Response to Jonathan Naden, Jo Miles and Simon Tapster for GChron-2020-30

The short comment of Jonathan Naden, Jo Miles and Simon Tapster is in black, and our response is in blue.

Zhou et al. present valuable Ar-Ar geochronological data, which is carefully evaluated and assessed. This is a welcome advancement for the understanding of the volcanic evolution of Milos, which prior to this work had only a limited range of geochronological data collected by modern techniques and sample locality distributions. Very few of these previous data have accompanying QA information and present just the age with uncertainty. Additionally samples rarely have clear geographical location information that enable the geological context to be assessed at an appropriate scale (e.g. 1:25 000 or smaller).

We thank Jonathan Naden, Jo Miles and Simon Tapster for their nice words on our $^{40}Ar/^{39}Ar$ geochronological work on the Milos Volcanic Field (MVF) and the constructive criticism they have on the sample locations.

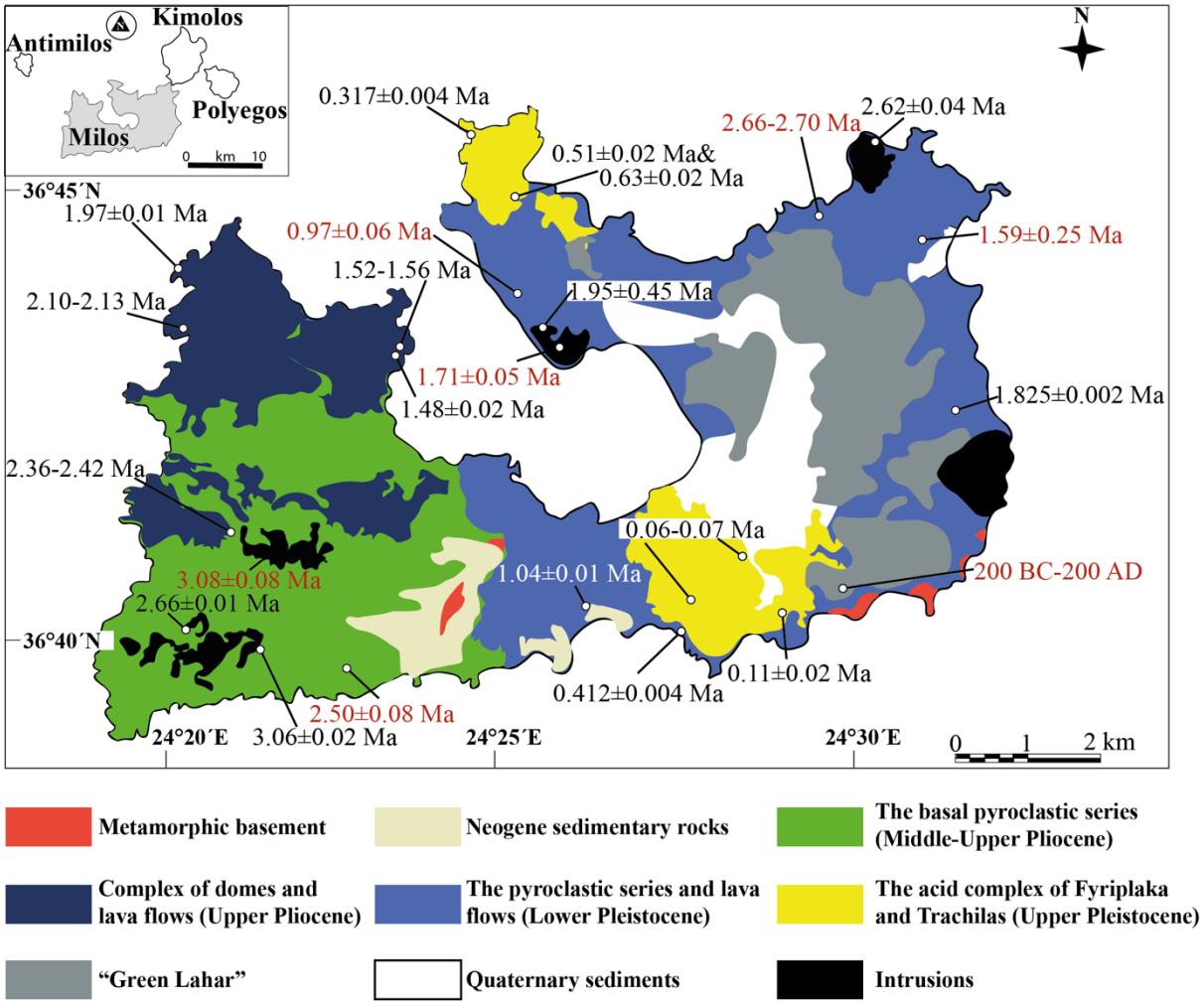
Zhou et al. provide this sample information (as recorded in Zhou et al. Tabs. 2 & 3). However, we find a significant number of errors (in 11 from 23 samples) in the location of samples and the attribution of volcanic centres. These are described below and listed in our Tab. 1 below.

