Supplementary material S2 for the following article:

Zircon from altered monzonite rocks provides insights into magmatic and mineralizing processes at the Douay Au project, Abitibi greenstone belt

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Principal Component Analysis

The impact of the diffusion-reaction process on the chemistry of zircon in the D1A sample is further investigated using a comparison with the D3 sample, and with samples from other syntectonic intrusions (i.e., Chevrillon, Saussure, and Muscocho) and synvolcanic plutons (Anville) of the Chibougamau area and compiled from recent studies [1,2]. These samples are compared using a principal component analysis (PCA) method, which is a coordinate transformation method used to reduce the dimensionality of a dataset (n observations and m variables). Here, PCA is used to reduce the number of variables, highlight the main correlations, and to facilitate comparison between different intrusions (**Figure S1**). A log-natural transformation was applied to the chemical data prior performing PCA. The PCA method was applied to all the analyses for which the bulk of elements displayed by the diagrams of **Figure S1** are above detection limit, and this corresponds to n = 170 (sample D1A), n = 103 (sample D3), n = 44 (Saussure syenite), n = 44 (Chevrillon monzodiorite), n = 64 (Muscocho granodiorite), and n = 50 (Anville TTG intrusive suite) analyses.

Results show that REE are consistently distributed from the left (HREE) toward the right (LREE) side of the diagrams for the bulk of samples (**Figure S1**). The main exception is Eu in the D1A sample (**Figure S1 a**) and this is a consequence of the Eu content of zircon being impacted by both radiation-damage and interaction with Eu(III)-depleted hydrothermal fluids (see above). Other trace elements will be discussed in regards to their association with REE.

For all intrusions, the Anville TTG intrusive suite excepted, Hf is un-correlated to other elements and plot on the far left of the diagrams. Hafnium was likely incorporated by simple substitution with Zr, which may explain its lack of correlation with other elements. Also, Hf is generally the most abundant trace element in zircon (webmineral.com). The studied zircon grains are no exception and contain 1-5 wt% Hf (sample D1A), 0.4-0.8 wt% Hf (sample D3), and 0.6-1 wt% Hf (other samples). Scandium, which is only available for samples D1A and D3, is also uncorrelated to other trace elements, and may be incorporated by specific substitution mechanism that may involve P (xenotime substitution). The role of P is unclear, as P is generally uncorrelated or is associated to Ca, because the distribution of this element is controlled by both the xenotime substitution and the abundance of apatite micro-inclusions. Only for the D1A sample is P correlated to other elements (Fe, Ta), indicating that its distribution has likely been modified by the diffusion-reaction process (**Figure S1**).

For most samples, U, Pb, Y, and Th are associated to mid-REE (Chevrillon pluton) and to HREE (other intrusions). This is also observed for the D1A sample, even if alteration redistributed these elements and induced a less pronounced correlation between U, Pb, Th, Y, and HREE. Regarding Sr, it is correlated to mid-REE in the most altered samples (i.e., D1A sample and sample from the Saussure syenite), for which zircon grains contain >20 ppm Sr and La (**Figure S1a, c**). For other samples, Sr, as well as Fe, is correlated to LREE. This suggests that La, Sr, and possibly Fe, are introduced together in grains for which alteration is limited, and that incorporation mechanism for these elements is different for more extensively altered zircons. The distribution of Nb, Ta, and Ti is complex and varies from a sample to the next, as these elements are likely controlled by the xenotime substitution [3] and by inclusions of a Ti-mineral (rutile?) heterogeneously distributed in the studied grains.

In summary, the distribution of trace elements is complex in the studied zircons, and the PCA method can be used to facilitate the identification of zircon grains strongly impacted by the diffusion-reaction process. Indeed, the main difference between sample D1A and other samples is the correlation between REE and U, Pb, Y, and Th. The Eu content of zircon is also a characteristic feature.

