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Magnetic features of the magmatic intrusion occurred in 2007 eruption at Stromboli Island (Italy)

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Significant local magnetic field changes marked the resumption of the eruptive activity at Stromboli volcano on 27th February 2007. After differential magnetic fields were filtered from the external noise by using adaptive filters and from the seasonal thermic noise by temperature data, step-like changes accompanied the eruptive fissure openings. Magnetic time sequences recorded at 2 stations, revealed a shallow NE-SW magmatic intrusion which started at about 13:00 GMT from the base of the summit crater and propagated in the depression of the Sciara del Fuoco within three hours. The magnetic variations, whose amplitude ranging between 1 and 4 nT, are consistent with those calculated from piezomagnetic models, where stress-induced changes in rock magnetization are produced by the magmatic intrusion and downslope propagation which took place in a few hours.
The continuous long-term decay characterizing the post-eruptive magnetic pattern was related to a time-dependent relaxation process. Assuming a Maxwell rheology, the proposed piezomagnetic model was able to fit the temporal variations in the local magnetic field observed during and after the magmatic intrusions in the Sciara del Fuoco. Post-eruptive magnetic variations were in general agreement with a viscoelastic relaxation process undergoing in the volcano edifice. The time scale of the magnetic variations involves a viscosity of about 10ˆ16 Pa.s assuming an average rigidity modulus of 30 GPa. The use of magnetic observations allowed gaining insights into the rheology of Stromboli volcano. The viscosity of the medium strongly influences time-dependent geophysical changes. Therefore, replacing elastic half-space models with more realistic approximations of viscoelastic rheologies could improve the interpretation of geophysical changes associated with volcano activity. In particular, the relaxation time inferred by viscoelastic models provides information about the time decay of the anomaly observed that could play an important role for the evaluation of a volcanic crisis and the related hazard alert level.