Consejo Superior de Investigaciones Científicas (CSIC)
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FORELAND PROPAGATION OF FOLDING AND STRUCTURE OF THE MOUNTAIN FRONT FLEXURE IN THE PUSHT-E KUH ARC (ZAGROS, IRAN)

Hadi Emami, 2008

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Memòria presentada per Hadi Emami al Departament de
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Presentation

This dissertation constitutes the work that I have done for the degree of PhD at the Department of the Geodynamic and Geophysics of the University of Barcelona (UB). It is prepared in the format recommended by university. This work conducted in the Institute of the Earth Sciences “Jaume Almera” (CSIC). It is elaborated in the framework of the a collaborative project between the Group of Dynamics of the Lithosphere at the Institute of Earth Sciences “Jaume Almera” of the CSIC in Barcelona, Spain and the StatoilHydro (former Norsk Hydro) research centre of Bergen in Norway. The study area focuses mainly in the northwest of the Zagros Fold and Thrust belt of Iran, Lurestan Province. The data set including geological maps, well data and reports have been prepared by StatoilHydro (former Hydro Zagros Oil and Gas Tehran) through the National Iranian Oil Company (NIOC). Several field campaigns have been accomplished in order to collect structural data and samples during the period of the study. The dissertation comprises five chapters, which were developed during 2003-2008. The Chapters are:

Chapter 1 General introduction to the Zagros Fold and Thrust Belt. Including a summery to geological setting, geodynamic evolution, petroleum system and objectives and methodology of this work.

Chapter 2 Fold analysis and structural interpretation of the Zangul anticline in Pusht-e Kuh, Lurestan area. In this chapter we present a 3D geometry for Zangul anticline.

Chapter 3 Structure of the Mountain Front Flexure along the Anaran anticline in the Pusht-e Kuh Arc (NW Zagros, Iran): Insights from sand box models. This chpter has been submitted as:

Emami, H.**, J. Vergés, T. Nalpas, P. Gillespie, and E. P. Blanc, in press, Structure of the Mountain Front Flexure along the Anaran anticline in the Pusht-e Kuh Arc (NW Zagros, Iran): Insights from sand box models, in P. Leturmy, and C. Robin, eds., Tectonic and Stratigraphic evolution of Zagros and Makran during the Meso-Cenozoic, **Geological Society of London Special Volume.

Chapter 4 Timing and sequence of folding in the NW Zagros, Iran constrained by Magnetostratigraphy analysis. This chapter will be submitted as:

Emami, H.**, J. Vergés, M. Garcés, S. Homke, B. B., and P. Scott, (submitted), Timing and sequence of folding in the NW Zagros in Iran: constrained by magnetostratigraphic analysis. **Earth and Planetary Science Letters.

Chapter 5 Summary of the previous chapters.

In addition to that the outhor of this study has been collaborated to the additional publications in the study area:

Homke, S., J. Vergés, M. Garcés, H. Emami, and R. Karpuz, 2004, Magnetostratigraphy of Miocene–Pliocene Zagros foreland deposits in the front of the Push-e Kush Arc (Lurestan Province, Iran): ***Earth and Planetary Science Letters****, v. 225, p. 397– 410.*

Vergés, J., R. Karpuz, J. Efstatiou, M. H. Goodarzi, H. Emami, and P. Gillespie, in press, Multiple Detachment Folding in Pusht-e Kuh Arc, Zagros. Role of Mechanical Stratigraphy, in K. McClay, J. Shaw, and J. Suppe, eds., ***AAPG Memoir*** *on "Thrust Fault Related Folding".*

Abstract

The focus of this work is to determine the folding characteristics including geometry, interaction of the surface and subsurface geometries, kinematic evolution of the structures and timing of deformation in Pusht-e Kuh Arc in Lurestan Province of Zagros fold and thrust belt in Iran.

Multidisciplinary methods have been used for different objectives in this thesis. Structural characteristic and fold geometry in two different units have been studied in the Zangul anticline. The Zangul anticline is a four closures anticline, with an open box folding shape and slightly verging to the SW. Its amplitude is of about 1.5 km and its half wavelength is ~4.5 km. The geometric construction of several cross-sections showing a regular position of the axial traces intersections indicates that the Triassic Dashtak evaporites may represent one of the major intermediate detachment levels in the sedimentary pile. The significant result is that the grouping of Asmari folds forms synforms (SE termination of the Zangul anticline) and antiforms (NW termination), which is so important for oil exploration.

The Anaran anticline on top of the Mountain Front Flexure represents the most external fold of the Pusht-e Kuh Arc. This anticline is asymmetric with a long and gently dipping backlimb and a very steep forelimb. However, the most characteristic tectonic feature is the large amount of normal faults that cut the crestal and forelimb domains of the anticline. These normal faults, formed by layer-parallel extension during folding, limit a crestal graben and are not very deep. In addition to these normal faults, the potential tectonic decoupling across the intermediate Gachsaran detachment level and the lack of reflections imaging the Anaran anticline forelimb in newly acquired seismic lines preclude the understanding of the geometry of the fold at depth. We propose a geometric and evolution model for the Anaran anticline with the help of sand box models and growth strata ages. We also explore the potential effects of erosion and sedimentation coeval to folding in the development of the Anaran anticline. The characteristic geometry of the Anaran anticline is directly related to its singular position on top of the Mountain Front Flexure. However, the proposed model may be applied to other folds on top of this major basement-related thrust as for example the Siah Kuh and Khaviz anticlines in Pusht-e Kuh Arc and Dezful Embayment domains.

The magnetostratigraphy dating technique applied to the syntectonic detrital sediments of the Agha Jari Formation in two locations across the Pusht-e Kuh Arc. The first location is the Afrineh syncline in the center part of the folded belt displaying field evidences of growth strata in the uppermost part of the Agha Jari Formation. The second section is located in front of the High Zagros Fault across the Chaman Goli

syncline with the same stratigraphy as in Afrineh syncline. The magnetostrigraphy dating technique in this study provides with the ages of the Agha Jari units and permits to constrain the sequence of the folding associated to growth strata across this particular part of the Zagros fold belt. Both sections are showing good paleomagnetic results with sequence of normal and reverse polarity intervals. They show very good correlation to the Global Polarity Time Scale. The correlation to the GPTS shows the base of the growth in Afrineh syncline dated at about 11.8 Ma. The onlap geometry in Afrineh syncline is indication of deformation pulse associated to the folding. This phase of folding is about 5.4±0.5 Ma earlier than folding in the front of the Pusht-e Kuh Arc. The correlation of the magnetic polarity sequence to the GPTS shows age of ~13.9 Ma in Afrineh and ~17.2 Ma in Chaman Goli synclines for the base of the Agha Jari Formation. It shows that both Agha Jari and Bakhtyari prograde from hinterland to foreland in agreement to other foreland basin in the World. The age of the folding becomes younger towards the foreland and therefore implying a foreland ward sequence of deformation that started at about 20 Ma in hinterland, reached the frontal folds at about 7.6 Ma and continued to about 2.5-1.5 Ma.

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