**Geological Society of America**
**Structural Geology & Tectonics Division**

**1995**
# Best Paper Award
**Presented to Steven Wojtal**

Wojtal, S. (1989) *Measuring displacement gradients and strain in faulted rock.* Journal of Structural Geology 11, 669-678.

*Citation by William M. Dunne*

This evening I have the pleasure of announcing that the winner of the Structural Geology and Tectonics Division "Best Paper Award" for 1995 is Measuring Displacement Gradients and Strains in Faulted Rocks by Steven Wojtal, which was published in the Journal of Structural Geology in 1989. Back in the depths of the 1970's and '80's, Steve was working at Dunlap, Tennessee. He had a decollement and a deformed hanging wall to investigate. The dominant agents of deformation in the hanging wall are several sets of faults. So, an issue was how to get a representation of deformation such as a strain ellipse from rocks deformed homogeneously, but discontinuously. Steve's award-winning paper addresses this issue. [Note: the remainder of the oral citation was given with a modified version of Figure 8 from the paper on the screen]

This illustration shows my only complaint about the paper, the title. There is nary a fault in the example, yet this picture shows the robustness of Steve's approach because it can be used for any set of discontinuities that are displacement loci (in this case solution surfaces). Steve considered the case of a homogeneous but discontinuous deformation where straight and parallel lines remain straight and parallel after deformation, but are offset across the structures. Using markers across the discontinuities, reciprocal displacement vectors are constructed and plotted in displacement space. These vectors allow the restoration of the rock to the undeformed state. More importantly, they are used to determine the derivatives of the reciprocal displacement gradients (slopes of lines in plots of magnitude of displacement component vs. position), which should be constant (constant line slope) for a homogeneous deformation. These derivatives are used to derive the reciprocal deformation matrix (the matrix that describes restoring the deformed state to the undeformed state) and hence the strain ellipse (via Mohr Circle, or eigenvalues/eigenvectors). The strain ellipse or its matrix description is the conventional means of describing and assessing the distortion component of rock deformation. So, Steve managed to develop a technique for taking the results of a discontinuous deformation and converting them to a standard format of deformation analysis. For example, in Markley & Wojtal (1996) in the American Journal of Science, this approach assesses the timing and contribution of solution cleavage to fold development. So now, a worker when faced with an outcrop of faults, veins or solution cleavage (or pick your favorite discontinuous structures) can use the geometry of the structures, the displacement of markers and some common sense to determine their strain contribution. I personally feel this approach while applicable at many scales, can make its greatest contribution at the outcrop scale where strain measurement has often proven intractable in the past.

A final point, it is a pleasure to see this award going to a researcher located at an institute where undergraduate training is the focus.

Congratulations, Steve.

*Response by Steven Wojtal*

Thank you Bill for such a kind introduction.

It is difficult to express my feelings at learning that I had been chosen to receive this award. The first words that came to mind were not, in fact, my own but were those memorable words of Admiral Stockdale, the third party candidate for the U.S. Vice Presidency in 1992, "Who am I? Why am I here?"

Who am I? In a very real sense, I am a reflection of my teachers and collaborators, and I wish fully to acknowledge their share of the recognition this award accords. I have been lucky to have as teachers Bill Chapple, Jan Tullis, Terry Tullis, and the late David Elliott. Considering the work presented in this 1989 paper, Dave Elliott is clearly the most influential. It was in Dave's Finite Strain course that I learned the fundamental approach outlined in this paper, that deformations may be inhomogeneous when viewed at one scale and homogeneous when viewed at a larger or smaller scale, and it was Dave who suggested that I look into using hodographs (which were the basis of what I called "displacement diagrams" in the paper) to analyze faulted rocks. The imprint of his approach to structural problems is, to my eye, apparent throughout this paper, and is to a large degree the reason that this paper is successful. I have also been lucky to count among my cohorts and collaborators Steve Boyer, Nick Woodward, Rick Williams, Paul Karabinos, Fred Diegel, Jane Gilotti, Joe Hull, and Gautam Mitra. I must single out Gautam Mitra as an especially strong influence and role model. Gautam understands what it is to search for a method to measure strain in rocks lacking strain markers, and, in his work on deformed basement in Virginia, he marked the route to an answer by demonstrating the importance of mapping in detail mesoscopic structural features. Finally, I should thank two anonymous collaborators -- the two anonymous reviewers who recommended rejecting an early version of the paper. In response to their critical comments, I was able to write a revised version that was sufficiently improved to sail through the review process and, apparently, communicate effectively to some readers.

Why am I here? I believe that I am here in large measure due to the increased interest in understanding the kinematic details of discontinuously deformed rocks. Since I have the opportunity, let me say that there are other "old" papers highly worthy of reexamination in light of the new interest in the study of discontinuous deformation, such as Francois Arthaud's study of the geometry of incremental strains in faulted rocks, Gautam Mitra's paper on estimating strain in deformed basement, and Jamie Jamison's paper on fault/fracture strain.

Allow me to close by repeating that I am deeply honored by this award. I sincerely thank the committee and the Division for this honor.