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# Article 8. The formation mechanism and forecasting of earthquakes

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**Abstract**
The formation mechanism and forecasting indicators of earthquakes are summarized with several cases studies to illustrate. The obstacles of earthquake prediction are also pointed out. So far rare research has included the microbial studies on earthquake forecasting, which is proposed in the article. The original viewpoints of earthquake formation mechanism and forecasting have been substantially discussed.

**Key words: Earthquake formation, Earthquake forecasting, Geophysics, Geochemistry, Geological layers.**

## Introduction

Massive research case studies have been conducted for the understanding of earthquake formation and forecasting of earthquake, the destructive natural disasters commonly occurring in earth. The main viewpoints of past research have been summarized in this article firstly, with the original viewpoints proposed in the final part of article for future research purpose.

## 1. The classification of geological zones

### 1.1 Bio-stratigraphic belt

Bio-stratigraphic unit is the standardized geological stratum divided according to fossil type, distribution and fossil characteristics, which is different from adjacent strata. Bio-stratigraphic belt is a commonly used biostratigraphic unit, which is divided according to different biological contents and characteristics [2].

### 1.2 The division of polarity zone

According to the change of magnetic characteristics among different strata, geological layers are divided into magnetic stratigraphic units. Within the same stratum, substances are unified by the consistency of magnetic polarity, distinguishing the units from adjacent strata, which is called polarity zone [2].

Tectonic polarity refers to the directional regularity of regional tectonic evolution. The sedimentary, magmatic and tectonic activities caused by the interaction of the two plates occurs regularly in temporal and spacial scales [5].

The division of polarity zone is based on the change of natural magnetic direction of rock stratum. The stratigraphic interval of gradual transformation of magnetic polarity is called ‘polarity conversion zone’, whereas the surface or thin layers shaping the change of magnetic polarity is called ‘polarity reversal surface’. There are three types of polarity zones: firstly, strata with the same magnetization direction as a whole; the mixed units with complex changes between positive and negative polarity; the strata rock stratum with main magnetization direction and secondary reverse polarity [2].

### 1.3 Mineral assemblage zones

According to the mineralogical characteristics of all stable minerals (heavy minerals that can be identified and measured) adhering to the stratum, the strata are divided into different heavy mineral assemblage zones. Heavy mineral characteristics includes: stable combination of mineral species, typomorphic characteristics, ZTR index which is the weight ratio of zircon, rutile, tourmaline to total weight component, indicating mineral maturity, and its changes in particle size of heavy minerals, percentage content of heavy minerals in rocks, relative percentage content, etc. The vertical and horizontal changes of heavy minerals in rock strata can be used as the basis for the division of heavy mineral assemblage zones [2]. The metal trace element analysis is capable of deducing the different original sources of geological layers. For example, the carbonate rocks of Carboniferous Baishan formation in shibanquanxi, yine basin were analyzed in detail. The geochemical test results showed that except for sample CH3, the contents of Al as one of major elements, and Ti, Zr, Th as other representative terrigenous trace elements were low, with the average value of Y / Ho of 45.58, reflecting that the carbonate rocks of Baishan formation in the study area were less influenced by the input of terrigenous materials; There was little correlation between δ CE and δ Eu、w（ΣREE）、（La/Sm）N, and there was no EU positive anomaly, indicating that the carbonate rocks of Baishan formation in the study area was also less influenced by diagenesis and hydrothermal process. The trace elements contained in carbonate rocks were mainly from seawater origin, which reflected the original sedimentary environment. The study of paleowater depth, paleosalinity, paleoclimate, paleooxygen facies and paleowater temperature according to the analysis of characteristic elements above reflected the differences of sedimentary Paleoenvironment in the early and late formation phases［11].

## 2. Two forms of earthquakes

Horizontal wedge. The bottom of the earth's crust is not a smooth concave surface. Some layers are deeply inserted into the mantle, and other layers are deeply wedged by the mantle. In the same region, if the accumulated stress of material B on A is less than the longitudinal pressure of the bottom layer on substance A, but is greater than the transverse pressure of soft fluid wedged into layer A, the wedge body of layer A will be separated into up and down layers under the stress of material B on A, leading to the movement on the surface like bouncing up and down. This bounce movement is particularly strong in gravity anomaly areas, because it is like a dragged spring. The greater the drag force, the greater the rebound force. Horizontal wedge separation destroys the gravity balance and structural firmness of a region. Therefore, the region may vibrate continuously for a long time during earthquake events. Horizontal wedge separation can easily lead to geological phenomena such as surface uplift and cracks, because the balanced crust floats upward due to the reduction of subsidence load. When the earth's crust floats up, the corresponding surface area will increase, so ground fissures from the outside to the inside will occur on this surface after earthquakes [1].

