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Interactive comment on “The ring-shaped thermal field of Stefanos crater, Nisyros Island: a conceptual model” by M. Pantaleo and T. R. Walter

H. Kinvig (Referee)

h.kinvig@liverpool.ac.uk

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This paper investigates the relationship between the spatial distribution of thermal activity in Stefanos crater, Nisyros, and its soil properties – specifically using grain size as a proxy to permeability. A correlation between soil type (cohesive vs granular) and thermal output (IR) is presented and hypothesised to represent a control of intra-crater sediment accumulation on the evolution of surface heat and gas fluxes, rather than deeper structural controls (ie faults/fractures). It is suggested that initial fill of the crater by loosely consolidated material provides high permeability pathways which encourage the appearance of surface thermal activity; however later-derived finer-grained material generates areas of low-permeability which reduce the thermal flux in these areas. It is suggested that consequently craters with time will develop an outer ring of higher

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thermal activity, surrounding an inner cooler area. The paper focuses in detail on the case study of Stefanos crater in Nisyros caldera, however the hypothesis is relevant to other volcanoes and will be of interest to a wider audience.

* General comments:

This paper is well presented, generally easy to follow and well illustrated. It addresses relevant scientific questions – it is a novel study for Nisyros and provides information which may be applicable to other volcanoes. However, it needs some modifications before being published formally. In particular, it needs to better address the structural controls on Nisyros to determine that it is indeed surface permeability which is affecting the distribution of thermal anomalies. For example a fault is reported to run through Stefanos crater, but little mention is made to this and how it may affect the observations (e.g. see Caliro et al, 2005; Tibaldi et al, 2008). The main mud pools in the centre of Stefanos crater apparently cannot be explained by the permeability model presented and thus alternative controls need to be addressed in more detail. Page 2028 – line 5: Need to expand on faults as an alternative control.

A word of caution must also be made with regard to linking thermal imagery of April 2010 with the soil samples of January 2013: The thermal activity in Stefanos crater and distribution of sediments varies on a day-to-day basis, and is particularly influenced by rainfall and changes in the local water table. Is the period of study truly representative? Given the difference between the ‘flooding in the crater’ in January vs none in April – can these data sets be compared? Analysis on just one day would not necessarily be reflective of the activity in Stefanos. How long was the analysis done for? It is not clear if the paper is based on a single day of measurements during each field trip.

The title would benefit from including reference to the permeability side of the study – for example ‘: a conceptual model linking surface permeability (or soil properties etc) and the spatial distribution of thermal flux’.

* Specific comments:

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It is not clear over what period the IR measurements were made. Activity in Stefanos crater varies day to day and particularly after rainfall - did you make repeat measurements over a few days to ensure a representative dataset or do the data represent just 2 days (April + January)? This needs addressing in Pages 2012-2013. Page 2013 – line 13 – ‘it was partially flooded’ – what is the effect of this? How could rainfall have influenced the heat output and sediment recorded at surface? The mud pools frequently overflow and distribute fine sediment with these floods and this could influence the soil analyses you did. Can you compare the data of April 2010 and January 2013 given these extra variables? In particular are the samples collected in January actually representative of ground conditions during April? This needs to be addressed. Page 2018 – lines 25-27: The flooded area could make a difference to the sediment sampled and comparison with thermal data for period when it wasn’t flooded (e.g. April). Page 2019 – line 10-11: If you can attribute cool areas as being from the ‘cooling effect of the rain’ – how can you verify that your trends are representative of the soil properties, and comparable over different time periods?

Page 2008 - Geological background: It is the African plate that subducts northwards below the Aegean-Anatolian plate, not the Mediterranean plate. It is perhaps better to refer the island as being in the South Aegean Active volcanic arc?

Page 2012: Formula and all components need to be in italics, including T_v , T_b , T_{atm} , T_{obj} .

Page 2025 – line 13: ‘the depositional processes, however cannot explain the mud-pools at the center of the crater’ – surely this is the one of the most important features of Stefanos crater and so needs to be accommodated by the model? An expansion on alternative controls would be beneficial here, rather than simply alternatively attributing these features to ‘a complex volcano-tectonic control’. Is such a volcano-tectonic control more influential in Nisyros than the sediment permeability?

