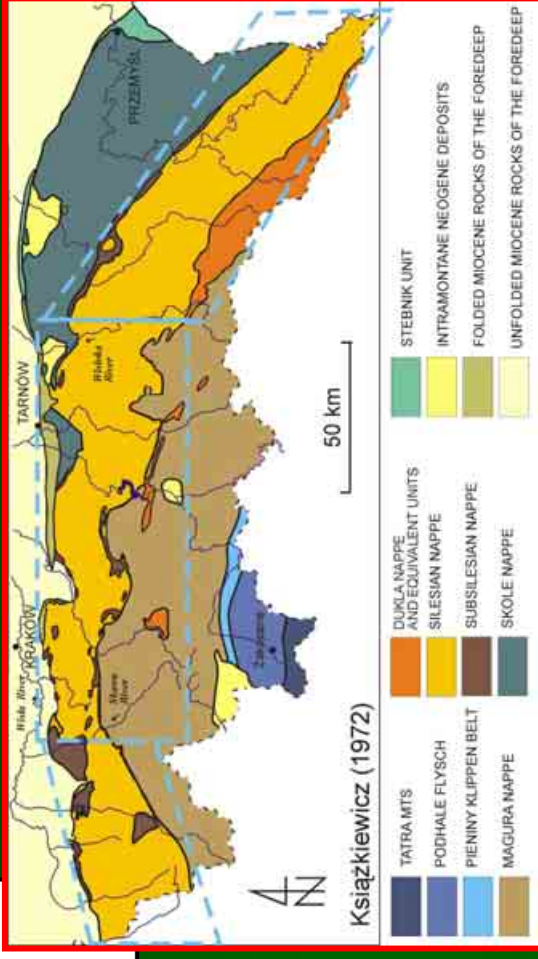
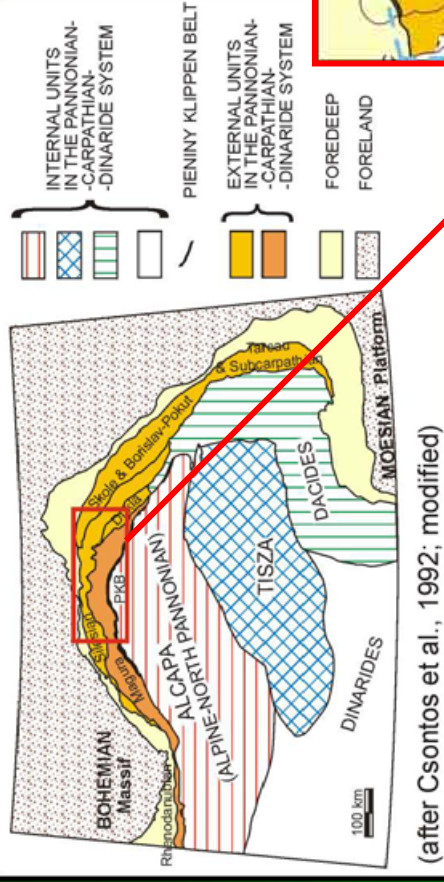


Tectonic shortening of the Western Outer Carpathians in light of the mesostructural data of the Silesian nappe

Marta Rauch-Włodarska

Institute of Geological Sciences
Polish Academy of Sciences
Department of Geology of the Sudetes

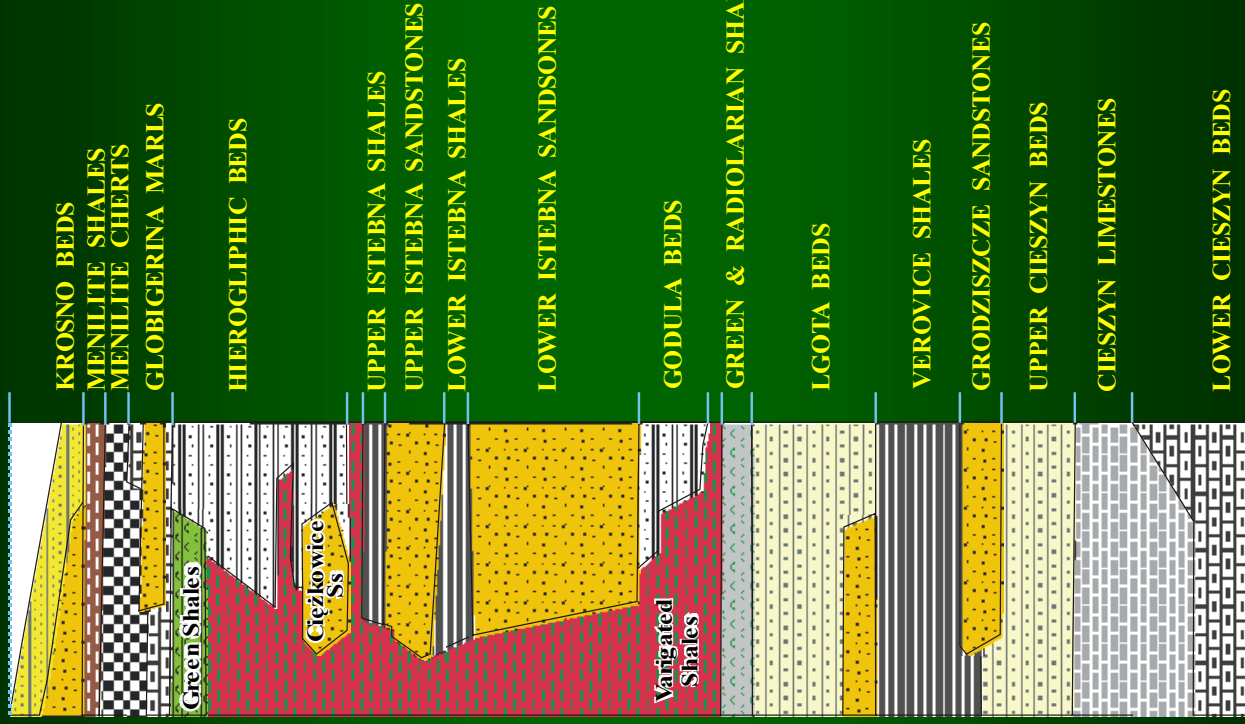
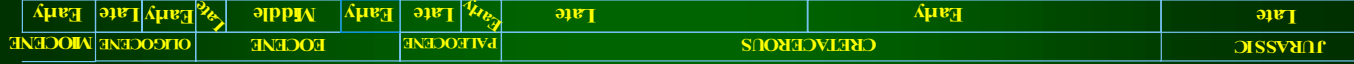
Introduction



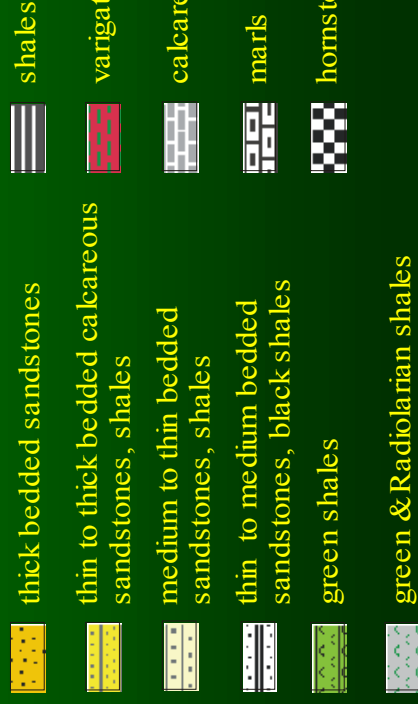
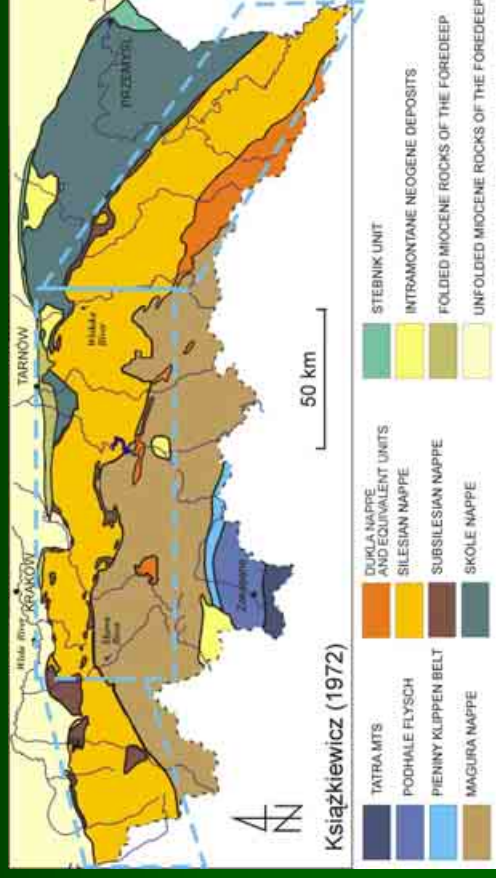
- In the traditional opinion, in the Polish Outer Carpathians the regional folding took place during single event in the Early Miocene (Książkiewicz, 1972);

- in the main nappes (Magura and Silesian) the map-scale folds change their orientation (from W to E): from WSW-ENE trough W-E to WNW-ESE (Tołwiński, 1921; Świdorski, 1952; Książkiewicz, 1972; Mastella et al., 1997; Szczesny, 2001);
- the history of the tectonic shortening of the Polish part of the Outer Carpathians is subdivided into 2 stages, which are characterized by horizontal compression oriented: 1) NNW-SSE (to N-S) and 2) NE-SW (to NNE-SSW) (Aleksandrowski, 1985 and 1989; Decker et al., 1997 and 1999); first stage terminated in the Early Miocene and second one in the early Late Miocene;

