ventional methods for interpretation of geological and geophysical data and is consistent with the concepts of an essential contribution of raid tectonics to the platform history developed in the past few years. In an alternative model of the destructive-accretionary history of the Barents-Pechera basin crust a distinctive methodology, used to reveal an old oceanic-type spreading belt buried at great depth under a young plate cover, is especially valuable. If these bold geophysical palaeoreconstructions are supported by geochemical and petrological data, then an integrated geological-geophysical methodology of analysis of the evolution of continents will be at a new, advanced level.

References

Lithospheric structure of the Russian part of the Barents region / Eds. N. V. Sharov, F. P. Mitrofanov, M. L. Verba, C. Gillen — Petrozavodsk: Karelian Res. Centre, RAS, 2005. — 318 p.

Earth's tidal tilt jumps and their relationship to earthquake source's physics

© V. Shliakhovyi[1], V. Chernyi[2], V. Shliakhovyi[1], 2010

[1]Poltava Gravimetric Observatory of the Institute of Geophysics, National Academy
of Sciences of Ukraine, Poltava, Ukraine
gravics@gmail.com
[2]eMeter Corporation, San Mateo, USA
scherniy@yahoo.com

Institute of Geology and Seismology and Poltava Gravimetric Observatory of Institute of Geophysics of National Academy of Sciences of Moldova and Ukraine researched earth's crust tilt deforma-

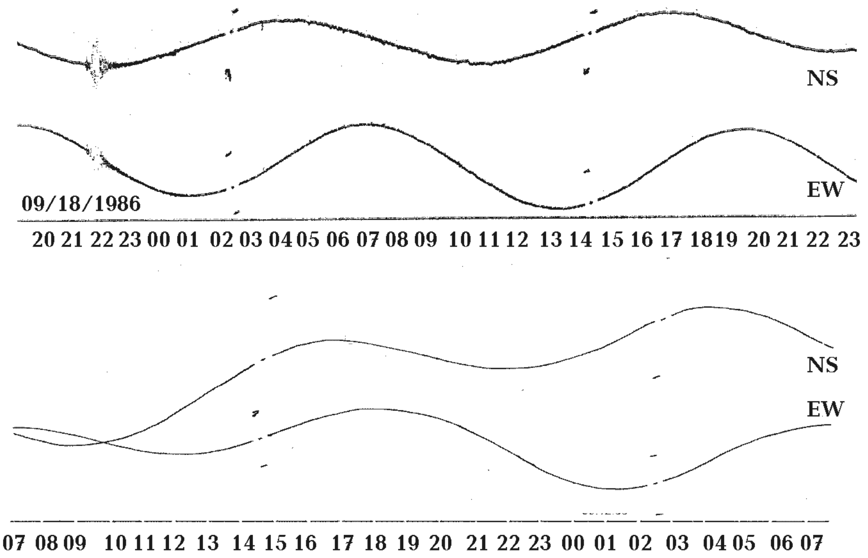

Fig. 1. Usual record of earth- tidal tilts at station "Chisinau". Top — with presence of seasonal microseisms and bottom — without.

