

METAMORPHIC CORE COMPLEXES -- EXPRESSION OF CRUSTAL EXTENSION BY DUCTILE-BRITTLE SHEARING OF THE GEOLOGIC COLUMN; G.H. Davis, Dept. of Geos., University of Arizona, Tucson, Arizona 85721

Metamorphic core complexes and detachment fault terranes in the American Southwest are products of stretching of continental crust in the Tertiary. The physical and geometric properties of the structures, fault rocks, and contact relationships that developed as a consequence of the extension are especially well displayed in southeastern Arizona. The structures and fault rocks, as a system, reflect a ductile-through-brittle continuum of deformation, with individual structures and fault rocks showing remarkably coordinated strain and displacement patterns. Careful mapping and analysis of the structural system has led to the realization that strain and displacement were partitioned across a host of structures, through a spectrum of scales, in rocks of progressively changing rheology. By integrating observations made in different parts of the extensional system, especially at different inferred depth levels, it has been possible to construct a descriptive/kinematic model of the progressive deformation that achieved continental crustal extension in general, and the development of metamorphic core complexes in particular.

The physical and geometric nature of structures, fault rocks, and contact relationships in metamorphic core complexes of southeastern Arizona can be understood in the context of shear-zone deformation. When so viewed, metamorphic core complexes emerge as mountain-size geologic exposures of low-dipping regional ductile-brittle shear zones. The zones vary in thickness from approximately .3 km to 3 km, and appear to taper upward. Normal-slip simple shear within individual shear zones resulted in kilometers of translation of hanging-wall crust. The tectonic denudation which accompanied progressive simple-shear raised early formed, deep level mylonites through higher and higher structural levels. The mylonites thus experienced a progressive deformation carried out under conditions of steadily decreasing temperature and confining pressure. The record of fault rocks and fabrics displays this history strikingly: mylonite gneiss comprising the interior of the shear zones is transformed upward into microbrecciated mylonite gneiss, which in turn is converted to cataclasite and ultracataclasite derived from microbrecciated mylonite gneiss. In outcrop the cataclasites typically form a resistant tabular ledge, the upper surface of which is a gently dipping detachment fault, or decollement. This surface of profound structural discontinuity sharply separates mylonitic and cataclastic fault rocks below from nonmylonitic, noncataclastic hanging-wall rocks.

When the brittle-ductile shear zones formed initially, as a response to continental crustal extension, they probably dipped at angles of 45 degrees or more, and not at their presently observed inclinations of 30 degrees or less. At the time of formation of the brittle-ductile shear zones, only the uppermost brittle surficial expression(s) of the zones would have been exposed to view. However, the brittle-ductile shear zones now lie on their sides, having been passively rotated to gentle inclinations through crustal extension that continued beyond their inception. While actively accommodating simple-shear deformation and displacement, the shear zones were geometrically required to rotate to shallower inclinations as the crust was distorted into a stretched, thinned counterpart of its original shape and size. Following this early-to mid-Tertiary deformation, the rotated shallow-dipping brittle-ductile shear zones were cut and differentially displaced along younger high-angle normal faults, which are fundamentally responsible for

Davis, G. H.

blocking-out the basins and ranges of southeastern Arizona today. Because of the combination of these structural circumstances, broad expanses of sub-regional brittle-ductile shear zones can be examined in single and/or adjacent mountain ranges. By traversing range to range, parallel to the direction of shear, the once-shallow and once-deep parts of a common shear zone may be examined right at the surface of the earth.