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Comment & Reply — Tectonics, Tectonophysics

Comment on *The Cu–Pb–Zn-bearing veins of the Bou Skour deposits (Eastern Anti-Atlas, Morocco): structural control and tectonic evolution* by Aabi A., et al.

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Abstract. This note is a comment to the article "The Cu–Pb–Zn-bearing veins of the Bou Skour deposit (Eastern Anti-Atlas, Morocco): structural control and tectonic evolution" by Aabi et al., published online on May 04, 2021, in Comptes Rendus Geoscience in Volume 353, 2021, pages 81–99 (https://doi.org/10.5802/crgeos.54). The authors' response to this comment has also been published in Comptes Rendus Géoscience in Volume 354, 2022, pages 125–130 (https://doi.org/10.5802/crgeos.117).

Keywords. structural model, Copper bearing mineralization, Bouskour, Anti Atlas, Morocco.

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1. Introduction

The newly published article in *C. R. Geoscience* by Aabi et al. [2021] appears very interesting and serves the useful purpose of highlighting and clarifying the tectonic framework of the Bou Skour ore deposit and its relation with deformation phases. The authors focus on tectonic analysis of structures and veins to discuss the fracturing–mineralization relationships (Figure 1). They mapped at least three main faults system NNW–SSE to WNW–ESE, N–S to NNE–SSE, and NE–SW to ENE–WSW. They lay emphasis on the main tectonic events which controlled and postdated the ore structures and assign them to episodes spanning from the last stage of the Pan-African orogeny to the Variscan or Atlasic shortening. This poly-phased tectonism has been previously inferred from varied studies [Clavel and Tixeront, 1971, Startsyne et al., 1975, Harfi, 1984, Walsh et al., 2008, 2012, El Azmi et al., 2014, El Ouardi et al., 2015, 2016, Bouabdellah et al., 2016]. According to the authors, the main mineralized veins in the Bou Skour deposit line up within the NNW to NW faults.

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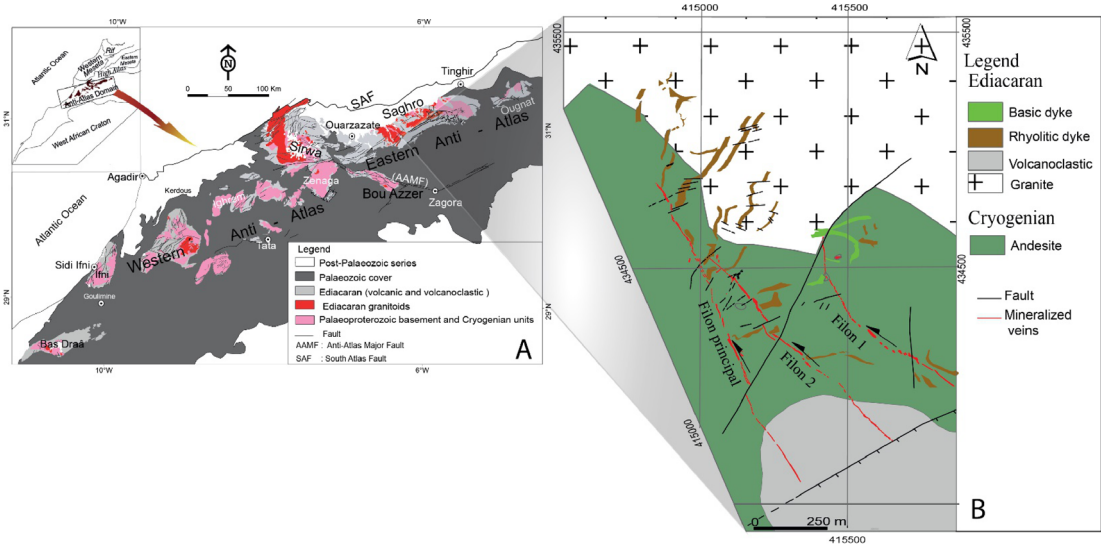

Figure 1. (A) Simplified geologic map of the Anti-Atlas, modified from Karaoui et al. [2015], and (B) detailed geological map of the "Patte d'Oie" copper deposit (extracted from Bou Skour 1/50,000-scale geological map).

Aabi et al. [2021] propose left-lateral strike-slip tectonics as a new model for the Bou Skour deposit and also a post-mineralization deformation event. However, the main result of El Ouardi et al. [2015, 2016] has been omitted or appears to have been misunderstood. Moreover, the proposed age for the mineralization in El Ouardi et al. [2016] was gained from data available in literature at that time. Here, we would like to only discuss the tectonic model for the Bou Skour vein system by Aabi et al. [2021] and the regional integration of the shear deformations occurring along the NNW–SSE trending mineralized veins [El Ouardi et al., 2016].

