Acoustic signal produced by the overpressure release of a cylindrical cavity

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Among the different volcanoes dynamics encountered worldwide, the repetitive bursting of giant, elongated gas bubbles (*'slugs'*) occupying the whole conduit diameter is a feature commonly described as Strombolian activity [**?**,**?**,**?**,**?**]. One of the key parameters to understand this eruptive behaviour is the estimate of the overpressure ΔP inside the bubble before its explosion, which may occur either at the volcano vent or inside the conduit. This quantification, however, is still a major challenge. On the one hand, it has been shown that for weak acoustic waves (linear regime), the amplitude of the pressure wave propagating in the atmosphere due to the bubble bursting does not depend linearly on ΔP, but also on an uncontrolled parameter, the bubble rupture time τ_{rupt}. When $\tau_{rupt} \geq \tau_{prop}$, the characteristic wave propagation time in the cavity formed by the bubble, the amplitude drastically decreases [**?**,**?**]. On the other hand, the gas pressure inside volcanic bubbles may strongly vary and sometimes exceed the atmospheric pressure by up to several MPa [**?**], exhibiting non-linear acoustic regimes.

We investigate experimentally the acoustic signal released by a cylindrical, overpressurized cavity initially closed by a stretched membrane. In a first series of experiments, we explore the transition between the linear and non-linear regime in the case where $\tau_{rupt} \ll \tau_{prop}$, i.e., when the membrane bursting can be considered instantaneous. We find that the acoustic waves generated inside and outside the cavity are well-described by the linear acoustic theory and a monopole source approximation [**?**] up to $\Delta P \simeq 20$ kPa. For higher ΔP, we report a decrease (resp. increase) of the wave amplitude inside (resp. outside) the cavity, compared to the linear prediction. The influence of the membrane position in the conduit at bursting is also investigated. In a second series of experiments, τ_{rupt} is increased (weakly stretched membrane). We point out the existence of an additional acoustic wave produced by the membrane flapping during its opening, superimposed on the overall acoustic signal.

Références

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