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Multiscale Behavior of Viscous Fluids Dynamics: Experimental Observations

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The dynamics of Newtonian fluids with viscosities of mafic to intermediate silicate melts (10-1000 Pa s) during slow decompression present multi-time scale processes. To observe these processes we have performed several experiments on silicon oil saturated with Argon gas for 72 hours, in a Plexiglas autoclave. The slow decompression, dropping from 10 MPa to ambient pressure, acting as the excitation mechanism, triggered several processes with their own distinct timescales. These processes generate complex non-stationary microseismic signals, which have been recorded with 7 high-dynamic piezoelectric sensors located along the conduit flanked by high-speed video recordings. The analysis in time and frequency of these time series and their correlation with the associated high-speed imaging enables the characterization of distinct phases and the extraction of the individual processes during the evolution of decompression of these viscous fluids. We have observed fluid-solid elastic interaction, degassing, fluid mass expansion and flow, bubble nucleation, growth, coalescence and collapse, foam building and vertical wagging. All these processes (in fine and coarse scales) are sequentially coupled in time, occur within specific pressure intervals, and exhibit a localized distribution along the conduit. Their coexistence and interactions constitute the stress field and driving forces that determine the dynamics of the conduit system. Our observations point to the great potential of this experimental approach in the understanding of volcanic conduit dynamics and volcanic seismicity.