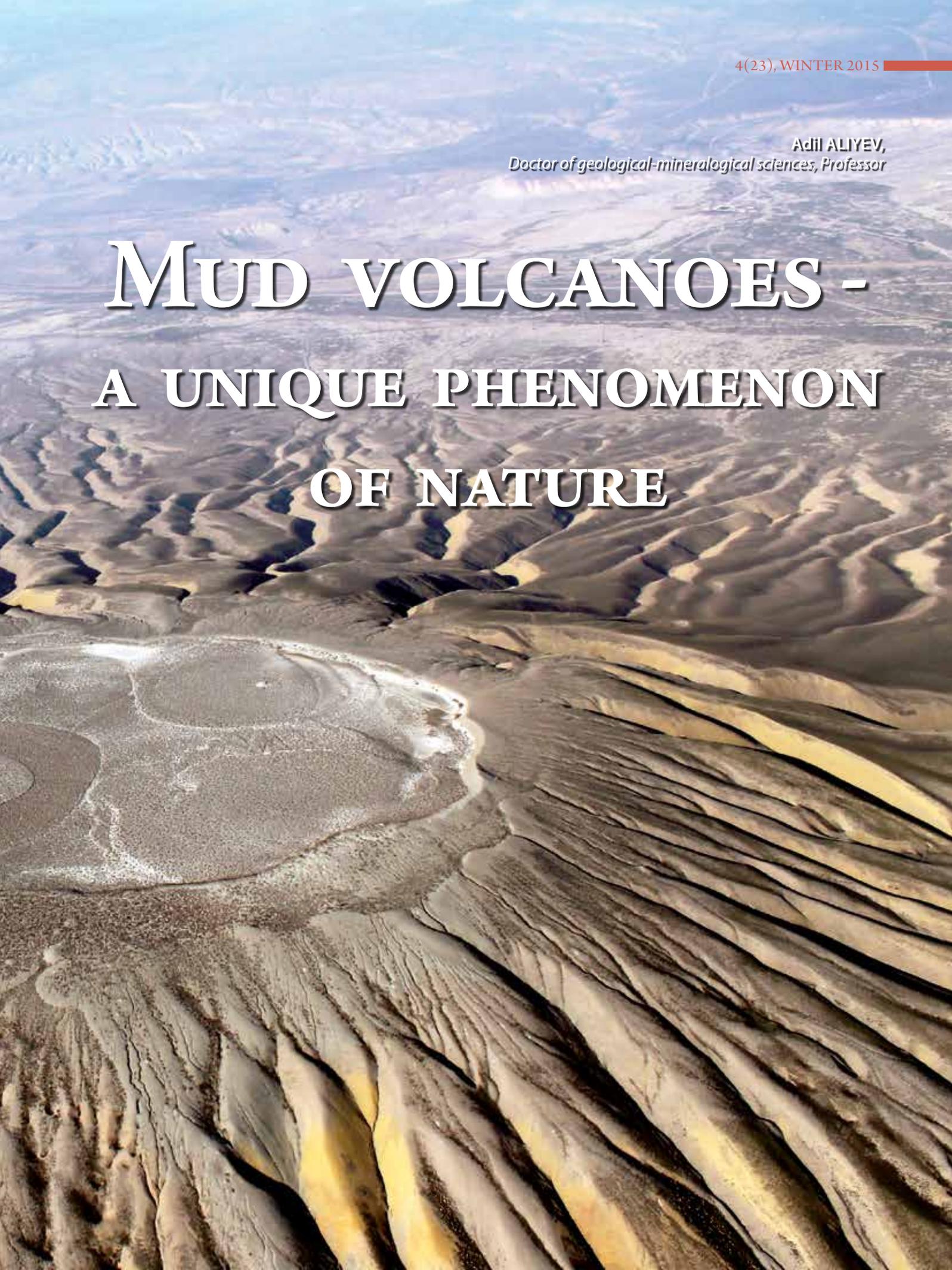
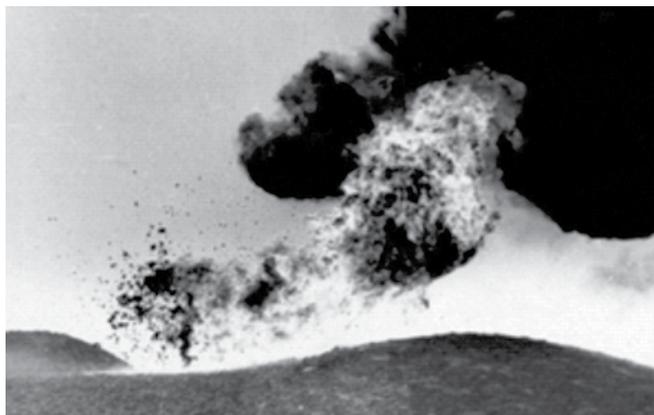




