Documentation for ModVisc 0.01

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### 1. General information

start model	
calculation plot model	
resp. models	
Modvisc 0.01 Celete	_ 8 ×
model	
Modul Viscosties resp. models	
general configuration $K_{*} = \ln 666  K_{*} = \ln 2  \mu_{*} = \ln 4  \mu_{*} = \ln 2  \mu_{*$	<u> </u>
densities for $\mathbf{v}_{n}$ and $\mathbf{v}_{i}$ : $\rho_{n} = \frac{13000}{3000}$ kmm <sup>3</sup> , $\Delta \rho = \frac{3000}{3000}$ kmm <sup>3</sup>	
geometry selection of the melt phase	
✓ Films      Tubes      Spheroids model name = model 4	
-configuration for geometries of the melt phase (sum of fraction has to be one)	
films configuration tubes configuration tubes configuration tubes configuration (anert ratio 0 < 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 0 < 1) = 0 (anert ratio 0 < 0 < 0 < 0 < 0))	
$c_{v_{1}}$ (solated fraction, value between 0 and 1) = 0 $c_{v_{1}}$ (solated fraction, value between 0 and 1) = 0 $c_{v_{2}}$ (solated fraction, value between 0 and 1) = 0 $c_{v_{2}}$	
$c_{1c}$ (connected fraction, value between 0 and 1) = 1 $c_{2c}$ (connected fraction, value between 0 and 1) = 0 $c_{3c}$ (connected fraction, value between 0 and 1) = 0	
relot options	
V plot K <sub>u</sub> (unrelaxed bulk-modulus) V plot μ <sub>u</sub> (unrelaxed shear-modulus)   plot v <sub>u</sub> (unrelaxed poisson-ratio) V plot K <sub>v</sub> (relaxed bulk-modulus) V plot μ <sub>v</sub> (relaxed shear-modulus)   plot v <sub>v</sub> (relaxed poisson-ratio)	
□ plot v,, (unrelaxed p-wave velocity) □ plot v,, (unrelaxed s-wave velocity) □ plot v, /v, (unrelaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, /v, (relaxed velocity-ratio) □ plot v, /(relaxed p-wave velocity) □ plot v, /v, /v, /v, /v, /v, /v, /v, /v, /v,	ity-ratio)
	unit
model1 1.0E-5 0.2 0.66 0.2 0.4 3300.0 300.0 0.01 0.0 0.1 0.0 0.0 0.0 0.0 0.0 0.	MPa MPa
model3 1.0E-6 0.2 0.66 0.2 0.4 3300.0 300.0 0.01 1000/0 0.1 0.0 1.0 0.0 0.0 0.0 0.0 100 100 10	MPa
plot selected values	

Figure 1: example for calculating and plotting elastic moduli or seismic velocities

In Fig. 1 you can see how to use ModVisc 0.01. It is possible to switch between the calculation of elastic moduli or effective viscosities. The handling is for both tabs the same.

