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Airborne magnetic mapping of volcanic areas – state-of-the-art and future perspectives

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Traditionally airborne magnetics surveys in volcanology are used for mapping regional geological features, fault zones and to develop a magnetic model of the volcanic subsurface. Within an Austrian-Italian-Japanese cooperation, several volcanic areas including Mt. Vesuvius, Ischia, Campi Flegreii and Aeolian Islands in Italy and Socorro Island in Mexico were mapped by high-resolution magnetic mapping during the last 15 years. In this paper, general conclusions from this long-term cooperation project on airborne magnetics in volcanic areas will be summarised. Basically the results showed the results from airborne magnetics could be used for three major purposes: 1. Developing a rough model for the magnetisation below the volcano down to several kilometres by applying advanced magnetic inversion algorithms helped to define the possible depth of the current or past magma chamber. Due to the complexity of the subsurface of volcanic areas, inversion of data was much dependent on constraints coming from other geoscientific disciplines. 2. After applying certain steps of reduction (topographic correction, field transformation) and a combination of source selective filtering, important regional structural trends could be derived from the alignment of the residual magnetic anomalies. 3. On the other hand during recent years, research has also focused on repeated measurements of the magnetic field of volcanic areas (differential in respect of time = differential magnetic measurements - DMM) using airborne sensors. Long-term temporal magnetic field variations in active volcanic areas can be caused by a changing size of the magma chamber or a general rise in temperature. This is caused by the fact that magnetization disappears, when a magnetic material is warmed up over a certain temperature (Curie- temperature). In consequence the resulting total magnetic field changes. Therefore, determining areas showing changes in the magnetic field could help to select areas where a possible renewal of eruptive activity could be expected. Such areas could then be targets for further detailed monitoring using ground-based methods. Since large areas could be covered by airborne magnetics within short time, this method is very cost effective. Consequently, if successful, this method could have a significant relevance for the prediction of future unrest and civil protection. However to make datasets comparable, delicate field transformation algorithms had to be developed in order not to lose the required high resolution. First promising results from Italy and Japan so far proved the seminal character of this approach.