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# MUD VOLCANOES - A UNIQUE PHENOMENON OF NATURE





*Kechaldag volcano eruption, October 2000*

Every year the oil industry of Azerbaijan requires more and more oil and gas. Oil has been extracted in the country by drilling wells for almost 150 years. In search of this valuable fuel, geologists are trying to penetrate deeper into the bowels of the earth. However, modern drilling technology only allows us to develop depths of up to 6-7 km. And we receive information on deeper reservoirs of oil and gas through mud volcanoes, these truly unique natural phenomena.

The territory of Azerbaijan is a classic region of mud volcanism. In eastern Azerbaijan and in the adjacent Caspian basin, there are more than 350 mud volcanoes. The volcanoes are represented in all their variety and glory. There are all kinds of mud volcanic manifestations here: actively operating, dormant, buried, underwater, insular

ones and ones that abundantly release oil. A number of large volcanoes are up to 400 meters height. By the number of mud volcanoes, their different morphology and activity there is no territory like Azerbaijan in the world. Therefore, the Land of Fire - Azerbaijan - is not called "the birthplace and region" of mud volcanoes by accident. Mud volcanoes are located in the Absheron Peninsula, in the Caspian, Shamakhi-Gobustan regions, southeast Shirvan and Baku and Absheron archipelagos. In Gobustan alone there are more than 100 volcanoes and manifestations [6].

The Institute of Geology and Geophysics of the NAS of Azerbaijan has been studying mud volcanoes comprehensively and thoroughly since 1965. During these 50 years, the formation of volcanoes, patterns of their spatial distribution, mud volcanic eruptions linked with earthquakes and most importantly, the role of mud volcanism in the search for deep underground accumulations of hydrocarbons have been examined [2].

**National property and natural resources.** Back in the 1920s, a major researcher of the Absheron Peninsula, Professor D.V. Golubyatnikov, called a mud volcano a free exploration drilling rig. As an ultradeep well, a mud volcano gives the necessary information about the processes occurring in the bowels of the earth. The depth of such



### *Map of Azerbaijan's mud volcanoes*

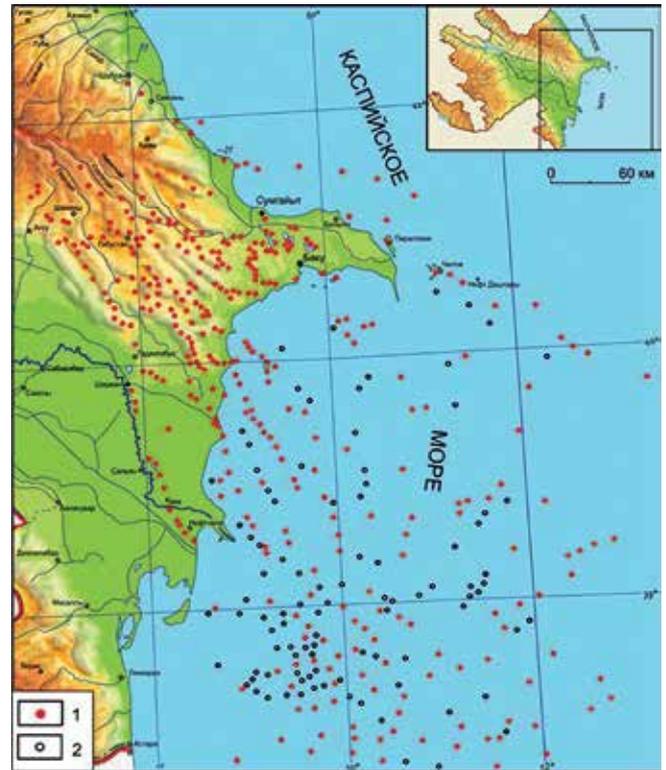
"wells" reaches 10-12 km. This means that various rocks, gases and minerals released by volcanoes to the earth's surface are a kind of "calling card" for mineral resources [7].

