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Comment on "Geochemistry, Rb-Sr whole rock age and Sr-Nd isotopic constraints on the Variscan A-type granite from Azegour area in the Marrakech High Atlas (Moroccan Meseta) and their geodynamic implications" by Hadani et al. (2024): Geologos 30, 1 (2024): 1–16

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In the article "Geochemistry, Rb-Sr whole rock age and Sr-Nd isotopic constraints on the Variscan A-type granite from Azegour area in the Marrakech High Atlas (Moroccan Meseta) and their geodynamic implications", Hadani et al. (2024) have attempted to classify the source of magma and magmatic processes using geochemistry and isotope data to understand the evolution of the Azegour granite better. In general, the authors deserve to be congratulated for the quality of their contribution in adding to our understanding of the Azegour granite wihtin its geodynamic context. However, some interpretations remain controversial.

Despite the strongly fractionated character of the Azegour granite, its multi-element patterns exhibit significant similarities to those of I-type granitoids. This observation has led to the hypothesis that parental melts of I-type granitoids were derived from the partial melting of mafic sources. The representative samples have initial $\varepsilon Nd_{(i)}$ values ranging between –0.94 and –4.85 and initial $\varepsilon Sr_{(i)}$ values ranging between –1.45 and 9.32, taking into account the emplacement age of the Azegour granite as 270 Ma. These data suggest that the Azegour granite may have been derived from partial melting of a mafic/intermediate magma source in the lower crust due to underplating of Ocean Island Basalt-like melts derived from asthenospheric mantle sources. Alternatively, these isotopic signatures can be attributed to contamination and/or mixing of mantle-derived basaltic melts with lower crust-derived mafic/intermediate melts.

Based on geochemical and isotope data, the authors have classified the Azegour granite as an I-type granite. Furthermore, they have suggested that the primary magma of the granite was derived from deep melting of mafic to intermediate rocks. This hypothesis is supported by the scarcity of mafic to intermediate rocks associated with the granite. However, in a recent study on the Western High Atlas, Loudaoued et al. (2023) have shown that volcanic rocks within the Cambrian series are represented by two different types of rock groups: (1) Cambrian basic rocks with tholeiitic affinity,

and (2) Permian basic, intermediate and felsic rocks with calc-alkaline affinity. Those authors have also revealed the presence of subvolcanic felsic rocks (granophyres) with geochemical similarities to the Azegour granites. The simultaneous emplacement of these two igneous masses, together with the presence of thermal and hydrothermal metamorphism in the Cambrian volcano-sedimentary series, have led those authors to hypothesise the existence of a large pluton similar to the Azegour granite. Moreover, they have suggested that granophyric intrusions as exposed in the Tnirt area (about 5 km south of Azegour) could be a hypabyssal equivalent of this insufficiently eroded pluton. Similarly, the existence of such a hypothetical pluton in the High Atlas has been suggested previously by numerous authors (e.g., Boukerrou et al., 2018; Taib et al., 2020; Jinari et al., 2023). The geochemical variations of igneous rocks in Harker diagrams (Fig. 1) are consistent with differentiation by fractional crystallisation. To evaluate the role of crustal contamination and/or assimilation in the petrogenesis of felsic magmas, we have plotted our data on a Th *vs* Fe diagram (Fig. 2). In this diagram, it is seen that the samples lie on a curve corresponding to an evolution that is compatible with fractional crystallisation (FC)

