ACTIVE FAULTING IN POLAND IN THE LIGHT OF RECENT STUDIES

WITOLD ZUCHIEWICZ [1], JANUSZ BADURA [2], MAREK JAROSIŃSKI [3]

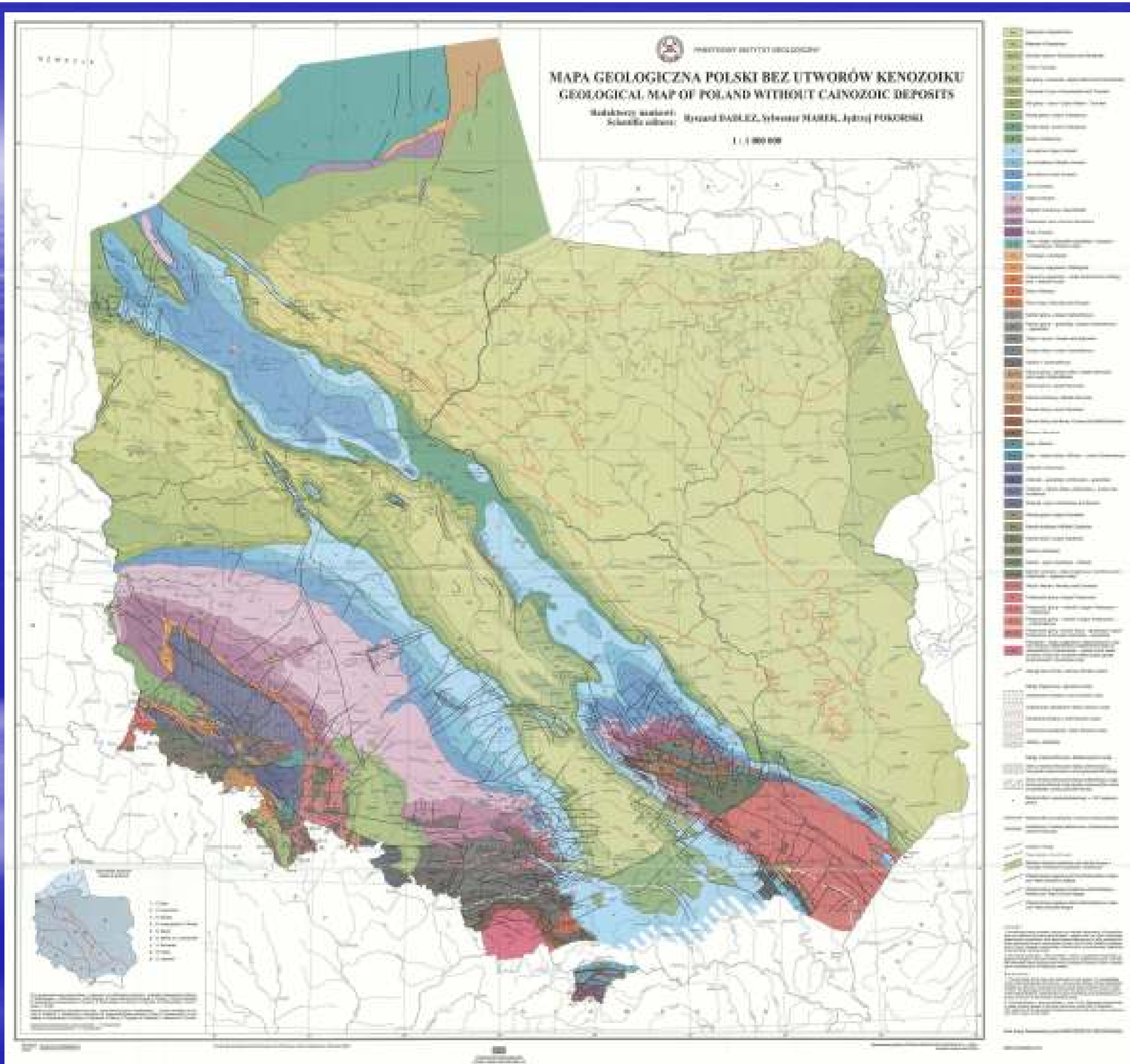
[1] Institute of Geological Sciences, Jagiellonian University, Oleandry 2A, 30063 Kraków, Poland; E-mail: witold@ing.uj.edu.pl

[2] Polish Geological Institute, Lower Silesian Branch, al. Jaworowa 19, 50-122 Wrocław, Poland; E-mail: janusz.badura@pgi.gov.pl

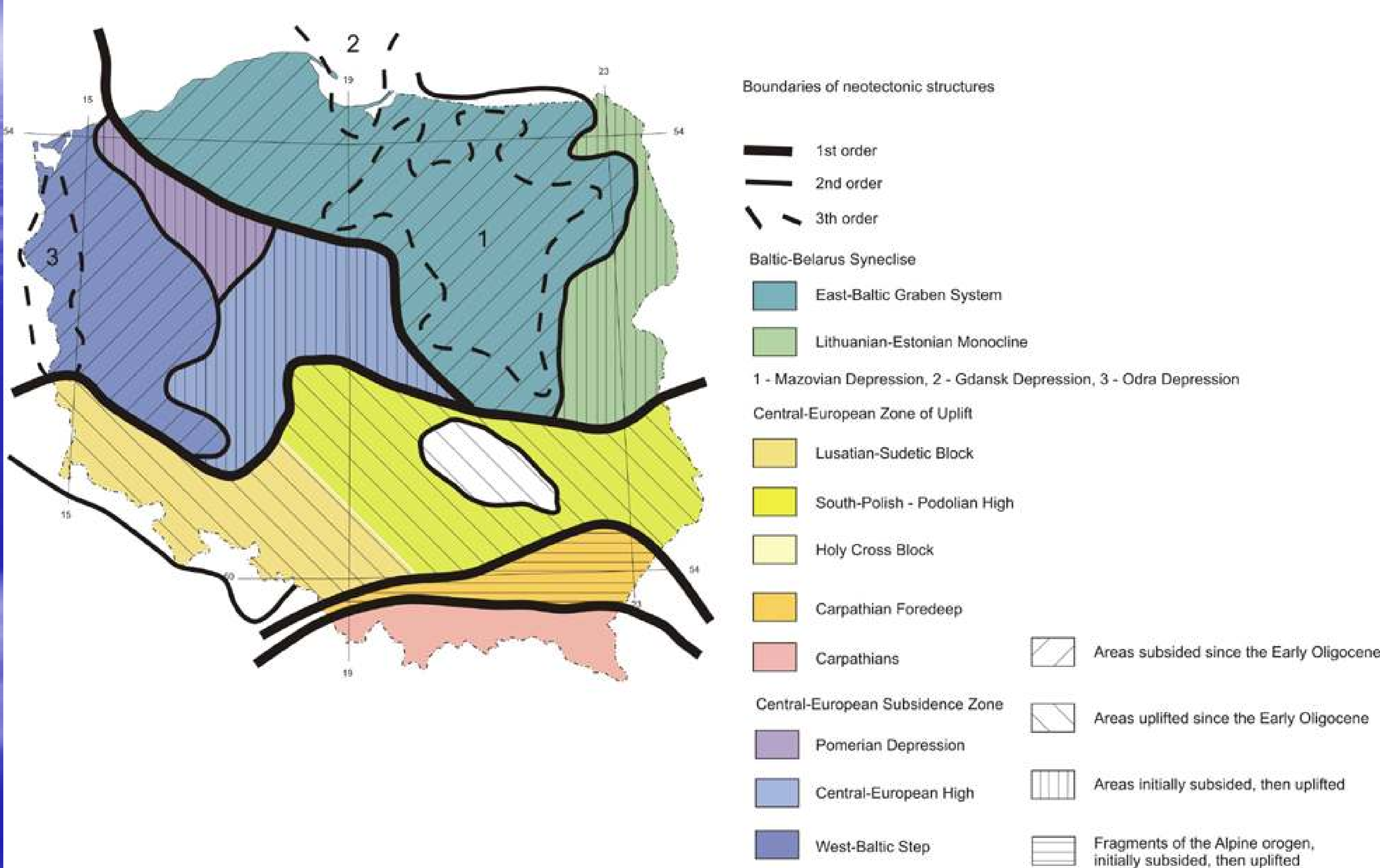
[3] Polish Geological Institute, Rakowiecka 4, 00-975 Warszawa, Poland; E-mail: marek.jarosinski@pgi.gov.pl

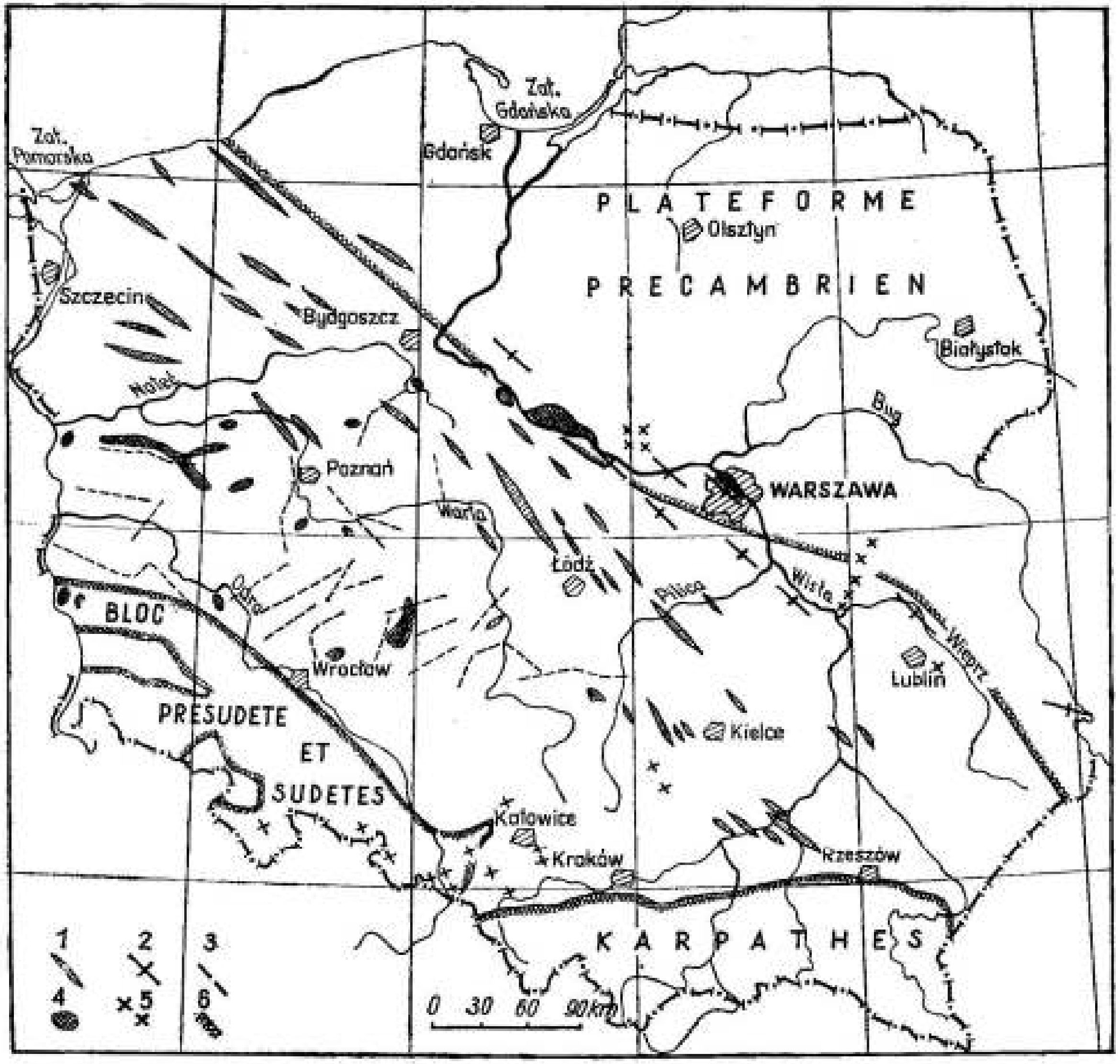
OUTLINE

- INTRODUCTION
- AN OVERVIEW OF NEOTECTONIC SETTING
- CASE STUDIES
- RECENT GEODYNAMICS
- CONCLUSIONS


MAPA GEOLOGICZNA POLSKI BEZ UTWORÓW KENOZOIKU
GEOLOGICAL MAP OF POLAND WITHOUT CAINOZOIC DEPOSITS

Neotectonic-structural units based on Karabanov & Schwab (1997)

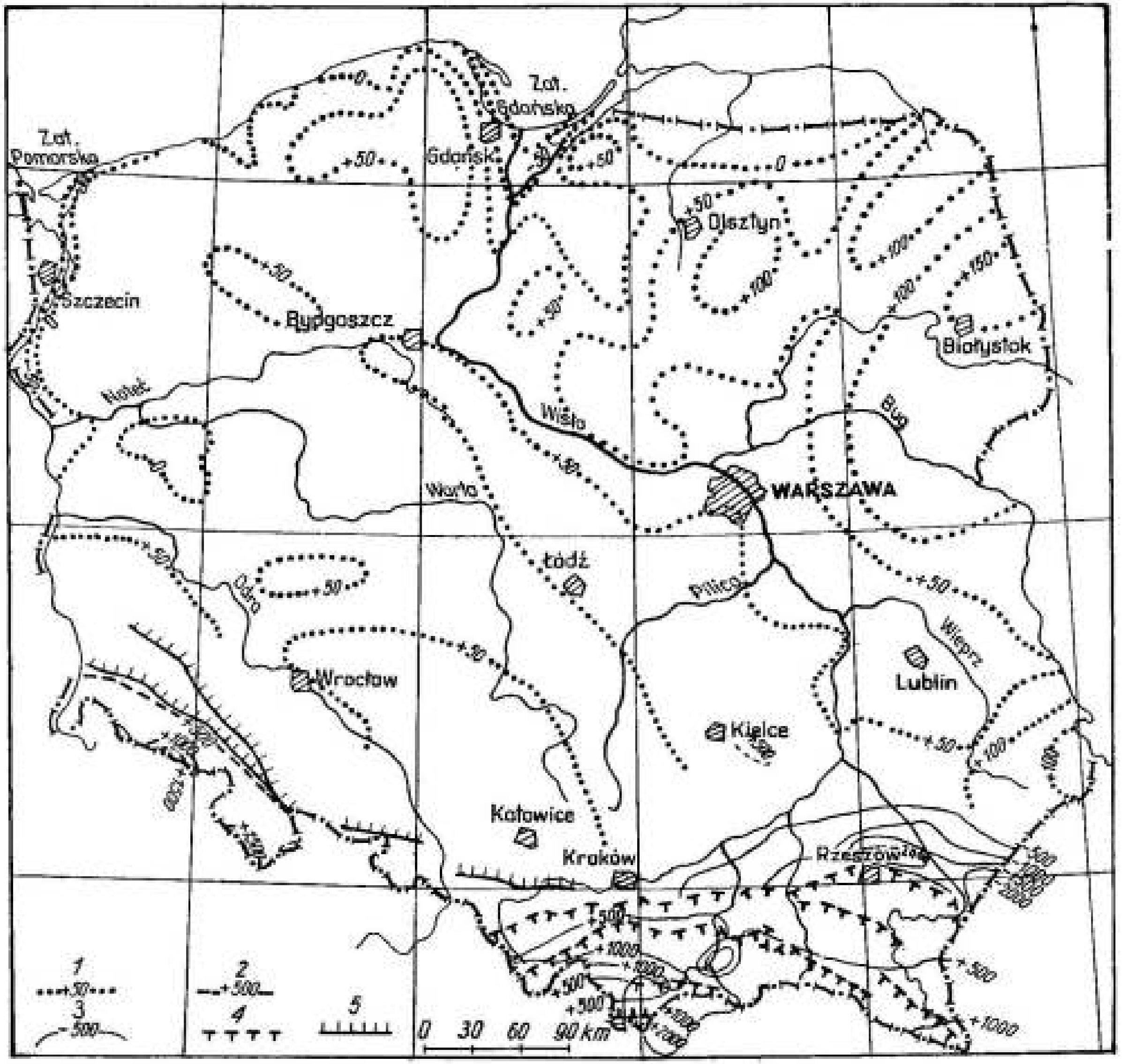




Unités et éléments tectoniques et néotectoniques de la Pologne

1 — structures anticlinales plus importantes dans la couverture du Zechstein et du Mésozoïque ainsi que dôme salifères, 2 — dislocations néogènes, éopleistocènes et mésopleistocènes probables, 3 — cavités constatées et probables liées aux mouvements néotectoniques, 4 — terrains néogènes à plissement, 5 — endroits de tremblements de terre, 6 — anticlinorium silésien — principales unités tectoniques de la Pologne (d'après S. Sokołowski et J. Znosko)

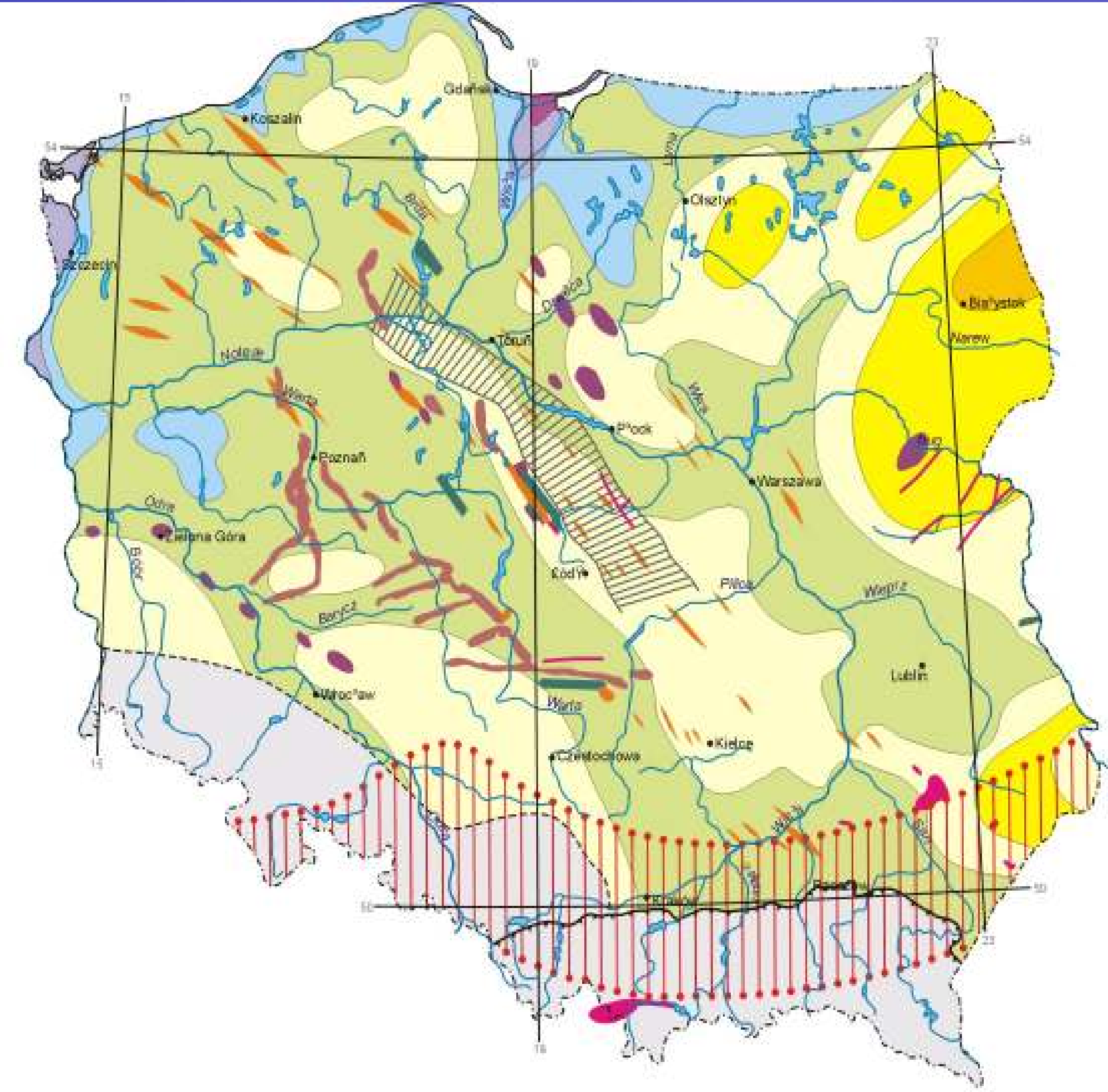
Ruehle 1969



Isoamplitudes des mouvements néotectoniques en Pologne

1 — isoamplitudes indiquées tous les 50 m sur le terrain de la couverture de plate-forme du Zechstein et du Mésozoïque sur la Basse-Plaine de Pologne, 2 — isoamplitudes indiquées tous les 500 m sur le terrain de l'orogène hercynien des Montagnes de S^te^ Croix et des Sudètes, 3 — isoamplitudes indiquées tous les 500 m sur le terrain de l'orogène alpin des Carpates et de l'avant-fosse carpatique, 4 — principaux charriages carpatiques, 5 — principales failles sur le terrain de l'anticlinorium silésien

Ruehle 1969



Amplitudes of Quaternary tectonic movements in the Polish Lowland:

m
150
100
50
0
-50
-100

Quaternary tectonic grabens and tectonically-controlled water reservoirs

Tectonic structures reactivated during Pleistocene ice sheet advances

main anticlines in Zechstein and Mesozoic strata and salt diapirs

glacial erosional depressions related to reactivated basement faults

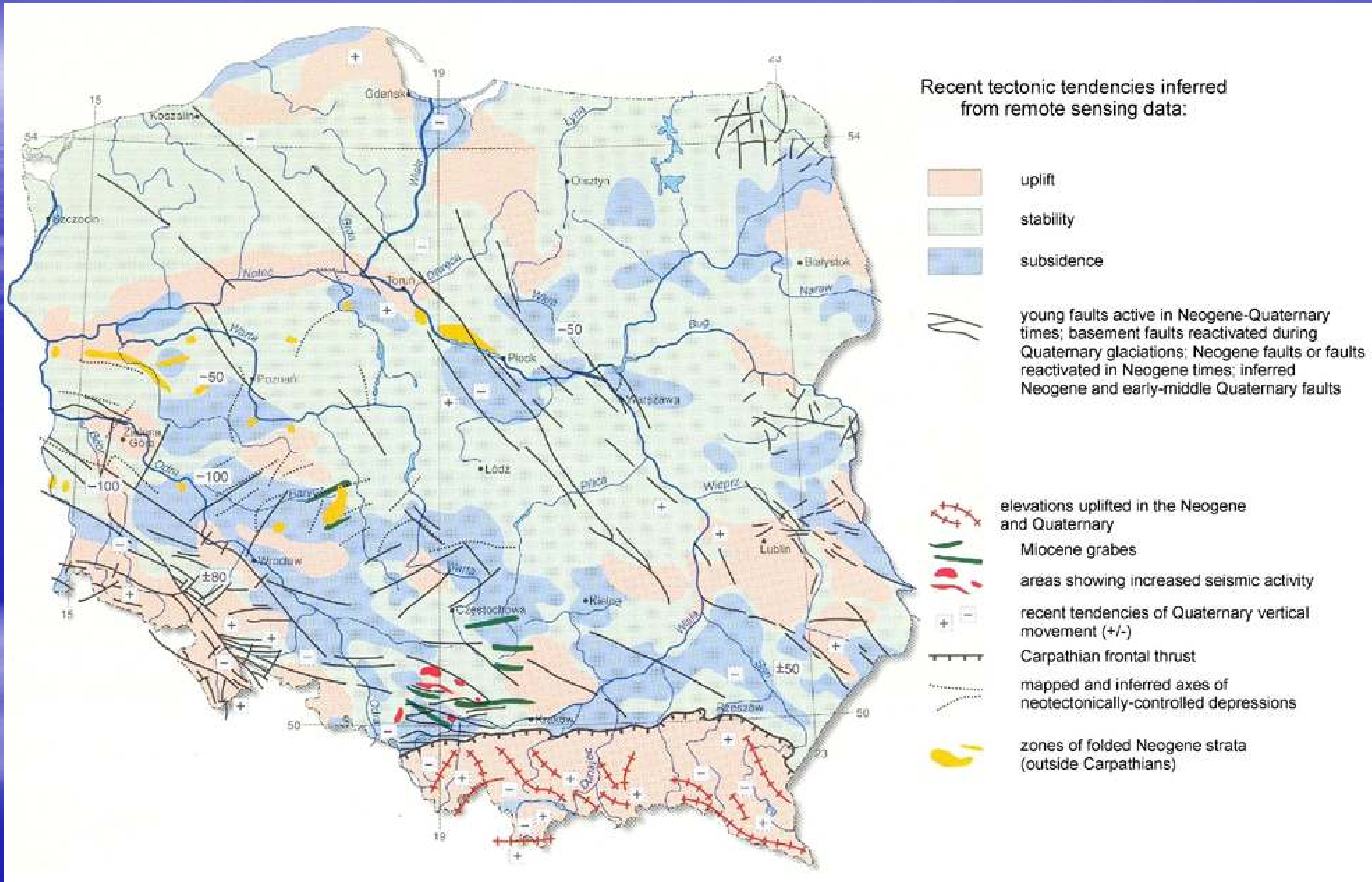
tectonic grabens reactivated in the Quaternary

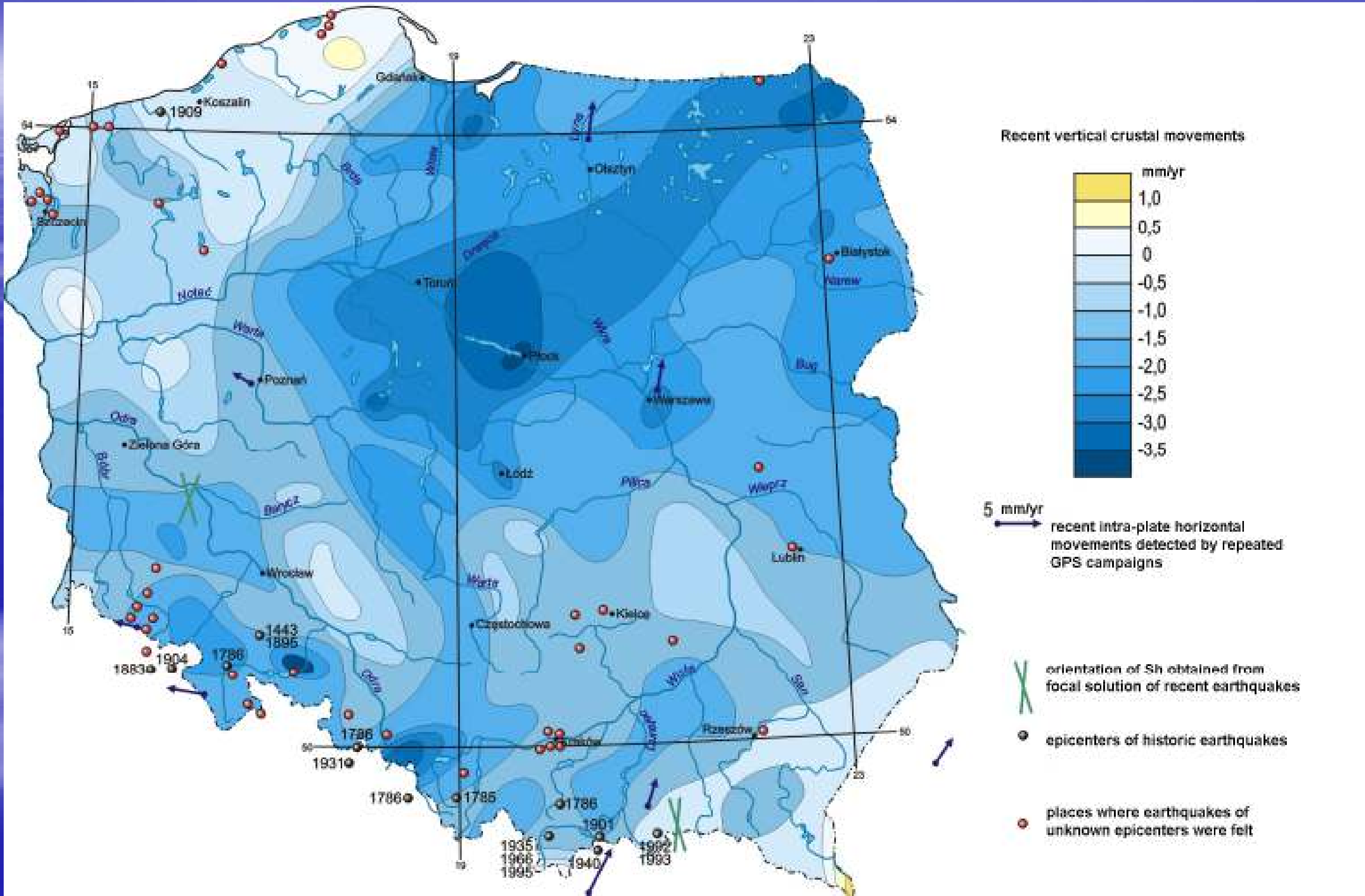
Kuyavian Swell uplifted in the Pleistocene

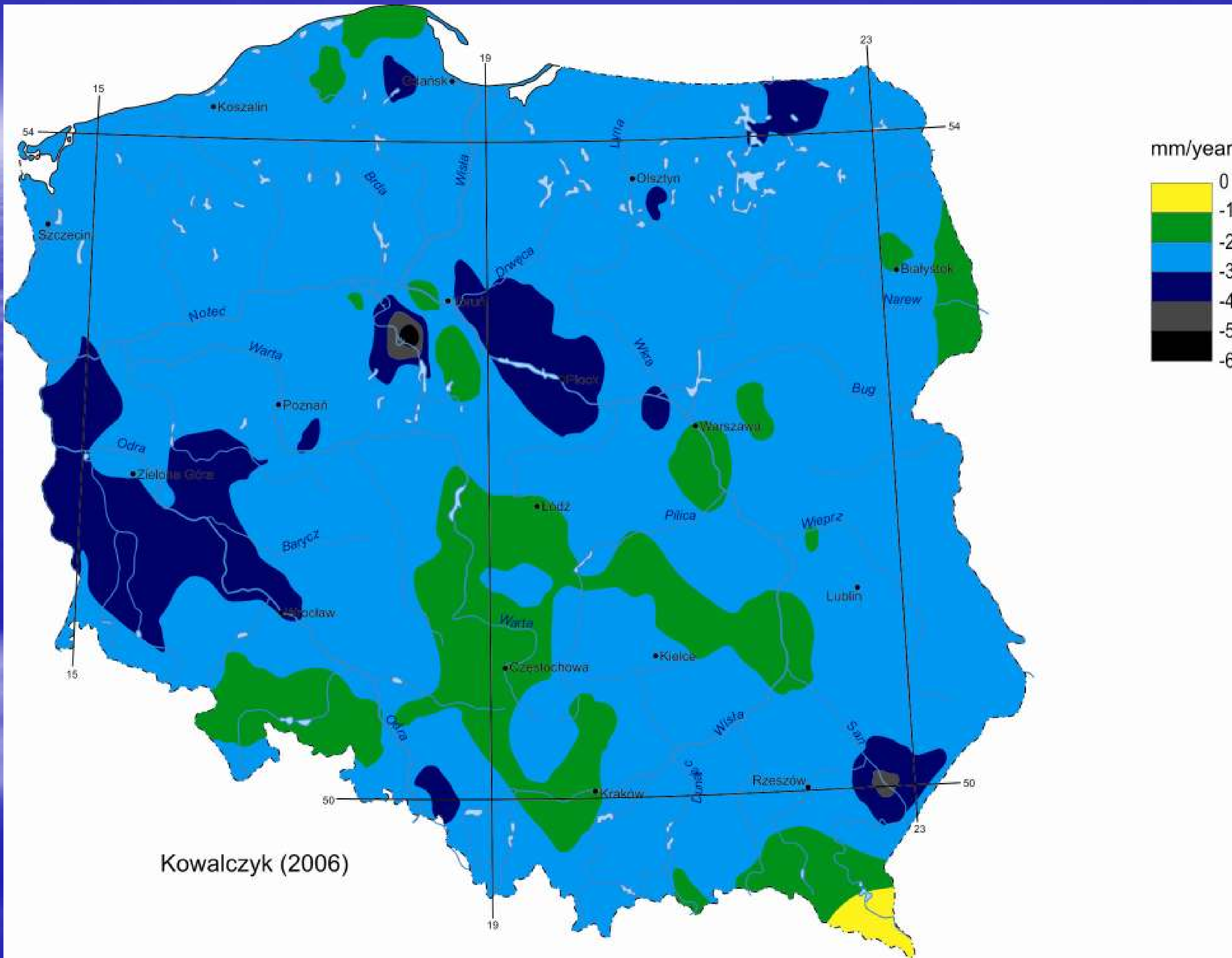
glacial-induced frontal bulge, associated with the Pomerania phase of the Weichselian

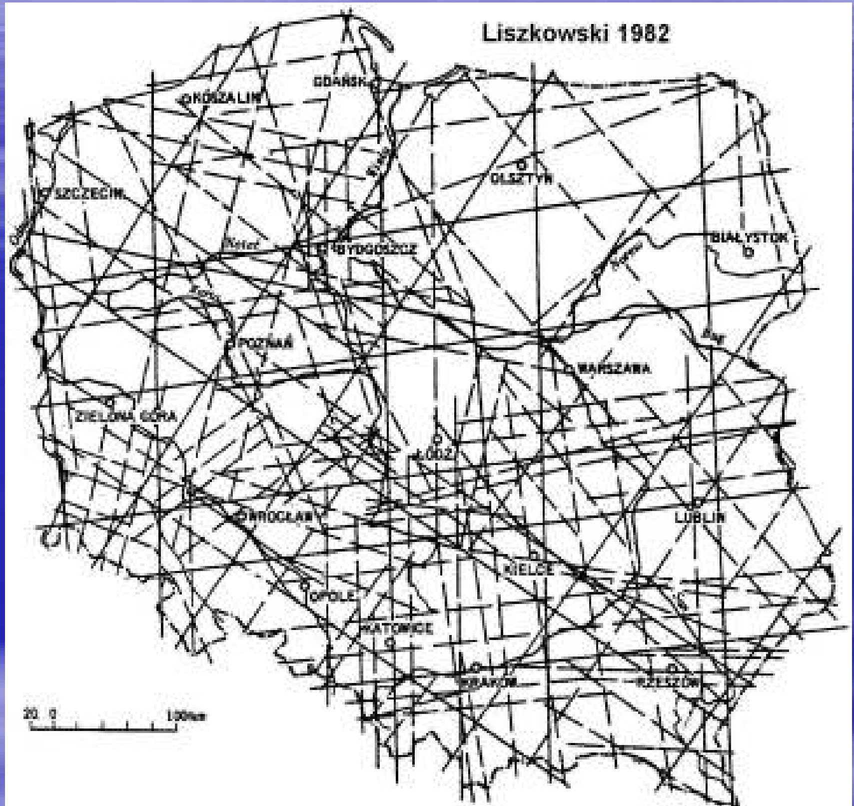
Palaeogene and Neogene grabens in the Polish Lowland, of maximum of subsidence in Miocene time, and reactivated in the Quaternary

