

Interactive comment on “Metamorphic history and geodynamic significance of the Early Cretaceous Sabzevar granulites (Sabzevar structural zone, NE Iran)” by M. Nasrabad et al.

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This paper reports interesting data from the Sabzevar range in NE Iran and focuses on the metamorphic evolution of migmatitic granulites included in an ophiolitic mélangé. This manuscript is a follow-up or companion study of a paper by Rosetti et al. (2009) published in *Terra Nova*. The new result presented here are indications for an anti-clockwise P-T path of the granulites. This contribution has an interesting potential and is of importance for an international audience. However, the presentation of data and ideas needs to be improved.

Major points of concern are:

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(1) The paper suffers from inadequate sample documentation. Judging from information given in the chapter “Granulite texture and petrography” four samples were selected for petrological studies which represent well-preserved granulites and severely overprinted samples, respectively. However, no information is given about the samples selected for geochemistry. A table that lists mineral assemblages and major characteristics (including degree of overprinting) for all individual samples would be very helpful.

(2) Thermobarometric results for each sample should be summarized in a table to make the presentation more reader-friendly. It is not really clear from the text whether or not Zr-in-rutile thermometry was applied to all samples, how many data points were collected etc, whether or not all thermobarometric methods mentioned in the text were applied to all samples.

(3) In the Geological background chapter it is claimed that “the age of rock units and the timing of metamorphism have been constrained by K-Ar and Rb-Sr geochronology, . . . This needs to be re-phrased and placed into a correct context. The K-Ar and Rb-Sr data has neither relevance for the protolith ages of the ophiolite succession nor the timing of HP granulite and/or the blueschist episodes. As stated elsewhere, the age of the granulite metamorphism has been dated by means of U-Pb zircon and titanite dating.

It is also claimed (page 4, line 14) that the Sabzevar ophiolites have a late Cretaceous formation age. However, no reference supporting this statement is given. This interpretation is based on which geochronological methods, data, field observations?

(4) It is concluded that the granulites are derived from MORB-type mafic protoliths, and this conclusion is used as a key argument to support the model of a nascent subduction zone formed at the expense of young oceanic lithosphere. Judging from information in the text (page 3, line 22), the geochemical signature of other ophiolitic rocks also indicate a MORB-like signature. Because of the importance of this argument, a more comprehensive discussion should include a comparison of the granulite data with the

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MORB-evidence of the other mélangé rocks. Such information can easily be added by outlining distinct fields in the diagrams used.

(5) In the chapter “A possible geodynamic scenario” reference is made to Early Cretaceous subduction zone metamorphism in the Sistan area, and the Proto-Sabzevar ocean is tentatively linked to the Sistan ocean and its metamorphic history. It is correct that previously published Ar–Ar data for HP rocks from the Sistan Suture Zone indicated apparent ages of ca. 125 Ma. However, caution is warranted in assigning geological significance to this data: Most of the apparent ages reported in the study of Fotoohi Rad et al. (2009) have a very low precision, but even more problematic is a potential contamination with excess Ar, a problem that has been described from many HP occurrences the world-over. New Rb–Sr results (internal mineral isochrons comprising several grain size fractions of white mica, \pm epidote, omphacite, glaucophane) for 5 samples collected at widely separated locations in the Sistan area indicate a regional consistent age pattern (86.1 ± 1.0 Ma, 86.6 ± 0.6 Ma, 84.3 ± 4.7 Ma, 84.7 ± 0.7 Ma, 85.7 ± 0.7 Ma) with considerably younger ages than indicated by Ar–Ar geochronology (Bröcker, M., Fotoohi Rad, G. & Theunissen, S., 2010. New time constraints for HP metamorphism and exhumation of mélangé rocks from the Sistan Suture Zone, eastern Iran. The abstract is available at the following website: <http://www.geosociety.org/meetings/2010turkey/>). This observation is consistent with assuming variable amounts of extraneous argon in the white mica, and suggests that the Ar–Ar data do not provide reliable ages. The Rb–Sr ages are in accordance with field and biostratigraphic observations and document subduction of the Sistan ocean in Late Cretaceous time. Thus, any regional correlations based on the assumption of Early Cretaceous subduction of the Sistan ocean need to be critically re-evaluated.

(6) In Fig. 12, four ellipses are shown for the M2b and M2a stages. Why? Does this refer to results of 4 different samples? This is not clear from the figure caption. It is also not clear, how these ellipses have been deduced from those shown in Fig. 10

(7) The description of the Analytical methods used for whole rock geochemistry can be

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improved by giving information about sample size and the grinding tools used (tungsten carbide or agate mill?)

(8) The paper suffers from many technical short-comings, typos etc, which need to be corrected.

(9) References should be presented in a consistent citation style.

Figures: Fig. 1: In Fig. 1b a rectangle labelled (c) is shown, which refers to a close-up geological map that is not presented in this paper.

Fig. 2: In (a) is a typo: Pliocene = Pliocene. Dashed lines in (b) and (c) are too thin and/or need a better visible colour.

Fig. 3: Most labels are difficult to read, especially some of the white labels used in (H) In the corresponding figure caption, page 34 line 6: Quartz-plagioclase. ...; line 7: Prehnite-calcite. ...; line 8: Plagioclase.

Fig. 4 caption, line 2: Back-scattered electron images.

Fig. 5 Why has a different symbol been used for sample SZ290?

Fig. 6 (a): correct: McDonough = McDonough; in the caption, line 3: ...spider diagram...

Fig. 7: Individual figures are not labelled a, b, c. In (b) correct: calc = calc; in (a) one of the fields (which includes some of the black dots) is not labelled.

Fig. 8: several typos; in (a) hedenbregite = hedenbergite; in (d) ferrochermakite = ferro-tschermakite

Fig. 9 caption, page 40, line 4: ..granulites. line 6: resorption

Fig. 12: Four ellipses are shown for the M2b and M2a stages. Why? Does this refer to results of 4 different samples?

Tables: Table 1: I suggest to restrict the data presentation to elements which are of

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relevance for general petrogenetic considerations. In the context of this paper, many of the elements listed in this table are simply superfluous, e.g. Be, Mo, Ag, In, Sn, Sb, Bi

Table 2 a, b, c: Endmember compositions should be calculated and included Correct headers: ... of clinopyroxene; ...of plagioclase, ...of amphibole

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