3D STRESS User's Guide for Version 1.3

Software License Notice

Technical Support

For technical support for 3DStress contact:

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Hardware Requirements

Silicon Graphics Workstation Running IRIX 5.x or later Operating System

Table Of Contents

Overview

Tendency Plot

Magnitude Tool

Stress Ratio Graph

Mohr Graph

3D Fault Viewer

Map Viewer

Rose Diagram

Surface Viewer

Options

Appendix

Exit Help

Table of Contents

Table Of Contents

Overview

Tendency Plot

Magnitude Tool

Stress Ratio Graph

Mohr Graph

3D Fault Viewer

Map Viewer

Rose Diagram

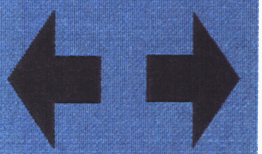
Surface Viewer

Options

Appendix

Exit Help

Table of Contents Continued



Overview

3DStress is a tool for computing the propensity for a fault to slip or dilate based on three–dimensional (3D) stress conditions. **Slip tendency** is a ratio of the shear stress (τ_s) divided by the normal stress (σ_n) on a fault surface, as shown in the equation below:

$$\text{Slip tendency} = \tau_s / \sigma_n$$

The stress axis with the **greatest** magnitude is called σ_1. The stress axis with the **smallest** magnitude is called σ_3. The **intermediate** stress axis is called σ_2. Any of the stress axes (σ_u, σ_v, or σ_w) can be σ_1, σ_2, or σ_3 depending on the user selection.

Dilation tendency is the relative propensity for a fault to dilate based on the 3D stress conditions and is computed as shown in the equation below:

$$\text{Dilation tendency} = (\sigma_1 - \sigma_n) / (\sigma_1 - \sigma_3)$$

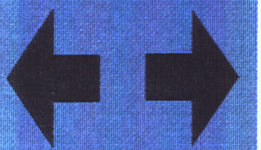
Leakage factor is a quantitative estimate of the propensity for a fault or fracture to dilate, for situations where fluid pressure and fault or fracture tensile strength are known or can be infered. Leakage factor is computed as a function of pore fluid pressure (P_f), σ_n, and tensile strength (T) by the equation below:

$$\text{Leakage factor} = P_f / (\sigma_n - T)$$

For additional background and details on slip tendency see the following references:

Morris, A., D. A. Ferrill, and D. B. Henderson, 1996, "Slip–tendency analysis and fault reactivation," *Geology*, March 1996, 24(3):275–278.

Morris, A. P., D. A. Ferrill, and D. B. Henderson, 1994, "Slip tendency analysis and fault reactivation," *EOS, Transactions of the American Geophysical Union*, 75(44):591.



Overview Continued

Ferrill, D. A., S. R. Young, A. P. Morris, D. B. Henderson, and R. H. Martin, 1994, "3–Dimensional stress domains interpreted from fault slip patterns in southern California and Nevada," *Geological Society of America Abstracts with Programs*, 26(7):A185.

Ferrill, D. A., A. P. Morris, D. B. Henderson, and R. H. Martin, 1994, "Tectonic processes in the Central Basin and Range region." *NRC High–Level Radioactive Waste Research at CNWRA*, July–December, 1994. CNWRA 94–02S. 121–139.

