ASCIB3D MATLAB Program

This program is referred to the manuscript

"Li, W., Schmitt, D.R., Tibbo, M., Zou, C.C., submitted. Stress state around an inclined borehole in anisotropic formation. Geophysics".

The program is composed of a main function file "ASCIB3D" and nine subroutines. "ASCIB3D.m" constructs the various input parameters as shown in Table 1. The function of all the subroutines are shown in Table 2. The inputs and outputs of all the subroutines are shown in Table 3 and 4, respectively. It should be noted that the output matrices are in cylindrical co-ordinate frame with the rows indicating the radius and columns indicating the azimuth. The program outputs seven figures. Fig. 1 shows the stress distributed on the contour of the borehole. Fig. 2 to 6 are the Pcolor images showing the distribution of stress components near the borehole.

Table 1. The inputs and outputs of the main program. 'I/O' means inputs or outputs.

I/O	Variables	Description
Inputs	rbh	The radius of the borehole rbh = R in meters.
	traj	traj = [boreholeI boreholeA]: A 1 X 2 vector describing inclination and azimuth of the borehole in degrees. y-axis.
	sigmas	sigmas = $\boldsymbol{\sigma}_{\mathbf{s}} = \begin{bmatrix} \sigma_{s11} & \sigma_{s12} & \sigma_{s13} \\ \sigma_{s12} & \sigma_{s22} & \sigma_{s23} \\ \sigma_{s13} & \sigma_{s23} & \sigma_{s33} \end{bmatrix}$. It is a symmetric 3 X 3 matrix containing the components of the stress tensor in MPa units.
	orientS	orientS = [strikeS, dipS, rakeS] = (ψ_s, δ_s, γ_s): a 1 X 3 vector containing the strike, dip, and rake of the stress tensor in degrees.
	pw	The borehole fluid pressure pw= p_w in MPa units.
	Cm	$\mathbf{C}_{\mathbf{m}} = \begin{bmatrix} C_{m11} & C_{m12} & C_{m13} & C_{m14} & C_{m15} & C_{m16} \\ C_{m21} & C_{m22} & C_{m23} & C_{m24} & C_{m25} & C_{m26} \\ C_{m31} & C_{m32} & C_{m33} & C_{m34} & C_{m35} & C_{m36} \\ C_{m41} & C_{m42} & C_{m43} & C_{m44} & C_{m45} & C_{m46} \\ C_{m51} & C_{m52} & C_{m53} & C_{m54} & C_{m55} & C_{m56} \\ C_{m61} & C_{m62} & C_{m63} & C_{m64} & C_{m65} & C_{m66} \end{bmatrix}$. It is a symmetric 6 X 6 matrix according to Voigt's organization containing from 2 to 21 independent elastic stiffnesses that depend on the material symmetry.
	orientM	orientM = [strikeM, dipM, rakeM] = (ψ_m, δ_m, γ_m): a 1 X 3 vector containing the strike, dip, and rake of the stiffness matrix in degrees.
	geom	geom = [rmedia, n1, n2]: a 1 X 3 vector that describes the geometry of the set of calculations to be performed where rmedia is the maximum radial distance into the medium that the calculations are to extend, n1 = the number of points calculated along the radial distance, and n2 = the number of points calculated along the azimuth. Plot the Pcolor images in cylindrical co-ordinate.
Outputs	sigmarr	n1 X n2 matrix containing the calculated values for σ_{rr} in MPa.
	sigmass	n1 X n2 matrix containing the calculated values for $\sigma_{\theta\theta}$ in MPa.
	sigmazz	n1 X n2 matrix containing the calculated values for σ_{zz} in MPa.
	sigmasz	n1 X n2 matrix containing the calculated values for $\sigma_{\theta z}$ in MPa.
	sigmarz	n1 X n2 matrix containing the calculated values for σ_{rz} in MPa.
	sigmars	n1 X n2 matrix containing the calculated values for $\sigma_{r\theta}$ in MPa.