Longitudinal wedge. In a region, if the accumulated stress of material B on A is less than the peripheral transverse pressure but is greater than the longitudinal pressure of the bottom layer A, it will break through the bottom layer of the crust longitudinally, suddenly resulting in vertical separation of the crust, such as magmatic and volcanic activity. However, compared with the horizontal wedge, longitudinal wedging does not cause large vibration on the surface, and the disaster is relatively weak [1].

## 3. The driven forces and energy causing earthquakes

In the process of horizontal crustal movement, the kinetic energy of vertical crustal movement mainly comes from horizontal compression. In this process, the range and intensity of both horizontal and vertical movements are very large over historical periods. However, due to the continuous and gradual strengthening of the structural strength imposed on the crust in the historical process, the crustal horizontal movement can hardly produce high-frequency and long amplitude seismic waves in the compression process, which is not the main cause of vibration to the substances attached to earthquakes, so that the geographical surface formation can not be achieved by the modern crustal movement. For example, the main mountains, plateaus and other complex terrain of the modern earth are mostly formed in the historical process [1].

As discussed above, there is rarely relevance between the modern crustal movement and the energy generated by crustal horizontal movement. More exactly, modern crustal movement is the consequences of energy generated by the differentiation of crustal materials under the earth gravity on the crust. On the crust layer of earth planet, the forces of earth gravity is not a constant, because many substances undergo spatial-temporal evolution due to changes in temperature and pressure in the crust. They often evolve and separate into other or multiple segment substances. In this process, both the force and motion direction differentiates from the previous center of earth gravity, which causes vibrations on the surface of crust, becoming the original forces of earthquakes [1].

However, there is controversial discussion against the above arguments. According to the observation studies, there is a closed relationship between seismic zones and active faults, which is considered as the first indicator to predict earthquakes. There are several evidences: the epicenter of most strong earthquakes is located in the active fault zone; the strike of modern faults in crust surface caused by destructive earthquakes in the earth is consistent with or completely coincides with the original faults; paleoearthquakes with important phenomena have been found on many active faults, with re-occurring time scales ranging from hundreds to thousands of years; the extension direction of the epicenter and isoseismalline of most strong earthquakes is consistent with the local fault strike; the focal mechanics analysis shows that the state of the focal dislocation surface is mostly consistent with the surface fault. Consequently, the role of active faults is considered as fundamental factor for the generation of earthquakes and the distribution of seismic zones [3]. There are some case studies using faults theory to analyze the earthquakes formation:

The 5.12 Wenchuan earthquake was caused by the sudden dislocation of Yingxiu Beichuan fault in Longmenshan fault zone, forming a surface fracture zone of more than 200 kilometers long on the mantle surface. The Guanxian Jiangyou fault was also ruptured during the earthquake, forming a surface fracture zone at the length of more than 60 km. GPS observation before the earthquake showed that the sliding rate across the whole Longmenshan fault zone did not exceed ~ 2 mm / yr, and the activity rate of a single fault did not exceed ~ 1 mm / yr, which was consistent with the results of seismic geological research and historical earthquake records. 5.12 Wenchuan earthquake showed a low sliding rate, with long recurrence period and high destructive intensity, which was a new type of earthquake worthwhile further study [6].

The thickness of the crust in the Piedmont wrinkle deformation area of the South Tianshan Mountain increased obviously, showing apparent deformation in the crust; There was obvious heterogeneity in the northern margin of Tarim Basin. The contact deformation relationship between Tarim Basin and Tianshan revealed the compression of Tarim Basin in the northwest direction. The topography of the crust mantle interface under the platform array showed closed correlation with the geomorphic characteristics of the surface, indicating that the formation of the Piedmont arc fold belt was formed by the deep underground structure and compression. Jiashi strong earthquake zones was distributed above the gradient zone of crust mantle interface, with genesis related to the concealed fault activity near the focal area. Because the focal point was located in the upper crust of the fold deformation area, the corresponding shear modulus was small, which was attributed to the obviously low stress drop in Jiashi strong earthquake zones. Consequently, the formation of Jiashi strong earthquake activity was attributed to the modern tectonic movement of Tarim Basin, altering the deep structure of the crust [7].

