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Short Communication | Open Access

The Experimental Research Results of the Effect of Rock Deformation on Its Physical Properties

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Abstract

In the article the prosesses used as a precursor in some earthquakes for accurate research work are investigated. In Japan in the period of a strong earthquake observed anomalous change of the height of the Earth's surface and according to the geodetic data a graph of latest vertical movements of faults are reviewed. The deformation of the Earth's crust has been widely covered. Besides the development of observed deformation precursors before the Niigata earthquake, acoustic emission monitoring in dehydration process of Hips, including the speed change of massive movement depending on the remaining time till the earthquake happens, and theoretically calculated marks of a speed of displacement of repers for the San Andreas model and other problems are shown in the article.

Keywords: Deformation of rocks; Anomalies; Precursors of earthquake; San Andreas model

Short Communication

To investigate in the right order the experimental research of the effect of rock deformation on its physical properties during the earthquake happened in Niigata (1964) viewing "the rise of the Earth's crust" process as a precursor let's make some researchs.

It should be noted that the results from Niigata earthquake is considered as convincing evidence of dilatant-diffusion model that took place before the earthquake. But the that idea does not receive one mark, so according to K.Mogi [1] during the occurrence of the Niigata earthquake, the results of geodesic measurements should be treated with suspicion. Because of an error in the preparation of measures the non-sustainability of the geodetic measurements used as precursors increases disbelief to results.

The epicenter was on the continental shelf off the northwest coast of Honshu (Figure 1.1a). The area length of epicenter is 80 km and a width is 30 km, the displacement is estimated 33 metres.

The Niigata earthquake was clearly visible and the results descibed in [2] researchs. An interesting point is that was there any anomalous rising tide indeed before the Niigata earthquake?

First, since 1955 the "abnormally rising tide" includes the effect of changes of a relief. Secondly, the mistakes in planning can be gathered in the same area. Here, it comes out that there are some problems with the results of the planning in 1955: Of course, a process of ascension is not necessary, so it is necessary to examine it in the future. During the establishment of the curve actions of the shell without noting the planning in 1955, excluding graphs are shown in Figure 1.1b. So we say, in fact, the region is stable rising tide of area. Thus, new investigations are needed, was there indeed, the rising tide a few years before Niigata earthquake?

Such a precursor was considered the most reliable geodesic sign in the past and was considered to be the foundation of dilettant-diffusion model. Can these measurements also be a result of the error?

In some cases, fostered by high-precision geodetic measurements data to other methods report the rapid several centimeters change of varations of the Earth's surface. This kind of example is shown in Figure 1.2.

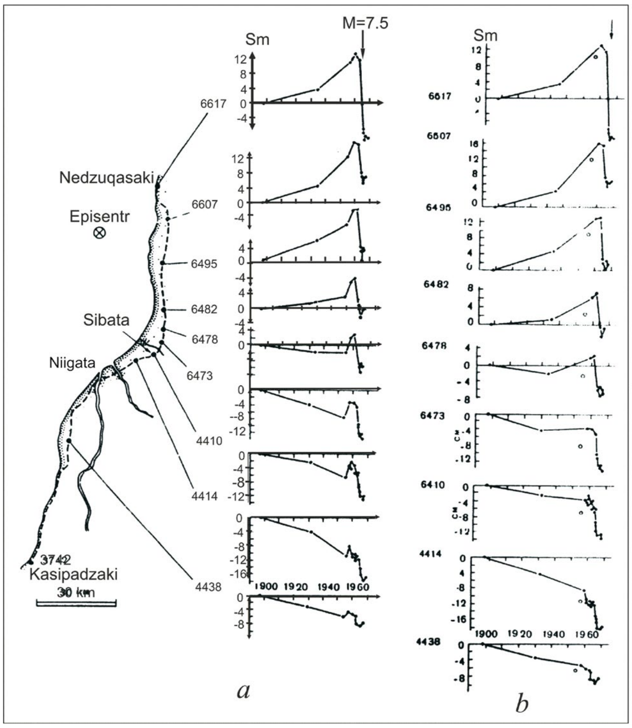

Figure 1.1: The development of observed deformation precursors before the Niigata earthquake (A moment of occurrence of the earthquake was indicated by an arrow).