At the same time, volcanic mud contains many valuable minerals such as boron, manganese, vanadium, copper, lithium and others, and volcanic water is rich in organic matter, boron, bromine and iodine. It is precisely thanks to these properties that **volcanic mud** is widely used in medicine.

Volcanic clay is widely used in construction as high quality raw material to produce cement, expanded clay, bricks and steel pellets. Volcanic breccia is a product of the eruption and contains a number of valuable chemicals and metals, which can also be extracted and used for the needs of the national economy. Imposing and active mud volcanoes are a perfect target for eco-tourism.

Finally, what is also very important is the genetic link between volcanoes and **seismicity and earthquakes**.

The activity of mud volcanoes is accompanied by the formation of landscapes with a special type of salinity. Saline soils form on mud volcanic breccia. The latter are impregnated with oil. These landscapes are **geochemically rare** and are of interest for the study of the effects of excessive trace elements (boron, molybdenum, etc.) on living organisms, which leads to endemic animal diseases.



That is why we need to take care of the mud volcanoes, use them as natural resources and preserve volcanic landscapes for future generations of researchers.

Let us consider some aspects of the practical study of mud volcanoes.



**Volcanoes in the search for oil and gas.** Until the 1930s, many petroleum geologists believed that the areas where mud volcanoes are located are not promising for the discovery of oil and gas in their bowels, as volcanoes destroy oil and gas accumulations. But there were some who even called for “drilling for oil on volcanoes”. The protracted discussion on this issue ended in 1933. Well №45 drilled near the Lokbatan mud volcano in the Absheron Peninsula produced a grand fountain with a flow rate of up to 20,000 tons of oil, and it was proved that an area affected by a volcano does not cause any damage to the reservoir.

Thus, on the example of the Lokbatan mud volcano, the genetic link between mud volcanoes and oil and gas deposits was confirmed for the first time in the former Soviet Union and the need to search for new underground accumulations of hydrocarbons near volcanoes was identified. It should be noted that discovered and operating oil, gas and gas condensate deposits in Eastern Azerbaijan and especially offshore deposits are mainly associated with mud volcanic structures. With regard to the Lokbatan field, more than 27 million tons of oil and 1 billion cubic meters of natural gas have been produced here over the past 82 years of development. The famous well №45 still “works” and gives oil, now a few tons per day [7].

**Volcanic eruptions and earthquakes.** Every year, 3-5 eruptions of mud volcanoes take place in Azerbaijan. However, there are times when the number of eruptions markedly increases, which essentially coincides with years of seismic activity in the country. For example, 1926, 1970, 1977, 1986 and 1988 saw 6-10 volcanic eruptions. A record number - 16 onshore and offshore eruptions of volcanoes - was recorded in 2001. And, in general, over the past two centuries (1810-2014), 405 eruptions on 93 mud volcanoes have been recorded in Azerbaijan. [3]

A sudden volcanic eruption naturally causes fear in people in the close vicinity of it - the underground buzz, the shaking ground, explosion, emission of breccias and spontaneous combustion of hydrocarbon gases which form pillars of flame reaching a height of 200-500 meters with a combustion temperature of 1,000-1,200. The eruptions of sea volcanoes are quite remarkable. On the one hand, it is the impressive picture of a water fountain hitting the sea and gradually turning into a pillar of flame among the blue sea, and on the other, it is the sudden appearance of an island in the sea, sometimes more than 5-7 meters in height. However, such islands are usually short-lived. The waves of the Caspian wash them away and turn them into underwater banks.



