it is clear that there is no movement. In general,  $\pm 1$  inch or  $\pm 25$ mm is suitable for displacement plots.



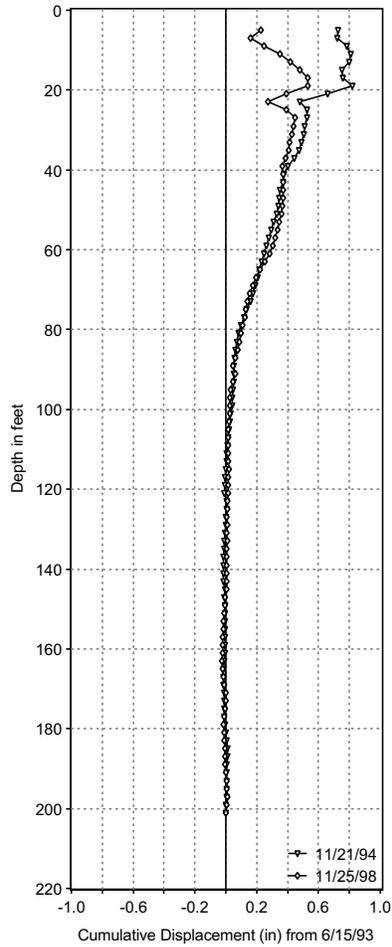
Auto-Scaled Plot



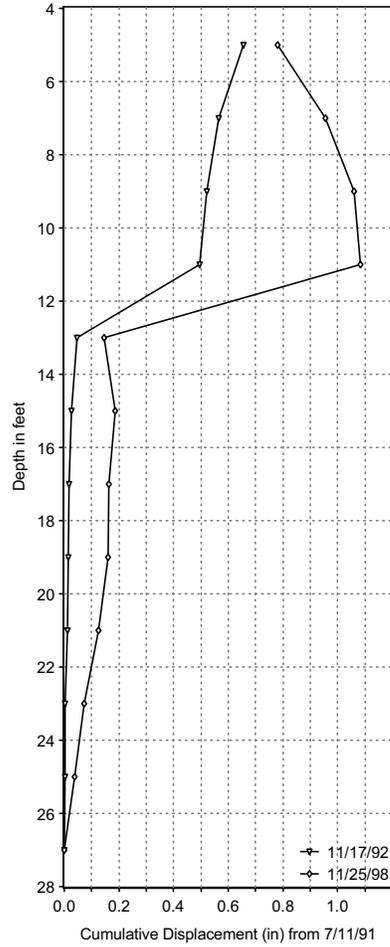
Manually-Scaled Plot

## Presentation Vertical Scales

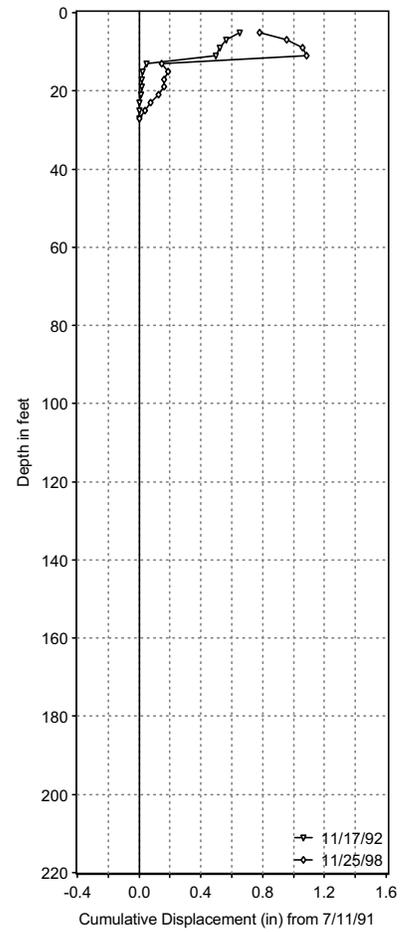
Graphing programs auto-scale depths as well. This is appropriate in some cases, but not in others. In the example below, we see one inclinometer with a 220 foot scale next to another inclinometer with a 28 foot scale. On the right, we see the 28 foot inclinometer scaled to match the 220 foot inclinometer.



Inclinometer 1



Inclinometer 2  
Auto-Scaled



Inclinometer 2  
Scaled to Inclinometer 1