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The coast of Izu peninsula for over 80 years in two episodes of relief was observed in a sharp change Δh. The first, in 1920-1930, 1923. M=8 l catastrophic earthquake and the second strong earthquake in 1930, M=7. However, according to the geodesic data of the anomalous area center in 1930 and 1978 do not match to the epicentral zones of occurred earthquake. (Figure 1.2a).

According to the isoline contour 30 km linear local rising tide occurred. This again has been strengthened with gravimetric data of planning. Anomalies are characterized by the existence of volcanism and active faults. In connection with this let's have a look at "Parametric" hypothesis of anomalies. Authors Y.Kuzmin and V.Sidorov [3,4] in their research at active Kopetdag region and Pacific Pripyat depression made a large number of measurements of seismic profiles. Both regions are characterized by solid materials of sedimentary rocks. 1-2 km at a vertical movement of the local anomalies have been found. These are formed at actions of the character 10-1-10 year high gradient (10-20 mm/ km in a year). The examples of anomalies of Kopetdag (a) and Pripyat regions (b) are shown in Figure 1.3.

Summarizing the results of the observation, the authors divided the local anomalies into 3 main types. γ-type anomalies (local inclination) shows itself more clearly. This type of anomalies are shown with strokes in Figure 1.3. and that are subhorizontal conditions. In terms of subhorizontal stretch the β -type anomalies (regional bending) are often mentioned. The third type of anomalies in the S-shaped (step-shaped) shape.

As we can see from Figure 1.3b local anomalies do not occur on all of split. In connection with this the authors [3] called this type of deformation of the Earth's surface as a parametric anomaly. The speed of the Earth's crust deformation, including the fault zone [3].

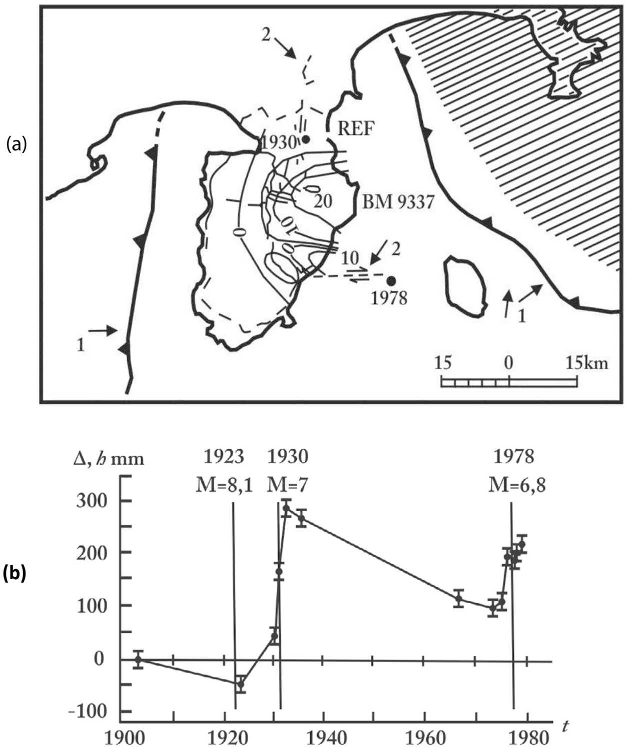

Figure 1.2: In Japan in the period of a strong earthquake observed anomalous change of the height of the Earth's surface.

a: Anomalies of Kopetdag region, **b**: Anomalies of Pripyat region

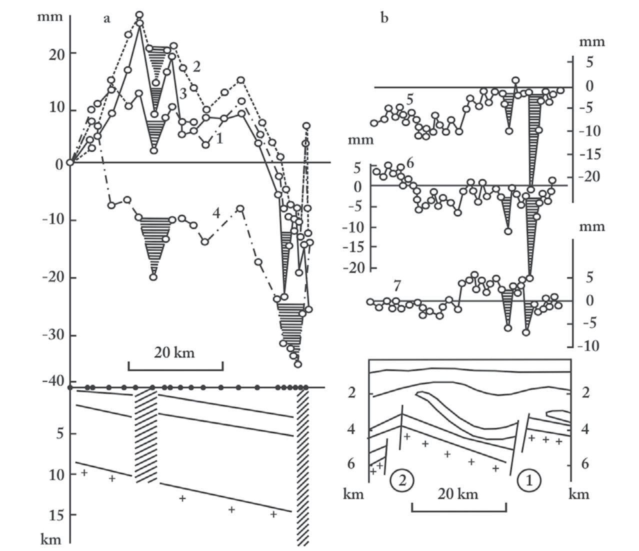

Figure1.3: According to the geodetic data a graph of the latest vertical movements of faults.

