Response to referee #2 for GChron-2020-30

The review of referee #2 is in black, and our response is in blue.

Referee #2: Jörn-Frederik Wotzlaw

Dear authors and editor,
I have now completed my review of the above-mentioned manuscript. The authors report groundmass, biotite and amphibole 40Ar/39Ar geochronological data for tephra deposits and lavas from the Milos volcanic field (MVF) in Greece. The data is used to reconstruct the eruptive history and eruptive flux of the MVF. Geochemical data is used to further track the compositional evolution of this volcanic center.

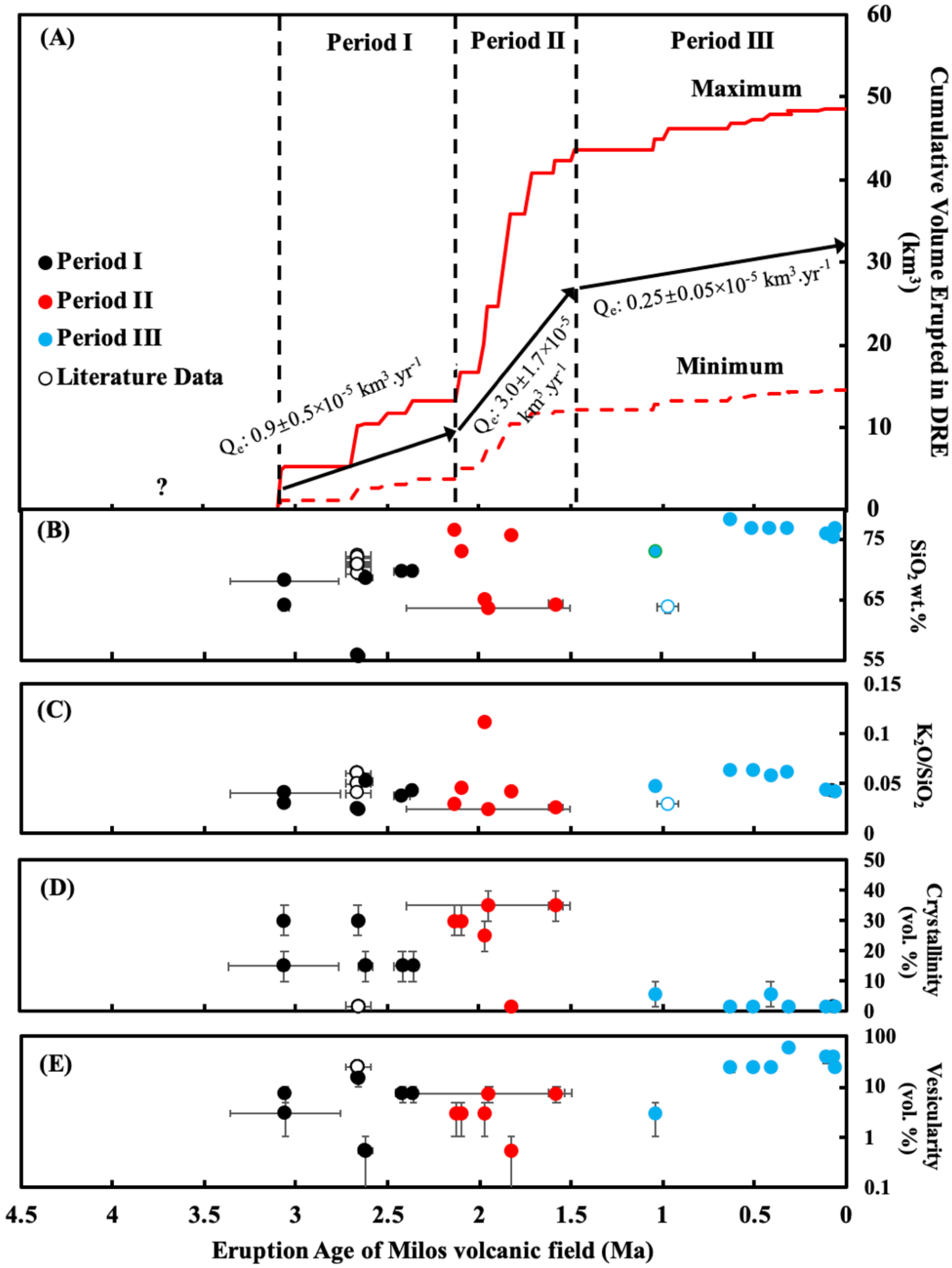
General comments: The manuscript reports a large amount of high-quality geochronological data and the interpretations are generally justified. Much of the Ar/Ar data is quite complex with complicated release spectra and age distributions. This is discussed in sufficient detail and the reliability of the data is assessed carefully. Considering that 40Ar/39Ar dating of such rather young deposits that lack alkali feldspars is rather difficult, the final interpretation of the data appears to be robust and agrees well with field relationships.

