

***THE 26-DECEMBER 2004
CATASTROPHIC SUMATRA-
ANDAMAN EARTHQUAKE AND
TSUNAMI IN THE INDIAN OCEAN : A
TRIGGER OF REORGANIZATION OF
GLOBAL GEODYNAMIC CONDITION
OF EARTH?***

AN EXAMPLE OF THE SEISMIC FLUID-
GEODYNAMIC MONITORING IN AZERBAIJAN

RAMIDA KERAMOVA



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On the 26th December 2004 in South East Asia, near the island of Sumatra a very large seismic event occurred ($m_b=9.0$); because of the destruction caused it is known as “the catastrophic earthquake of Sumatra-Andaman”. The earthquake occurred at a depth of about 10km according to USGS, and it reached Magnitude 9. The enormous energy released corresponded to about 10 nuclear bombs dropped on Hiroshima. It provoked major destruction in the area as well as a massive tsunami. Both of these events inflicted considerable economic losses, damage and death with more than 170 estimated deaths. Seismologists consider that the Sumatra earthquake was one of the largest in the last 40 years. Considering the mechanism of its occurrence, many geophysicists came to the opinion that this oceanic earthquake resulted from a collision of tectonic plates of the Indian Ocean and the Eurasian plate. Thus, the Indonesian island of Sumatra entirely moved on 30 m to the south-west and one of tectonic plates fell down almost of 10 meters. Thence at the bottom of the Indian Ocean was formed a break with a length up to 1100 km. Some

geophysics of the NASA Laboratory in California said that as a result of the given seismic event some strong aftershocks followed it and it occurred the displacement of mantle masses to the planet kernel, a displacement of an axis of rotation of the globe on 2.5 cm and a reduction of time of making a complete revolution of the Earth about the axis, i.e. days, on a fraction of a second. Besides, the given seismic centre in the Indian Ocean played a role of the trigger mechanism, having provoked some strong earthquakes ($m_b=5.4\div 6.2$; $M_{LH}=4.6\div 5.8$) in Iran and in Turkey, i.e. within the Arabian plate. According to the Azerbaijan geologist A.D.Ismailzade, the seismic event in the Indian Ocean which has provoked the subsequent collision of the Eurasian, Arabian and African tectonic plates was also the reason of the discharge of energy in these hypocenters.

Thus, as a geological result, some tectonic and physical-chemical processes taking place in the centre of Sumatra-Andaman earthquake (temperature, pressure, mechanical, acoustic, electromagnetic and gravitational fields of a various range, a shock wave, etc.) occurred the global geodynamic changes both in the structure of some tectonic zones and in megastructures, and short-period – in seismic-fluid-geodynamic conditions of "water-rock" system.

Let us consider the given fact more in details, on an example of results of researches of the seismic-fluid-geodynamic monitoring in Azerbaijan.

In Azerbaijan for many years the complex seismic-forecasting of researches presented with seismological, geophysical, seismic-fluid-geodynamic monitoring of various fields started for the first time in 1979 in RSC ANAS and continues till now. Seismic-fluid-geodynamic analysis are given every year by studying the seismic-hydro-geodynamic (discharge, level of waters in wells) and the seismo-geochemical (hydro, - gas - and radio-geochemical) mode of fluids. Now the observant network consists of 19 objects which include underground waters of wells, mineral sources, sea water of the Caspian Sea and local sites of the Earth's surface. They are located in 5 seismic zones of the Azerbaijan part of mega-anticlinorium of the Big Caucasus, in Talish and on the coast on the coast of the Caspian Sea. Thus, the studied waters differ among themselves on genesis, migration conditions, depth occurrence, temperature, ionic-salt and gas structures, and local sites of the Earth's surface - on intensity of radioactive radiation of alpha-field. The territory where the monitoring is carried out is seismically active. It includes Absheron, Shamakha, Ismailli, Sheki, Siazan and Lankaran regions of Azerbaijan, and the coast of the Caspian Sea (Absheron, Siazan and Lankaran regions of Azerbaijan).