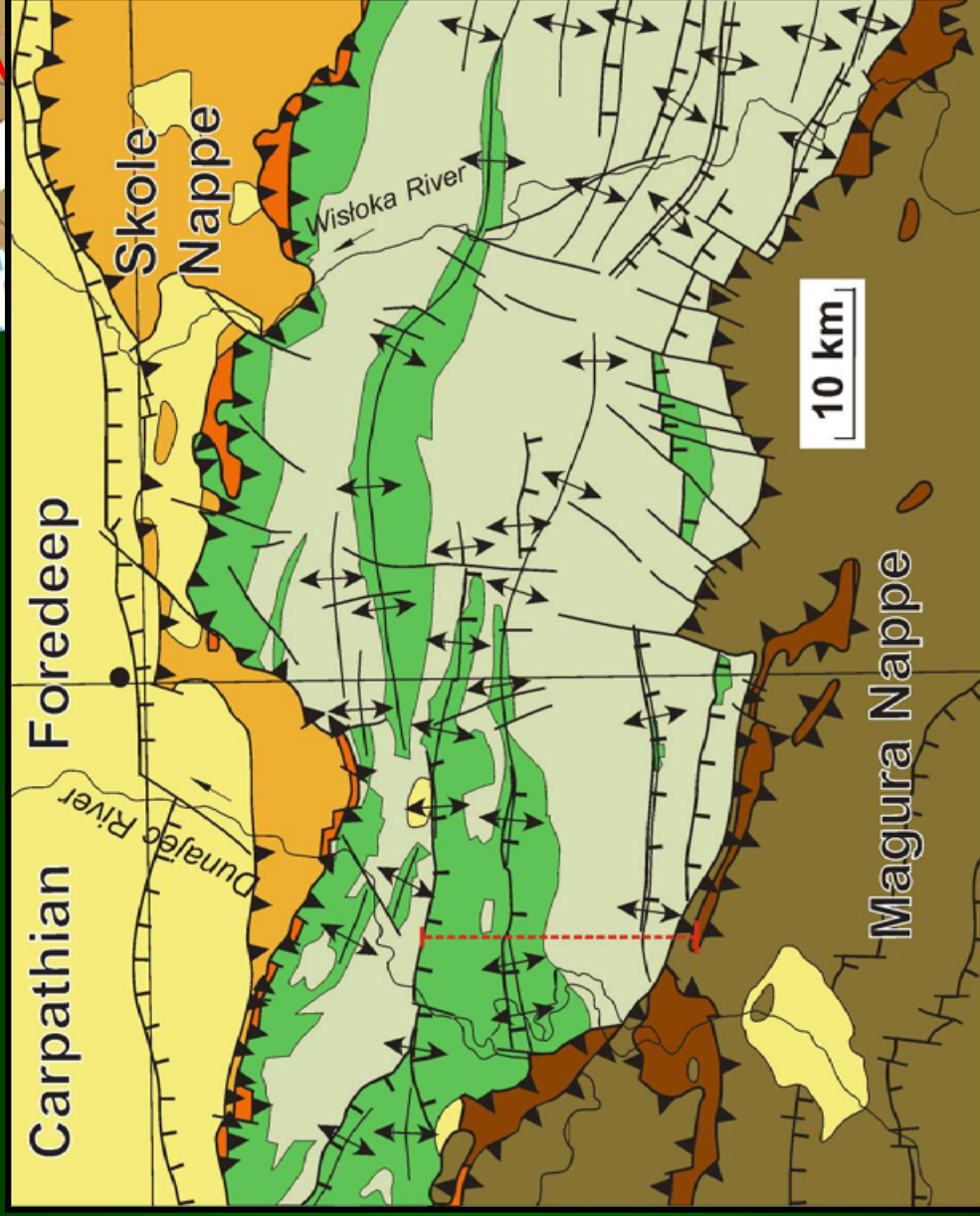
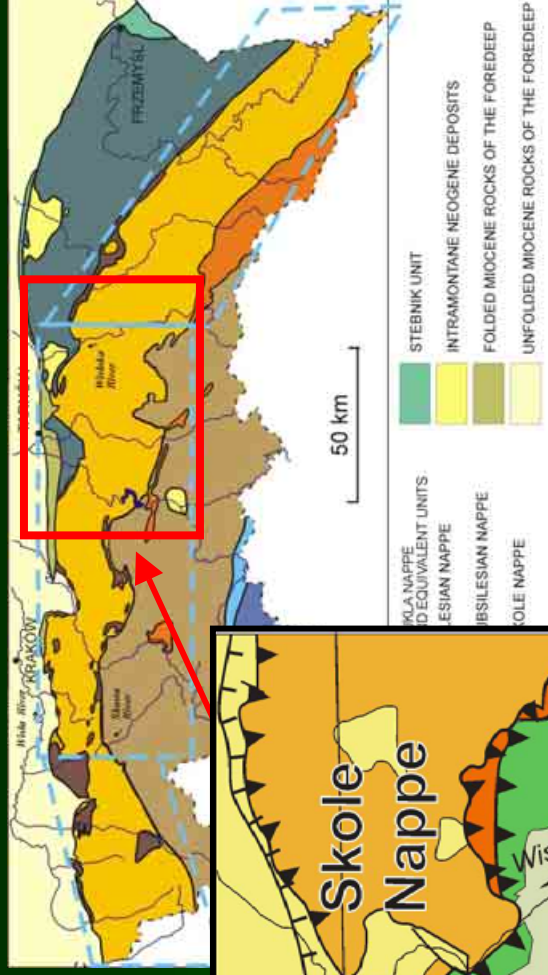
[Ma] 15



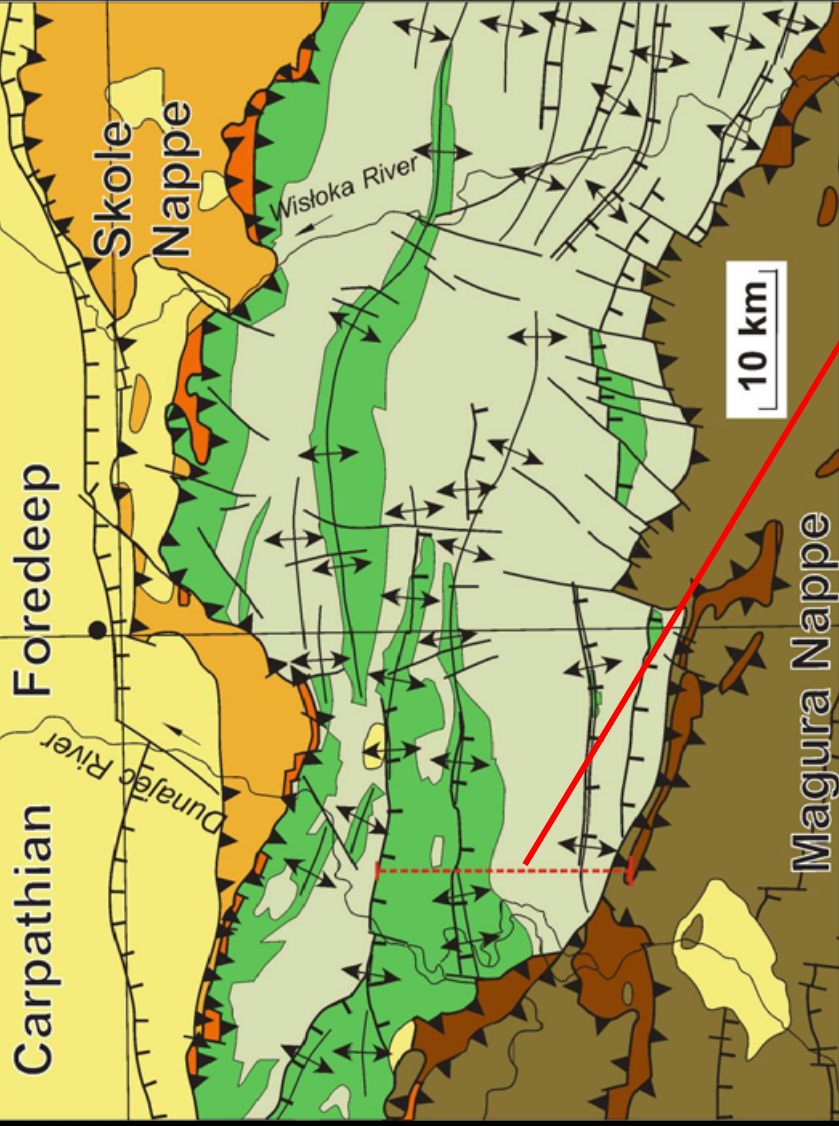
Lithostratigraphy of the Silesian nappe after Kamiński and Ślaczka (1998) and Oszczypko (2004)



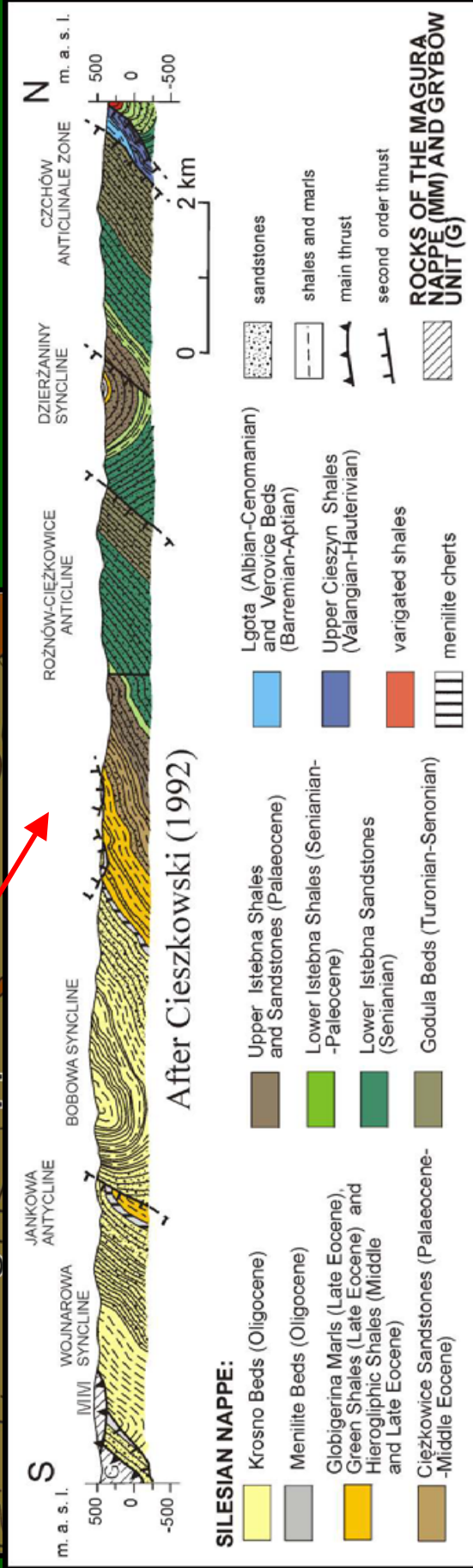
Silesian nappe



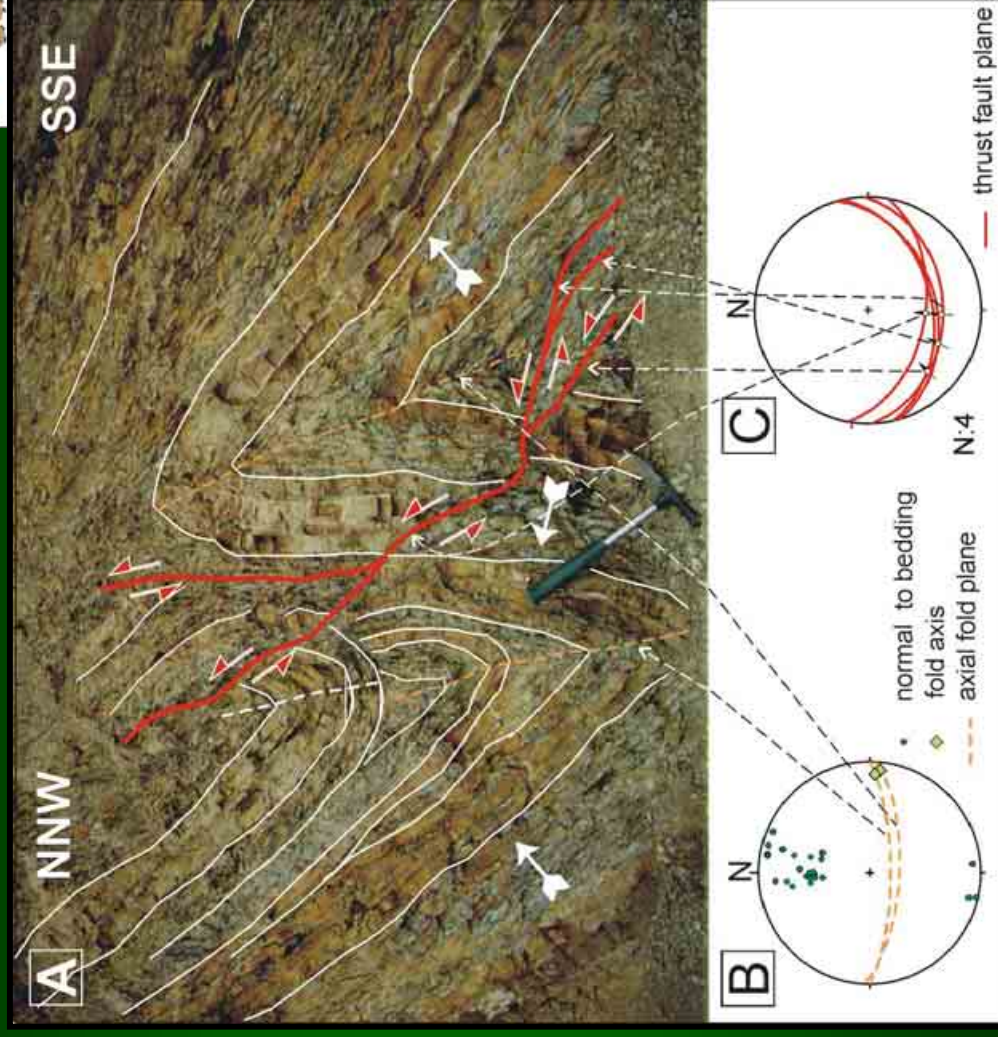
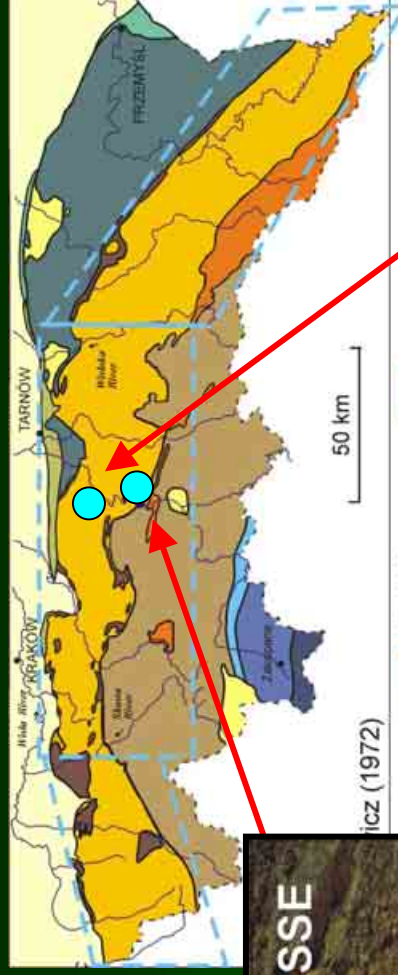
Geology mainly after Żytko et al. (1989). Modifications: 1) frontal thrust of the Magura nappe after Jankowski (1997); 2) orientation of the fold axes in the Silesian nappe after Kuśmerek (1990), Cieszkowski (1992), Leszczyński and Radomski (1994), Jankowski (1996 and 1997) and Rauch (2002 and referenced therein).



