Reverse and Forward 3D Kinematic Modeling of the Northern Negev Monoclines and Underlying Faults Since Triassic

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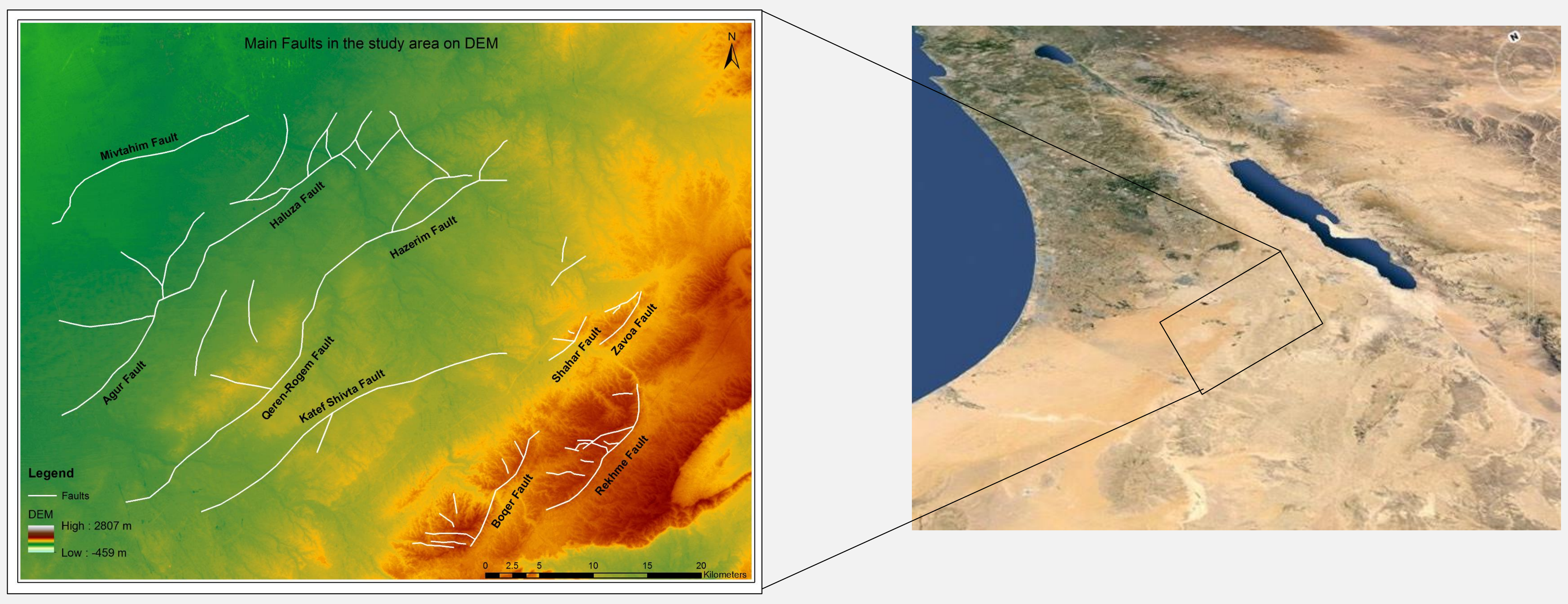
1 Introduction

The northern Negev records major deformational events that shaped the terrain since the early Mesozoic and can be regarded as an evolution model for much of the Levant.

Basin inversion has been proposed to explain the deformation on a regional scale (Freund et al, 1970). However, subsurface data has challenged the concept for some of the structures in the Northern Negev (Druckman, 1981). Moreover, the spatio-temporal distribution of shortening is poorly resolved.