We thank Dr Wotzlaw for his positive comments on our geochronological work.

After reading the other review (which maybe I should not have done), I think I very much agree that the subdivision into different phases and intervals of quiescence is somewhat artificial and doesn't really reflect the eruption dynamics of the MVF. There seem to be "gaps" within some of the "phases" that are as long as the intervals of quiescence (e.g. 0.3 Ma between Mavros Kavoslava dome and Triades dome and 0.3-0.4 Ma between Dhemenegaki and Kontaro). I feel like this subdivision is not really justified based on the data, neither the geochronology nor the geochemical data. The cumulative eruptive volume versus time figure (Fig. 12) is much more revealing and I would say that there are secular variations in eruptive flux and eruption frequency with an early low-flux interval, a short high-flux interval followed by an extended lowflux interval. I find that this represents the dynamics of the MVF more naturally than assigning these artificial "phases".

In this context I would recommend to combine figures 11 and 12 to display the eruptive flux and compositional variations together on the same scale. I think this would be quite illustrative (e.g. it seems like the transition from the high-flux to late low flux interval coincides with a rather sudden change in magma composition, crystal content etc. This has some important petrological implications and reveals some important change in the magma plumbing system from producing crystal-rich (20-40%) intermediate eruptions to crystal-poor (<5%) rhyolitic magmas that represent the extracted residual liquids. Describing and discussing this in detail in a short paragraph on the petrologic implication I think would be very interesting.

We do agree with Dr. Wotzlaw (and reviewer #1: Dr. McPhie) that this part of the paper needs to be improved. We have followed the suggestion of Dr. Wotzlaw to improve Figure 12 and incorporate the 3 periods (or intervals) of low/high flux (Q_e) and we combined Figure 12 with 11 (see below). We will rewrite section 4.3 to remove the "phases" and base the discussion of the volcano type and composition on the three periods with different fluxes.



(A)
Period I
Period II
Period III
Maximum
Minimum
Period I
Period II
Period III
Literature Data
?
Qe: 0.9±0.5×10-5 km3.yr-1
Qe: 3.0±1.7×10-5 km3.yr-1
Qe: 0.25±0.05×10-5 km3.yr-1
Cumulative Volume Erupted in DRE (km3)
0
10
20
30
40
50
60
(B)
SiO2 wt.%
55
65
75
(C)
K2O/SiO2
0
0.05
0.1
0.15
(D)
Crystallinity (vol. %)
0
10
20
30
40
50
(E)
Vesicularity (vol. %)
0.1
1
10
100
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Eruption Age of Milos volcanic field (Ma)

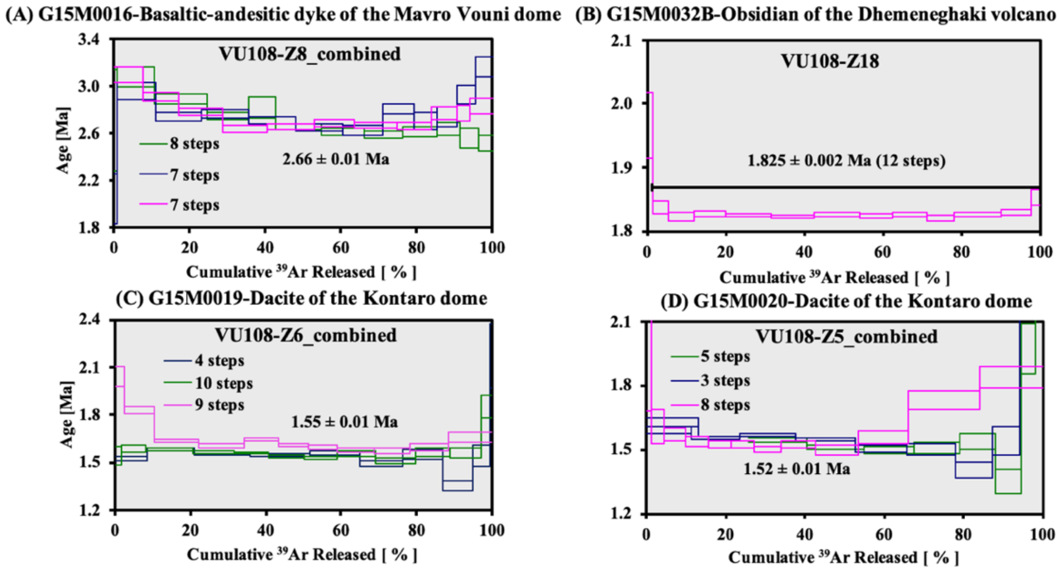
New Figure 11 (We combined Figure 11 with 12 of the original version).