Carpathian frontal thrust

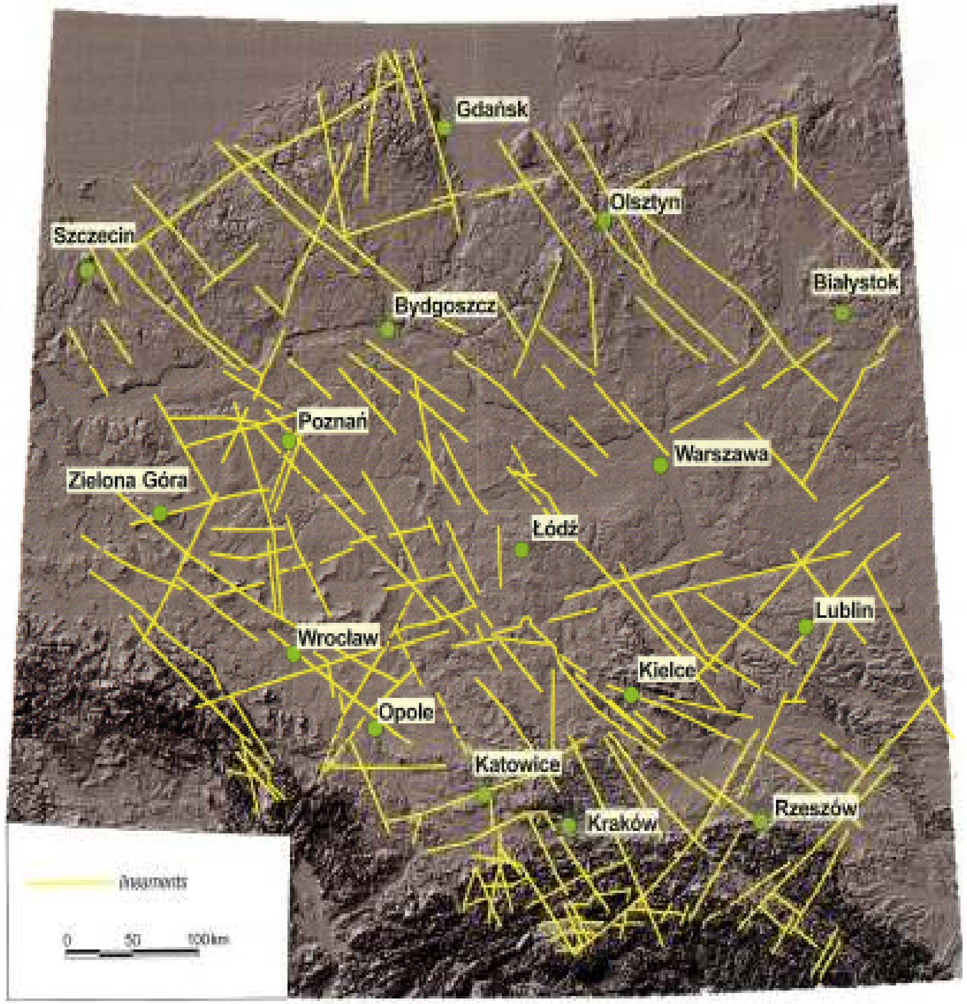

Recent tectonic tendencies inferred
from remote sensing data:
uplift
stability
subsidence
young faults active in Neogene-Quaternary times; basement faults reactivated during Quaternary glaciations; Neogene faults or faults reactivated in Neogene times; inferred Neogene and early-middle Quaternary faults
elevations uplifted in the Neogene and Quaternary
Miocene grabes
areas showing increased seismic activity
recent tendencies of Quaternary vertical movement (+/-)
Carpathian frontal thrust
mapped and inferred axes of neotectonically-controlled depressions
zones of folded Neogene strata (outside Carpathians)
Gdańsk
Koszalin
Olsztyn
Białystok
Toruń
Płock
Warszawa
Poznań
Łódź
Wrocław
Lublin
Kielce
Częstochowa
Kraków
Rzeszów
Warta
Wisła
Bug
Narew
Wieprz
Pilica
Odra
Noteć
-50
-100
±80
±50


Recent vertical crustal movements
mm/yr
1,0
0,5
0
-0,5
-1,0
-1,5
-2,0
-2,5
-3,0
-3,5
5 mm/yr
recent intra-plate horizontal movements detected by repeated GPS campaigns
orientation of Sh obtained from focal solution of recent earthquakes
epicenters of historic earthquakes
places where earthquakes of unknown epicenters were felt
Gdańsk
Koszalin
Szczecin
Olsztyn
Białystok
Toruń
Płock
Poznań
Warszawa
Zielona Góra
Łódź
Wrocław
Lublin
Częstochowa
Kielce
Rzeszów
Kraków
Odra
Wisła
Warta
Noteć
Bug
Narew
Pilica
Wieprz
San
Bóbr
Barycz
Drwęca
1909
1443
1895
1786
1904
1883
1931
1785
1901
1935
1966
1995
1940
1993


mm/year
0
-1
-2
-3
-4
-5
-6
Gdańsk
Koszalin
Szczecin
Olsztyn
Białystok
Toruń
Noteć
Warta
Poznań
Płock
Warszawa
Odra
Zielona Góra
Łódź
Pilica
Wieprz
Barycz
Wrocław
Lublin
Kielce
Częstochowa
Wisła
Kraków
Rzeszów
San
Dunajec
Brda
Drwęca
Narew
Bug
Wkra
Łyna
Kowalczyk (2006)
15
19
23
54
50

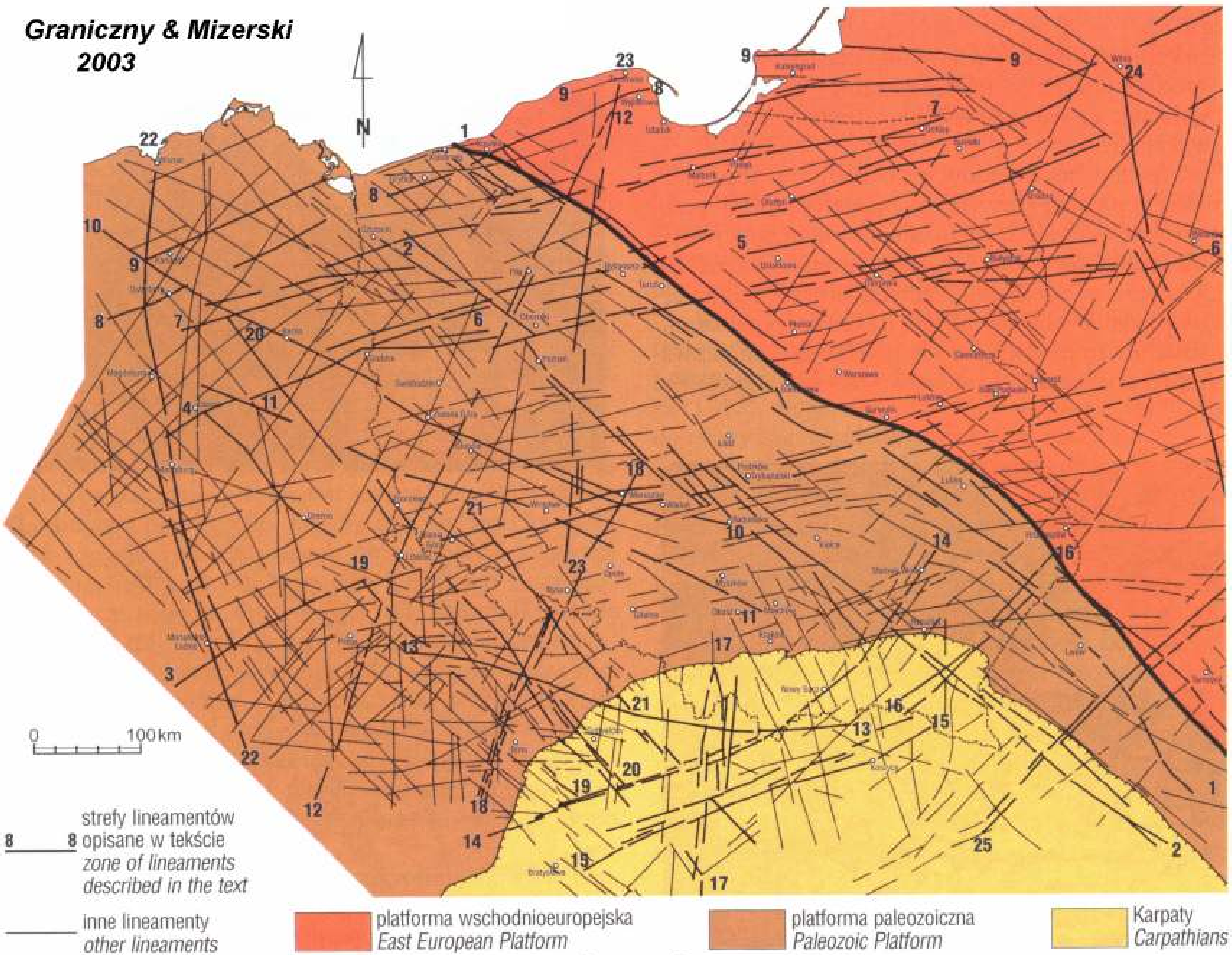


Photolineaments in Poland



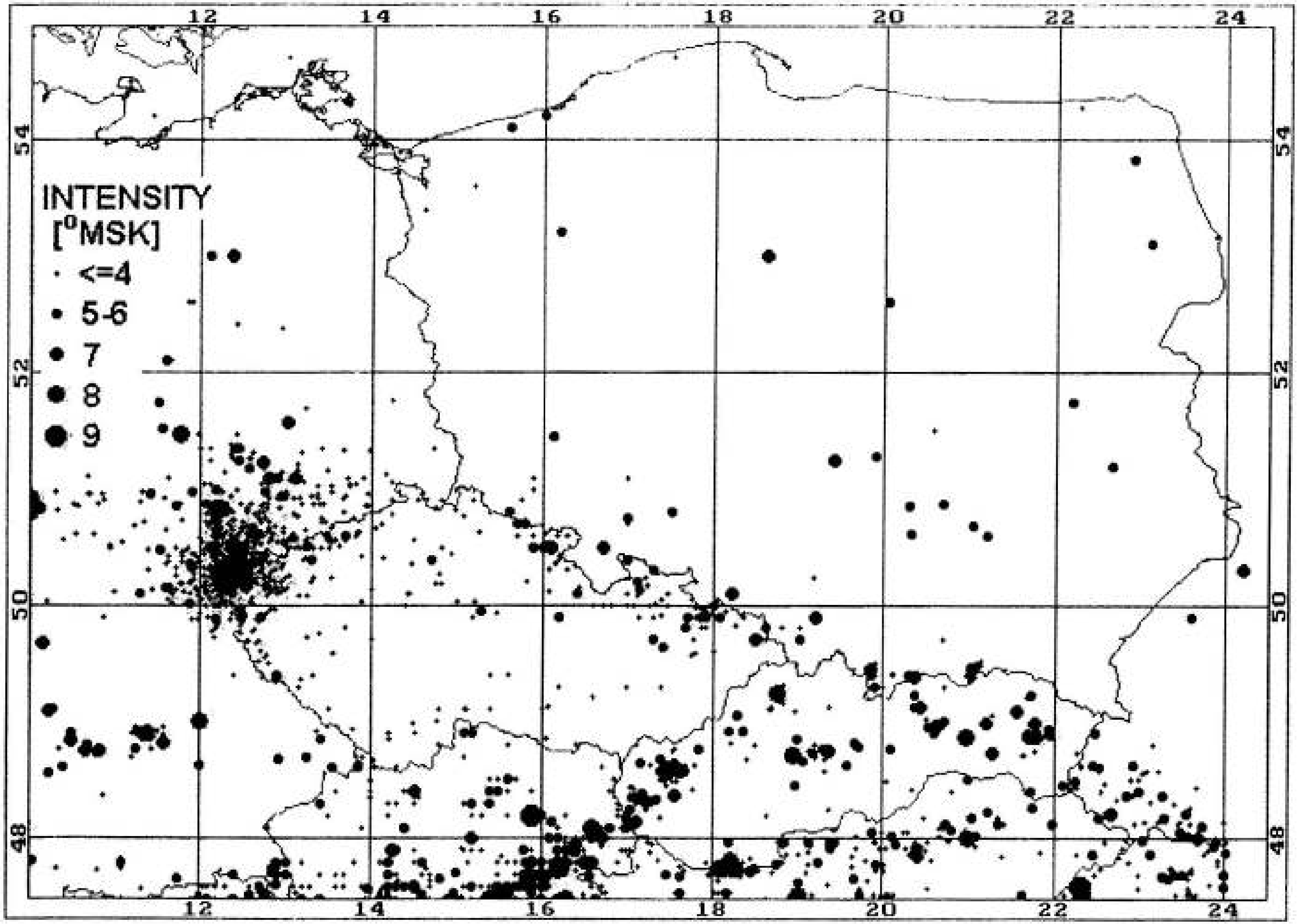
Satellite lineaments in Poland and surrounding countries

Graniczny 2005



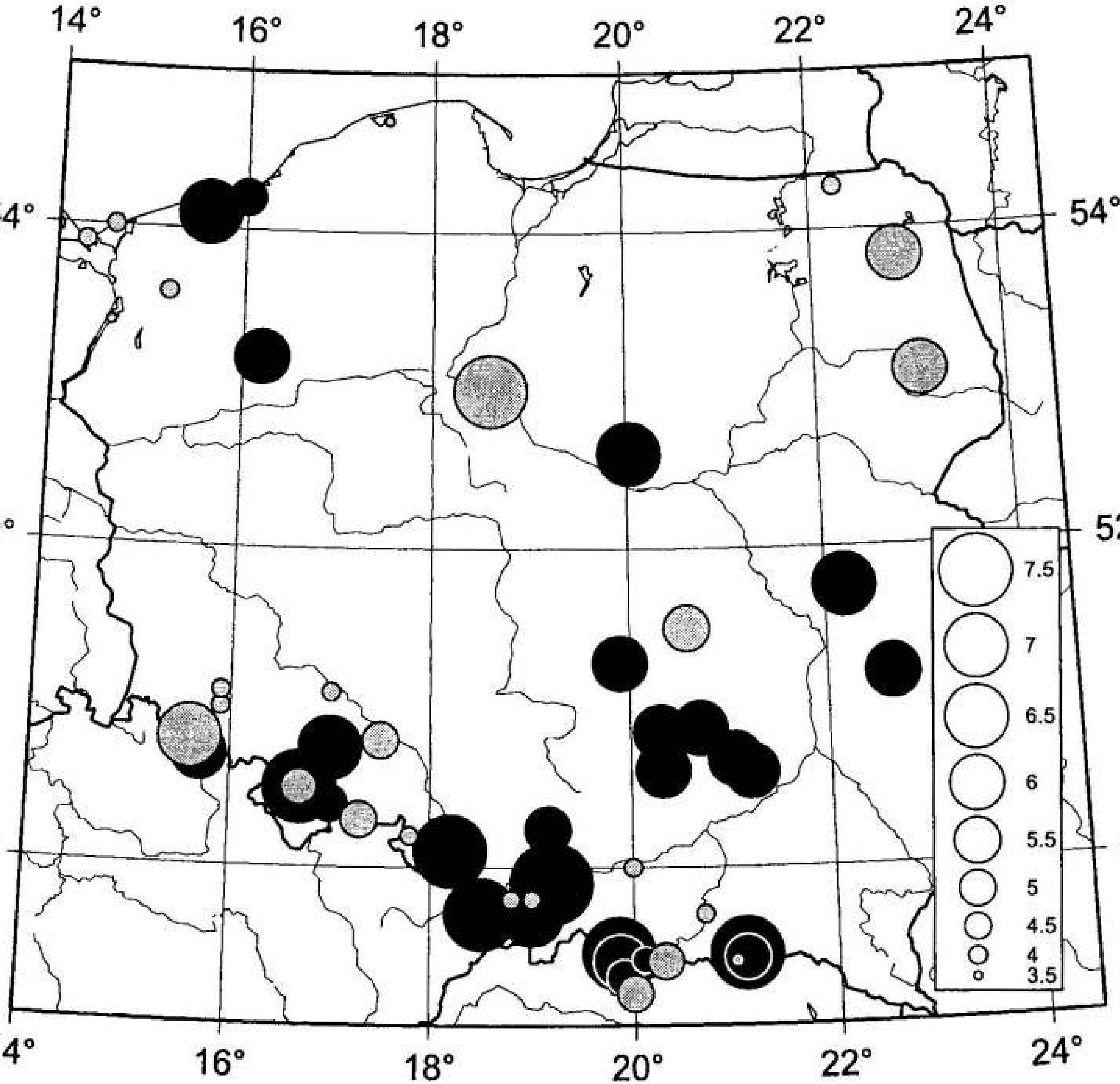
LINEAMENTS IN POLAND

Guterch & Lewandowska-Marciniak 2002



The earthquake epicenters for the Czech Republic, Poland, Slovakia, and adjacent areas (SCHENKOVÁ et al. 1999, SCHENK et al. 2000)

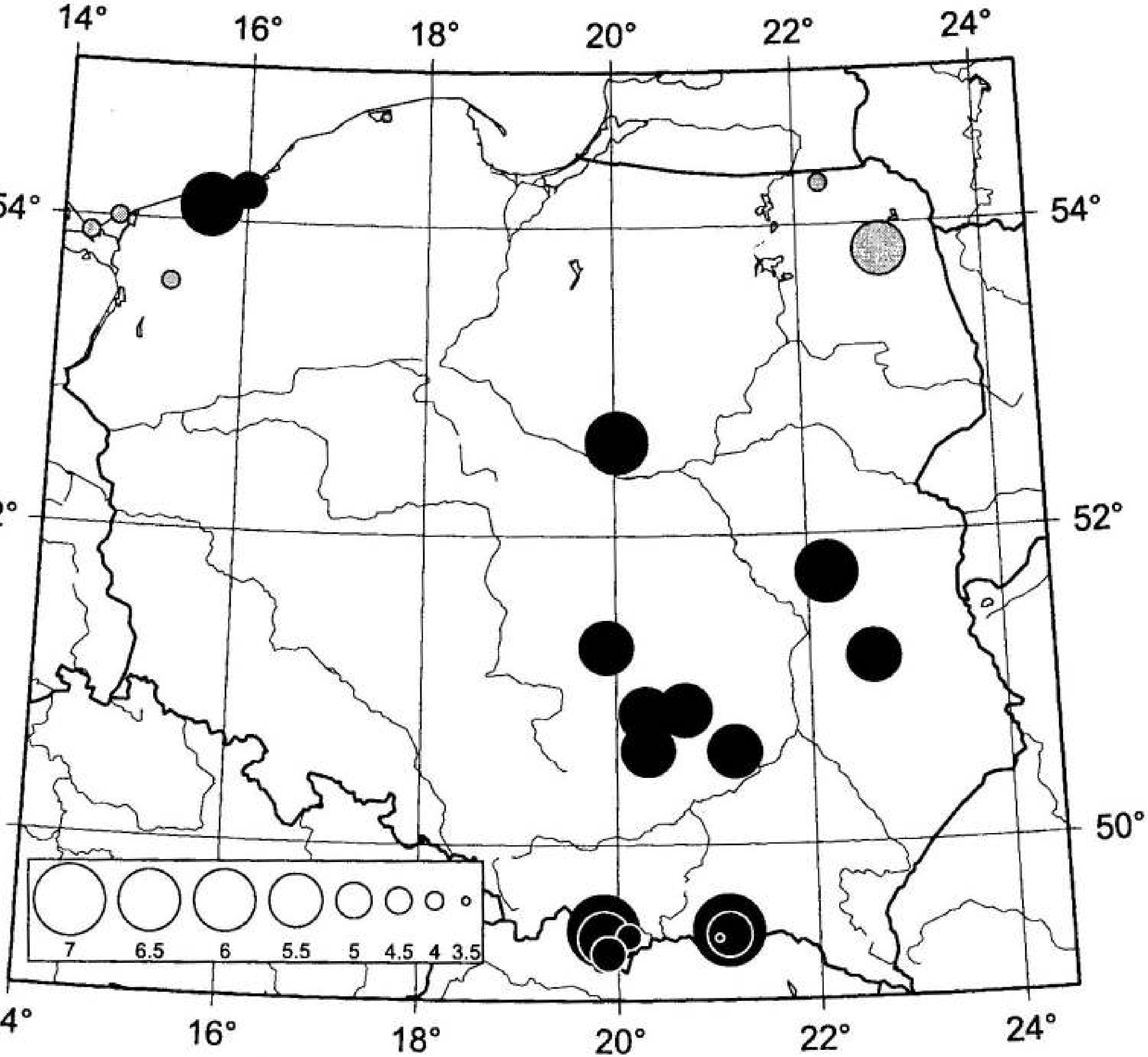
Historical seismicity in Poland *Mortimer 2002*



All earthquakes recorded in Poland since the 15th century, in the MSK intensity scale

Black circles – reliable data, grey circles – uncertain data

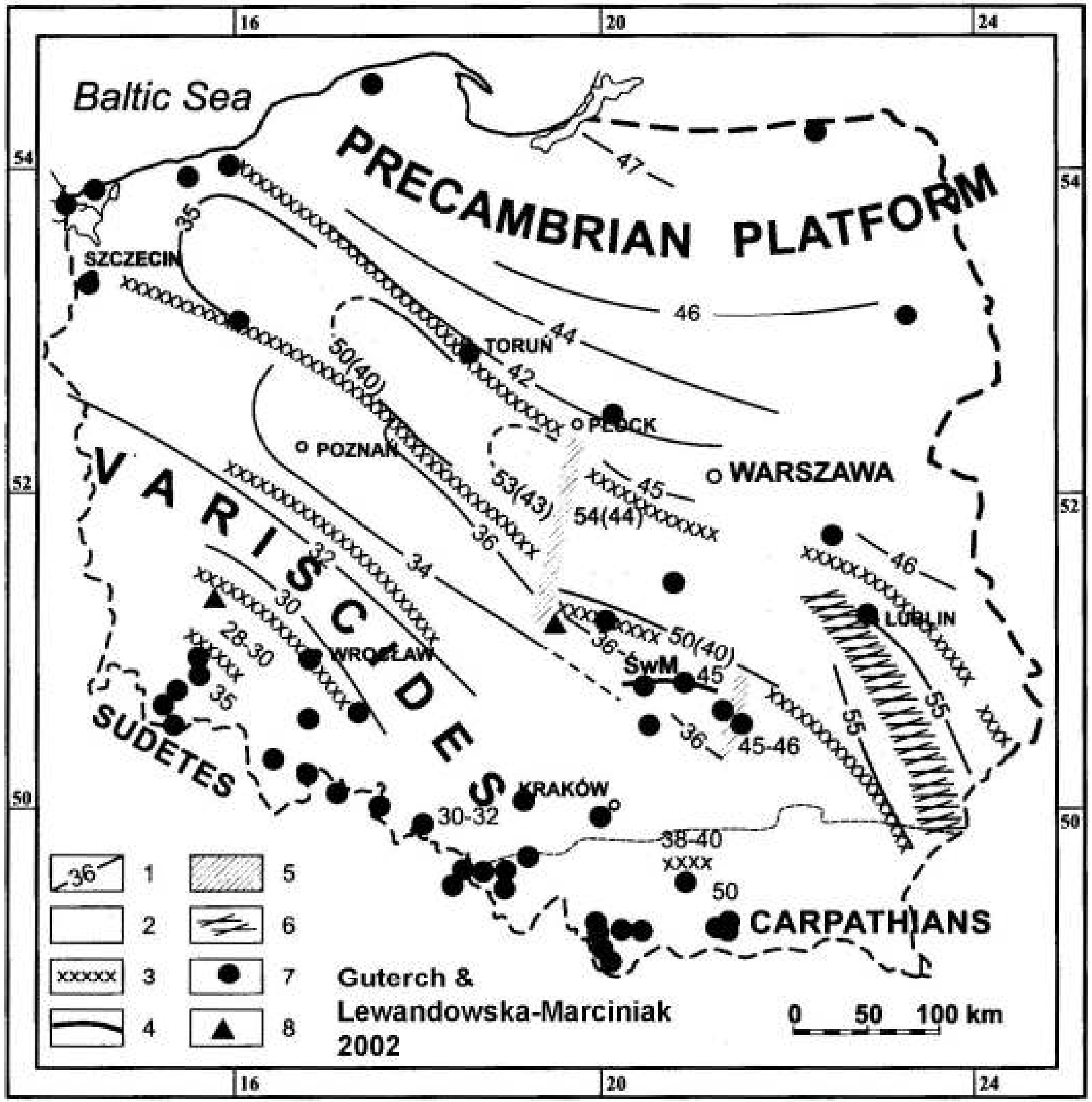
Guterch & Lewandowska-Marciniak '02



Earthquake epicenters in Poland in the 20th century, in the MSK intensity scale

Black circles – reliable data, grey circles – uncertain data

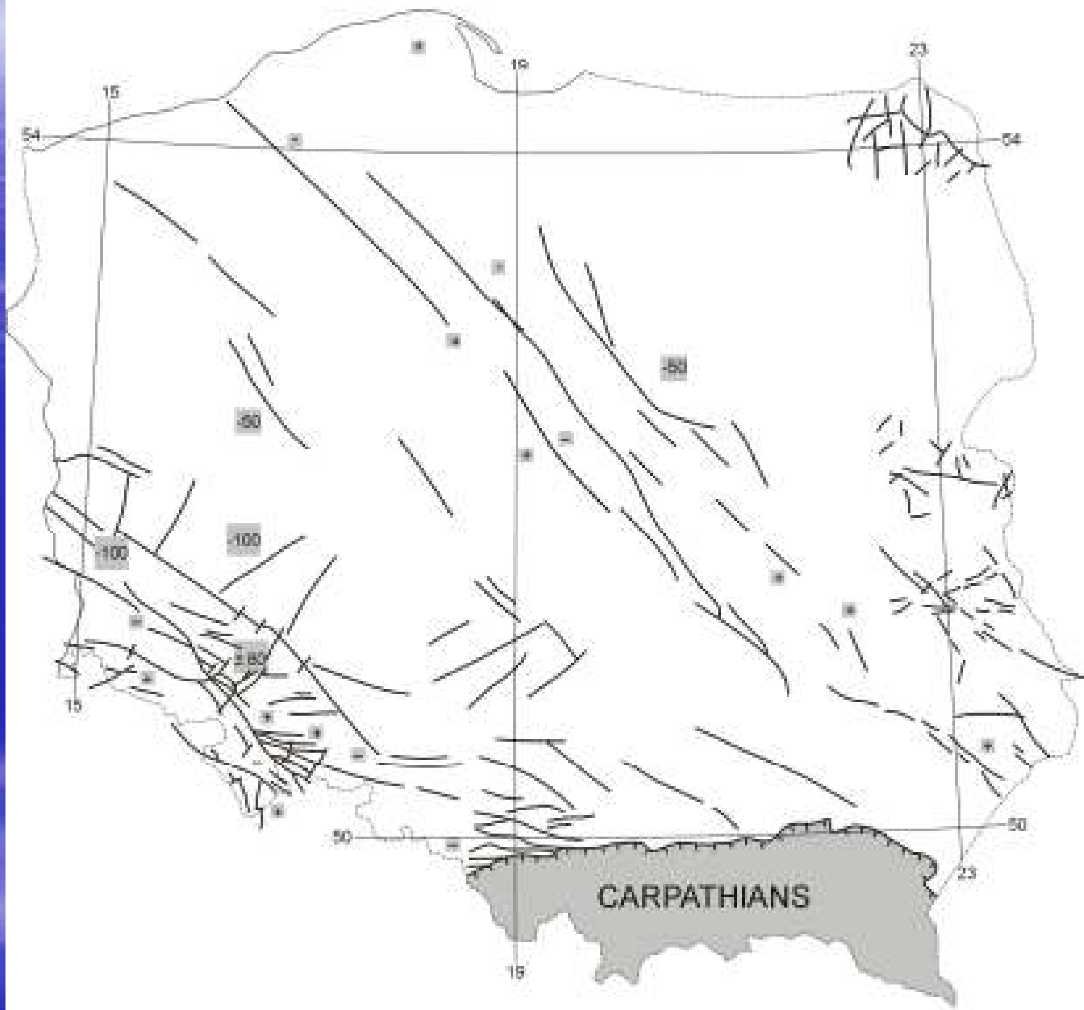
Guterch & Lewandowska-Marciniak 2002



Geotectonic crustal scheme based on the DSS studies (after GUTERCH and GRAD 1996) and earthquake epicenters recorded in Poland since the 15th century

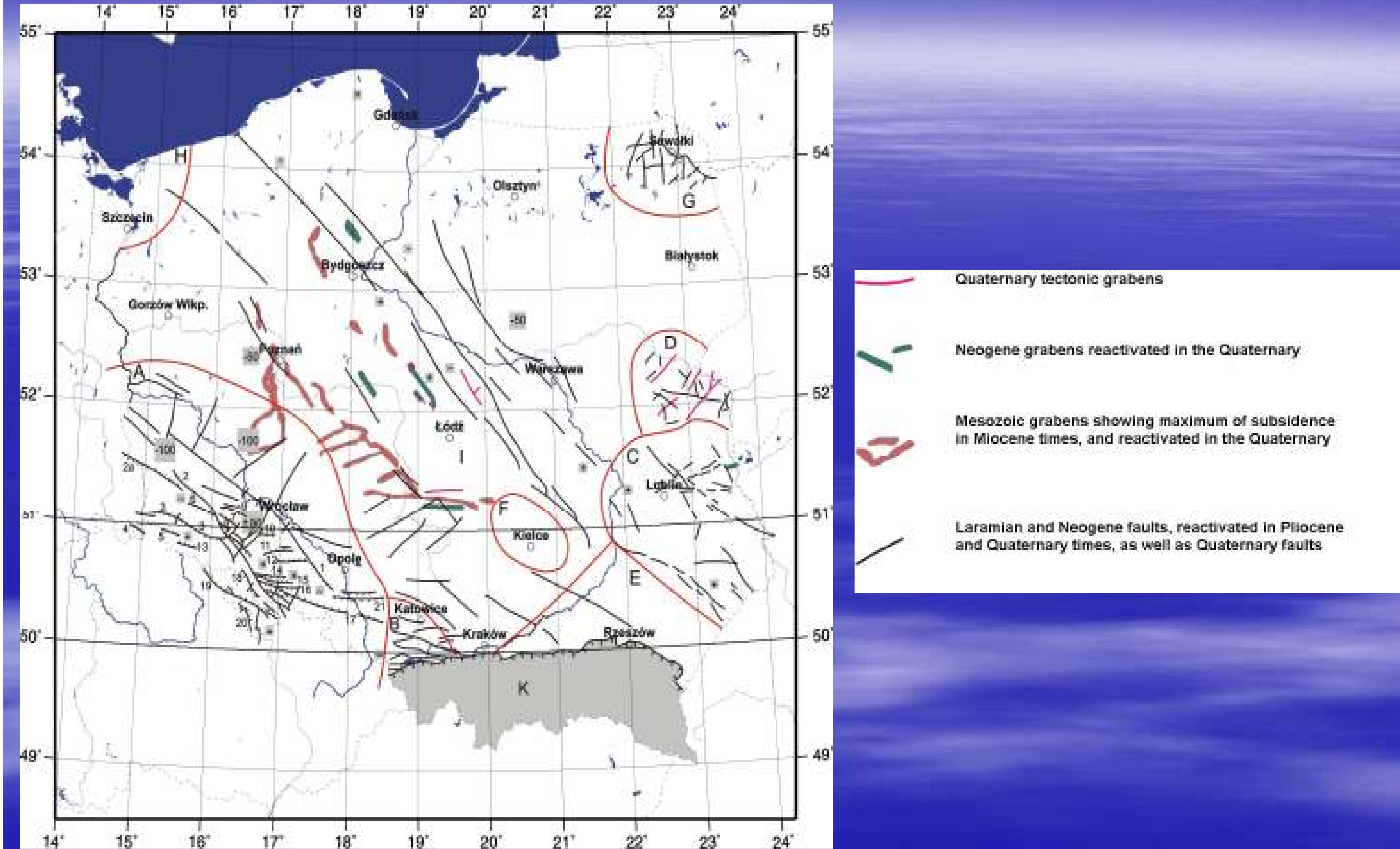
1 – depth to the Moho discontinuity in kilometres; 2 – the TTZ; 3 – boundaries of crustal blocks; 4 – Holy Cross Mountains main fault; 5 – transverse fractures in the TTZ; 6 – anomalous zone in crustal structure in the TTZ in SE Poland. For the TTZ area, depths of the layer with velocity Vp = 7.4 km s^{-1} are given in parentheses; Św M – Świętokrzyskie Mts. (Holy Cross Mts.); 7 – earthquake epicenters; 8 – seismic events induced by mining