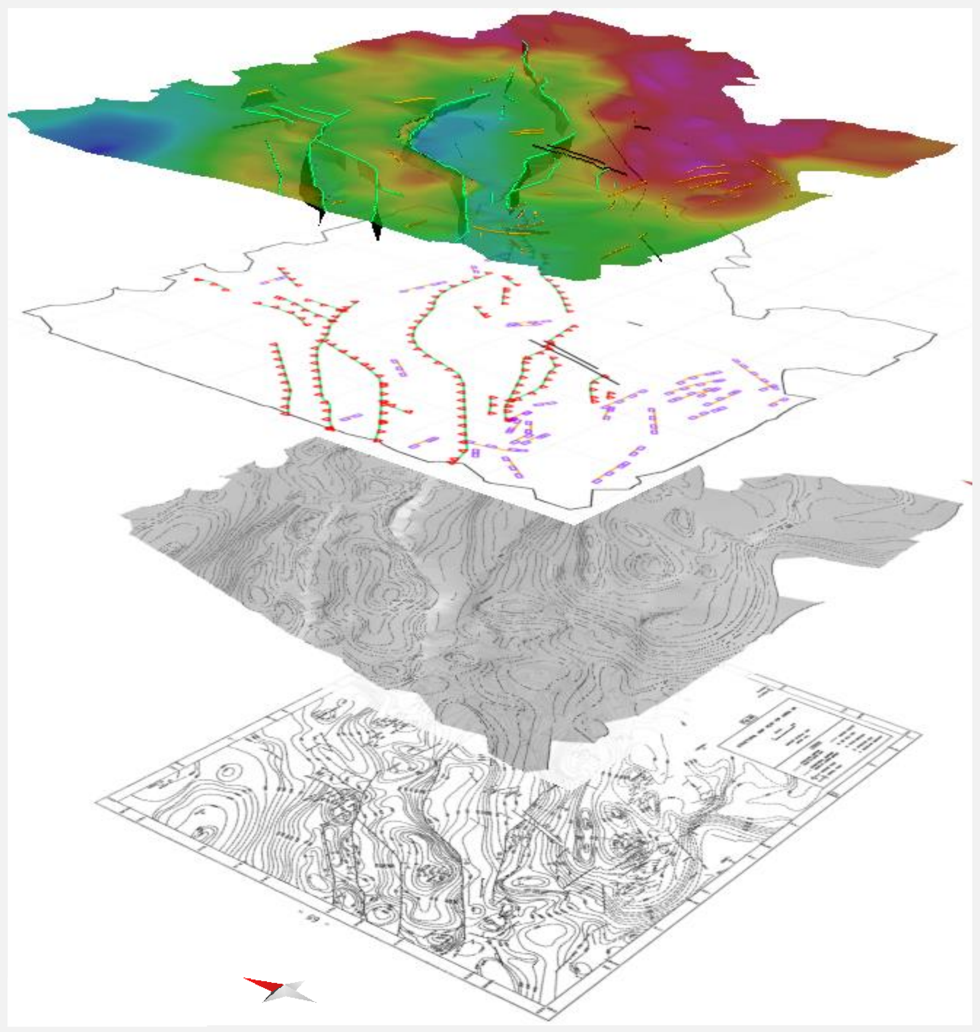


Our study area lies at the north-western corner of the northern Negev. It is dominated by four roughly parallel chains of monoclines, whose axes are oriented NE-SW.
In this study, eight structural maps derived from 2D seismic interpretations are used to examine and model the deformation of the northern Negev.

2 Research Objectives

- Composition of a 3D structure of the northern Negev from ~2500 km of 2D seismics
- Testing the basin inversion hypothesis for each monocline and the applicability of flexural slip
- Resolving the evolution of depth, shape and overall geometry of faults underling each monocline
- Obtaining the shortening history of each monocline as well as the entire NW Negev

4 Model Building



3D Structure

Digitized Faults

Mesh surface

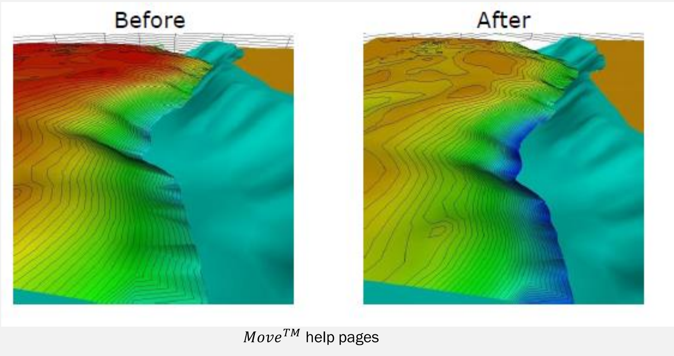
Structural map

5 Simulation Algorithms

Decompaction

$$f = f_0 * e^{-cy}$$

f: Present day porosity at depth
f_0 : Porosity at the surface
C: Porosity-depth coefficient ($\frac{1}{m}$)
y: Depth (m)
Sclater & Christie (1980)



