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IS THE SUDETIC MARGINAL FAULT STILL ACTIVE? RESULTS OF THE GPS MONITORING 1996 - 2002

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ABSTRACT

The major tectonic structure of the Lower Silesia Region is connected with the Sudetic Marginal Fault (SMF), which past and contemporary activity has been pointed by many authors. Within the "GEOSUD" project the geodynamic profiles have been set up across the most active tectonic zones covering Sudetes and Fore–Sudetic Block. Repeated every year satellite GPS measurements were carried out on the sites of these profiles during the period 1996–2002. The analysis of the results of these measurements shows that tectonic activity of the SMF zone is still going on, but individual segments of this zone are marked by different character of horizontal movements.

KEYWORDS: Sudetic Marginal Fault, GPS, tectonic activity monitoring

INTRODUCTION

Earth crust of Lower Silesia was broken into numerous tectonic blocks, grabens and horsts during late Alpine orogeny. The major tectonic zones of the Lower Silesia Region were connected with the Sudetic Marginal Fault (SMF). These crustal movements were at its peak in Miocene and Pliocene (Dyjor, 1993, 1995). Throughout the Quaternary till the present times this activity wakened, nevertheless their existence is still felt as local earthquakes (Dyjor, 1993, 1995; Guterch & Lewandowska, 2002) and evident visible in the morphotectonics (Badura et al., 2003). The results of the repeated measurements of the 1st order national leveling network and geodetic investigations performed up to the 90's in the local geodynamic research areas in Lower Silesia show the current crustal movements, both horizontal and vertical, which locally can be of several mm/year *(*Cacoń & Dyjor, 1999; Cacoń et al., 1998, Wyrzykowski, 1985). In 1996 the geodynamic geodetic investigations, using an annual GPS epoch measurement technique in a special research network, were started within the "GEOSUD" project (Cacoń & Dyjor, 1999; Cacoń et al., 1998). The network GEOSUD, covering initially the Eastern Sudetes and the Fore Sudetic area, was extended to the entire of region in 2000 (Cacoń & Dyjor, 2000; Kontny, 2003). Results of repeated annually (in 1996-2002 period) GPS measurements, performed on the sites located on the both sides of SMF give the opportunity of contemporary activity assessment.

GPS DATA PROCESSING OF GEOSUD NETWORK ANNUAL CAMPAIGNS 1996-2002

The GPS data of daily sessions of each annual campaign were processed by BERNESE software (Hugentobler et al., 2001). Then site velocity components and satellite antenna phase center corrections were estimated. The linear model of site velocities and the unaffected by gross errors M-estimation method with the "logistic" weighting function were applied (Kontny, 2003). The GPS observations on the local network with reference to selected permanent IGS/EPN stations allowed the velocity within the ITRF2000 reference frame and their reduction to "local" velocities using geokinematic model APKIM2000 (Drewes, Angermann, 2001) to be calculated. The horizontal velocity vectors of the GEOSUD network points' linear movement with their 95% confidence ellipses are presented on the Figure 1.

Maximum velocities of horizontal movements, exceeding values of 5 mm/year, were estimated for sites located in the north-west part of the Sudetes (KOZO, RADO) but only three years of observations (2000-2002) on these sites seems to be to short period for reliable interpretation. However, these values must be verified for possible systematic effects due to different antennas used on GPS sites. Significant velocity values were also calculated for sites KAMI, KLOD, SPAL, WINN and ZLOT. Detailed analysis of the significant movements of sites NYS1 and ULIC showed their evident episodic displacements (Kontny,

