Geological Society of America
Structural Geology & Tectonics Division

2011
Outstanding Publication Award

Presented to Haakon Fossen and Basil Tikoff

Fossen, H., & Tikoff, B. (1993) *The deformation matrix for simultaneous simple shearing, pure shearing and volume change, and its application to transpression-transtension tectonics.* Journal of Structural Geology 15, 413-422.

Tikoff, B., & Fossen, H. (1993) *Simultaneous pure and simple shear; the unifying deformation matrix.* Tectonophysics 217, 267-283.

Citation by Peter Hudleston

It looks like the awards committee this year could not make up its mind when it selected two papers to be given the best publication award of the division. But the two papers, by Haakon Fossen and Basil Tikoff: "Simultaneous pure and simple shear; the unifying deformation matrix " and "The deformation matrix for simultaneous simple shearing, pure shearing and volume change, and its application to transpression- transtension tectonics, " published in 1993, are two sides of the same coin – the first presenting elegant theory and the second presenting practical applications. It makes perfect sense to take them as an entity. They stand out as milestones in the large literature that has developed over the past several decades on the geometry and kinematics of strain, the interest stemming from the fact that strain is commonly localized and the growing recognition that localized strain is rarely "simple shear."

Basil and Haakon developed the ideas for these papers while they were graduate students in an institution not far from here, and it was stimulating to have the pair of them, with their different temperaments, involved in intense discussions in the department as these papers took shape.

Pure shear and simple shear have been fundamental concepts used by geologists in interpreting and modeling natural structures almost since the beginning of the discipline. These two papers utilize the kinematics of combined pure shear and simple shear in the most general way for the first time. The first paper builds most closely on the work of Ramberg (1975), by generalizing Ramberg's approach to 3D, allowing for deformation involving combinations of stretch in three directions and simple shear on three sets of orthogonal planes. This allows very general deformation states and deformation histories to be modeled simply and efficiently. The mathematics is presented clearly, and in a way that simplifies the algebra and allows for a more intuitive understanding of the way the components of deformation are combined. The bottom line is that this paper provides a powerful tool for kinematic modeling of general strain paths and resulting finite strains. And that tool has been used!

In the second paper, Haakon and Basil apply their theory to analyze various combinations of pure shear, simple shear, and volume change. They provide the framework in which the kinds of data that structural geologists collect in the field can be interpreted. This paper is frequently cited by aficionados of kinematic vorticity, a specialty within the discipline that has expanded at an amazing rate since the publication of these papers. This paper explains, I believe, better than any other the kinematics and structural consequences of transpression/transtension.

These two papers have stimulated much work by others on the kinematics of deformation, as evidenced by the 100's of citations they have received. In recognition of the original and continuing influence the papers have had on our discipline, it is surely fitting that they are to receive the 2011 Best Publication Award.

Response by Haakon Fossen

It is a great honor to receive the Outstanding Publication Award, and we both wish to thank the Division for selecting our papers. We take this as evidence that our two papers have been found to be useful, which is something we all hope for every time we submit a new manuscript.

The papers were written about two miles from here by two graduate students, who were both taking a bit of a detour from what our PhD projects were supposed to be about. Prior to that I (Haakon) had run into strain matrices as a Master student in Bergen in some papers authored by Derek Flinn, David Sanderson and Mike Coward. Like many other geology students I had kept mathematics at a respectful distance, but I was convinced by UMD professor Tim Holst, who at the time spent his sabbatical in Bergen, that this strain matrix stuff wasn't hard to deal with at all. This lead me to take some math courses, first in Norway and later at the U of MN when I started my PhD there in 1989.

The snowball really started rolling when I got to know fellow student Basil at the U of MN and found that we shared a common interest in strain and structural modeling. We "attacked" several papers, particularly some authored by the late Hans Ramberg, who pioneered much of the theory on which our two papers build. After meters of paper with mathematical derivations and weeks on the Mac II in room 210 in Pillsbury Hall, we felt that the work had rewarded us with a much better understanding of what deformation theory is all about and the usefulness of linear algebra in this context. Writing these papers was a great learning process.

Response by Basil Tikoff

I'll start by acknowledging Steve Wojtal, who got me started on thinking about strain and strain history during a senior project at Oberlin College. Steve provided me with a geological context for this work, and motivated my intellectual curiosity to pursue it. We would also like to thank Gerhard Oertel, whose review – particularly of the mathematics – allowed the Tectonophysics paper to be published.

Francis Pettijohn, toward the end of his book, "Memoirs of an unrepentant field geologist" addresses the question "What is it that makes a department a creative, stimulating place – an exciting place where the lights burn late into the night, while students and faculty often appear

on Sunday and holidays...". I can't answer that question, but we know that we were part of one of those times, much of which occurred in room 210 in Pillsbury Hall. We were privileged to have been part of a dynamic group of structural geology students under the wings of two outstanding structural geology professors, Christian Teyssier and Peter Hudleston, and with repeated interaction with co-students Jim Dunlap, David Kirschner, Labao Lan, Paul Kelso, Gustave Tolson, Jerry MagLoughlin, and Eric Heatherington. Our two papers would never have materialized without that supportive and creative environment, which we were lucky to be part of.

Thank you, again, for this award.