[PS]New Ductile Microscopic Shear-Sense Indicators (Oman Mountains)*

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Abstract

Two shear-sense indicators were discovered in different tectonic settings of the Oman Mts. The first one occurs in mylonitized Upper Bajocian -Bathonian limestone at the northern margin of the Jabal Akhdar Dome (JAD). It is associated with top-to-the-NNE extension and agrees with ongoing research showing that the northern flank of the JAD was affected by major late Alpine extensional strain. The second indicator was found in mylonitized Cenomanian plagiogranite (trondhjemite) with vertical to subvertical foliation and strike-slip deformation within harzburgite of the Semail Ophiolite in Wadi Fizh. All plagiogranites of the Wadi Fizh display the same kinematics, but the regional significance is not yet clear. For both regions, these kinematic data are new. The new indicators can be used as general/universal tools in structural geology. i) The carbonate mylonite displays thin parallel shear laminations with a compositional aspect, as there are alternations between pure calcite laminae and dark laminae of accumulated limestone impurities. Despite the fact that the mylonite is associated with extension, the shear sense criterion is linked to top-to-the-NNE microthrusts, involving shortening of the dark laminae (Scharf et al., 2017, this session). The thrusts form an acute angle in relation to the lamination. Thrusting between segments of these microthrusts created pull-aparts whose voids were eventually filled with drusy calcite. The shear sense is revealed by (1) shortening and related imbrication of the thrust laminae, (2) pull-apart structures and (3) drag folds at either end of the microthrusts. The shear is independently confirmed by ductile and brittle macroscopic shear sense criteria in the same outcrop, e.g., drag folds, Riedels and mineral steps. The new shear fabric measures ~0.5mm in width and 1mm in length. ii) The mylonitized granite contains 2mm long plagioclase porphyroclasts. A rotated plagioclase crystal displays twin lamellae, dragged by rotation during HT conditions during late Cretaceous cooling (Alpine I). Drag folds occur on either end of the lamellae/crystal. As a result, an “S” shape is produced by counterclockwise rotation and sinistral shear, respectively. The observed shear sense is confirmed by synthetically sheared K-feldspar porphyroclasts. “Z” shapes are expected to develop in case of opposite rotation and shearing.

Reference Cited

Béchennec F., J. Le Métour, J.P. Platel, and J. Roger, 1993, Geological Map of the Sultanate of Oman (GIS version), 1:250000: Ministry of Petroleum and Minerals, Directorate General of Minerals.

NEW DUCTILE MICROSCOPIC SHEAR-SENSE INDICATORS (OMAN MOUNTAINS)

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Introduction

Two shear-sense indicators were discovered in different tectonic settings of the Oman Mts. The first one occurs in mylonitized Upper Bajocian-Bathonian limestone at the northern margin of the Jabal Akhdar Dome (JAD). It is associated with top-to-the-NNE extension and agrees with ongoing research showing that the northern flank of the JAD was affected by major late Alpine extensional strain. The second indicator was found in mylonitized Cenomanian plagiogranite (trondhjemite) with vertical to subvertical foliation and strike-slip deformation within harzburgite of the Semail Ophiolite in Wadi Fizh.

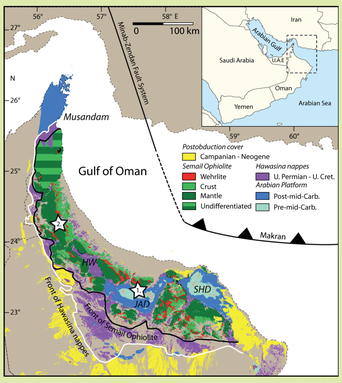

Fig 1. Tectonic overview map of the northeastern Arabian Peninsula. HW – Hawasina Window; JAD – Jabal Akhdar Dome; SHD – Saih Hatat Dome. Base map modified after the digital Geological Map of Oman, 1:250.000, Ministry of Petroleum and Minerals (Béchennec et al., 1993. Ooid samples are listed in Table 1.). Inset shows the greater study realm. Stars indicating the sample sites.

Sample site 1

Wadi Bani Kharus, northern Jabal Akhdar Dome
Lithology: Mid-Jurassic Limestone, Dhruma Fm., associated with top-to-the-NNE extension.

The carbonate mylonite displays shear planes, in thin, flat and parallel laminations with a compositional aspect as there are alternations between pure calcite laminae and dark laminae of accumulated limestone impurities (iron compounds, clay). Despite the fact that the carbonate mylonite is associated with extension, the shear sense criterion is linked to top-to-the-NNE microthrusts, involving shortening of the dark laminae (see Scharf et al., 2017, this session). The thrusts form an acute angle in relation to the lamination. Thrusting between segments of these microthrusts created pull-aparts whose voids remained temporarily open cavities but were eventually filled with drusy calcite cement.