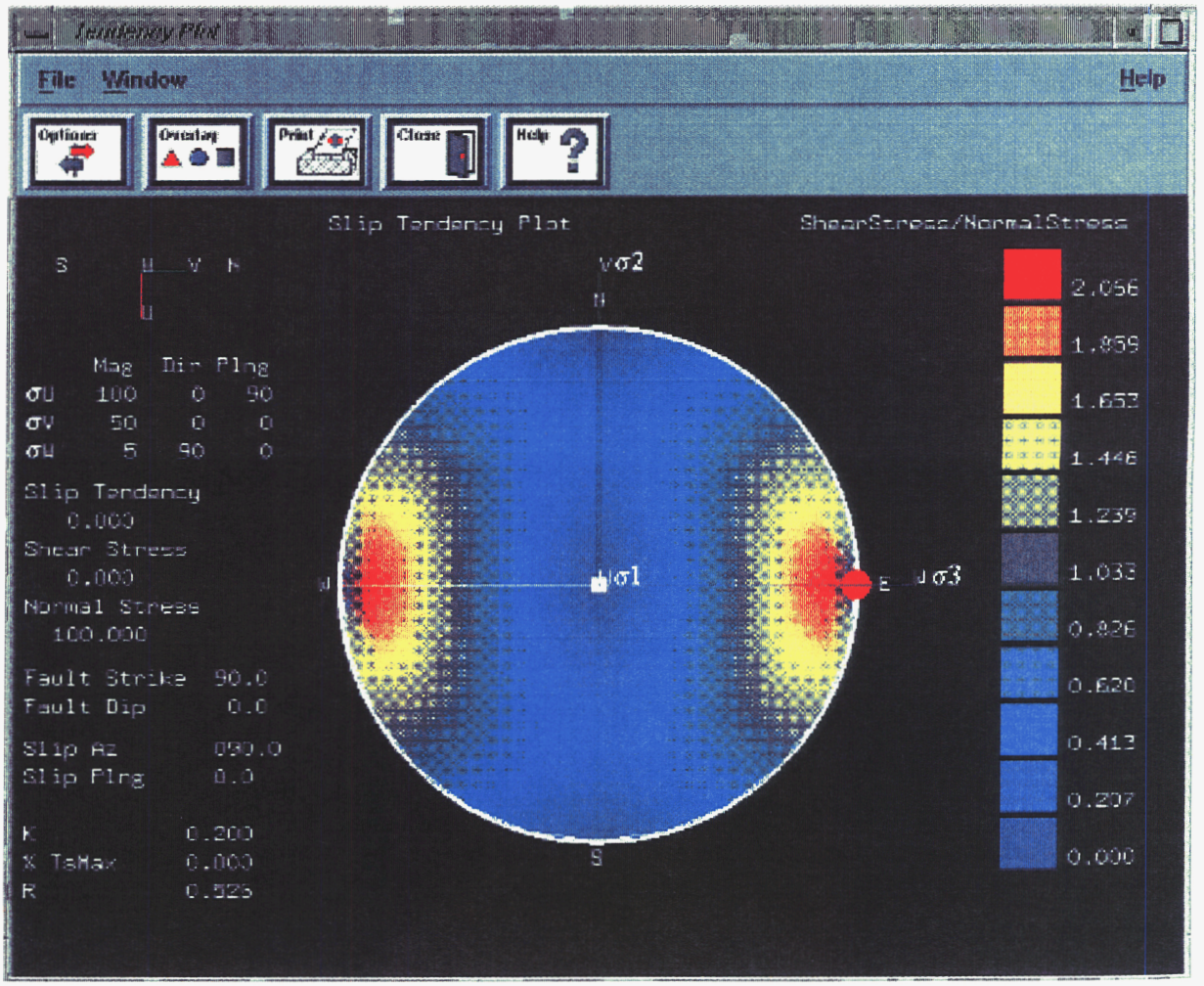
Ferrill, D. A., A. P. Morris, S. M. Jones, and J. A. Stamatakos, 1998, "Extensional Layer–Parallel Shear and Normal Faulting." *Journal of Structural Geology*, 20(4):355–362.

Starting 3DStress

To start 3DStress from a shell window, change directories to the directory with the executable for 3DStress and enter:

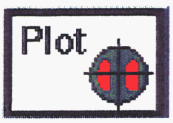
% 3dstress

Two windows similar to the ones below will appear on the display.



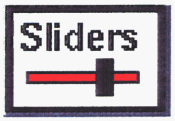
The Controller

The 3DStress controller is used to access each of the main windows by clicking the left mouse button over the desired button.



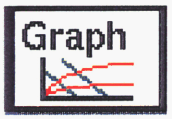
Tendency Plot

Map Viewer

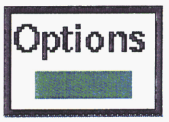


Magnitude Tool

Surface Viewer



Stress Ratio Graph



Options

Mohr Graph

Help

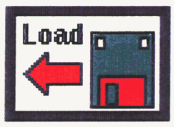
3D Fault Viewer

Exit 3DStress

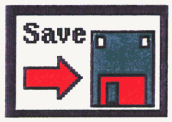
Overview Continued

Common Buttons

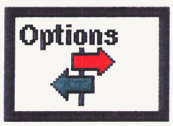
Each of the different main windows accessed from the Controller has buttons located near the top of the window that serve a common purpose.



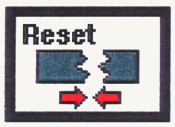
Load a file



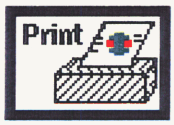
Save loaded file(s)



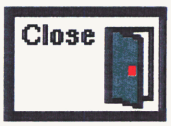
Options applying to that particular window



Centers the viewer and any loaded file(s)



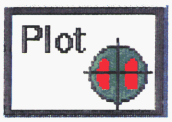
Saves the window to a screen raster file (Silicon Graphics rgb format)



Closes the window.

Showcase help file for the window.

Tendency Plot



3DStress computes slip tendency based on a user–selected stress state. The stress state is defined by the magnitudes and orientations of the orthogonal stress axes called σ_u, σ_v, and σ_w. The magnitude values in 3DStress are **normalized** to range from 1 to 100. These represent principal compressive stresses.

The stress axis with the **greatest** magnitude is called σ_1. The stress axis with the **smallest** magnitude is called σ_3. The **intermediate** stress axis is called σ_2. Any of the stress axes (σ_u, σ_v, or σ_w) can be σ_1, σ_2, or σ_3 depending on the user selection.