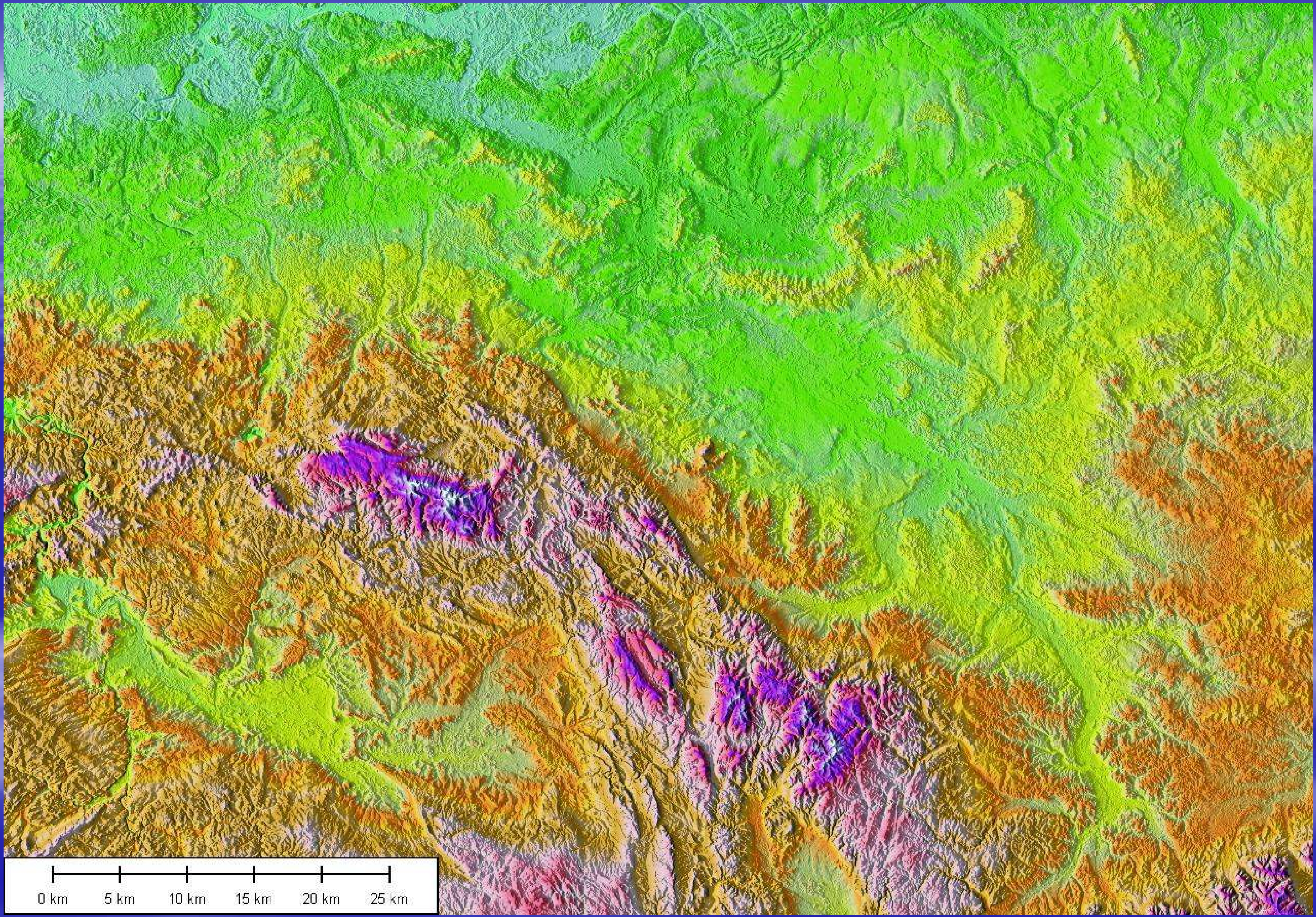
YOUNG FAULTS

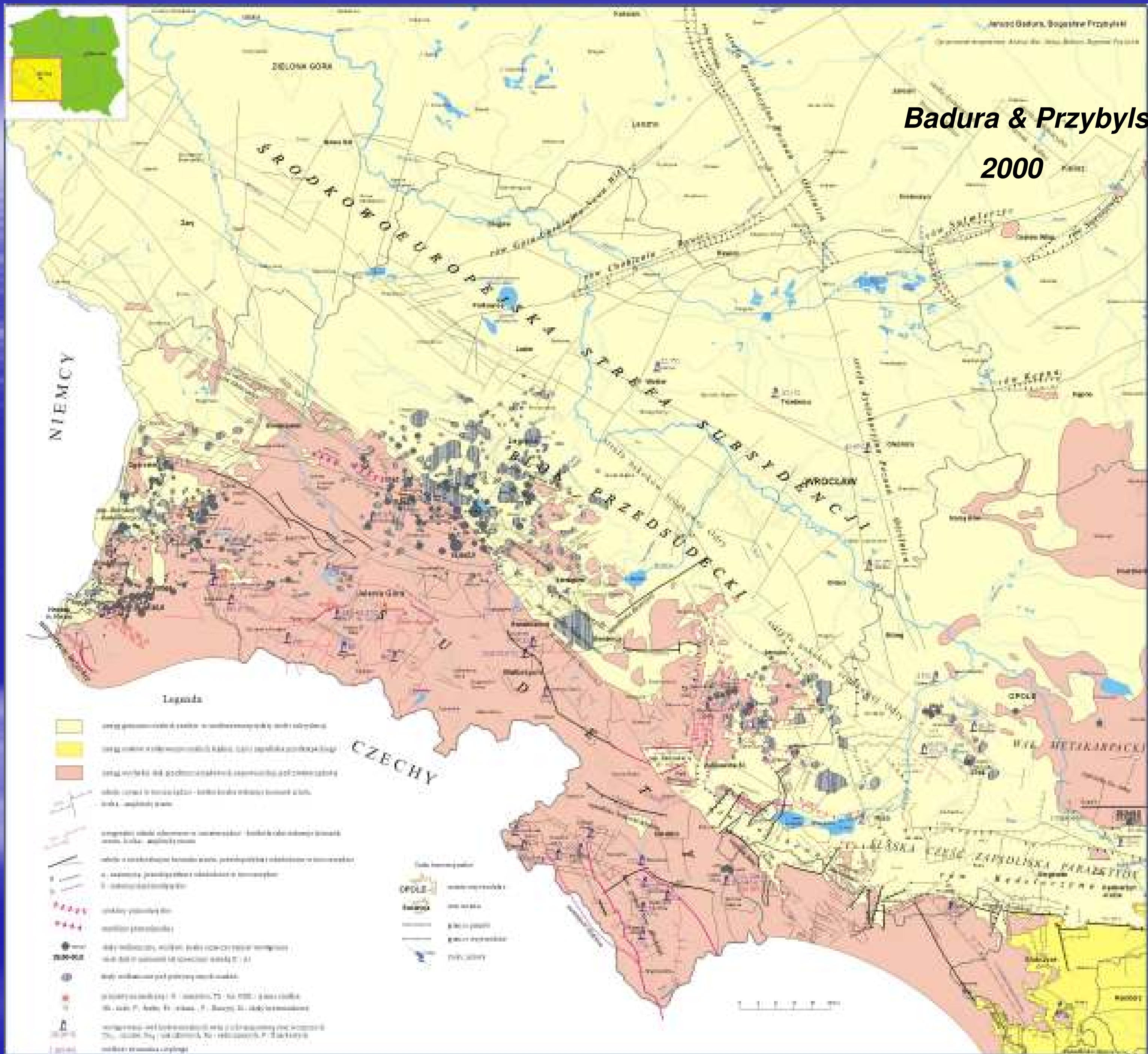


-100 Tendencies of Quaternary vertical movements [m]

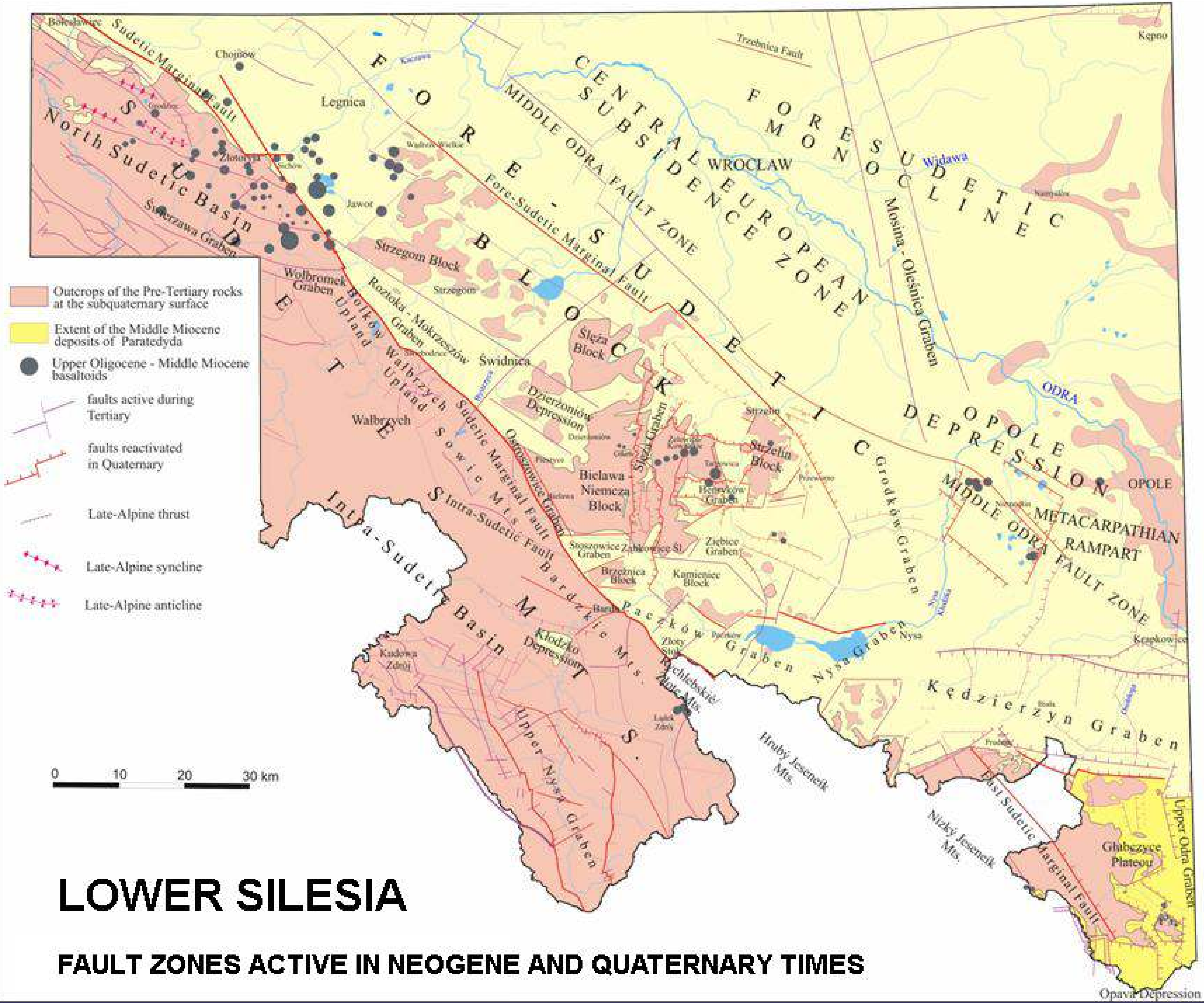
Laramian and Neogene faults reactivated in the Late Neogene and Quaternary; as well as Quaternary faults


Gdańsk
Olsztyn
Suwałki
Szczecin
Bydgoszcz
Białystok
Gorzów Wlkp.
Poznań
Warszawa
Łódź
Lublin
Wrocław
Kielce
Opole
Katowice
Kraków
Rzeszów
A
B
C
D
E
F
G
H
I
K
Quaternary tectonic grabens
Neogene grabens reactivated in the Quaternary
Mesozoic grabens showing maximum of subsidence in Miocene times, and reactivated in the Quaternary
Laramian and Neogene faults, reactivated in Pliocene and Quaternary times, as well as Quaternary faults


0 km
5 km
10 km
15 km
20 km
25 km

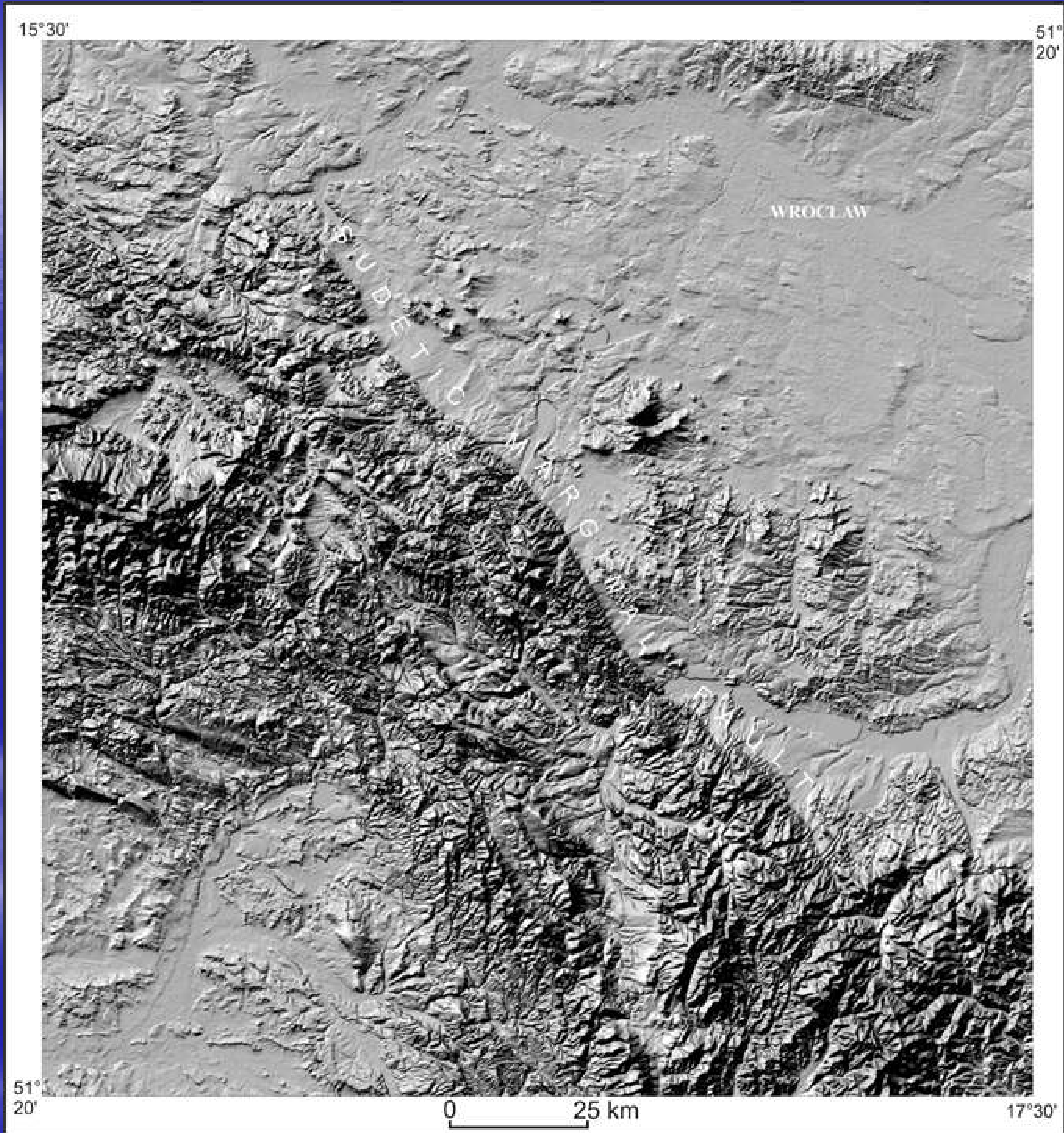


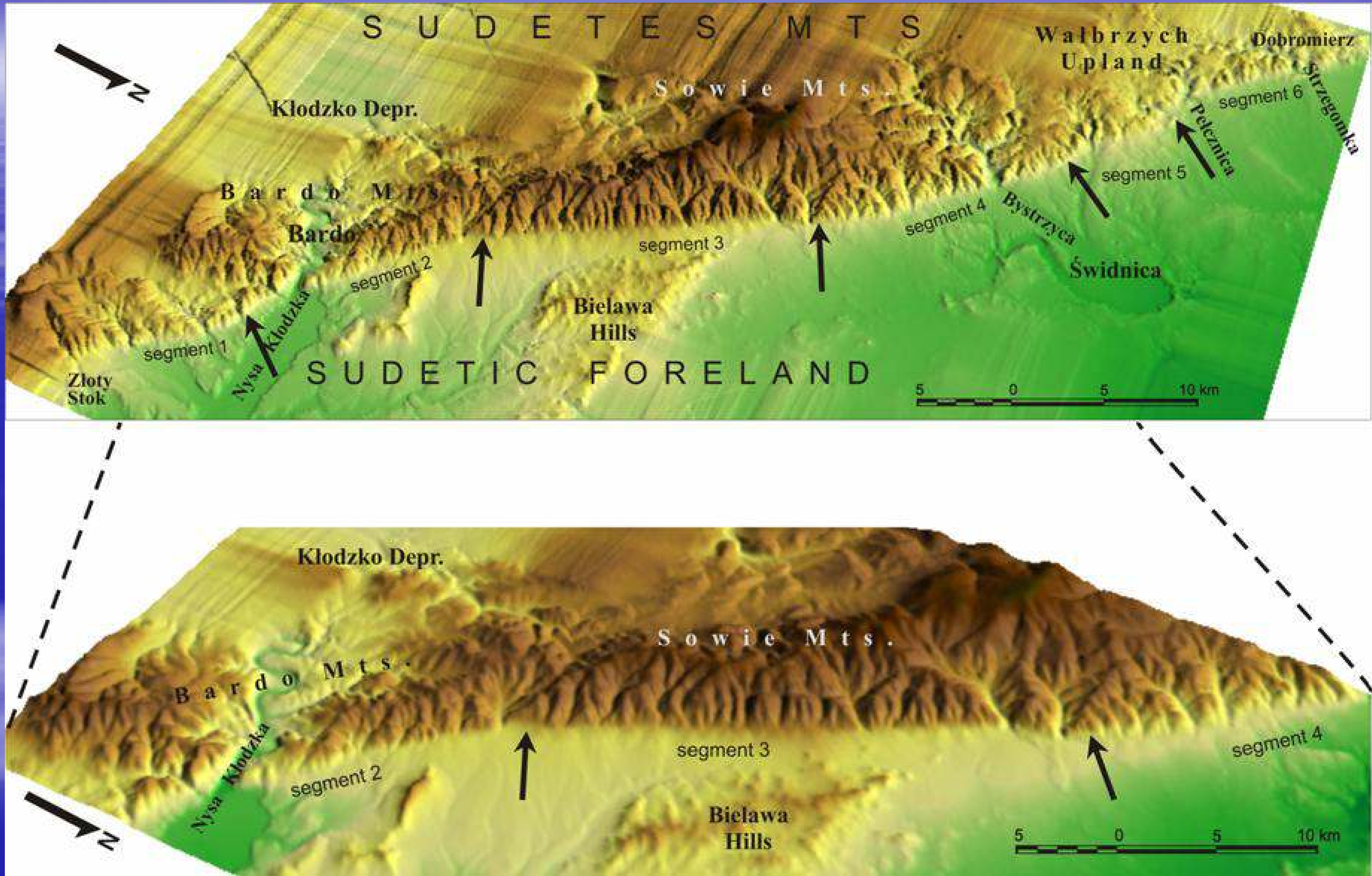
Badura & Przybylski 2000



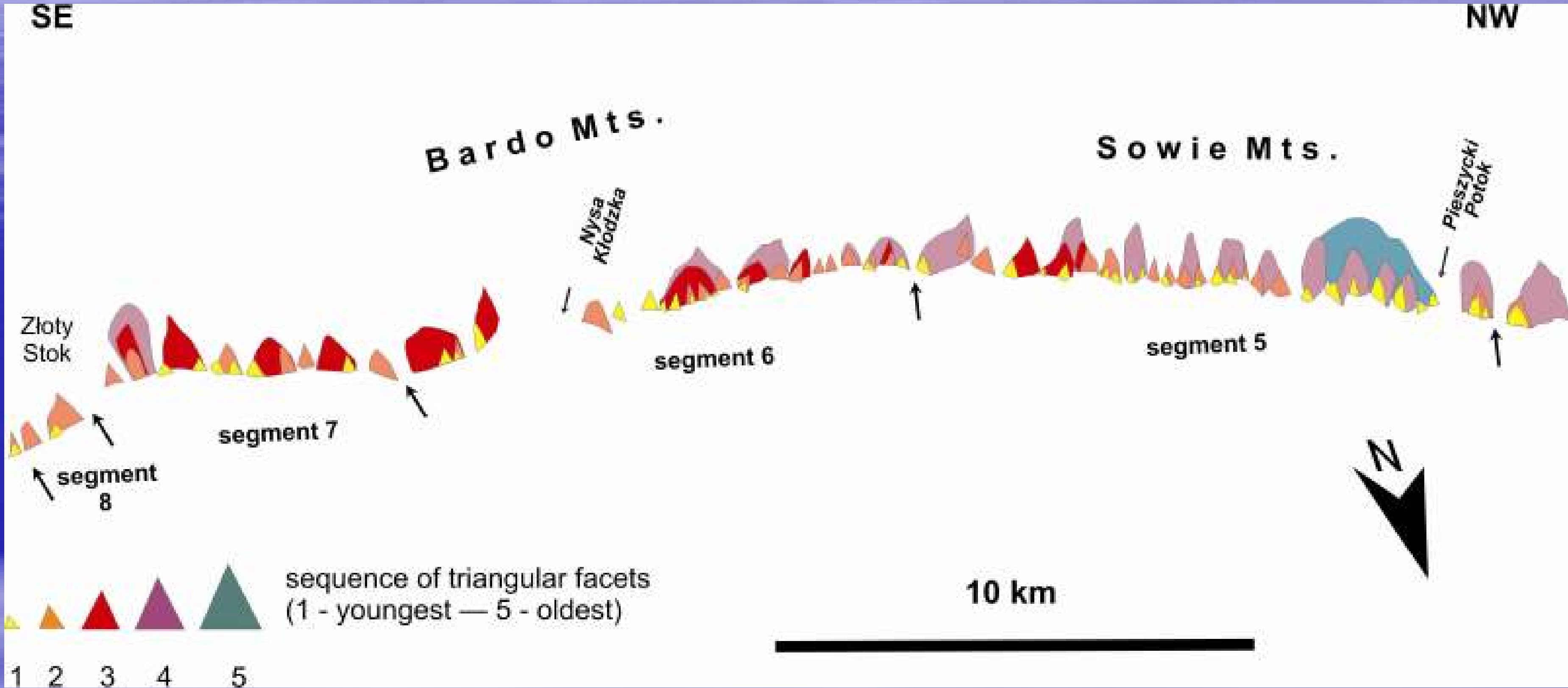
LOWER SILESIA

FAULT ZONES ACTIVE IN NEOGENE AND QUATERNARY TIMES

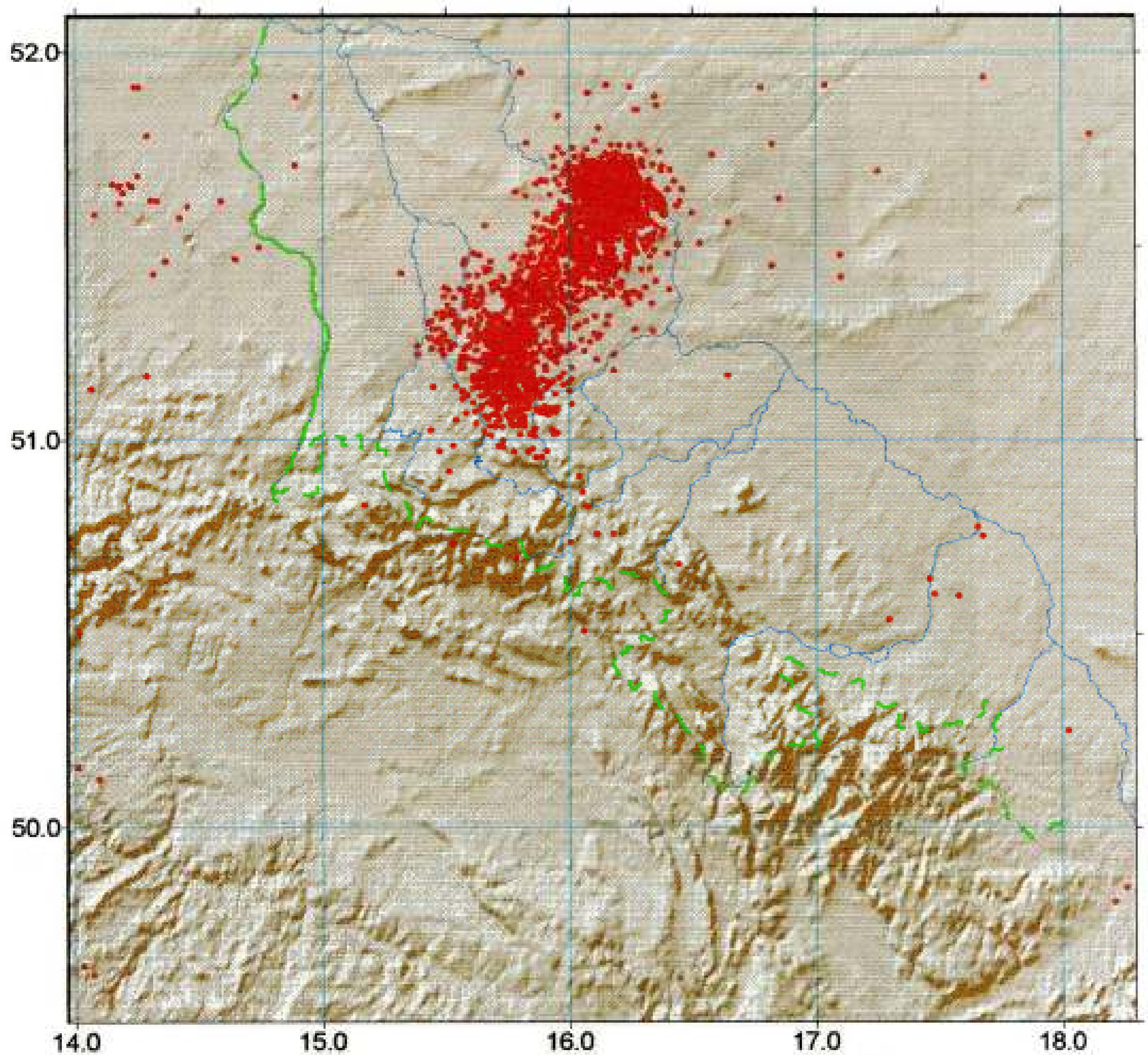

15°30'
51° 20'
WROCLAW
SUDETIC MARGINAL FAULT
51° 20'
0
25 km
17°30'



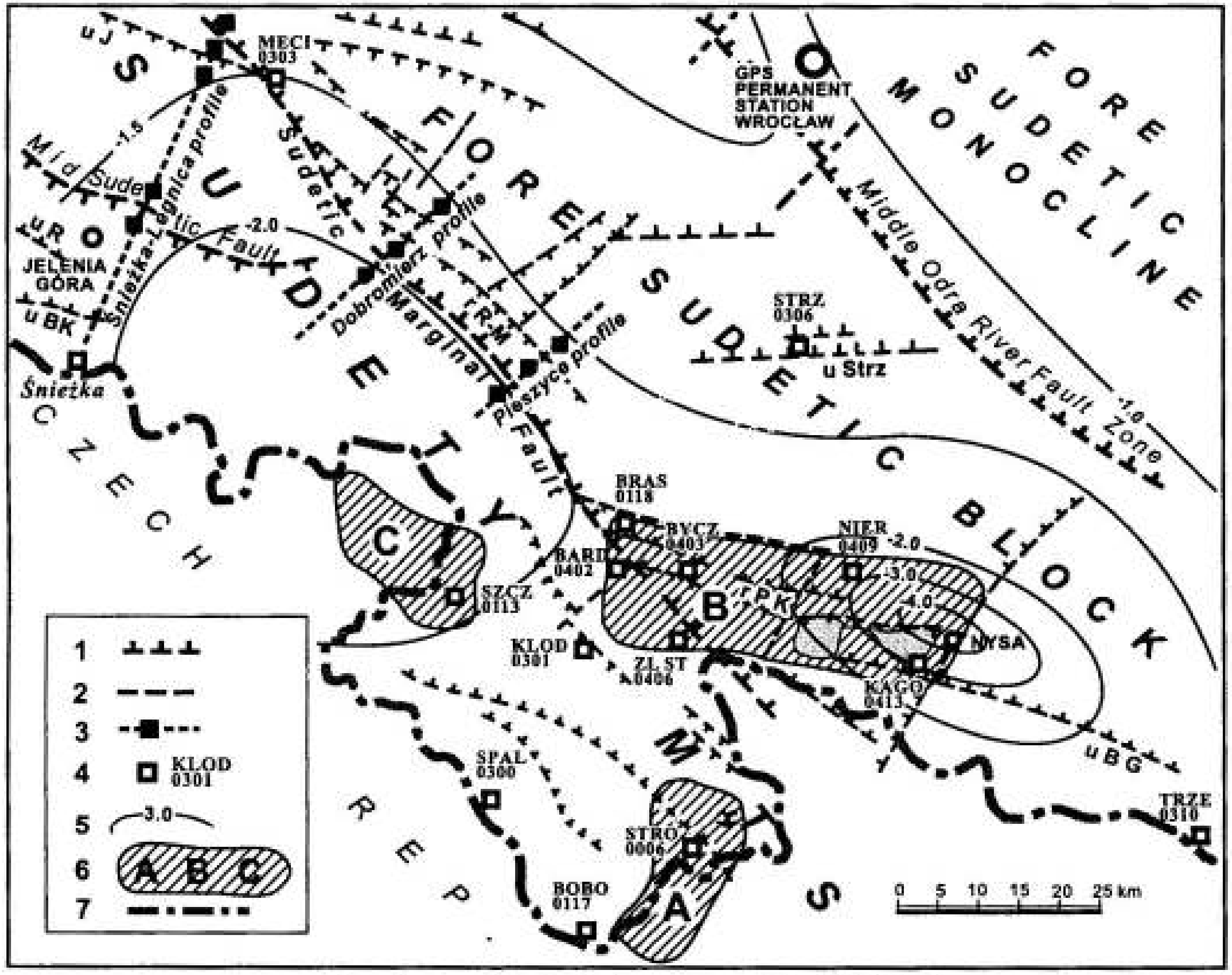
S U D E T E S M T S .
Wałbrzych Upland
Dobromierz
Sowie Mts.
Kłodzko Depr.
Strzegomka
segment 6
Pełcznica
segment 5
Bardo Mts.
Bardo
segment 4
Bystrzyca
segment 3
Świdnica
segment 2
Bielawa Hills
Nysa Kłodzka
segment 1
Złoty Stok
S U D E T I C F O R E L A N D
5 0 5 10 km
N
Kłodzko Depr.
Sowie Mts.
Bardo Mts.
segment 3
segment 4
Nysa Kłodzka
segment 2
Bielawa Hills
5 0 5 10 km
N



SE
NW
Bardo Mts.
Sowie Mts.
Nysa Kłodzka
Pieszycki Potok
Złoty Stok
segment 8
segment 7
segment 6
segment 5
N
sequence of triangular facets
(1 - youngest — 5 - oldest)
1 2 3 4 5
10 km



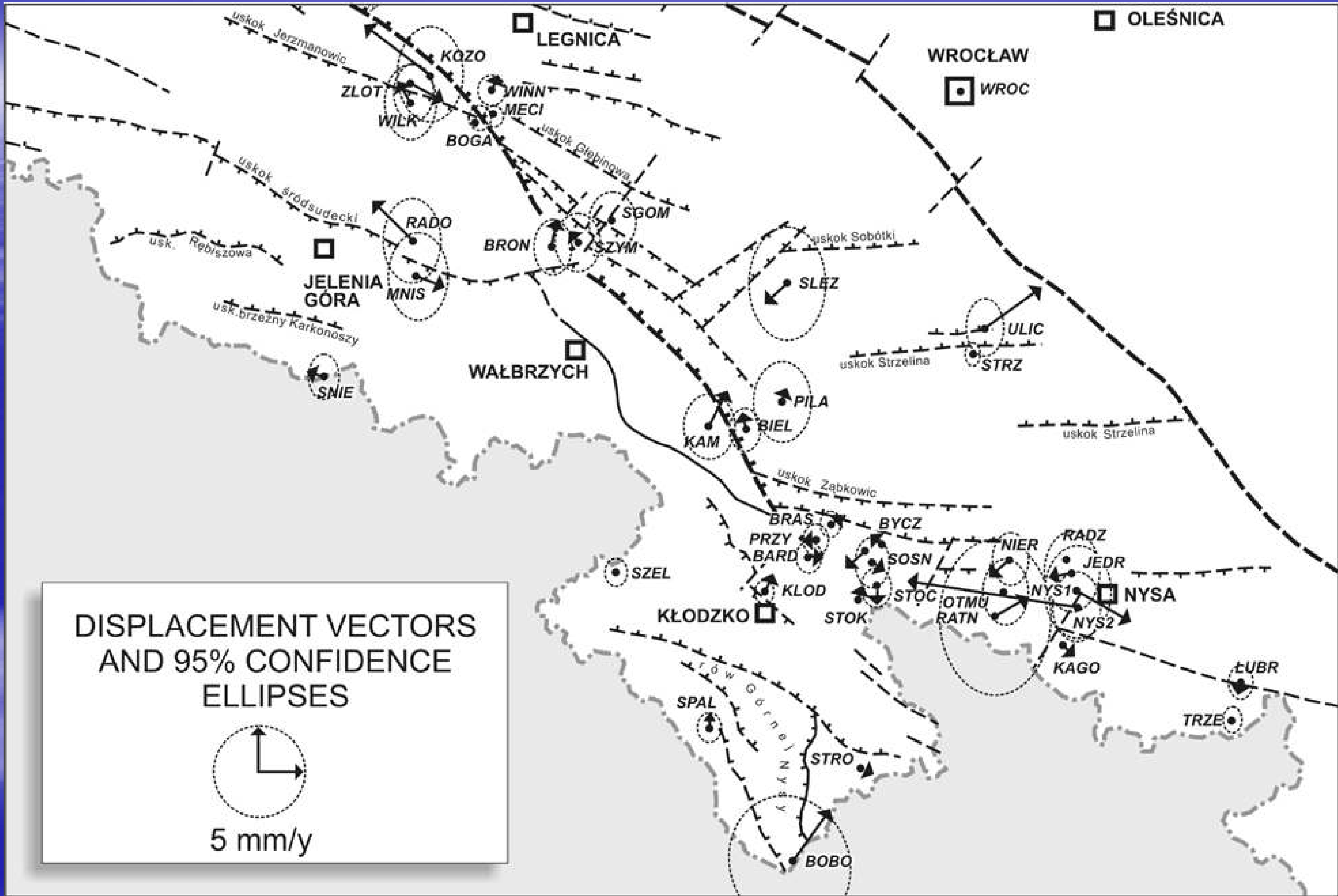
Earthquakes in Lower Silesia 1964-2000 *Badura & Przybylski 2000*



Sketch map of geological structure of the Polish Sudetes

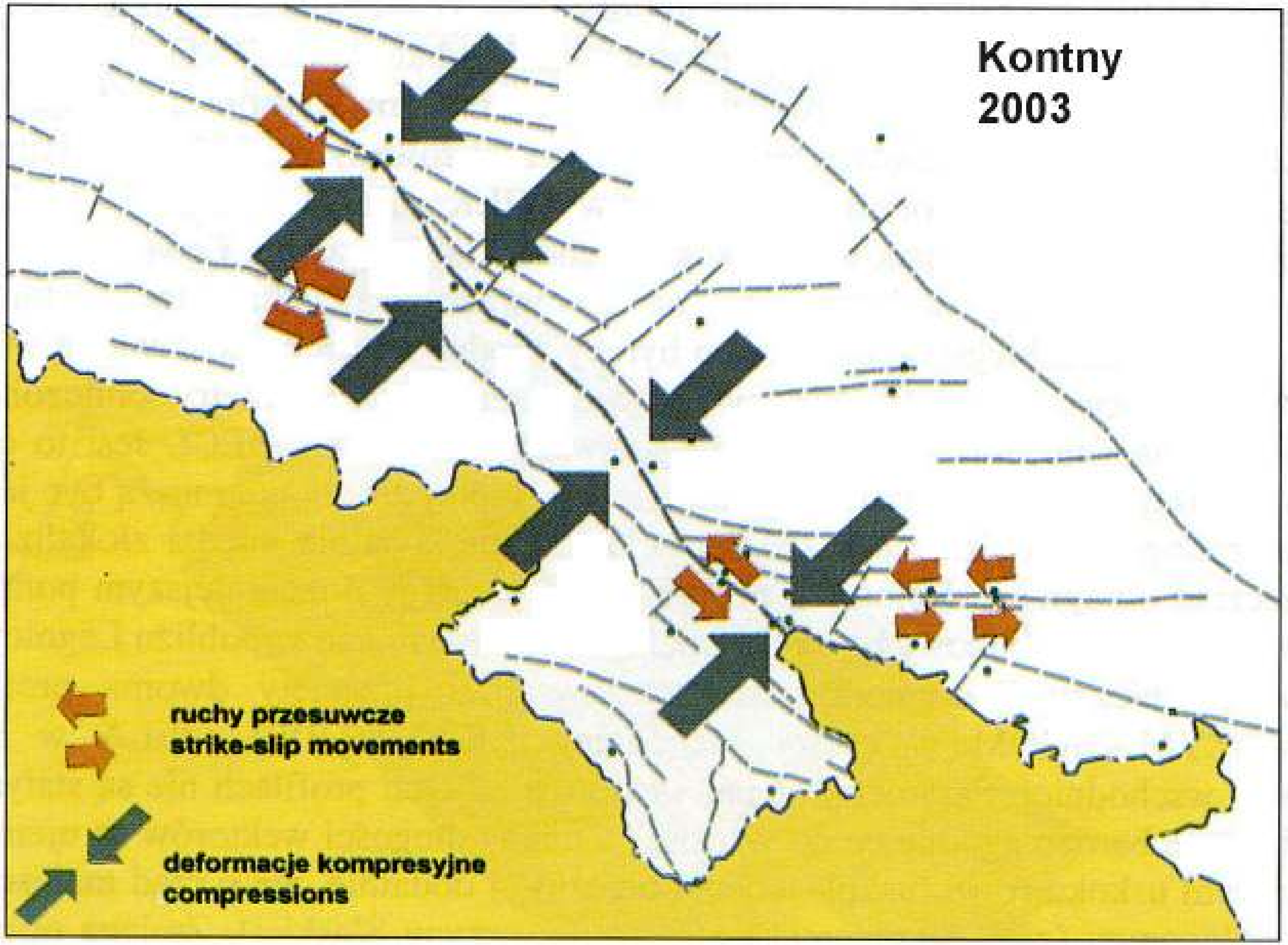
Faults active in the Tertiary and Quaternary: 1 – faults with undetermined sense of throw; 2 – faults with confirmed sense of throw: ubK – Karkonosze Marginal Fault, uR – Rębiszów Fault, uJ – Jerzmanowa Fault, rR-M – Roztoki-Mokrzeszów Graben, uStrz – Strzelin Fault, uBG – Biała Głuchołaska Fault, rP-K – Paczków–Kędzierzyn Graben; 3 – new geodynamic profiles; 4 – geodynamic network points; 5 – isolines of recent vertical crustal movements according to WYRZYKOWSKI (1985); 6 – geodynamic polygons: A – "Śnieżnik Massif", B – "Paczków Graben", C – "Stołowe Mts."; 7 – national border