Silesian nappe



Folds



Sienna (central part of Silesian nappe), Hieroglyphic beds, Middle and Upper Eocene

Złota (central part of Silesian nappe), Krosno beds, Lower Oligocene

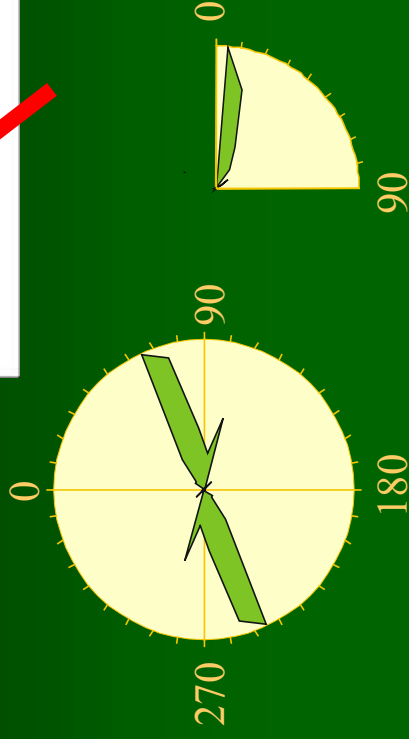
Folds - western part of the Silesian nappe

1

FOLD AXES

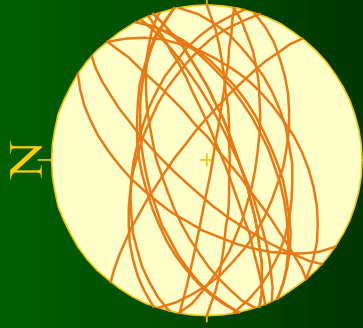


N: 43

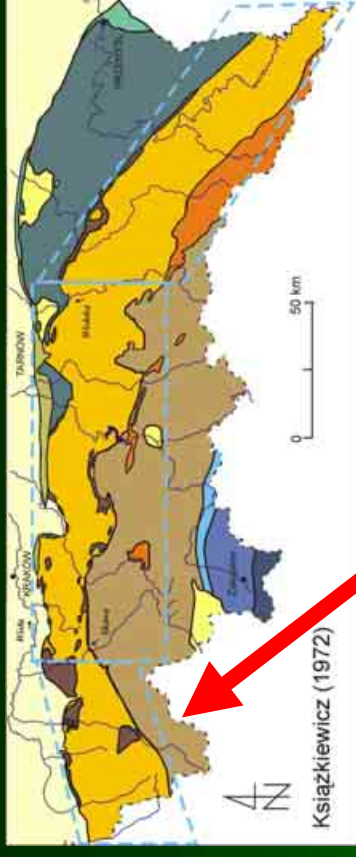
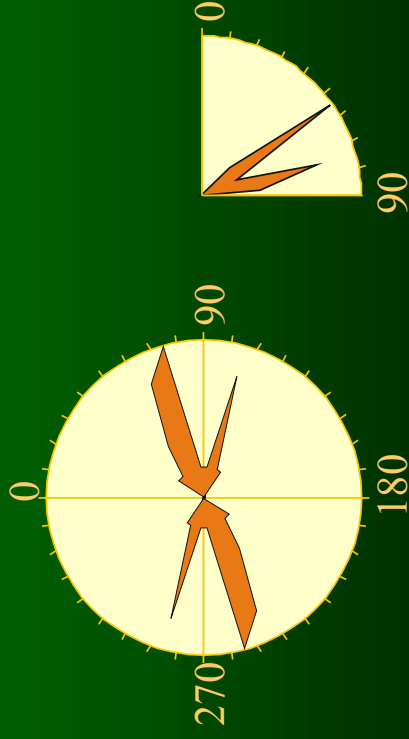


2

AXIAL FOLD PLANES



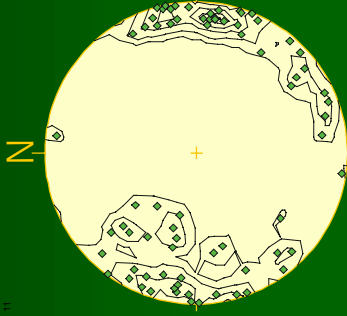
N: 21



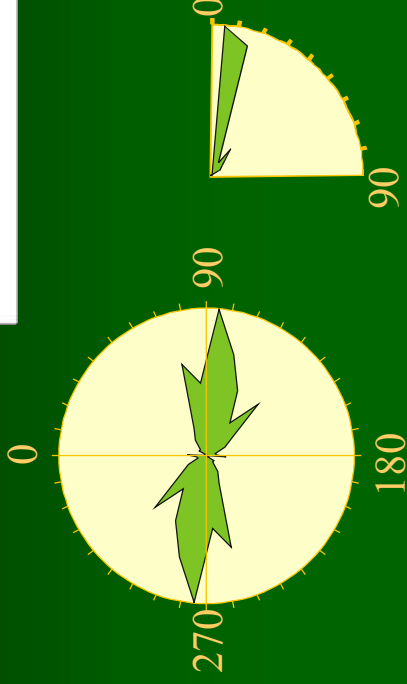
Folds – central part of the Silesian nappe

1

FOLD AXES



N: 74

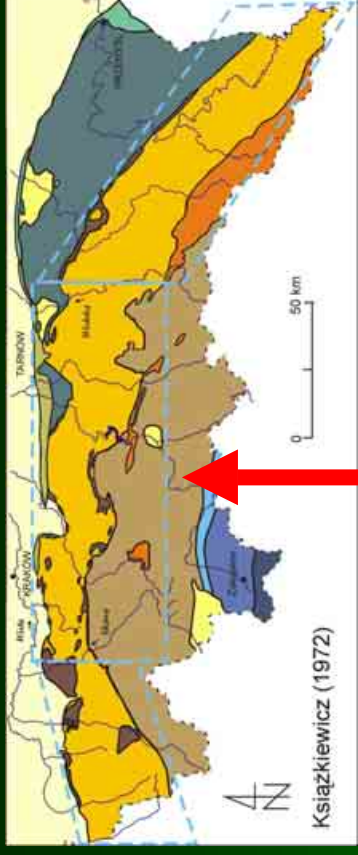
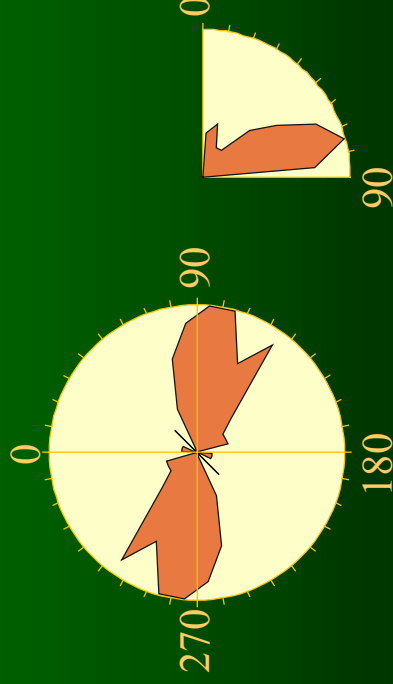


2

AXIAL FOLD PLANES



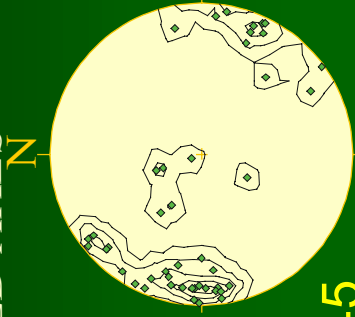
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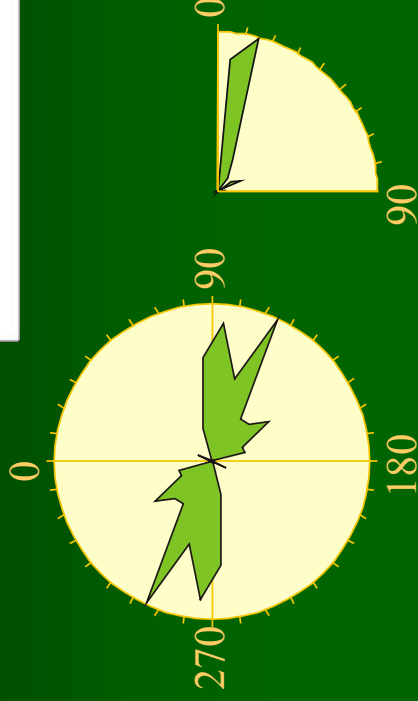
Folds – eastern part of the Silesian nappe

1

FOLD AXES

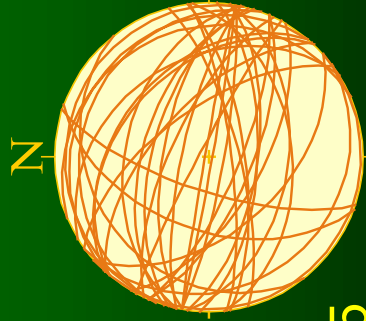


N: 45

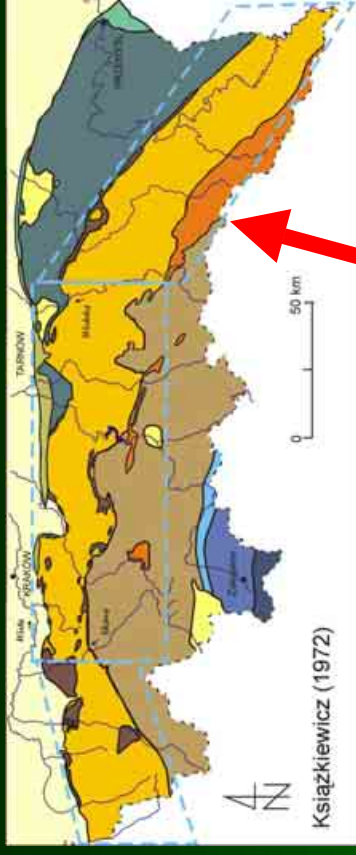
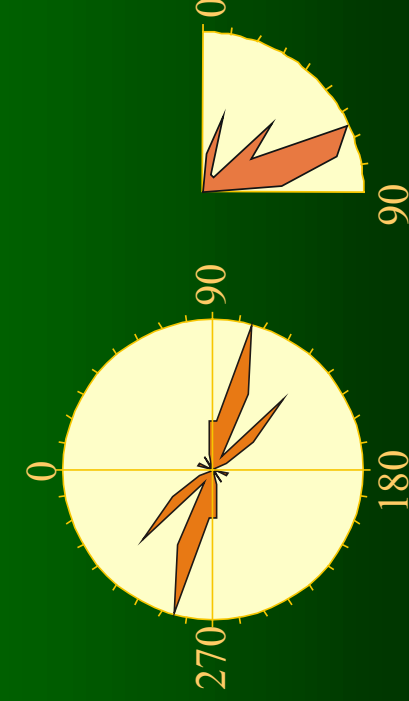