I.V.Mushketov, B.B.Golitsin and many others assert that the seismic-hydro-geodynamic and seismo-geochemical effects do not take place just in the epicentral area of a catastrophic earthquakes (e.g. 1755 – Lisbon, 1855 – Japan, 1902 – Shamakha, 1905 – Mongolia, 1953 – South California, 1964 – Alaska, etc.), but even in several cases at large distances from the epicenter (e.g. at distance up to 5000

km;I.V.Mushketov, 1899; B.B.Golitsin, 1960). These results were confirmed by foreign studies in several countries (e.g. Russia, USA, China) and also from 1979 to 2012, all those years are seismic-fluid-geodynamic monitored in Azerbaijan. Within 33 years of continuous monitoring of variations of seismic-hydro-geodynamic and seismic-geochemical fields the vast material has been verified and collected. It reflects the process of changes of a mode of migration and formation of fluids structure under the influence of hydrometeorological, tectonic, seismic and other physical and chemical factors occurred within the Anatolian-Iranian-Caucasian segment of the Alpine-Himalayan tectonic belt of the Earth and water area of the Caspian Sea. This data is unique since they have no analogue in the world considering the practice and duration of attested supervision with a seismic-fluid-geodynamic method.

In particular, after receiving the attested material it has been established that the anomalies arising in separate cases in geochemical fields have been considered "false" for many years but with these premises they have been finally considered true. It was impossible to explain the occurrence of these anomalies neither with a seasonal fluctuations, nor with seismic conditions in the water area of the Caspian Sea and in the territory of Azerbaijan limited in $\Delta \leq 300 \div 400$ km radius. In 1986, as a result of interpretation and correlation of materials of the "Data bank of seismological and seismic-fluid-geodynamic information" for the period between 1981 and 1996 [Gasnov, Keramova, 1997] the following important facts have been established for the first time: seismic fields of epicenters of

earthquakes of average force ($m_b=5.7\div 6.2$; $M_{LH}=5.1\div 5.9$), strong ($m_b=6.3\div 7.6$; $M_{LH}=6.0\div 8.1$) and catastrophic ($m_b\geq 7.7$; $M_{LH}\geq 8.2$). Some occurred from 1979 to 2004 within Anatolian-Iranian-Caucasian (core centres: $h\leq 70$ km) and Hindukush (upper mantle ones - $h=100\div 400$ km) segments of the Alpine-Himalayan tectonic belt of the Earth also influence on seismic-fluid-geodynamic conditions of Azerbaijan. As it is known, during the specified time, in the limits of the above-mentioned region (Georgia, Armenia, Turkey, Iran), there were 13 catastrophic earthquakes which were accompanied by considerable human victims and a immense destruction. Besides, these seismic events for the specified period there also occurred 8 strong ($m_l\geq 4.1\div 5.5$; $M_{PV}\geq 4.8\div 6.0$) earthquakes in the Caucasus and 5 – in water area of the Caspian Sea. All these earthquakes have been accurately fixed in the form of abnormal variations in seismic-hydro-geochemical fields of supervision objects of Azerbaijan. So, abnormal values of concentration of the studied parameters exceeded the background ones up to $300\div 1200\%$, depending on magnitude of the seismic event and the hypocentral distance till the object of supervision.

Keramova's research from 1990 to 2012 proved that **the manifestation time of the seismic-fluid-geodynamic anomalies in objects monitored all the years corresponds to the final stage of formation of epicenter zones of strong and catastrophic earthquakes.** Between 1986 and 2000 some atypical effects were discolored as a result of the analysis of the data of all-year monitoring of fluids retrospectively and, after that,- some results had been recently "on-line" released.(more precisely from 2001 to 2012). The latter

results revealed the abnormal effects in preparation period of all catastrophic earthquakes ($m_b=7.0$; $M_{LH}=7.1$) that occurred in other regions of the Earth and that provoked a lot of human victims and economic damage as well.

