Pergamon

Journal of Structural Geology, Vol. 19, No. 9, pp. 1253 to 1254, 1997

0191-8141/97 $17.00 + 0.00

PII: S0191-8141(97)00049-7

The Neogene structural evolution of the western margin of the Pelagian Platform, central Tunisia: reply

JOHN ANDERSON

Ranger Oil Limited, Ranger House, Walnut Tree Close, Guildford, Surrey GU1 4US, U.K.

(*Received* 21 *May* 1997; *accepted in revised form* 27 *May* 1997)

INTRODUCTION

Ouali and Mercier raise several points of discussion regarding the structural evolution of the North–South Axis in central Tunisia. Although Ouali and Mercier largely concur with the thin-skinned thrusting model presented in my 1996 paper, it is clear that our interpretations diverge on two key issues. These are:

(1) the role of salt diapirism in generating the structural geometries observed in the field; and
(2) the existence of passive roof backthrusting.

SALT DIAPIRISM

Assessing the contribution of halokinesis in generating the structural geometries at Djebel Cherichira is not a simple task. Although evaporites and associated sediments outcrop, there is no clear cut evidence for salt diapirism. Ouali and Mercier's fig. 2 does not include any stratigraphic evidence for mobile salt: e.g. rim synclines or turtle backs in the Upper Cretaceous and Tertiary section. I agree with their observation that the Triassic rocks "... are truncated and overthrust by Cretaceous and Tertiary thrust sheets", a geometry which is wholly consistent with complex out-of-sequence thrusting, but which is incompatible with halokinesis and the formation of so-called 'salt glaciers'. It is an observation made by myself (Anderson, 1991, Anderson, 1996) and by other authors (e.g. Boccaletti *et al.*, 1988, 1990) that southeast of the Mejerda Valley the Triassic sediments outcrop mainly along the thrust front where they occur as tectonic sheets of evaporites, shales, dolomites and sandstones, interleaved with younger sediments as the result of a complex sequence of thrusting. These are thrust slices of Triassic sediments which lack halite. I referred to the overlying thrust sheets as out-of-sequence thrusts because they place younger Cretaceous–Tertiary rocks onto Triassic (this relationship of Tertiary overthrusting the shallow dipping Triassic rocks can be observed on the northwest limb of the Cherichira anticline). Out-of-sequence thrusts are interpreted in other parts of the Atlas mountain belt. Morley (1988) interpreted the Numidian flysch thrust sheet as out-of-sequence and estimated shortening of several tens of kilometres on this structure. My own estimate for shortening on the out-of-sequence thrusts at Djebel Cherichira does not assume linkage to Djebel Ousselat and is approximately 5–10 km. I propose that out-of-sequence thrusts are as important an aspect of the Atlas Mountains structural geometry as they are in many other mountain belts (e.g. Butler, 1987; Butler and Coward, 1984).

DJEBEL OUSSELAT/BOU DABOUSS PASSIVE ROOF BACKTHRUST

The passive roof backthrust model for the Ousselat/Bou Dabouss fault fits well with the observed structural geometries outlined in my paper and complements the observation that this sector of the thrust belt is dominated by southeastward propagating blind thrusts. Ouali and Mercier have produced an alternative cross-section to my fig. 12 (Anderson, 1996) to illustrate their model. Their cross-section omits the observation that the Bou Dabouss/Ousselat anticline is predominantly a SE-verging structure, is underlain by a SE-verging blind thrust, and has folded the Ousselat/Bou Dabouss backthrust. Ouali and Mercier's assertion that the backthrust splays from the Triassic décollement, has a large component of sinistral strike-slip and post-dates the associated Bou Dabouss and Ousselat anticlines, is not consistent with the field evidence in this area as outlined below:

(1) Ouali and Mercier's observation that the Triassic outcrops "in the *footwall* of the Ousselat/Bou Dabouss fault" effectively kills their argument for a Triassic décollement. I propose instead that the Triassic was thrust over Upper Cretaceous sediments in a complex out-of-sequence system similar to that observed at Djebel Cherichira, prior to the formation of the main fold and associated passive roof backthrust.

(2) Kinematic indicators (*S–C* fabrics and slickenline lineations) in the backthrust fault rocks clearly show that

this is a dip-slip thrust (Anderson, 1996, fig. 13d), with transport to the west-northwest.

(3) Field evidence indicates that the backthrust is synchronous with the formation of the Bou Dabouss/ Ousselat anticline (Anderson, 1996, fig. 12a). The backthrust is a flat at the base of the El Haria Formation and further east in the Halfa anticline is folded in a classic passive roof geometry (compare with Banks and Warburton, 1986). Note that this geometry continues to the north to location K (Anderson, 1996, fig. 4) but that the backthrust has cut down-section to the base of the Abiod Formation suggesting that there is a lateral ramp between localities J and K. In the vicinity of locality J the Bou Dabouss anticline is a double fold forming the Zemlia and Halfa anticlines. Because the forethrusts here propagated in-sequence to the southeast, when the backthrust formed synchronously with the Halfa fold, some displacement caused the backthrust to cut into the oversteepened, subvertical forelimb of the Zemlia fold. Note that the thrust cuts down-section through the Zemlia fold forelimb so that El Haria lies on the older Abiod Formation because of this geometry, and that the Abiod in the hangingwall of the backthrust is folded into a large NW-verging tip-line fold at Djebel Zemlia.

It is my contention that these observations provide ample evidence for a passive roof geometry.

CONCLUSIONS

The Atlas Mountains in central Tunisia are a largely blind SE-verging thrust belt of Middle Miocene age. Passive roof duplexes formed as a result of the blind thrusting and partially accommodate the additional shortening required in the passive roof sequence (disharmonic folding, for example in the Aleg Formation in Djebel Bou Dabouss, may also account for some of the required roof sequence shortening). Out-of-sequence thrusting is a feature of the thrust belt in both the internal zone structures and at the thrust front. This style of deformation conceivably occurred in response to rapid lengthening of the thrust wedge in Miocene times; I estimate that the thrust front propagated approximately 100 km to the southeast, from the Tell Atlas in the Burdigalian to the North–South Axis by Langhian times. The rapid thrust front propagation was effectively balanced by out-of-sequence thrusting and folding which caused internal structural thickening and continued forward propagation of the thrust wedge.

REFERENCES

Anderson, J. E. (1991) Structural evolution and subsidence history of the western margin of the Pelagian Platform, central Tunisia. Unpublished PhD thesis, Kingston University, U.K.

Anderson, J. E. (1996) The Neogene structural evolution of the western margin of the Pelagian Platform, central Tunisia. *Journal of Structural Geology* **18**, 819–833.

Banks, C. J. and Warburton, J. (1986) 'Passive roof' duplex geometry in the frontal structures of the Kirthar and Sulaiman mountain belt, Pakistan. *Journal of Structural Geology* **8**, 229–237.

Boccaletti, M., Cello, G. and Tortorici, L. (1988) Structure and tectonic significance of the North–South Axis. *Annales Tectonicae* **2**, 12–20.

Boccaletti, M., Cello, G. and Tortorici, L. (1990) First order kinematic elements in Tunisia and the Pelagian block. *Tectonophysics* **176**, 215–228.

Butler, R. W. H. (1987) Thrust sequences. *Journal of the Geological Society, London* **144**, 619–634.

Butler, R. W. H. and Coward, M. P. (1984) Geological constraints, structural evolution and deep geology of the northwest Scottish Caledonides. *Tectonics* **3**, 347–365.

Morley, C. K. (1988) Out-of-sequence thrusts. *Tectonics* **7**, 539–561.