Structural evolution of the Silesian nappe (Outer Carpathians) inferred from the analysis of cross-fold joints: case study from Bieszczady Mts (Poland)

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The eastern part of Polish segment of Outer Carpathians consists of several NE-verging nappes. The Silesian nappe belonging to this stack was folded during Late Oligocene — Miocene times. Map-scale fold axes in inner part of the Silesian nappe are oriented N130E. Lower Cretaceous — Lower Miocene strata crop out in this area. This made possible to study developement of jointing in rocks spanning a considerable time interval. Joints have been studied in 23 stations. Research has been focused on cross-fold joints comprising: (1) a single set of joints striking perpendicular to map-scale fold axes (T- joints) and (2) two conjugate sets of joints with the acute bisector oriented perpendicular to map-scale fold axes. Orientation of T-joints as well as orientation of the acute bisector between the conjugate sets and the value of the acute angle were determined for: (1) Lower Cretaceous, (2) Upper Cretaceous and, (3) Paleogene — Lower Miocene strata.

(1) In Lower Cretaceous strata, T-joints are oriented N45E. Acute angle between the conjugate sets is 32°, whereas the bisector of this angle is oriented N42E. (2) In Upper Cretaceous strata, T-joints are oriented N41E. Acute angle between conjugate sets is 44°, whereas the bisector of this angle is oriented N49E. (3) In Paleogene and Lower Miocene strata, T-joints are oriented N48E. Acute angle between conjugate sets is 60°, whereas the bisector of this angle is oriented N47E.

The disscused data may be summarized in the following way: (i) both the T-joints and the acute bisector between the conjugate sets are oriented perpendicular to the regional fold axes within the whole studied stratal sequence, (ii) the mean value of the acute angle between the conjugate sets increases from 32°, in Lower Cretaceous strata (1) to 44° in Upper Cretaceous strata (2) and 60° in Paleogene and Lower Miocene strata (3).

In the present interpretation, the orientation of maximum stress axis (σ_1) is considered to be parallel both to the T-joints and to the acute bisector between the conjugate sets, whereas the relative value of σ_1 is considered to be positively related to the value of the acute angle between the conjugate sets. In this interpretation: (1) the orientation of the main stress axis (σ_1) was permanent since Early Cretaceous time to Early Miocene time and, (2) the relative value of σ_1 was continuously increasing during the discussed span of time.