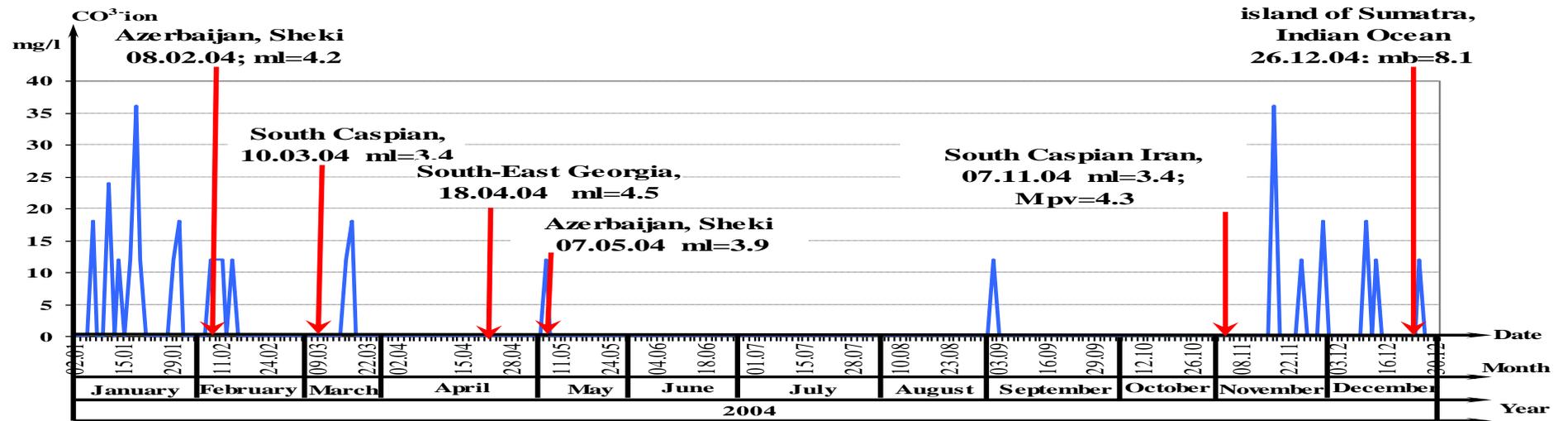
Let's give some examples: in December 2004, the short-period abnormal changes of seismic-hydro-geodynamic and of seismic-geochemical mode were fixed in many objects of all-year monitoring. Data in opposition to the background of relative seismic calm within the ocean water area of the Caspian Sea and the Anatolian-Iranian-Caucasian tectonic block (Azerbaijan and the adjacent states: Russia-Dagestan, Georgia, Armenia, Turkey, Iran). These are underground waters of 3 seismic zones of mega-anticlinorium of the Big Caucasus (Absheron, Shamakha, Siazan regions) and sea water of the Caspian Sea at 3 coasts: on north-east (Siazan), the central (Absheron) and the south-east ones (Lankaran). As a result of a daily analysis data concerning the period going from the 11th of December 2004 to the 26th the accurate anomalies in variations of ion-salt structure of waters for macro- and micro-cells for 13÷16 days before the basic seismic impact in the Sumatra-Andaman earthquake centre were revealed. The given fact is reflected on an example of synchronously variations arising of sea water ion-carbonate of the Caspian Sea developed by the earthquake we have just cited, that is to say the one occurred on the 26th December 2004 (fig.1). Besides this parameter, in waters of objects of supervision the following ions have appeared the most informative: acid-base properties (pH); oxidation-reduction properties of the medium (Eh); magnesium (Mg); the sum of

chlorine, bromine, iodine $[\Sigma(\text{Cl,Br,I})]$; the sum of sodium and potassium $[\Sigma(\text{Na,K})]$. It is necessary to note that according to all-year monitoring of fluids in 2004, a dispersion of these parameters did not exceed 10.0 percent of the background deviations from fall 2004 to December 2004. We will also notice that besides the schedule of abnormal variations, **we make for the first time the scheme of the given seismic centre on seismic-geochemical fields of fluids** (fig.2). It clearly reflects combinations and associations of abnormal parameters in all-year space-time variations of ionic-salt structure of fluids on 16 parameters.

The fact established by us has appeared the main moment in working out of our express-method of diagnostics of "the dangerous centre": **for the concrete seismic centre of an earthquake so strong is characteristic the individual seismic-geochemical scheme made of combinations and associations of abnormal parameters of monitoring of fluids (16 parameters in total).**

As it is seen in the presented seismic-geochemical scheme it is shown the centre of the catastrophic earthquake at the bottom of the Indian Ocean (fig.2) and the greatest quantity of informative elements-indicators appeared in sea water of the Caspian Sea (on the whole coast), and on Absheron too.

