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MORB Rheology: Experimental Insights on the Mid-Atlantic Ridge

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Mid Ocean Ridge Basalts (MORBs) represent the most abundant magmatic composition on Earth. Yet, their rheology had not been extensively experimentally investigated so far, hindering our ability to attain quantitative models of their emplacement processes. We thus obtained a series of detailed measurements on the rheology of a mid-ocean ridge basalt representing the average composition of MORB melts worldwide. The investigated sample was dredged from the South Mid-Atlantic Ridge during the 1998 RV Meteor cruise M41/2, and is catalogued as 139-KDS-2. In order to characterize the sample rheology, we ran high temperature, controlled oxygen fugacity experiments in a concentric cylinder rheometer mounted on a tube furnace. Reducing conditions compatible with natural scenarios were imposed on all experiments. Liquid only experiments spanned the temperature range comprised between 1530 ℃ and 1160 ℃, and revealed low viscosities of 2.2 Pa s to 58 Pa s. Additionally, three subliquidus experiments were conducted on samples crystallized at the equilibrium temperatures of 1149 ℃, 1139 ℃, and 1129 ℃. Apparent viscosity values increase from 1206 Pa s at 1149 ℃ to 1678 Pa s at 1129 ℃ for a constant strain rate of 0.52 s^{-1}. Likewise, apparent viscosity values were determined for a range of strain rates. Crystal fraction increases with decreasing temperature, driving the observed viscosity increase as well as prompting shear thinning behavior. Quenched post-experimental samples were recovered for quantitative textural analyses.

Authors: SOLDATI, Arianna (LMU); HASENCLEVER, Jörg (Universität Hamburg); Dr HANSTEEN, Thor (GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, DE); Prof. DINGWELL, Donald (LMU Munich)

Presenter: SOLDATI, Arianna (LMU)

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