Caption:

Eruption age versus (A) cumulative eruption volume for the volcanic deposits of Milos, (B) SiO_2 wt.%, (C) K_2O%/SiO_2%, (D) crystallinity vol. % and (E) vesicularity vol. % of Milos volcanic units of this study and previous studies. The maximum (Max; red line) and minimum (Min; dashed red line) cumulative eruption volume curves were estimated from Campos et al. (1996) and Stewart and McPhie (2006). Q_e is the long term volumetric volcanic output rate. The exact volume of volcanic products between 4.1 and 3.08 Ma is poorly constraint and indicated with a question mark. In this study, estimates of crystallinity and vesicularity of the older samples (>1.0 Ma) are all from lava and domes whereas those of the younger samples (<1.0 Ma) are from pumiceous pyroclastic units. The major element, crystallinity and vesicularity data of the pumice deposits of the Filakopi volcano (2.66 Ma) are from Stewart (2003) (black open circles). The major element data of the Plakes lava dome is from Fytikas et al. (1986) (blue open circle). Geochemical, crystallinity and vesicularity data of the old pumice deposits of the Profitis Illias (~3.08 Ma) is lacking due to the severe alteration.

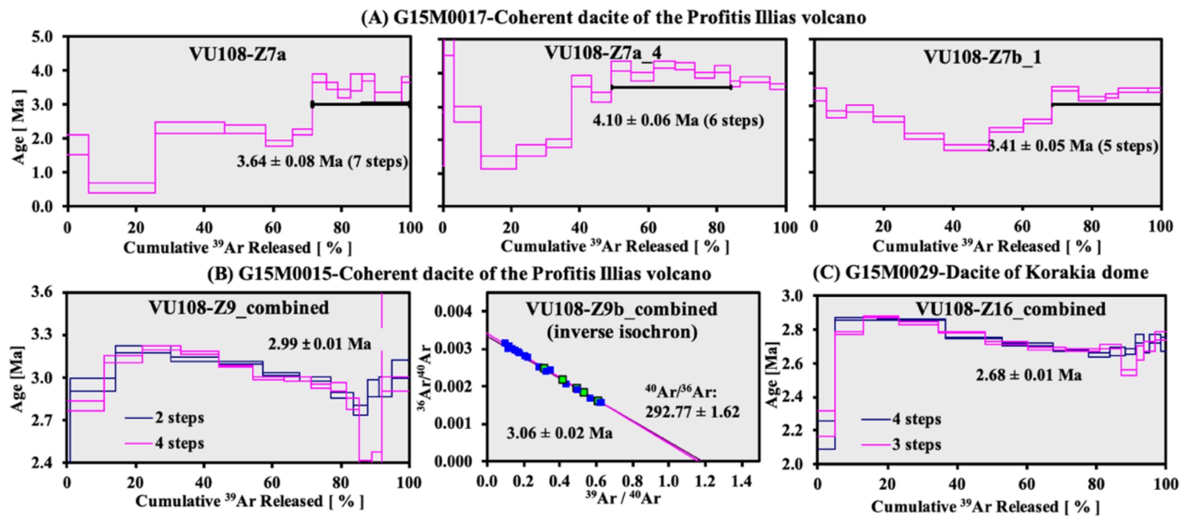
Figures: There seem to be significant differences in effort that went into the different figures and some are a bit repetitive and not necessary, Fig. 5-8 look like supplementary figures that I think need some editing to make them even useful. The Ar release spectra are alright but they are many and in many cases are shown as individual samples and as combines spectra. Maybe it would be more useful to have larger panels only with the combined data and move the individual ones into the supplementary material. It would just make things less messy. Similarly, the ranked age plots for total fusion analyses have loads of text in each panel but the scaling of the axes is so stretched out, that it is difficult to assess the dispersion of the data. As mentioned above, Fig. 11 and 12 could be combined but need some general editing. I don't think Fig 13 is necessary and could be deleted or moved to the supplementary material. Fig. 15 is a bit of a mess and I don't find that this figure is doing the amount of new high-quality data justice. A better-quality summary figure that integrates all the new and published data would sum up this work nicely for any reader.

