

Advanced structural geology and tectonics:

Geometry and evolution of fold-and-thrust belts

GEOS 611 (3 credits)

Fall, 2007

Class times: MW 10:30-12:00

Reichardt (Natural Sciences) Building 233

Instructor: Wesley K. Wallace

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Office hours: After class, M 1:00-2:00, or by appointment

Fold-and-thrust belts of all ages are found around the world. They contain many of the deformed sedimentary rocks in the world, form many of its mountains, and have a major influence upon deposition, particularly in foreland basins. This class will consider fold-and-thrust structures from the scale of individual folds and thrust faults to the lithospheric scale of an entire mountain belt. The class will first explore the geometry and kinematics of folds and thrust faults, and then move on to broader topics related to fold-and-thrust belts. The class will address both concepts and applications and hands-on exercises will illustrate both, as well as providing experience in techniques for the analysis of fold-and-thrust belts. An outline of the topics to be covered is on the second page.

Readings will be assigned from key papers on fold-and-thrust structures, some of which will be presented by students for class discussion.

The class will be letter-graded based on the following components:

1. Completion of in-class exercises (40%)
2. Construction of a balanced cross section using an assigned map (20%)
3. Completion of a seismic interpretation exercise (20%)
4. Presentation of two scientific papers (20%): Students will select two papers to summarize in ten-minute presentations. The objective will be to identify and present the most significant contribution(s) of the paper, and to lead discussion of the implications of the contribution(s).

Tentative outline of topics to be covered

Concepts

Geometry and sequence

Controls on fold geometry

Variables

Single layer

Multi-layer

"Mechanical stratigraphy"

Parallel folds

Geometric constraints

Flexural-slip folding

Kink band geometry

Chevron geometry

Fixed vs. migrating hinges

Rotating vs. fixed limbs

Fault-related folds

Classification

Detachment folds

Fault-bend folds

Fault-propagation folds

Fault-arrest folds

Truncation by thrust faults

Thrust systems

Sequence of faulting

Forward

Hindward

Out-of-sequence

Duplexes

Geometry

Sequence

Variables

Passive vs. active roof

Thrust fault growth and lateral variation

Thrust fronts and range-front structure

Strain and low-temperature small-scale structures

Applications

Axial surfaces and limb thickness

Fold extrapolation

Conservation of bed length and thickness

Flexural slip, pin lines, and loose lines

Geometry and kinematics of fault-related folds

Implications for balancing

Fold vs. fault shortening

Detachment depth

Sequence of reconstruction

Direction of tectonic transport

Displacement vs. horse length

Branch lines

Stratigraphic separation diagrams

Displacement-distance diagrams

Implications for depth to detachment

Accounting for strain in balancing

Tentative outline of topics to be covered, continued

Concepts

Related topics

Influence of stratigraphy and existing structure

Thrust mechanics

 "The paradox of thrusting"

 Wedge models

 Erosion and topography

 Extension in fold-and-thrust settings

 Out-of sequence and breaching thrusts

Lithospheric-scale structure and balancing

Foreland basin subsidence and deposition

Growth folding

Thermal history and geochronology

Plate tectonic setting

Applications

Synthesis of balancing methods

Balanced cross section project

Collection of field data (based on geometry, sequence, and balancing methods)

Dip domain mapping

Interpretation of seismic reflection data