The Kaiping Syncline in the east of Tangshan was Mesozoic structure. The detection results showed that the syncline axis was nearly vertical crustal fault, so the horizontal topographic deformation during the Tangshan earthquake was mainly caused by the displacement of Kaiping crustal fault, which was a kind of dextral slip fault from North-North-East to South-South direction. Douhe normal fault was just below the epicenter of Tangshan city. In comparison, the vertical topographic deformation during the Tangshan earthquake was mainly attributed to the sliding of Douhe normal fault. Both Kaiping crustal fault and Douhe normal fault slipped simultaneously during the Tangshan earthquake, indicating that there was a kind of pull-out tension force above the crust in addition to the regional horizontal tectonic force. At the Kaiping fault belt, the inclination of the reflecting surface on the upper crust showed disordered shape directly below the fault, and the Moho interface was obviously faulted. It was deduced that the thermal material at the top of the mantle would rise from the Kaiping crustal fault, so that this thermal stress produced by thermal material led to tensile stress above the crust, but caused compressive stress below the crust, which was consistent with the phenomenon of reflection seismic profile [8].

## 4. The dynamics of fluid substance in crust

### 4.1 The gravity differentiation

The modern earth is the sphere structure, in which the heavier materials are distributed in the deep layer of the earth, while lighter substances is distributed in the shallow layer of the earth, becoming the regular substance layers in the deep earth's core and mantle. However, there are significant irregularities in this substance layer between the upper mantle and the crust. The crust is the surface solid layer on the earth to absorb and capture external materials. These external substances vary in weight and mass. In the surface layer of the earth's crust where the gravity differentiation movement does not play the major role, different substances are often mixed together to move deeply into the earth and is subsequently buried by new substances. In further progress, the heavier ones move toward the deep layer of the earth, while the lighter ones reverse to move away from the gravity center. Consequently, this complex movement of different substances makes this area high risks in causing earthquakes [1].

### 4.2 Mantle nuclear fission

The convection of the mantle causes nuclear fission materials to react, once it exceeds the critical limit of volume, so that the mixed nuclear fission leads to nuclear fusion, resulting in instantaneous rapid expansion in crust. Rebound of the crust generates longitudinal waves, and longitudinal waves further stretch the crust to form shear waves. Subsequently, the mechanism of aftershocks is that the temperature generated by nuclear transformation melts the mantle and causes uneven mantle temperature at the same time, further accelerating its convection and enhancing the mixture among nuclear fission materials; secondly, the temperature generated by nuclear transformation can also melt the crust and release nuclear fusion materials, such as increasing the pyrolysis proportion of hydrogen containing compounds (such as seawater steam), the elements of nuclear fission [1].

**4.3 Inner high-pressure**

Many geological spaces can be formed in the interior of the earth, especially in the crust, due to the faulting, folding, sedimentation and magmatic activity. The high-pressure melt and gaseous liquid in the earth will enter the geological space along the fault or other channels, forming high-pressure reservoir. Under the action of high pressure, the space partition or space surrounding rock leads to bounce movement, consequently causing internal force earthquake [1].

**4.4 The imbalance of inertia momentum**

Earthquakes are caused by the mutual extrusion between plates, driven by the asynchronous drift of plate motion. The driving force to plate motion is the exogenous planets to the earth. Like tidal phenomena, its driving force source is mainly from the gravitational change of the moon. Similarly, the driving force of plate motion is caused by the uneven distribution of inertia momentum on the earth's surface. The high mountains and deep gullies on the earth's surface produce an uneven distribution of inertial momentum due to the interaction with celestial motion. The variation in the overall inertial momentum between different plates will cause a slight difference in the motion rate between plates, resulting in the impact of inter plate compression, which causes earthquake events [1].