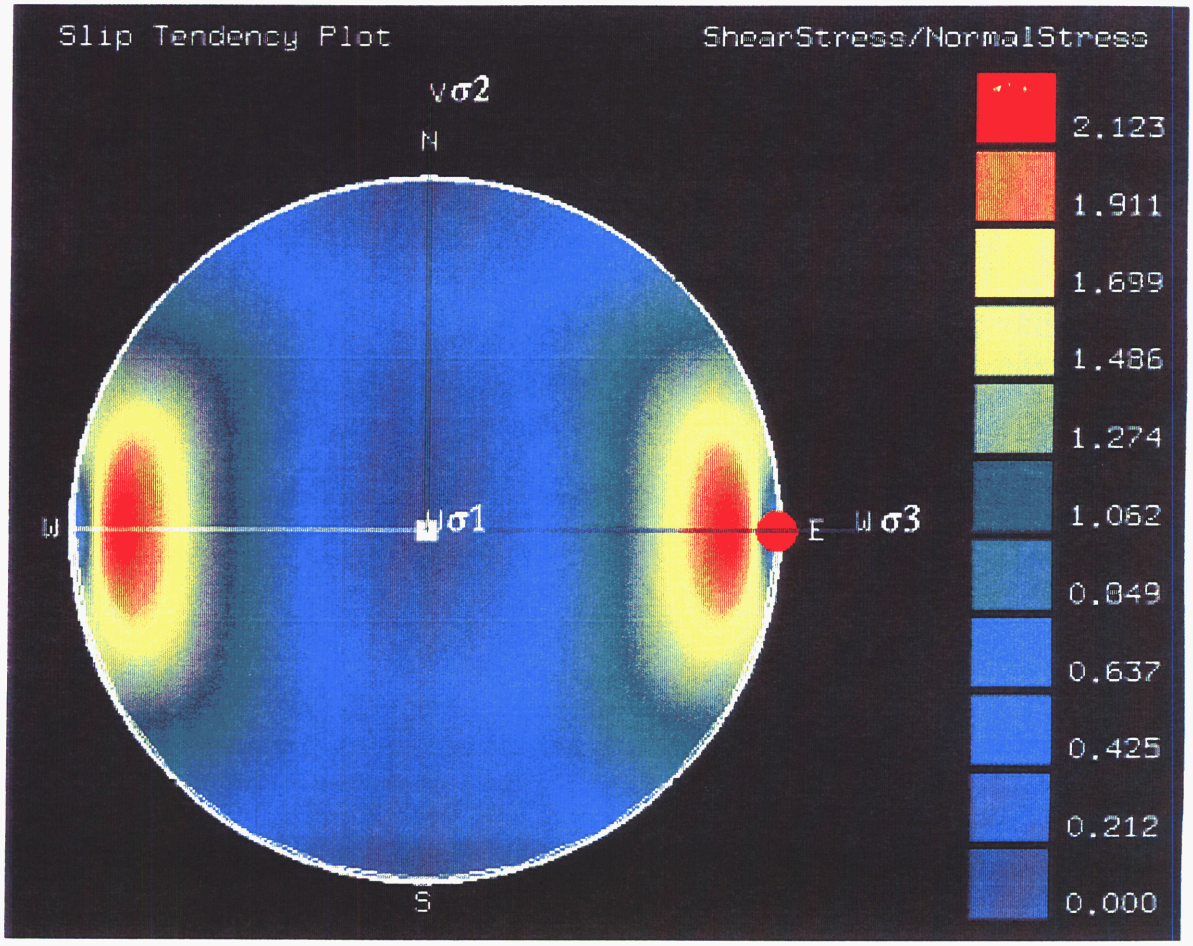
A **stress state** is defined in terms of principal stress components σ_1, σ_2, and σ_3 ($\sigma_3 \leq \sigma_2 \leq \sigma_1$), which are oriented along orthogonal directions u, v, and w. The user may set the relative magnitudes of the principal stress components and may choose any two of the three orthogonal axes for σ_1 and σ_3. Initially, u points vertically down, but the user may rotate the stress axes to other orientations (see the **Magnitude Tool** section). Only mutually orthogonal stress–axis orientations are allowed by 3DStress.

Exit Help

Tendency Plot Continued

Reading Slip Tendency and Direction Values

Slip tendency is displayed on a lower hemisphere equal–angle stereographic projection as shown below. Locations on the lower hemisphere plot correspond to fault surface poles. The slip tendency for a given fault pole is indicated on a color scale where **red** indicates relatively high slip tendency and **blue** indicates relatively low slip tendency.



Slip is likely to occur on a surface when the resolved shear stress equals or exceeds the frictional resistance to sliding. For more information see the references listed in the **overview** section.