Influence of Regional Tectonics on Trap Integrity in Zagros Foothills and Foreland, Kurdistan & SE Turkey

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SUMMARY

- Oblique collision of Arabia and Eurasia caused transpressional deformation that partitioned (Figure 1) into wide zone of shortening (mainly folds, some thrusts), and several narrow strike-slip zones (Figure 2).
  - Shortening: very many large, world-class traps.
  - Strike-slip: risk of trap breach, sub-surface complexity, unpredictable fluid flow, large magnitude seismicity.
- Strike-slip zones include orogen-parallel (Main Recent Fault), and an array of NNW-SSE right-lateral strike-slip and oblique-slip faults.
  - This array is well documented in Iran (e.g. Berberian 1995; Blanc et al. 2003), though not previously widely recognised in Iraq and SE Turkey.
  - These faults are of profound importance to the development, extent and integrity of folds across the northern Zagros.

METHODOLOGY & DATA

New primary data and legacy datasets used:
- Several hundred days of fieldwork in Kurdistan & SE Turkey:
  - Structural mapping.
  - Petrographic and biostratigraphic analyses.
  - 35,000 georeferenced field photos.
- Multi-spectral satellite data and digital elevation data with a variety of spatial resolutions.
- Geology maps published by national geological surveys in Turkey, Iraq and Iran.
- Published seismological data (www.globalcmt.org; earthquake.usgs.gov).
- Topographic datasets including and topographic maps.
- Published geology maps, cross-sections, outcrop descriptions, biostratigraphic age determinations, sub-surface data etc. in scientific journals, books, theses, and company websites.
- Unpublished geology maps, proprietary maps, biostratigraphic age determinations, and other geological and geophysical data.

New outputs:
- Region-wide geological maps (whole Zagros).
- Ca. 8,000 km of balanced structural cross-sections.
- Series of proprietary reports.
- **A new transpressional model for the northern Zagros, presented here…**

TRANSPRESSION AND STRAIN PARTITIONING

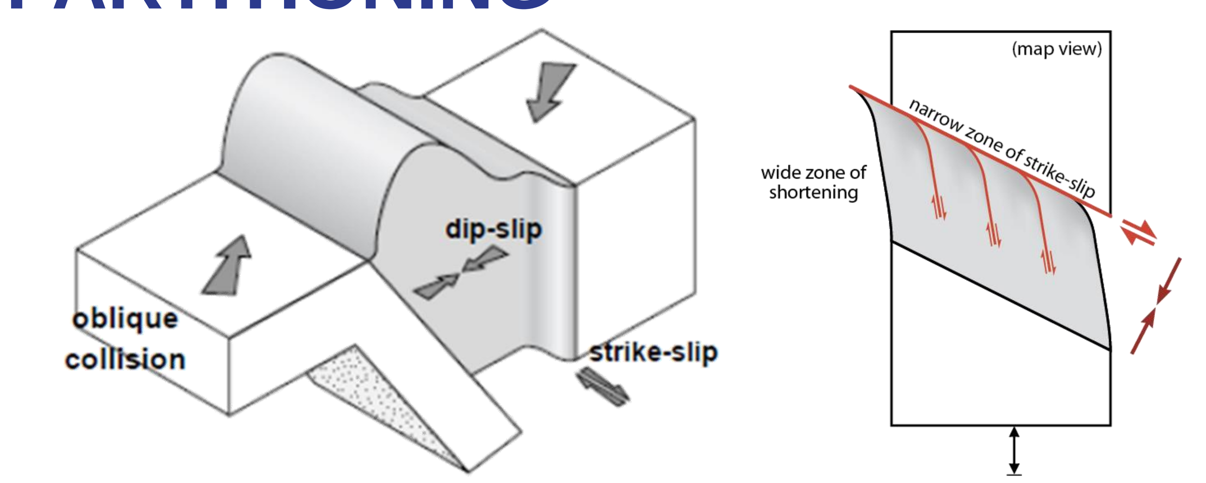


Figure 1. Left: Partitioning of transpressional deformation into a broad zone of shortening (folds and thrusts) and a narrower, orogen-parallel zone of strike-slip (Jones & Tanner 1995; Jones et al. 2005). Right: Strike-slip deformation accommodated on a NW-SE orogen-parallel fault and an array of NNW-SSE synthetic, right-lateral fault zones (plan view).