E= σ/E- σ /E2 (1)

Here, the σ, the E - Regional tectonic and Jung module of rocks at the edges of the fault zone. The σ and the E - Strain and Jung module of breaking materials change according to the time.

For example, the γ-type anomalies may be due to changes in the field of regional strain and the collapse of rocks in the fault area. Suppose that the strain of the regional area T1 is varying with the harmonic law and local characteristics of fault chandes faster like T2<<T1.

σ=σ0cos(2Πt/T1) (2)

E=E0cos(2Πt/T2) (3)

The T1 period is about 103-105 year, the T2 is 10-1-10 year according to the results of the observation of local anomlies. E is an estimation of average annual deformation according to the formula (1) [3] and according to the formula (2-3):

σ=103 kq/sm^2, E=105 kq/sm^2, T1/T2=10 4 , σ=0,1 kg/m^2•year,

E/E= 0,01/il. The result is E=10-5 /year.

Sidorov, Kuzmin [3,4] have discovered the consistency of local anomalies along the profile, so that can be interpreted as a migration (deformation wave). It became clear that the average speed of this kind of waves at Kopetdag is 20 km/year, and is 26 km/year in Pripyat.

Parametric anomalies can be used in earthquake prediction research. And also the effect of a local anomaly can influence the long periodness of precursors, and their mixed distribution of the Earth's surface.

According to the data of V.Starkov an example from 3 stations of local earthquakes is shown in the Figure 1.4. The distance between Hissar, Qarasu and Kondara stations was 40–50 km, and this measures at the station like the distance to the earthquake (K=12,2 and M=4,5).

As we can see from the Figure 1.4, the changes was observed towards to the increasing of deformation in the middle of December.

More detailed analysis showed that the anomalies started at Karasu

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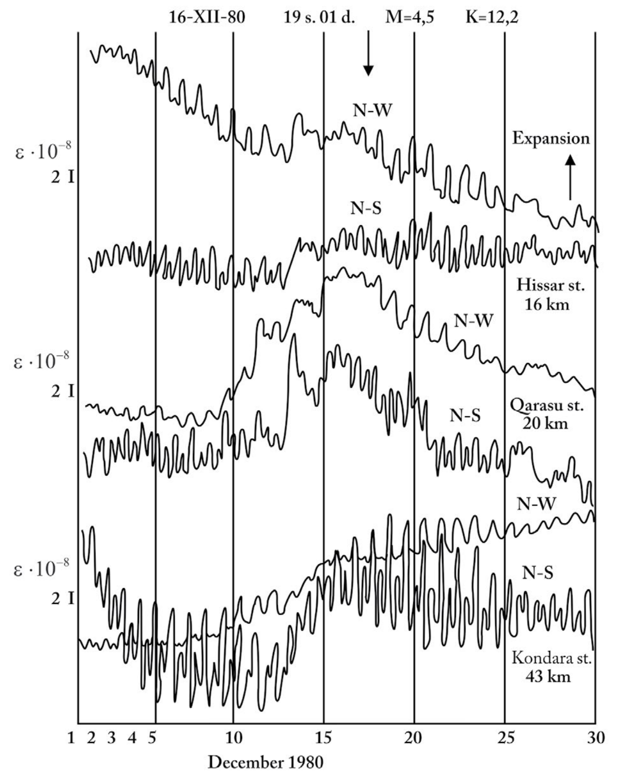

Figure 1.4: Example for the Earth's surface deformation observed in three stations of Dushanbe-Vakhsh forecast polygon.

station on December 9, at Hissar - on December 12 and at Kondar - on December 13. It was estimated excluding a flow effect of the speed of deformation. The results are like this: Karasu - l,4•10-8, Hissar - 2,0 •10-8, and Kondora - 2,46 •10-8 days.