We agree with Dr. Wotzlaw that we can place individual age spectra of Figure 5-9 into the supplementary material. We will only present the combined spectra and final age calculations in Figure 5-9. We will modify the x- and y-axis of the total fusion analyses (Fig. 7) so these are consistent, as suggested by Dr Wotzlaw. We also agree with Dr Wotzlaw that Figure 11 and 12 can be combined (see above). Figure 13 is an important figure for this manuscript because it shows that some of the older age data give different results than this study for the same volcanic units and this is discussed in section 4.1. This diagram also shows the smaller uncertainties on the age data we report compared to some of the published data. We have modified Figure 15 to incorporate the three periods with different fluxes (see above), and combine published age data for Milos with our new $^{40}Ar/^{39}Ar$ ages.



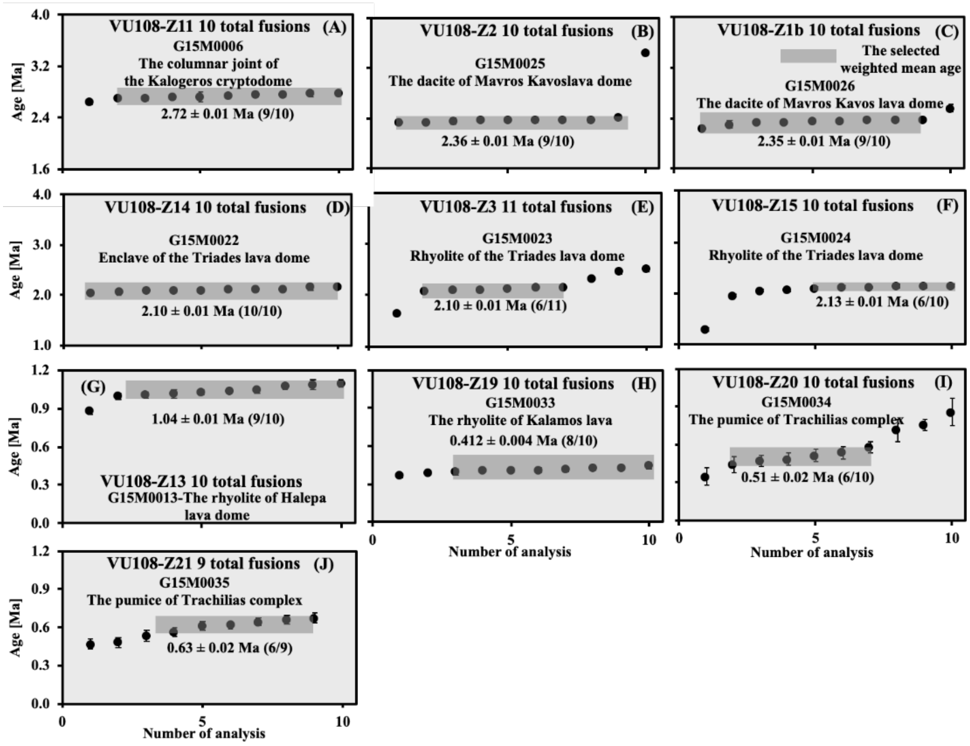
New Figure 5.

Groundmass $^{40}Ar/^{39}Ar$ plateau ages for samples G15M0016 (A), G15M0032B (B), G15M0019 (C) and G15M0020 (D). The Mavro Vouni dome (A), Dhemeneghaki volcano (B) and Kontaro dacitic dome (C, D) are located in respectively the south-western, eastern and north-eastern parts of Milos VF. The final age is reported with 1σ errors. See the individual steps of sample G15M0016, G15M0019 and G15M0029 in supplementary material II.