REGIONAL STRUCTURE & SEISMICITY

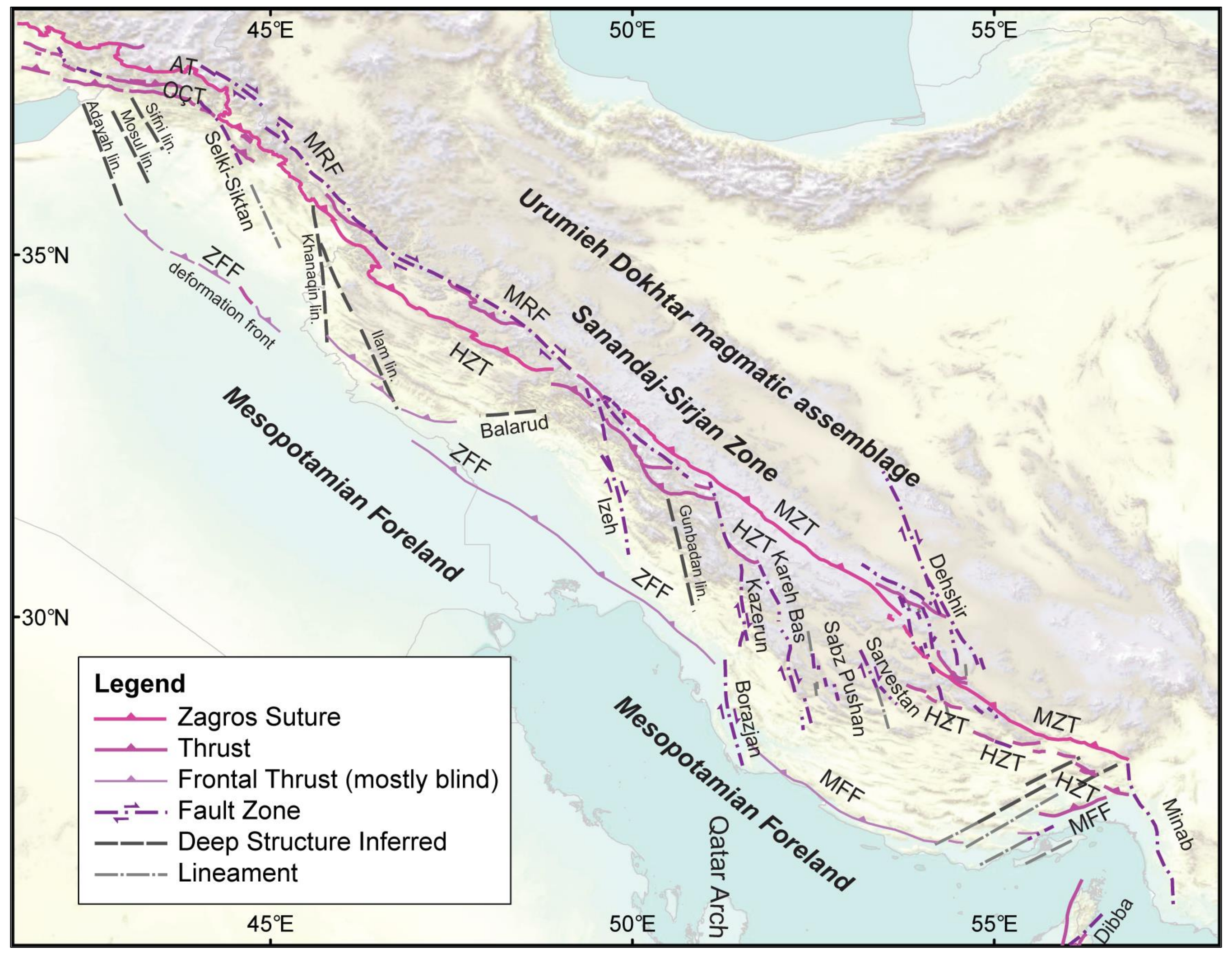


Figure 2. Overview map showing the main regional tectonic elements of the Zagros. AT = Alandaş Thrust; HZT = High Zagros Thrust; MFF = Main Frontal Fault; MRF = Main Recent Fault; MZT = Main Zagros Thrust; OÇT = Ora-Çukurca & Ortabag-Çiğli Thrusts; ZFF = Zagros Frontal Fault; lin. = lineament. Coordinate system: WGS84. Background topographic data: ESRI, USGS, & NOAA.