Table 2. The purpose of the subroutines.

Subroutine	Purpose
StressDistribution	Solve the stress distributed near the borehole.
BondY	The rotate matrix for the elastic stiffness tensor around y-axis.
BondZ	The rotate matrix for the elastic stiffness tensor around z-axis.
StiffnessRotation3D	Z-Y-Z elastic stiffness rotation from NED to borehole frame.
StrRMatrixY	The rotate matrix for the far-field stress tensor around y-axis.
StrRMatrixZ	The rotate matrix for the far-field stress tensor around z-axis.
StressRotation3D	Z-Y-Z far-field stress rotation from NED to borehole frame.
Cartocylin	Convert the stress from Cartesian to cylindrical co-ordinate.
PolarPcolorWeili	Plot the Pcolor images in cylindrical co-ordinate.

Table 3. The inputs of all the subroutines.

Subroutine	Iutput	Description
BondY	alpha	Rotational angles.
BondZ	alpha	Rotational angles.
StiffnessRotation3D	C1	The elastic stiffness matrix in the media symmetric frame.
	alphazm1	The rotation angle of the medium symmetry frame around D-axis.
	alphaym	The rotation angle of the medium symmetry frame around y'-axis.
	alphazm2	The rotation angle of the medium symmetry frame around z_m-axis.
	boreholeA	Azimuth of a borehole.
	boreholeI	Inclination of a borehole.
StrRMatrixY	alpha	Rotational angles.
StrRMatrixZ	alpha	Rotational angles.
StressRotation3D	stress	Stress tensor in the principle stress frame.
	alphazs1	Rotation angle of the far-field stress frame around D-axis.
	alphays	Rotation angle of the far-field stress frame around y'-axis.
	alphazs2	Rotation angle of the far-field stress frame around z_s-axis.
	boreholeA	Azimuth of a borehole.
	boreholeI	Inclination of a borehole.
Cartocylin	Carstr	the stress in Cartesian co-ordinates.
	theta	Azimuth angle.
StressDistribution	rbh	Radius of the borehole.
	traj	Orientation of the borehole
	sigmas	Far-field stress.
	orientS	Orientation of the far-field stress.
	pw	The borehole fluid pressure.
	Cm	The elastic stiffness matrix.
	orientM	Orientation of the elastic stiffness matrix.
	geoM	The vector defining the size and mesh of the medium.
PolarPcolorWeili	sigma	The stress component planed to plot
	theta	Azimuth angle.
	radius	The radius of the points from the center of the borehole.
	rmedia	The radius of the area around the borehole.
	n2	Mesh of azimuth angle.
	nthe	Mesh of the azimuthal axis in the polar plot.
	nrr	Mesh of the radial axis in the polar plot.

Table 4. The outputs of all the subroutines.

Subroutine	Output	Description
BondY	M	The matrix used to rotate elastic stiffness matrix around y-axis.
BondZ	M	The matrix used to rotate elastic stiffness matrix around z-axis.
StiffnessRotation3D	C	The elastic stiffness matrix in the borehole coordinate frame.
StrRMatrixY	N	The matrix used to rotate the stress tensor around y-axis.
StrRMatrixZ	N	The matrix used to rotate the stress tensor around z-axis.
StressRotation3D	is	The stress tensor in the borehole coordinate frame.
Cartocylin	Cylinstr	The stress in cylindrical co-ordinates.
StressDistribution	sigmarr	The stress component σ_{rr}.
	sigmass	The stress component $\sigma_{\theta\theta}$.
	sigmazz	The stress component σ_{zz}.
	sigmasz	The stress component $\sigma_{\theta z}$.
	sigmarz	The stress component σ_{rz}.
	sigmars	The stress component $\sigma_{r\theta}$.
PolarPcolorWeili	\	Output a Pcolor image in polar coordinate frame.