*An active mud volcano*





*An active mud volcano*

The Baku archipelago has nine islands of volcanic origin (Hare-Zira, Garasu, Zenbil, Gil, Sengi-Mugan, etc.), where eruptions occur from time to time. By the way, the very first eruptions in Azerbaijan in 1810 were observed on the Hare-Zira and Gil island volcanoes [4].

There is another form of mud volcano eruptions. This is an eruption with mud being released, when breccias are squeezed out of the crater. Such phenomena are quite rare, and only two volcanoes in Gobustan - Cheildag and Goturdag - owe their origin to such an outflow of mud.

The impact of seismicity on the activity of mud volcanoes in Azerbaijan was noted in the second half of the 19<sup>th</sup> century by Academician G. V. Abikh. Later, many years of monitoring of the activities of mud volcanoes and a comparative analysis of data on earthquakes and eruptions convinced geologists and volcanologists of the existence of a genetic connection between mud volcanism and seismic events.

In the 1980s, we monitored some volcanoes of the Absheron Peninsula, Gobustan and Shamakhi District. The results showed that during the final stages of the "preparation" of weak earthquakes, the activity of mud volcanoes intensifies and separate components in emitted fluids (gases, water) abnormally increase, for example, CO<sub>2</sub> and helium in gases, and boron, chlorine and sul-

phates in water. Thus, monitoring the activity of a volcano, it is possible to predict a seismic event. [1]

Generally, it has been established that an underground tremor "triggers" an eruption, i.e. earthquakes plays the role of a "trigger mechanism" in the mud volcanic process. This causal link is registered when the epicenter (hearth) of the earthquake and the volcano are located within the same fault line structure and if the volcano has been dormant for a long time and has accumulated the necessary energy for an eruption. We have also established that if a mud volcano is located in a zone of tension within a range of 80-100 km from the epicenter of a strong earthquake, it definitely wakes up. In 1902, after a catastrophic earthquake in Shamakhi, the Shihzarli volcano near Maraza (now Gobustan) erupted violently after 15 minutes. There are many of such examples. [2]

**Volcanic mud is natural healing medication.** Since the 1980s, our institute, in creative collaboration with the Institute of Health Resorts (now the Azerbaijan Research Institute of Medical Rehabilitation) and academic institutions, in particular the Institute of Soil Science and Agricultural Chemistry, has conducted research to identify biologically active substances (salts, gases, vitamins, enzymes, hormones and biogenic stimulants); we have studied the balneological properties and geochemical characteristics of volcanic mud and managed to introduce this mud in medical practice at more than 15 health care facilities. [5]

It should be noted that volcanic mud is found in oil and gas-bearing areas, and this naturally has a positive effect on their therapeutic properties, which distinguishes this mud from ground mud - silt, peat and sapropelic mud. Being released from great depths, volcanic and ecologically clean mud is enriched in trace elements and organic substances with a high bio-stimulating effect.

Due to its exceptionally high balneological properties, volcanic mud is successfully used by physicians in the treatment of many diseases such as diseases of the musculoskeletal system, joints, spine, peripheral nervous system, skin, gastrointestinal tract, diabetes, atherosclerosis and cervical osteochondrosis, in gynecology, urology and cosmetology.

In recent years, we have scientifically substantiated the need to use volcanic mud for treating patients, and in the near future, the construction of mud baths – a balneological resort - will begin near Alat close to a mud volcano near the sea.

Of course, you cannot even briefly describe all the areas of research into this natural phenomenon in one article. I should note that over these years, atlases, maps, catalogs of eruptions and numerous scientific articles on the mud volcanoes of Azerbaijan have been published. There are many publications with foreign colleagues, with whom scientific research was conducted jointly, and their results were discussed at international forums. However, there are still unresolved scientific and practical issues. Therefore, the study of mud volcanoes is continuing...

And currently, our atlas "Mud volcanoes of the world" in Azerbaijani, English and Russian, each with 320 pages, which characterizes mud volcanoes in 42 countries and in deep-water areas of the Caspian, Black and Mediterranean seas, is being published in Italy for the first time with numerous colored graphic materials, terrestrial and aerial photographs. 🌸

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