However, from December 3 to December 12, a gradual decrease in atmospheric pressure in the region ((15 ÷20)10-3 km/sm^2) and the return on December 13 increasing in the same size was observed. The issue of registration of local deformation from one station can not be true. Weather forecast, after 10 years of observation, the authors obtained an interesting results. 8 earthquakes happened near the Harm polygon in 1981-1988 (K>13,3). In the first half of the interval bending anomalies has been recorded before the earthquake (Figure 1.5). However, the same distance from the epicenter of the earthquake precursors disappeared. Because of the observation techniques and methods remained stable that effect can be connected with the regional strain area.

The authors showed that before the earthquake distortions occurs in a type of anomaly, without any reason and without any relation with the earthquake. They have noted that the by estimating the rate of change in the tilt of the two cases can be distinguished: tilt before the earthquake occurs rapidly. However, in our opinion, these results have not been strengthened with the statistical observations. In researchs [5], a comparison between the theoretical data and the changes of rising tide amplitudes cases was recorded before the earthquake.

In this case that effect have been taken 10 hours before the earthquake in Fargana valley on May 6, in 1982 K=14,4 at Harm station (150 km from the epicenter). Jalanas-Tyup earthquake on March 24, 1978 M=6.8 growth amplitude was observed at Turgen station (130 km from the epicenter) within 2-3 months.

The theoretical basis for the use of deformation measurements on predicting earthquakes can be evaluated in a more simple way to linear fault.

E. Lorensetti and T. Tullis conducted modern computational experiments. The model that will be estimated was descibed at the experiments of C. Dieterix and the theory of C.Raysm. It was given in Figure 1.6.

$$(\tau)V= \tau0+\sigma n(a-b)\ln(V/V^*) \quad (4)$$

Based on the τ0, it is possible to make a correct measurement of the surface layers. The calculation of other parameters is given that are included in formula (4). The calculation of the speed changes in the vertical fault edges is shown for the earthquake with magnitude 6-7 in Figure 1.7. (applied in San Andreas).

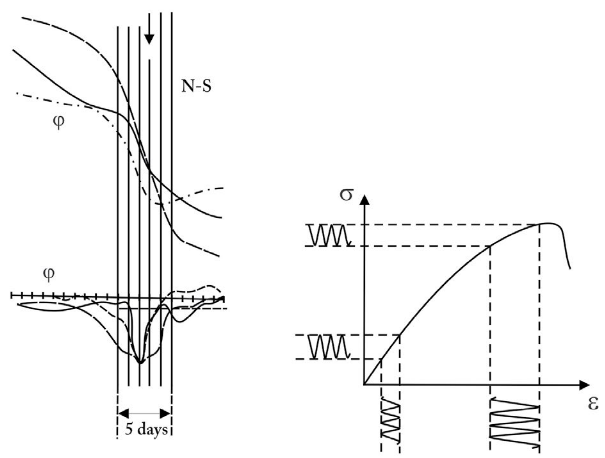

Figure 1.5: Example of anomalous changes graph observed at local earthquake crust Chil-Dora station.

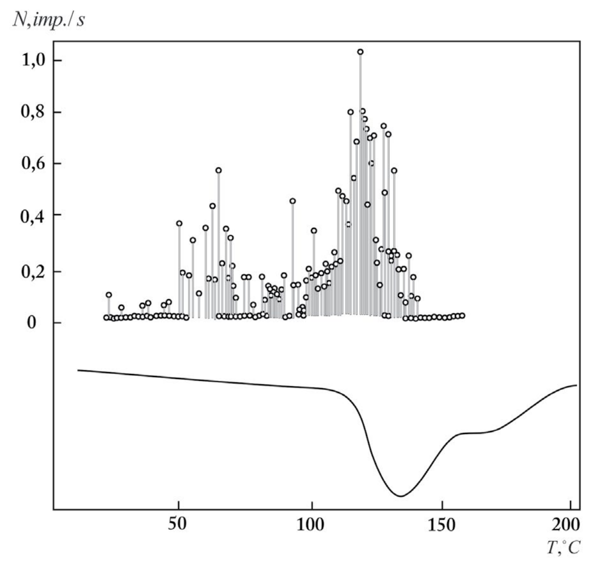

Figure 1.6: Acoustic emission monitoring in dehydration process of Hips.