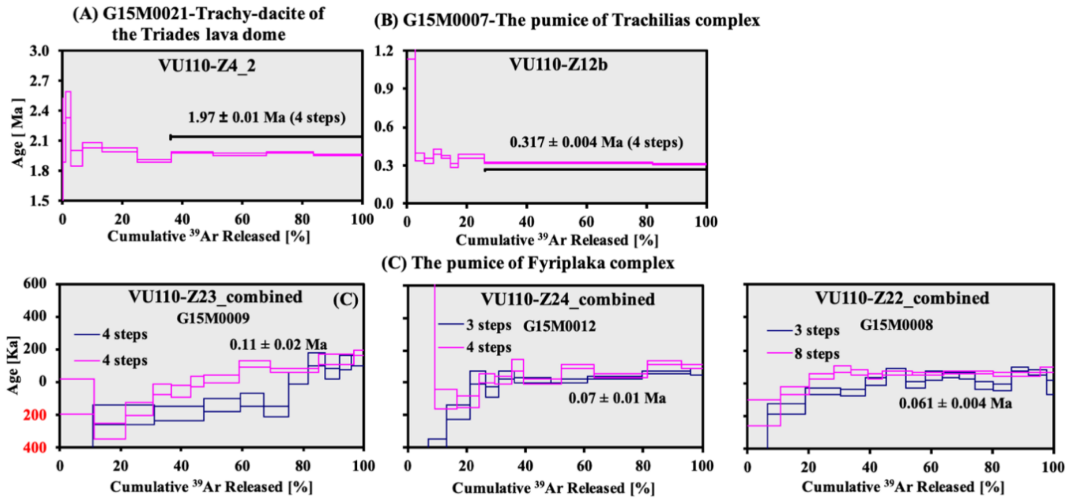
New Figure 6.

Groundmass $^{40}Ar/^{39}Ar$ plateau or inverse isochron ages for samples G15M0017 (A), G15M0015 (B) and G15M0029 (C). Individual steps and final age are reported with 1σ errors. The Profitis Illias volcano (A, B) and dacitic Korakia dome (C), respectively, are located in the south-western and north-eastern parts of Milos VF. See the individual steps of sample G15M0015 and G15M0029 in supplementary material II.



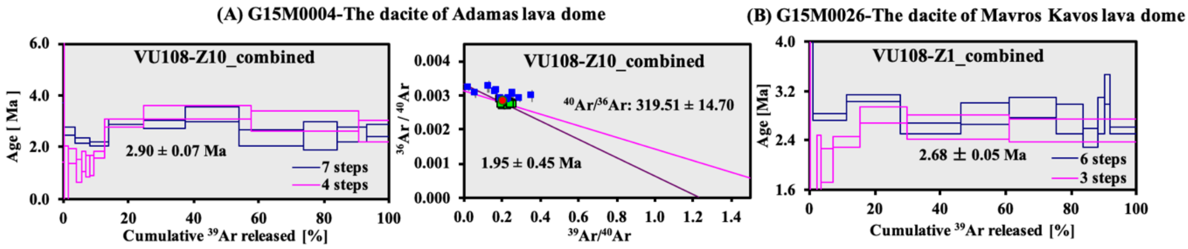
New Figure 7.

Biotite $^{40}Ar/^{39}Ar$ total fusion ages for samples G15M0006 (A) and G15M0025-26 (B, C), G15M0022-24 (D-F), G15M0013 (G) and G15M0033-35 (H-J). Data outside shaded area are not included in the weighted mean. The final age is reported with 1σ errors. The Kalogeros cryptodome and Mavros Kavos lava dome are located in, respectively, the north-eastern and western parts of Milos VF. Triades lava dome, Halepa lava dome, Trachilias complex and the Kalamos lava, respectively, are located in the southern, northern and south-eastern parts of Milos VF.



