

Interactive comment on “Inversion tectonics: a brief petroleum industry perspective” by Gábor Tari et al.

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General comments

The paper of Tari et al. presents a brief yet comprehensive overview on the exploration aspects of inversion tectonics. The authors had to follow a tricky path as to the level of details which is inevitably a balancing act for review type papers. The topic and the wide range of its implications for petroleum exploration merits the size of a textbook. Yet the paper successfully navigates through some of the key features of basin inversion such as trap formation, charging, maturation, etc., and their temporal aspects.

Continuous improvement in seismic imaging has helped significantly the reconstruction of 3D subsurface anatomy, both tectonics and stratigraphy. This presents a good op-

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portunity to revisit the concept of basin inversion from a phenomenological, kinematic and dynamic point of view. Indeed, the use of the term “inversion” has been quite slack ever since its introduction some 40 years ago. The authors recognize this and make a good attempt to explore reasons and consequences. Ultimately, the questions comes down to this: i) is the original definition of basin inversion good enough for practical use by the industry and ii) how can we make a shift from (semi-)qualitative analysis to more quantitative interpretation and ultimately more successful prospecting? The paper provides essential insights to get closer to answering these questions.

On a side note, publishing A. Bally’s unpublished work (Fig. 1) is a timely gesture after the pass away of this visionary geoscientist last year.

In conclusion, the paper by Tari et al. is a well-presented scientific contribution with practical significance and inferences.

Specific comments

The paper needs a somewhat better definition of scope and rationale. What is the focus: more descriptive or process oriented or covers both?

The authors’ definition for inversion (lines 73-74) is inevitably a bit loose which is inescapable. What is the scale of anticlines? Would fault-bend anticlines qualify whereby main deformation is taken up by reverse faulting rather than ‘pure’ folding? Where is the boundary between complete basin inversion and onset of (over)thrusting and nappe formation in former extensional settings (passive margins becoming active margins to the extreme). Little chance to get to a generally accepted definition though.

The authors present the seemingly surprising statistics of underreported inversion cases for trap forming mechanism using the IHS Markit database. This goes back to the practical value of its definition. Compression is generally easy to recognise but applying the definition of inversion, whatever that is, is another matter. Support with data the statement that “inversion tectonics appears to be somewhat overrated in ex-

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ploration” (lines 115-117).

The Pannonian case studies are well presented and discussed. Large-scale uplift of Transdanubia deserves some more details. Is it due to lithospheric/crustal buckling as a result of horizontal compression, or perhaps isostatic adjustment due to lateral variation of preceding extension? In addition, as shown in several cases in a hot yet thermally disturbed lithosphere a few hundreds meters of uplift has a significant footprint on maturation. What is the impact of 800 to 1,000m estimated uplift at the Lovászi field? How do inverted extensional faults and newly propagating reverse faults behave in terms of fluid migration and subsequently what is their seal capacity? These aspects may merit a few paragraphs of additional discussion. Figure 7a needs visual improvement. Highlight with colour the main stratigraphic units so that “... the thickening/thinning geometries within the Upper Pliocene (Pannonian) strata in the apex of the anticline show the switch from extension to compression” (lines 175-177) hits the eye and hence becomes more apparent for the reader. The EastMed case studies are also educative – well written with sufficient details. Figure 9 is hard to read, increase resolution (presumably, printed version will be clearer) and find more distinct symbols for depicting the two inversion phases.

Sections 6 and 7 provide an excellent summary on the implications of inversion on petroleum systems and exploration. A couple of specific discussion points to consider further:

- Negative impact of inversion tectonics: even significant uplift, if reservoirs sealed properly, or self-sealed, may have positive impact such as enhancing reservoir energy (overpressure) and dewatering (tight gas in the Rockies), gas segregation in biogenic setting (see examples in PanBas), etc.
- Extend discussion on the impact of thickness difference of syn-rift vs post-rift sediments.
- Inversion often results in anticlines high above blind reverse faults within the ‘base-

ment' – clarify further how charge occurs in such unfaulted traps.

- Elaborate further the role of the trend of inverted structures vs regional dip as per Tari and Jabour (2011). The current paper presents only a brief summary of this relevant topic without explaining the causes.

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