Cacoń & Dyjor 2002

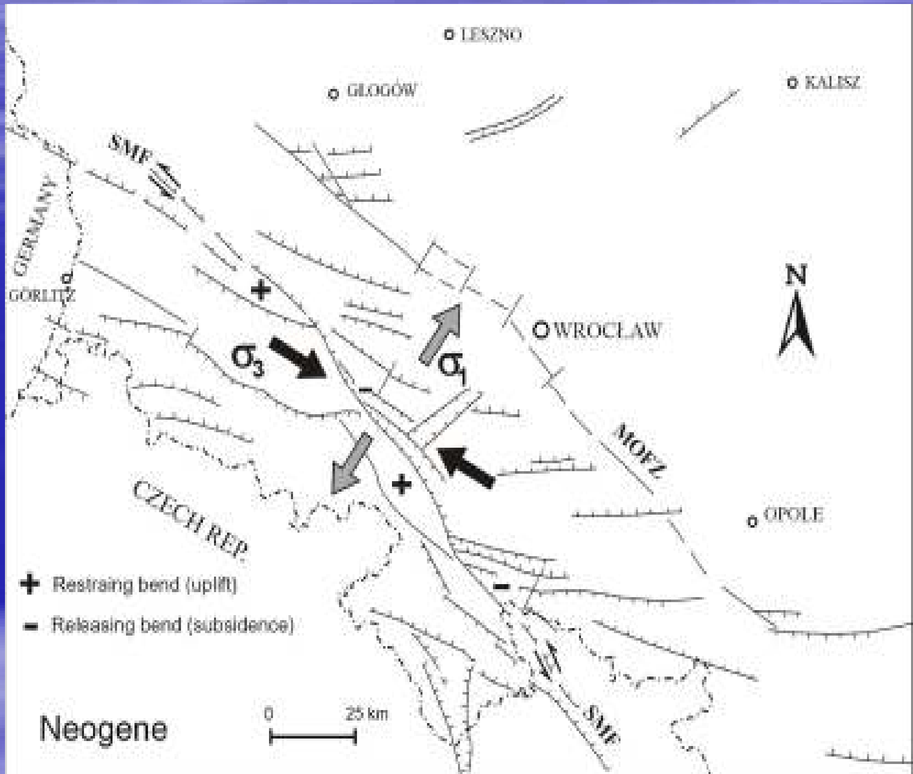


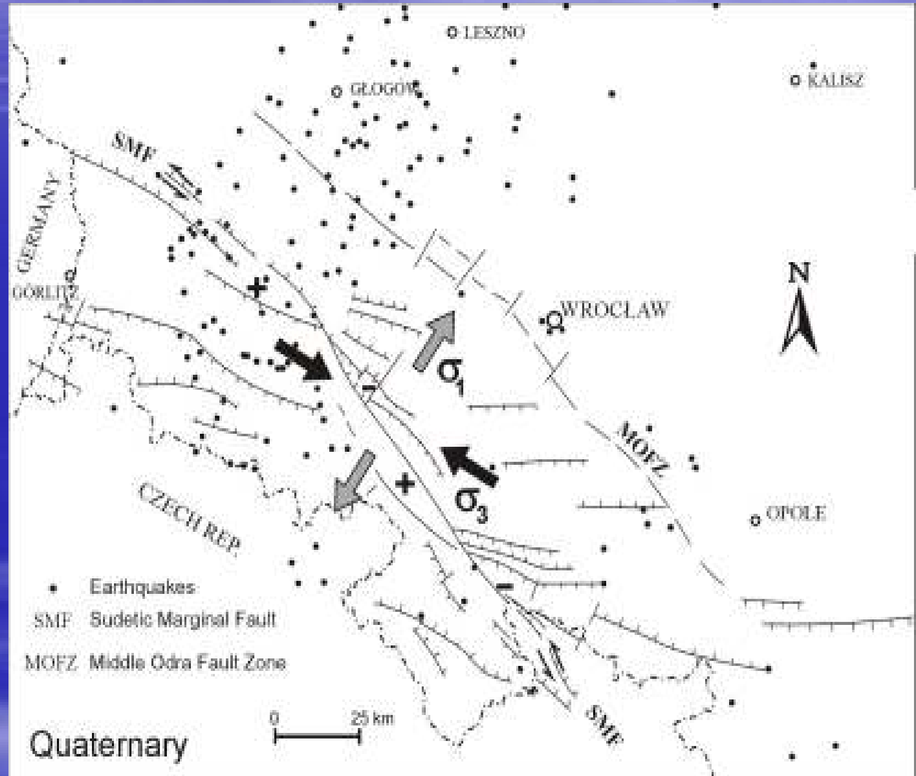
LEGNICA
OLEŚNICA
WROCŁAW
WROC
KOZO
ZLOT
WILK
WINN
MECI
BOGA
uskok Jerzmanowic
uskok Głębinowa
uskok śródsudecki
usk. Rębiszowa
RADO
MNIS
JELENIA GÓRA
BRON
SZYM
SGOM
usk.brzeżny Karkonoszy
SNIE
WAŁBRZYCH
SLEZ
uskok Sobótki
ULIC
STRZ
uskok Strzelina
PILA
KAM
BIEL
uskok Strzelina
uskok Ząbkowic
BRAS
BYCZ
PRZY
BARD
SOSN
NIER
RADZ
JEDR
SZEL
KLOD
STOC
OTMU
NYS1
NYSA
KŁODZKO
STOK
RATN
NYS2
KAGO
ŁUBR
TRZE
rów Górnej Nysy
SPAL
STRO
BOBO
DISPLACEMENT VECTORS AND 95% CONFIDENCE ELLIPSES
5 mm/y

Kontny 2003

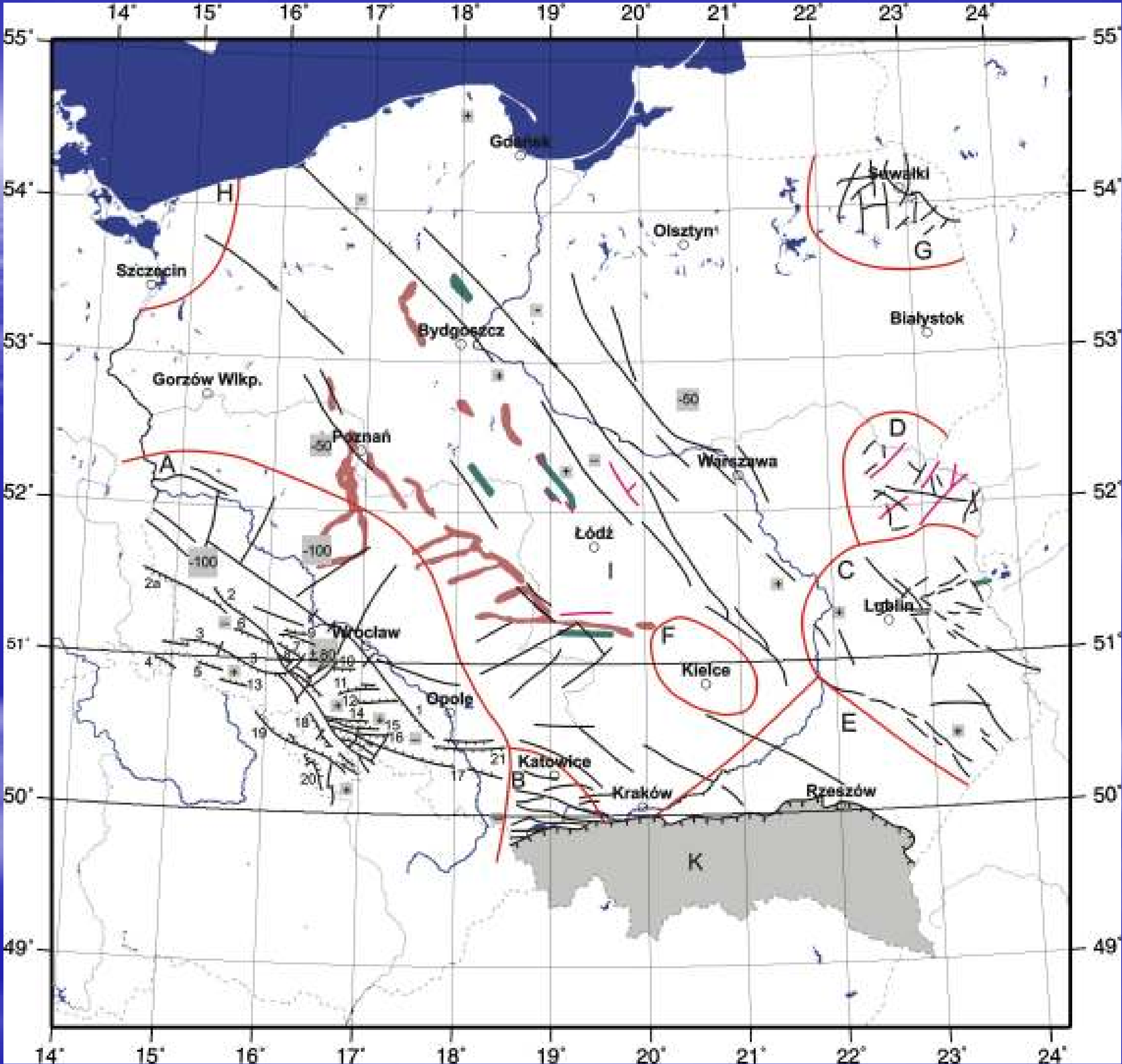


Type of motion inferred from GPS data

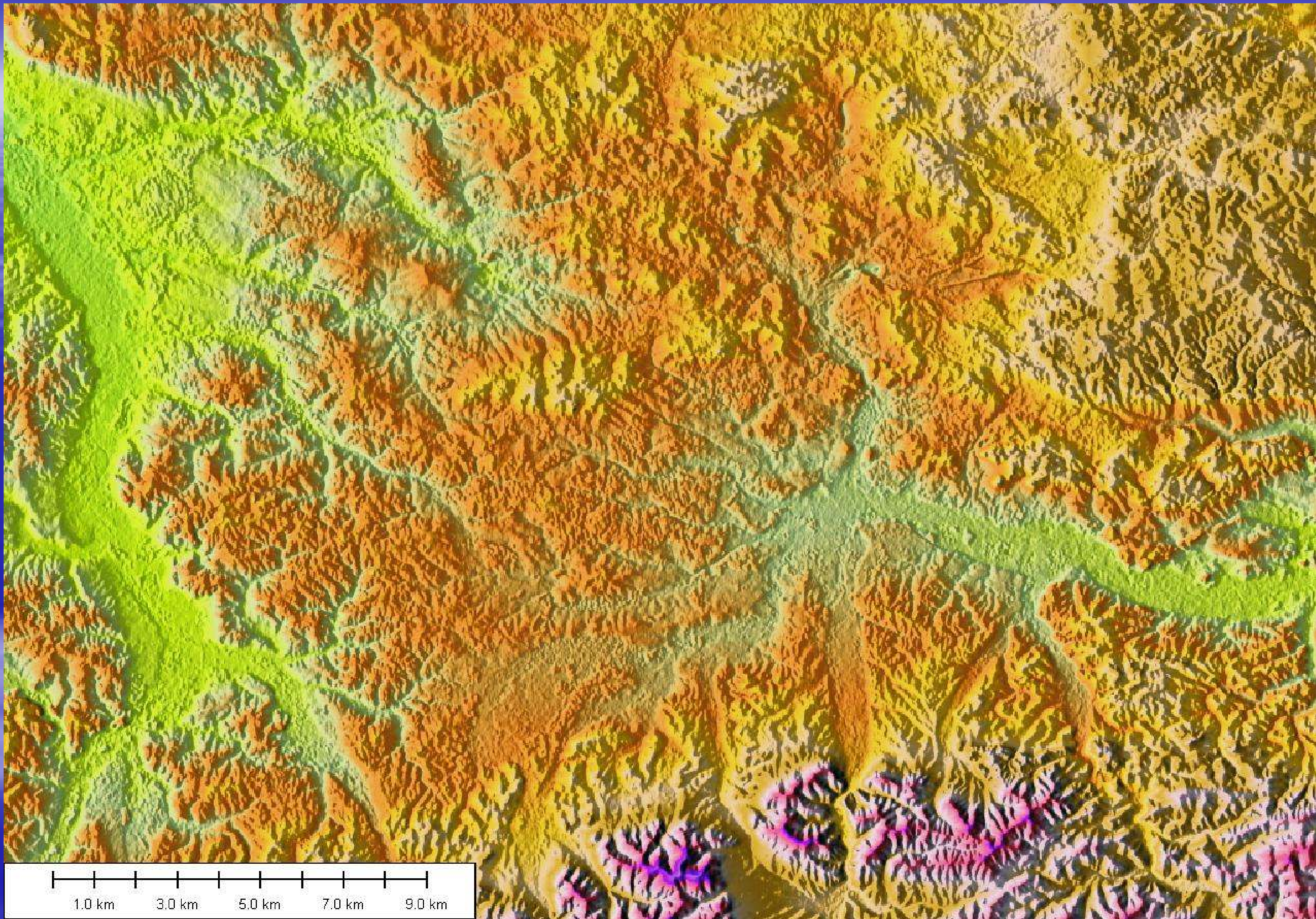


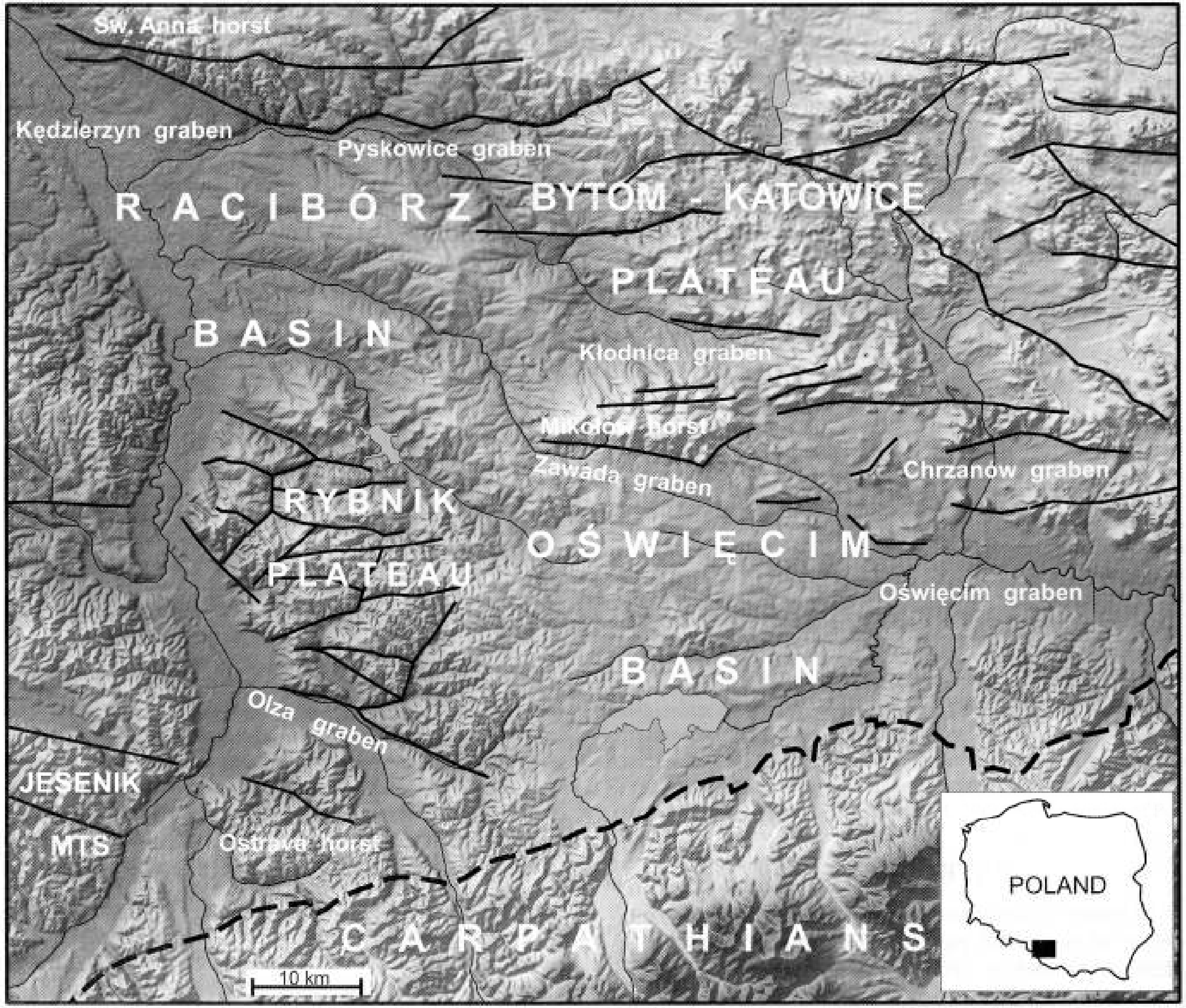


Stress field pattern in Lower Silesia

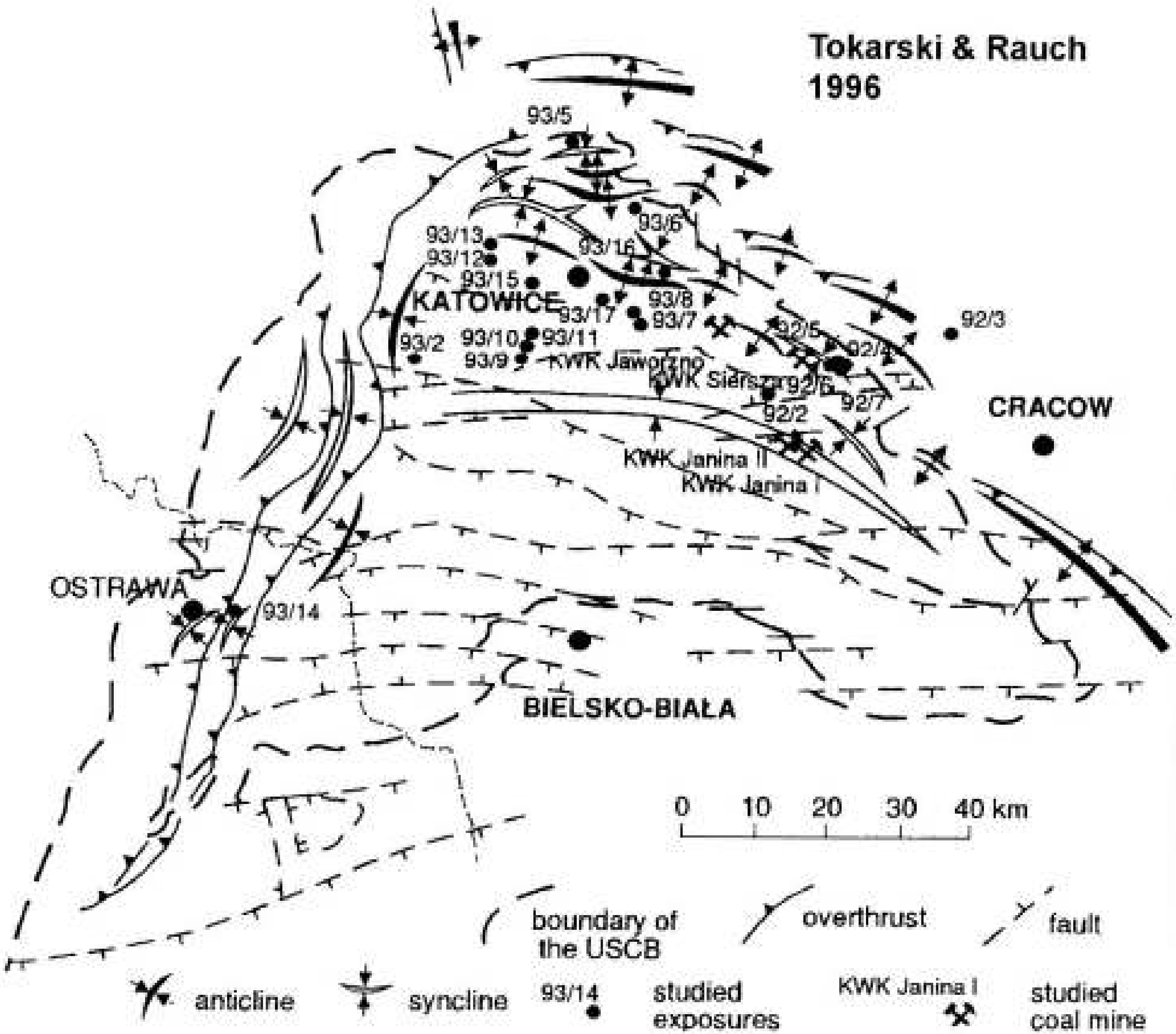


Gdańsk
Olsztyn
Suwałki
Szczecin
Białystok
Bydgoszcz
Gorzów Wlkp.
Poznań
Warszawa
Łódź
Lublin
Wrocław
Opole
Kielce
Katowice
Kraków
Rzeszów
A
B
C
D
E
F
G
H
I
K
-50
-100


1.0 km
3.0 km
5.0 km
7.0 km
9.0 km

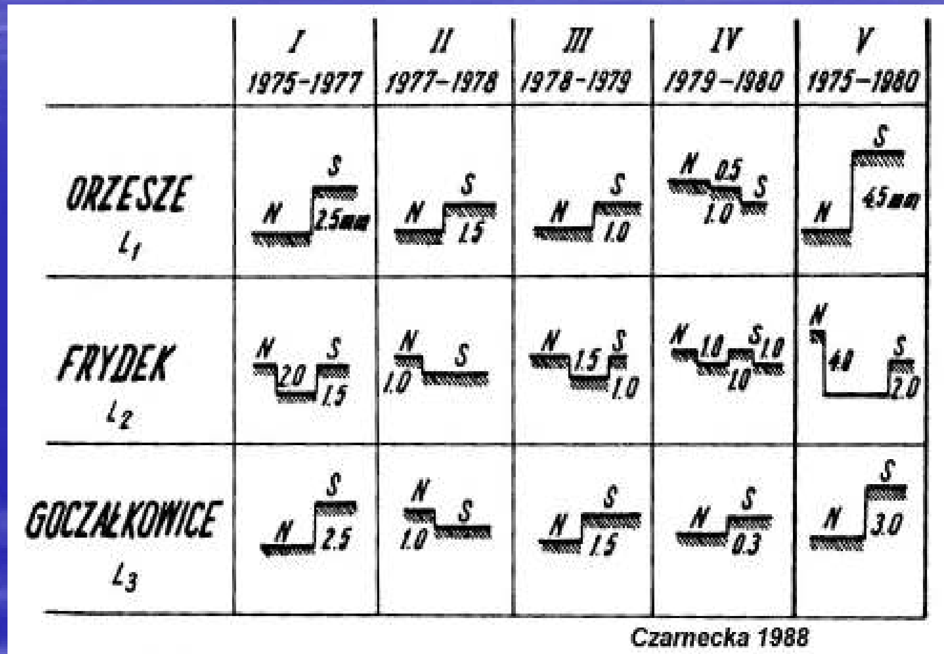


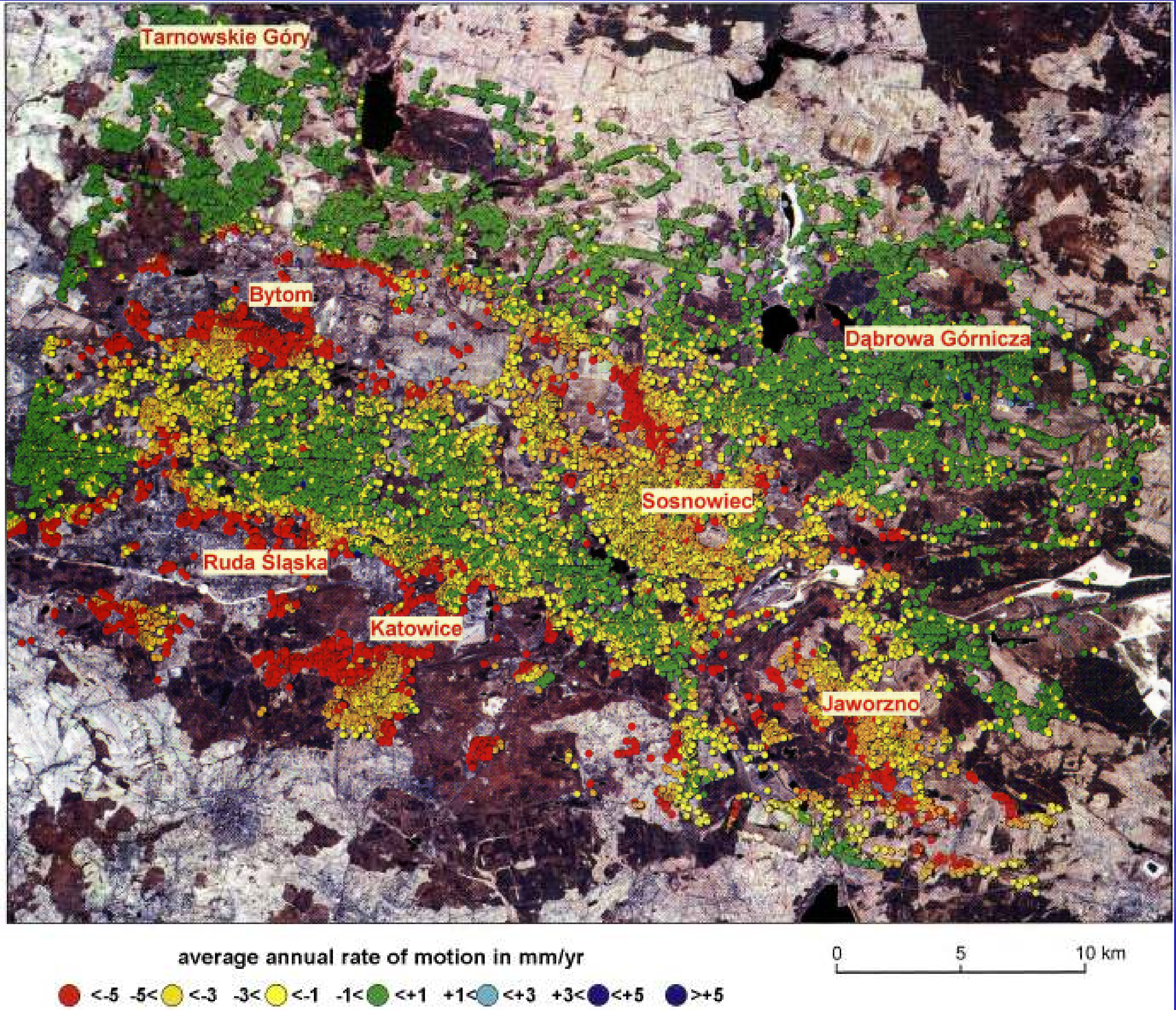
Location of major Miocene faults in Upper Silesia, reactivated in Quaternary times
(after Lewandowski, 2007)



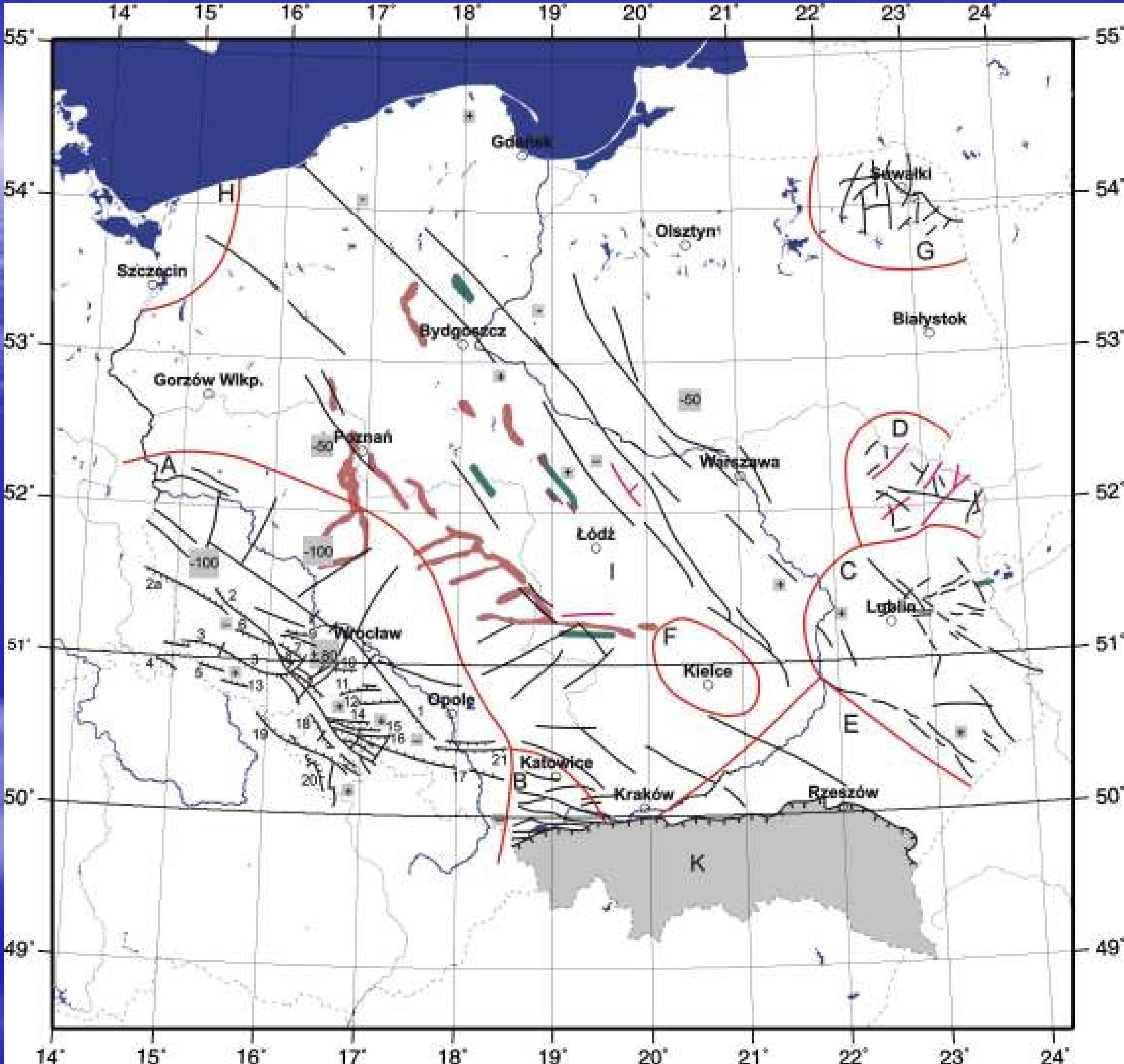
Tectonic sketch of Upper Silesia Coal Basin (after K o t a s, 1987, modified) with location of joint measurement stations in coal mines and in surficial exposures


UPPER SILESIA
xxxxxx tectonic faults of the second order
main fault zones
Bytom block
Cieszyn block
L1
L2
L3
Czarnecka 1988

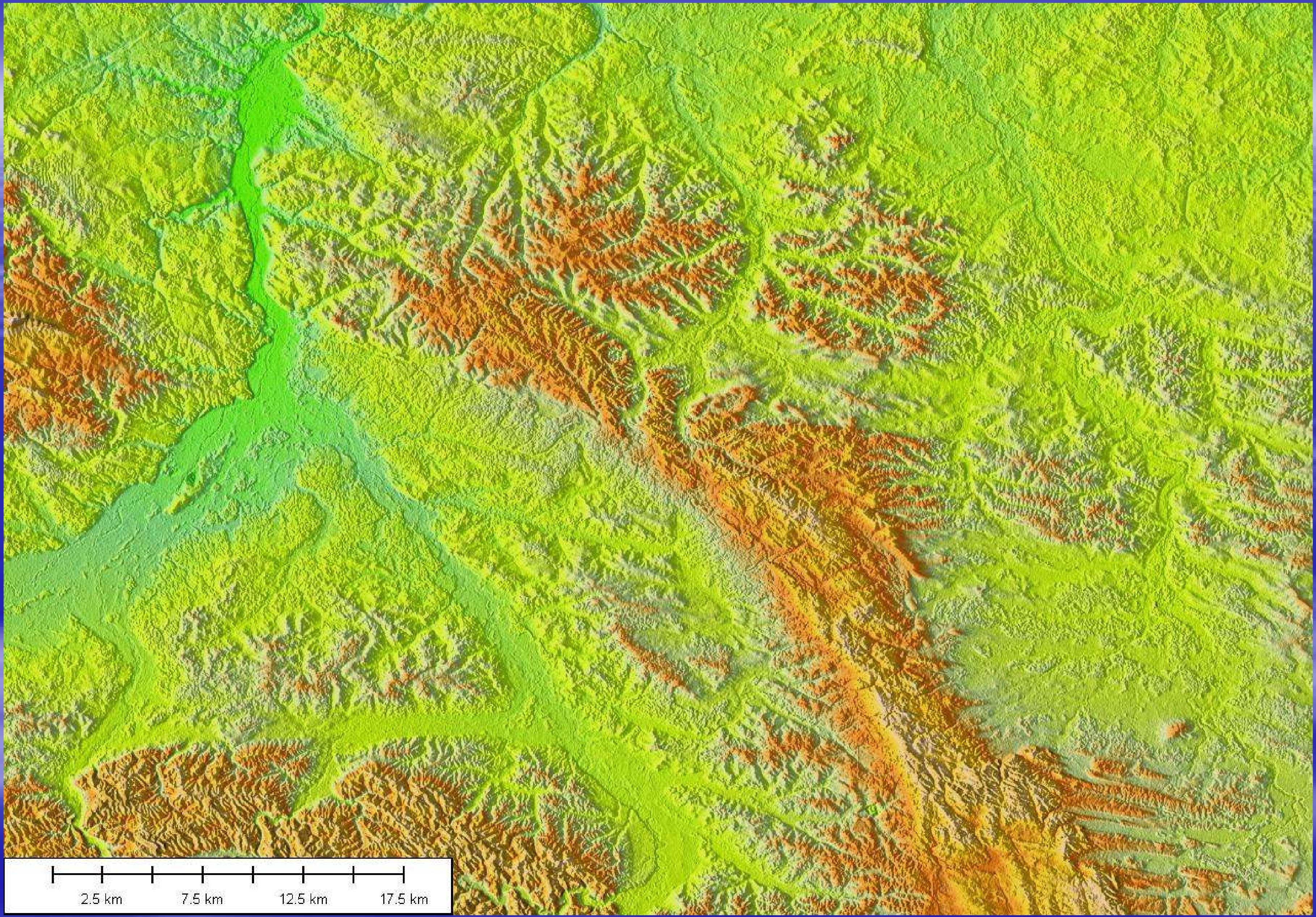

I 1975-1977
II 1977-1978
III 1978-1979
IV 1979-1980
V 1975-1980
ORZESZE L1
FRYDEK L2
GOCZAŁKOWICE L3
N
S
2.5mm
1.5
1.0
0.5
45mm
2.0
4.0
3.0
0.3
Czarnecka 1988