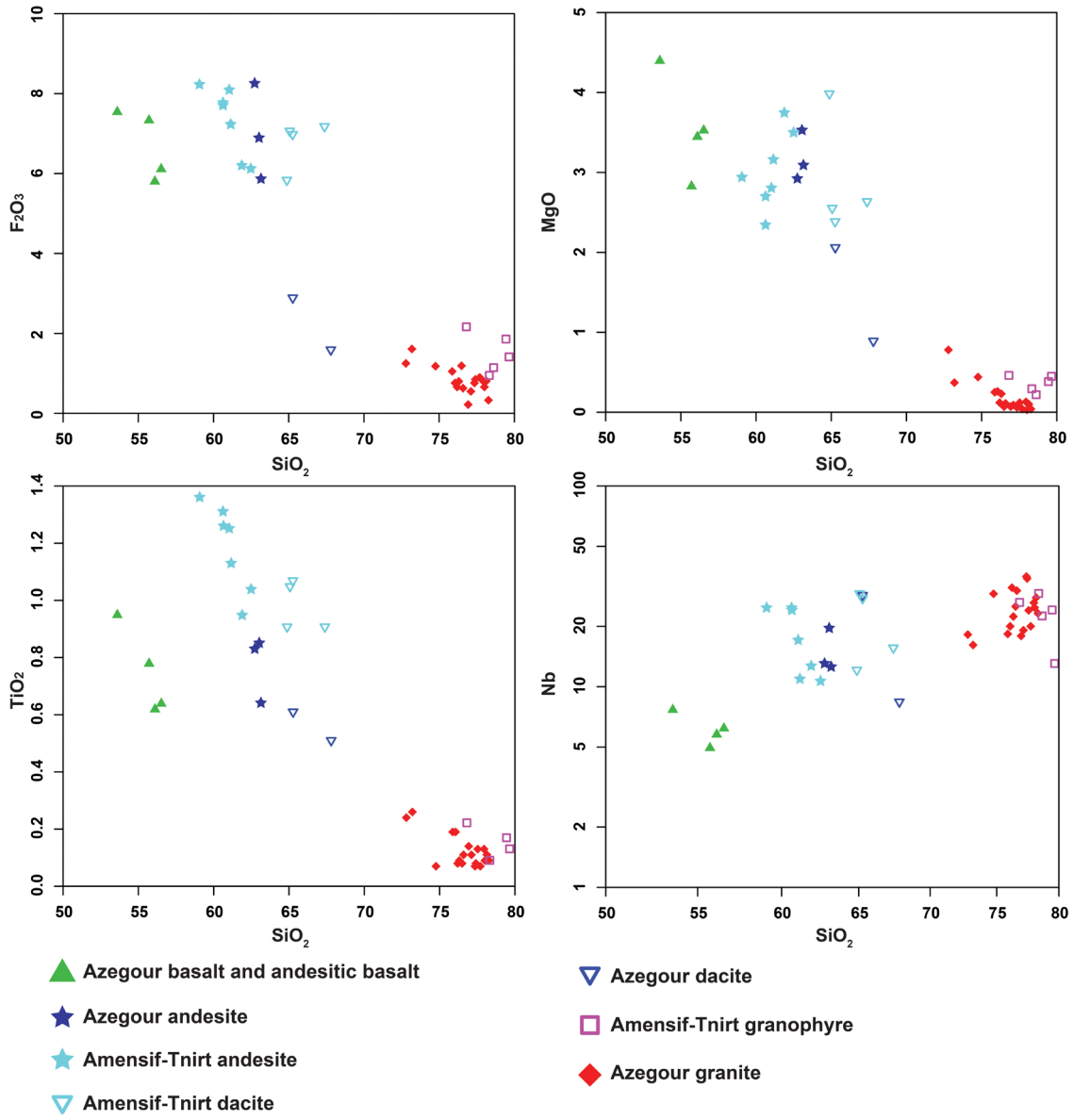

Fig. 1. Harker diagrams of calc-alkaline magmatic rocks in the Azegour, Amensif and Tnirt regions. Geochemical data are those from Ouazzani et al. (1998, 2001), Pouclet et al. (2008), El Khalile et al. (2023), Loudaoued et al. (2023) and Hadani et al. (2024).

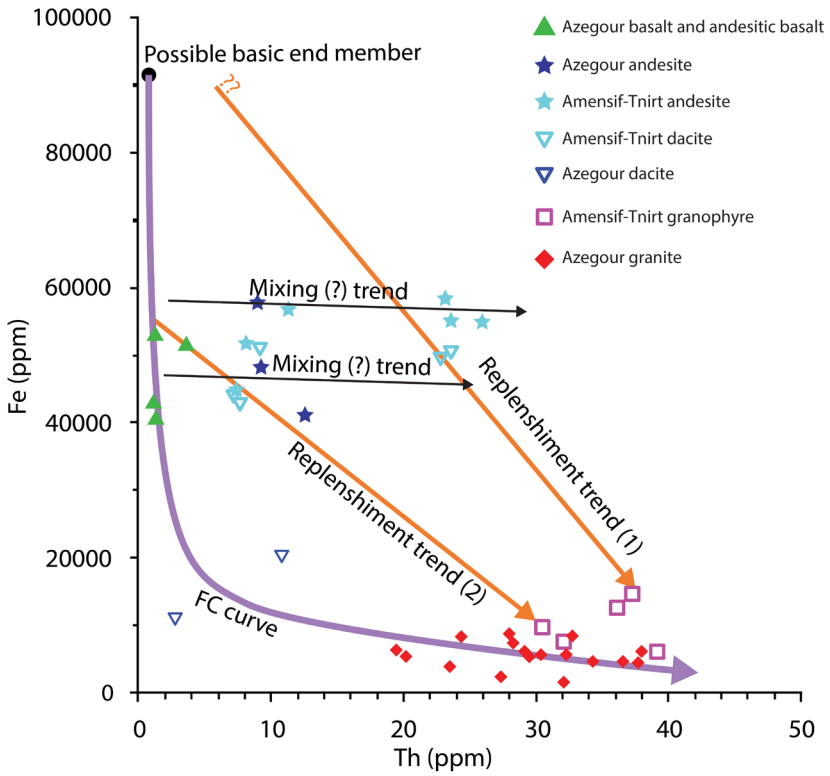

Fig. 2. Th vs Fe diagram, displaying the possible fractional crystallisation (FC) and magma replenishment trends among each of the Amensif-Tnirt magmatic units (Loudaoued et al., 2023).

from Azegour basic/intermediate rocks, although there is a gap between the series. In addition, the diagram shows that andesitic and dacidic rocks in the Azegour and Amensif-Tnirt regions plot in different fields. This probably results from magma replenishment from different basic-end members and/or mixing between different magmas. These linear trends may account for the dispersion of samples in the binary diagrams and support the mixing of felsic crust-derived magmas with mafic magmas. Indeed, the contribution of crustal melts to the petrogenesis of intermediate and felsic rocks in the High Atlas has been proved by Loudaoued et al. (2023), especially by the presence of zircon xenocrysts and/or inherited zircons in these rocks. Thus, we may conclude that the Azegour granites have a petrogenetic origin involving fractional crystallisation, crustal contamination and/or assimilation processes, similar to andesitic magmas and associated rocks formed in magma chambers in the continental crust. The Azegour granite probably represents an outcrop of a major uneroded plutonic intrusion related to widespread volcanic and subvolcanic intrusions in the High Atlas.

Hadani et al. (2007) obtained an ^{40}Ar-^{39}Ar age of 275 Ma from the Medinat granite in the Marrakesh High Atlas and compared it with the Azegour granite. However, according to Ettachfini et al. (2018) and Berrada et al. (2022), the zircon 207Pb/206Pb age of this intrusion is 514 ± 3 Ma and it is classified as a Lower Cambrian quartz diorite. This ^{40}Ar-^{39}Ar age probably corresponds to a thermal/metamorphic event related to Hercynian orogeny.

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