We use a high resolution airborne remote sensing survey that includes a LiDAR DEM (as shown in Ferrier et al. 2019) and aerial digital photography (accessible from the CEDA Archive project EM10/02), to georeference the various published geological maps (Fytikas 1977, Stewart and McPhie 2006, Zhou et al., in review) and plot the location of Zhou et al (in review) samples as recorded in their Tabs. 2 & 3 to ascertain and assess sample geological context.

This raises some issues with Zhou et al. Fig 2 as there are mismatches between this and the coordinates given in Zhou et al. Tabs. 2 & 3. Specifically, the 3.06±0.02 Ma located at Mavro Vouni-Krotiraki corresponds with the age given for sample G15M0015. According to the given Lat-Long coordinates this is someway (c. 2.7 km WNW) from the location given on Zhou et al Fig. 2 (see Fig. 1). There are other examples of this, e.g. GM150022, GM150007, GM150034 and GM150013 (see Fig 1 and Tab.1 for complete list). In any final publication, we hope that these will be corrected and account taken of any changes to the geological context.

We agree with the concerns of Naden et al. Figure 2 only serves as a map where the different volcano types were located and does not show exact sample locations. Naden et al. are correct about Fig. 3 of our manuscript. This map has all the age formation, but the lines connect the age information to the volcanic units and not necessarily to the exact sample locations. This can be fixed by adding white symbols for the exact samples locations. We have corrected this in Fig. 3 of our revised manuscript with the lat-long location of samples taken from Table 2 and 3. Note, that the provided coordinates in the tables are correct.

Some samples have been collected from the same localities (e.g G15M0021 and G15M0022; G15M0034 and G15M0035). Sample G15M0022 is a mafic enclave enclosed in host G15M0021 as we mentioned in section 3.1.3 of our manuscript. Samples G15M0034 and G15M0035 were sampled from different layers of the same volcanic deposit at the same locality which can be seen in the Fig. S1.5 of supplementary material I.



New Figure 3. Simplified geological map of Milos with our $^{40}Ar/^{39}Ar$ ages of key volcanic deposits, modified after Fytikas et al. (1986), Stewart and McPhie (2006) and Grasemann et al. (2018). The stratigraphic units of Milos are from Fytikas et al. (1986). Age data from this study are in black, published ages are shown in red (Fytikas et al., 1986, Traineau and Dalabakis, 1989, Van Hinsbergen et al., 2004 and Stewart and McPhie, 2006). The “Green Lahar” is composed of phreatic explosion products (Fytikas et al. (1986). The white solid cycle indicates the exact sample location.

The second issue we raise is with the attribution of dates to a certain volcanic centre. On Zhou et al., Fig. 2 they present the Fytikas et al (1986) 3.08±0.08 Ma age as being located on the Profitis Ilias – Chondro Vouno volcanic centre (see Figs. 1 & 2 below). This date is not from there, according to the Fytikas et al (1986) Fig. 1 and Tabs. 2 & 3, this date is from a locality on the southern coast (see 3.1 Ma age on Fig. 2 and compare with Fig. 1). Currently, there are no published ages that are clearly from the Profitis Ilias – Chondro Vouno volcanic complex. Fytikas et al (1986) have two K-Ar dates (2.03±0.09 and 2.04±0.06 Ma) close to Profitis Ilias (Fig 2). However, these are located in the Complex of Domes and Lavas, to the north of the Profitis Ilias and to the south of the Ralaki fault. It is important that this erroneous location of the 3.08±0.08 Ma age is corrected and any interpretation of volcanic centre attribution based on it amended.

We have a further concern about the samples within this work also attributed to the Profitis Ilias volcanic complex. Samples GM150017 and GM150015 labelled as “Coherent dacite of Profitis Illias volcano”, according to the coordinates presented, are located in the volcanic centre to the south of the main Profitis Ilias volcano identified in Stewart and McPhie (2006)

Fig. 2 as the andesitic complex associated with the Kleftiko fault (Fig. 3 below). In terms of geological context these samples are perhaps more related to sample GM150016 (2.66±0.01 Ma and wrongly located, c. 0.8 km SE of Lat-long coordinates on Zhou et al. Fig. 2), which is from a basaltic andesite dyke (Zhou et al. Tab. 4), rather than the Profitis Ilias volcanic complex.

We agree with Dr. Naden that the age of 3.08 ± 0.08 Ma of Fytikas et al. (1986) is derived from a sample locality on the south coast. Fytikas et al. (1986) referred to this age as representative for the basal pyroclastic series (Middle-Upper Pliocene) and not that of the Profitis Illias volcano. We agree with Dr. Naden that there are no published ages for the Profitis Illias volcanic centre. We think that this is because these deposits are strongly altered.