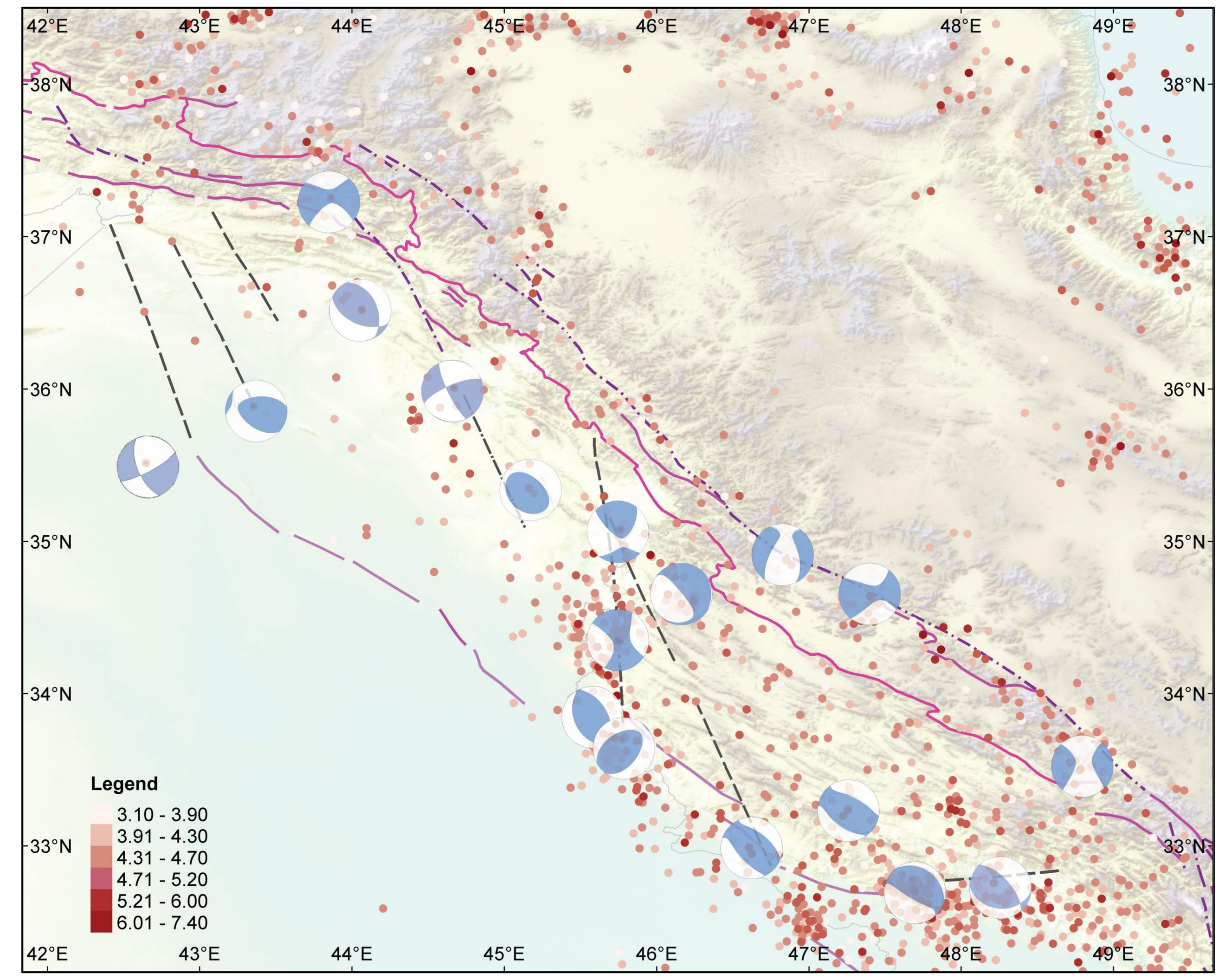


Figure 3. Recent seismicity in NE Iraq and the Lurestan region of Iran. Focal mechanisms and moment tensor interpretations of larger earthquakes suggest a wide variety of thrust, strike-slip, and oblique-slip displacements. Coordinate system: WGS84. Seismicity data: https://www.globalcmt.org and https://earthquake.usgs.gov. Background topographic data: ESRI, USGS, & NOAA.

