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A textbook example of triply-folded Ediacaran carbonates – insights into geodynamics and geomorphology (Hat Plateau, Jabal Akhdar Dome, Oman Mountains)

Andreas Scharf¹, Ivan Callegari², Frank Mattern¹, Katharina Scharf², and Eugenio Carminati³

¹Sultan Qaboos University, College of Science, Department of Earth Sciences, Muscat, Oman (scharfa@squ.edu.om)

²Department of Applied Geosciences, German University of Technology GUTech, P.O. Box: 1816, PC 130, Halban, Sultanate of Oman

³Dipartimento di Scienza della Terra, Sapienza Università di Roma, Rome, Italy

The Jabal Akhdar Dome (JAD) of the Oman Mountains contains superbly exposed sedimentary Neoproterozoic formations in its core. Carbonates of the Hajir Formation are resistant against erosion in the prevailing semi-arid conditions unlike the subjacent and overlying siliciclastic formations. Structural fieldwork and satellite image analyses reveals that the central-western JAD (Hat Plateau) was affected by three folding events. Each event produced its own fascinating fold style with associated structures. The widely exposed Hajir carbonates displays these folds spectacularly. The geomorphology of these carbonates reflects the folds with differently oriented ridges and troughs as anti- and synclines, respectively. Thus, the JAD acted as a natural laboratory where the 3D fold styles can be directly linked to the geomorphology and vice versa.

A previously unrecognized folding event (F1) produced overturned NNE-verging tight folds. The fold amplitude ranges between tens and hundreds of meters, and the overall non-plunging fold axes trend ESE. The F1 folds are associated with a gently to moderately SSW-ward dipping penetrative axial plane cleavage. Open to tight upright kilometric F2 folds refolded the F1 structures. The F2 folds are overall non-plunging and NE/NNE-trending, and contain a penetrative sub-vertical axial plane schistosity, parallelly oriented to the F2 axes. The youngest folding event (F3) produces one open and broad anticline. The F3 fold axis trends WNW through the Hat Plateau and the anticline contains a WNW-striking sub-vertical spaced axial plane schistosity.

The deformation style of the F2 folds and related structures changes abruptly along a NNE-oriented zone at the western end of the Hat Plateau. West of this, the F2 structures are ENE-oriented while east of it the orientation is NE to NNE. Furthermore, the amplitude of the F2 folds decreases from ~3 km in the west to <1 km in the east. We relate this sudden change of the F2 style to the western flank of a pre-existing subsurface basement horst. We suggest that this NNE-striking horst is the northern continuation of the Makarem-Mabrouk High/Horst below the JAD. The eastern horst shoulder would be at the eastern margin of the JAD and parallel to the Semail Gap. A buttressing effect along the western horst's shoulder during NW/SE to WNW/ESE-directed F2 shortening would explain the dramatic change in the F2 style.

In summary and in 3D terms, the F1 folds were originally oriented parallel to the present F1 anticline, i.e. before the F2 deformation, while the F2 folds strike almost perpendicularly to this direction. The F1 and F2 folding episodes associated with the abrupt change in F2 style are depicted in a steric block diagram, which visualizes the complex findings, allowing for a 3D understanding of the structures.