Accepted Manuscript

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PII: S0191-8141(18)30278-5

DOI: 10.1016/j.jsg.2018.05.022

Reference: SG 3663

To appear in: *Journal of Structural Geology*

Received Date: 15 November 2017

Revised Date: 15 May 2018

Accepted Date: 24 May 2018

Please cite this article as: Reber, J.E., Pec, M., Comparison of brittle- and viscous creep in quartzites: Implications for semi-brittle flow of rocks, *Journal of Structural Geology* (2018), doi: 10.1016/j.jsg.2018.05.022.

Comparison of brittle- and viscous creep in quartzites: Implications for semi-brittle flow of rocks

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Abstract

The co-existence and interaction between brittle and viscous deformation processes contributes to the integrated strength of the crust and results in a wide range of energy-release mechanisms ranging from earthquakes to creep. Here, we compare flow laws derived for quartz-rich rocks deforming by brittle creep, wet dislocation power-law creep and dissolution-precipitation creep. We investigate theoretically the conditions when both brittle and viscous processes contribute significantly to deformation provided that all processes act independently and in parallel. Utilizing a comprehensive data set for deformation experiments in quartz-rich rocks, we find that the transition between deformation mechanisms is strongly dependent on input variables such as initial flaw size and grain size. The transition can occur abruptly or over hundreds of MPa in differential stress and hundreds of degrees Kelvin at a constant strain rate. The transition is strongly dependent on grain-size and confining pressure. Limitations to this