Caspian sea (Siazan zone).



Caspian sea (Absheron zone).

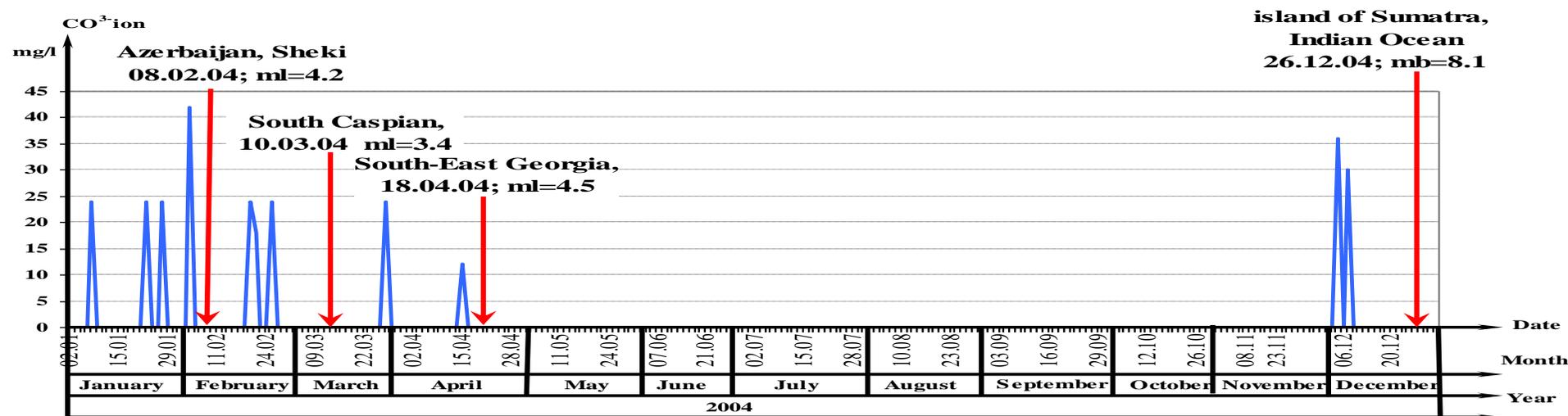


Fig. 1 Abnormal variations of the seismic-geochemical fields in Caspian sea-water in period of preparation earthquake in Indian Ocean (26.12.2004).

Indonesia - Northern Sumatera (26.12.04; mb=8.1; M_{LH}=8.9; K=15.6; h=10 km)