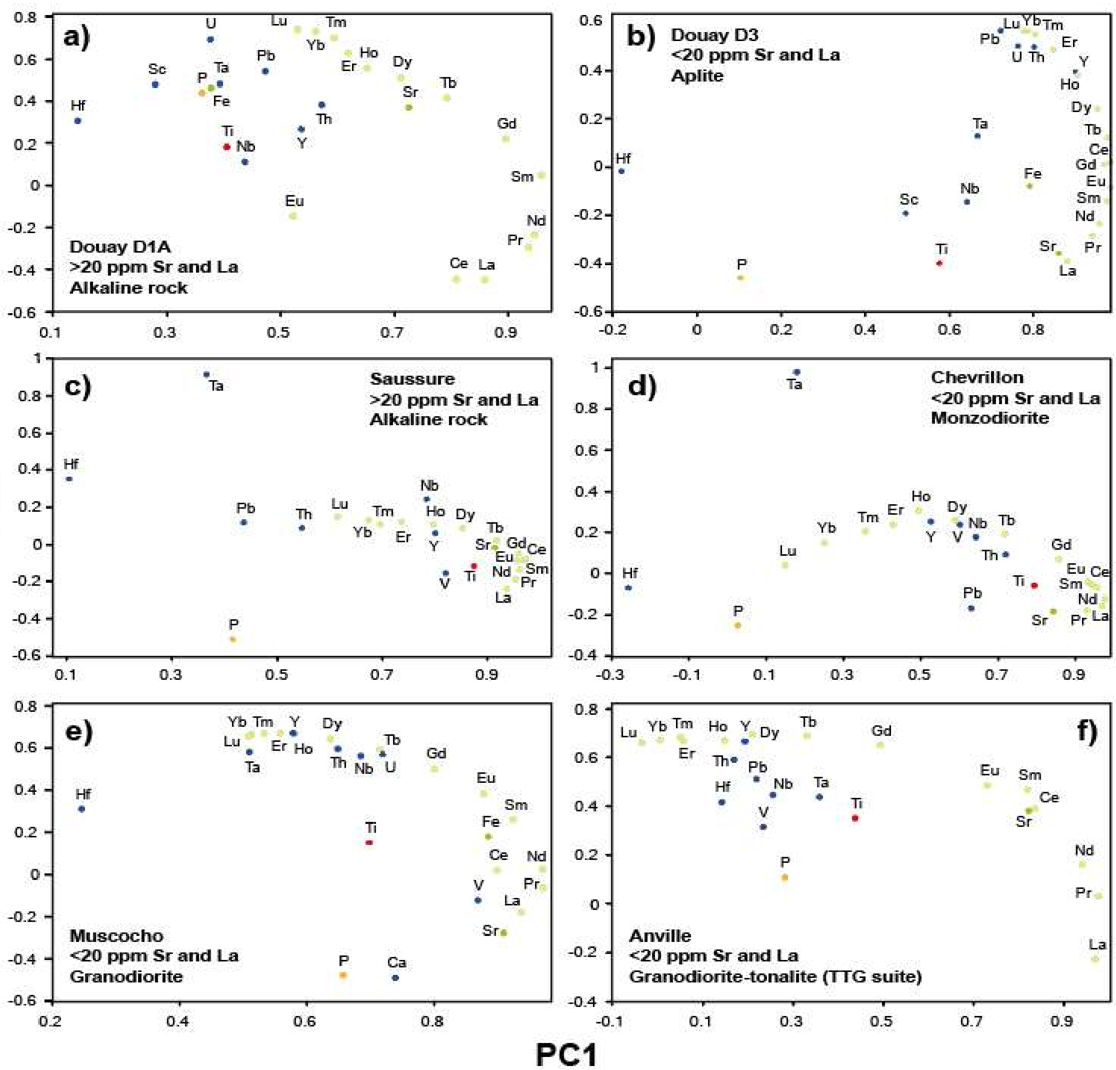

Figure S1. Results of principal component analyses (PCA) performed on new and compiled zircon analyses from the Douay intrusion, i.e., samples D1A (**a**) and D3 (**b**), and from the Saussure (**c**), Chevrillon (**d**), Muscocho (**e**), and Anville (**f**) plutons. A color code is used to help the reader locate REE (yellow), Ti (red), P (orange), and some non-stochiometric elements (Fe, Sr; shown in green).

References

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