geoconvention
Calgary • Canada • June 20-22 2022

Multiduplex emplacement in the Cate Creek window, southern Canadian Rocky Mountains: interaction of erosion and tectonic underplating in thrust wedges with décollements based on 2D forward modeling

Elena Konstantinovskaya
Earth and Atmospheric Sciences, University of Alberta
Peter Fermor
Retired

Summary

Interaction between tectonic underplating and surface erosion in thrust wedges with multiple décollements may result in strain partitioning with the development of multiduplex antiformal stacking, strong uplift, and synchronous normal faulting within discrete areas. These processes are studied through 2D numerical simulations along a 115-km long 2D cross-section in the area of the Cate Creek window, southern Canadian Rocky Mountains.

Methods and Workflow

Fault propagation and structural evolution of multiduplex structure at the base of the Lewis Thrust is studied through the real-size flexural-slip restoration and forward modeling. The numerical fault restoration is compared to the results of analog sandbox modeling.

Results

The thrust wedge is underlain by the Precambrian basement dipping at ~2° to the SW. The 4-5 km-thick tectonic slices of Precambrian rocks in the SW are emplaced along the Lewis Thrust (Fig. 1) to the NE over Cretaceous clastic deposits that are exposed in the Cate Creek tectonic window (Fermor and Moffat, 1992).

The multiduplex structure is composed of imbricate NE-vergent sigmoidal thrust slices of 200-400 m to 1200-1400 m thick that form a series of antiformal stacks below the roof décollement along the Jurassic Fernie shale (Fig. 1). The duplexes are composed of Upper Devonian - Mississippian carbonate rocks. The basal detachment is located in Cambrian carbonate-shale succession in the SW and it ramps up forward to the upper Devonian-lower Mississippian strata. There are several culminations in antiformal stacks distributed over 67-km segment. The highest cumulative thickness of stacked horses of 5.7 km below the Cate Creek window gradually decreases forward to 1.4 km. The low-angle Flathead normal fault and minor normal faults record the extension at the rear side of the most prominent antiformal stack. The Eocene-Oligocene clastic deposits of the Flathead Valley Graben have preserved thickness of 700-900 m.

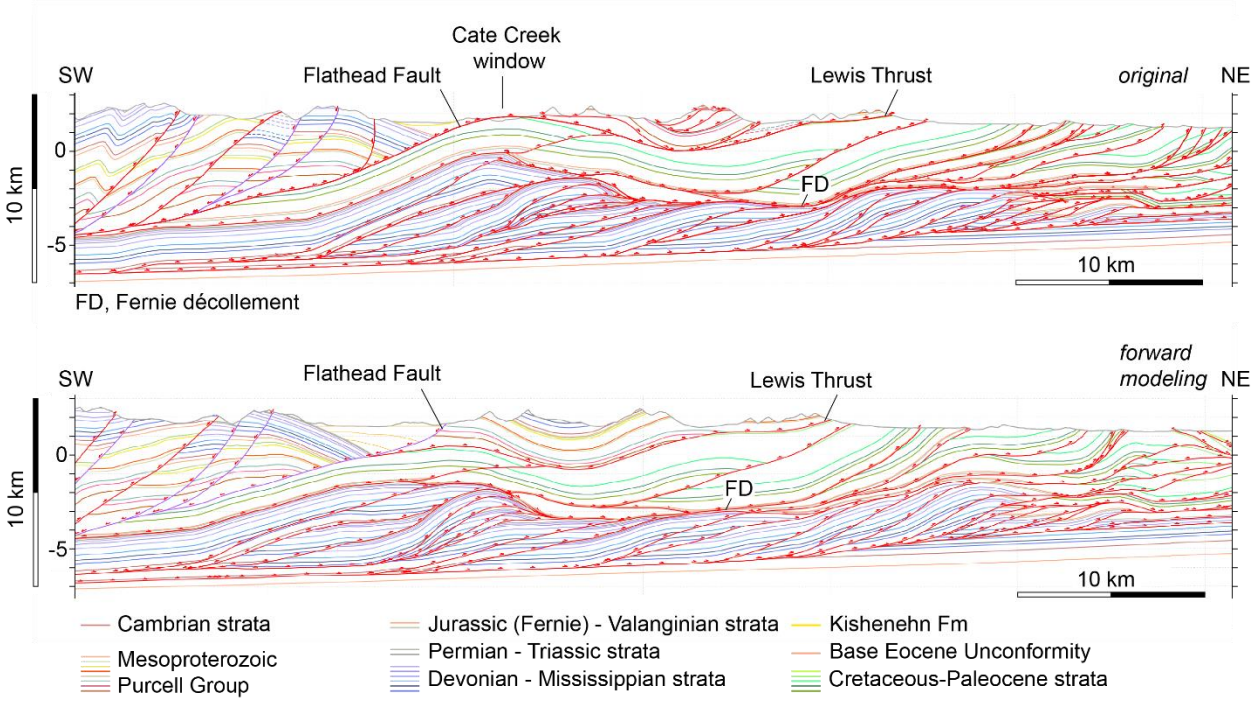

Fig. 1. The central part of the original and modeled cross-sections, southern Canadian Rocky Mountains.

Conclusions

Shortening in a sedimentary succession with contrasting mechanical strength of the rocks results in strain partitioning in thrust wedges. Accretion mechanisms in thrust wedges with decollement layers: duplexing and underplating below a weak layer at the back of the wedge and frontal accretion above the décollement at the wedge front. Amount of shortening varies with the thickness of tectonic slices.

Syntectonic erosion is favorable for antiformal stacking, uplift and exhumation at the back of the thrust wedge. Antiformal stacking and uplift result in subvertical shearing at the back of the wedge with the development of syn-shortening faults with normal-fault kinematics (Flathead normal fault?).

Acknowledgements

Authors thank Petroleum Experts for Move academic non-commercial license and very helpful technical support; Government of Canada for topographic digital data licensed under the Open Government License – Canada. This work was funded by Natural Sciences and Engineering Research Council of Canada through grants RGPIN 2019 04397, DGECR 2019 00186.

References

Fermor, P., and Moffat, I.W., 1996. Tectonics and Structure of Western Canada Sedimentary Basin. In: R. W. Macqueen and D. A. Leckie, eds., Foreland basins and fold belts: AAPG Memoir 55, p. 81–105.