2

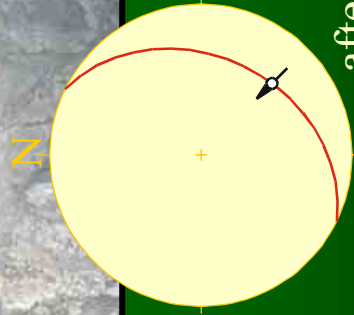
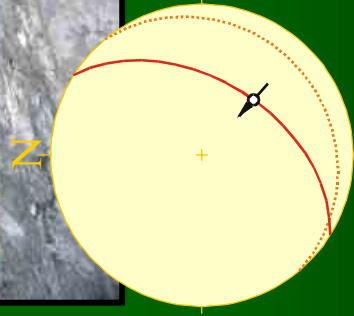
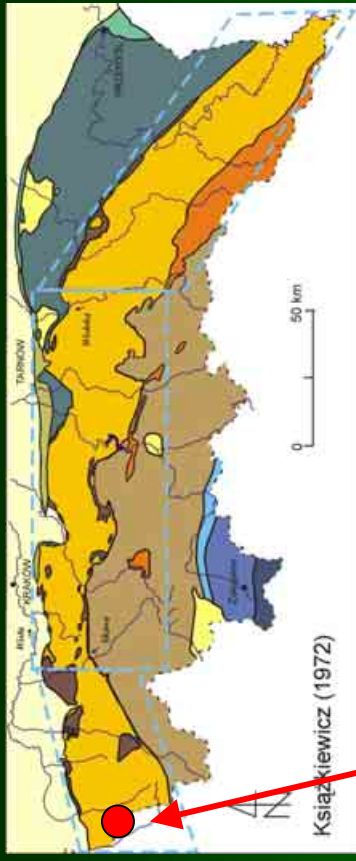
AXIAL FOLD PLANES



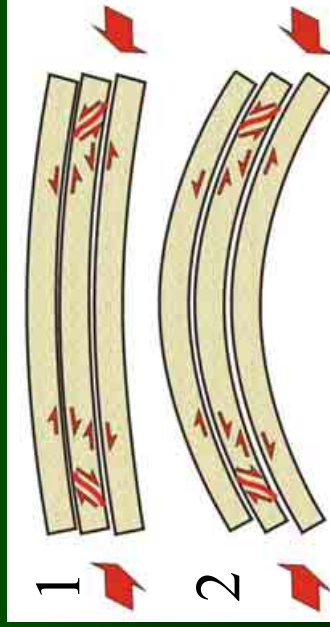
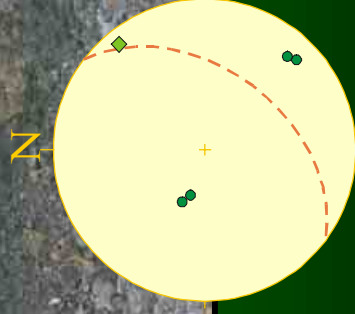
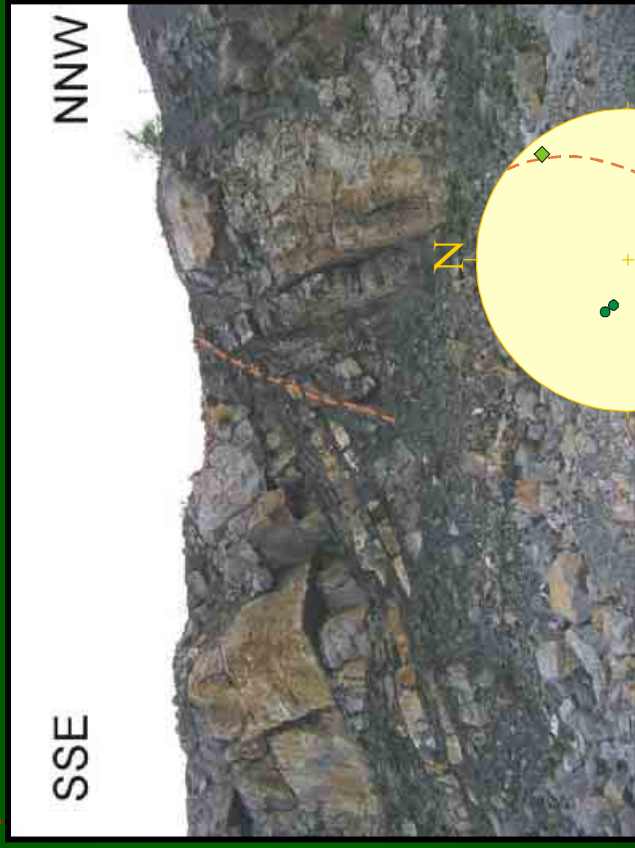
N: 35



Thrust faults of (1B) group

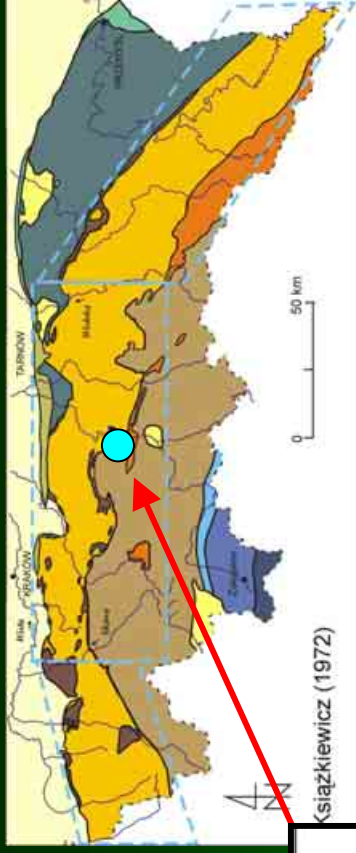
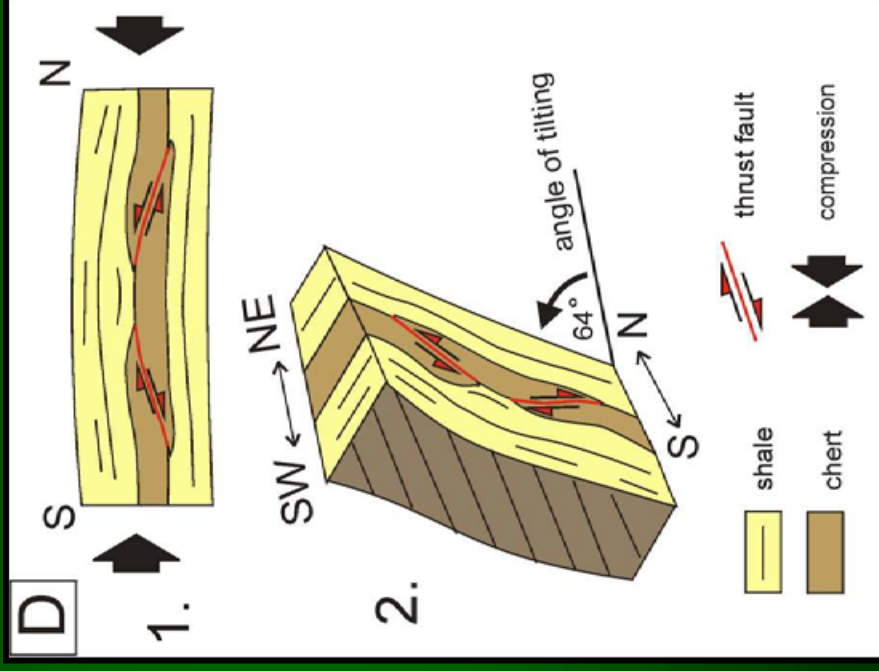
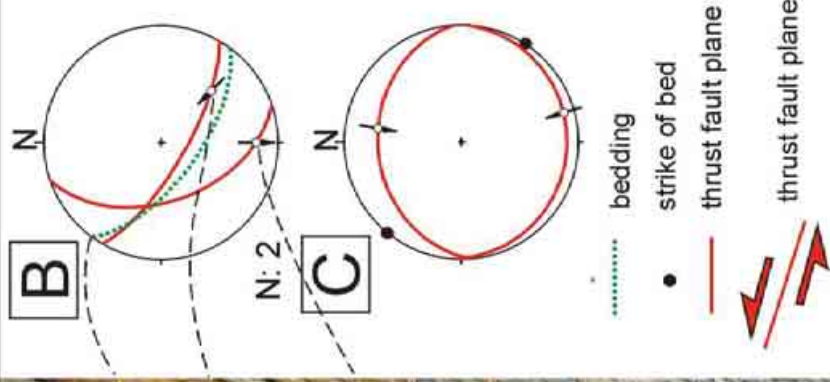


after
backtilting



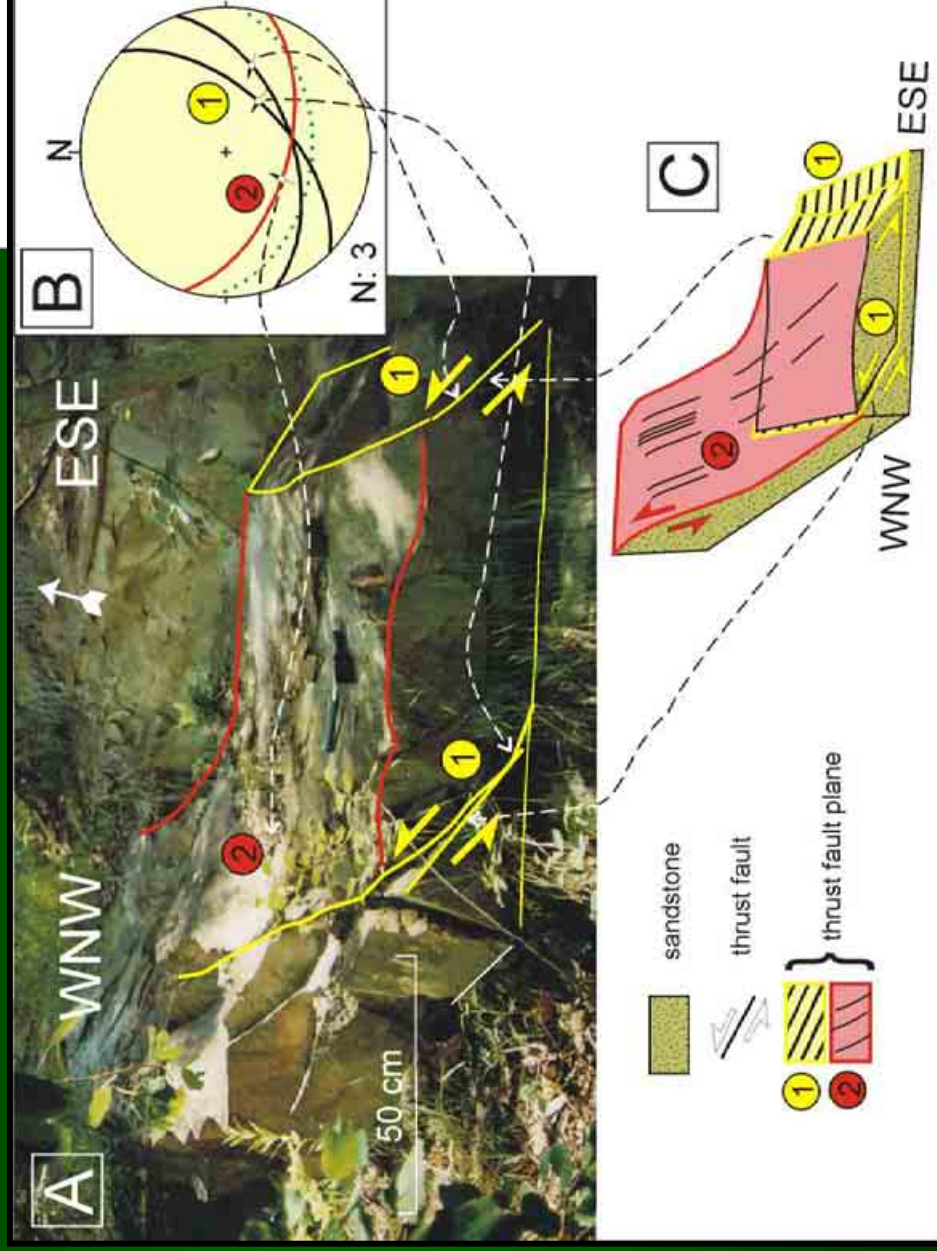
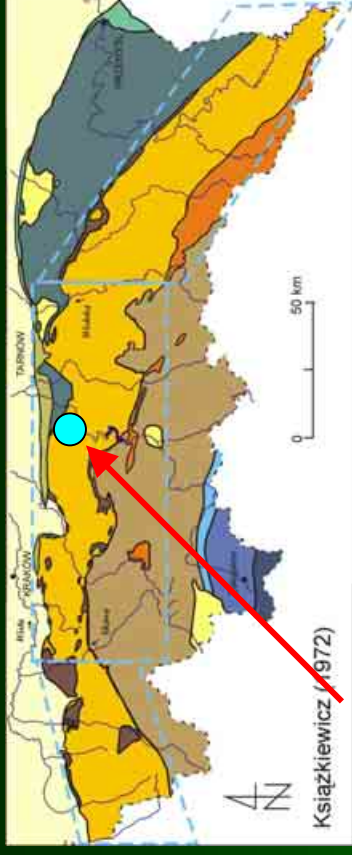
Leszna Góra (western part of the Silesian nappe)
Upper Cieszyn Beds, Lower Cretaceous

