Rheology of PDMS-corundum sand mixtures from the Tectonic Modelling Lab of the University of Bern (CH) (http://doi.org/10.5880/fidgeo.2018.023)

1. Citation

 When using the data please cite:

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Zwaan, F. & Schreurs, G. (2017). How oblique extension and structural inheritance influence rift segment interaction: Insights from 4D analog models. *Interpretation*, 5(1), SD119–SD138. https://doi.org/10.1190/int-2016-0063.1

Zwaan, F., Schreurs, G. & Adam, J. (2017). Effects of sedimentation on rift segment evolution and rift interaction in orthogonal and oblique extensional settings: Insights from analogue models analysed with 4D X-ray computed tomography and digital volume correlation techniques. *Global and Planetary Change*. https://doi.org/10.1016/j.gloplacha.2017.11.002

2. Data Description

This dataset provides rheometric data of silicone (Polydimethylsiloxane, PDMS SGM36)-corundum sand mixtures used for analogue modelling in Zwaan et al. (2016, 2017), Zwaan and Schreurs (2017) and in the Tectonic Modelling Lab of the Institute of Geological Sciences at the University of Bern (CH). The PDMS is produced by Dow Corning and its characteristics have been described by e.g. Rudolf et al. (2016a, b). The corundum sand (Normalkorund Braun 95.5% F120 by Carlo Bernasconi AG: https://www.carloag.ch/shop/catalog/product/view/id/643/s/normalkorund-braun-95-5-f120-0-088-mm-0-125-mm/category/3/),#), has a grainsize of 0.088-0.125 mm and a specific density of 3.96 g cm^{-3}. Further rheological characteristics are described by Panien et al. (2006). The density of the tested materials ranges between 1 (pure PDMS) and 1.6 g cm^{-3} (increasing corundum sand content in mixture). The material samples have been analysed in the Helmholtz Laboratory for Tectonic Modelling (HelTec) at GFZ German Research Centre for Geosciences in Potsdam using an Anton Paar Physica MCR 301 rheometer in a plate-plate configuration at room temperature. Rotational (controlled shear rate) tests with shear rates varying from 10^{-4} to 10^{-1} s^{-1} were performed.

According to our rheometric analysis, the material is quasi Newtonian at strain rates below 10^{-3} s^{-1} and weakly shear rate thinning above. Viscosity and stress exponent increase systematically with density from ~4*10^4 to ~1*10^5 Pa s and from 1.06 to 1.10, respectively. A first application of the materials tested can be found in Zwaan et al. (2016).

2.1 Measurement procedure

The data presented here are derived by rheometric testing using an Anton Paar Physica MCR 301 (e.g. http://www.ih.cas.cz/files/uploads/3_vyzkum/6_pristroje/MCR-501-brochure.pdf) at the Helmholtz Laboratory for Tectonic Modelling (HelTec) of GFZ. We used a sandblasted plate-plate configuration (PP25/S) with a 1 mm gap. A 3 mm gap was tested beforehand but yielded similar results. Tests were performed at 21°C.

Each sample has been carefully prepared by the same person to obtain a homogeneous mixture and measured consistently following a consistent test protocol. Rotational tests with controlled shear rate were performed at 19 different shear rates varying from 10^{-4} to 10^{-1} s^{-1} and respective interval lengths from 1000 to 10 s.

Table 1: *Sample overview*

GFZ-ID	Material	Mix Wt-ratio PDMS : Crd'sand	Density (g cm^{-3})	File name
MCR-UB03	PDMS SGM36	1 : 0	0.965	MCR301-UB03.txt
MCR-UB04	PDMS-corundum sand mix	1 : 0.7	1.4	MCR301-UB04.txt
MCR-UB05	PDMS-corundum sand mix	1 : 0.35	1.2	MCR301-UB05.txt
MCR-UB08	PDMS-corundum sand mix	1 : 1.1	1.6	MCR301-UB08.txt
MCR-UB09	PDMS-corundum sand mix	1 : 0.52	1.3	MCR301-UB09.txt
MCR-UB10	PDMS-corundum sand mix	1 : 0.89	1.5	MCR301-UB10.txt

2.2 Analysis and visualization

Analysis of the rheometric data has been done using the RheoPlus software (version 3.4, see http://www.mate.tue.nl/~wyss/softwiki/doku.php?id=equipment:antonpaar501-rheometer for instructions) by the Anton Paar GmbH. The resulting viscosities corresponding to distinct shear stresses and rates are summarized in the file "Results.txt" and plotted in Figure 1 as a function of shear rate (also available as file "Results.pdf"). A Matlab script "MCRshow.m" is provided along with this data set allowing visualizing the results as in Figure 1. A stress exponent n can be derived from these data using the script "MCRn.m". Accordingly, the material is quasi Newtonian at strain rates below 10^{-3} s^{-1}. Viscosity and stress exponent increase systematically with density from ~4*10^4 to ~1* 10^5 Pa s and from n = 1.06 to 1.10, respectively.

