STRUCTURAL DIVISION

Fold-Thrust Interactions in the Canadian Rocky Mountains Revisited: New Kinematic Models and Their Implications for Other Shallow Fold-Thrust Belts

SPEAKERS

Jürgen Kraus & Paul F. Williams

Time: 12:00 pm
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Location: Schlumberger, Second Floor of the Palliser One Building, 125 9th Ave. Calgary T2G 0P6

ABSTRACT

We review the history of structural interpretation techniques used in the Rocky Mountains Foothills and Front Ranges for the last half century, from quantitative cross section construction through ramp-flats folds (detachment fold, fault-propagation fold, fault-bend fold) and submit a broader view of fold-thrust interactions. Folds have been traditionally considered as the product of thrusting and no footwall syncline exists in any current geometrical or kinematic ramp-flat fold model.

We show a discrepancy between observation and interpretation by examining prominent structures in the Foothills and Front Ranges. All our examples of fold-thrust scenarios have footwall synclines, substantially thickened fold hinges even in Devonian carbonates, and, where exposed, other evidence of layer-parallel shortening such as cleavage and parasitic folds.

It appears that the current models are not exhaustive in describing most observed fold-thrust scenarios and that the fault-propagation-fold model is overused in subsurface interpretations. The latter, while possible, is probably an artifact of seismic imaging, biased processing, and model-driven interpretation in many cases. Footwall synclines appear to be the norm rather than the exception in outcrop.

We show that large folds generally form by one of two mechanisms, one that does not involve thrusting and a second that does. The latter is a variety of detachment fold. Although they develop along different strain paths, they may be geometrically indistinguishable.

We then integrate these folds in a progressive deformation and view them as earlier stages in the development of a fault-bend fold. During progressive deformation, the hanging wall anticlines evolve and "travel" with the hanging wall, whereas the footwall synclines are left behind.

Extending the interpretation of the ramp-flat folds from end members to stages, and relating these interpretations to the hanging wall only, eliminates the need for the outdated term “break-thrust fold” and explains all structures found in the Rockies and any other shallow fold-and-thrust belt. Classic fault-propagation folds are possibly rare in nature.

It is concluded that the Rocky Mountains Foothills and Front Ranges experienced a higher degree of penetrative, ductile deformation than previously believed.

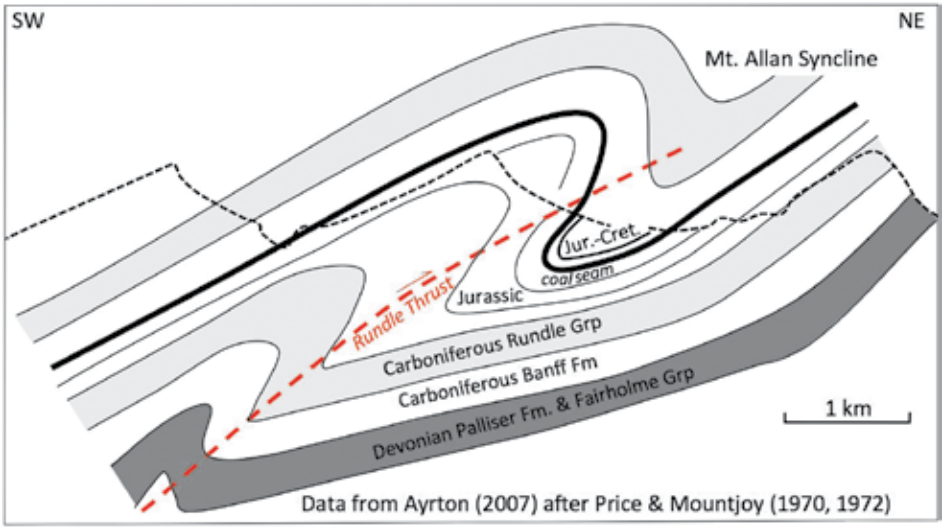

Figure 1: Attempted reconstruction of an anticline/syncline pair prior to being overprinted by the Rundle thrust. Dashed black line represents current erosional surface.

Paul Williams & Jürgen Kraus

BIOGRAPHIES

Jürgen Kraus is a structural geologist and international exploration geologist with his own consulting company, Franconia Geoscience Ltd. He is also a director of the Canadian Global Exploration Forum and co-chair of CSPG’s International Division. Jürgen held his first petroleum-related position in 1987. He received an M.Sc in Structural Geology and Geophysics from Göttingen University in 1991 and a Ph.D. in Structural Geology from the University of New Brunswick in 1998.

After assignments with the Geological Survey of Canada, Aachen Technical University, and the Saskatchewan Geological Survey, he joined Shell Canada

in 2001 and created drillable prospects in the Foothills at Waterton and Pincher Creek. Jürgen established his consultancy in 2003 and has worked on international oil and gas projects for various companies since.

Apart from the Foothills, Jürgen's experience in fold-and-thrust belts goes back to the 1980s (Rhenish massif as the central European extension of the Appalachians), his M.Sc. mapping in the Moine Thrust Belt in the Scottish Caledonides, and the Longmenshan in Sichuan Province of China.

Paul F. Williams, Professor Emeritus at the University of New Brunswick, is an internationally acclaimed structural geologist who has influenced his subject tremendously for 45 years. He has published over 80 peer-reviewed scientific papers, and 'An Outline of Structural Geology', co-authored by Paul, is regarded as one of the most influential structural geology textbooks of the 20th century. He mentored over 50 graduate students and post-doctoral fellows.

In 1980, Paul established the Canadian Tectonics Group, which will hold their 36th annual workshop in Muskoka in October. The Journal of Structural Geology has dedicated two special volumes to Paul's lifetime achievements, one in recognition of his contributions as a scientist, the other for his contributions as a mentor.

In 2013, Paul won the inaugural Henk Zwart Medal in structural geology for his outstanding contribution to the advancement of science in the field of rock deformation.

REFERENCES

Ayrton, W.G., 2007, The Mountains, the rocks, the oil and gas, second edition: http://www.cspg.org/cspg/documents/Publications/CSPG_poster.pdf

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