Review of: "The Quaternary Kurobegawa Granite: an example of a deeply dissected resurgent pluton"

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Ito et al. review by Vanderhaeghe

The paper untitled ***"The Quaternary Kurobegawa Granite: an example of a deeply dissected resurgent pluton"*** submitted to Nature Scientific Reports by Ito et al. presents a very exciting new set of geochronological and chemical-thermal data on zircon from one of the youngest exposed volcanic-plutonic complex that provide invaluable insights on the timing of magma transfer, differentiation and emplacement. The paper is pertinently organized, well written and nicely illustrated, the data are of good quality and their interpretation is convincing. Nevertheless, I have identified several shortcomings and a few gaps that might be considered in order to strengthen this contribution and increase its impact. These points are summarized below and refer to comments and corrections made directly on the annotated version of the manuscript.

1. **Presentation of the geological context and published models**

Two models are presented by the authors as being in contradiction regarding the emplacement of plutons, namely "(i) plutons represent the remains of large-volume magma chambers that are genetically linked to caldera-forming eruptions, or (2) plutons are emplaced incrementally through amalgamation of intrusions over millions of years and consequently not formed by the crystallization of large-volume magma chambers." I do not think that these propositions are mutually exclusive and indeed, in their model, the authors propose that the Kurobegawa pluton was formed by several pulses of magma injection associated in part with eruptions of the Jiigatake volcanics. Accordingly, the processes of magma transfer and emplacement should be distinguished from the ones related to magma differentiation-segregation, although these processes might occur concomitantly in natural examples.

Then it is claimed that "Seismic data may be consistent with protracted timescales of plutonic suite construction because geophysical studies have failed to locate large volumes of melt beneath active volcanic regions." This sentence is confusing first because its syntax is peculiar (how can seismic data be consistent with protracted timescales of plutonic suite construction, if they have failed to locate large volumes of melt?!). Then, it is not clear what "large volumes of melt" refers to. As far as I know, melt (not to be confused with magma) has been identified by geophysical data in active magmatic arcs and hotspots by the pioneer work of Iyer (Iyer, 1984) and more than 20 years ago beneath regions of thickened crust such as the Andean and Tibetan plateaux (e.g. Nelson et al., 1996; Schilling and Partzsch, 2001). These findings have been confirmed by new development that point to the presence of 10-20 % of melt in different geodynamic settings marked by active magmatism (see Magee et al., 2018 and references therein). In contrast, this amount of melt is not sufficient to account for the formation of crustal-scale mush columns as proposed for magmatic arcs (Cashman et al., 2017) and neither consistent with the presence of magma layers that are inferred to be present in zones of thickened crust from the structural analysis of migmatites in exhumed crustal roots (Brown, 2001; Sawyer, 1998; Vanderhaeghe, 2009). This discrepancy might indeed be explained by (i) a resolution of geophysical methods that is not adapted or (ii) a timescale for magma transfer that was not captured by geophysical studies.

1. **Field data**

The geological context of the Kurobegawa pluton is briefly presented with the mention of a control of magma transfer and/or tilting of the pluton by faults, which is very insufficient from my point of view. Given the seismic activity of the studied and the rugged topography of te Hida mountain range, with deeply incised valleys by rivers and glaciers, it should be possible to provide a much more thorough analysis of the geological setting, with kinematic analysis on faults and fault plane solutions. This is a pity not to take this opportunity to document such an extraordinary geological object.

1. **Geochronological data**

The geochronological data provide the key constraints to decipher the dynamics of emplacement of the Kurobegawa pluton and associated Jiigatake volcanics. They show a very convincing age gradient from 1.5 Ma to the East in the Jiigatake volcanics to less than 0.9 Ma to the West, in plutonic rocks of the Kurobegawa. The distribution of the ages within plutonic rocks is consistent with distinct periods of zircon crystallization that are interpreted to represent distinct pulses of magma emplacement progressively from East to West.

Images of analyzed zircon grains under cathodoluminescence are provided in the supplementary material but, from my point of view, are pivotal for the interpretation of the geochronological data. Indeed, zircon grains show very nice textures that might be used for a more thorough analysis of the data. For example, the few grains that display a core/rim texture that have been analyzed systematically yield an older age for the core than the one of the rim. Some of the cores show textures of dissolution (Corfu, 2003; Hoskin, 2003; Martin et al., 2006). These features are not discussed in the main body of the text but might reflect a succession of dissolution-precipitation cycles, which have been used to propose that zircon grains might record distinct pulses of fluid circulation (Keay et al., 2001) or complex growth during protracted high-temperature metamorphism (Guergouz et al., 2018) and entrainment in convection cells (Vanderhaeghe et al., 2018). A similar geochronological record is shown by the well exposed Torres del Paine laccolith in Patagonia (Leuthold et al., 2012), which might also serve as an example for comparison.

