

## **Chronological constraints of pyroclastic deposits on Anafi Island, (Cyclades, Greece): Are they Minoan?**

Katerina Theodorakopoulou<sup>1</sup>, Konstantinos Kyriakopoulos<sup>1</sup>, Kostas Stamoulis<sup>2</sup>, Magali Rizza<sup>3</sup>, Roberto Sulpizio<sup>4</sup>, M. Cihat Alçiçek<sup>4</sup>, Constantin D. Athanassas<sup>6</sup>

<sup>1</sup> Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, Greece, katheo@phys.uoa.gr

<sup>2</sup> University of Ioannina-Archaeometry Center, Greece

<sup>3</sup> Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement, Aix-en-Provence, France

<sup>4</sup> Department of Earth and Geo-environmental Sciences, University of Bari Aldo Moro, Italy,

<sup>5</sup> Department of Geology, Pamukkale University, Denizli, Turkey

<sup>6</sup> Department of Geological Sciences, School of Mining and Metallurgical Engineering, National Technical University of Athens, Greece

This study attempts to clarify whether formerly-documented pyroclastic deposits (Keller et al. 2014, McCoy and Dunn, 2002) belong to the Minoan eruption of Santorini or an earlier event. The 'Minoan' eruption, occurred in the 17th century BCE (1627–1600 BCE, Friedrich et al., 2006) and had widespread impacts on the civilization of the Aegean and Eastern Mediterranean (Marinatos, 1939).

Anafi Island could be a key site for the dispersal of Minoan tephra as it is the most nearby island of Santorini. Despite its proximity, only a few spots with pyroclastic deposits have been found on the island (Keller et al. 2014, McCoy and Dunn, 2002). The occurrence of tephra layers of the Minoan eruption on Rhodes, Kos and western Turkey (Keller, 1980; Eastwood et al., 1999), suggests that Anafi must have been covered by Minoan tephra, which was probably eroded and swept away afterwards (Keller et al., 2014).

In recent years, a debate has sparked regarding the relation of the Anafi deposits to the Minoan eruption. McCoy and Dunn (2002) associated the thick pumice deposits on Anafi with the Minoan eruption, suggesting "a far larger (Minoan) eruption than previously thought". In contrast, Keller et al. (2014), after geochemical determination of glass composition by electron microprobe analysis on the samples from Anafi, pointed out a strong geochemical similarity with those analyzed from the LP2 eruption of Thera at 172 ka, as has been determined by Druitt et al. (1999), excluding any correlation with the Minoan eruptive phase.

In this study we attempt to settle the debate of the tephra chronology on Anafi on the basis of numerical dating and specifically by applying the OSL dating method to colluvial deposits that bracket the pumice deposits, reported by McCoy and Dunn (2002) and Keller et al. 2014. It is noted that it's the first time that the pyroclastic deposits of Anafi will be chronologically constrained, providing indirectly the provenance (Minoan or of an earlier eruptive phase) of the pyroclastic deposits.

Our field survey aimed to collect samples from two pumice deposits on Anafi, already studied by Keller et al. (2014) and McCoy and Dunn (2002, 2004) at Prassa and Vounia, in the western and central part of the island accordingly. We collected 2 samples for OSL dating from the colluvial deposits that cover the pumice layer (Fig 1), as the base of the pumice deposits is not exposed in the section. The sample preparation was carried out at the Department of Geology and Geoenvironment, University of Athens and aimed at extracting quartz grains from the sampled colluvia. OSL measurements were carried out at the OSL dating laboratories at CEREGE, Aix-Provence, France and the Archaeometry Center, University of Ioannina, Greece.



**Figure 1. Sampling sites for OSL dating of Anafi Island. Localities: a) Vounia and b) Prassa. Red dot=OSL sample.**

The results derived by the application of OSL dating, demonstrated that the colluvium above the pumice deposition at Prassa was dated about 21.04 ka and in Vounia about 29 ka. According to our new chronological framework from the two sites at Vounia and Prassa, we conclude that tephra deposits in Anafi could not be of Minoan origin as McCoy and Dunn (2002) have suggested, given that the age of the stratum above ranges between 21 ka- 29.ka. The age form Prassa, coincides well with the Cape Riva eruption of Santorini at about  $21.8 \pm 0.4$  ka (Druitt, 1999). On the other hand, we could not unquestionably exclude its LP2 origin as suggested by Keller et al. (2004) as we did not date the base of pyroclastic deposits.

More geochemical and chronological analyses on pyroclastic deposits are needed, for the more efficient determination of their provenance and for the better understanding of the effects of Minoan eruption in the Aegean and eastern Mediterranean.

### Acknowledgements

Katerina Theodorakopoulou is a post-doctoral fellow of the State Scholarships Foundation (IKY) at the Department of Geology and the Geoenvironment, University of Athens. This study is funded by this post-doctoral fellowship. Dating of the deposits was supported through the ENVI-Med/Mistrals (Acronym: Med-HolVol), granted to CEREGE, France.

### References

- Druitt, T.H., Edwards, L., Mellors, R.M., Pyle, D.M., Sparks, R.S.J., Lanphere, M., Davies, M.,Barriero, B., 1999. Santorini volcano. *Geol. Soc. Lond. Mem.* 19, 1-165.
- Eastwood, W.J., Pearce, N.J.G., Westgate, J.A., Perkins, W.T., Lamb, H.F., Roberts, N., 1999. Geochemistry of Santorini tephra in lake sediments from Southwest Turkey. *Glob.Planet. Chang.* 21, 17–29.
- Keller, J., Gertisser, R., Reusser, E. and Dietrich, V., 2014. Pumice deposits of the Santorini Lower Pumice 2 eruption on Anafi island, Greece: Indications for a Plinian event of exceptional magnitude. *Journal of Volcanology and Geothermal Research*, 278,120-128.
- Marinatos, S., 1939. "The Volcanic Destruction of Minoan Crete." *Antiquity* 13, 425–439.
- McCoy,F.W.,Dunn,S., 2002.Modelling the climatic effects of the LBA eruption of Thera: new calculations of tephra volumes may suggest a significantly larger eruption than previously reported (abstract). *Proceedings of the Chapman Conference on Volcanism and the Earth's Atmosphere*, American Geophysical Union, Santorini, Greece, 21–22.