Thrust faults of (1A) group



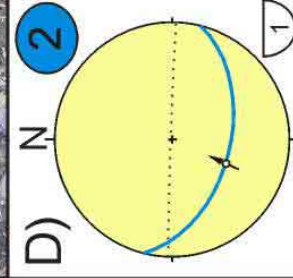
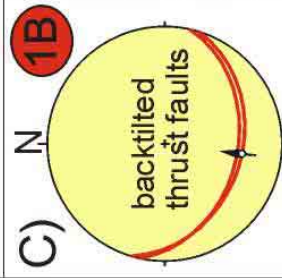
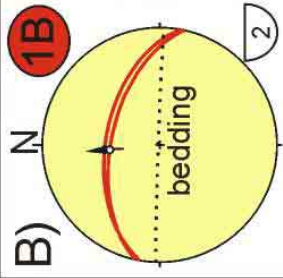
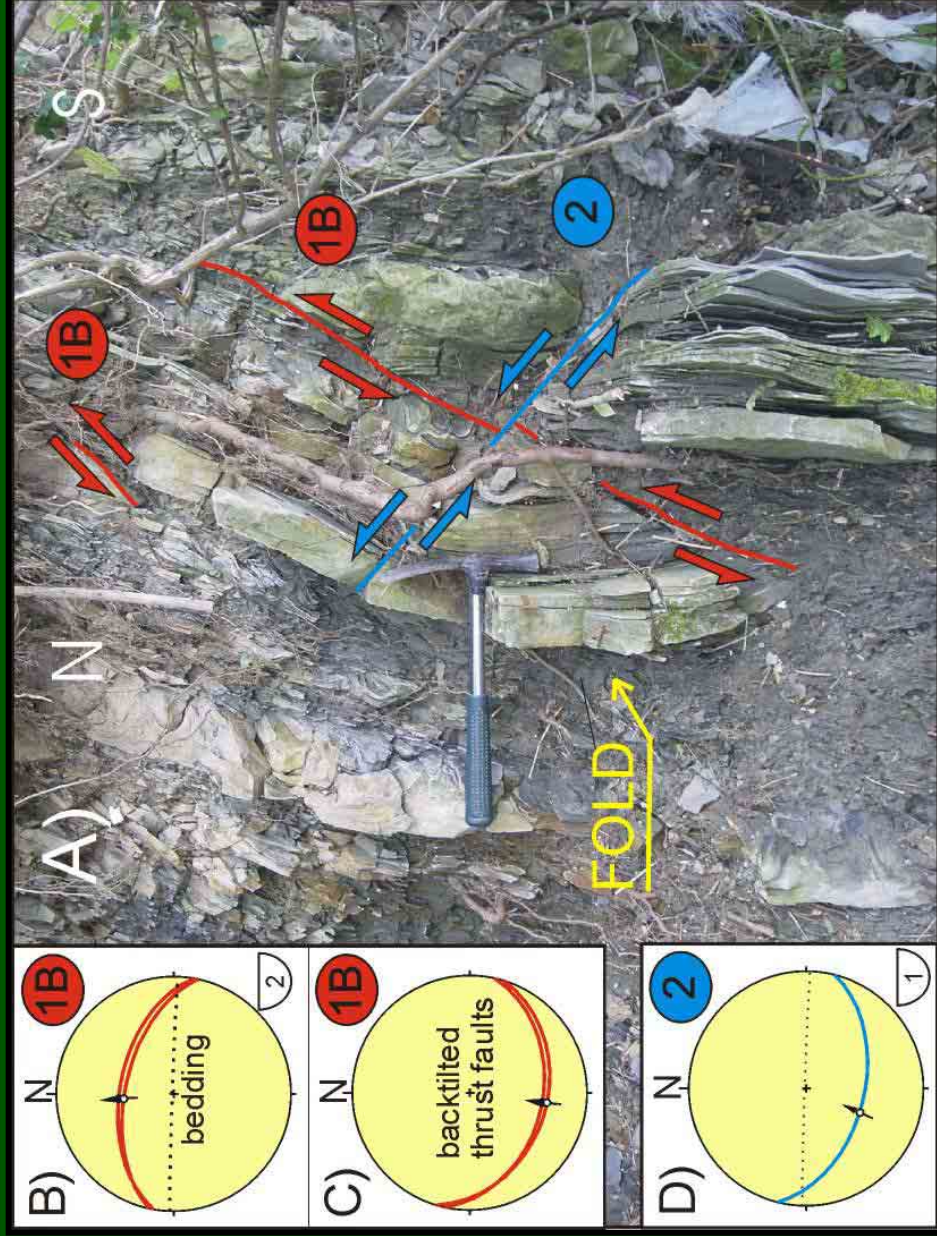
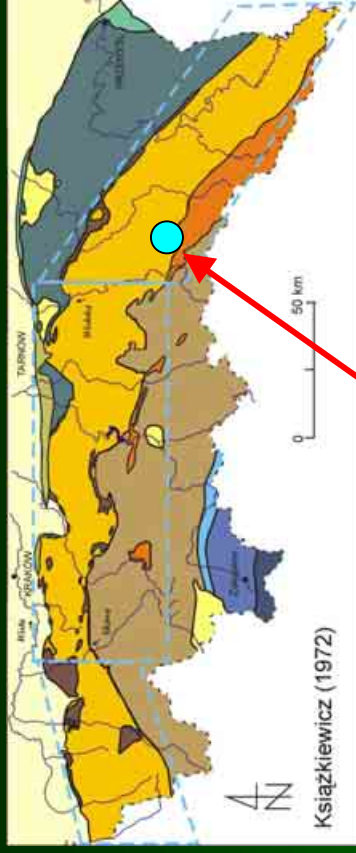
Znamierowice (central part of the Silesian nappe)
Menilite Beds, Oligocen

Thrust faults of (1AB) group



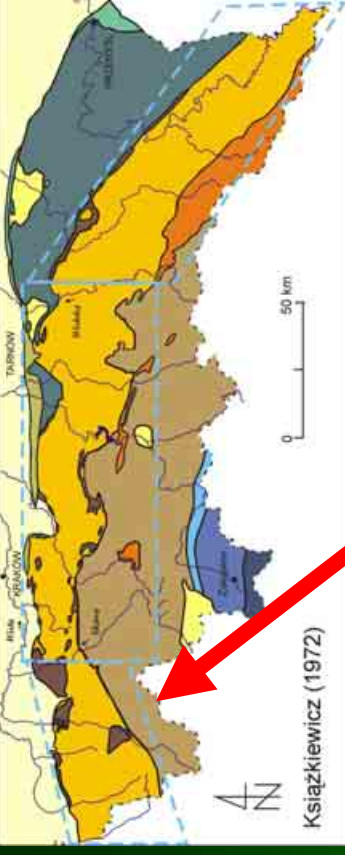
Melsztyn (central part
of the Silesian nappe)
Ciężkowice Sandstones,
Paleocene – Middle Eocene

Thrust faults of (1) and (2) group

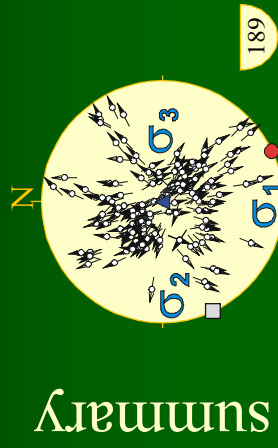


Rogi (eastern part of the Silesian nappe); Krosno Beds (Oligocen)

Thrust faults in the western part of the Silesian nappe

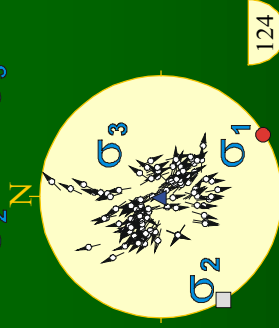


Fault planes



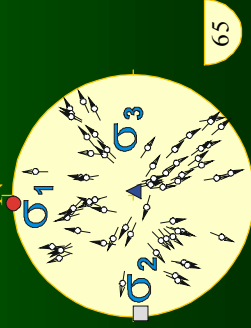
σ_1 155/01 σ_2 245/01 σ_3 16/89

1 group



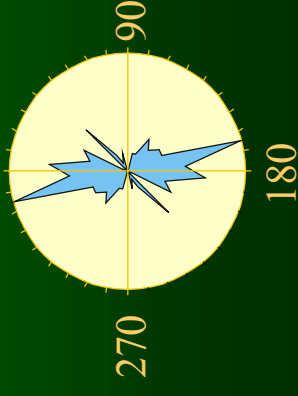
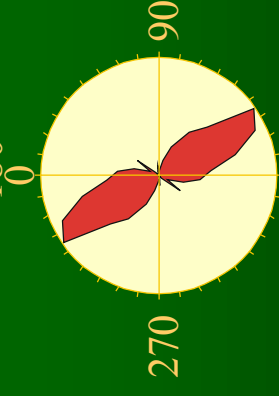
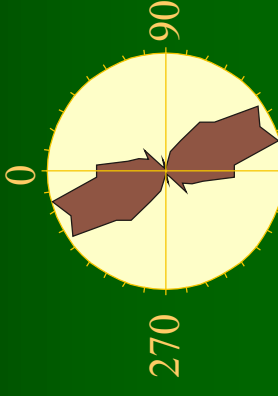
σ_1 149/01 σ_2 239/00 σ_3 334/89