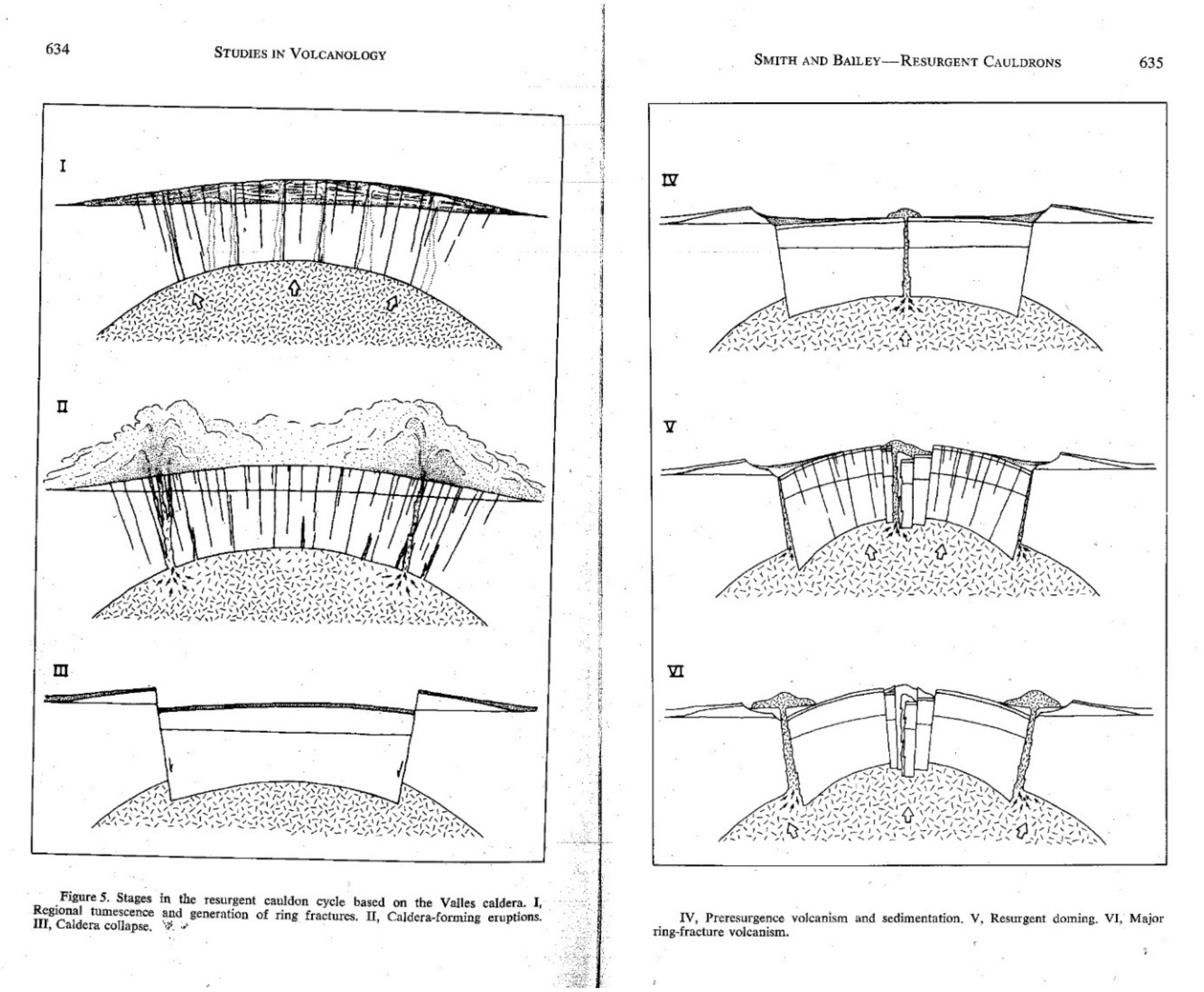
As an alternative to successive pulses of magma emplacement, I suggest that the authors consider the possibility of progressive East-West cooling and crystallization.

The geochronological data should be represented on an East-West cross section of the Hida Mountain range.

1. **Model**

The proposed model for the tectonic and magmatic emplacement evolution of the Hida Mountain during emplacement of the Kurobegawa pluton and Jiigatake volcanics is very schematic. Given the exceptional geological site of the Hida mountain range and the unprecedented quality of the geochronological record of these magmatic rocks, I strongly encourage the authors to provide a much more detailed model with a representation at scale with a final stage that resembles the current day geological cross section and topography.

At last, in the title and in the discussion of the data, the authors compare the Kurobegawa pluton and Jiigatake volcanics to a resurgent cauldron. However, from the analysis of the geological map and from the schematic model presented by the authors, the resemblances between the Kurobegawa-Jiigatake plutonic-volcanic complex and the cauldron structure first proposed for the Valles caldera in New Mexico (see figure below, Smith and Bailey, 1968).



I hope that these suggestions will help clarifying the presentation and interpretation of these wonderful data and increase the impact of this paper.

Best regards,

January 10th 2021

Olivier Vanderhaeghe

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