**4.5 The electric field impacts**

The temperature of the earth's core can reach 6000K, and the temperature difference is about 5000K as compared with the temperature in the earth's crust. In this case, the outermost electrons in lava atoms break the bondage of 'energy level' and become free electrons. These free electrons tend to cluster at the low temperature part of crust forming a negative charged layer, where a 'thermal - electric field' is formed under the crust. Under the induction of electric field, there will be local electric field in some ore layers in the crust. When these electric field accumulates to a certain extent, the resultant force of electric field interacts with gravity, resulting in "gravity anomaly", and their ionization will generate 'ionized light' in the surface air. Under the effects of this electric field, the atmospheric electric field turns to be the disorder, resulting in strange and unpredictable wind, rain, snow and other abnormal climate events. When the relative potential (voltage) accumulation of these local electric fields reaches the limit value, water infiltrates into the electric field and alters the resistivity of the medium, which breaks down the insulating layer and produces severe underground thunderstorms. The energy released by this underground thunderstorm can reach the energy level of nuclear explosion, which is very destructive. It can not only destroy the stratum structure resulting in the fracture of the stratum, but also generates P-wave and S-wave spreading around the stratum, further destroying the earth surface buildings or causing landslides [1]. There are several evidences of magnetic field impacts on earthquakes causes:

1. There are 'magnetic field anomalies' on the surface of the impending earthquake area, such as abnormal compass whirling, losing magnet force, and sparks from

underground metal materials, all of which indicate that there is huge electric field movement or shift under ground. This is the strong evidence of underground lightning [1].

2. Advanced instruments for seismological detecting have found that before earthquake incident, the gravity on the ground surface turns to be abnormal. As discussed above, the electric field is generally attractive to polar substances, and there is gravity anomaly on the ground surface, which indicates that there is a local strong electrostatic field under the ground, so that its resultant force with gravity results in gravity anomaly [1].

3. Abnormal climate. The change of underground electric field inevitably affects the change of atmospheric electric field, under which the electric ions in the atmosphere turns to be the 'unbalanced state', leading to the increase in condensation nuclei of water molecules and the change of atmospheric pressure. The occurrence of strange and unusual rain, snow, wind is also a robust indicator of underground lightning [1].

4. Earthquakes are closely related to the reservoir of water storage. When the reservoir starts to accumulate water, there is no earthquake or a small earthquake; and subsequently when the water of reservoir is full, larger earthquakes come; and after that it gradually weakens or even disappears. Moreover, when water is artificially injected into deep underground, earthquakes also occur. The frequency of earthquakes increases with the increase of water injection, and the earthquake phenomenon also stops after water injection stops. This reveals that the resistivity of the stratum changes after the water permeates deeply into the stratum, which leads to the discharge phenomenon between different electric fields. It is another verification of underground lightning [1]. For example, after the impoundment of Xinfengjiang Reservoir in Guangdong Province, the seismicity activities increased frequently. Most of the earthquakes occurred in the deep-water canyon area near the dam, forming a dense belt in the northwest direction, and the source of earthquake depth was very shallow. Subsequently, at approximately two and a half years after the impoundment, a strong earthquake of magnitude 6.1 occurred on March 19, 1962. Based on the analysis of leveling related to seismic spectrum data, the fault parameters of the main earthquake were determined. Combined with seismicity and geological background, it was deduced that the infiltration of water was the main reason inducing the earthquake [10].

5. In recent years, the aerospace monitoring projects have confirmed that there is 'electrical disturbance phenomenon' in the atmospheric ionosphere corresponding to the impending earthquake, which shows the same characteristics as the 'thunderstorm transit' under the ionosphere, which further proves that the earthquake is a large-scale underground thunderstorm [1].

6. According to the field observations, after a large earthquake, 'infra-sound waves'

is generated, which shows the same characteristics as those generated by nuclear explosion. This shows that the earthquake is a violent explosion phenomenon, other than just the dislocation or fracture of rock strata [1].

7. Another important indicator of electric field impacts is the conductivity of crust layers. For example, the distribution of high conductivity layers along the depth map of the upper mantle in the Chinese mainland was pointed out by Xu (2003), and its physical cause was explained. It was considered that the causes by brine generation was more convinced, with the representative chemistry species of NaCl, CaCl2-NaCl, carbonate. Because the distribution and buried depth of high conductivity layers in the crust and upper mantle were closely related to the occurrence of strong earthquakes, as an example, Xu (2003) illustrated the crustal structure in Tangshan area, explaining the role of deep fluids under the crust in earthquake formation, with the main evidences of transformation of topography, change of underground water, underground thermal temperature, the change of oil well pressure, underground light, change of gravity field, etc [9].

