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% MSAT FOR HUDSONS EFFECTIVE MEDIUM for FRACTURES:

% LOOPING ROCK PARAMETERS TO GET ELASTICITY AND MAXIMUM ANISOTROPY VARIATION

%-----------------------------------------------

% Defining rock paramenters for Effective medium:

 vpm = 5.5 ;     % in TVZ wide range from 1.5 to 5.5km/s
 vsm = vpm/1.75 ;  % Vs  as fraction of Vp might vary
 rhm = 2700 ;
 vpc = 0.33; %6.125; %0.33; %0.5073 ;  %0.5489; %0.9227; %1.3622; %1.5642; %7.6;
%km/s for fluid, 0km/s for air, variation in solid %6 ; 5.7 for solid quartz
 vsc = 0; %4.75; %4.083;
 %vsc = vpc/1.75;
 %vsc = vpc/1.484;  % IFF solid infill (QUARTZ/PYRITE) - Vs in fluid = 0km/s, but
this might vary with solid infill

% Definbing rotation angles, similar to Taupo Rift orintations
% For Phasevels we consider looping over fracture orientations while using
% specific earthquake arrival incident

a = 0 ; % null axis of rotation
% b = 25 % corresponds 'dip' of fracture plane
% c = -55 % corresponds azimuth of fracture plane ('plane')

%-------------------------------------------------------------------------

% Open file for writing data from loops:
% name the columns according parameter

fileID = fopen('C:\Users\jylhansi\OneDrive - Victoria University of Wellington -
STAFF\Desktop\Siru MSc\MSc_Siru (H)\MSAT CODE WORK\2023 FINAL
Analysis\Ceff_analysis_data\Elastic_Anisotropy\NEWNEW_Corrected_Elastic_Anisotropy
\ar_air_Ceff_NO_split.csv','w');
fprintf(fileID, '%s , %s , %s , %s , %s , %s , %s , %s , %s , %s , %s , %s ,
%s\n', 'cd', 'ar', 'rhc', 'vpc', 'vsc', 'azi', 'dip', 'MAXdVS', 'pol', 'avs',
'vs1', 'vs2', 'vp');

for rhc = 0;  %5013;  %2660; %0; %2000:50:6000;  %100.5; %63.8; %715.3; %870.9;
%962.9; 5013;  0:50:6000;
    for cd = 0.055 ; %0.00:0.005:0.5 ;  %0.055 ;
        for dplane = 10 %0:10:30;
            for azplane = -45 %-10:-10:-50;
                for strike = 90+azplane;
                    for dip = 90-dplane;
                        for ar = 0.00001:0.00001:0.01 ; %0.0001;

%----------------------------------------

%   ROTATION OF CRACKS
%   (this comes more important when applying earthquakes through the medium)
%   For shearwave anisotropy models this is only for visual presentation and can
be
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%   kept constant, it does not affect the outcome values.

             [Ceffx,rhx] =
MS_effective_medium('hudson',vpm,vsm,rhm,vpc,vsc,rhc,ar,cd);
             [ROTCeffx] = MS_rot3(Ceffx,a,dplane,azplane) ;
             MS_plot(ROTCeffx, rhx, 'reverse');

%-------------------------------------------------------------------------

% Building the grid and calling velocities from MSAT-plot Source code:

% min and max shear wave anisotropy
% define rad and degrees for incidents
             cvect = 10 ;     % number of contours
             VPcvect = cvect ;
             AVScvect = cvect ;
             VScvect = cvect ;
             view_angle = [-90,90] ;
             rad = pi./180 ;
             deg = 180./pi ;

% Define X and Y:

% Set up inc-az grids (for ALL possible incident angles)
             [INC,AZ] = meshgrid([90:-6:0],[0:6:360]) ;
% generate X/Y matrices for plotting, (do not print in command window)
             [X,Y,Z] = sph2cart(AZ.*rad,INC.*rad,ones(size(AZ))) ;
% Invoke MS_phasevels to get wave velocities etc.
             [~,~,vs1,vs2,vp, S1P] = MS_phasevels(ROTCeffx,rhx,...
             reshape(INC,61*16,1),reshape(AZ,61*16,1));

% Reshape results back to grids
             VS1 = reshape(vs1,61,16);
             VS2 = reshape(vs2,61,16);

% These are part of original code in MS_Plot (Phasevels)
% they are not required when retrieve th s-wave  anisotropy
             VP =  reshape(vp,61,16);
             VS1_x = reshape(S1P(:,1),61,16);
             VS1_y = reshape(S1P(:,2),61,16);
             VS1_z = reshape(S1P(:,3),61,16);

% dVS data:
             dVS =  (VS1-VS2) ;
             VSmean = (VS1+VS2)./2.0 ;
             AVS = 100.0*(dVS./VSmean) ;

% Printing out the maximum value of S wave anisotropy from a matrix
             MAXdVS = max(max(AVS));

%-------------------------------------------------------------------------

% Calculating S Split:
% define EQ arrival angle:
             incp = 67; %(converted to MSAT to correspond 23deg incidence)
             azip = 70;
             [pol, avs, vs1, vs2, vp] =  MS_phasevels(ROTCeffx, rhx, incp, azip);

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% Defining the parameters saved into file:

            Dparams = [cd, ar, rhc, vpc, vsc, strike, dip, MAXdVS, pol, avs, vs1,
vs2, vp];
            fprintf(fileID,'%f , %f , %f , %f , %f , %f , %f , %f , %f , %f , %f ,
%f , %f\n', Dparams);

%             % without splitting:
%              Dparams = [cd, ar, rhc, strike, dip, MAXdVS];
%              fprintf(fileID,'%f , %f , %f , %f , %f , %f\n', Dparams);

% Naming model plots according the variables in loop - text2 requires
% change with the variable.
% Saving values automatically into a file and close all figure windows:

path = 'C:\Users\jylhansi\OneDrive - Victoria University of Wellington -
STAFF\Desktop\Siru MSc\MSc_Siru (H)\MSAT CODE WORK\2023 FINAL
Analysis\Ceff_analysis_data\Elastic_Anisotropy\NEWNEW_Corrected_Elastic_Anisotropy
\ar_NoSplit_air_infill';


              text1 = ['cd, ar, rhc, vpc = ' num2str('[') num2str(cd), num2str('
'), num2str(ar), num2str(' '), num2str(rhc), num2str(' '), num2str(vpc)
num2str(']')];
              subtitle(text1, 'fontsize', 8, 'FontWeight', 'bold');
              %text2 = ['rhc960', num2str('_'),'cd', num2str(cd), num2str('('),
num2str(strike), num2str('_'), num2str(dip), num2str(')')];
              text2 = ['cd', num2str(cd), num2str('_'),'ar', num2str(ar),
num2str('_'), 'rhc', num2str(rhc), 'vpc', num2str('_'), num2str(vpc)];
              name = [text2 '.png'];

              %tx = 'Conventional geothermal, 100C, 10MPa';
              %tx = 'Supercritical geothermal, 400C, 15MPa';
             % %tx = 'Host-rock density variation';
             tx = 'Crack infill air';

              annotation('textbox', [0.6450 0.090 0.1657 0.1325],'String',
tx,'FitBoxToText','on','BackgroundColor', "w", 'FontWeight', 'bold', 'FontSize',
10);

              saveas(gcf, fullfile(path, name), 'png');
              close all

%-----------------------------------------------------------------------

% End all the loops:
                            end
                        end
                    end
                end
            end
        end
    end

% End the file writing after loops are finished

fclose(fileID);

%-----------------------------------------------------------------------
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