Page 2026 – line 6: - changes in thermal anomalies between measurements do not

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necessarily represent permanent changes in the system - just a change between repeated measurements, which further stresses the need to justify comparison of the April and January datasets.

* Technical comments:

Page 2007-line 25: dubitably - perhaps use 'alternatively' instead. Page 2008 – line 1 – “The testing the stratigraphic” – word missing Page 2008 – line 20 – should be ‘Plan view’ Page 2008 – line 23 – Should be African plate below Aegean, not Mediterranean Page 2008 – line 24: ‘the volcanic edifice developed through 5 stages’ – this is somewhat controversial. See for example Vougioukalakis 2008, Francalanci et al 1995; 2005, Tomlinson et al, 2012, Kinvig, 2012. Page 2009 – line 12-25: The depths of the permeable layers should be referenced to the drill reports of Geotermica Italiana. Page 2009 – line 16: No permeable zone ‘was found’ in... Page 2009 – line 18: delete ‘but’ from ‘but at 1000-1300m...’ Page 2009 – line 22: Coming from what “depths”? Page 2010 – line 6: Add Tibaldi et al, 2005 and 2008. Page 2010 – line 14: Fluctuates by ‘a’ few... Page 2010 – line 14: You don’t need to repeat the general temperatures of the fumaroles (see line 1) Page 2010 – line 19: Incomplete sentence – ‘inferred to instabilities of’ – add ‘be related to/attributed to’? Page 2010 – line 23: Pantaleo 2013 is not in the reference list – it needs adding to ref’ list or removing from paper. Page 2010 – line 26: ‘at crater scale because’ – replace ‘because’ with ‘due to’? Page 2011 – line 16: IN April, not ON April. Specify when – and how long for. Page 2012: Formulae and all components need to be italicised, including T_v , T_b , T_{atm} , T_{obj} . Page 2014 – line 1-3: Remove sentence “Finally...reasons”. Page 2014 – line 11 & 17: Weighted should be ‘weighed’. Page 2014 – line 18: Suggest rewording to ‘We used four sieves, which allowed the separation of gravel and coarse sand fraction ... etc’ - i.e. remove ‘with mesh....0.064mm’. Page 2015 – line 8 & 24: replace ‘side’ with ‘size’. Page 2017 – line 12: Needs a reference e.g. Tibaldi et al, 2005; 2008. Page 2020 – line 6: change ‘stronger expressed’ to ‘expressed more strongly’. Page 2021: Put all formulae components in italics, e.g. T_{atm} . Page 2022: Put all formulae components in italics, e.g.

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Tatm. Page 2024 – line 9: Reference e.g. Tibaldi et al, 2005; 2008. Page 2025 – line 10: Caliro et al, 2005. Page 2025 – line 13: Incomplete sentence – ‘it is also possible a combination...’. ‘Possible that’? Page 2026 – line 6: - changes in thermal anomalies between measurements do not necessarily represent permanent changes in the system - just a change between repeated measurements, which further stresses the need to justify comparison of the April and January datasets.

Page 2026 – line 22-23: ‘A scoria layer and an ash layer’ or make plural – layers. Page 2027 – line 7: add word ‘of’ or ‘in’? ‘overpressure of/in the hydrothermal system’ Page 2028 – line 3: Nisyros has an extensional stress regime. Page 2028 – line 4: ‘that observed’ or ‘what is observed’. Page 2028 – line 11: Repeat surveys would be crucial at Nisyros as the thermal activity can be seen to change dramatically with the local water table and rainfall. Page 2029 – line 3: Capital I for Island – keeps it consistent with earlier in text. Page 2028 – line 5: Need to expand on faults as an alternative control. Page 2030 – line 2: ‘A few centimetres’.... References: Add Pantaleo 2013, change Caliro et al 2004 to 2005. Page 2037 – line 4: ‘From’ SW to NE? Page 2042 – line 6: Change ‘it results cooler’ to ‘it appears cooler’.

Interactive comment on Solid Earth Discuss., 5, 2005, 2013.

SED

5, C810–C814, 2014

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