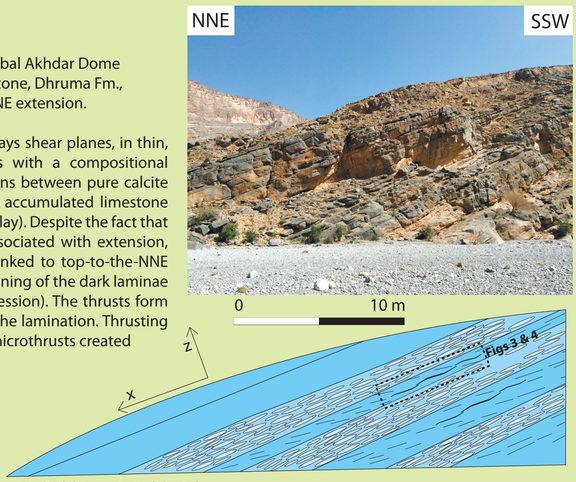

Fig. 2. a) Outcrop in Wadi Bani Kharous
b) Schematic sample site. Layering of mylonitic limestone (dark blue) with ooid-bearing beds (light blue). Ooids are deformed (see poster of Mattern et al. this session).

Shear-sense indicator I

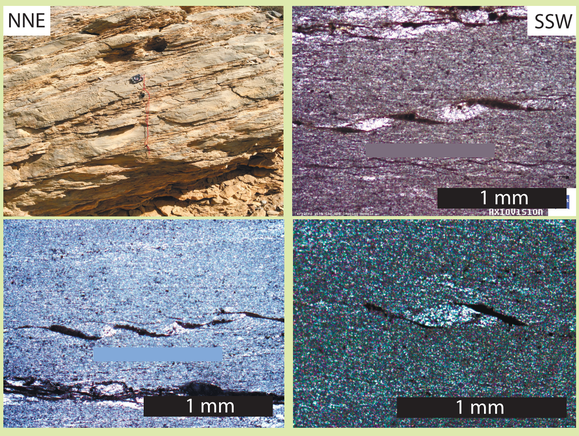

Fig. 3. a) Carbonate mylonite
b-d) Photomicrographs of the new shear-sense indicator. Width of the indicators is 1mm or less.

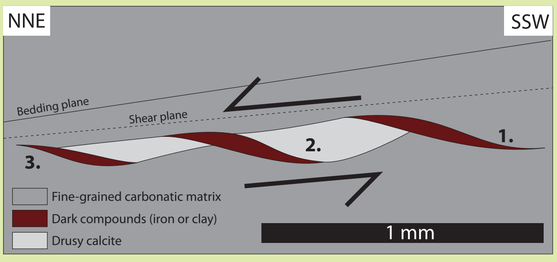

Fig. 4. Schematic sketch of the new shear-sense indicator.

Top-to-the left motion
because
1. shortening and related imbrication of the thrust laminae
2. formation of pull-apart structures, filled with drusy calcite
3. of drag folds at either end of the thrust laminae
4. independent ductile and brittle macroscopic shear-sense criteria in the same outcrop, such as drag folds, Riedel shears and mineral steps confirm the shear sense.

Shear-sense indicator II

Sample site 2

Wadi Fizh, northern Oman Mountains
Lithology: Upper Cretaceous plagiogranite (trondhjemite), associated with vertical to subvertical foliation and strike-slip deformation within harzburgite of the Semail Ophiolite

The mylonitized granite contains large (2mm long axis) plagioclase porphyroclasts. We encountered a rotated plagioclase crystal whose twin lamellae have been dragged by the rotational motion during high-temperature conditions during late Cretaceous cooling (Alpine I). Drag folds occur on either end of the lamellae/crystal. As a result an "S" shape is produced by counterclockwise rotation and sinistral shear, respectively. The observed shear sense is independently confirmed by synthetically sheared K-feldspar and feldspar porphyroclast systems. "Z" shapes are expected to develop in case of opposite rotation and shearing.

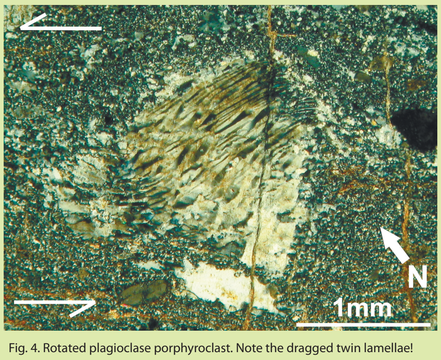

Fig. 4. Rotated plagioclase porphyroclast. Note the dragged twin lamellae!

Conclusions

The two new ductile microscopic shear-sense indicators are a fundamental contribution as a geological tool to understand the kinematics of shear zones at various scales.

Significant NNE-extensional strain affected the northern flank of the Jabal Akhdar Dome during Alpine II.

All plagiogranites of the Wadi Fizh display the same kinematics, but the regional significance is not yet clear.

References

Béchennec F, Le Métour J, Platel JP, Roger J (1993) Geological Map of the Sultanate of Oman (GIS version), 1:250000. Ministry of Petroleum and Minerals, Directorate General of Minerals.

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