2 group

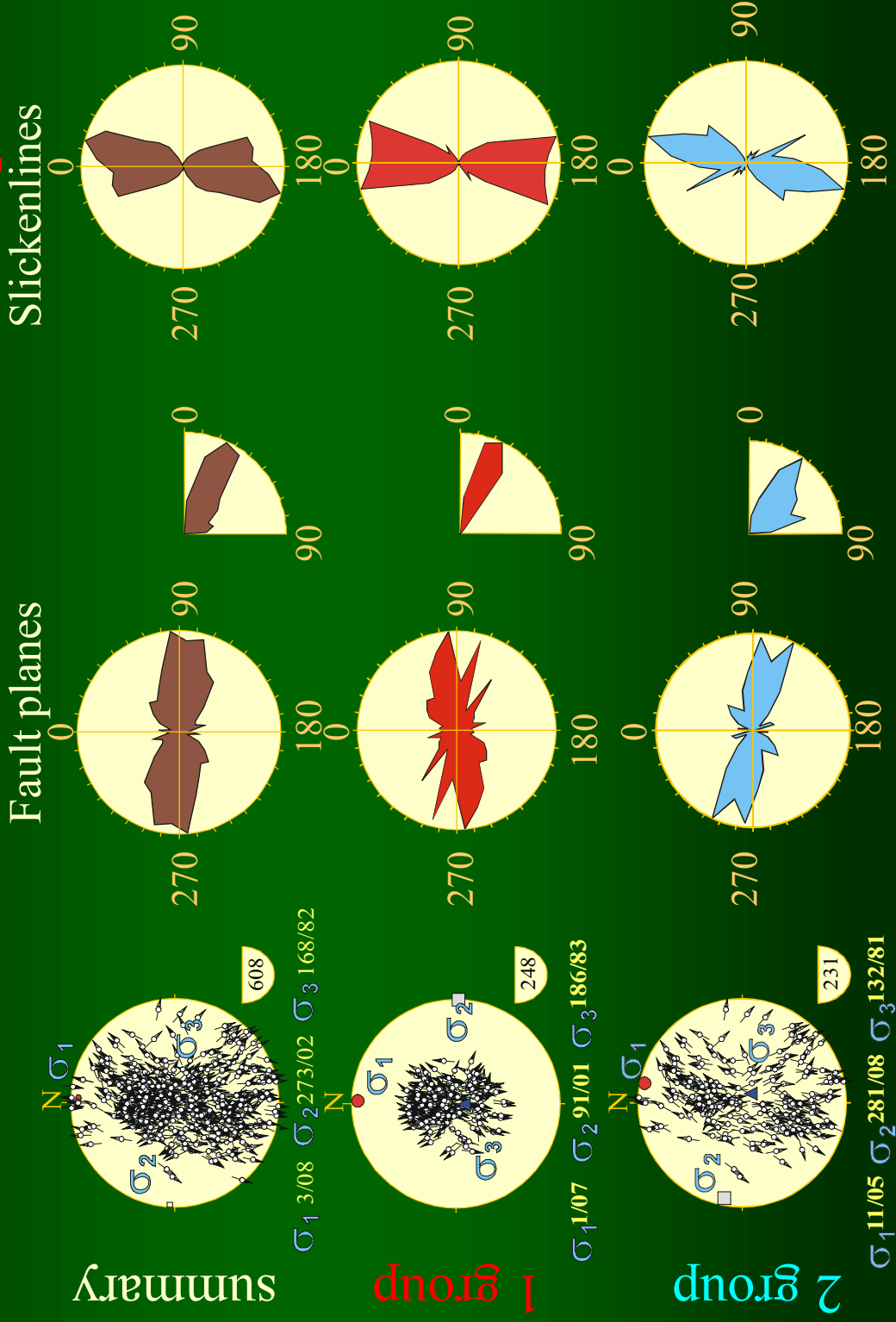
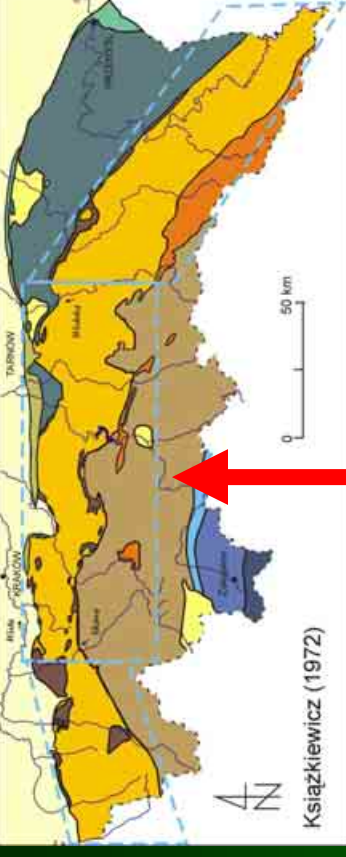


σ_1 356/01 σ_2 266/03 σ_3 98/87

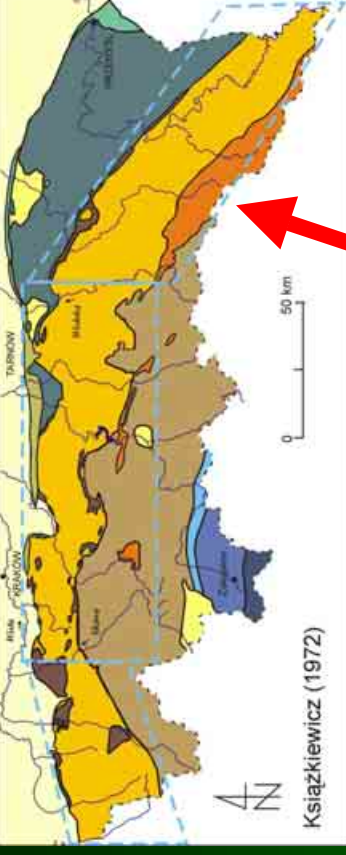
Slickenlines



Thrust faults in the central part of the Silesian nappe

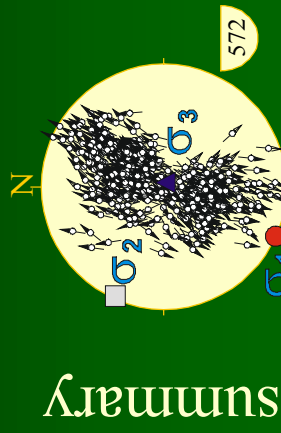


Thrust faults in the eastern part of the Silesian nappe

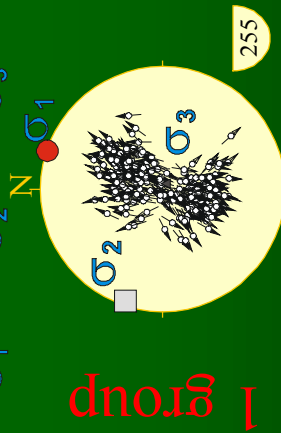


Fault plans

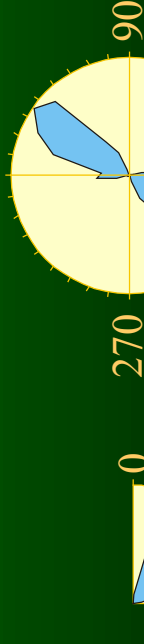
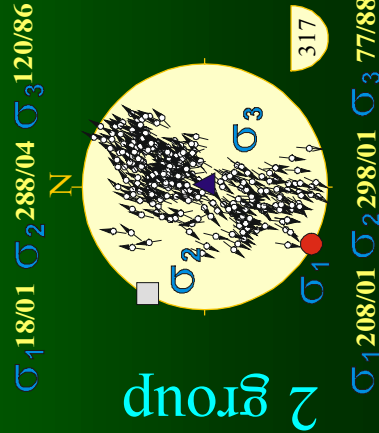
Slickenlines