## 5.The indicators of earthquakes forecasting

According to the historical records, observation contents and methods of macroscopic anomalies in underground fluid before earthquake mainly include: the rising and falling of groundwater level before the earthquake, the changes of physical and chemical properties, the manifestations of water temperature change, turning, bubbling, swirling, muddy, discoloration, smelling change, etc. For the observation of groundwater level, we should understand the causes and the structural position of groundwater change, mainly containing water supply source, normal dynamics, interference factors (rainfall and industrial water, farmland irrigation, climate change, seasonal change, supply source change), water transparency, etc [4].

The observation contents and methods of macro-abnormal phenomena of animals before earthquake mainly includes: birds, such as domestic pigeons, mainly focusing on startling flight, audio-visual response and nest entry time; other birds, such as parrots, which are usually abnormal by bumping into cages and screaming; the most behavioral reactions of fish are floating, jumping up, startling swimming, jumping out, stabbing in the water, cocking up their tails, aggravating their activities and so on. For the observation of livestock, poultry, dogs, cats, snakes and other terrestrial animals, 2 to 3 species should be selected as representatives, focusing on the observation of behavioral activities and life rhythm. Plant may also show abnormality before earthquakes [4].

Other geological observation before earthquakes includes: local atmospheric warming, ground fissures, ground bulges or collapses, local thermal anomalies, ground sound, ground light, ground air fog etc [4].

Chen (2007) pointed out that there were mainly three obstacles in earthquake prediction faced so far. The first obstacle is the ‘inaccessibility’ of the earth's interior, which here means that human beings can not go deeply into the earth's interior under high temperature and high pressure, to hardly set up stations and install observation instruments, so that the earthquake sources can not be directly observed; The second obstacle is the ‘non-frequent occurrence’ of large earthquakes. Large earthquakes rarely occur, and the recurrence time between large earthquakes is much longer than people's life since the observation with modern instruments, which results in limited sample cases in the observation of phenomena, so the cognition of empirical laws in earthquakes is eliminated correspondingly. As a type of natural disaster, people feel that earthquakes are frequently happen, but when we have to study its regularity, we are limited by the scarcity of ‘samples’; Thirdly, the complexity and variability in earthquake omen may be closely related to the high non-linearity and complexity of earthquake process in the geological environment [12] [13].

It is further proposed that the nature of seismic systems is the systems with ‘self-organized criticality’ (abbreviated as SOC) that systems fluctuate at the edge of the critical state. In a system with ‘self-organized criticality’, any small event may evolve into a large event in a cascade with a certain probability, once the critical state value is exceeded [12] [13].

In order to resolve the three obstacles above, it is advised to build up the experiment modeling to simulate the earthquakes by Wu etc al (2021) [14]. For the first obstacle of ‘inaccessibility’, the geodynamic model of the experimental simulation is constructed to test the ability of the prediction model to grasp the real seismic activities, and the observation requirements are put forward by using the results of repeated trials with validation and correction of its error; for the second obstacle of ‘non-frequent occurrence’ of large earthquakes, when we notice that an earthquake may occur in a specific site, we can build a ‘situation’ simulation of the ‘target earthquake’ based on the local structures of seismogeology, then deploying several observation indicators according to this ‘situation’ simulation, and systematically investigating the evolution of the existing ‘precursor’ of observation information for prediction; for the third obstacle of SOC, in order to prove that a precursory method is effective, it must be tested by long-termly and preferably intensive observation experiments. One of the tasks of the seismic experiment simulation is to provide backbone facilities, background information and baseline (3B) for open and cooperative observation experiments, which can even provide the important and rare condition for forecasting models [14].

## 8. The original viewpoints of earthquake formation and forecasting

The original viewpoints about earthquake causes have been presented in my previous article as below, and it is to further discuss the research gaps in geochemistry and geophysics for earthquake forecasting for future research purposes:

The formation mechanism and causes of geological faults can be easily deduced after fully understanding the discussion of stratification mechanism [17] and the dark matter theory [18] in the fourth dimension space in this journal [15].

Firstly, the neutral substance layer arranged symmetrically between yin and yang poles can be easily formed on the substances boundary between different densities or chemistry compositions in crust, and the neutral substance layer blocks the transport of polar molecules, thus forming the boundary and stratification of the geological structures. This leads to significantly different potential energy between different geological layers along the boundary, and this difference in potential energy can be caused by different pressure, density or electric charges between both sides of the boundary. If the boundary between different geological layers suddenly ruptures, the layer with higher potential energy will release the fluid flow energy to the layer with lower potential energy, thus forming the convection between different layers in crust [15].