On the other hand, Stewart and McPhie (2006) provided detailed stratigraphic columns, which allows us to correlate the associated volcanic units from different volcanic centres. Figures 10A and 10B of Stewart and McPhie (2006) show that the products of Profitis Illias volcano occupy the area of southwestern Milos. Stewart and McPhie (2006) considered these products as the medial facies of Profitis Illias volcano, which consist of dacitic-rhyolitic cryptodomes. These cryptodomes are referred to by Stewart and McPhie as the coherent rhyolite or dacite facies. Our samples G15M0017 and G15M0015 are derived from the coherent dacite facies based on the stratigraphic columns of Stewart and McPhie (2006). This is consistent with our field observations (supplementary material I) and the compositions of these two samples (dacite, Table 5).

There is a possible relation between sample G15M0016 and samples G15M0015&G15M0017. All these samples are derived from intrusive units ("crypto domes" or dykes). However, the age of sample G15M0016 (2.66 Ma) is much younger than that of sample G15M0015 (3.06 Ma). Sample G15M0016 is basaltic-andesitic in composition and is significantly more mafic than samples G15M0015 and G15M0017. Therefore, we consider samples G15M0017 and G15M0015 as representatives for the coherent dacite facies of the Profitis Illias volcano and sample G15M0016 is derived from a basaltic andesite dyke near Kleftiko.

We assumed the age of 3.08 ± 0.08 Ma of the rhyolite from Kleftiko (Fytikas et al., 1986) as the eruption age of Profitis Illias volcano. This age is older than our $^{40}Ar/^{39}Ar$ ages of the coherent dacites facies (= intruded cryptodome) and the rhyolitic composition is consistent with that of the Profitis Illias unit. We also agree that the age of the Profitis Ilias – Chondro Vouno volcanic centre is still unclear, as we discussed in the manuscript. Considering the stratigraphic framework of Stewart and McPhie (2006), previous K-Ar age data of Fytikas and our new $^{40}Ar/^{39}Ar$ ages, we argue that the age of 3.08 ± 0.08 Ma is most likely eruption age for the Profitis Illias volcano. Stewart and McPhie (2006) used a similar line of reasoning for the age of Profitis Illias. Samples G15M0015 and G15M0017 are thus derived from cryptodomes that intrude the Profitis Ilias volcanic complex.

Figure 4, below (in the short comment of Naden et al.), also details the location of these samples against the Fytikas (1977) geological map and identifies key named geographical localities used by Zhou et al.

On the geological map of Fytikas (1977), shown in Fig. 4 of the short comment of Naden et al., samples G15M0015 and G15M0017 seem to be from the volcanic units of $Q(\alpha, \delta\alpha)_2$ (andesitic and dacitic lava domes and flows; purple field of Fig. 4), Ne. tf (white to grey-black acid old tuffs; the yellow field of Fig. 4) or Qlh (various lahars of different age and composition). Fytikas (1977) described the volcanic units as Ne. ig, well cemented and generally altered ignimbrites as the volcanic units of the Profitis Illias volcano. In Fig. 1 of Fytikas (1986) and

Fig. 2 of Naden et al., our two samples could belong to the units of basal pyroclastic series or the complex of domes and lava flows. Fytikas et al. (1986) integrated the Ne. tf and Ne. ig into one series, the basal pyroclastic series. These two units probably are from the syn-volcanic eruption or have a similar age. The studies of Fytikas (1977) and Fytikas et al. (1986) indicate an old eruption age (Middle-Upper Pliocene) for the Profitis Ilias volcano.

Our samples G15M0015 and G15M0017 are not felsic pumices and tuff but are dacitic lavas. Therefore, we are confident that these two samples are derived from dacitic lava/cryto- domes and flows. As we describe above, sample G15M0015 and G15M0017 are from some units of the coherent dacitic-rhyolitic cryptodomes of the Profitis Ilias volcano. These cryptodomes should have younger ages consistent with multiple intrusions into Profitis Ilias volcano.

In view of this, we think the age of the Profitis Ilias volcanic centre activity has not yet been assessed and is still an open question and should be left as such.

We agree. In our manuscript, we only gave the time interval in which the Profitis Ilias volcano could have been active. The exact age and duration of the Profitis Ilias volcanic centre activity has not yet been dated due to the strong alteration of the pyroclastic units.

Also, any geological interpretations should be made according to the correct locations. In any revision we would recommend that the authors consult the Fytikas (1977) geological map (not referenced in their submission) in addition to geological information published in variety of articles and theses, which is often at a much lower resolution than the 1:25 000 geological map of Milos. We do not think these errors significantly affect the merits of the submission identified by Reviewers 1 & 2. However, it is important they are corrected to ensure that they are not propagated in future publications on Milos.

We have corrected the sample locations in Fig. 3. We are grateful to Jonathan Naden, Jo Miles and Simon Tapster for pointing out these inconsistencies in our manuscript.