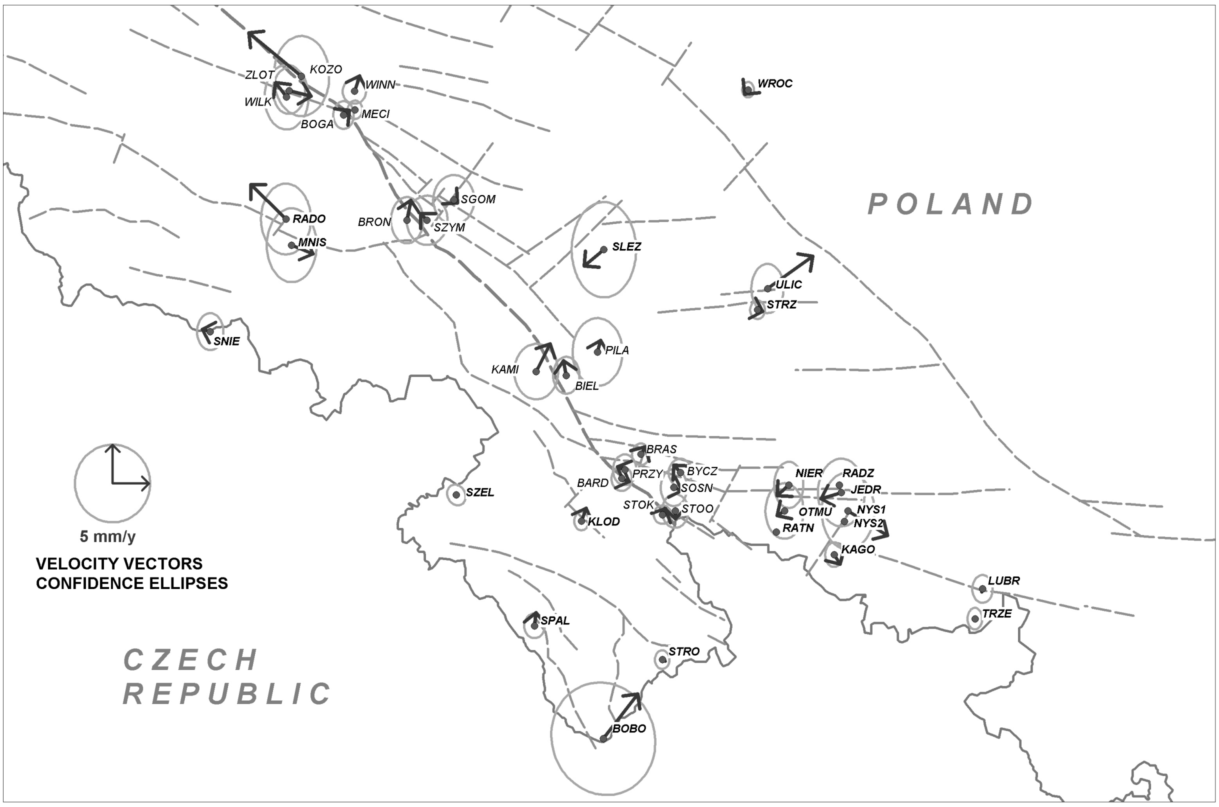

Fig. 1 Horizontal velocity vectors of the GEOSUD network points and their confidence ellipses (according to Kontny, 2003)