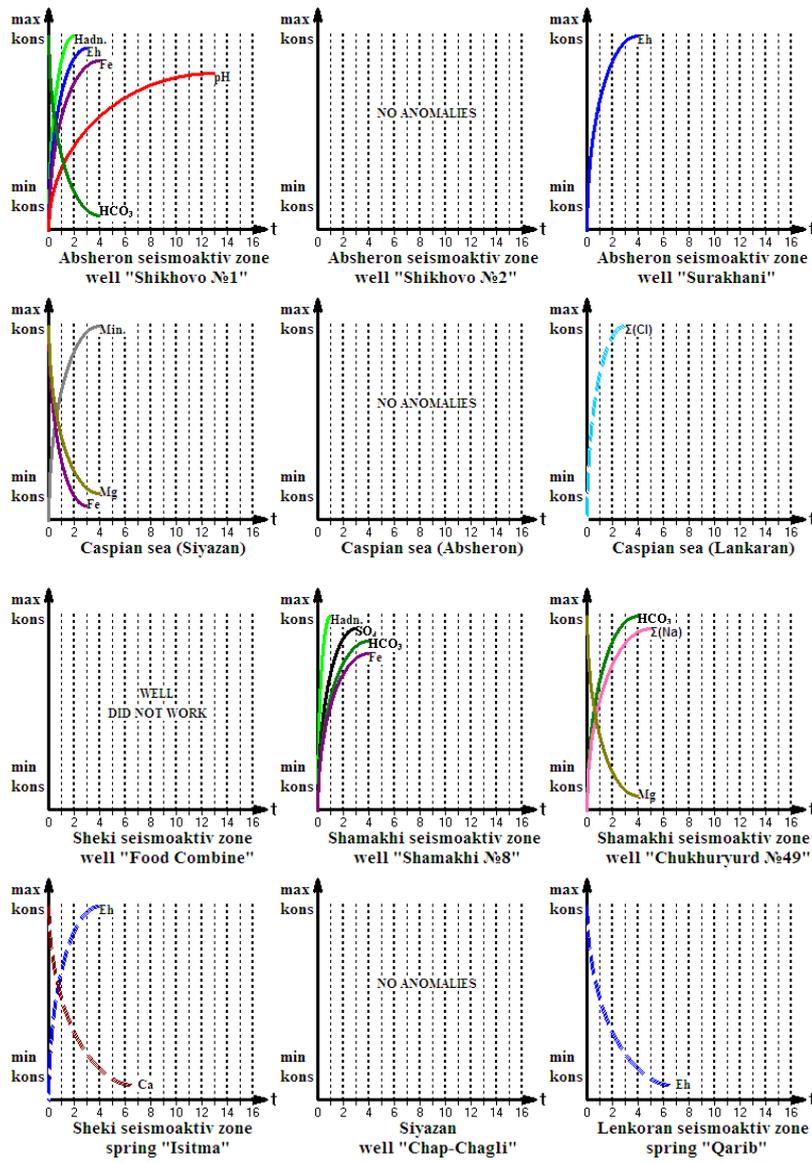


Fig. 2. Seismic-geochemical scheme of Sumatra-Andaman earthquake (26.12.2004).

Figure 1 and Figure 2 show the thermal (well "Shikhov #1; $t^{\circ}\text{C}=52\div 60$) and subthermal (well "Shikhov #2; $t^{\circ}\text{C}=20\div 23$), highly mineralized ($M=18\div 260$ g/l) waters of a deep circulation ($h=760\div 1300$ m), and the geological-exploratory wells drilled on oil and gas as well. The informative ones were also fissure-vein waters of a geological-exploratory well "Chukhuryurd #49" and artesian water of the well "Shamakha #8" which have been drilled in the Shamakha-Vandam seismic zone on the depths equal accordingly to $h=300\div 100$ m. Abnormal variations of seismic-geochemical parameters have been found out during the earthquake of the 26th december 2004 and also in the water of a mineral source called "Garib" which is in the Talish seismic zone (Lankaran region) of Azerbaijan. The general supervision for all these objects is the circulation of waters in a hypergenesis zone and it is characterized of gas components to nitrogenous-hydrogen-sulfide-methane type. Thus, the studied waters differ among themselves for a temperature mode, for a ionic-salt structure, for the conditions of formation and migration of underground waters and for the depths of their occurrence as well.

Considering that the found out anomalies have arisen in seismic calm in the water area of the Caspian Sea and in all the Anatolian-Iranian-Caucasian tectonic block (Azerbaijan and the adjacent states: Russia-Dagestan, Georgia, Armenia, Turkey, Iran), it is possible to speak confidently enough about the influence of the centre of the catastrophic Sumatra-Andaman earthquake (26.12.2004 year; $m_b=8.1$; $M_{LH}=8.9$) on the seismic-fluid-geodynamic fields of Azerbaijan. This fact takes place despite the considerable distance from the objects of

supervision ($\Delta=6170\div 6300$ km). It is explained by the global geodynamic factors which accompanied the preparation of this most powerful seismic event, such as:

a) the stressed-deformation processes near the surface of the Earth's crust parts as well as the redistribution of fields of tectonic stresses;

b) the participation of a difficult complex of various geological, tectonic, physical and chemical processes.

Finally, the factors we have listed concerning the Sumatra-Andaman earthquake centre of the Indian Ocean have provoked the catastrophic earthquake having an extensive pleistoseist area as well as, and the complex of data still unknown to science. This seismic event became the trigger of global change of geodynamic conditions for many thousand kilometers from the hypocenter, i.e. – within the whole globe.

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