Figure 1.7 a refers to the point of monitoring in 1 m away from the fault. Hachures show a level of effectiveness of modern data which is for measurement. In Figure 1.7b the result of calculation for the point which is in 1 km away from the fault. Figure 1.7. shows that in all cases the speed of the edges rises as the moment of occurrence of the earthquake comes.

The more optimistic situation from the data of changes in the speed of rock massive deformation before the earthquake was described in Figure 1.8. Depending on the critical change Dy during the convergence of earthquake the speed of deformation increases in different ways.

The main seismic risk in the fault region is a comparison the speed of rock massive movement with the result of theoretical calculations of experimental data.

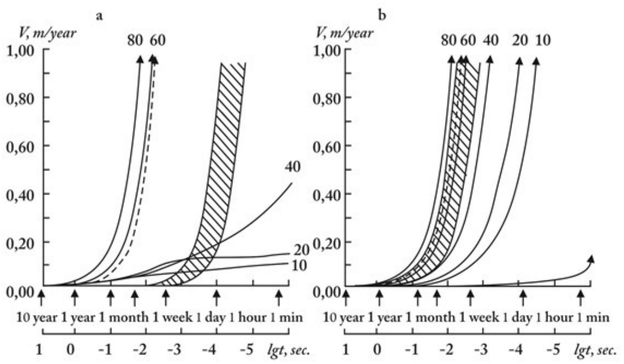

Figure1.7: The speed change of massive movement depending on the remaining time till Earthquake happens (a-1 m from the fault; b-4 km away).

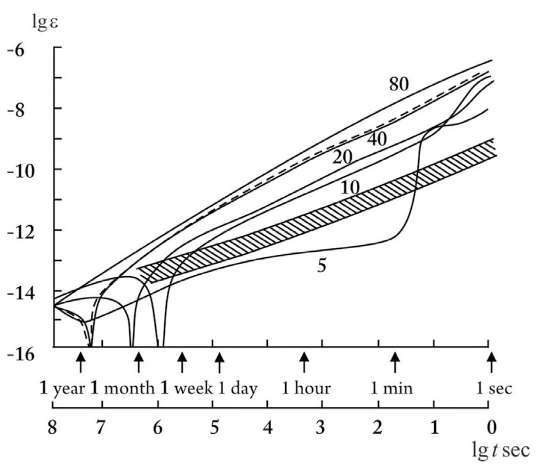

Figure 1.8: The change of the rock massive deformation depending on the remaining time of the earthquake (1 m away from the fault).

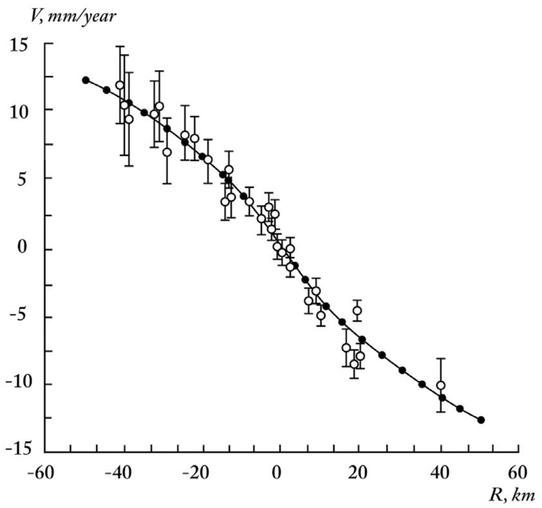

Figure 1.9: Theoretically calculated marks of a speed of displacement of repers for the San Andreas model.

This kind of comparison has been conducted for the condition of the simple San Andreas fault (Figure 1.8).

The vertical fault of the Earth's crust was reviewed in the theoretical model of V.Li and C.Rays and there is not any movement with the depth of 10 km here. The speed of massive movement away from the fault occurs as a result of the movement of tectonic plates and has 30 km density, a period of relaxation is 12 years.

The speed of rock massive movement from the fault was described with a complete line in Figure 1.9. Here the experimental measurements have been included. It can be seen a deep relation between the experiment and the theory. The speed exceeds 10 mm in size and is located at 50 km away from the fault .

Of course, it differs from the theoretical model considered in a real condition on seismoactive regions.

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