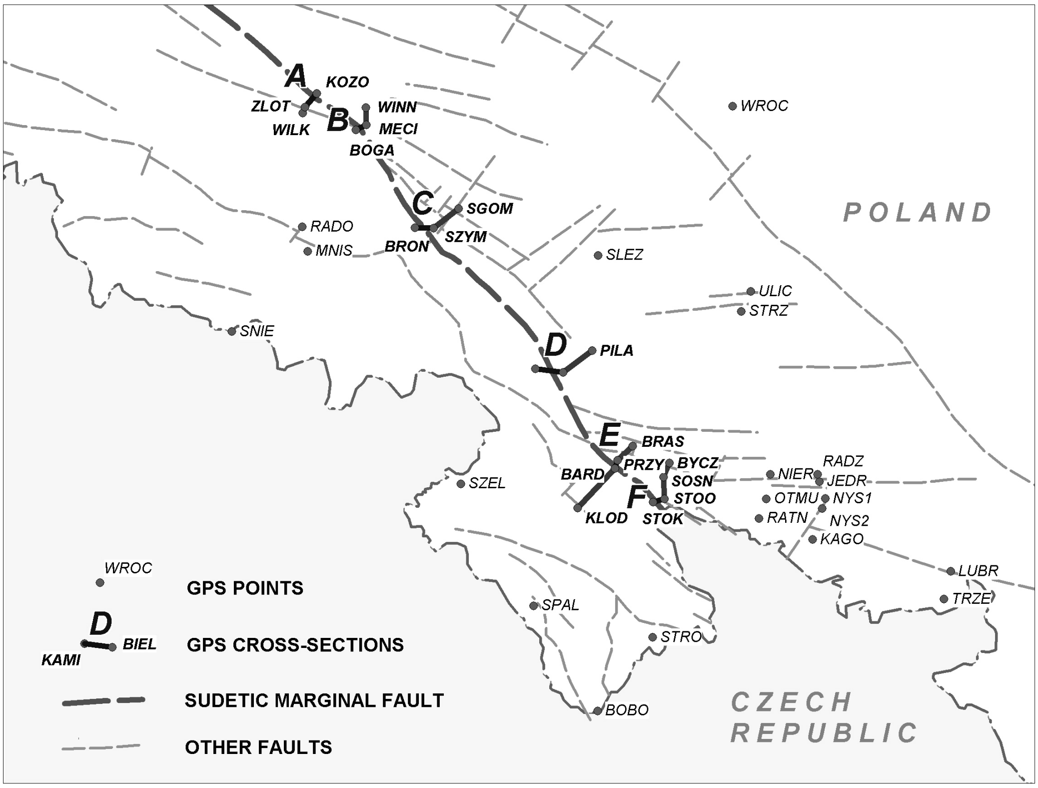

Fig. 2 Location of the GEOSUD Network points with respect to the Sudetic Marginal Fault

Table 1 Rates of vector relative elongation and rotation on the profiles

PROFILE	FROM	TO	ε_{AB} (mm/10km/y)	RMS (mm/10km/y)	RATIO	$\hat{\varpi}_{AB}$ (rad/year)	RMS (rad/year)	RATIO
A	**ZLOT**	**KOZO**	**-4.65**	**8.04**	**-0.6**	**-3.56E-06**	**7.54E-07**	**-4.7**
A	WILK	ZLOT	-7.18	21.14	-0.3	4.35E-06	1.65E-06	2.6
B	**BOGA**	**MECI**	**-4.72**	**4.14**	**-1.1**	**3.04E-08**	**4.78E-07**	**0.1**
B	MECI	WINN	5.81	3.13	1.9	2.80E-07	2.95E-07	0.9
C	**BRON**	**SZYM**	**-4.11**	**5.14**	**-0.8**	**4.85E-07**	**6.33E-07**	**0.8**
C	SZYM	SGOM	0.48	3.59	0.1	3.24E-07	3.69E-07	0.9
D	**KAMI**	**BIEL**	**-4.03**	**3.33**	**-1.2**	**3.65E-07**	**4.11E-07**	**0.9**
D	BIEL	PILA	0.57	3.17	0.2	1.19E-07	3.38E-07	0.4
E	**BARD**	**PRZY**	**1.05**	**7.83**	**0.1**	**-1.33E-06**	**6.71E-07**	**-2.0**
E	KLOD	BARD	-1.26	0.92	-1.4	1.68E-07	9.09E-08	1.9
E	PRZY	BRAS	4.00	2.86	1.4	1.82E-07	2.85E-07	0.6
F	**STOK**	**STOO**	**-4.08**	**4.80**	**-0.9**	**6.96E-07**	**5.41E-07**	**1.3**
F	STOO	SOSN	1.25	4.01	0.3	2.83E-07	3.15E-07	0.9
F	SOSN	BYCZ	1.89	5.14	0.4	-8.41E-07	4.40E-07	-1.9