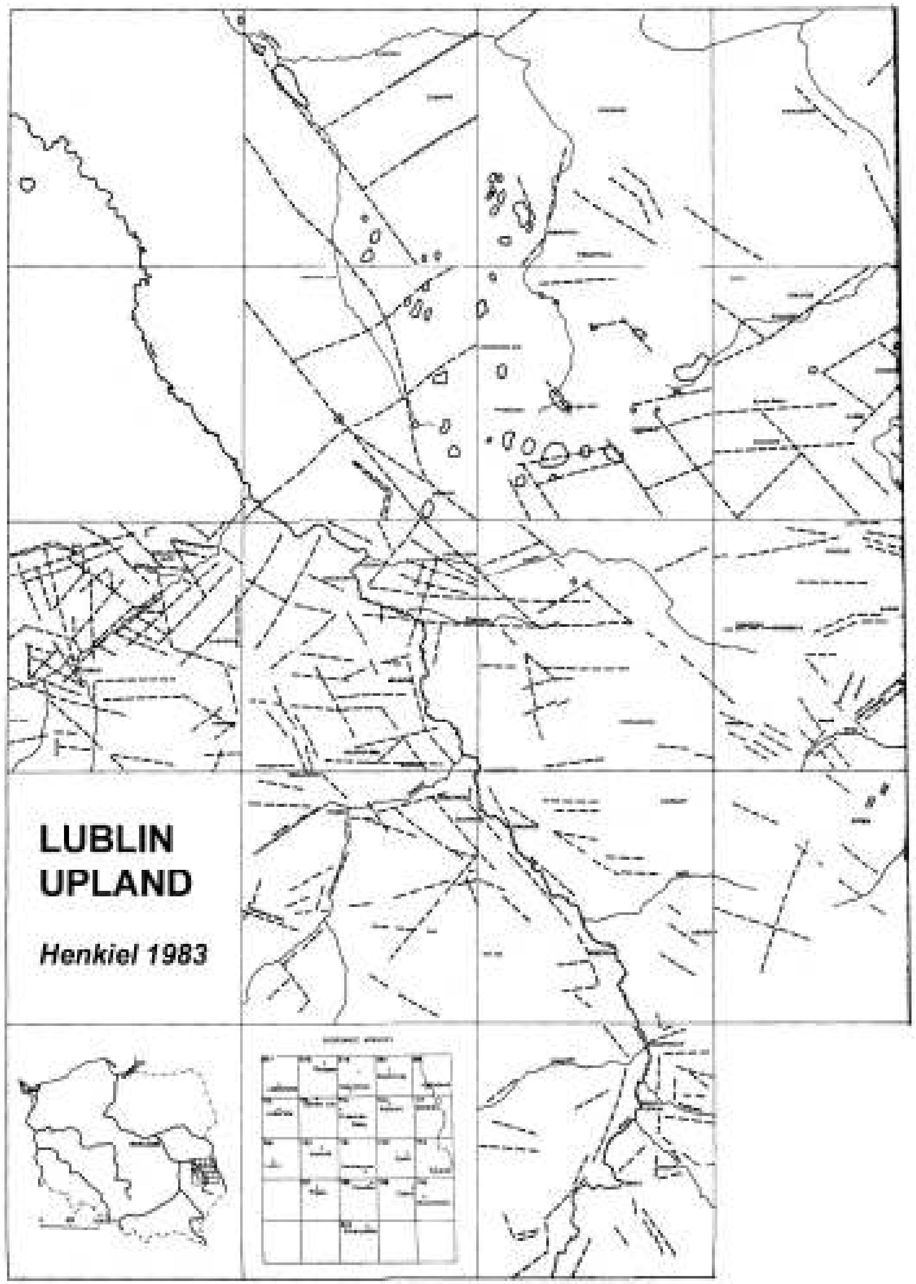


PSinSAR measurement points in Upper Silesia (based on Graniczny et al., 2005)

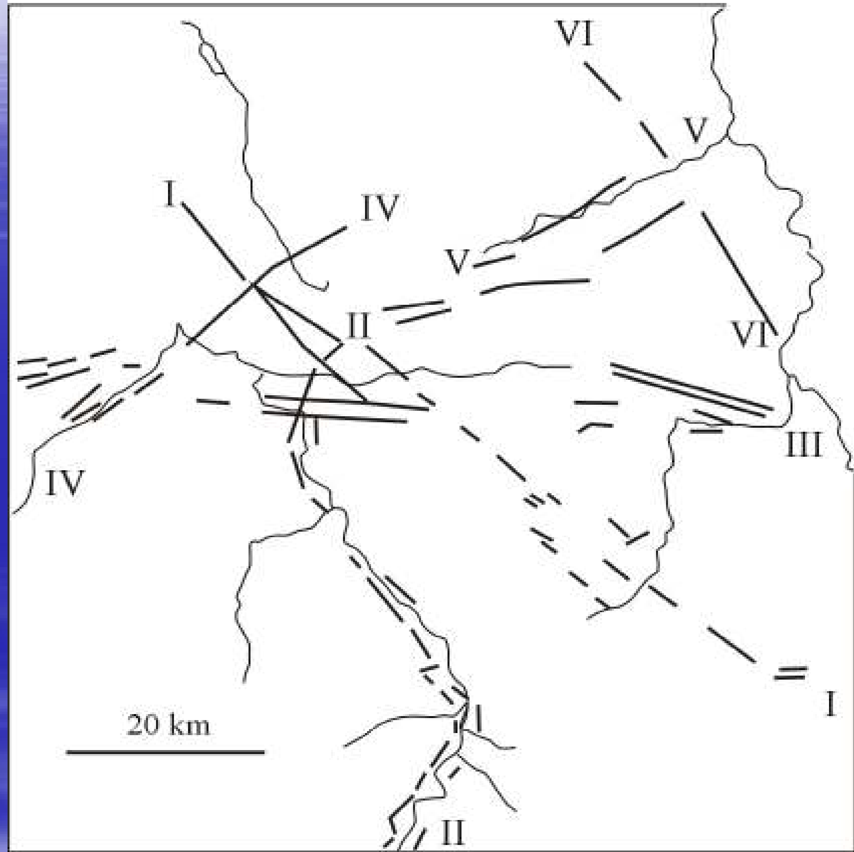


Gdańsk
Suwałki
Olsztyn
Szczecin
Białystok
Bydgoszcz
Gorzów Wlkp.
Poznań
Warszawa
Łódź
Lublin
Wrocław
Opole
Kielce
Katowice
Kraków
Rzeszów
A
B
C
D
E
F
G
H
I
K
-50
-100


2.5 km
7.5 km
12.5 km
17.5 km

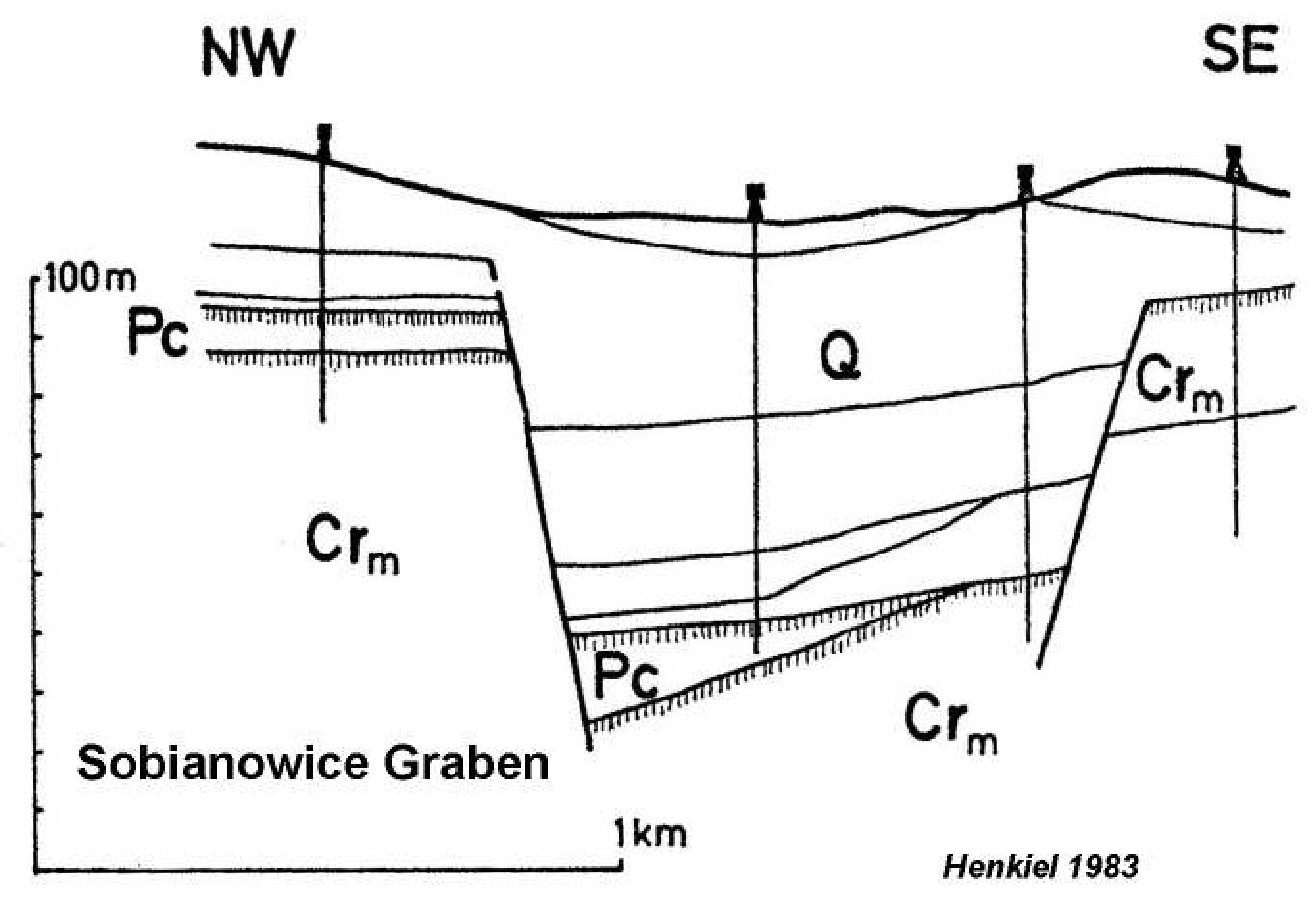


LUBLIN UPLAND (SE POLAND)

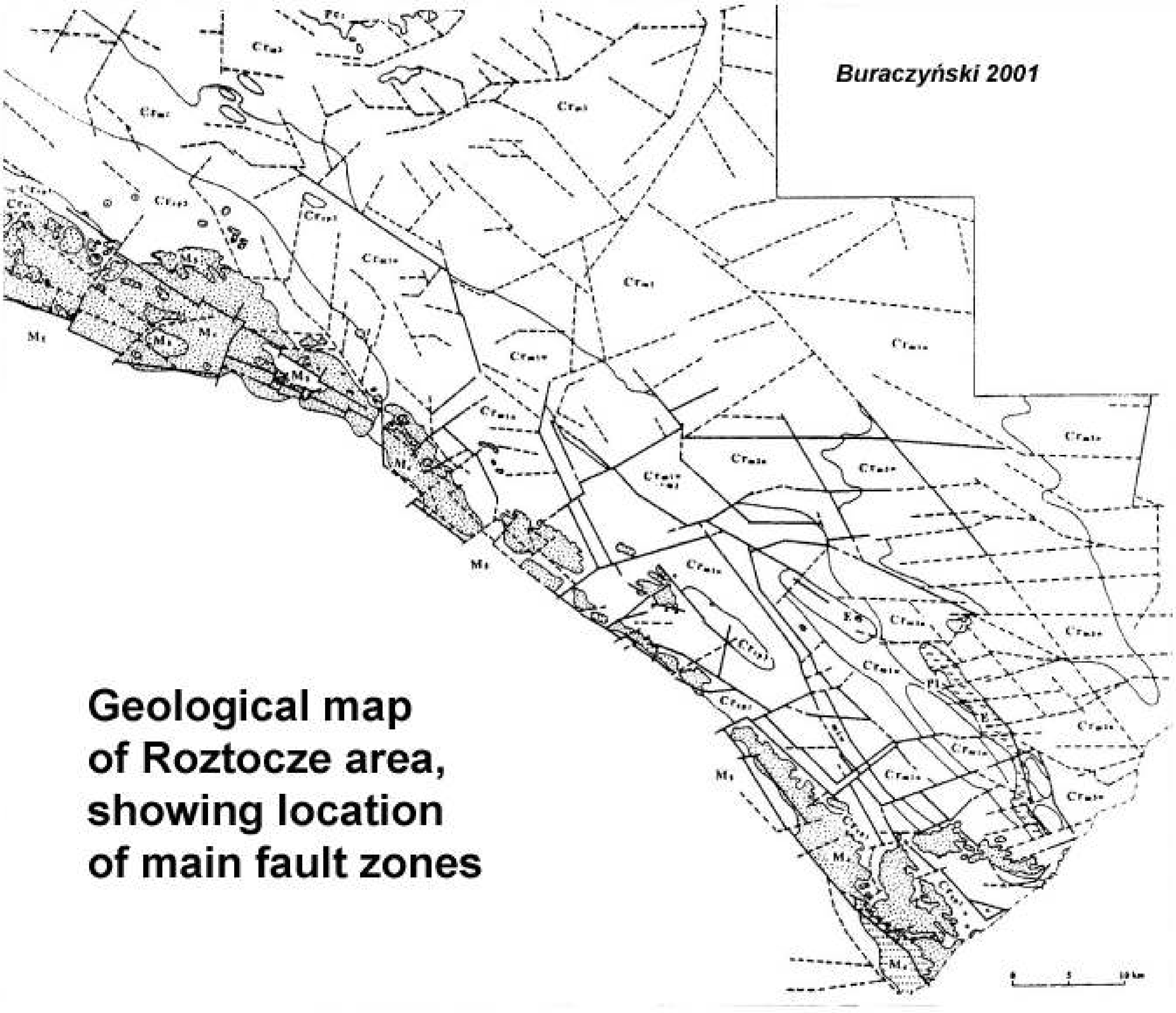


FAULT ZONES:

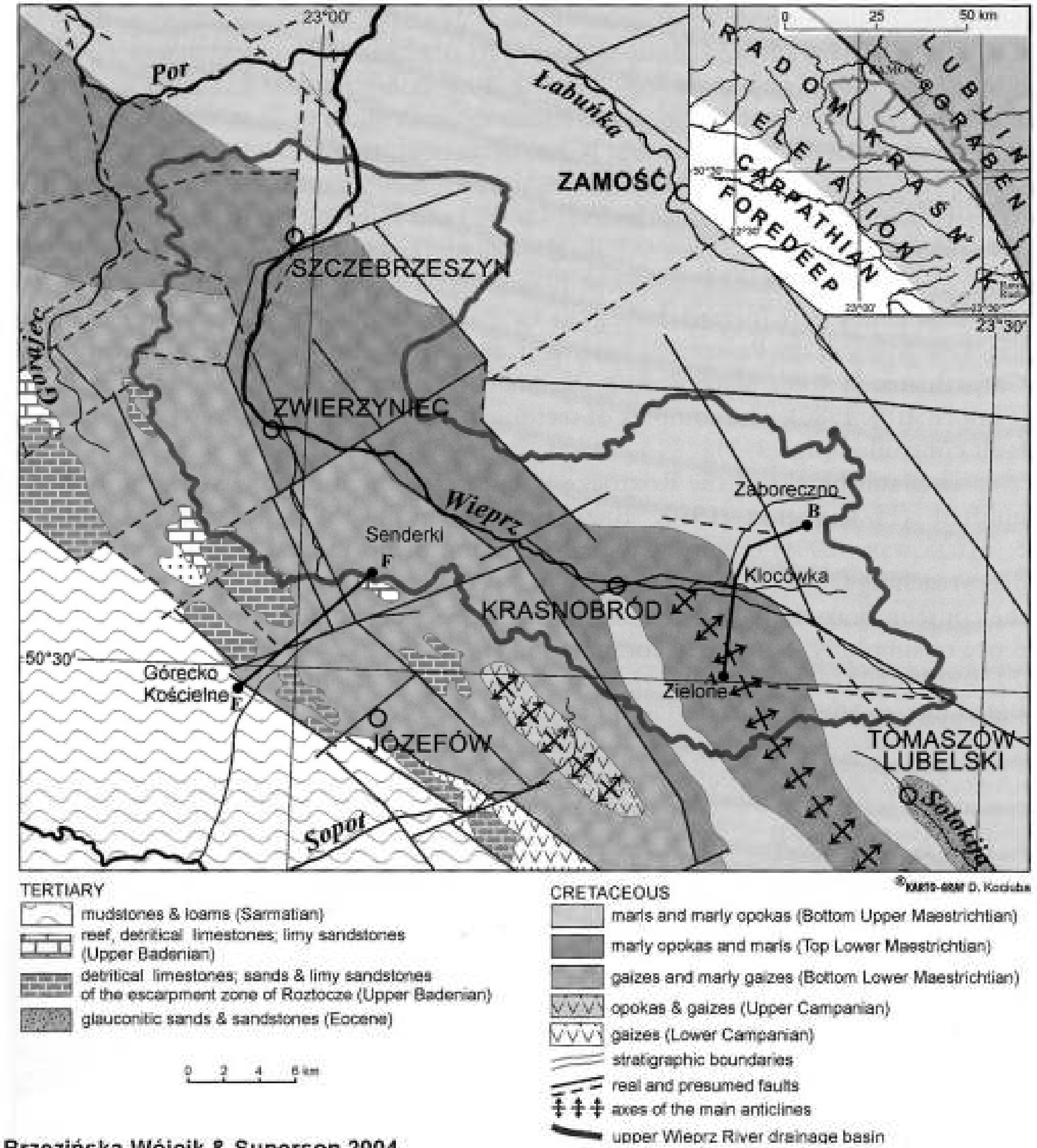
I - Kock - Łęczna; II - Wieprz River valley;
III - northern margin of the Lublin Upland;
IV - Bystrzyca River valley; V - Włodawka;
VI - Kaplonosy (*Henkiel, 1983, 1984*)



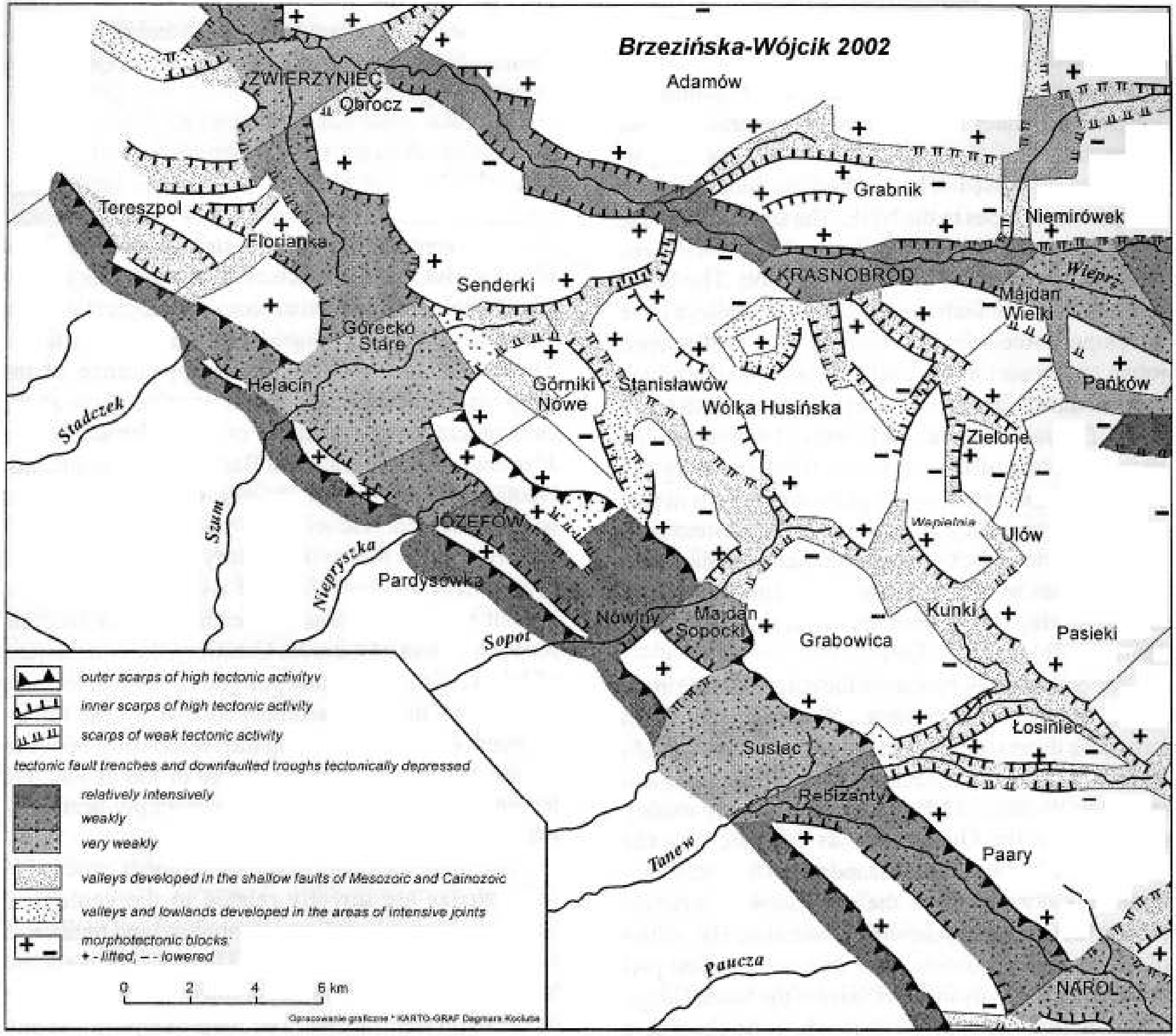
NW
SE
100m
Pc
Q
Cr_m
Cr_m
Pc
Cr_m
Sobianowice Graben
1km
Henkiel 1983



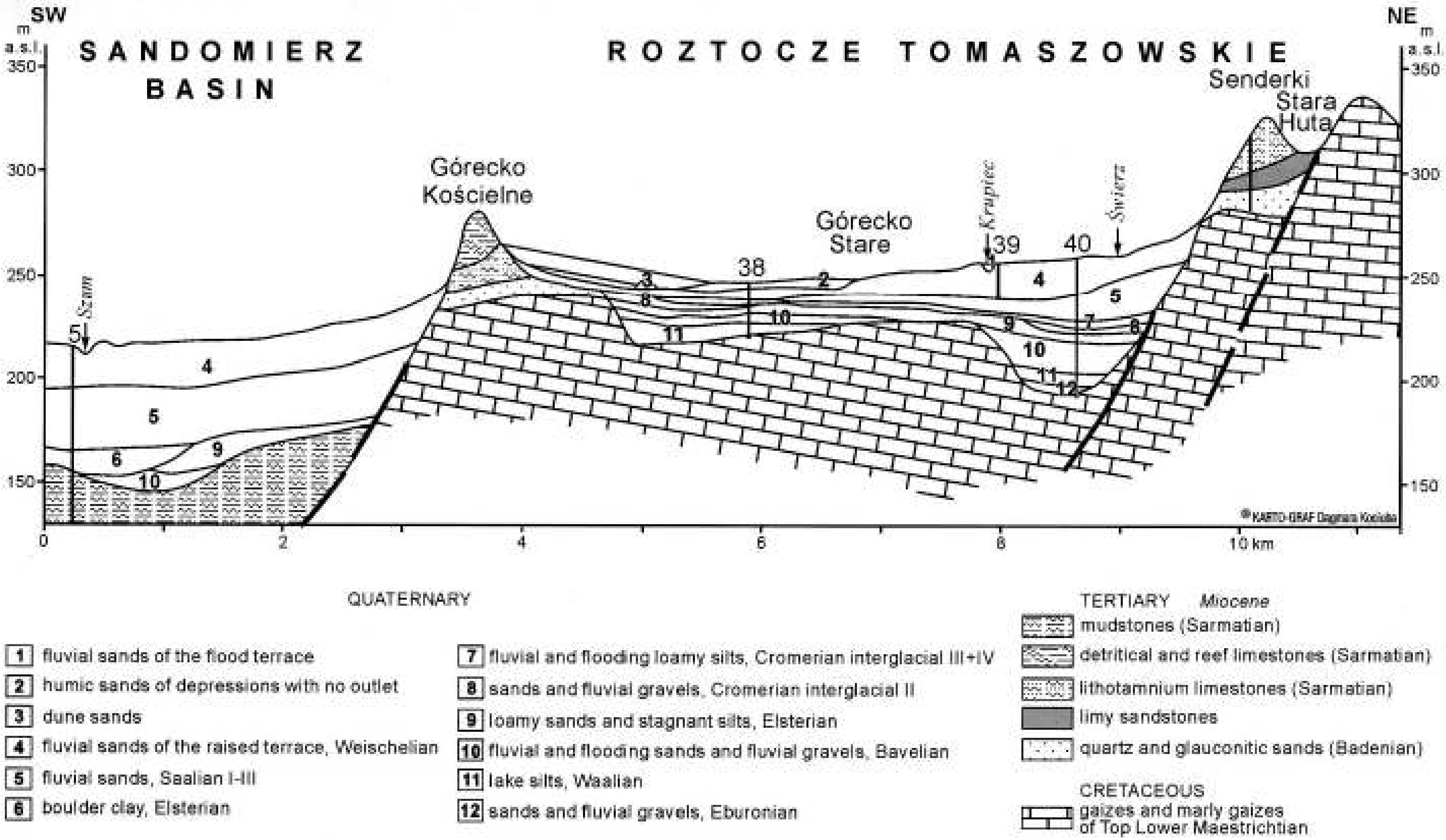
Geological map
of Roztocze area,
showing location
of main fault zones



Brzezińska-Wójcik & Superson 2004

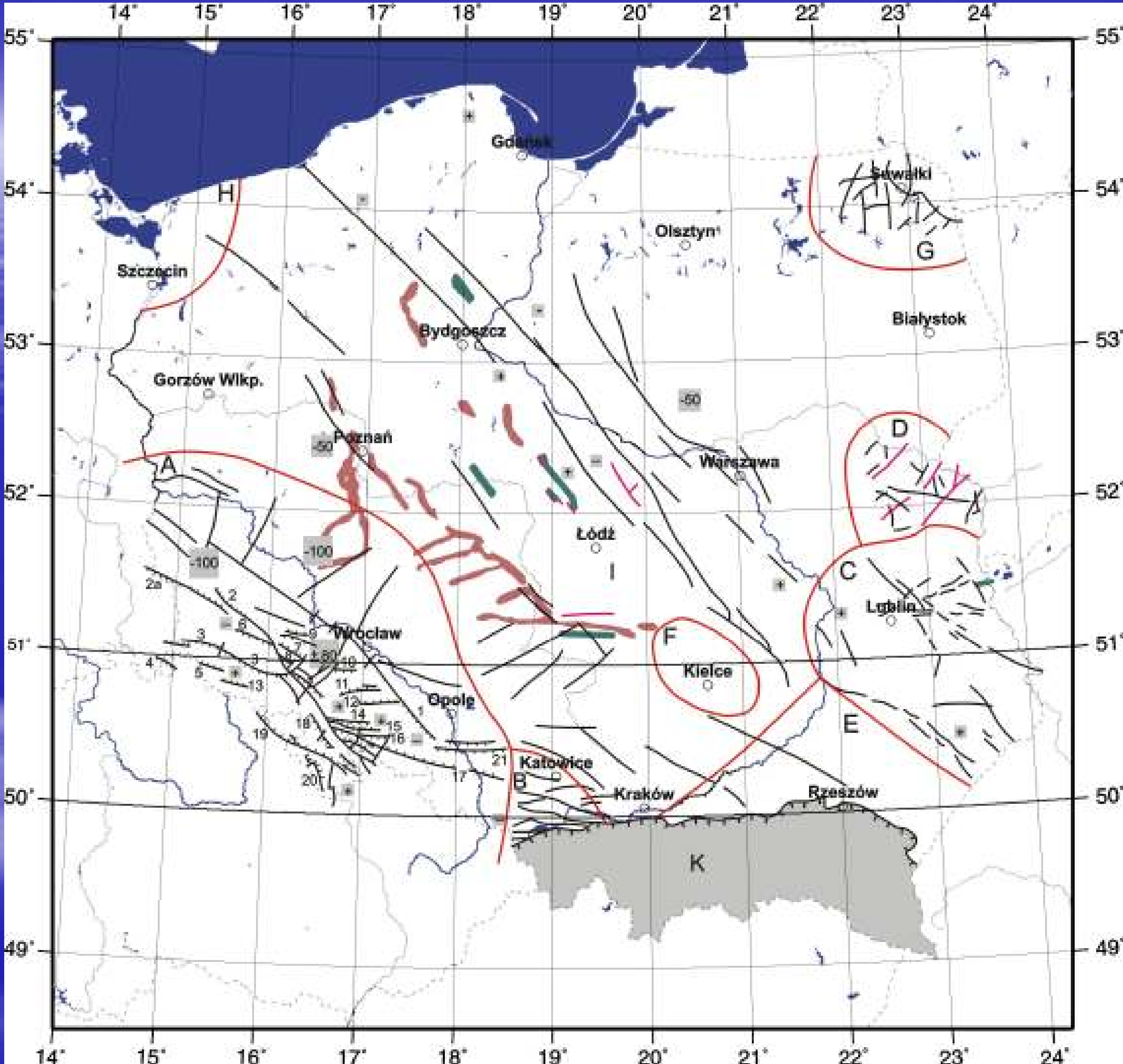


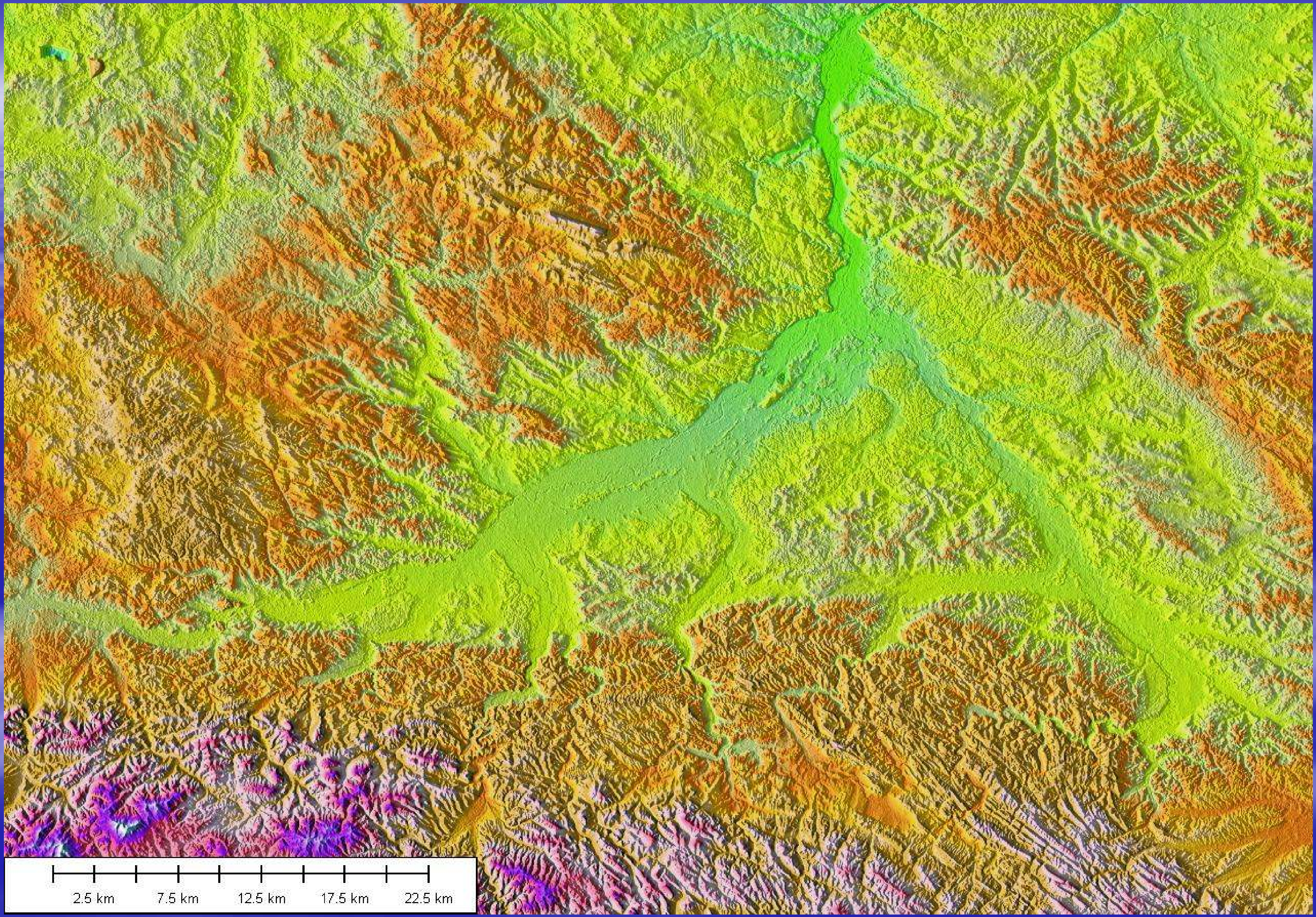
MORPHOTECTONIC PATTERN, ROZTOCZE WIEPRZ RIVER BASIN

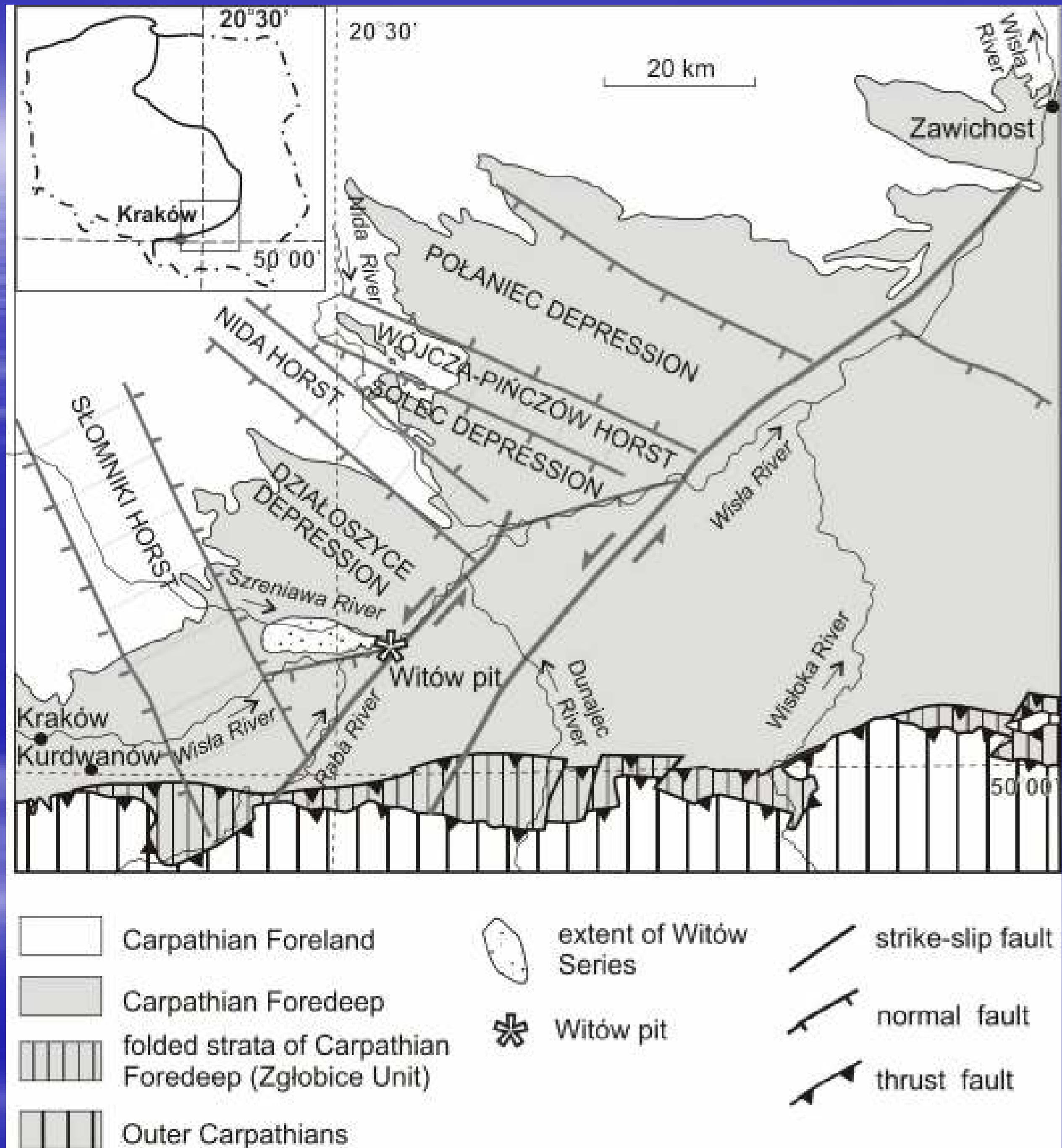


Geological cross-section of the Zwierzyniec Downfaulted Trough (E–F) (compiled after: KURKOWSKI 1994, POPIELSKI 1994, BURACZYŃSKI 1996, CIEŚLIŃSKI et al. 1996).