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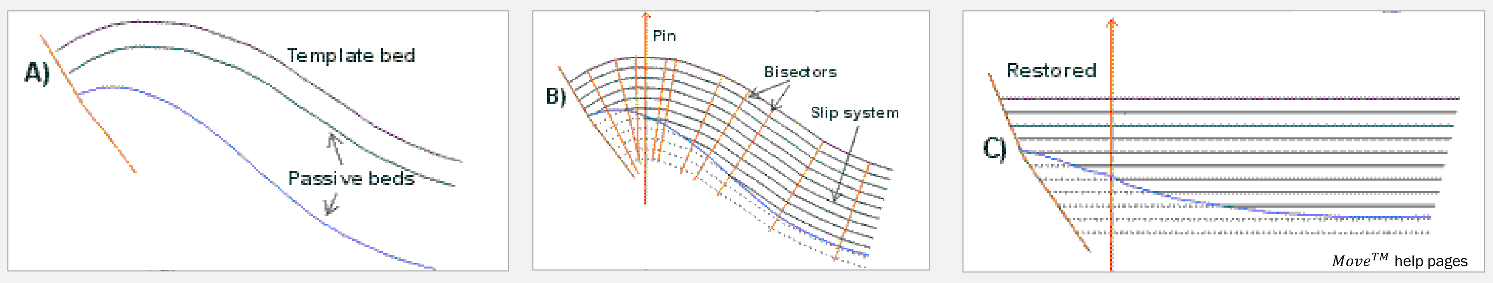
Flexural Slip



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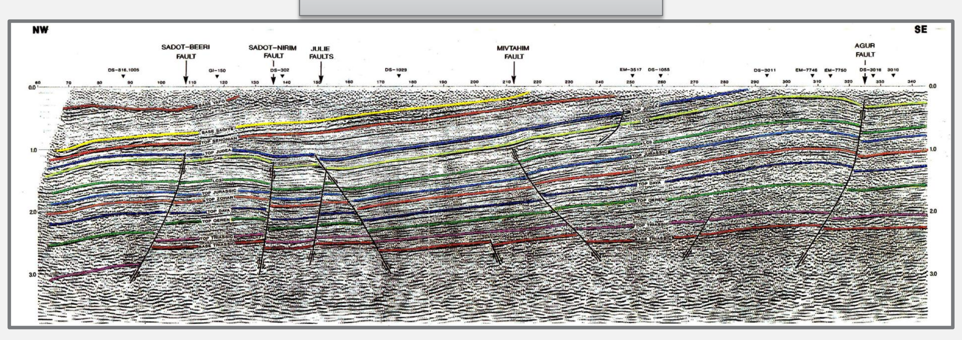
A) Fold with thickness variations to be unfolded
B) A slip system is constructed parallel to the template bed using dip domain bisectors of the template bed
C) The template bed and passive beds are unfolded about the pin using the slip system

3 Data and Methodology

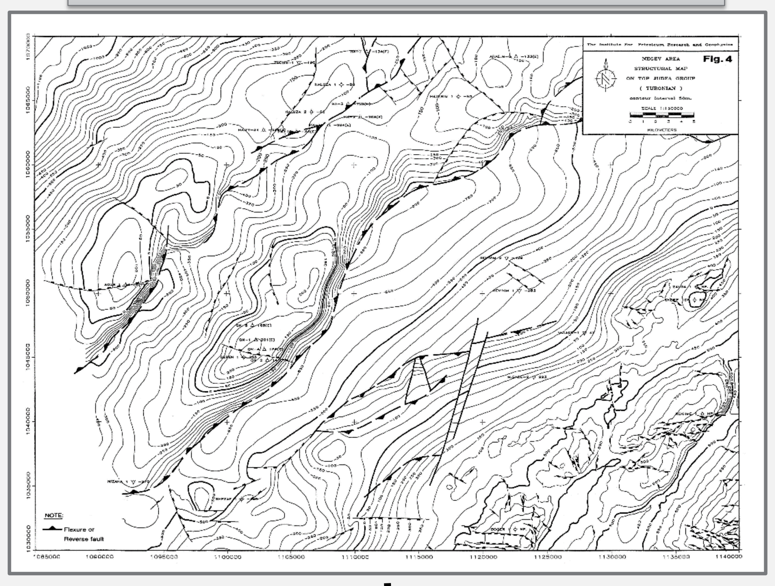
2D seismics



2670 km of 2D reflection seismic lines had been collected and interpreted; ten seismic horizons were mapped within the study area (Gelbermann, 1990; Davis and Grossovicz, 1990; Bruner, 1991; Druckman et al, 1994)

A 3D composite model with fault surfaces between the layers is generated.