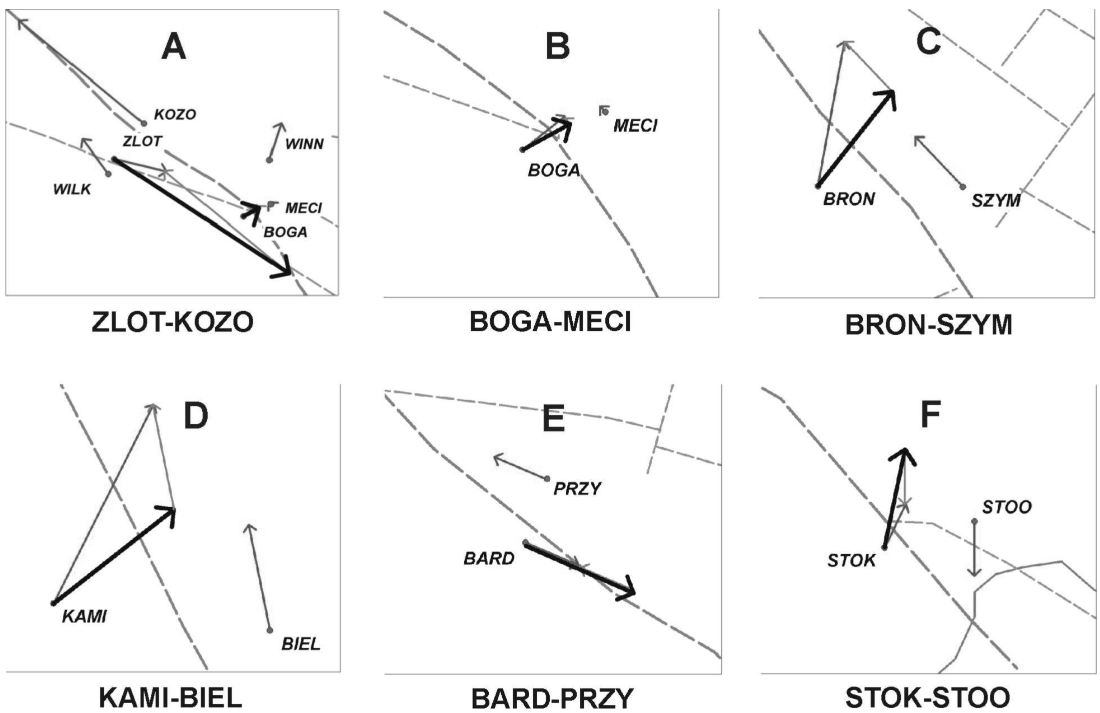

Fig. 3 Relative horizontal velocity vectors on the GPS profiles (dark vectors) – NE side site fixed