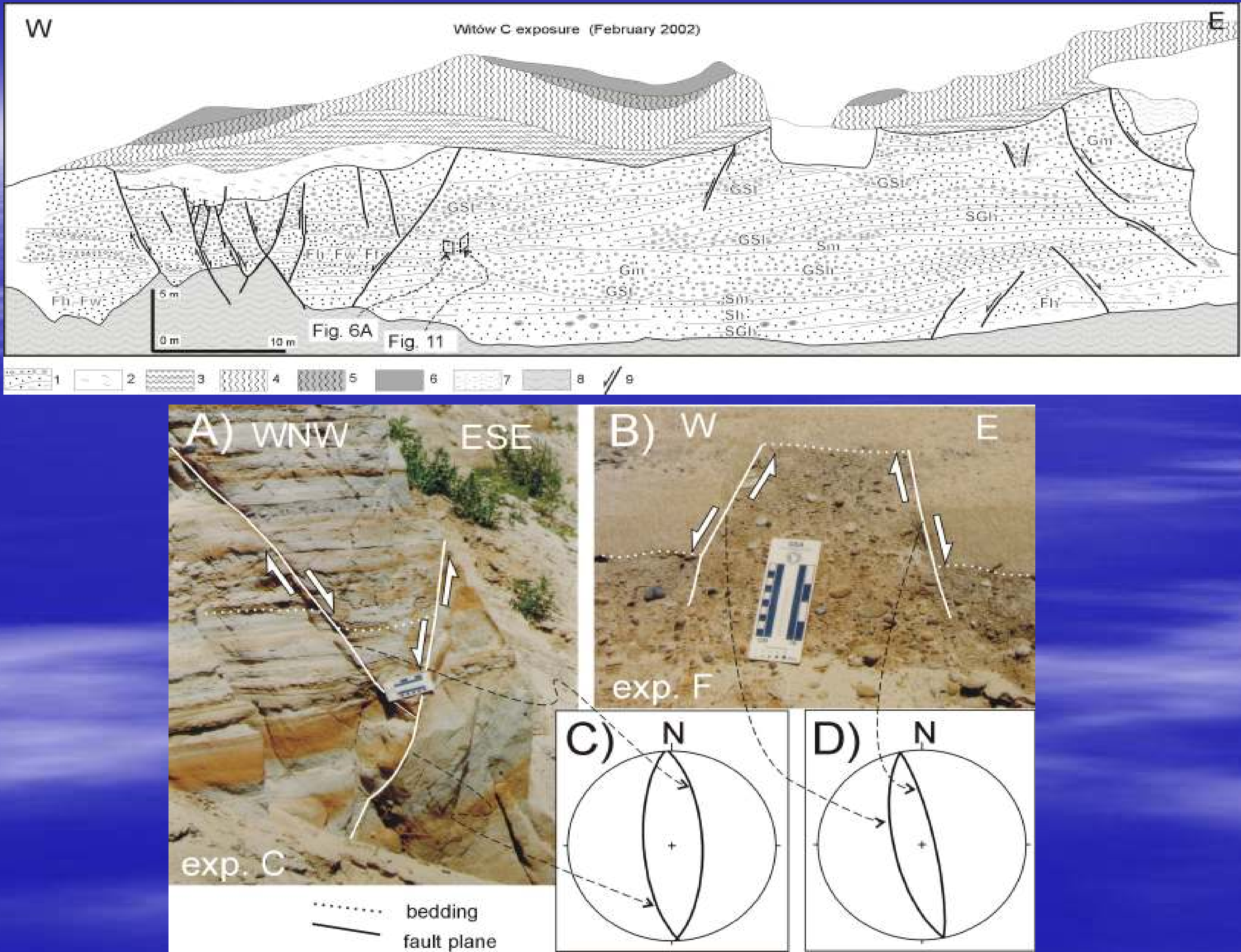
Brzezińska-Wójcik & Superson 2004

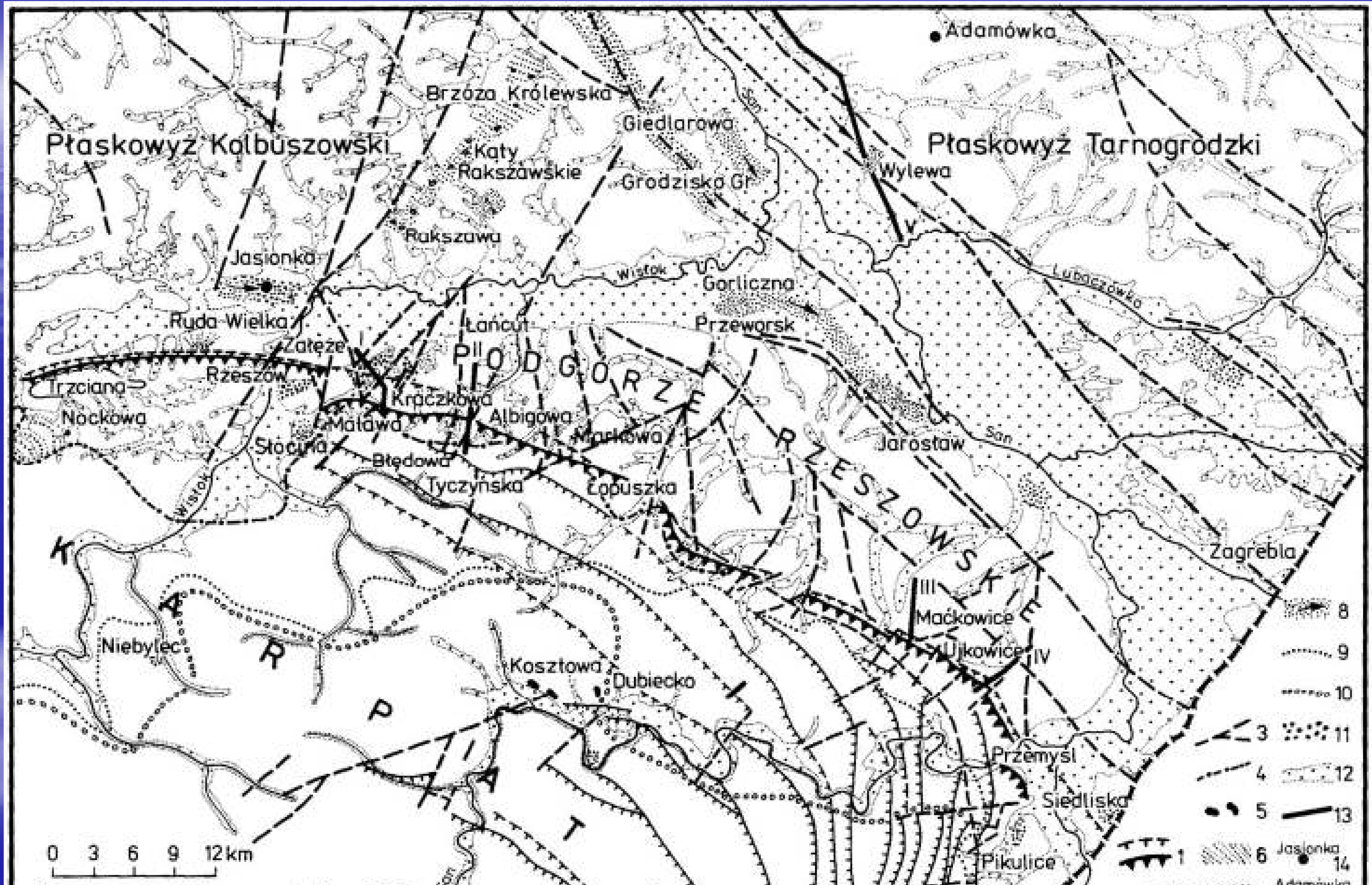

Gdańsk
Olsztyn
Suwałki
Szczecin
Białystok
Bydgoszcz
Gorzów Wlkp.
Poznań
Warszawa
Łódź
Lublin
Wrocław
Opole
Kielce
Katowice
Kraków
Rzeszów
A
B
C
D
E
F
G
H
I
K
-50
-100
14°
15°
16°
17°
18°
19°
20°
21°
22°
23°
24°
49°
50°
51°
52°
53°
54°
55°


2.5 km
7.5 km
12.5 km
17.5 km
22.5 km

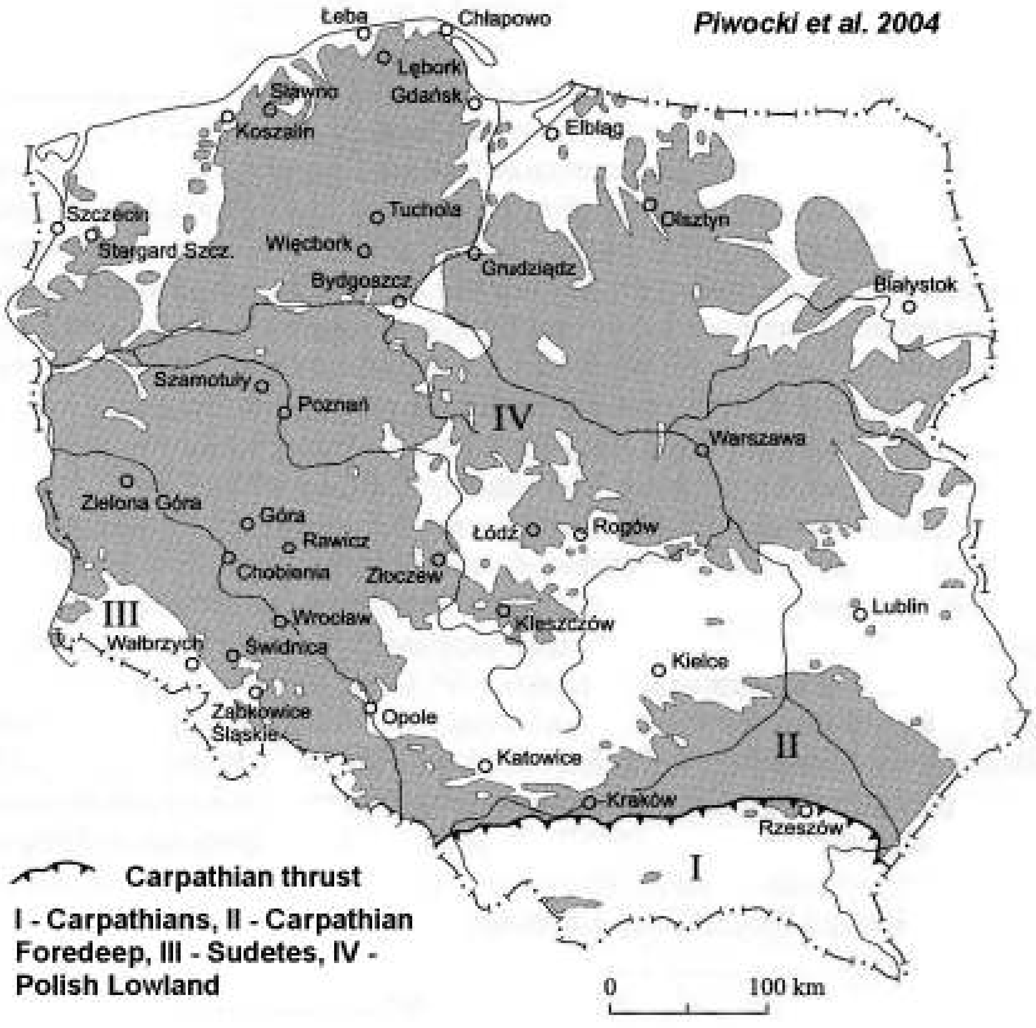


20°30'
Kraków
50°00'
20°30'
20 km
Wisła River
Zawichost
Nida River
POŁANIEC DEPRESSION
WÓJCZA-PIŃCZÓW HORST
NIDA HORST
SOLEC DEPRESSION
SŁOMNIKI HORST
DZIAŁOSZYCE DEPRESSION
Szreniawa River
Wisła River
Witów pit
Dunajec River
Wisłoka River
Kraków
Kurdwanów
Wisła River
Raba River
50°00'
Carpathian Foreland
Carpathian Foredeep
folded strata of Carpathian Foredeep (Zgłobice Unit)
Outer Carpathians
extent of Witów Series
Witów pit
strike-slip fault
normal fault
thrust fault

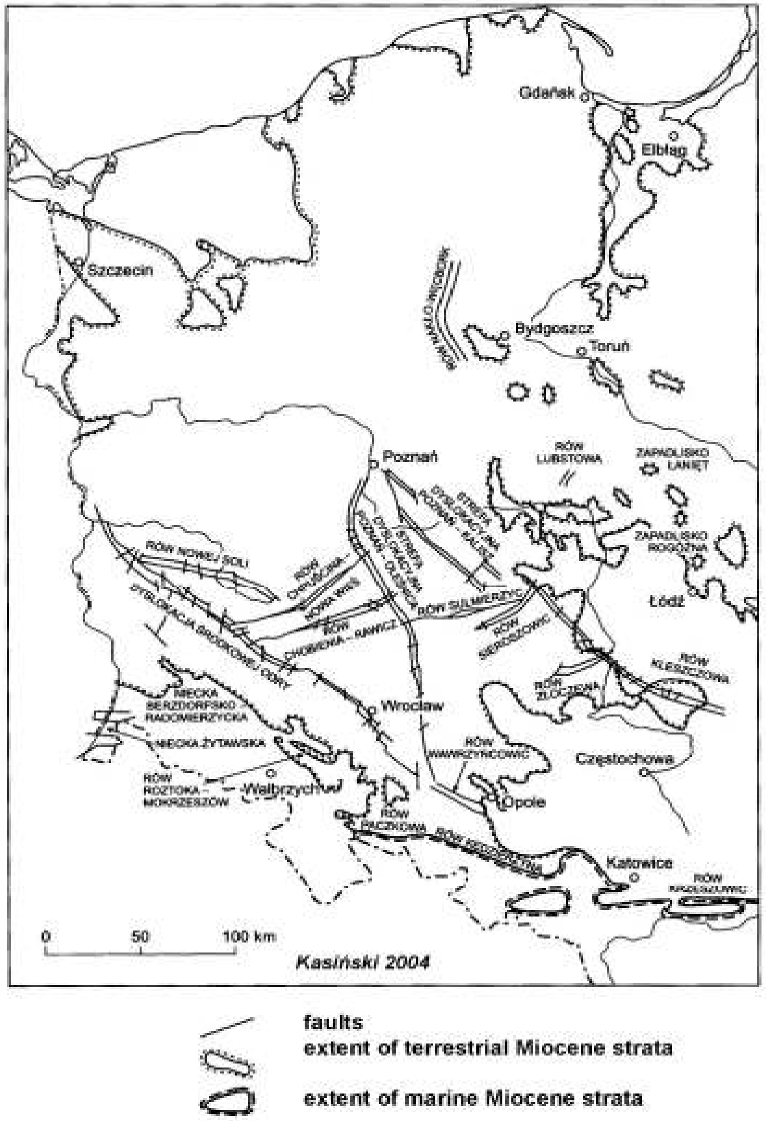

W
Witów C exposure (February 2002)
E
GSI
GSl
GSl
SGh
Gm
Fh Fw Fh
Fh Fw
5 m
0 m
10 m
Fig. 6A
Fig. 11
Gm
GSl
GSl
Sm
GSh
Sm
Sh
SGh
Fh
1 2 3 4 5 6 7 8 9
A) WNW
ESE
exp. C
B) W
E
exp. F
C)
N
D)
N
bedding
fault plane



Laskowska-Wysoczańska 1993

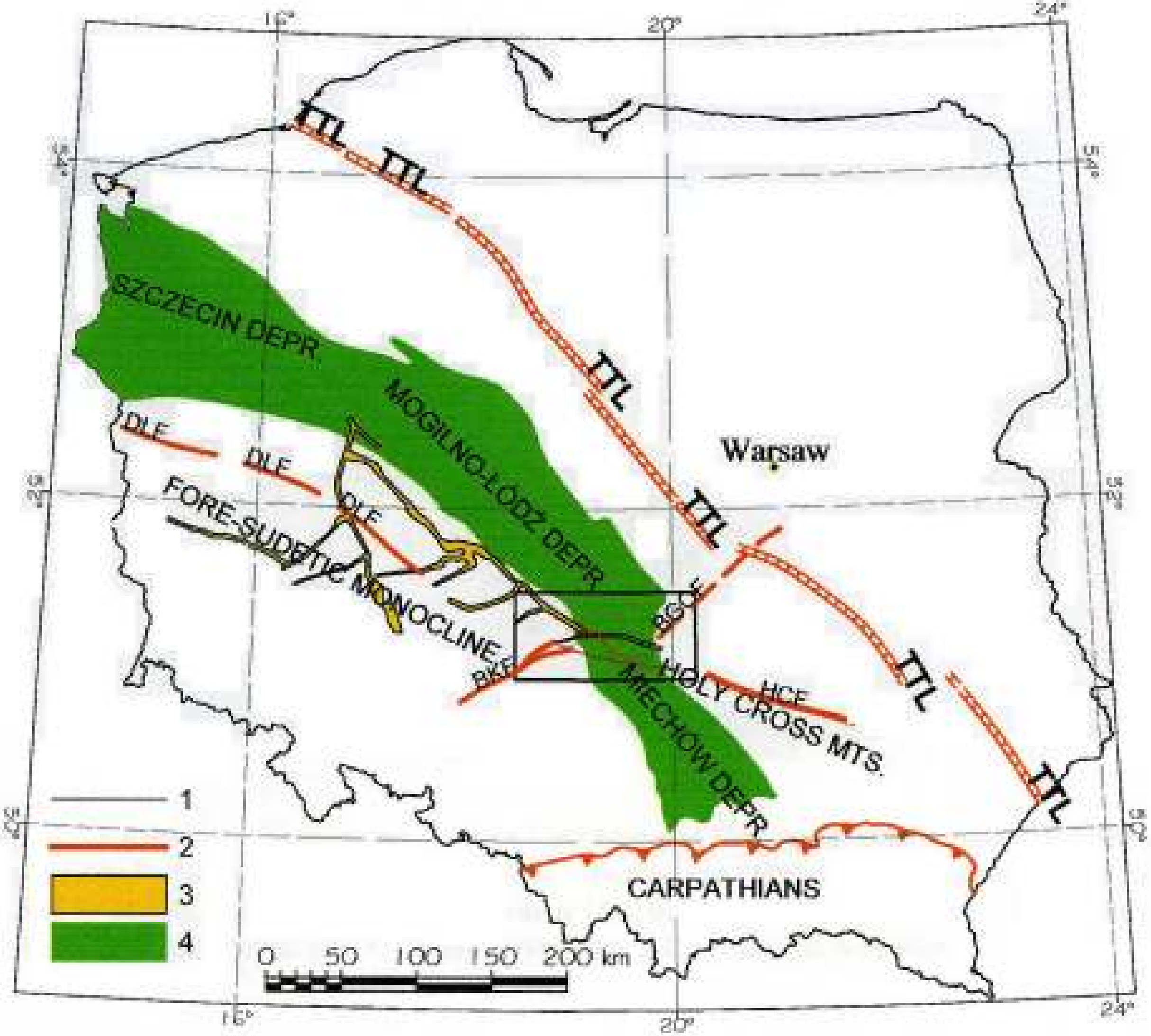


NEOGENE STRATA IN POLAND



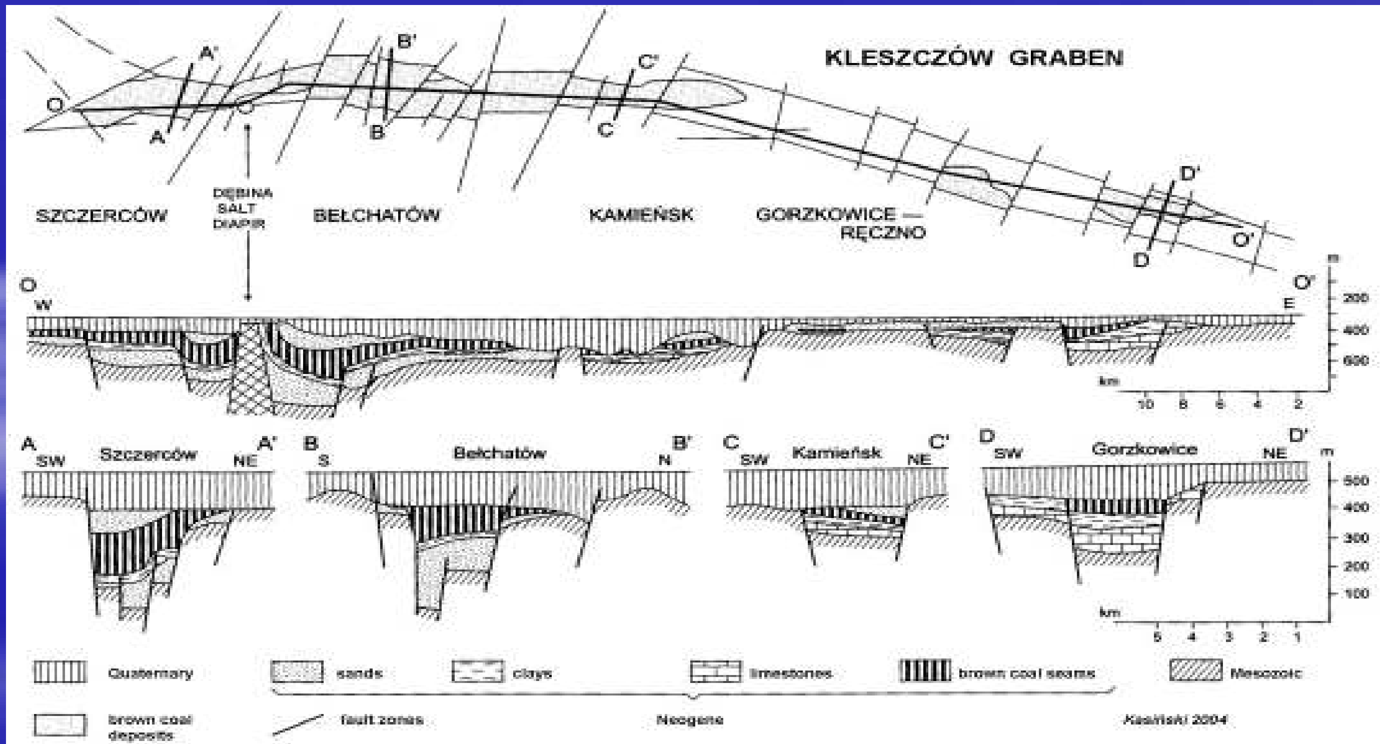
Tectonic grabens filled with Palaeogene and Neogene

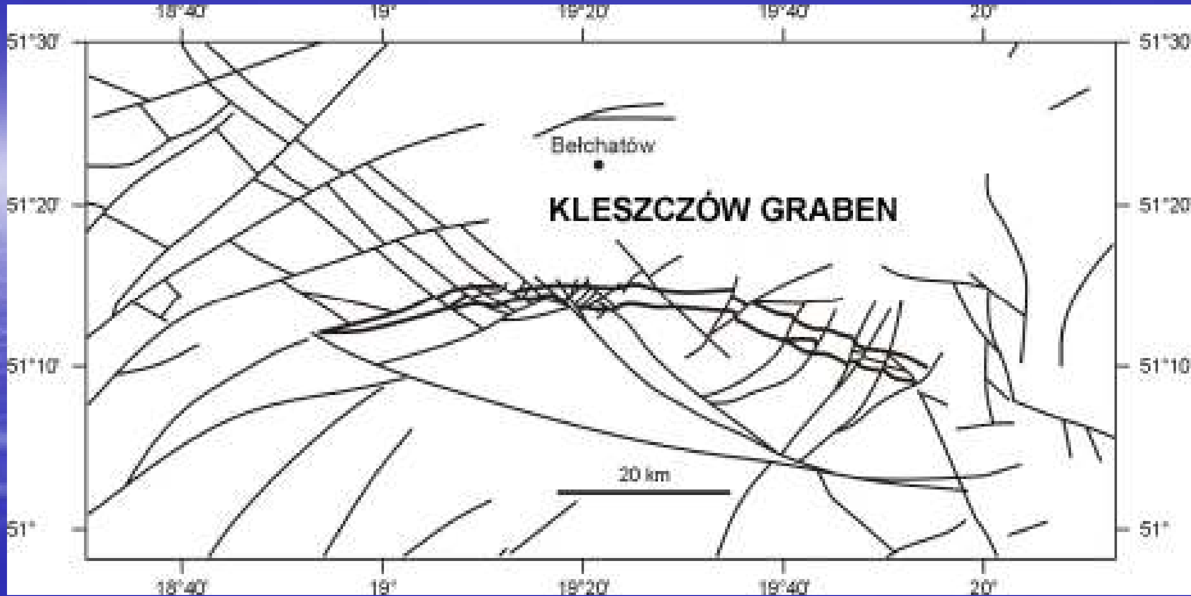
Gotowała & Hałuszczak 2002

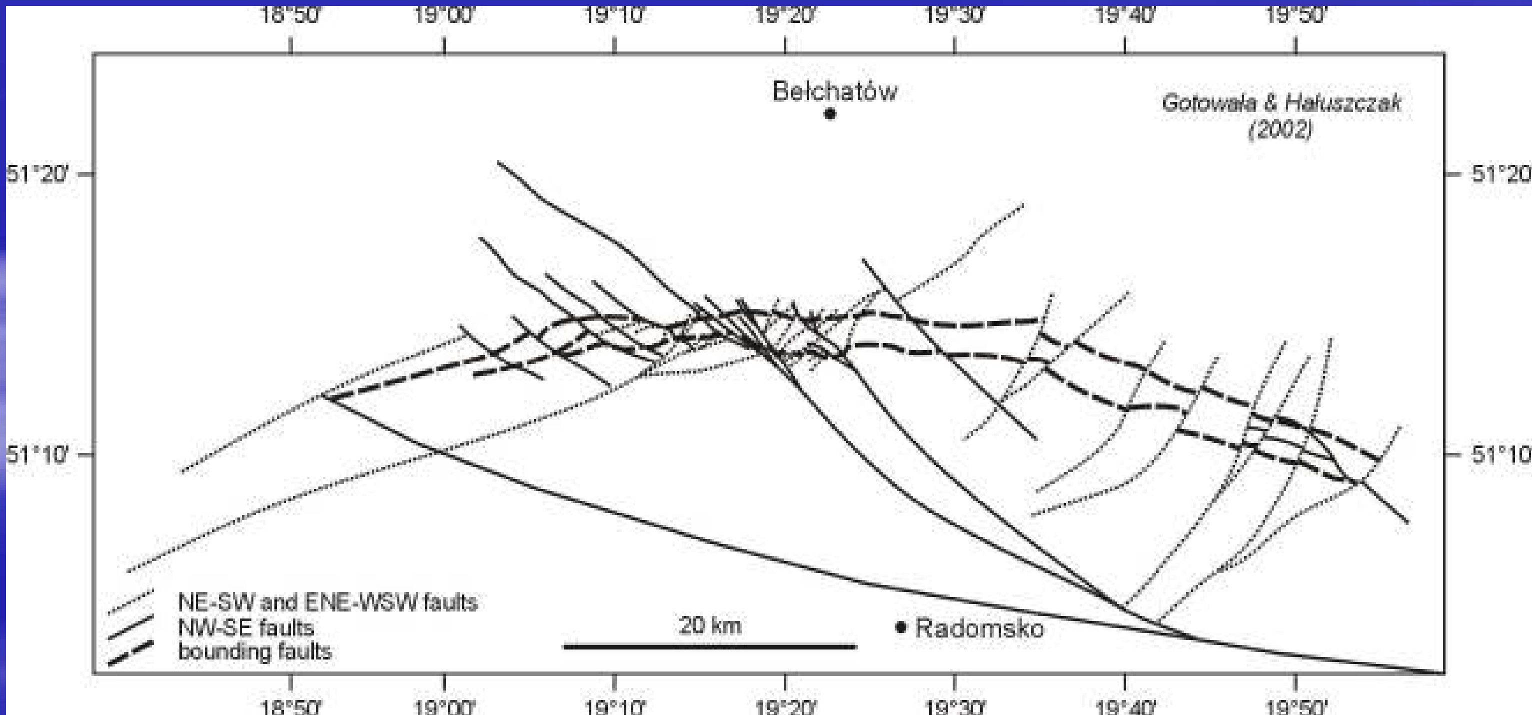


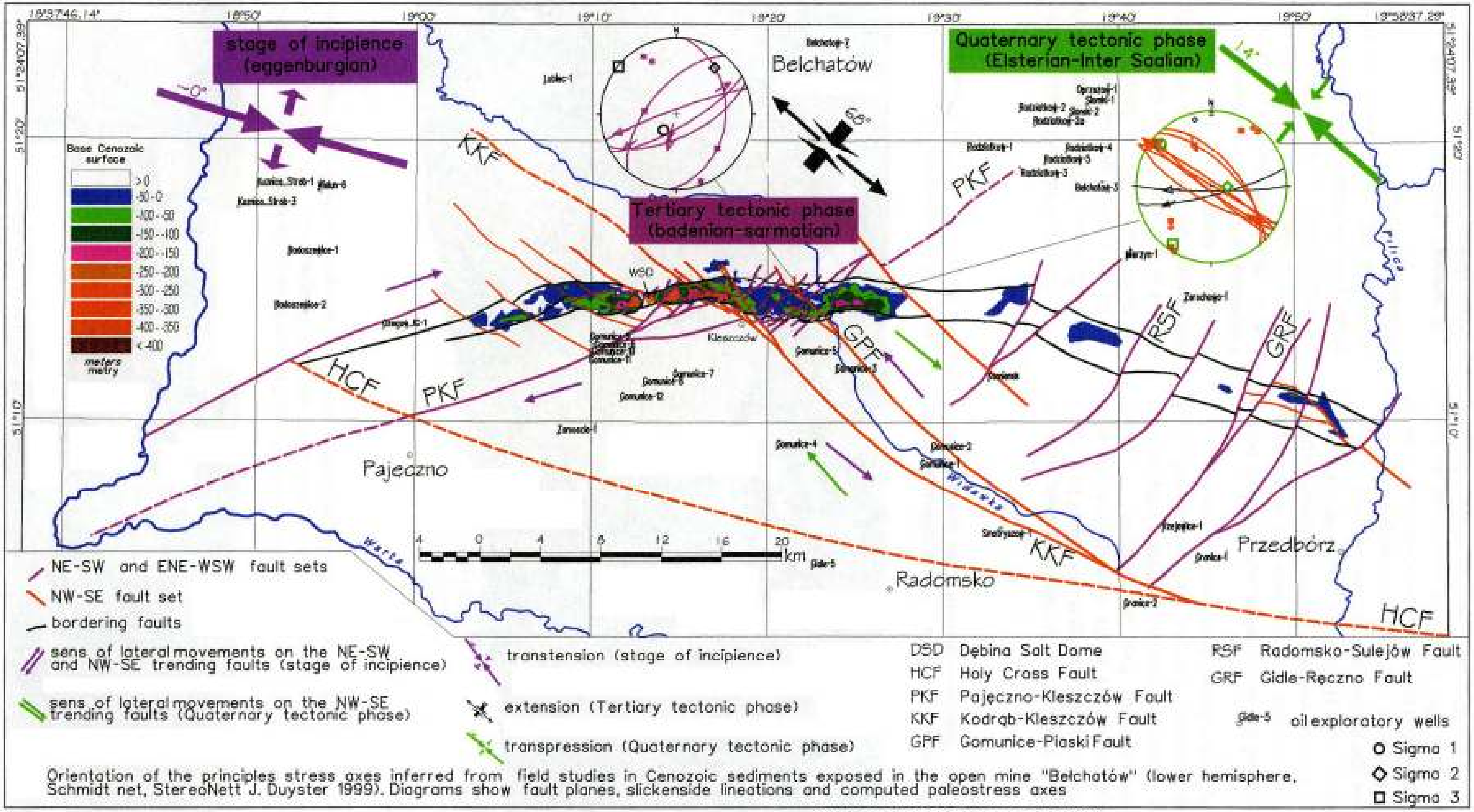
Area of study and location of the major structural components. Notations are: 1) master faults of the Kleszczów Graben; 2) regional fault zones after Dadlez (1997), Rühle et al. (1978); 3) Tertiary grabens system after gravity data (Dąbrowski, 1980); 4) Szczecin-Mogilno-Łódź-Miechów Depression area. Abbreviations are: TTL – Teisseyre-Tornquist Line after Pożaryski (1986); HCF – Holy Cross Fault; DLF – Dolsk Fault; BOGF – Bełchatów-Opoczno-Grójec Fault; BKF – Brzeg-Kluczbork Fault; DEPR – depression.

