Structural Evolution And Seismic Modelling Of Fold-Thrust Structures Developed In Analog (Centrifuge) Models

Todd E. Noble* and John M. Dixon
Queen's University, 99 University Ave. Kingston, ON K7L 3N6
noble@geoladm.geol.queensu.ca

Susan Pfister
C-CORE, St. John's, NF

and

Don Lawton
University of Calgary, Calgary, AB

ABSTRACT

We investigate the structural evolution of fold-thrust systems by analog scale modelling carried out in a large geotechnical centrifuge at C-CORE, St. Johns, NF. In accord with scaling theory, the experiments replicate models previously deformed in the smaller but higher-***g*** centrifuge at Queen's University. Multilayer models of foreland stratigraphic sequences are constructed of plasticine and silicone putty and shortened horizontally to simulate the nucleation and progressive growth of fold-thrust structures and fold-thrust systems as a whole.

Plane-layered models composed of five internally laminated stratigraphic units of alternating bulk competency deformed in the C-CORE centrifuge develop geologically realistic fold and thrust structures that offer insight into the timing of different deformation mechanisms that contribute to the development of an individual overthrust. Individual fold-thrust structures develop in the following progression: a buckle-fold train propagates serially from hinterland to foreland through a competent unit; small reverse faults (shear bands) localize in the forelimb of each buckle fold; a thrust ramp then cuts through the forelimb of the fold and the hanging-wall panel is displaced over the footwall ramp. The models clearly display an evolutionary relationship between folding and thrusting and the ramp spacing in model duplex structures is inherited from the buckle fold train that pervades the competent unit. During the structural evolution of the overthrust structures we interpret that the fault tip cuts both up-section towards the foreland through the forelimb of the fold in the competent unit, and down-section towards the hinterland into the underlying incompetent unit.

Fixed-offset and multi-offset physical seismic data have been collected from a deformed centrifuge model of a large fault-bend fold. Migrated sections correctly image the major reflection boundaries within the model, demonstrating the potential for using model seismic surveys for refining seismic processing and interpretation techniques in areas of complex structure.