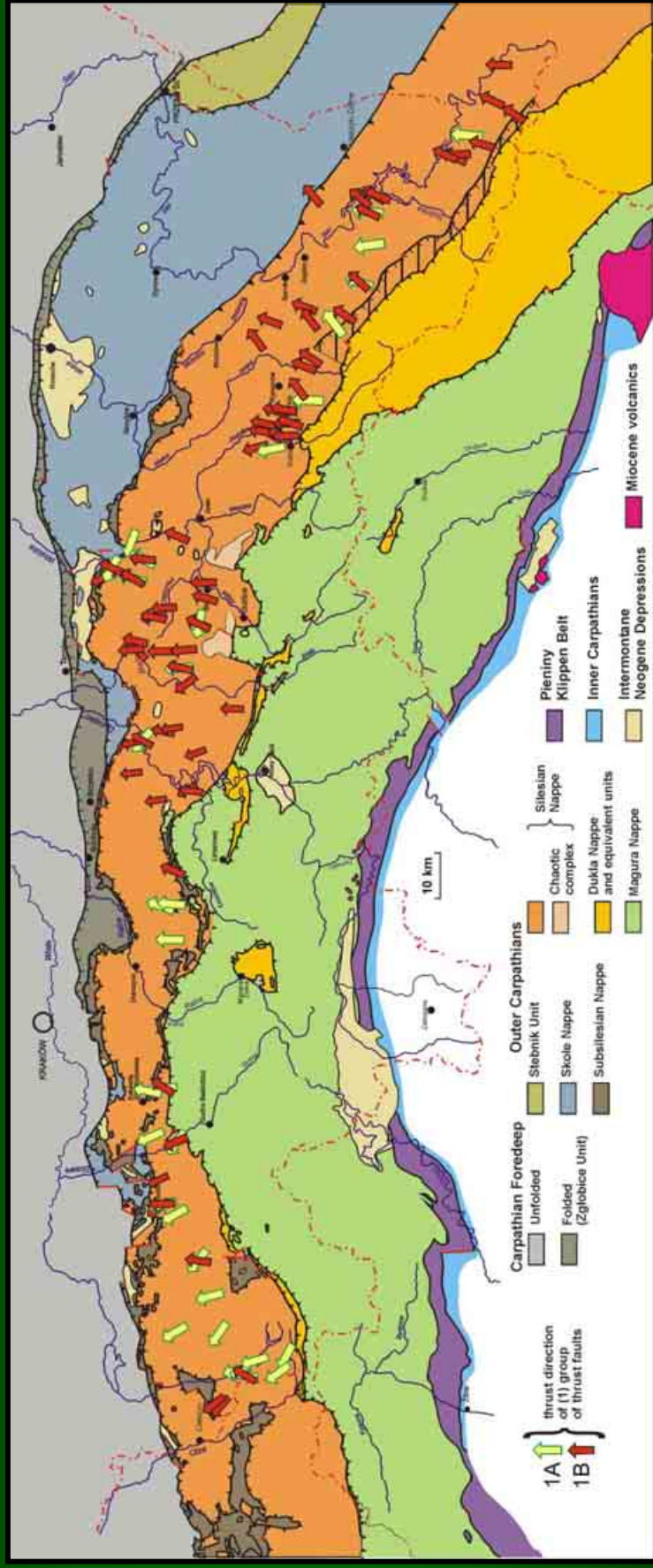
1 group



2 group

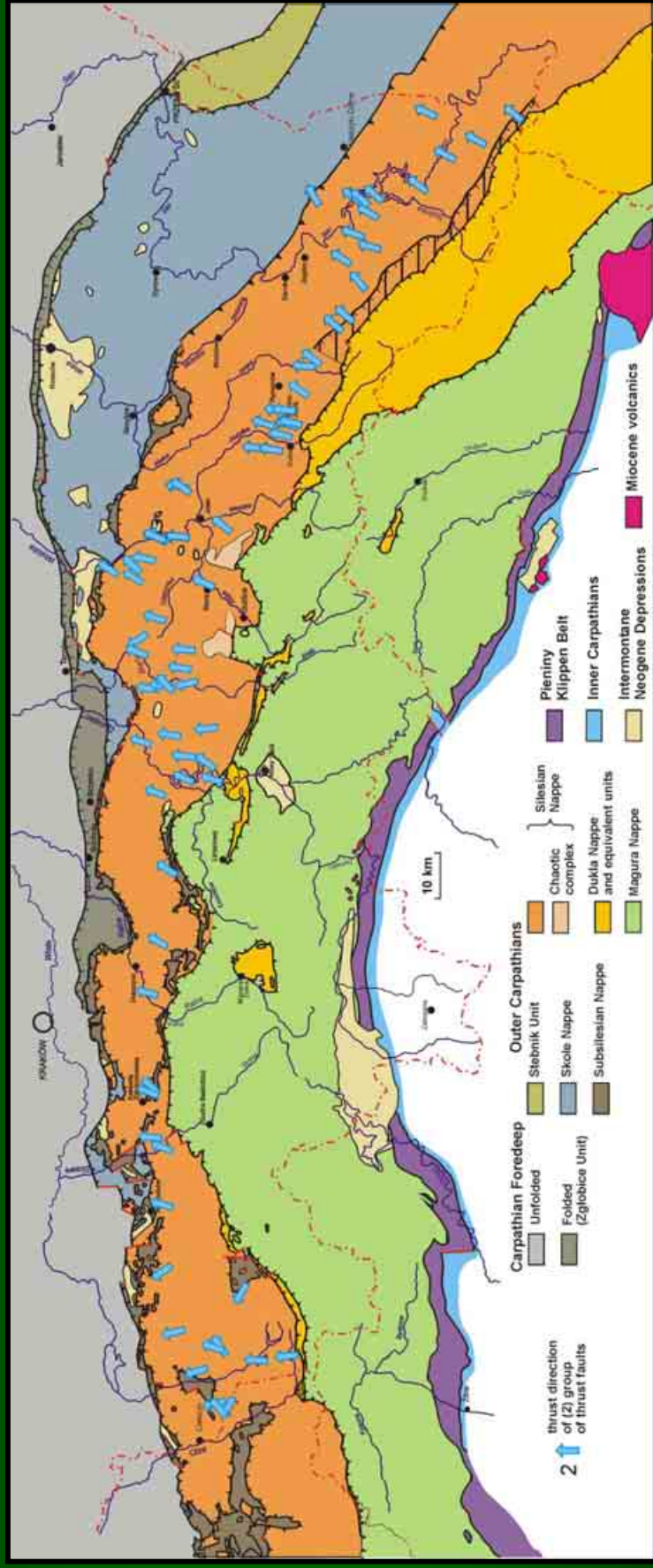


Distribution of thrust direction of (1) thrust group



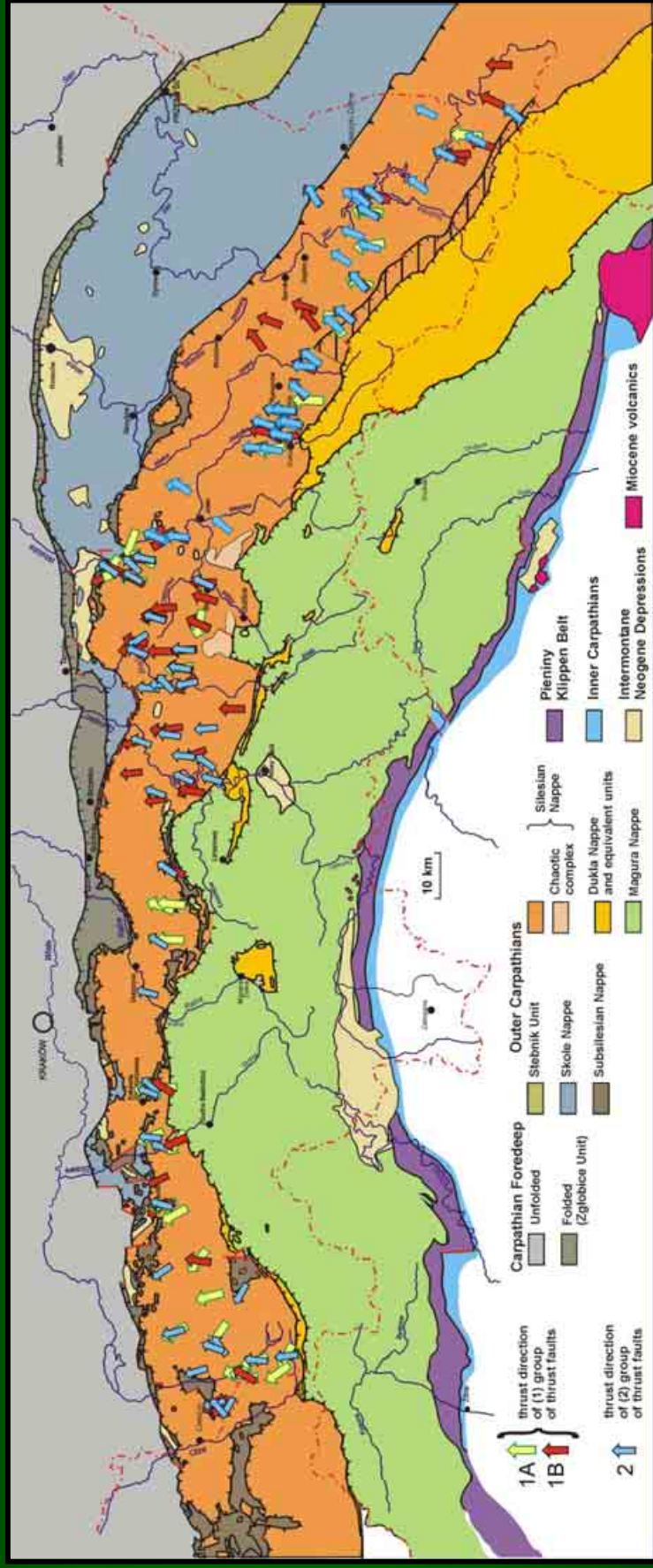
Geology mainly after Żytko et al. (1989). Modifications after Jankowski, Kopciowski, Rylko (2005)

Distribution of thrust direction of (2) thrust group



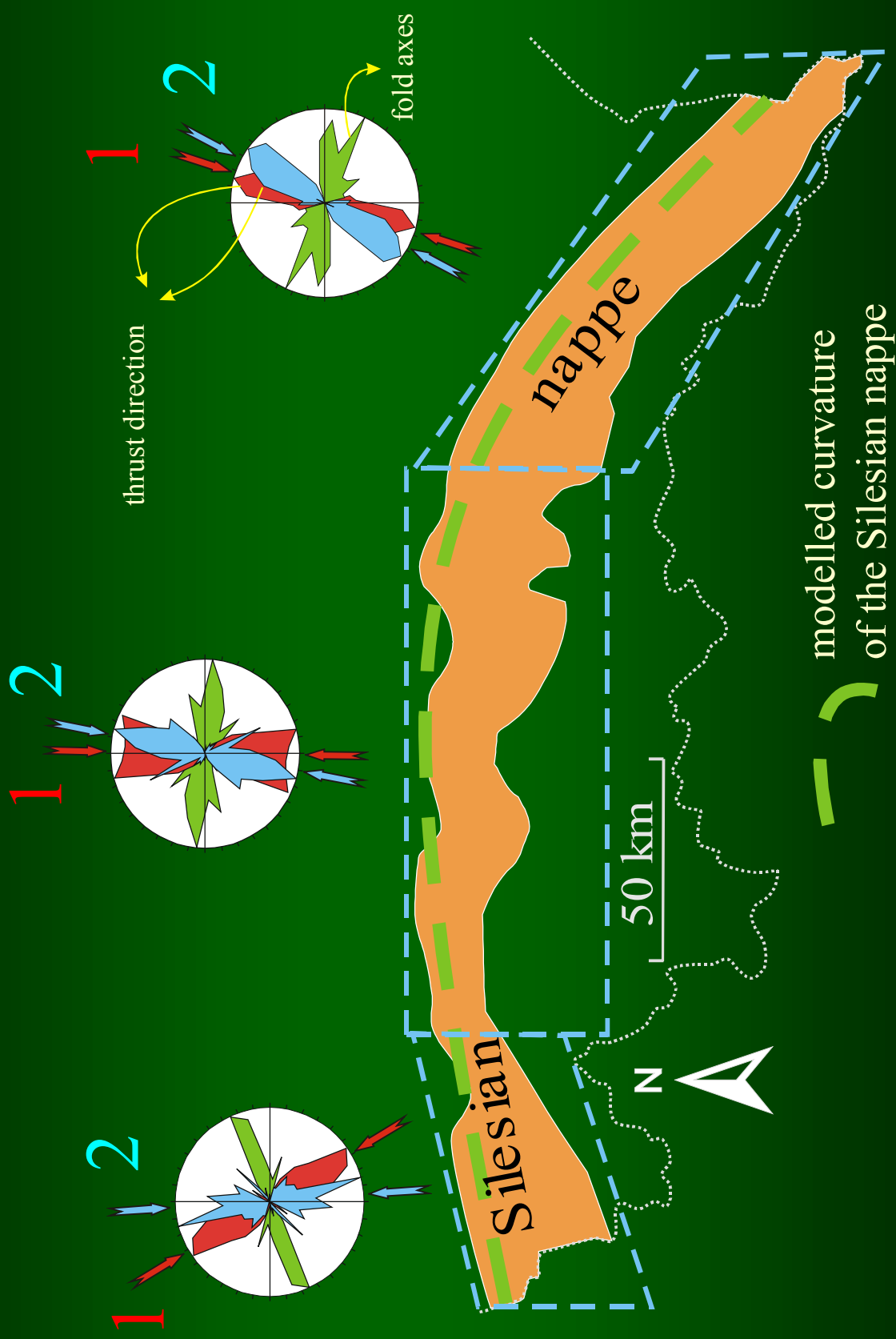
Geology mainly after Żytko et al. (1989). Modifications after Jankowski, Kopciowski, Rylko (2005)

Distribution of thrust directions of (1) and (2) thrust group

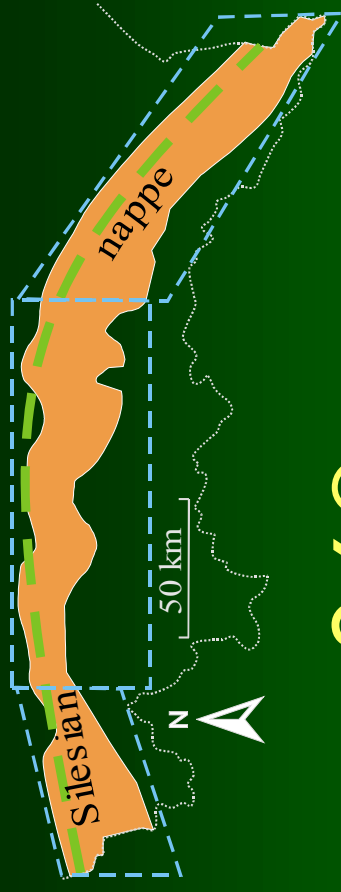


Geology mainly after Żytko et al. (1989). Modifications after Jankowski, Kopciowski, Rylko (2005)

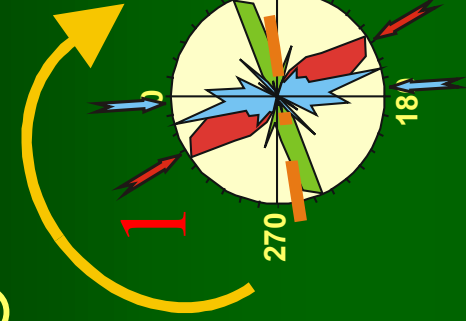
Summary:



Interpretation

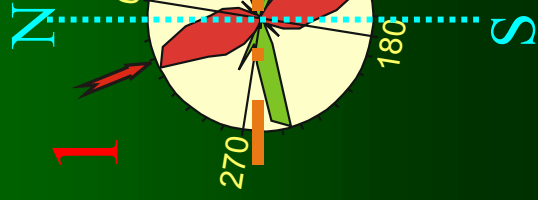
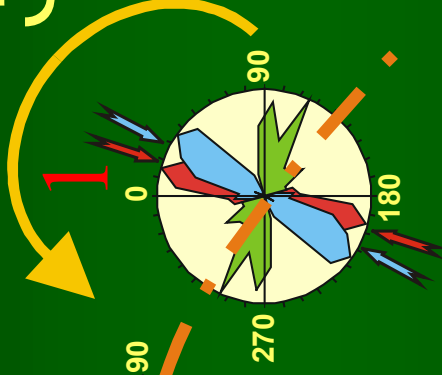