Geological map of the Kleszczów Graben area without Cenozoic and Cretaceous strata (lithostratygrafic units after Rühle et al. 1978, modified and supplemented). Notations are: 1) Late Jurassic – Portlandian (J3p); 2) Late Jurassic – Kimmeridgian (J3km); 3) Late Jurassic – Oxfordian (J3o); 4) Middle Jurassic (J2); 5) Early Jurassic (J1); 6) Triassic (T); 7) Permian – Zechstein (P); 8)–15) faults of the Kleszczów Graben; 16) faults after Rühle et al. (1978). Abbreviations are: AŁ – Łękińsko Anticline. **Gotowala & Haluszczak 2002**

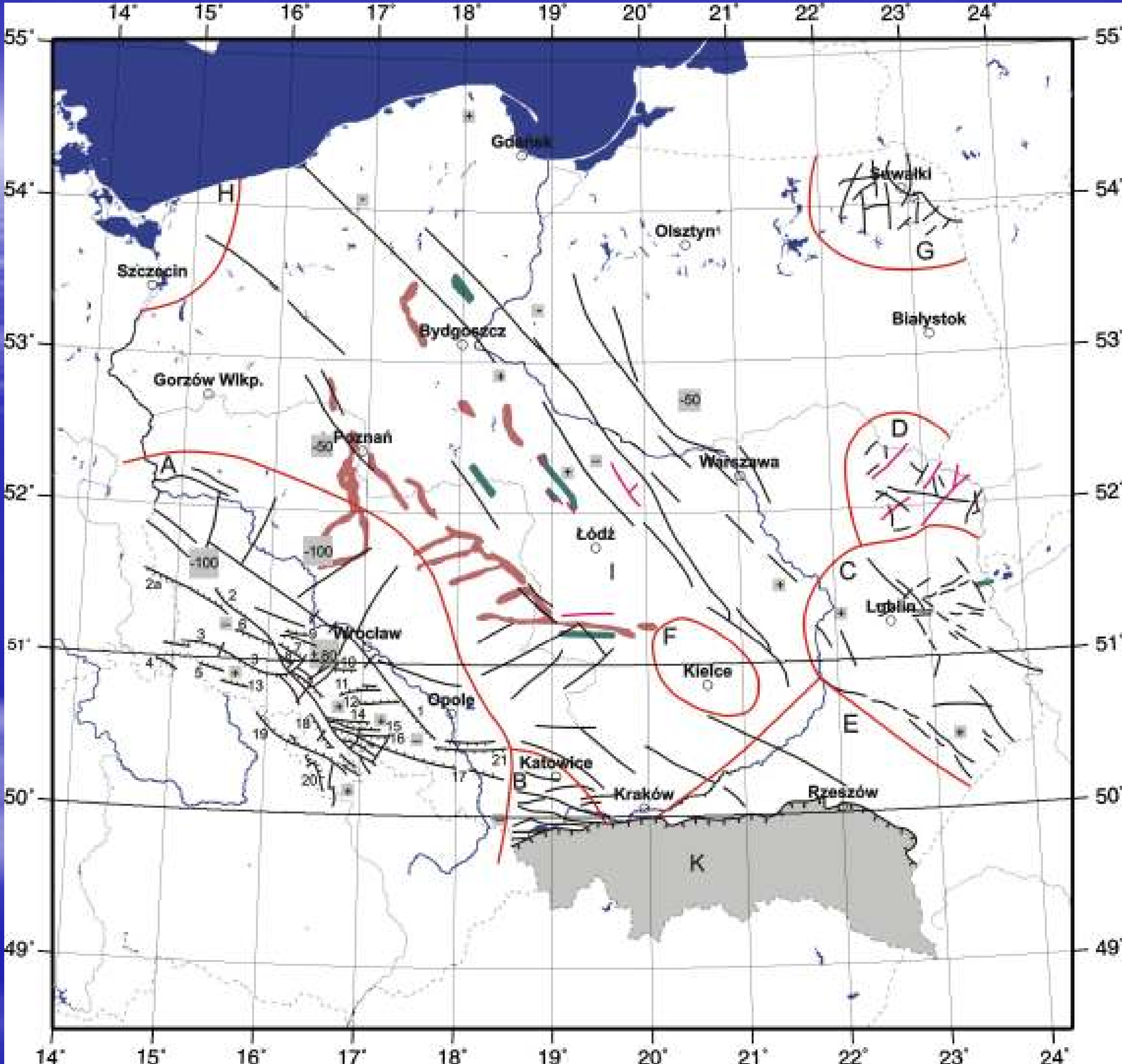


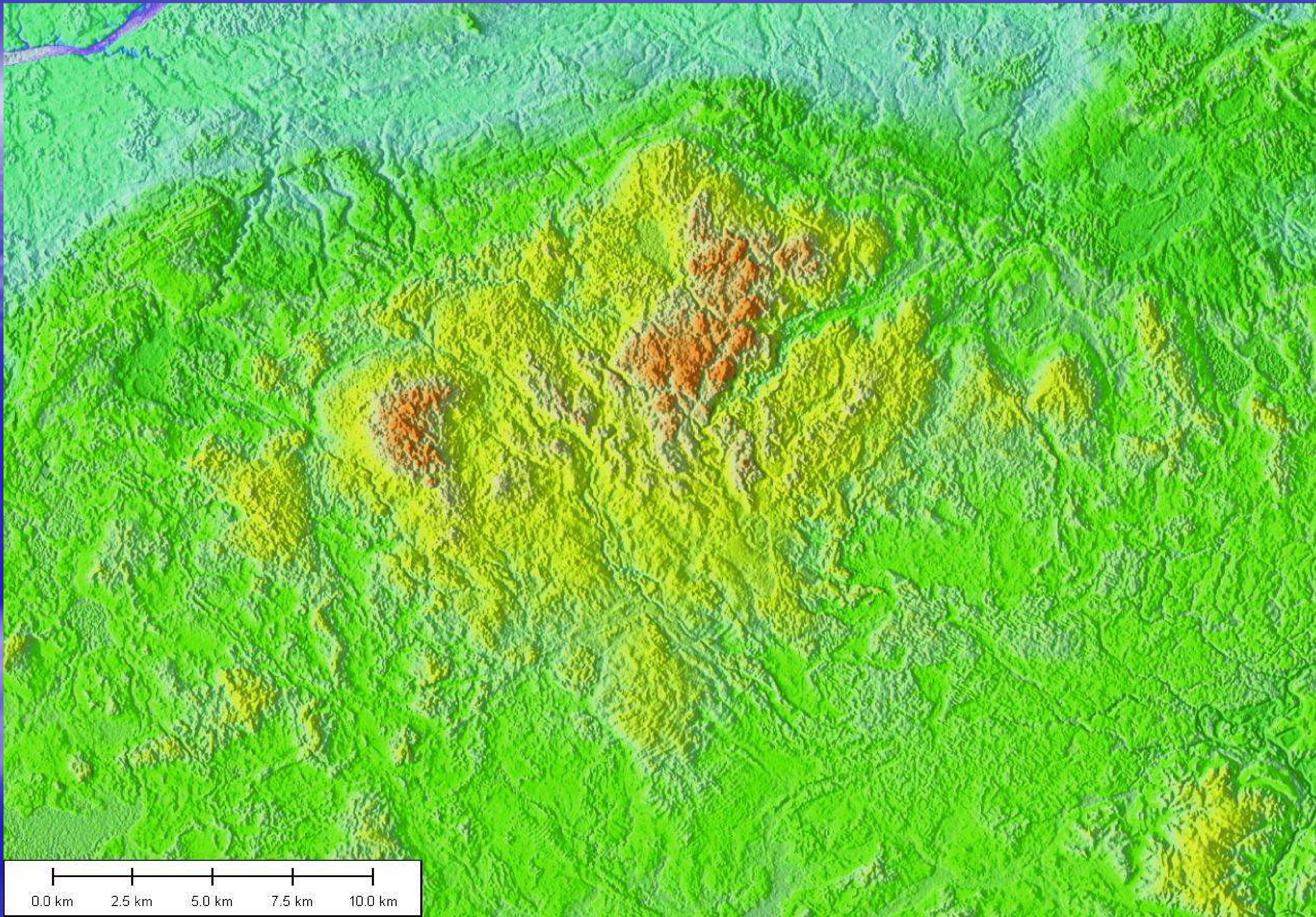

18°40'
19°
19°20'
19°40'
20°
51°30'
51°20'
51°10'
51°
Bełchatów
KLESZCZÓW GRABEN
20 km

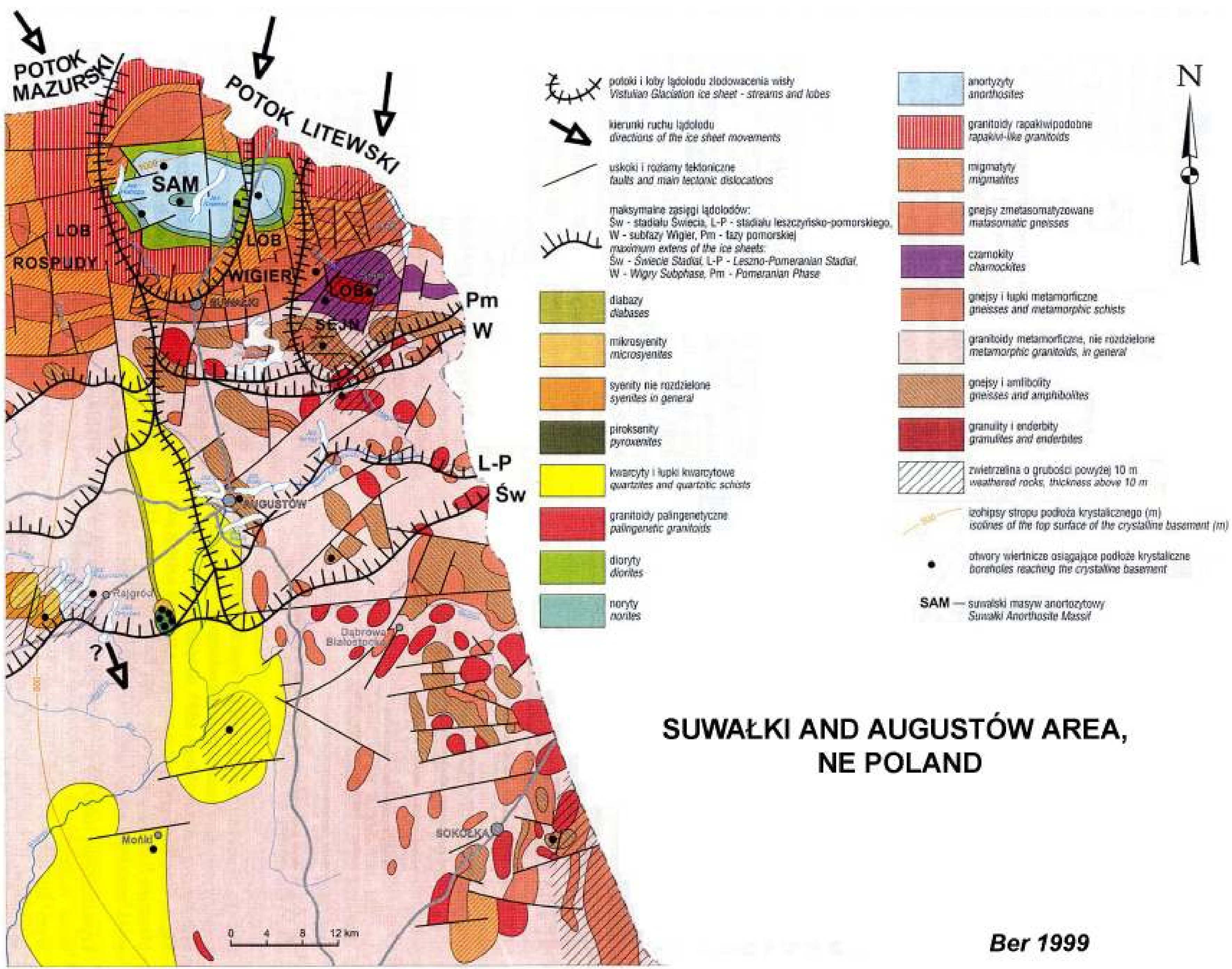

18°50'
19°00'
19°10'
19°20'
19°30'
19°40'
19°50'
51°20'
51°10'
Bełchatów
Gotowała & Hałuszczak (2002)
NE-SW and ENE-WSW faults
NW-SE faults
bounding faults
20 km
Radomsko



Gotowała & Hałuszczak 2002

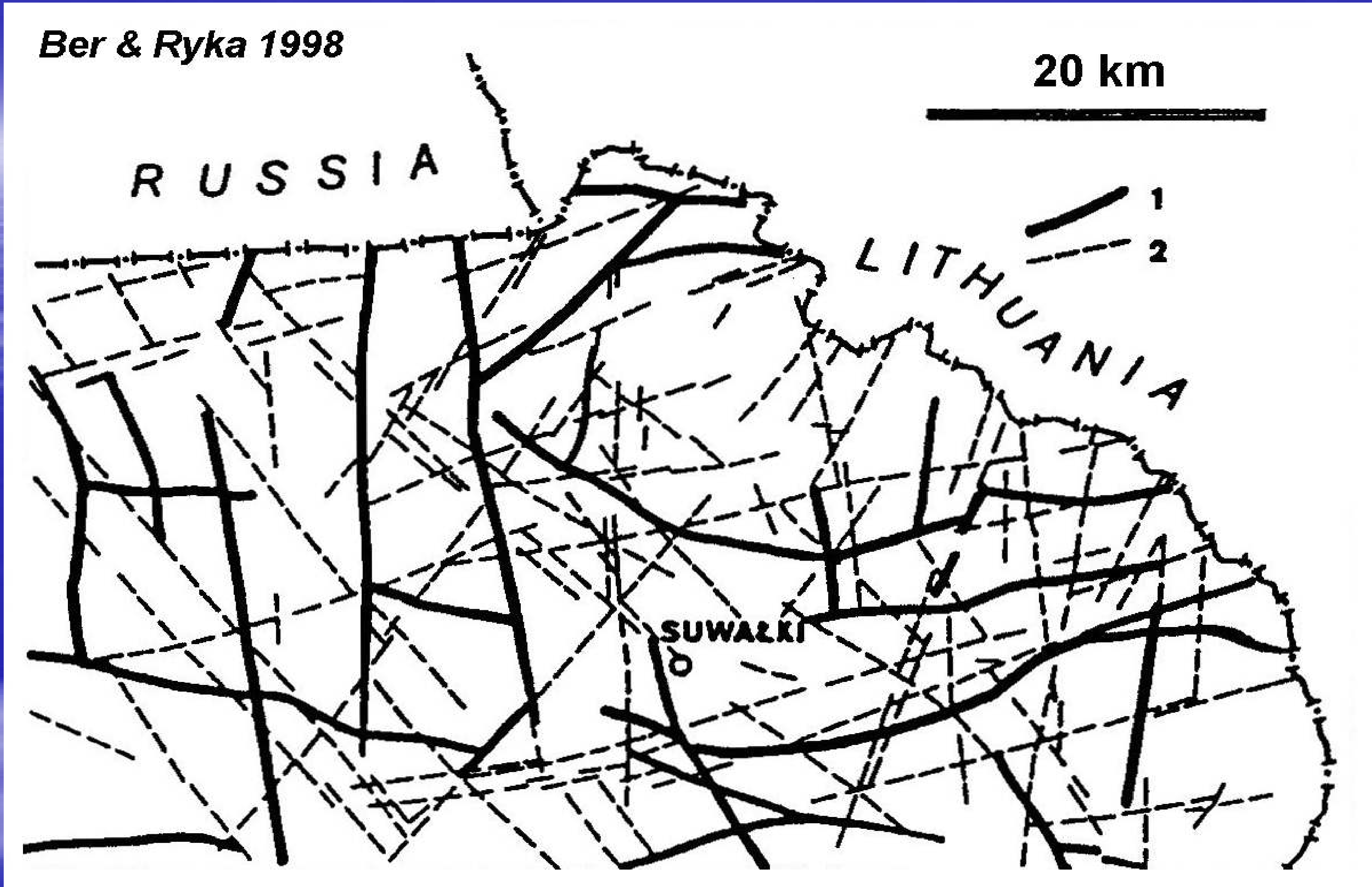

Gdańsk
Suwałki
Olsztyn
Szczecin
Białystok
Bydgoszcz
Gorzów Wlkp.
Poznań
Warszawa
Łódź
Lublin
Wrocław
Kielce
Opole
Katowice
Kraków
Rzeszów
A
B
C
D
E
F
G
H
I
K
-50
-100


0.0 km
2.5 km
5.0 km
7.5 km
10.0 km



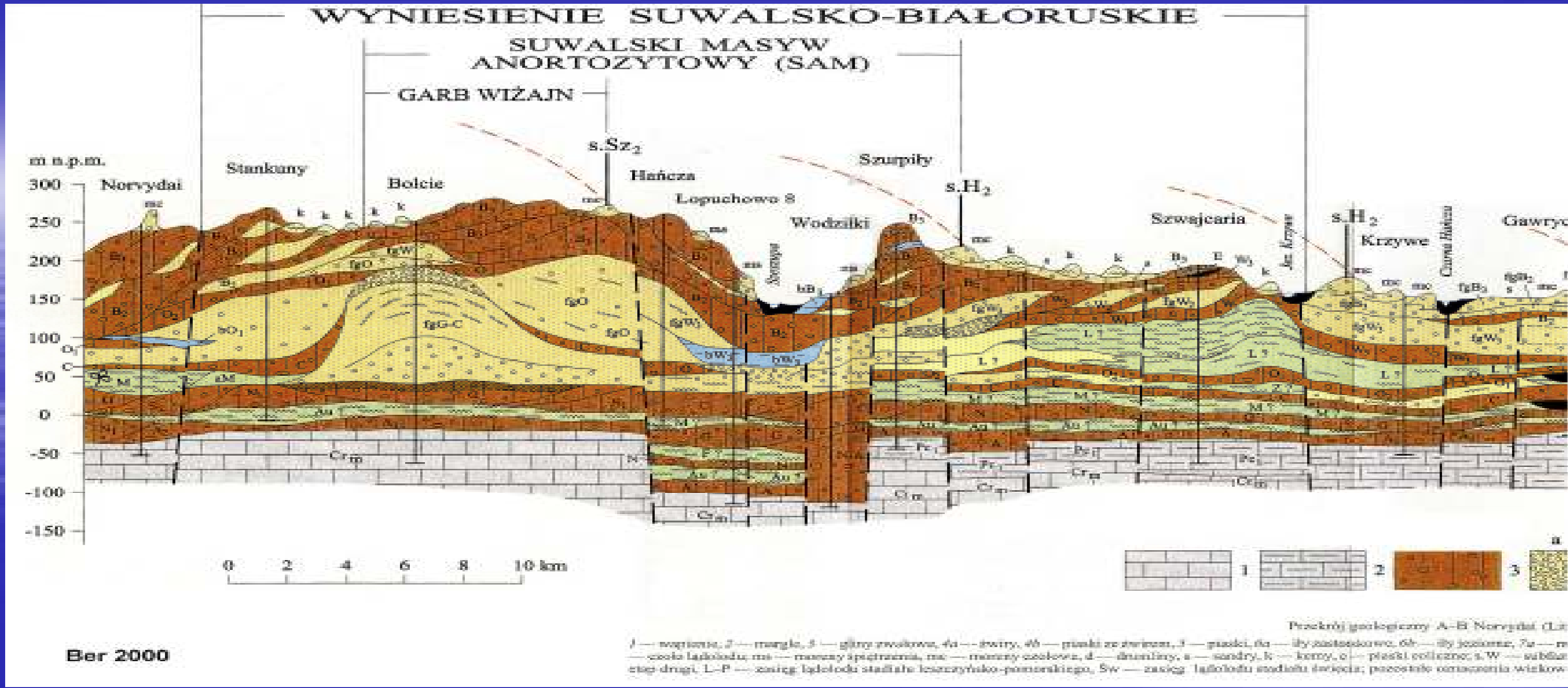
SUWAŁKI AND AUGUSTÓW AREA, NE POLAND

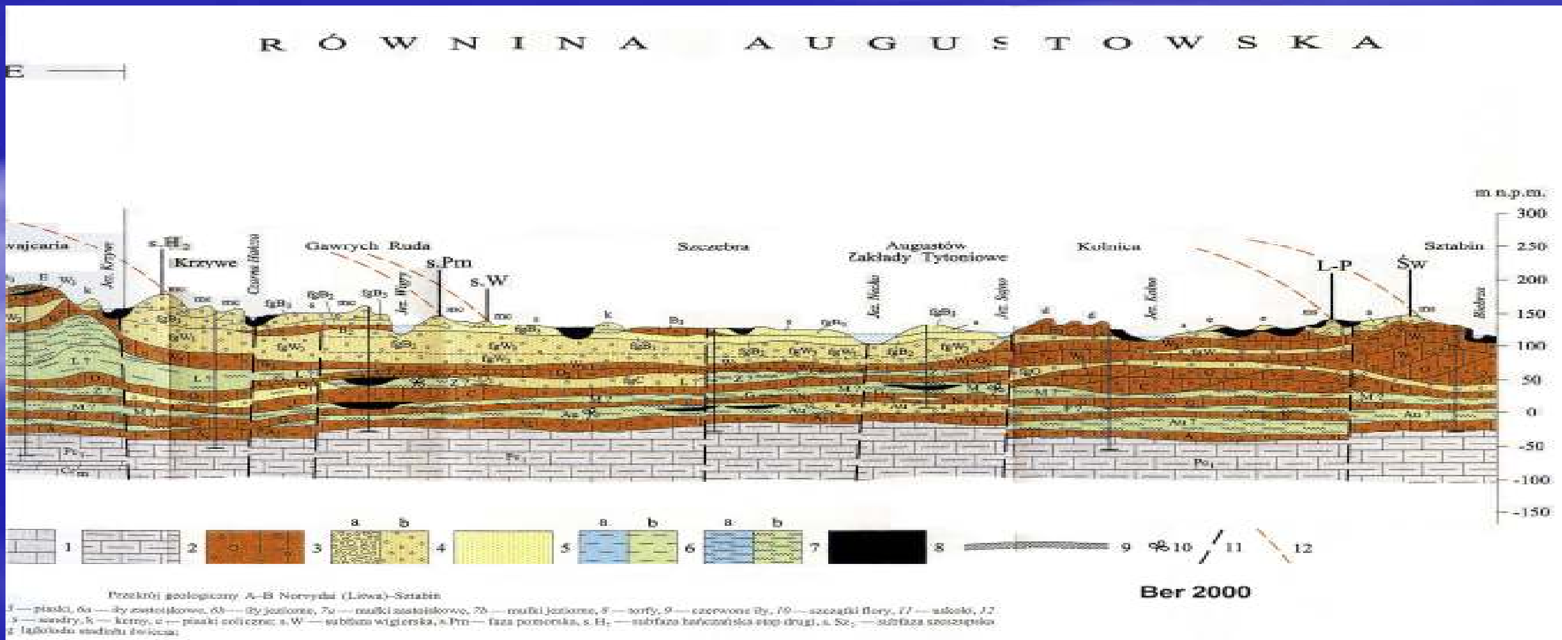
Ber 1999

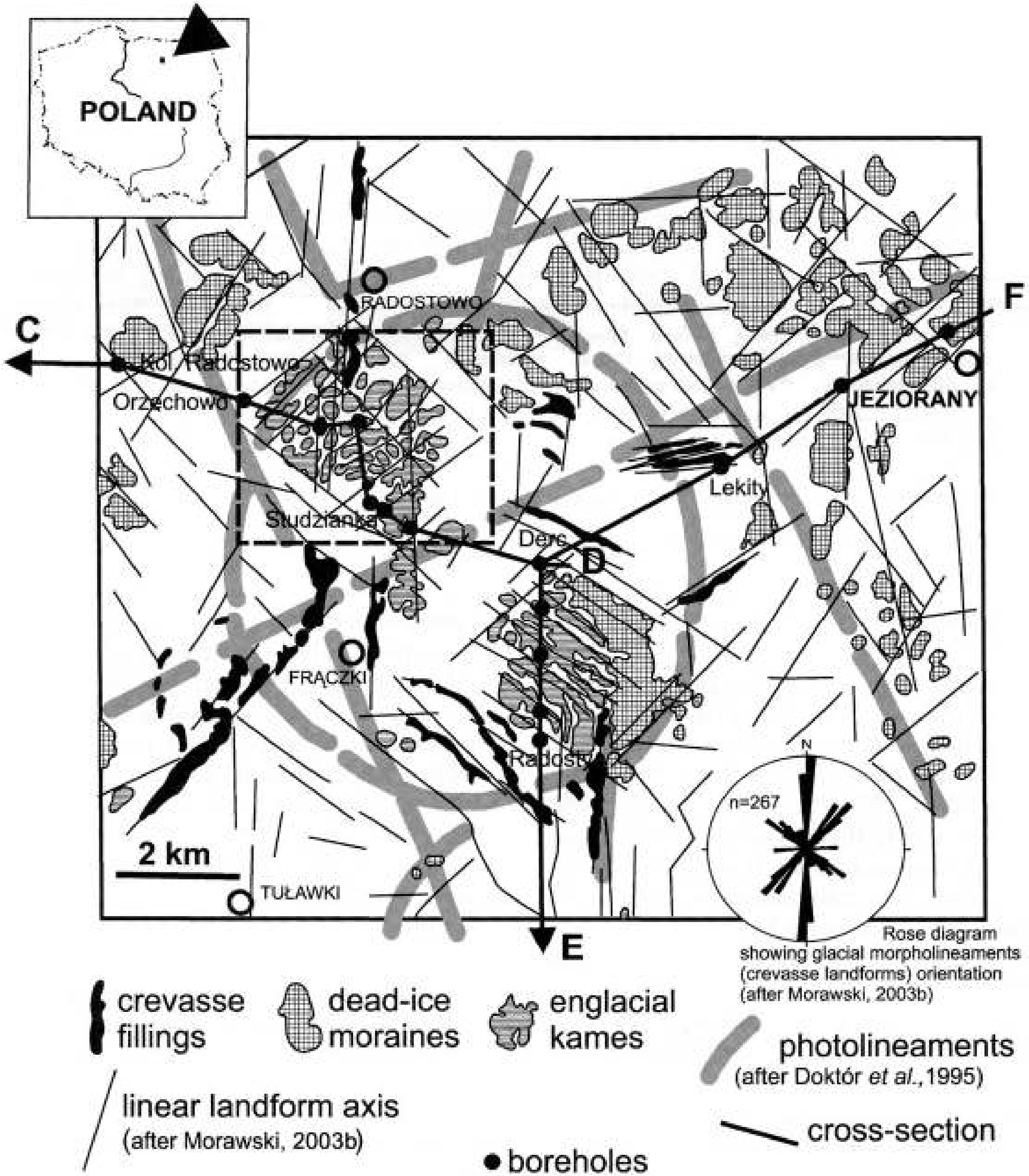


Simplified map of linear tectonic elements derived from the remote sensing geophysical analysis

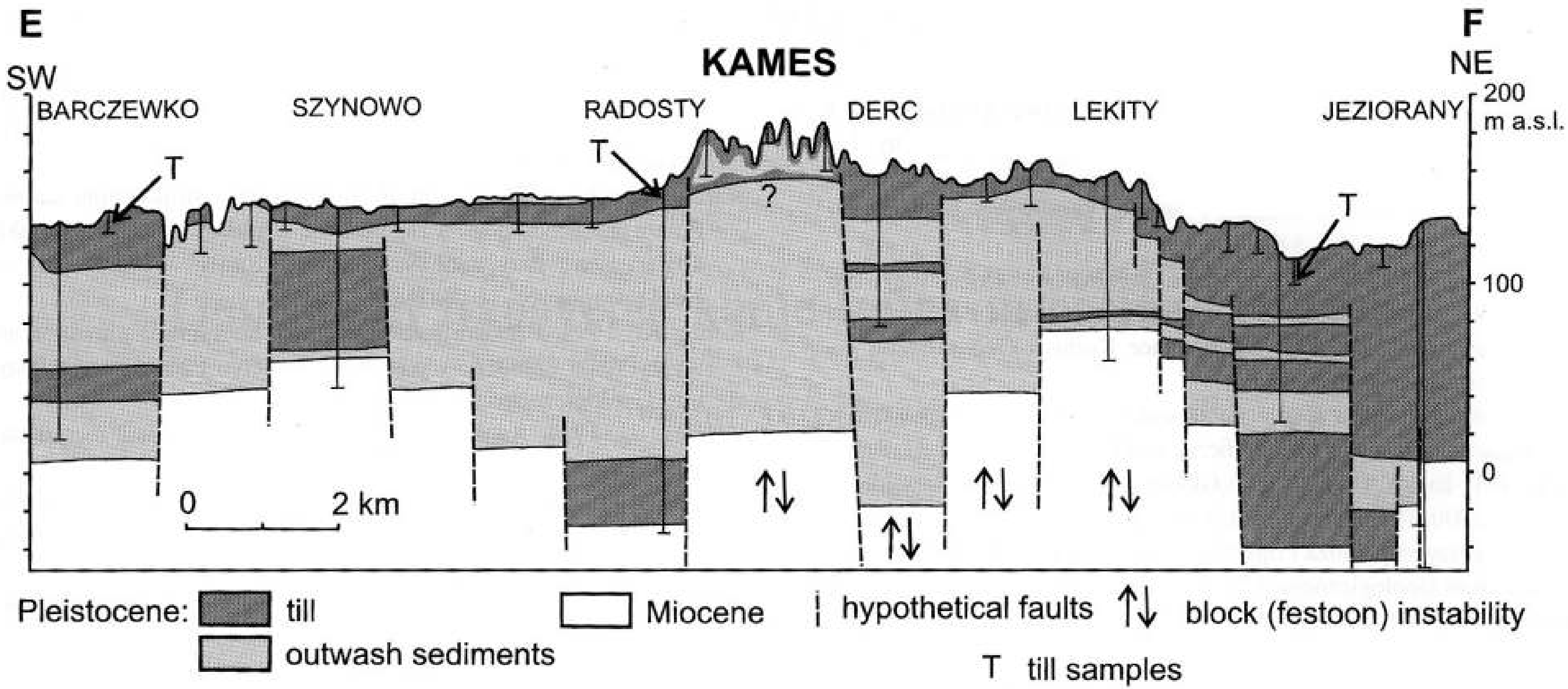
1 — principal unconformity zones, 2 — other unconformity lines


WYNIESIENIE SUWALSKO-BIAŁORUSKIE
SUWALSKI MASYW ANORTOZYTOWY (SAM)
GARB WIŻAJN
m n.p.m.
Norvydai
Stankany
Bolcie
s.Sz2
Hańcza
Łopuchowo 8
Wodziłki
Szurpiły
s.H2
Szwajcaria
Krzywe
0 2 4 6 8 10 km
Ber 2000

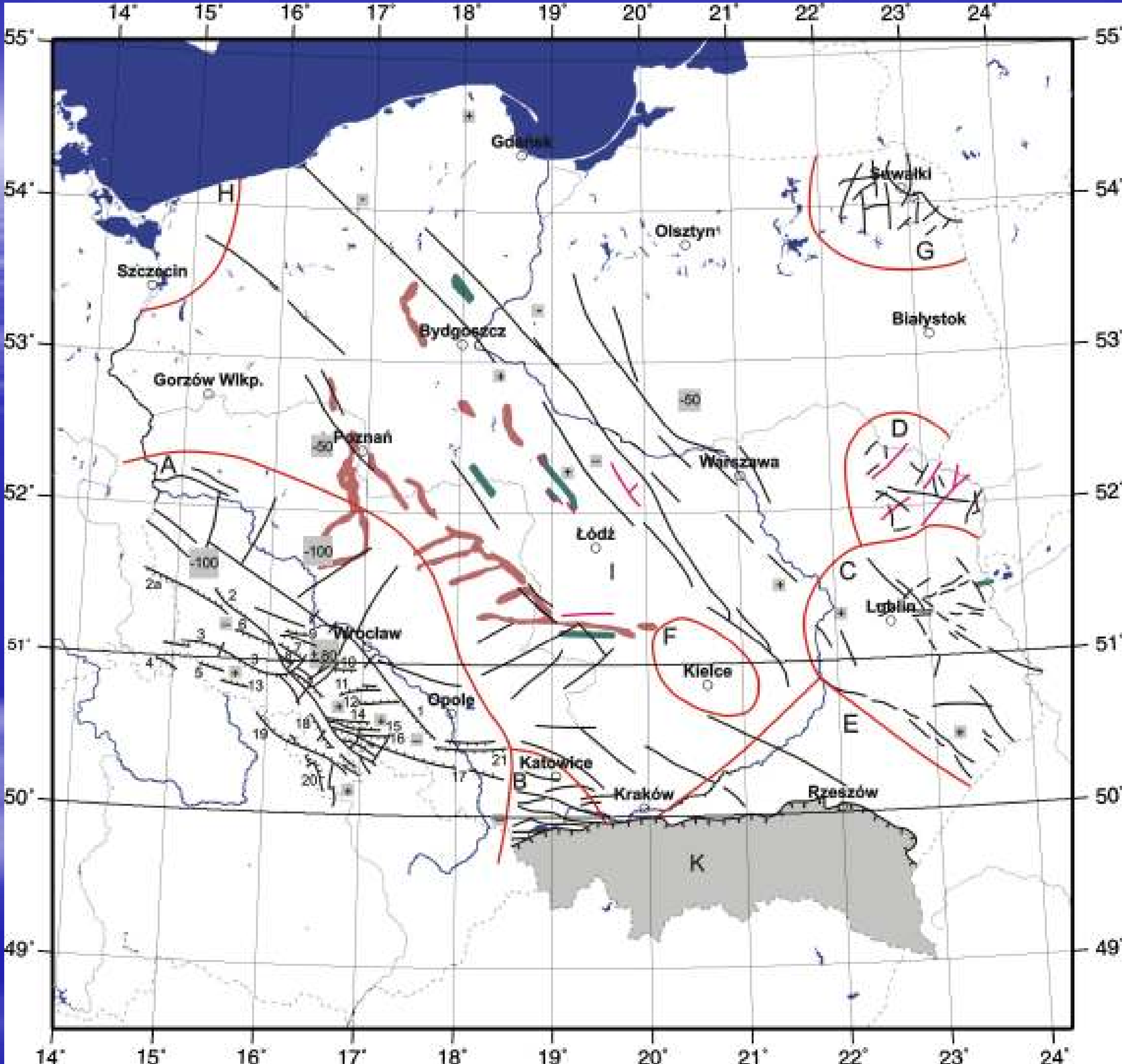

RÓWNINA AUGUSTOWSKA
m n.p.m.
Krzywe
Gawrych Ruda
s.Pm
s.W
Szczebra
Augustów Zakłady Tytoniowe
Kolnica
L-P
Św
Sztabin
Przekrój geologiczny A–B Norvydai (Litwa)–Sztabin
Ber 2000



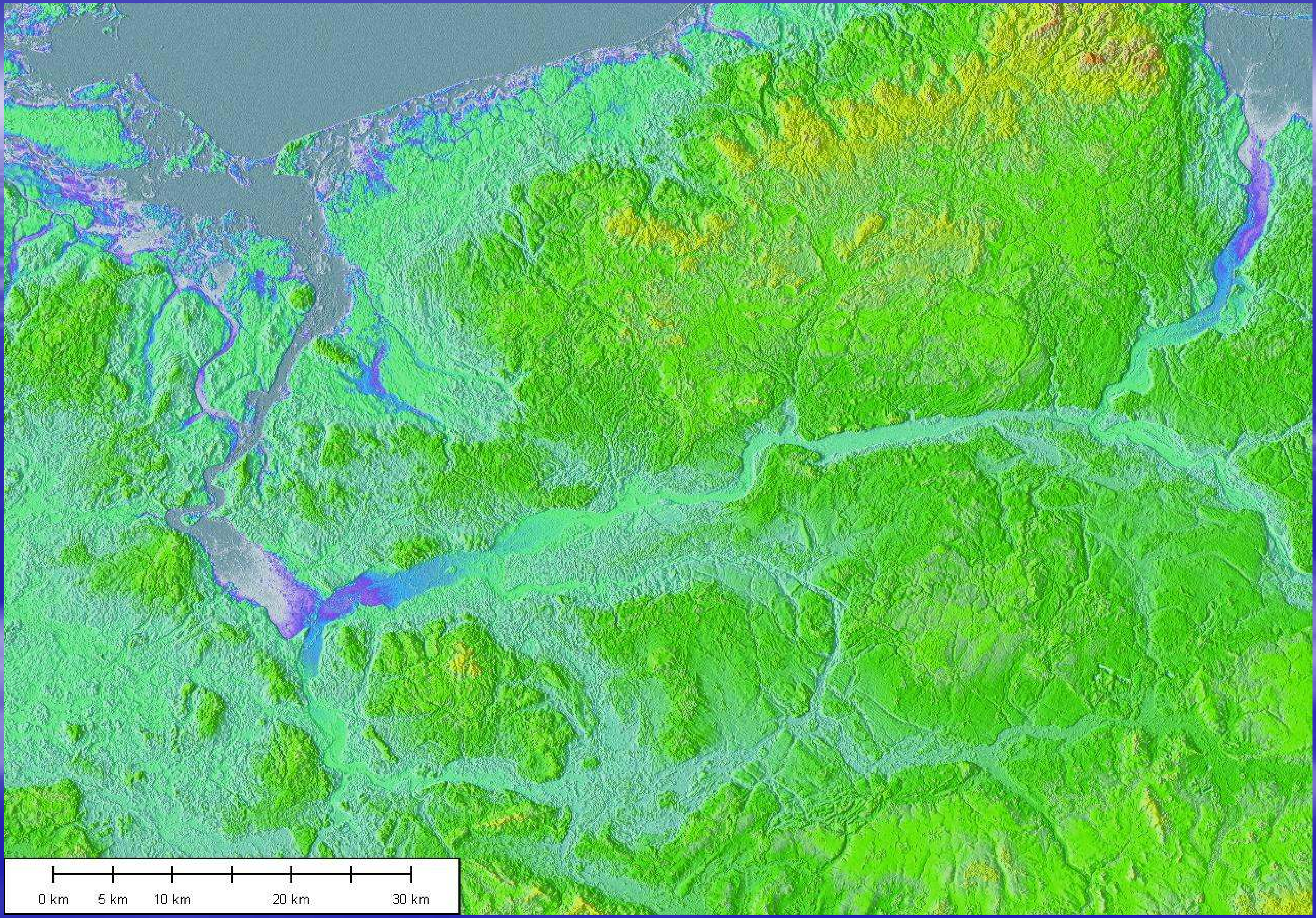
Englacial kame fields and glacial topolineaments in Mazury Lakeland (after Morawski, 2007)