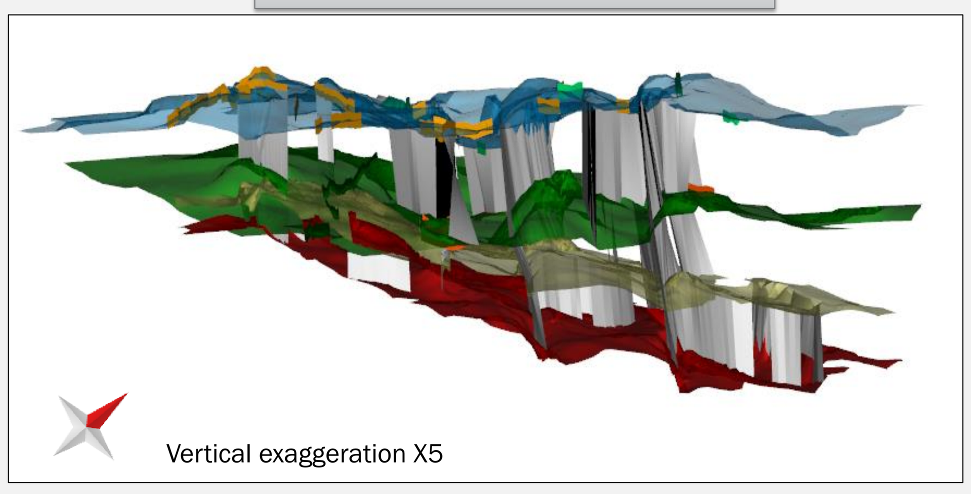
Structural seismic horizons



Reverse modelling of the structure, or '3D seismic restoration' under a flexural slip mechanism, allows efficient testing of various deformation scenarios and estimating shortening distributions, temporal as well as spatial.

Forward modelling enables testing the kinematic understanding of the shape and geometry of the structure.

3D structural model



Top Judea (Upper Cretaceous)

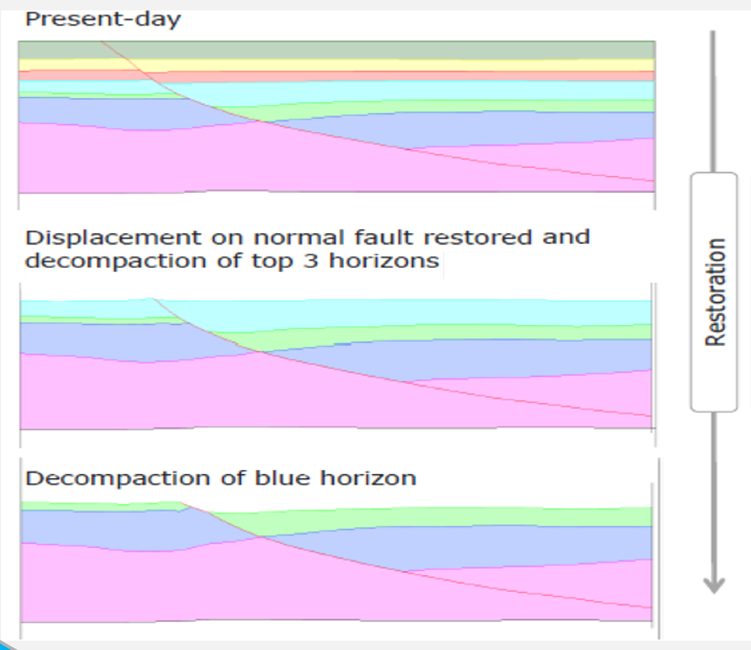
Top Zohar (Mid Jurassic)

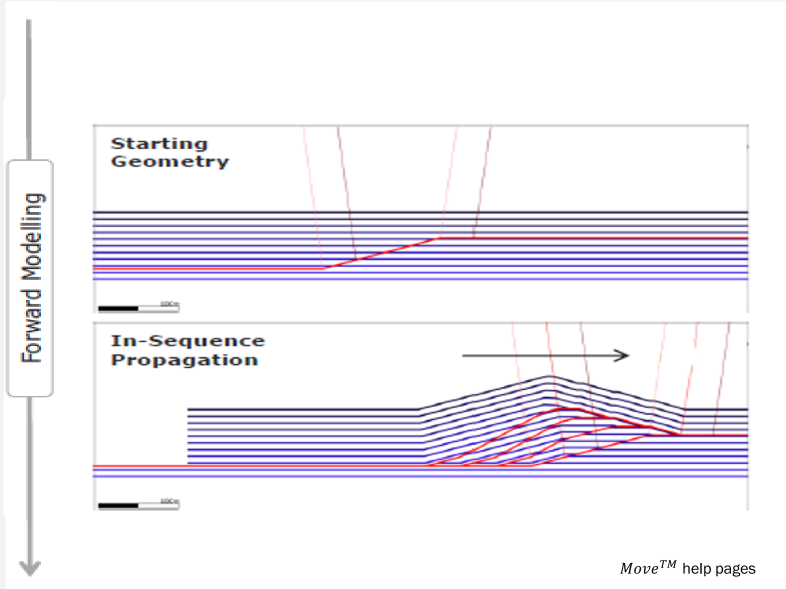
Top Qeren (Early Jurassic)