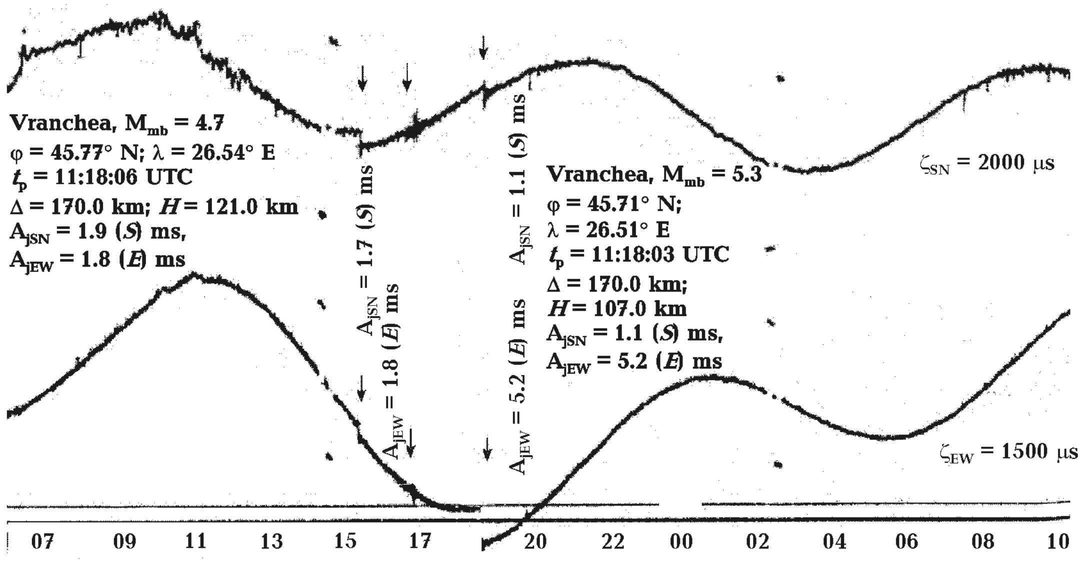

Fig. 2. The sample of earth-tidal tilts record with doubled Vranchea earthquakes and corresponding tilts jumps ("Chisinau").

Earthquakes parameters with corresponding tilt jumps

№ п/п	Data, time	M	Lat	Long	H, km	L, km	Jump, msec arc		P (press)		B		T (tension)	
							EW	NS	az	pl	az	pl	Az	pl
1	1.08.85 11:17	5.2	45.8	26.75	120	200	1.8	−1.7	135	8	42	19	248	69
2	1.08.85 14:35	5.5	45.35	26.52	105	195	5.2	−1.1	252	10	358	57	156	31
3	27.04.86 00:04	5.1	45.48	26.95	41	235	0.5	0.7	128	2	38	8	229	82
4	16.08.86 06:41	5.2	45.53	26.42	154	245	1.5	5.6	293	27	29	12	142	61
5	30.08.86 21:28	7.0	45.52	26.49	137	255	160	−49	330	20	238	7	131	69
6	16.12.86 22:33	4.8	45.59	26.56	142	235	2.4	2.4	272	9	8	32	169	57
7	23.09.87 20:40	4.5	45.6	26.59	140	220	1.4	0.8	276	26	19	25	146	52
8	8.01.88 16:50	4.8	45.54	26.26	135	258	12.3	1.5	311	0	220	77	41	13
9	30.05.90 10:40	6.5	45.87	26.87	89	215	460	−710	318	17	51	9	168	70
10	31.05.90 00:17	6.4	45.83	26.89	79	205	-100	180	27	22	123	15	244	63
11	26.06.90 07:54	4.3	45.75	26.8	82	200	-0.4	0.7	97	0	187	5	1	85
12	13.01.91 23:48	4.9	45.73	26.75	120	210	1.6	15	20	1	290	8	115	82
13	31.01.91 13:29	5.1	45.72	26.69	127	195	1.2	1.5	23	16	115	5	221	74
14	21.11.92 12:55	4.8	45.8	26.58	124	215	12.8	7	261	18	352	5	99	71

tion in the vicinity of earthquake source zone Vranchea during 14 years. Auto-compensating tiltmeters allow to broaden the spectrum of the research, including earth-tidal study, recent movement of the earth's crust, and geodynamic processes in area adjacent foci zone of Vranchea earthquakes — one the most active seismogenic regions in Europe.