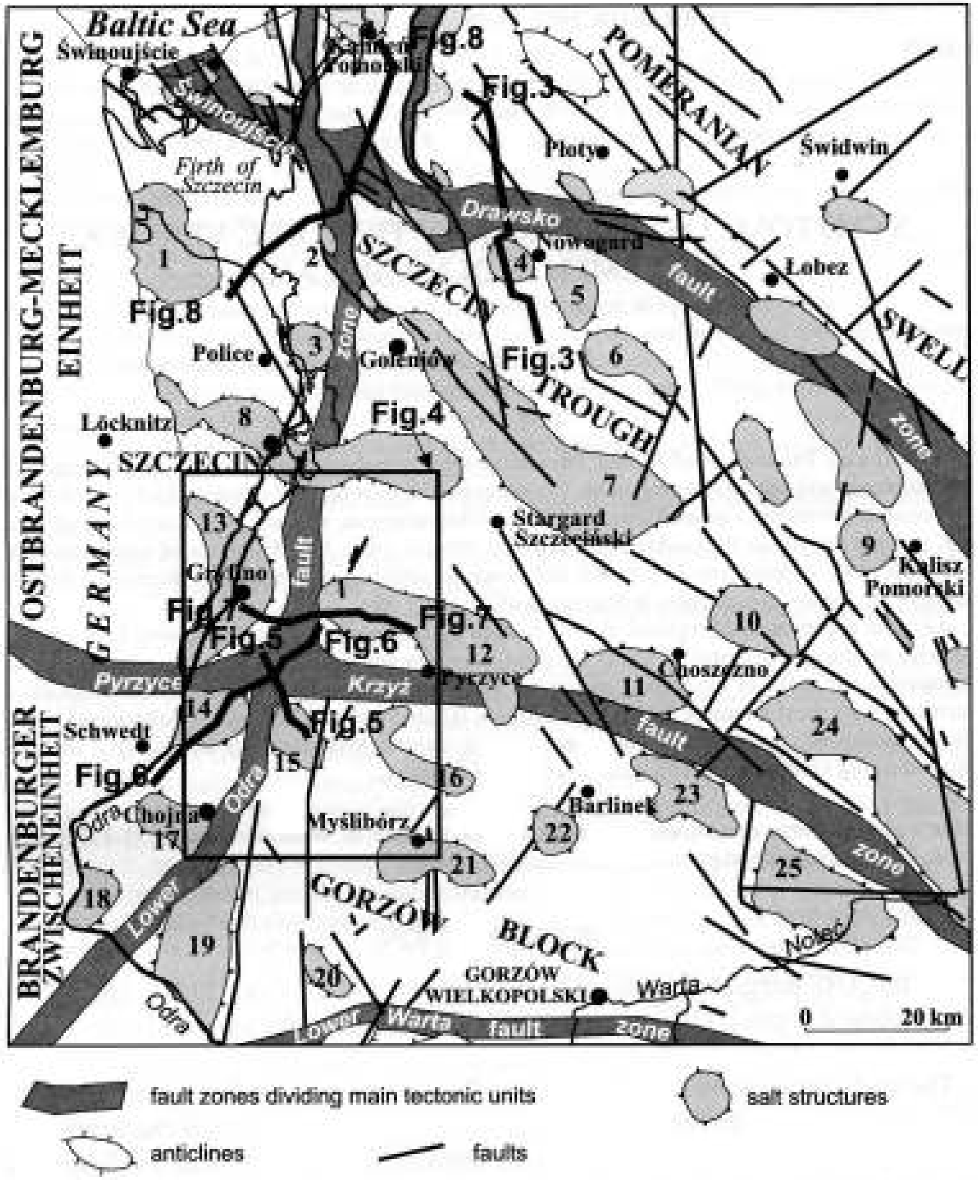


Geological cross-section through the Jeziorany region (after Morawski, 2007)



Gdańsk
Olsztyn
Suwałki
Szczecin
Białystok
Bydgoszcz
Gorzów Wlkp.
Poznań
Warszawa
Łódź
Lublin
Wrocław
Opole
Kielce
Katowice
Kraków
Rzeszów
A
B
C
D
E
F
G
H
I
K
-50
-100

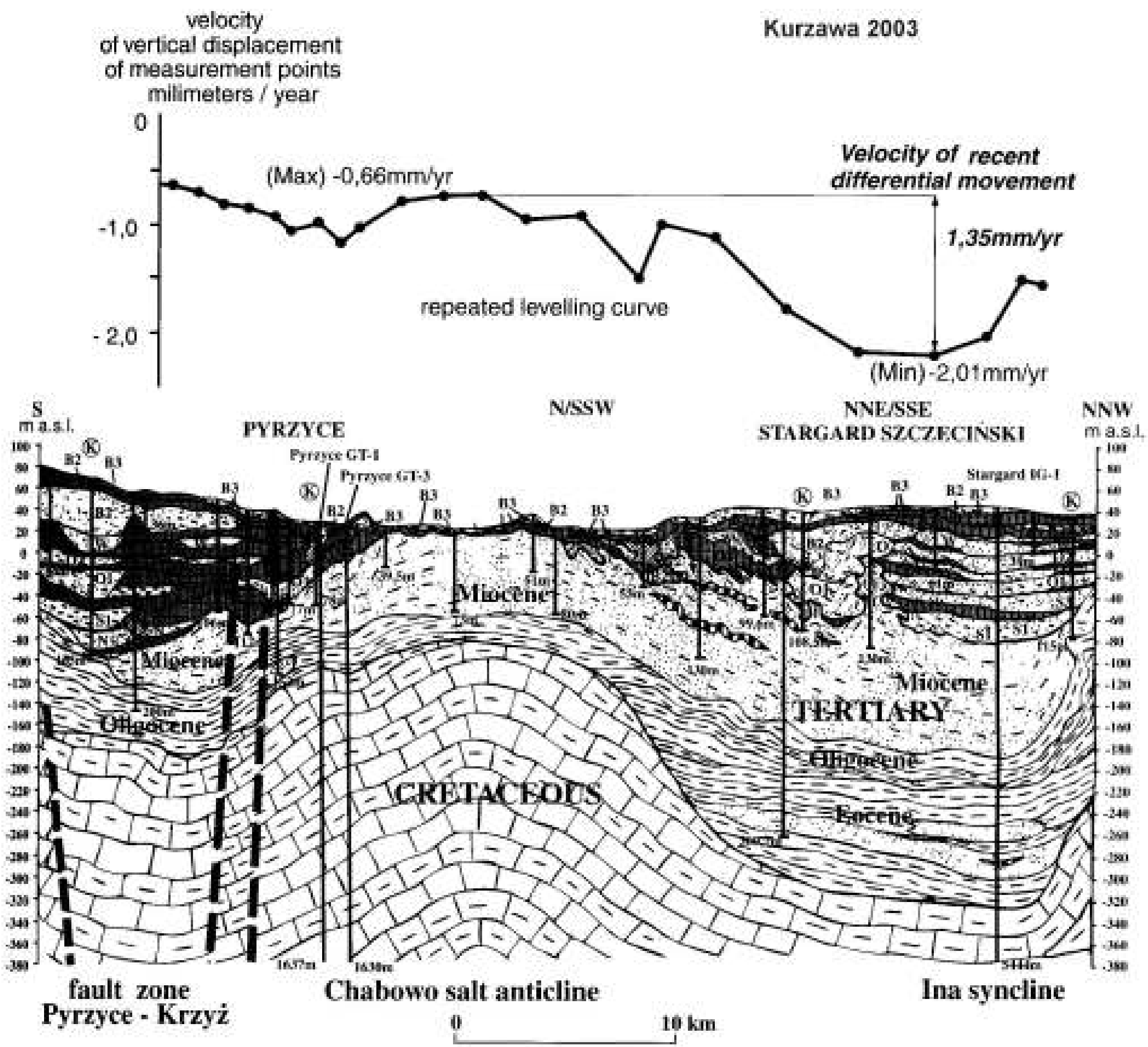

0 km
5 km
10 km
20 km
30 km



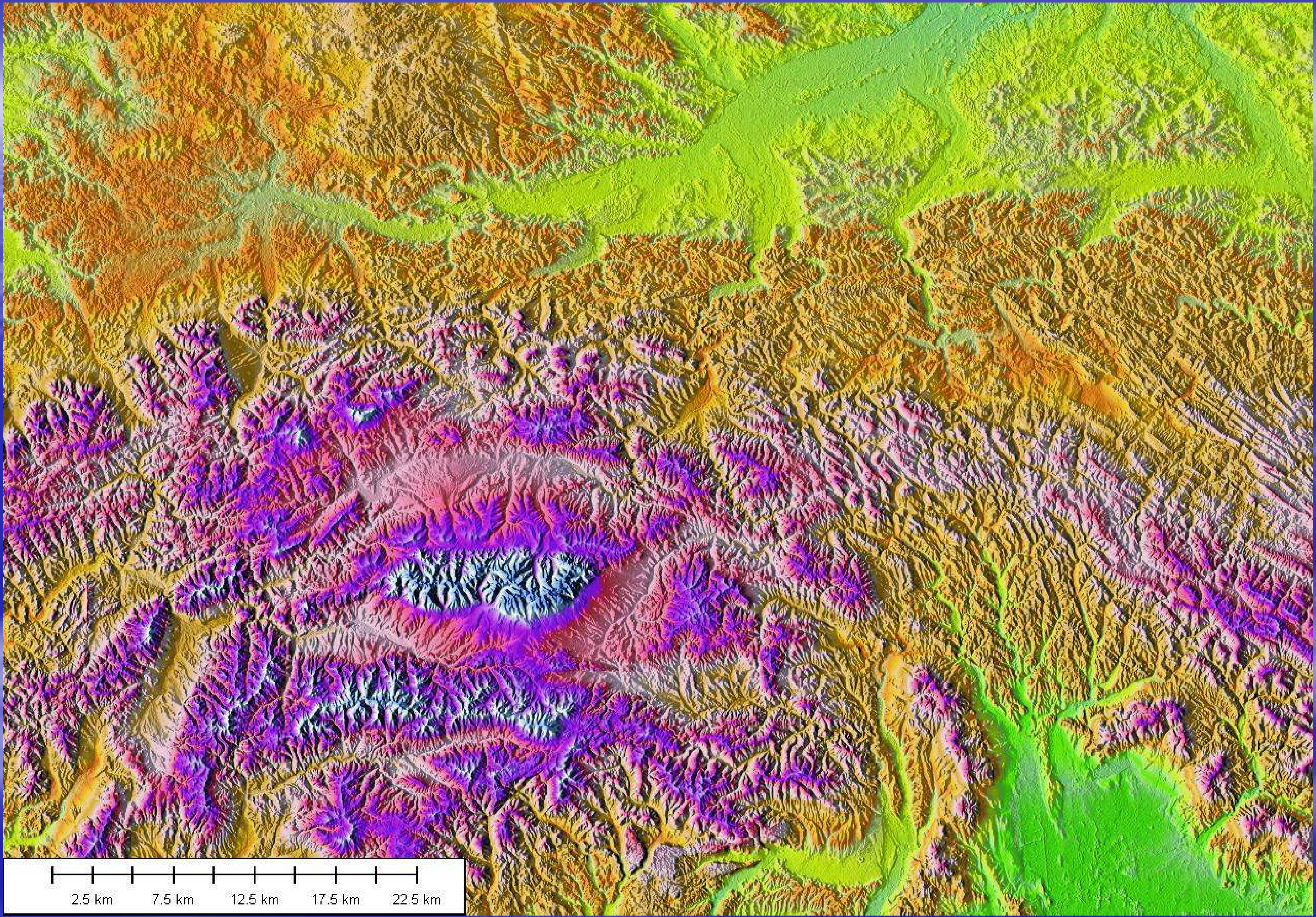
Location of the examined Permo-Mesozoic tectonic elements and units (after DADLEZ 1979; WRONICZ 1988a, b, and PETECKI and JÓŹWIAK 1991a, b)

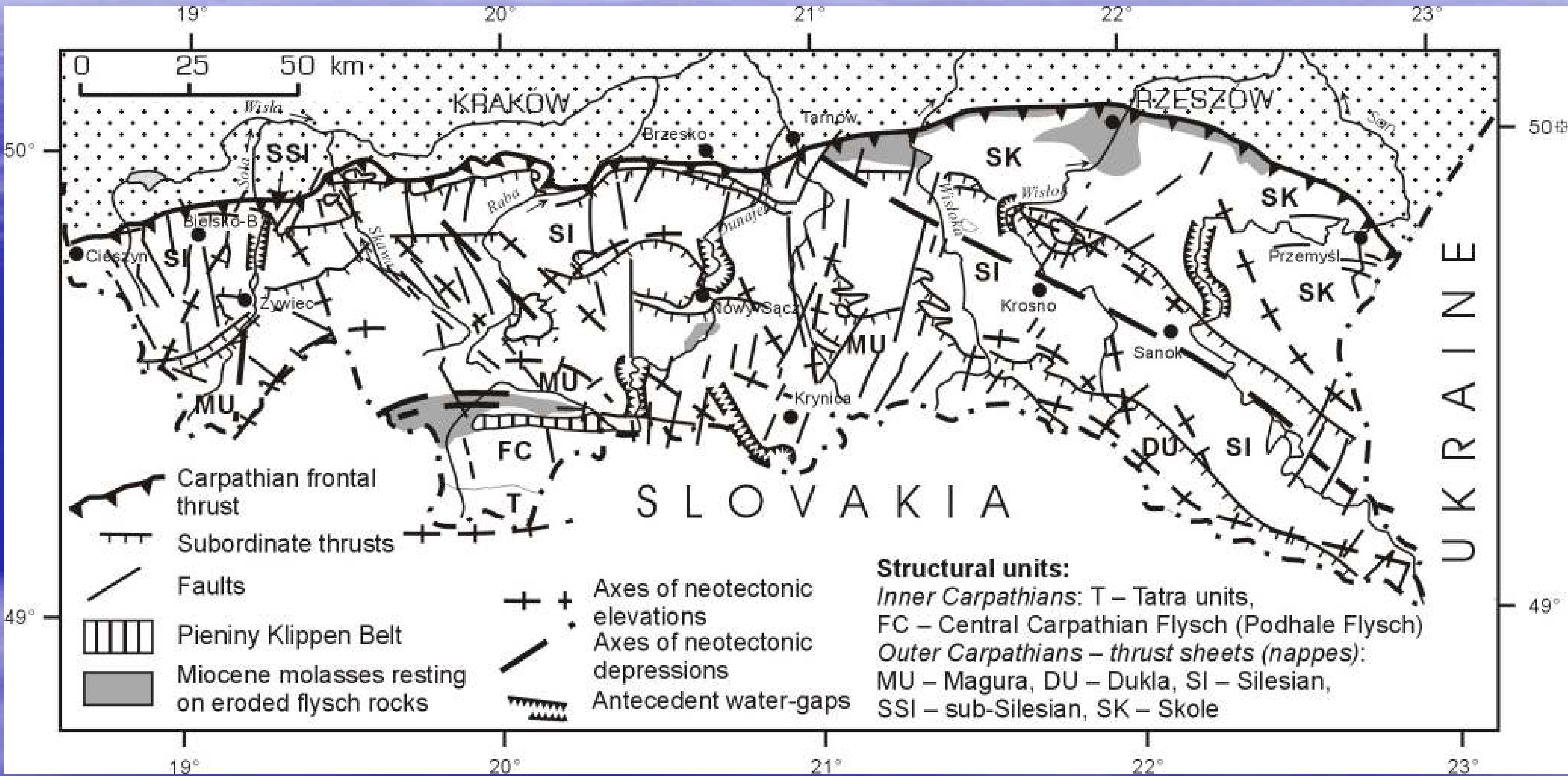
Investigated salt structures: 1 – Nowe Warpno, 2 – Zielonczyn, 3 – Krakówek, 4 – Nowogard, 5 – Ostrzyca, 6 – Grzęzno–Woświn, 7 – Maszewo–Marianowo, 8 – Szczecin, 9 – Drawno, 10 – Recz, 11 – Choszczno, 12 – Chabowo, 13 – Gryfino, 14 – Widuchowa, 15 – Banie, 16 – Lipiany, 17 – Chojna, 18 – Cedynia, 19 – Czelin, 20 – Dębno, 21 – Myślibórz, 22 – Karsko, 23 – Pełczyce, 24 – Pławna, 25 – Drezdenko.

Kurzawa 2002

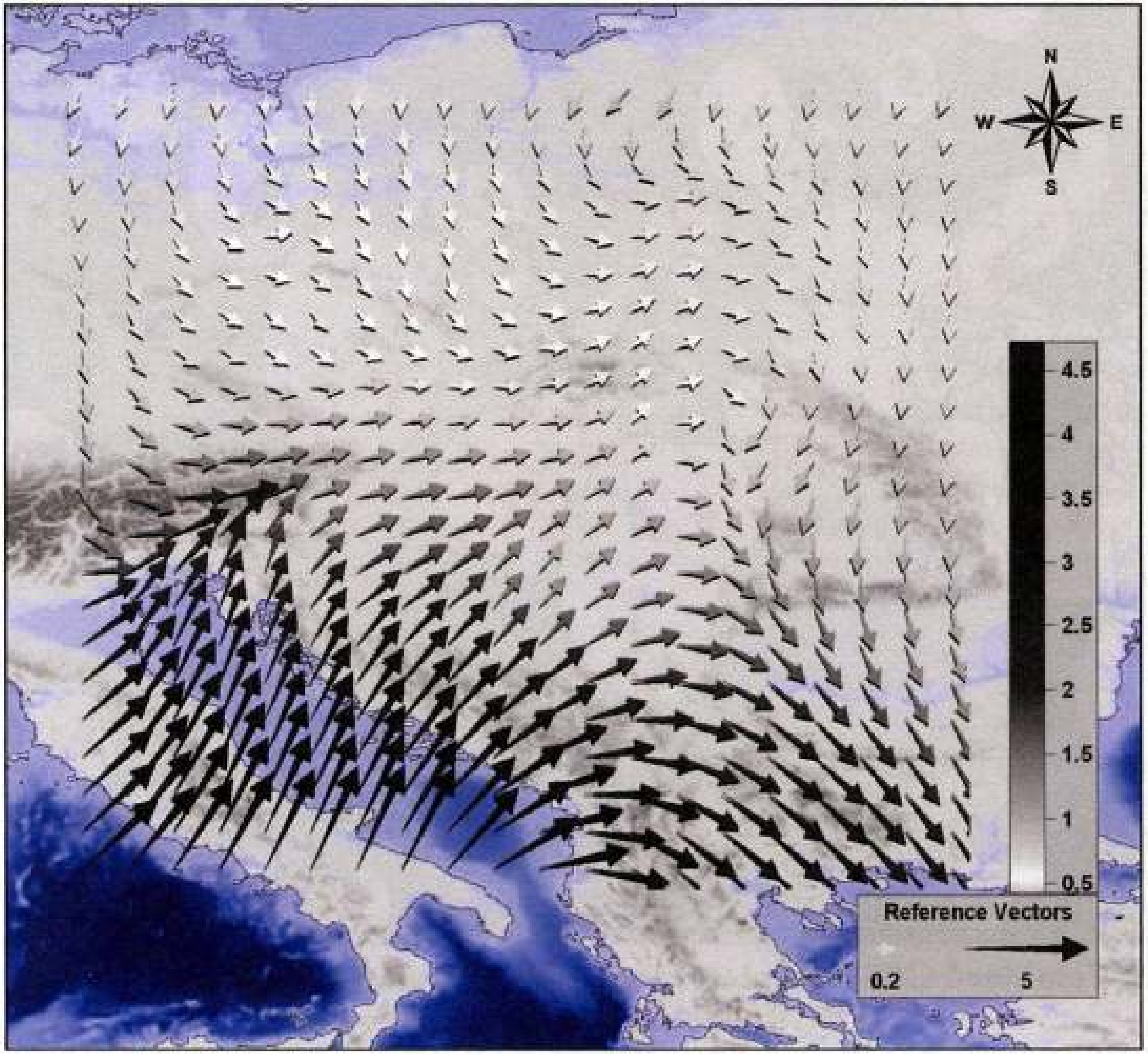


Geological cross-section presenting differentiation of the Pleistocene cover over local Permo-Mesozoic tectonic elements: Pyrzyce-Krzyż fault zone—Chabowo anticline (salt structure)— Ina syncline compared with a repeated levelling curve resulting from two measurement stages with a 20 yr time interval. Explanation of Pleistocene stratigraphic symbols: Vistulian glaciation: B3—upper stadial, B2—middle stadial; W—Wartanian glaciation; Odranian glaciation: O2—middle stadial, O1—lower stadial; Sanian glaciation: S2—upper stadial; S1—lower stadial; N—Nidanian glaciation; A—Narevian glaciation.

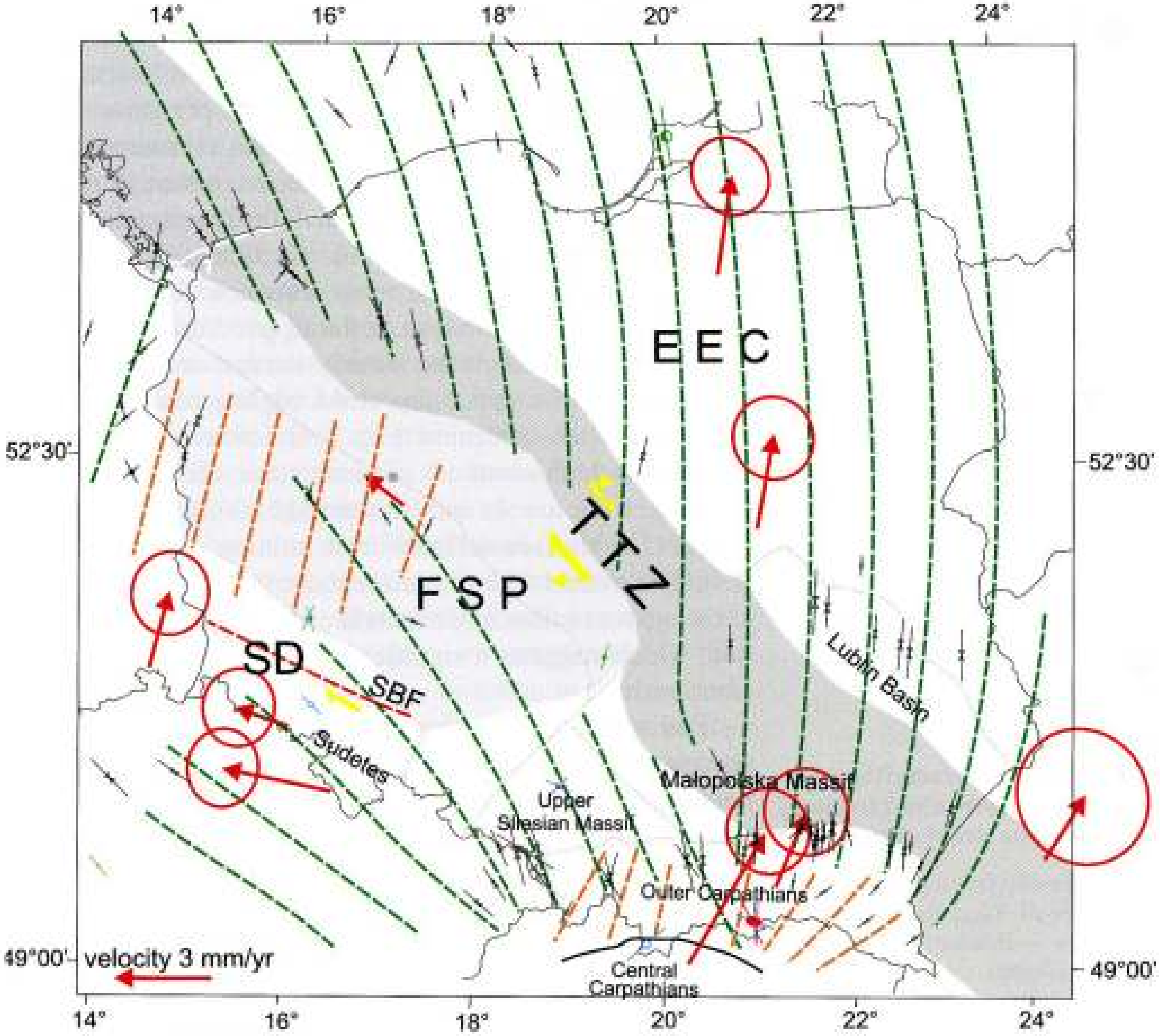

2.5 km
7.5 km
12.5 km
17.5 km
22.5 km



0 25 50 km
KRAKÓW
RZESZÓW
Tarnów
Brzesko
Bielsko-B
Cieszyn
Żywiec
Nowy Sącz
Krynica
Krosno
Sanok
Przemyśl
SSI
SI
SK
MU
DU
FC
T
SLOVAKIA
UKRAINE
19°
20°
21°
22°
23°
50°
49°
Carpathian frontal thrust
Subordinate thrusts
Faults
Pieniny Klippen Belt
Miocene molasses resting on eroded flysch rocks
Axes of neotectonic elevations
Axes of neotectonic depressions
Antecedent water-gaps
Structural units:
Inner Carpathians: T – Tatra units,
FC – Central Carpathian Flysch (Podhale Flysch)
Outer Carpathians – thrust sheets (nappes):
MU – Magura, DU – Dukla, SI – Silesian,
SSI – sub-Silesian, SK – Skole



Interpolated GPS velocity field from the combined velocity map obtained from CEGRN, HGRN, and EPN data (after Grenerczy, 2006)

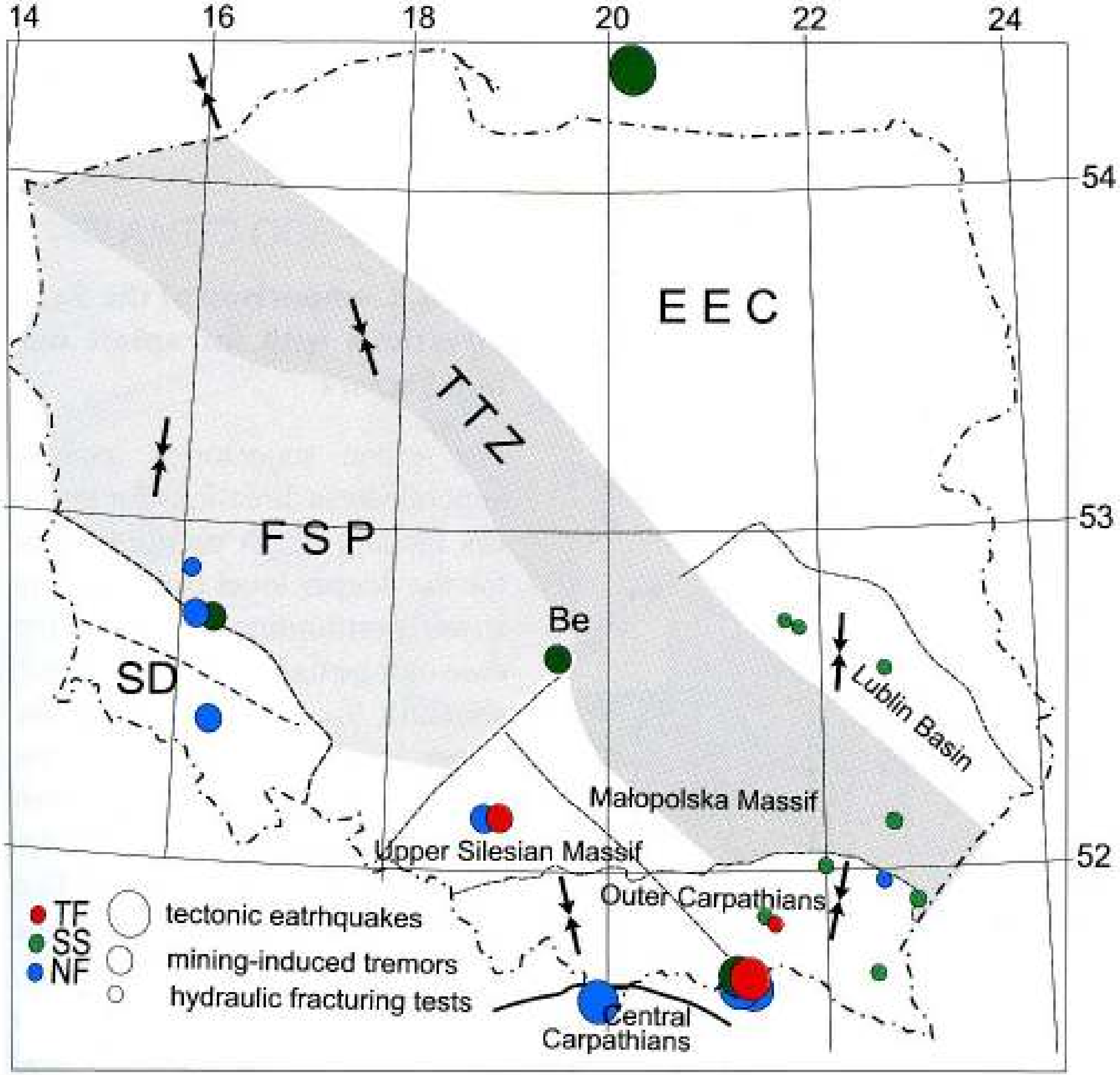


Comparison of the S_{Hmax} directions with intraplate motion vectors

The green trajectories indicate general stress directions for the areas lacking stress partitioning or for the deeper level in the case of stress partitioning. In the latter case orange trajectories are added, showing S_{Hmax} directions for the upper level. For comparison the World Stress Map data are shown in the background

Red arrows show directions of the intraplate motions (after Hefty, 1998); length of each arrow is proportional to the velocity; one-sigma error ellipse is attached to each arrow. Yellow arrows show hypothetical strike-slip motions along the TTZ and the Sudetic Boundary Fault (SBF) that might be responsible for discrepancy between directions of S_{Hmax} and the intraplate motions.

after Jarosiński (2006)

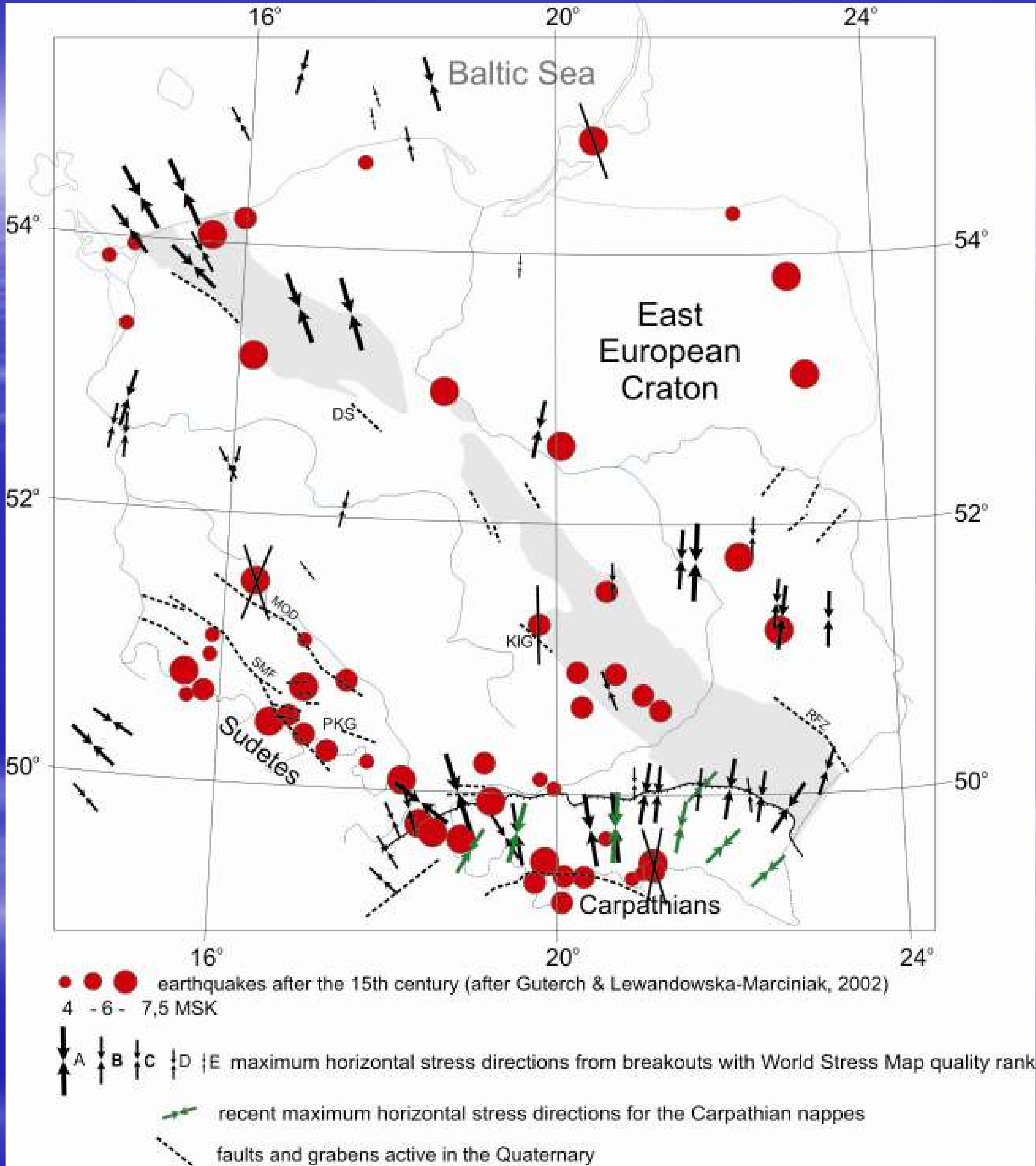


Jarosiński 2006

Distribution of stress regime data from hydro-fracturing tests (small circles) and from natural earthquake focal mechanism (greatest circles) and mining-induced tremors (intermediate size of circles)

Stress regimes: TF - thrust faulting, SS - strike-slip faulting, NF - normal faulting; arrows indicate mean direction of SHmax; Be - Bełchatów mine

Recent stress field in Poland



CONCLUSIONS

* The size of throw of Quaternary faults changes from 40-50 m and >100 m in the Sudetes and the Lublin Upland, to several - several tens of metres in the Carpathians.

* The average rate of faulting during Quaternary times has been 0.02 to 0.05 mm/yr, what enables one to include these structures into the domains of inactive (D) or low-activity (C) faults. A similar conclusion can be drawn from the results of repeated precise levellings and GPS campaigns.

* Episodes of increased intensity of faulting took place in the early Quaternary, in the Mazovian (Holsteinian) Interglacial, and during or shortly after the Odranian (Drenthe) glacial stage. Some of the faults have also been active in Holocene times.

* The seismic activity is often related to strike-slip faults, which in the Carpathians trend ENE-WSW and NE-SW, whereas outside the Carpathians they are orientated parallel to the margin of the Easteuropean Platform and the Sudetic Marginal Fault.