In this journal, the relationship between van der Waals force and dark matter have been discussed to reveal the effect on electric conductor, caused by the adhesion force of dark matter on the fourth dimension axis. Due to the neutralization of electric charges, the electric field effect of neutral boundary layer is weaker, and the adhesion force of dark matter underlying neutral boundary layer is strong so that the free electrons' motion of cutting the fourth dimension is restricted. **Once the free-formed electrons of different charges are accumulated between both sides of the neutral boundary, which are less influenced by dark matter, it becomes highly unstable. When massive free charged atoms penetrate the rupture space of the neutral boundary layer, the dark matter suddenly and sharply increases the adhesion force against the free-form charged atoms at transient time, to make the whole substance layer maintain its inertial and stable form. This instantaneous increase in the adhesion force on the fourth dimension makes the mass of micro-particles in three-dimensional space instantly reduced, thus releasing nuclear energy according to the mass-energy conversion Law and amplifying the destructive energy of earthquake. Therefore, the accumulation of electric charged particles between different sides of the substance boundary layers should be one of the compulsory conditions leading to the releasing of nuclear energy, and is the pre-condition under which geological disasters are evolved from local shaking to the displacement at geological plate level** [15].

**Research gaps in geochemistry and geophysics**

As discussed above, seismic systems is the systems with 'self-organized criticality' (abbreviated as SOC) that large event is triggered when the small event exceeds the critical state value. Consequently, this critical state value becomes the key to measure the pre-conditions causing the large earthquakes. There are two pre-conditions triggering the critical state value: firstly, the stability of neutral boundary layers is the pre-condition. The higher stability in neutral boundary layer, the stronger adhering force imposed by the dark matter in the fourth dimension, and eventually the more mass to be reduced in the three-dimension spaces, the higher destructive nuclear energy released in earthquake. Secondly, the voltage potential accumulated between both sides of the boundary layers would be positively correlated with the nuclear energy releasing incidents. In summary, the geological simulation and monitoring of the stability in neutral boundary layer and the accumulated voltage potential between the boundary would be the key to predict the destructive earthquakes in the future research.

As discussed in my previous paper [15], accumulating different charged particles on both sides of the boundary layer between different geological polar zones is one of the main conditions leading to geological disaster damage, so the sudden change of conductivity between different geological polar zones should be the main indicator of this condition for earthquake forecasting, which would be caused by the physical variation in fluid substances, such as the reservoir of water storage supported in above case studies. This is further supported by Xu [9] who has reported that the distribution and buried depth of high conductivity layers in the crust and upper mantle are closely related to the occurrence of strong earthquakes. However, Xu [9] has not pointed out that the conductivity in different geological zones may vary with the change of physical characters in fluid substances on both sides of the boundary layer between different geological polar zones, which consequently need to be closely monitored.

My another article has proposed that the high intensity of voltage imposed by underground lightning is the essential pre-condition to produce large amount of free-form charged ions, so the occurrence in underground lightning events should be utilized to predict earthquake [20].

The geochemistry composition would be important in the accumulation of charged particles between the boundary of different geological zones, it is necessary to simulate the geochemistry reaction of each composition species in Lab to capture the knowledge in the generation of charged particles in crust, and this helps to better evaluate the risks of earthquakes in the specific geological layers. It is hypothesized that the higher ratio of electric charges to mass in geochemistry reaction increases the risks in accumulating charged particles around the boundary of different geological zones, and the lower melting point of geochemistry composition facilitates the convection motion between the geology boundary so that the risks of earthquake rises.

Further, by comparing and contrasting with the vortex motion model of tornadoes in the process of air substance convection between the atmospheric boundary [19], this vortex model would be also applicable on the liquid substance convection between the geological boundary, so the mechanics model of earthquakes would tend to be the twisted and tortured split, rather than the linear cutting split model, which increases the destructive effects on the crust.

For the biological indicator of earthquake forecasting, it is further proposed that here the monitoring of microbial gene expression modes, which survive in underground water, would be another key indicator of earthquake forecasting. The experimental test of metabolomics to analyze the microbial gene expression modes is presented in my physiological article [16].

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