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Interactive comment on "Evolution of a long-lived continental arc: a geochemical approach (Arequipa Batholith, Southern Peru)" *by* Sophie Demouy et al.

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We have red carefully the anonymous referee #1 review by and we agree that the introduction and discussion should be improved according to the new insights coming mostly from the geochronologist community. You will find below a detailed answer to referee #1.

First, it exists a philosophical controversy enclose within his criticism. We are working at the batholith scale using whole rock (WR) chemical and isotopic data obtained on a large sample set collected regularly along this massif. Referee #1 argues that we don't take into account recent results coming from more and more precise geochronological

and isotopic measurements of zircons extracted in similar lithologies, using analytical apparatus (or methods, or skills) that we don't have. The philosophical question is: should we banish the naturalistic (or descriptive) approach at large scale of a single batholith in regards to what can be measured using the zircon/WR combined work on a less amount of samples? It is true to say that the latter allow to access cryptic chemical and geochronological variations, which are used to propose more and more complex models of magma petrogenesis, like those cited by referee #1. However, are they all directly transposable at the batholith spatial and temporal scale, like for Arequipa? The main criticism that we are facing is the same that the scientific community working on mantle processes had 15 years ago: the global, naturalistic approach should erase itself with regard to in-situ measurements of melt inclusions trapped in olivine extracted from mantle peridotites. At the end, the scientific community agrees to say that both may co-exist: as it is not possible to measure all melt inclusions coming from 100 samples collected in a 50x50 kms geological area, the same conclusions may apply to zircons. And even so, the data will provide so much detail that a de-magnifier may be necessary in order to transfer the signification of the observed heterogeneity at the batholith scale. Therefore, we maintain that the naturalistic approach of the isotopic signal enclosed in our 100 sample set is relevant, considering that it would have been a huge effort, maybe not scientifically relevant, to analyse all zircons in those samples. This is a first step, which will help scientist like referee #1 to define some targets where zirconology may be applied. This approach may be considered "outdated" by isotope geochemists (no fancy new isotopes) or "descriptive" by geochronologists (no in-situ ID-TIMS TEA on zircon), we consider it as "naturalistic" (even if radiogenic isotopes/trace elements are measured) and we agree that it does not allow to "enhance our knowledge or arc magmatism" but it's a useful tool to explore an entire massif, in more details than all U/Pb ages available may do.

Secondly, and as the referee says, models and approaches become outdated. We have no doubt that modern, fractal, stochastic, ab-initio, thermodynamic modelization of processes happening 30 to 90 kms below the surface of the Earth will be outdated in 20 years, unfortunately. Moreover, like AFC in the early 80's, more complex, computing-based, modelization of magma mixing/interaction is still an over-simplification of what really happen when the melts are leaving the mantle wedge to interact with the base of the continental crust. Obviously, it doesn't mean that we should vanish all conceptual models but the purpose of this study is descriptive. We present 100 WR trace element and isotopic data obtained for samples collected in the Arequipa batholith and use an "isochron" approach to demonstrate that they homogenize themselves with time. The referee argues that they are many examples published of such demonstration of homogenization with time, but do not give any references that use the same approach. Neither Boekhout et al. (2012, 2013) or Spikings et al. (2016) are treating the WR radiogenic isotopes the way we propose. In absence of in situ systematic zircon dating for all samples collected, we suggest to report the data in classical isochron diagrams in order to check the co-genicity of samples from a single batholith. Furthermore, the idea is not to propose conceptually that this system is getting more and more homogeneous with time but to present 100 data showing this. We deeply regret that the review do not mention at any moment the radiogenic isotope treatment we present. All the criticism is about bibliography and models using high –resolution zircon isotopic and trace element data (that we don't have, unfortunately) but not a single word about the way the whole rock data are processed. It is well know that almost all the recent progress in the understanding of the "granitic" magmatic systems comes from zircon data: ID-TIMS, LA-ICPMS, in situ isotopes, for example. But still, other way should be explore, to our modest opinion. As says earlier, our approach may seem prehistoric in terms of methodology but gives very interesting results at the batholith scale. As Clemens et al. (2010) concludes: "There is a general need to reassess the meaning of the geochemical and isotopic data for felsic magmatic systems." Detailed and precise measurements of Zircons are part of the answer. Large-scale radiogenic isotope exploration of batholiths is another, simply because radioactive decay and time reveal the co-genetic characters of the emplaced units, whatever the complexity of their genesis at zero ages.

Again, we do agree that our introduction and conclusion need a severe overhaul, but we still maintain that the descriptive approach is valuable and scientifically relevant, considering the number of samples processed for a single area.

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