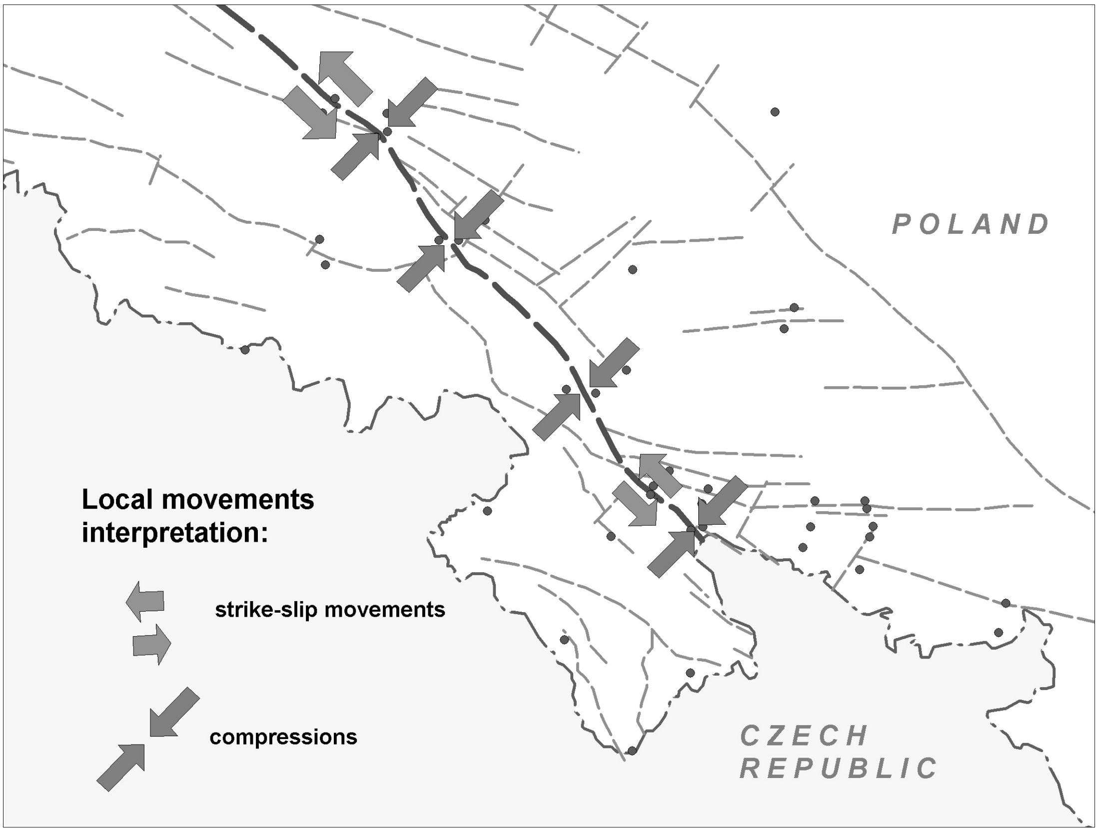

Fig. 4 Graphical representation of the deformation character on the Sudetic Marginal Fault *(according to Kontny, 2003)*

2003). The remaining sites showed movements within 1-2 mm/year limits, which did not exceed their confidence ellipses. Considering relatively short period of observations and considerably lower accuracy of height estimation in comparison with the accuracy for horizontal coordinates, velocity of vertical movement was not calculated at present time.

SUDETIC MARGINAL FAULT ACTIVITY ANALYSIS

GPS sites located near SMF create six profiles, named A, B, C, D, E and F, approximately perpendicular to the fault line (Figure 2).

The activity of the investigated tectonic structures (major faults and tectonic grabens in adjacent area) was analysed on the basis of values of parameters of changing relative extension ε and the rotation ω of the vectors located in the research profiles (Table 1).

Relative extension rates for the all vectors crossing SMF (bold type), except BARD-PRZY, turn out negative and very similar values, indicating compressions, although not significant taking into account values of RMS. Significant and anticlockwise rotation rate of vectors ZLOT-KOZO and BARD-PRZY indicate possible sinistral components of the movements. Compressional and sinistral character of the local movements of SMF zone is visible on the picture of relative velocity vectors of the sites crossing the main fault, reduced to the southern side of the fault by fixing the northern part (dark vectors on the Figure 3).

The findings evidence that the area of the Polish Sudetes and the Fore-Sudetic Block undergoes a compression process with a negative linear deformation (compression) towards the NE-SW (Kontny, 2003). The contact zone between the two blocks, covering the area of the SMF and the Fore-Sudetic grabens, is submitted to the greatest deformation. Simplified interpretation of the deformation of SMF zone on the basis of geodetic (GPS) results is presented on the figure 4. The results of GPS measurements indicate local character of the movements of individual segments of the fault and relatively highest activity of horizontal movements in the western part of the region. However, a short period of observations in the western part of the network (2000-2002) does not allow for far-reaching conclusions.

CONCLUSIONS

The presented analyses of the relative movements in the Sudetic Marginal Fault zone are limited only to the horizontal movement resulting from GPS measurements. Preliminary results of the study indicate NE-SW probable compression of the main fault zone and local, left-lateral horizontal movements of the individual segments of the fault. Taking into account very short observation period specially advanced conclusions may not be constructed yet.

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