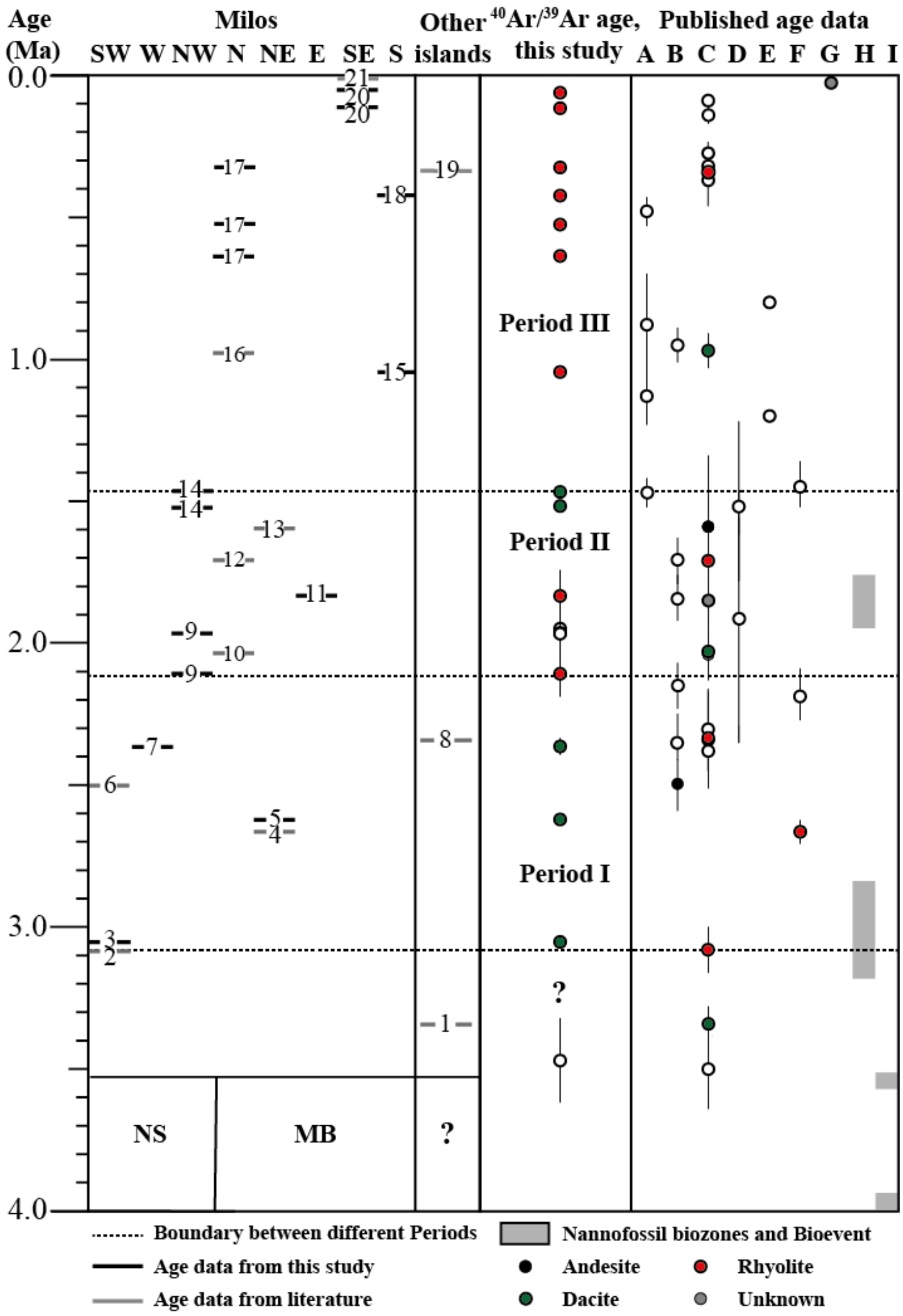
New Figure 8.

Biotite $^{40}Ar/^{39}Ar$ plateau ages for samples G15M0021 (A), G15M0007 (B), and G15M0009, G15M0012 and G15M0008 (C). The numbers in red represent negative ages. Individual steps and final age are reported with 1σ errors. The Triades lava dome, Trachilias and Fyriplaka complexes are located in the north-western, northern and south-eastern parts of Milos VF, respectively. The individual step diagrams of sample G15M0021, G15M0007, G15M0009, G15M0012 and G15M0008 are given in supplementary material II.



New Figure 9.

Amphibole $^{40}Ar/^{39}Ar$ plateau or inverse isochron ages for samples G15M0004 (A) and G15M0026 (B). The final age is reported with 1σ errors. The Adamas and Mavros Kavos lava domes are located in the northern and western parts of Milos VF respectively. The individual step diagrams of sample G15M0004 and G15M0026 are given in supplementary material II.