# 2. Parameter description

# 2.1 <u>Modulus</u>

parameter name	description	default value
K <sub>0</sub>	Intrinsic bulk-modulus of the matrix	0,66
K <sub>f</sub>	Intrinsic bulk-modulus of the fluid	0,2
μ <sub>0</sub>	Intrinsic shear-modulus of the matrix	0,4
φ <sub>min</sub>	Minimum value for melt fraction (zero is not allowed)	10-6
φ <sub>max</sub>	Maximum value for melt fraction (has to be smaller or	0,2 (20%)
	equal to one; one means 100% melt fraction)	
φ <sub>num</sub>	Number of fraction values between $\phi_{min}$ and $\phi_{max}$ ; realized	1000
	with $\varphi = \text{logspace}(\log 10(\varphi_{\text{min}}), \log 10(\varphi_{\text{max}}), \varphi_{\text{num}})$ ; for	
	detailed information please read matlab documentation	
	about logspace	
n <sub>max</sub>	Tells maximum number of iterations which are allowed for	1000
	each fraction value $\phi$	
unit	Unit for the moduli; free choose is not allowed because	MPa
	seismic velocities are also calculated	
ρ <sub>0</sub>	Intrinsic density of the matrix	3300 [kg m <sup>-3</sup> ]
Δρ	Density difference between matrix and fluid; density for	300 [kg m <sup>-3</sup> ]
	calculating the seismic velocities is given by	
	$\rho = \rho 0 - \Delta \rho \phi$	
films	Check if you want to include film geometry	unchecked
tubes	Check if you want to include tube geometry	unchecked
spheroids	Check if you want to include spheroid geometry	checked
model name	This name appears in the model table and in the legend for	model 1
	the case of plotting	
$\alpha_1$	Aspect ratio of the oblate ellipsoidal films;	0,01
	should be << 1 otherwise there will occur relative errors for	
	K and $\mu$ which increase linear with melt fraction; detailed	
	information are given in 1)	

c <sub>1i</sub>	Relative fraction for isolated oblate ellipsoidal films; has to	0
	be a value between zero and one (zero means 0%, one	
	means 100%); see *	
c <sub>1c</sub>	Relative fraction for connected oblate ellipsoidal films; has	0
	to be a value between zero and one (zero means 0%, one	
	means 100%); see *	
κ	Shape parameter for the cross section of the tubes; value	0
	interval reachs from zero to infinity (choose a really large	
	value); for detailed information see 1) resp. 2)	
c <sub>2i</sub>	Relative fraction for isolated tubes; has to be a value	0
	between zero and one (zero means 0%, one means 100%);	
	see *	
c <sub>2c</sub>	Relative fraction for connected tubes; has to be a value	0
	between zero and one (zero means 0%, one means 100%);	
	see *	
α <sub>3</sub>	Aspect ratio of the oblate ellipsoidal spheroids; value has to	0,1
	be larger than zero and equal or smaller than 1 (	
	$0 < \alpha_3 \leq 1$ )	
c <sub>3i</sub>	Relative fraction for isolated oblate ellipsoidal spheroids;	0
	has to be a value between zero and one (zero means 0%,	
	one means 100%); see *	
<b>c</b> <sub>3c</sub>	Relative fraction for connected oblate ellipsoidal	1
	spheroids; has to be a value between zero and one (zero	
	means 0%, one means 100%); see *	

\* the sum of all c's has to be 1

# 2.2 <u>Viscosities</u>

parameter name	description	default value
$\eta_{b0}$	Effective bulk-viscosity of the matrix is set to infinity,	$\infty$
	because matrix is incompressible; for detailed information	
	see [1]	
$\eta_{bf}$	Effective bulk-viscosity of the fluid is set to zero, because	0
	effective bulk viscosity relates the dilatational strain rate to	
	the isotropic part of the viscous stress tensor and not to the	
	pore fluid pressure; for detailed information see [1]	
$\eta_{s0}$	Intrinsic dynamic shear-viscosity of the matrix	1018
φ <sub>min</sub>	Minimum value for melt fraction (zero is not allowed)	10-6
φ <sub>max</sub>	Maximum value for melt fraction (has to be smaller or equal	0,2 (20%)
	to one; one means 100% melt fraction)	
φ <sub>num</sub>	Number of fraction values between $\phi_{min}$ and $\phi_{max}$ ; realized	1000
	with $\varphi = \text{logspace}(\log 10(\varphi_{\min}), \log 10(\varphi_{\max}), \varphi_{\text{num}})$ ; for detailed	
	information please read matlab documentation about	
	logspace	
n <sub>max</sub>	Tells maximum number of iterations which are allowed for	1000
	each fraction value $\varphi$	
unit	Unit for the viscosities; is set to SI-unit and not changeable	Pa s
films	Check if you want to include film geometry	unchecked
tubes	Check if you want to include tube geometry	unchecked
spheroids	Check if you want to include spheroid geometry	checked
model name	This name appears in the model table and in the legend for	model 1
	the case of plotting	
$\alpha_1$	Aspect ratio of the oblate ellipsoidal films;	0,01
	should be << 1 otherwise there will occur relative errors for	
	$\eta_b$ and $\eta_s$ which increase linear with melt fraction; detailed	
	information are given in 1)	
<b>c</b> <sub>1</sub>	Relative fraction for oblate ellipsoidal films; has to be a	0
	value between zero and one (zero means 0%, one means	
	100%); see **	