FIELD DATA

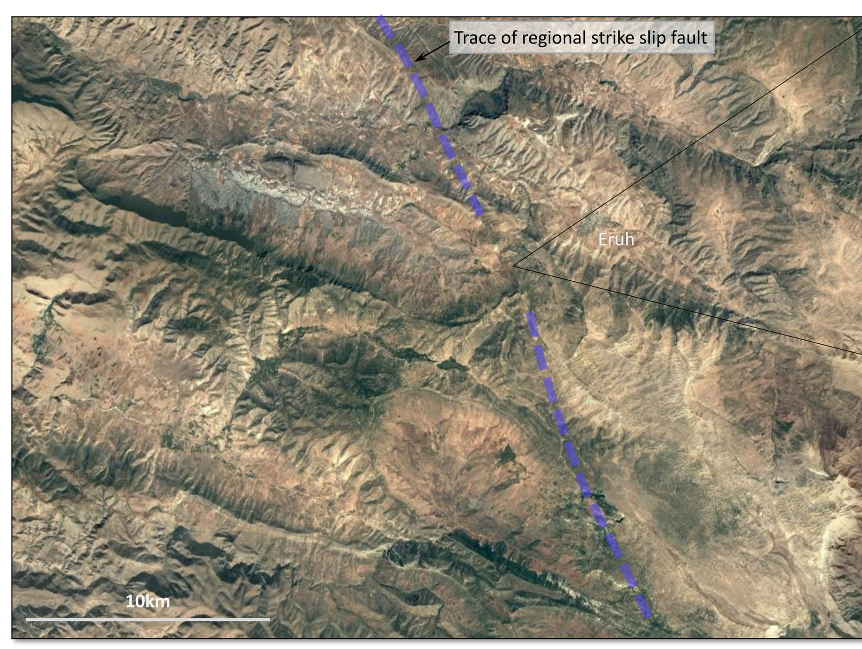
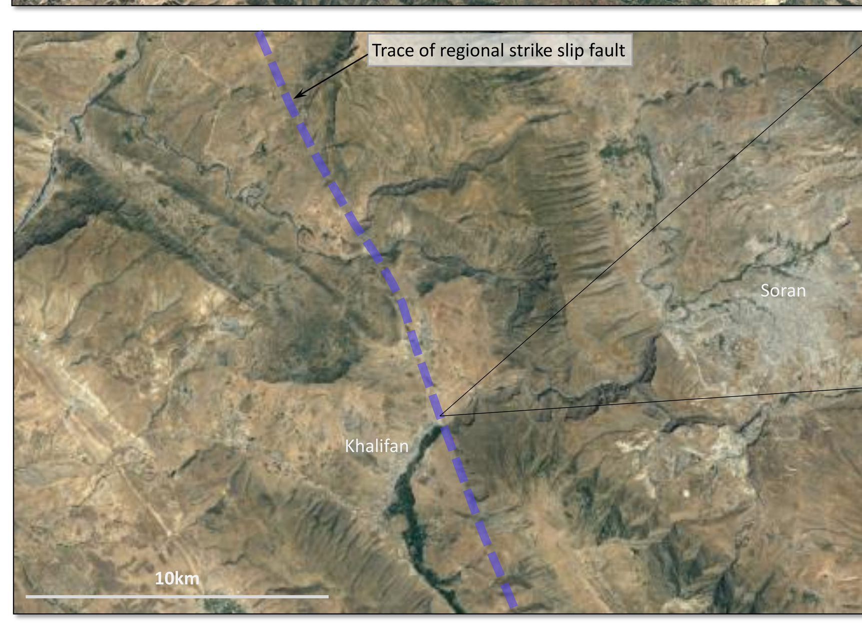


Figure 4. Eruh-Sirnak Fault, SE Turkey. This strike-slip zone has only very localised surface expression, but truncates the ESE end of the Ispandika pericline. It offsets the Eocene Midyat carbonates on the flanks of the anticline, and locally causes steep tilting, faulting and tight folding in Germav Fm. shales (inset photo).



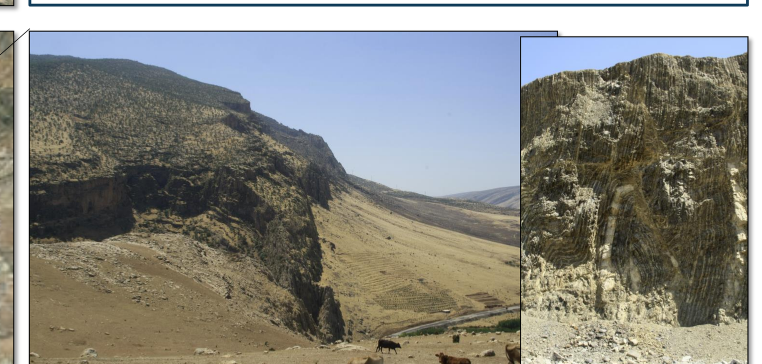


Figure 5. Selki-Siktan Fault, Kurdistan; this regional-scale oblique-slip zone truncates several anticlines (including the NW nose of Korek, seen here). Inset photo shows sub-vertical, folded and faulted Tanjero Fm. in the footwall of the main fault (height of section ~15m).