Age (Ma)
Milos
SW W NW N NE E SE S
Other islands
$^{40}Ar/^{39}Ar$ age, this study
Published age data
A B C D E F G H I
0.0
1.0
2.0
3.0
4.0
Period III
Period II
Period I
NS
MB
?
Boundary between different Periods
Age data from this study
Age data from literature
Nannofossil biozones and Bioevent
Andesite
Dacite
Rhyolite
Unknown

New Figure 14 (Figure 15 in the original version).

Diagram illustrating the three periods of different long term volumetric volcanic output rate of the Milos volcanic field based on the new $^{40}Ar/^{39}Ar$ data of this study and published age data. The location of the different volcanoes is given in Fig 3. and indicated in the left panel (from left to right: SW, W, NW, N, NE, E, SE and S of Milos. Other islnds include Kimolos, Polyegos and Antimilos). The two right panel corresponds to the new $^{40}Ar/^{39}Ar$ ages of this study and published age data: [A]=Fytikas et al., 1976, [B]=Angelier et al., 1977, [C]=Fytikas et al., 1986, [D]= Bigazzi & Radi, 1981, [E]=Matsuda, 1999, [F]=Stewart and McPhie (2006), [G]= Trainau and Dalabakis, 1989, and Biostratigraphic data of the Neogene sediments (NG) is from [H]=Calvo et al. (2012) and [I]=Van Hinsbergen et al. (2004) calibrated to Gradstein et al. (2012) (LCO of Sphenolithus spp. and FO of D. tamalis). In the two left panels, the number represents the volcanic centres on Milos (see details in Table 5), and black and grey lines indicate new $^{40}Ar/^{39}Ar$ data of this study and the preferred published age data for volcanic centres/units without available $^{40}Ar/^{39}Ar$ data, respectively. The start of volcanism (3.34-3.54 Ma) on Milos is poorly constraint and indicated with question marks (see text for discussion). The simplified basement cross-section (NS: Neogene sediments and MB: Metamorphic basement) below the Milos volcanic units is based on Fytikas et al. (1989).

Table 5. Summary of the eruption ages of the Milos volcanic field (The name of volcanic centre/unit or fossil content in the sediments corresponds to the number in the left panel of new Figure 14).

No.	Name of volcanic centre	Age (Ma)	Reference
1	Kimolos volcano	3.34	Fytikas et al., 1986
2	Profitis Illias crypto/pumice cone	3.08	Fytikas et al., 1986
3	coherent dacite of Profitis Illias volcano	3.06	This study
4	Filakopi volcano	2.66	Stewart and McPhie, 2006
5	Kalegeros cryptodome	2.62	This study
6	Mavro Vouni lava dome	2.5	Angelier et al., 1977
7	Mavros Kavos lava dome	2.42-2.36	This study
8	Polyegos lava dome	2.34	Fytikas et al., 1986
9	Triades lava dome	2.13-2.10 and 1.97	This study
10	Adamas lava dome	2.03	Fytikas et al., 1986
11	Dhemeneghaki volcano	1.83	This study
12	Bombardo volcano	1.71	Fytikas et al., 1986
13	Korakia dome	1.59	Fytikas et al., 1986
14	Komntaro dome	1.52-1.48	This study
15	Halepa lava dome	1.04	This study
16	Plakes lava dome	0.97	Fytikas et al., 1986
17	Trachilias complex	0.63, 0.51 and 0.317	This study
18	Kalamos lava dome	0.41	This study
19	Antimilos domes	0.32	Fytikas et al., 1986
20	Fyriplaka complex	0.11 and 0.07-0.06	This study
21	Phreatic activity	200 AD-200 BC	Trainau and Dalabakis, 1989

In summary, this manuscript reports abundant high-quality data for the Milos Volcanic Field that significantly improves the temporal calibration of this volcanic center. I think it needs some revisions especially regarding the eruption dynamics and relationship with compositional variations. A paragraph on the petrologic implications would make this more interesting for a wider magmatic petrology community. Ultimately, I recommend publication of this interesting manuscript in Geochronology after some moderate revision.
I hope the authors find my comments useful and that they will improve the paper.

We thank Dr Wotzlaw for his constructive suggestions.