90°

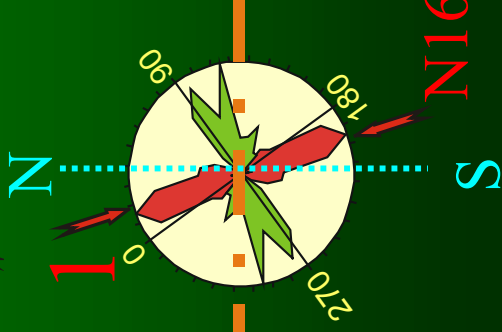


360°

Present
Silesian nappe
curvature



Straightened
Silesian nappe
curvature

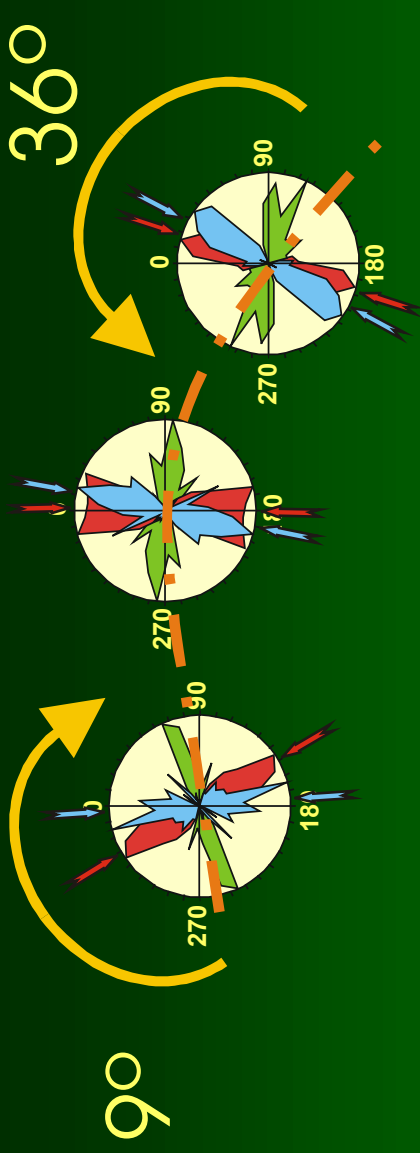


N161°E

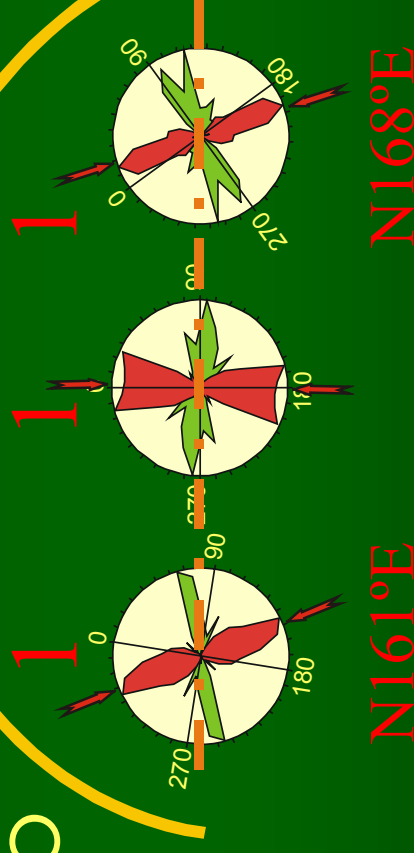
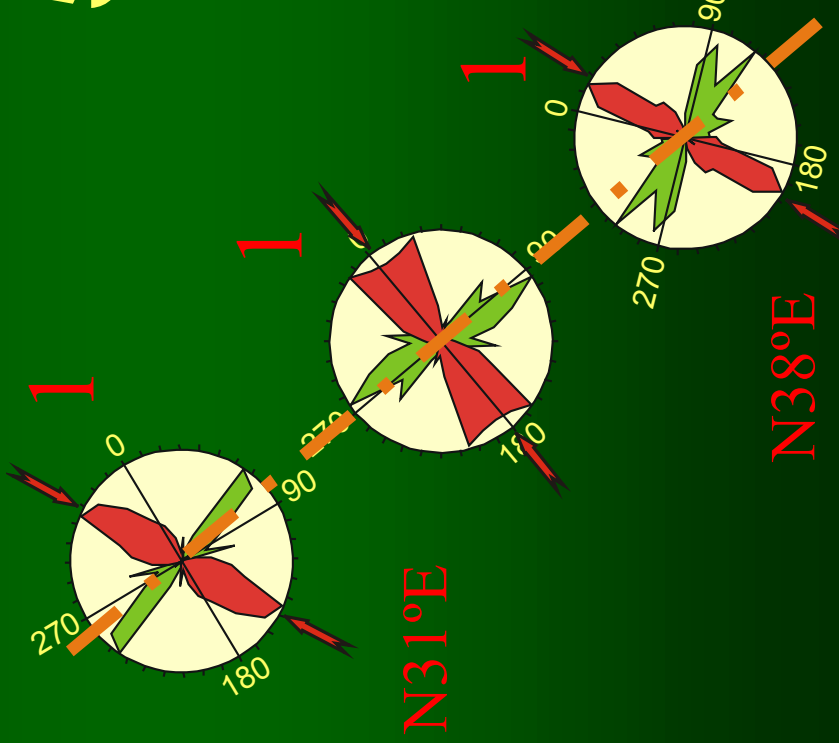
N168°E

Interpretation

3. Present curvature of the Silesian nappe



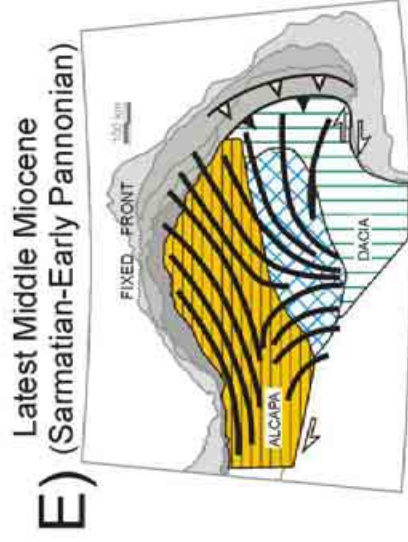
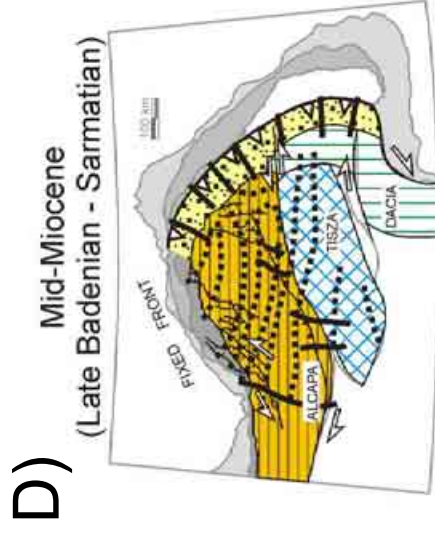
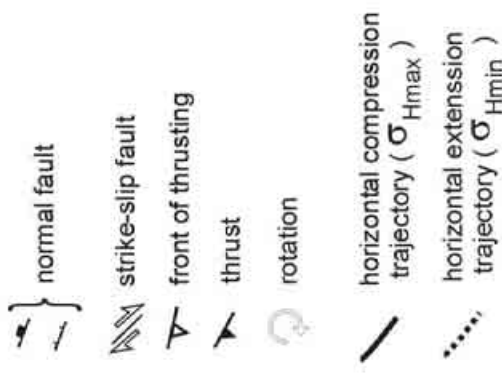
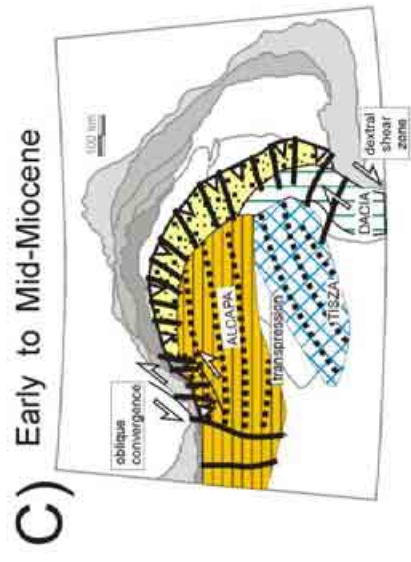
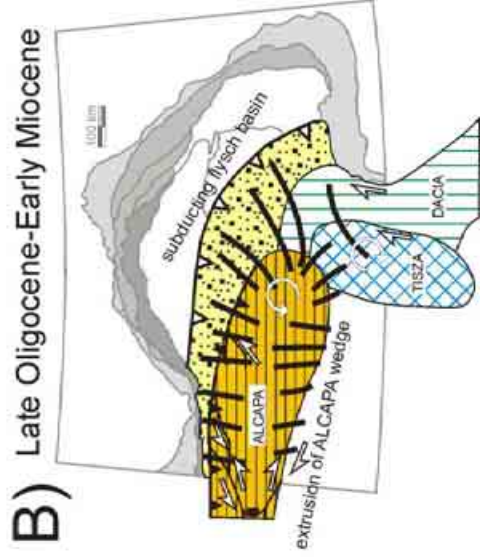
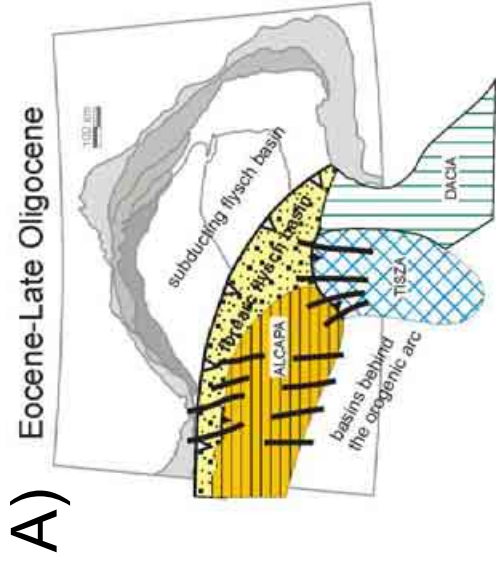
2. „Straightened Silesian nappe”



1. Clockwise rotation of the Silesian nappe about 50 degree.

According to Marton et al. (2006) the results of the paleomagnetic investigation suggest such counter-clockwise rotation of the Silesian nappe)

Reconstruction of the tectonic evolution of the Pannonian-Carpathian-Dinaride system (Fodor et al., 1999)



Interpretation and conclusion

- 1) Clockwise succession of thrust faulting suggests: a) clockwise rotation of the horizontal compression or b) counter-clockwise rotation of the rocks in the stable stress field (the results of the paleomagnetical investigation suggest the last possibility);
- 2) 2 systems of the thrust faults, which formed in the (sub) horizontal beds (1 group of thrust faults) suggest that this rotation could take place before local folding of rocks;
- 3) Thrust direction related to the (1) group of thrust faults is usually perpendicular to the regional fold axes; that suggests a strong connection of these thrust faults with regional folding;
- 4) Thrust direction related to the (2) group of thrust faults is nearly stable and usually oriented NE-SW (in the western part of the Silesian nappe this direction is poorly visible; here dominate direction N-S), therefore regional folding had the little influence on the orientation of these thrust faults;
- 5) The regional horizontal compression was most probably permanent and oriented NE-SW during the tectonic shortening of the Silesian nappe;