2. Structural model for the Bou Skour deposit

Structural analysis undertaken by El Ouardi et al. [2015, 2016] and petrographic–geochemical and metallogenic studies carried out by El Azmi et al. [2014], Bouabdellah et al. [2016], respectively, have been focused essentially on the southern sector "Patte d'oie" which seems to host the most important Cu–Pb–Zn stocks. Thus, the Bou Skour mining district seems to be well studied both structurally (structural model of the mineralized veins) and from a cartographic, magmatic and geochemical point of view contrary to what is claimed by Aabi et al. (p. 82).

The El Ouardi et al. [2016] paper is the fruition of cartographic and structural studies carried out in the Bou Skour district since 2015 [Unpublished confidential report, El Ouardi et al., 2015]. The main aim of this study was to establish a comprehensive structural model for the Bou Skour mineralized veins. Previous geological and structural investigations considered the Bou Skour mineralization to be hosted in NNW–SSE-trending dextral shear zones [Clavel and Tixeront, 1971, Tixeront, 1971, Startsyne et al., 1975, Harfi, 1984, Fekkak et al., 2003, Gasquet et al., 2005, Walsh et al., 2008, Maacha et al., 2011, Walsh et al., 2012, El Azmi et al., 2014]. Since 2015 [El Ouardi et al., 2015, 2016], the structural model for copper-bearing mineralization in the Bou Skour district was reconsidered and it was proved that the ore bodies occur along NNW–SSE-trending left-lateral strike-slip faults which are FP "Filon Principal", F1 "Filon 1" and F2 "Filon 2" (Figures 2 and 3). This crucial result is not mentioned by Aabi et al. [2021] although they cite the structural study conducted by El Ouardi et al. [2016]. At the same time, they contest El Ouardi et al. [2016] about two subsidiary points, i.e., late reactivation and regional integration.

The fact that the main vein (Filon Principal) has been subsequently reactivated in dextral movement outside the "Patte d'Oie" area does not disturb our