3. File description

For each sample the original file "MCR301-UBxx.txt" as exported from the RheoPlus software is provided (see Table 1). These data files include a header with relevant measurement information and a table with semicolon-separated columns:

- Meas. Pts.: Measurement interval (number)
- Shear Rate: Mean shear rate (s^{-1})
- Shear Stress: Mean shear stress (Pa)
- Viscosity: Mean viscosity (Pa s)
- Speed: Number of revolutions (min^{-1})

- Torque: Mean torque (µNm)
- Status: Device status

Shear stresses and viscosities for corresponding shear rates are summarized in the file "Results.txt" which is organized as a matrix with the first three rows describing the samples according to the header in the first column (see Table 2).

Table 2: *Structure of file "Results.txt"*

%ID	UB03		UB05		UB09		…	
%Material	PDMS_SGM36		PDMS-Crd'Sand mix		PDMS-Crd'Sand mix		…	
%Density (g cm^{-3})	0.99		1.2		1.3		…	
%								
%Shear rate	Shear stress	Viscosity	Shear stress	Viscosity	Shear stress	Viscosity	…	…
%s^{-1}	Pa	Pa s	Pa	Pa s	Pa	Pa s	…	…
0.0001	4.21	421000	513000	…	…	…	…	…
0.000147	6.32	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…

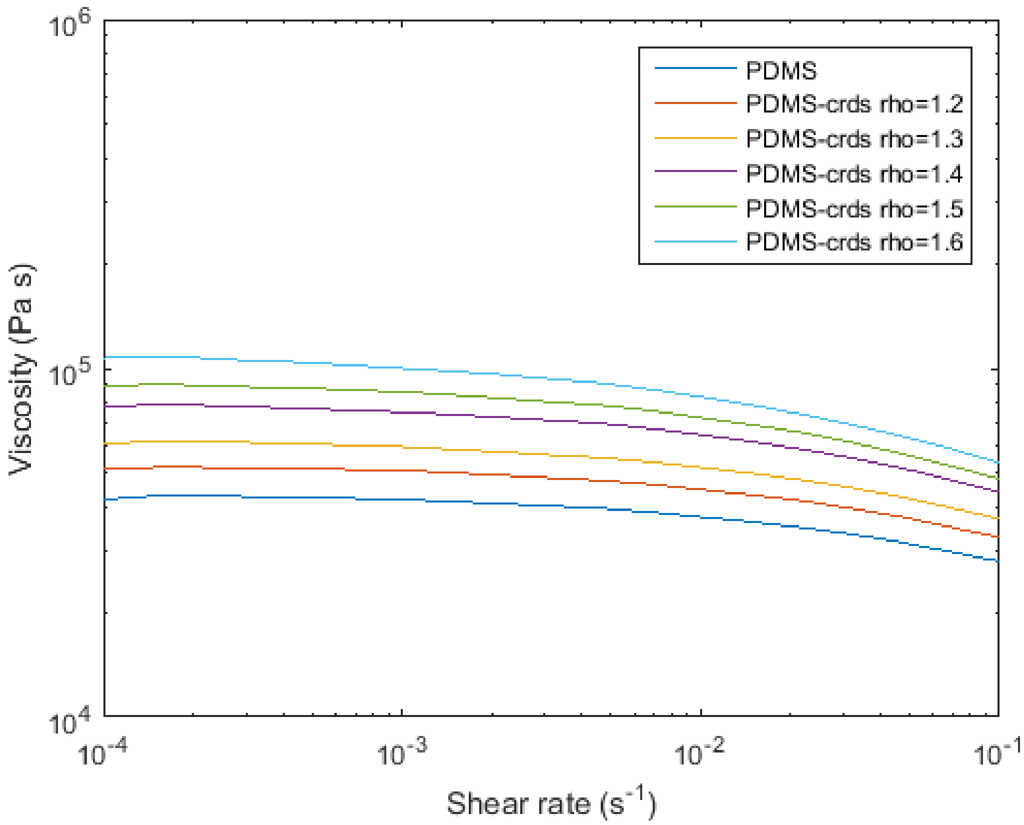

Figure 1: *Viscosity vs. shear rate for UB samples (density (rho) indicated in g cm^{-3}).*

4. References

Anton Paar MCR 501 Stress-controlled rheometer: Software and Instruction Manuals - Rheoplus Software. URL: http://www.mate.tue.nl/~wyss/softwiki/doku.php?id=equipment:antonpaar501-rheometer

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