IMPLICATIONS FOR EXPLORATION

NNW-SSE faults can be difficult to recognise (particularly towards the foreland where they are buried by Neogene to Recent cover).
- Most faults in the array are marked by active seismicity (Figure 3)…
- … although in some cases there is demonstrably little/no offset in Eocene and younger units (c.f. Figures 4 & 5).

NNW-SSE fault zones typically coincide with:
- An alignment of map-scale to small-scale faults (Figures 5 photos).
- Sudden dip-changes in bedding (Figures 4 & 5).
- Co-aligned termination of anticlines (i.e. the plunging noses of periclines) (satellite imagery Figures 4 & 5).
- Coincidence of other poorly defined geomorphic features.
- Hydrocarbon seeps.

Major significance in the sub-surface:
- High likelihood of compartmentalisation of large anticlines.
- Can breach traps by cutting the nose of anticlines.
- Major through-going fault zones extending from depth to (near-) surface.
- Major conduits for extensive fluid flow over a protracted period of time.
- Very complex zones of progressive 3D deformation – very difficult to interpret at depth (even with good 3D seismic).

OTHER EFFECTS OF REGIONAL TECTONICS & STRUCTURE

Several other aspects of structure and tectonics have a strong influence on **trap geometry** and **integrity** (though are not the main focus of this poster):
- Mechanical stratigraphy: stacked reservoir/seal sequences provide multiple targets, and also strongly influence the fold style and dominance of folding instead of thrusting.
- Pervasive development of fracture systems in massive competent carbonates has produced very extensive Type II and III naturally fractured reservoirs.
- Interbedded weak shales and evaporites allow large-scale detachment zones to develop at a number of levels within the cover sequence.
- The presence of early Tethyan rift structures at depth may have significantly influenced the location and progressive development of major anticlines across the region..

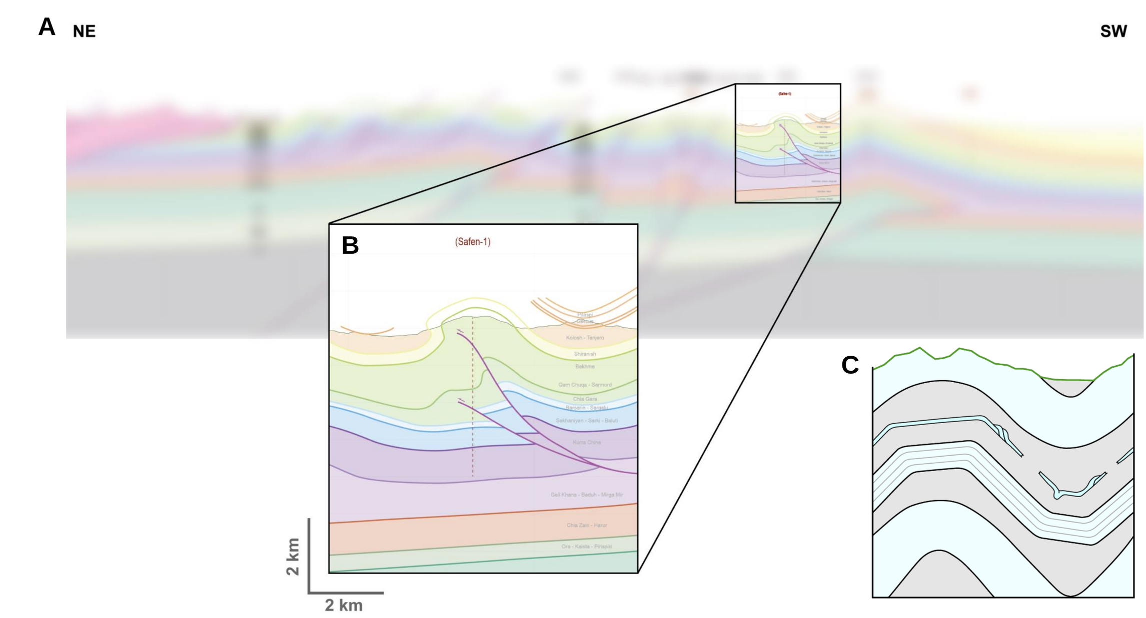


Figure 6. (A) Regional cross section. (B) Close up of stacked reservoir seals within a anticline. (C) Schematic example of how mechanical layering changes with depth and as a result structural style that will influence trap geometry and integrity.

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(See extended abstract for other regional references)

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