Geophysical Research Abstracts
Vol. 21, EGU2019-3715, 2019
EGU General Assembly 2019

Structure of the frontal ranges of the Verkhoyansk fold-and-thrust belt: example from the Southern Verkhoyansk

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The Verkhoyansk fold-and-thrust belt was formed as a result of the collision of the Siberian paleocontinent and the Kolyma-Omolon superterrane. It is mostly composed of Carboniferous-Triassic sediments, but older sediments up to the Mesoproterozoic are exposed in its outermost zone. The sediments were accumulated within the ancient Siberian continent or on its passive margin. The most complete section is exposed in the South Verkhoyansk sector, which consists of Kyllakh, Sette-Daban and South Verkhoyansk zones.

The study area is located within the outermost (western) Kyllakh zone. It is composed of Mesoproterozoic terrigenous-carbonate succession unconformably overlain by Ediacaran, Cambrian and Ordovician predominantly carbonate succession, in turn unconformably overlain by Carboniferous terrigenous-carbonate and Lower Permian and Jurassic terrigenous successions. According to the fission track study (Prokopiev et al., 2004, Malyshev et al., 2018), the most intense deformations occurred at 80-70 Ma with some reactivation at 20-30 Ma.

The Nelkan-Kyllakh thrust separates Kyllakh zone from the Siberian platform forming an emergent thrust front. The total displacement is under discussion, but it can reach the first tens of kilometers. Structural style of the Kyllakh zone is dominated by the leading imbricate fan of thrust with closed hanging wall anticlines and wide open to gentle synclines. Western limbs of anticlines are often cut by thrusts.

In the hanging wall of the sole thrust (Nelkan-Kyllakh thrust) limestones of the Malga Formation are exposed. The underlying shales of the Totta Formation likely forms a week horizon favorable to development of a regional-scale detachment. Dipping of the sole thrust to the east is controlled by increasing thickness of Mesoproterozoic rocks, especially of the uppermost Uy Group. Its thickness increases eastward from 1.8 km in the Nelkan anticline to 2.9 km in the Guvinda, 3.5 km in the Chagda and 4.6 km in the Ulakhan-Bam anticline. Although in the east the thickness of the entire thrust sheet is about two times greater than in its frontal part, the structural style does not show significant variations.

Cross-section balancing was performed using the Move software (Midland Valley). The shortening for the entire Kyllakh zone calculated for the Malga and Tsipanda Formations of the Kerpyl Group and for the Lakhanda Group is 24% or 16.5 km. The shortening between the Nelkan-Kyllakh and Guvinda thrusts is 25%, between the Guvinda and Chagda thrusts - 27%, whereas between the Chagda and the Chelat thrusts does not exceed 8%, and between the Chelat and Ulakhan-Bam thrusts reaches 30%.

Similar values of shortening were obtained by less detailed reconstructions to the north of the study region (Prokopiev, Deikunenko, 2001). In general, the shortening values are significantly less than in the frontal zones of similar fold-and-thrust belts; for example, in the Rocky Mountains of the Cordillera of Canada shortening reaches 50-60% (e.g. Price, 1994).