Observation station was located in the mine, about 75 m underground and maximally distant from the technogenic and climotogenic sources of noise. High quality of data allows use of observations in study of strong earthquakes precursors; three of these stronger earthquakes (M~6.4÷7.0) occurred during observation period, which also allowed getting precious scientific results for whole spectrum of study areas. Some results of these studies were published [Schlikhovoi et al., 1989; 1997; 1998; Drumea et al., 1990], some — are still in progress. The study of jump events corresponding to strong earthquakes of Vranchea is important to study of their relation with regional geotectonic and to earthquake precursor study. This aspect of study is imperative due to the expected strong earthquake according to known seismic activity cycle of Vranchea region. Usually, the jumps are recorded for earthquakes with $M\geq 4,5$. During the period of observation, 35 earthquakes of similar magnitude took place in Vranchea; five of which ($M\leq 4,8$) are missing jumps, four — concealed with mine noise, data for twelve is missing due to equipment malfunction and blackouts. We ended up with 14 sets of high quality jumps data displayed in Tab. 1 along with foci mechanism parameters. Examples of record of tidal tilts at station "Kishinev" at usual registration and with jumps at earthquakes are shown Fig. 1, 2. Analysis of data in table shows that jumps accompany all $M\leq 5$ earthquakes. Analysis shows that meaningful statistical relationship could be established between magnitudes of earthquakes (M) and amplitudes of jumps (Am). The dependency can be expressed by regression: $M=(4.58\pm0.41)+(0.74\pm0.11)\lg|Am|$ with 10 % accuracy. The values and sign of the jump components depend on position of the fault's surface and azimuth line between obser-

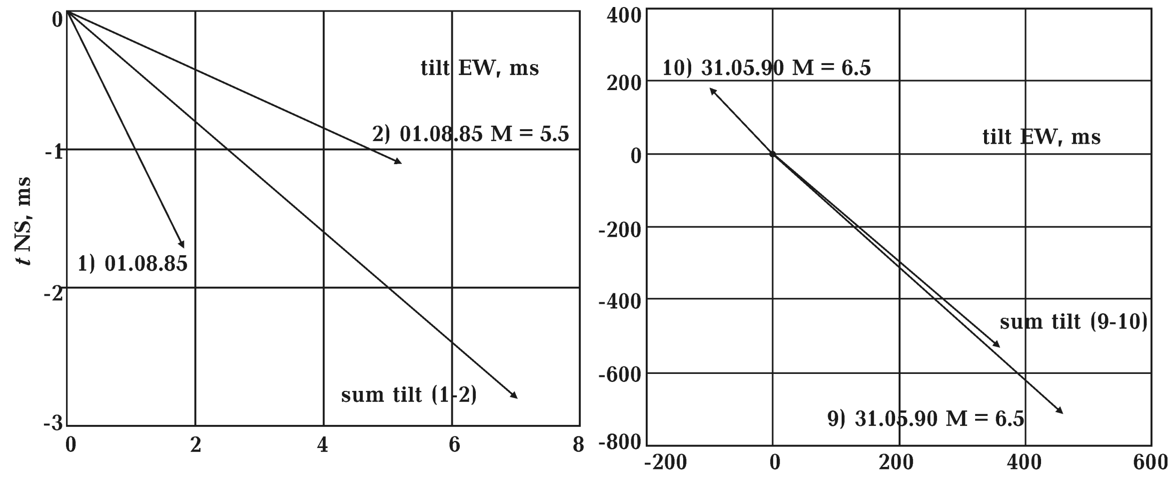

Fig. 3. Vector-diagram of tilt jumps.

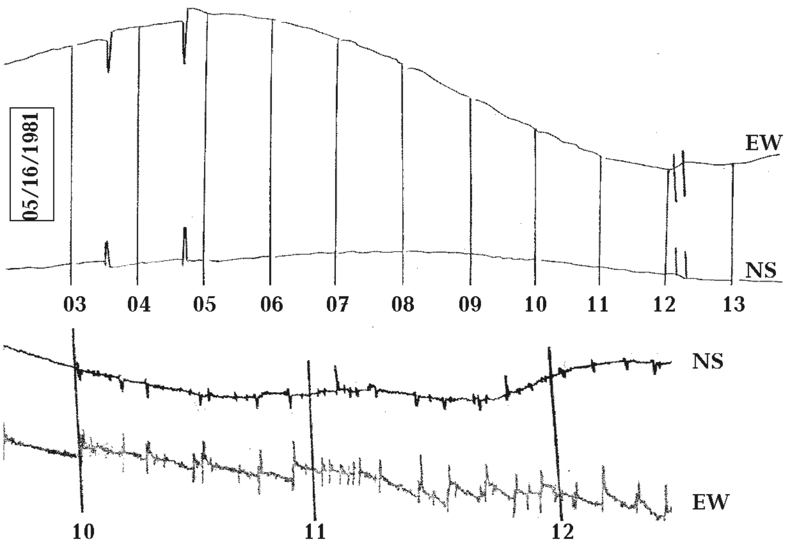

Fig. 4. Samples of tiltmetric records with the presence of technogenic tilt jumps originated by heavy traffic during the experiments: top — st. Sudievka and bottom — Dniester river bridge.