Top Ramon (Late Triassic)

Reverse modelling

Forward modelling





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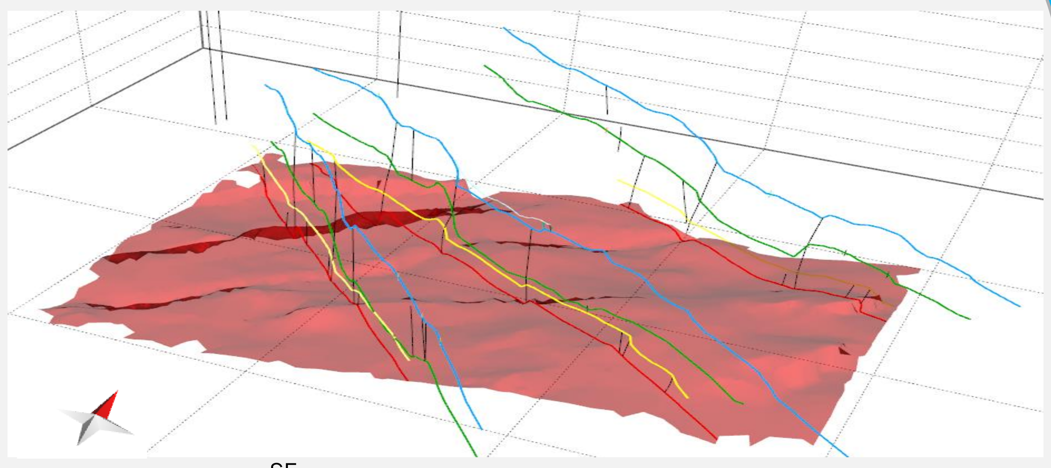
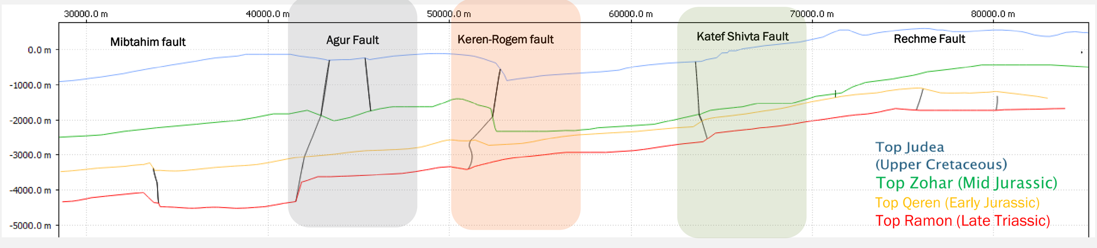
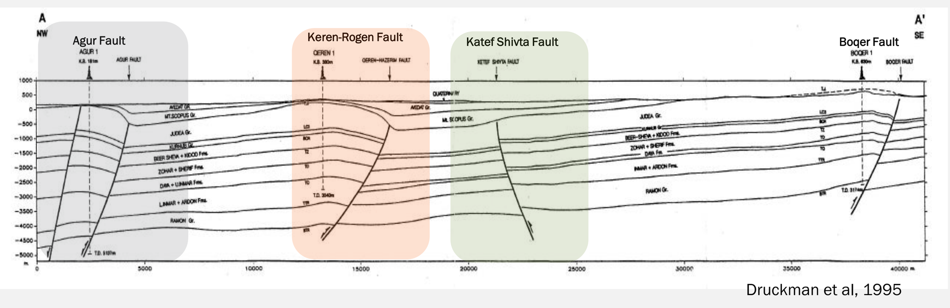
6 Preliminary Results

Cross sections through the 3D model have been completed in order to compare with Druckman (1994).
Agur and Keren-Rogem show normal faulting during late Triassic shifting to reverse faulting during mid Jurassic.
Katef Shivta and Boqer faults do not show such trends.







These results are in line with to Druckman (1994).
Further detailed analysis will resolve the evolution of basin inversion to shortening for each monocline. This will complete basic validation of the 3D model and will set the stage for seismic restoration to provide a 3D test for the basin inversion concept.

7 Acknowledgements

We thank Midland Valley for the permission to use Move software, the geophysical institute of Israel for the structural maps, and Steve Tobias for introducing $Move^{TM}$ to us.

midland valley