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Numerical simulation of conduit dynamics during paroxysms at Stromboli

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Major explosions and paroxysms at Stromboli occur with a frequency of a few events per year, or a few per century for the largest events of size similar to that of the April 5th, 2003 eruption. Such events represent a source of high danger, especially for hundreds of tourists who daily approach the summit craters to admire the ordinary Strombolian activity. During major explosions and paroxysms, a volatile-rich, crystal-poor magma is erupted together with the common volatile-poor, crystal-rich magma which feeds the normal Strombolian activity. We have simulated the dynamics of convection, mixing, and ascent of the above two magma types at Stromboli, through a recently developed numerical code which describes the trasient 2D dynamics of multicomponent fluids from the incompressible to the compressible regime. The conditions for the simulations are taken with reference to the last paroxysm at Stromboli in 2003, and by using melt inclusion data to constrain the pre-eruptive conditions. Multicomponent (H_2O+CO_2) saturation is modeled by using a recently up-dated non-ideal model which accounts for actual melt composition. The numerical results show the formation of a rising bulge of light magma, and the sink of discrete batches of dense magma towards deep conduit regions. Such dynamics are associated with a complex evolution of the pressure field, which shows variations occurring over a wide spectrum of frequencies. A first order analysis of the propagation of such pressure disturbances through the country rocks shows that the pre-eruptive conduit dynamics are able to produce mm-size, mainly radial deformation of the volcano, and a seismic signal with spectral peaks at periods of about 50 s.