vation's location and earthquake focus. Tilt jumps vector-diagrams display this (Fig. 3). In case of doubled earthquakes (with close time of occurrences) we have clearly identified jumps for each earthquake respectively. In case of weak earthquakes the jumps are mono-directed, for strong — multi-directed. Tilt jumps quantitative interpretation follows fault- dislocation model, which precisely depicts foci processes. This approach allows determine earthquake geometrical and energetical parameters on the basis of several observation stations. The method represented in monograph "Earthquake mechanics" [Kasahara, 1981] was used to interpret observed data. Unfortunately, we only have one station data, thus can use only simple model (dip-slip). This model fits most of strong Vranchea earthquakes due to faults surface angle falling into 70°—85° and slips being vertical [Drumea et al., 1990]. Even for the simple model three stations observation are required. Assuming relation between magnitude and fault parameters (height, length), slip parameters were computed; the results of computation (except: May 1990 earthquakes) were in sync with the results derived by other methods [Drumea et al., 1990]. Jumps appeared on tidal tilt records aside from seismic events, and were considered as noise and ignored. Turns out, the jumps appeared as result of sudden overload of geophysical continuum. This was proven by real time sync tiltmetric observations in pit-hole at station Sudievka (Poltava suburb) and deformation study at Dniester river bridge (Bender). Records of these observations often contained peak impulses with residual tilts from 0,001 (in pit-hole) to 1 (bridge) arc.sec (Fig. 4). Some time these jumps were considered as instrumental noise, but then have established that they are caused by loadings from moving transport. Observations on the bridge delivered records of elastic and non-elastic tilt jumps; with lesser quantity and amplitude of jumps in areas where pillars were set in denser rocks. Most likely, tilt jumps are caused by non-elastic rock deformation. Moreover, tilt frequency and jump amplitude indicate critical condition of rock deformation. Based on the above-mentioned observations and results of the data analysis, we were able to arrive at following conclusions:

a) tilt jumps occur at geo-objects of different scale and composition, yet display same physical nature;

b) presence of jumps (deformations, slides) demonstrates unstable condition of geo-objects;

c) increase of amplitude and number of jumps indicates transformation of geo-object into more dynamic deformation phase that predeceases catastrophes such earthquake, landslide, mine collapse, and other; and, possibly, may be considered as direct precursor of natural and technogenic cataclysm;

d) tiltmetric observation are direct indicators of continuum deformational state, thus must be considered as necessary component in complex geophysical monitoring of deformational processes.

References

Drumea A. V., Shebalin N. V., Skladnev N. N. The Carpathian Earthquake of 1986. — Chisinau: Stiinza, 1990. — 334 p.

Kasahara K. Earthquake mechanics. — Cambridge University, 1981. — 260 p.

Schlikhovoi V. P., Cherny V. I., Ostrovsky A. E. Investigation of deformation processes in the area of the Vrancea focal zone using precise tiltmeters // 6th In. Symp. "Geodesy and Physics of the Earth", Potsdam (GDR), 1988. III. Recent Crustal Movements. — Potsdam, 1989. — P. 217—228.

Schlikhovoi V. P., Schlikhovoi V. P., Slusar E. G. Jumps of the Tilts at Earthquakes of Vranchea // 29th General Assemble Int. Association of Seismology and Physics of the Earth's Interior, Abstract. (Thessaloniki (Greece) August 18—28). — 1997. — P. 197.

Schlikhovoi V. P., Slusar E. G., Schlikhovoi V. P., Cherny V. I. Results of a study of tidal tilts near to Vranchea zone // Proc. Thirteenth Int. Symp. on Earth Tides. (Brussels, July 22—25, 1997). — Brussels, 1998. — P. 243.