Part V
Zagros/Makran Thrust Belts

Part V of the volume is dedicated to the understanding of the building, structural evolution and active tectonics of the Zagros and Makran thrust belts, as well as to the history and role of early salt diapirism on the deformation of the Zagros detached cover.

Ahmadhadi et al. (Chapter 11) demonstrate that in the Central Zagros basement faults were reactivated during a Lower Miocene early stage of collisional stress build-up. This early basement fault reactivation presumably produced an early phase of large-scale flexure/forced-folding in the cover which strongly controlled intra-basin architecture and facies changes in the Lower Neogene and likely played a significant role during the early stage of fracturing within the Asmari Formation before the main Mio-Pliocene phase of cover folding.

On the basis of field work, seismic profile interpretation and well data aiming at reconstructing the history of subsidence, temperature and maturity of source-rocks in the Izeh Zone and in Northern Fars, Rudkiewicz et al. (Chapter 12) report a coupled structural, thermal and geochemical basin modelling undertaken to handle compositional generation, maturity and expulsion of hydrocarbons in these areas. Important result are that generation and expulsion behaviour of Jurassic and Albian source-rocks considerably varies within the Izeh Zone and that thickness of the Late Cretaceous–Eocene sediments and the first vertical movements at regional scale in the inner part of the belt considerably influenced the maturation expulsion, migration and entrapment of petroleum from these source-rocks.

Moutherereau et al. (Chapter 13) synthesize structural, seismotectonics and microtectonics studies, as well as results of recent mechanical modelling of the topography and stratigraphic constraints on the timing of Plio-Pleistocene folding and Zagros basin evolution, in order to examine which mechanical behaviour better explains the development of the Zagros Folded Belt at both local and regional scales. They argue that an overall thick-skinned deformation has followed the initial margin inversion during the late Neogene, probably coeval with buckling of the detached sedimentary strata. Their interpretation disagrees with the classical view of thin-skinned propagation of the Zagros Folded Belt.

Oveis et al. (Chapter 14) report a geomorphic analysis in the Mand anticline at the south-western-most front of the Zagros wedge. They show that the Mand anticline is a very active structure, which would absorb 35 to 50% of the 8 mm/yr convergence across the entire Zagros, with the Late Pleistocene shortening rate being inferred to be 3 to 4 mm/yr perpendicular to the anticline. This result is consistent with a classical forward-propagating deformation sequence during at least the Late Pleistocene.

Jahani et al. (Chapter 15) describe the morphology and the present activity of the salt diapirs of the eastern Zagros and discuss the chronology of salt movements as well as their relationships with the regional geodynamic context. They show that nearly all the diapirs were already active prior to Zagros folding either
as emergent diapirs forming islands in the Paleogene to Neogene sea or as buried domes initiated at least by the Permian. These diapirs first helped localizing subsequent deformation, then were reactivated by salt-cored detachment folding which allowed salt movement along faults in the whole eastern Fars Zagros Fold-Thrust Belt.

As a complementary approach to chapter 15, Callot et al. (Chapter 16) address the timing of salt diapirism, the influence of salt distribution and structures on fold propagation, the mechanisms of rapid salt extrusion, and the localization of salt diapirs relative to fault and folds in the Fars domain by means of analogue sandbox experiments. Their main results are that the driving mechanism of Hormuz halokinesis during the Zagros folding and erosion is the squeezing of pre-existing salt diapirs, which also influenced the location of thrusts and strike-slip faults. Depending on the diapir wall attitude and its thickness relative to the sedimentary column thickness, the diapirs are either shortened and localize sharp overturned folds, or else act as preferentially oriented ramps, part of the diapir being incorporated in the fold. During fold growth and active shortening, erosion or rejuvenation of the diapir allows upward salt extrusion.

Ellouz et al. (Chapter 17) present an update of the onshore geology of the Makran accretionary prism based on new field data in the Pakistani area combined with interpretations of remote-sensing satellite data and interpretation of reprocessed seismic lines. The results are synthesized in the form of two synthetic geological transects, with an updated stratigraphic chart based on the new dating. The results reveal strong along-dip and along-strike changes in tectonic style through time, which are related to changes in velocity rates and direction of convergence due to re-organization along plate boundaries, location and rates of sedimentation over the growing prism, involvement of oceanic ridges in the subduction zone, and/or activity of secondary décollement levels within the accretionary prism.

In their companion paper, Ellouz et al. (Chapter 18) complement onshore field investigations of Chapter 17 and report the results of the 2004 CHAMAK research cruise which surveyed most of the accretionary complex off Pakistan. Analysis of new bathymetric and seismic data as well as drill cores shows that the frontal part of the Makran accretionary prism is less two-dimensional than previously expected, and that the along-strike tectonic variations reflect lateral variations in sediment deposition as well as underthrusting of a series of basement highs and kinematic complexity in the vicinity to the Ar-Eu-India triple junction.