**Supplementary Text 1 - ST1.**

This supplementary material provides and explains how to use the numerical codes utilized for 1D shear zone modelling (*Main\_code.m*), viscosity mixing with W and H (*Eta\_mix\_H.mat* and *Eta\_mix\_W.mat*), visualization (*Visualization.m*), and post pure shear flattening (*Flattening.m*).

*Main\_code.m* (run first)

This code provides the 1D shear zone model including all variations to run the code. Both influxes are implemented: aqueous fluid inflow (W) and hydrogen diffusion (H) based on the principles of continuum mechanics as described in section three. All steps are explained within the code using the commenting function. Furthermore, .mat files needed for further visualization or flattening are stored after each run automatically. Possible lines to change the initial values are as follows:

Line 8 : diffusivity of W  
Line 11 : size of initial shear zone width   
Line 15 : diffusivity ratio (to change *DH*based on *DW*)  
Line 16 – 20 : if *DW* is variable – uncomment, and adjust for a and b (see equation 5)  
Line 29 – 33 : if *DH* is variable – uncomment, and adjust for a and b (see equation 5)  
Line 41 : weak viscosity   
Line 44 : viscosity ration (to change the transition viscosity based on the weak viscosity)  
Line 50 & 51 : change DW or DH to DW\_var or DH\_var, respectively,  
 if variable diffusivities are suggested  
Line 59 & 60 : uncomment if variable DW or DH are suggested  
Line 80 – 84 : uncomment if variable DW or DH are suggested  
Line 109 – 112 : comment if variable DW is suggested  
Line 113 – 117 : uncomment if variable DW is suggested  
Line 118 – 121 : comment if variable DH is suggested  
Line 122 – 126 : uncomment if variable DH is suggested  
Line 173 : define output after X-timestep (now 100)  
Line 237 & 238: uncomment if variable DW or DH are suggested  
Line 243 & 244: adjust if variable DW or DH are suggested

*Eta\_mix\_H.mat, Eta\_mix\_W.mat*

Viscosity mixing model using the Minimized Power Geometric (MPG) mixing model for viscously deforming polyphase rock of Huet et al., 2014.

*Visualization.m*

This code can be used to plot Figure 6 and Figure 7 hence, the evolution of parameters, e.g., W and H, normalized displacement, effective viscosity, and diffusivities. Adjust with respect to constant or variable *DW* and *DH*.

*Flattening.m*

Use to apply a pure shear component to the results of the *Main\_code.m*. Adjust Line 13 and Line 15 to change the limits of flattening, area and strain, respectively.