Investigation of the inner structure of La Crosa de Sant Dalmai maar (Catalan Volcanic Zone, Spain)

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INTRODUCTION

La Crosa de Sant Dalmai volcano is one of the most representative volcanic edifices of the Catalan Volcanic Zone (NE Spain). It is a very well preserved maar-type structure, of 1.5 km in diameter, which was excavated at the contact between a hard and a soft substrate formed by Palaeozoic granites and Quaternary gravels, respectively. In order to infer the uppermost inner structure of La Crosa de Sant Dalmai maar we have performed a multiparametric geophysical study including gravimetry, magnetometry, self potential, and electric resistivity tomography. The

results obtained, together with a field geology revision and a 15 m probing information from a borehole drilled inside the maar crater, have permitted to get a detailed 3D picture of the post-eruptive maar infill sequence as well as of the uppermost part of the maar-diatreme structure, which helps to understand its origin and posterior evolution. In this sense, it is worth mentioning the little erosion and degradation suffered by original tuff ring, which accounts for a much younger age, probably Holocene, of La Crosa de Sant Dalmai maar than it was previously stated.

CATALAN VOLCANIC ZONE (CVZ)

- The Catalan Volcanic Zone (CVZ), situated at the NE of the Iberian Peninsula (Girona Province), is one of the Quaternary alkaline volcanic provinces belonging to the European rifts system (Martí et al., 1992)
- This basaltic monogenetic volcanic field comprises more than 50 monogenetic cones including scoria cones, lava flows, tuff rings, and maars. The area has traditionally been divided into three different sub-zones: L'Empordà to the North-east (12–8 Ma), La Selva (7.9–1.7 Ma) to the south and La Garrotxa (0.5–0.01 Ma) to the west (Araña et al., 1983; Martí et al., 1992).
- Volcanism in this area, as well as in the rest of the CVZ, is characterized by cinder cone eruptions along fissure zones. The existence of hydromagmatic events is also common. Small-sized cinder cones were produced during monogenetic short-lived eruptions associated with widely dispersed fractures of short lateral extent. Each eruption was probably caused by an individual batch of magma that was transported rapidly from the source region, each batch representing the products of an individual partial melting event (Martí et al., 1992).
- La Crosa de Sant Dalmai maar is located in the northern sector of La Selva depression (Girona province, NE Spain). Its deposits cover an area of about 7 km², 2 km north-west of the Girona-Costa Brava international airport. This maar volcano is mostly composed of phreatomagmatic deposits that form a circular tuff-ring around a shallow crater of 1250 m in diameter. The tuff-ring is asymmetrical, being higher at the west (maximum height of 50 m), where the internal and external slopes are also steeper, than at the east (maximum high of 30 m). Also, the deposits surrounding the rim show a wider distribution towards the east.
- The deposits reached distances of nearly 4 km towards the east and only of a few hundred metres towards the west. This asymmetrical distribution of the deposits was attributed to different strength of the rocks that form the substrate at each side below the volcano (Martí et al 1986).

GEOLOGICAL MAP

GRAVIMETRY

MAGNETOMETRY

SELF-POTENTIAL

ELECTRIC RESISTIVITY TOMOGRAPHY (ERT)

DISCUSSION

CONCLUSION

Combining all the data obtained we have constructed a 3D geological model of the internal structure of the uppermost part of La Crosa de Sant Dalmai maar-diatreme system. We could determine the relation between the pre-eruptive basement, the phreatomagmatic, strombolian and post-eruptive deposits highlighting:

- the asymmetrical distribution of the phreatic deposits, interpreted as the result of a mixed hard-soft basement.
- the paleotopography in the maar crater before the emplacement of the strombolian cone and its associated lava flow.
- the extension of this lava flow in the whole maar crater, under a 10 to 20m thick post-eruptive sediment level.
- the presence of a NW-SE lineament interpreted as the tectonic contact between the paleozoic and the quaternary basement.
- the control of this tectonic contact on the location of the strombolian cone whilst the phreatomagmatic activity resulted from the interaction with an aquifer in the granitic basement.

This multiparametric geophysical research has provided relevant information on both the internal structure of the maar and the subsequent sedimentary infill of the maar crater. However the results obtained by geophysical methods do not always have sufficient spatial resolution for the geological formations we wish to observe. It is therefore essential to adjust the models with geological data. In this case the mechanical probing has been a good help, but the shallow depth reached still leaves some questions about the lower part of the diatreme. In order to reach a greater depth of exploration and to obtain information on the lower part of the diatreme, other methods such as pole-dipole ERT profiles or seismic reflection profiles should be used.

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