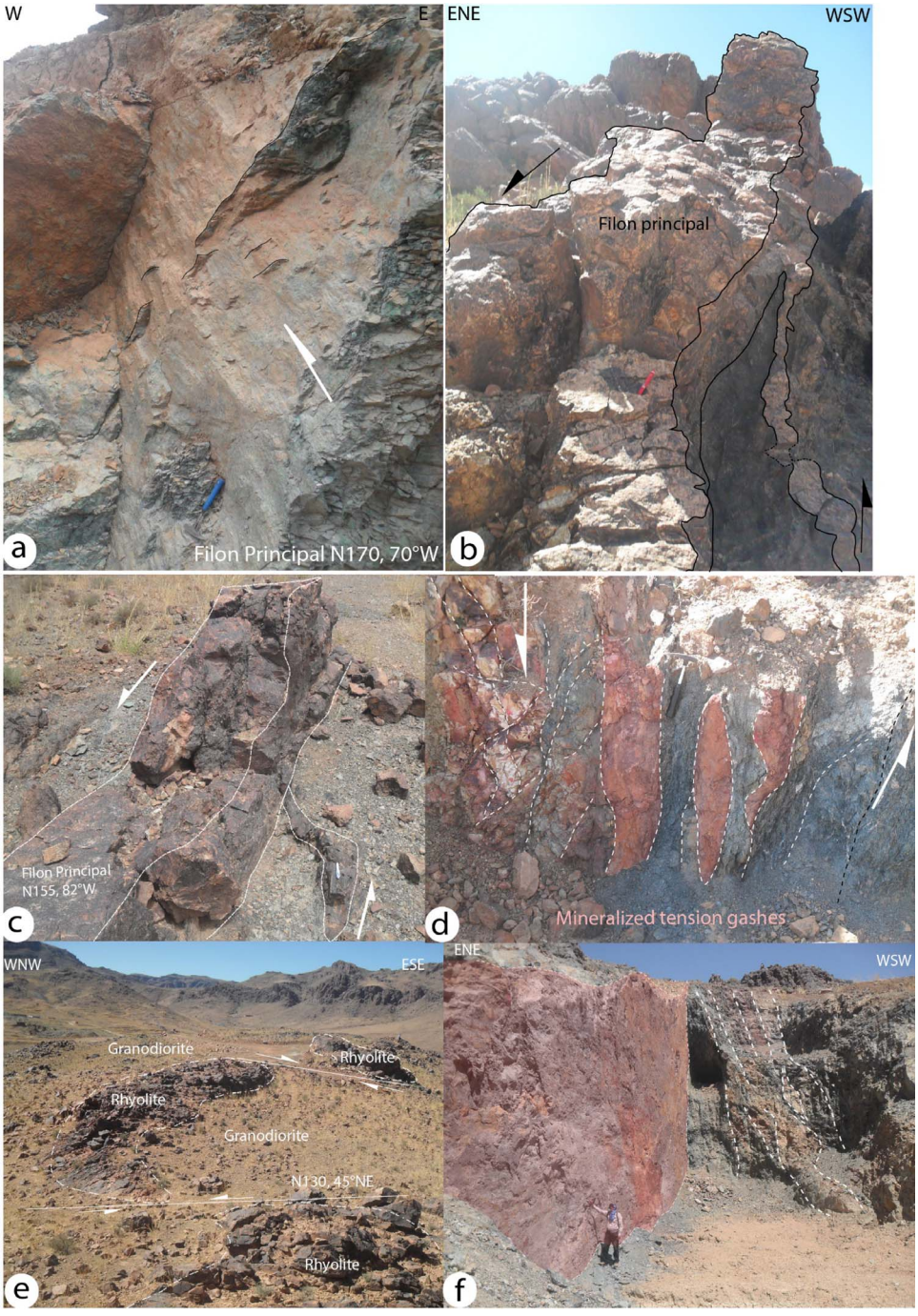

Figure 2. Some mineralized structures analysed in the "Patte d'Oie sector". (a) Sense of movement indicator (striation and slickenside), (b) mineralized vein with an andesite fragment and tension gash associated with "Filon Principal" (FP) indicating a sinistral movement, (c) sigmoidal lenticular-shaped tension gash induced by left-lateral displacement along the FP, (d) mineralized vertical tension gashes observed along the FP, (e) dextral and sinistral faults dissecting rhyolitic dyke, (f) northward view of the FP showing deformed rocks (mylonite) along the vertical mirror fault hosting the copper mineralization.

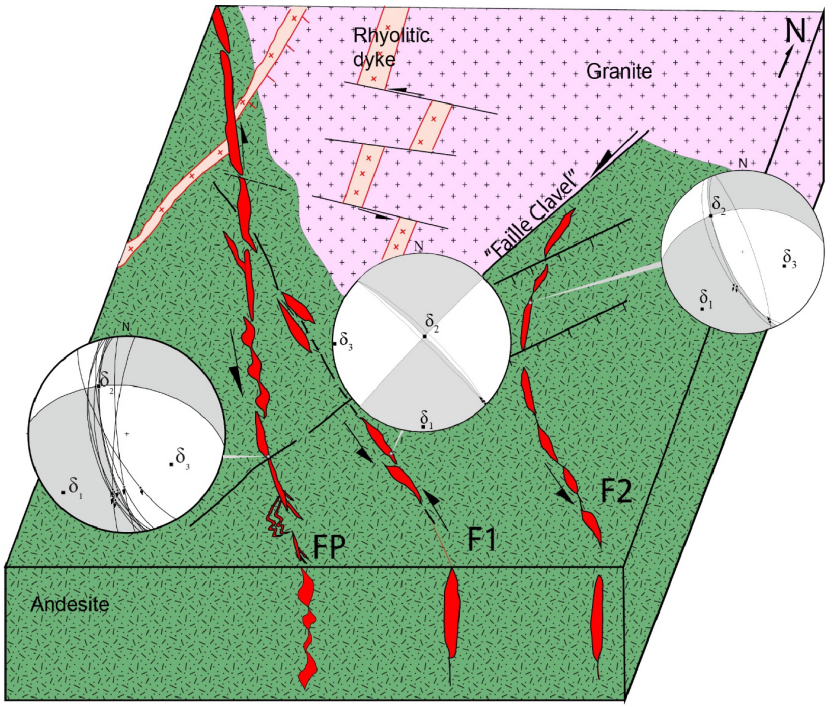

Figure 3. Schematic tectonic model explaining the copper mineralization of the "Patte d'Oie" deposit by the NNW–SSE shear faults [El Ouardi et al., 2015, 2016].

structural model proposed for the veins since it is a post-mineralization tectonic event. Such tectonic inversion is very common along strike-slip faults.

In addition, it is true that sinistral brittle–ductile tectonism along the veins was not integrated in its regional and global geodynamic framework, because no isotopic dating on mineralization was available at that time. The only possible stratigraphic unit was sub-meridian rhyolitic dykes dated at 564 ± 7 Ma [Walsh et al., 2008].

3. Age of the mineralization

Attributing the mineralization to Pan-African deformation phases [Aabi et al., 2021] based on new dating [Bouabdellah et al., 2016] and on regional research work seems very convincing to us. It should of course be pointed out that linking the age of the mineralization to Variscan or even Alpine tectonics [El Ouardi et al., 2016] was an assumption from literature but not our main concern. Dating molybdenite in the mineralized veins yields an age of 574.9 ± 2.4 [Bouabdellah et al., 2016]. It is therefore obvious that any subsequent work focused on the Bou Skour district could benefit from the copious previous data, which must be correctly acknowledged.

In conclusion, if our work in the region deserves to be cited, it is on the basis of this interpretative structural model of copper mineralization and not on the secondary ideas mentioned according to the bibliography in just a speculative manner.

Conflicts of interest

Authors have no conflict of interest to declare.

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