κ	Shape parameter for the cross section of the tubes; value	0
	interval reachs from zero to infinity (choose a really large	
	value); for detailed information see 1) resp. 2)	
$c_2$	Relative fraction for tubes; has to be a value between zero	0
	and one (zero means 0%, one means 100%); see **	
$\alpha_3$	Aspect ratio of the oblate ellipsoidal spheroids; value has to	0,1
	be larger than zero and equal or smaller than 1 ( $0 < \alpha_3 \le 1$ )	
<b>c</b> <sub>3</sub>	Relative fraction for oblate ellipsoidal spheroids; has to be a	1
	value between zero and one (zero means 0%, one means	
	100%); see **	

\*\*  $c_1 + c_2 + c_3 = 1$  has to be fulfilled

### 3. Plotting

You are able to plot the results of one or many models in one plotting window. Depending on whether you want to plot modulus or viscositiy models you can choose between different values to plot. All values are plotted against the total melt fraction  $\varphi$ .

#### 3.1 <u>Modulus</u>

value	description
Ku	Unrelaxed bulk-modulus
K <sub>r</sub>	Relaxed bulk-modulus
$\mu_{u}$	Unrelaxed shear-modulus
μ <sub>r</sub>	Relaxed shear-modulus
$\upsilon_u$	Unrelaxed poisson-ratio
υ <sub>r</sub>	Relaxed poisson-ratio
V <sub>pu</sub>	Velocity of p-waves calculated with unrealxed moduli
V <sub>pr</sub>	Velocity of p-waves calculated with realxed moduli
V <sub>su</sub>	Velocity of s-waves calculated with unrealxed moduli
V <sub>sr</sub>	Velocity of s-waves calculated with realxed moduli

V <sub>pu</sub> /V <sub>su</sub>	Ratio of the velocities calculated with unrelaxed moduli
V <sub>pr</sub> /V <sub>sr</sub>	Ratio of the velocities calculated with relaxed moduli

If you want to have for example  $K_u$  and  $K_r$  from one or from different models in one plot window you have to check these checkboxes and choose one model or by holding CTRL many models inside the model table. After that you have to press the plot button in the toolbar at the top of the program (see Fig. 1)

#### 3.2 <u>Viscosities</u>

value	description
$\eta_b$	bulk-viscosity
$\eta_s$	shear-viscosity
υ	poisson-ratio

For the viscosities it is possible to plot bulk- and shear-viscosity in one plot window. There is even an option to plot only the important parts, because in some configurations the bulk- resp. shearviscosity will rapidly decrease until the error boundary is reached. These values are not biased and maybe you don't want to plot them.

# 4. Saving

It is possible to save the calculated models as a text file (\*.txt) or as a Matlab file (\*.mat).

# 4.1 <u>matlab data files</u>

ModVisc saves the calculated models internally as a structure (struct). So even when you choose more than one model for saving there will be only one mat file. This mat file contains all models in the form of a struct (see "help struct" in matlab). To import your saved data in Matlab two alternatives. On the one hand you can do it interactive with File > Import Data and on the other hand you can do it in the command line with the command:

# >>load 'path/filename'

When the saved data contains moduli models the variable name is "mod\_models", when the saved data contains viscosity models the variable name is "visc\_models". The following table should give you an overview which