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How sill intrusion affects caldera unrest?

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Calderas are among the most dangerous types of volcano, as their eruptive history demonstrates. Indeed, the largest eruptions are associated with calderas. Calderas also often experience unrest, testified by seismicity, degassing and surface deformation. Current knowledge indicates that unrest at calderas is due to magma intrusion. In particular, the depressed morphology of calderas promotes the formation of sills. The lateral expansion of the sills traps the rising magma, preventing it from reaching the surface and making non-eruptive unrest likely to occur at calderas. However, the physical properties of the caldera system and a high injection rate during the intrusion can create the conditions for an eruption. To better understand caldera unrest, we investigate the conditions for eruption caused by the intrusion of an expanding sill. Results show that an eruptive evolution of the unrest becomes more likely when the stress in the host rock above the sill reaches its maximum (days to months from the beginning of the intrusion), to successively decreases. After the end of the intrusive phase, magma remains eruptible for a period that depends on the temperature of the crustal environment where the sill intruded (days to years). Repeated intrusions modify physical conditions of the volcanic system and promote the eruptive evolution of unrest in the calderas. Moreover, higher rock rigidity and higher mass flow rate promote eruptive evolution of the unrest. Our results show a good agreement with statistical studies of unrest at calderas, traditionally classified in mafic and felsic.