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Isa Habibbayli
President of the Azerbaijan National Academy of Sciences, Academician

THE AZERBAIJAN NATIONAL ACADEMY OF SCIENCES – 80
DEVELOPMENT STAGES AND THE MOVEMENT FOR RENEWAL IN THE
AZERBAIJAN NATIONAL ACADEMY OF SCIENCES

Azerbaijan has a long history and rich scientific traditions. Throughout history, science, literature, and the role of the intelligentsia have played a unique and vital role in the spiritual evolution of the nation and the advancement of statehood. In our centuries-old history, prominent scholars such as Abu Muhammad Hasan al-Azari, Ahmad ibn Ibrahim Bardai, Abulhasan Bahmanyar al-Azerbaijani, Khatib Tabrizi, Ibrahim Ganjavi, Kamaladdin Tiflisi, Abd al-Qadir Maraghi, Shihab al-Din Suhrawardi, Muhammad Hindushah Nakhchivani, and Haji Zeynalabdin Shirvani have left an indelible mark on the development of science and culture in Azerbaijan.

As early as the Middle Ages, institutions such as the Dar al-Shifa Academy in Tabriz, Nasir al-Din al-Tusi's Maragha Observatory, and Abulfaz Nakhchivani's Ganja Library gained recognition and high prestige not only in Azerbaijan but throughout the East. Alongside these developments, Azerbaijani science, which has been enriched by centuries of tradition, entered a phase of institutional formation in the 20th century.

The establishment of the Society for the Study and Exploration of Azerbaijan on November 2, 1923, laid the groundwork for the future Azerbaijan Academy of Sciences. Following this, scientific research in the country was organized through the Azerbaijan State Scientific Research Institute, which began operations in 1929. This period marked the initial stage in the development of an academic institution in Azerbaijan.

On December 29, 1932, the Azerbaijan Department of the Transcaucasian Branch of the USSR Academy of Sciences was established, marking the creation of the first scientific institution in Azerbaijan with academic status. Subsequently, on October 25, 1935, the Presidium of the USSR Academy of Sciences decided to transform this department into the Azerbaijan Branch of the USSR Academy of Sciences, representing a significant step toward establishing an independent national academy.

The Transcaucasian Branch's Azerbaijan Department was initially led by Academician Franz Yulievich Levenson-Lessing and Ruhulla Akhundov, while the Azerbaijan Branch of the USSR Academy of Sciences was headed from 1937 to 1939 by Academician Ivan Mikhailovich Gubkin, followed by Academician S.S. Namyotkin, and finally by Professor Heydar Huseynov.

During the operational years of both the Azerbaijan Department of the Transcaucasian Branch and the Azerbaijan Branch of the USSR Academy of Sciences, significant measures were taken to organize scientific research institutions in the republic. A highly qualified body of scientific personnel with academic degrees was formed, thereby creating the necessary groundwork for the future establishment of the Azerbaijan Academy of Sciences. For these reasons, 1932–1945 may be referred to as the preparatory period of academic institution-building in Azerbaijan.

By the decision of the Council of Ministers of the Azerbaijan SSR dated March 27, 1945, the Academy of Sciences of the Azerbaijan SSR was officially established. The first founding members of the Academy were: Mir Asadulla Mirgasimov, Shamil Azizbeyov, Heydar Huseynov, Yusif Mammadaliyev, Mirali Gashgay, Uzeyir Hajibeyov, Samed Vurghun Vakilov, Alishraf Alizade, Mustafa Bey Topchubashov, Mikayil Useynov, Alexander Alfonsovich Grossheim, Iosif Gavrilovich Yesman, Mirza Ibrahimov, Ivan Ivanovich Shirokogorov, and Sadig Dadashov.

At the first General Assembly of the Academy, held on March 31, 1945, Academician Mir Asadulla Mirgasimov was elected as President of the Academy, while Academician Shamil Azizbeyov and Academician Heydar Huseynov were elected as Vice-Presidents. Academician Mirali Gashgay was appointed as the Academic Secretary. The Presidium of the Academy,

consisting of five members, included these elected officials along with Academician Yusif Mammadaliyev.

At the same assembly on March 31, 1945, the scientific departments of the Academy were established, their heads were appointed, and their structures were defined. Additionally, the first Charter of the Academy of Sciences of the Azerbaijan SSR was adopted.

Thus began a new stage in the functioning of the Azerbaijan Academy of Sciences as the country's main state scientific institution. This period, which laid the solid foundation for the Academy's subsequent development, continued from 1945 to 1969, and is considered the era of its formation, institutional organization, and consolidation, playing a crucial role in the advancement of fundamental science.

The Azerbaijan Academy of Sciences is a recognized scientific institution with a strong tradition of organizational development in our country. In the mid-20th century, within a short period, large-scale efforts were carried out within the Academy to establish scientific research institutes, to create their material and technical infrastructure, and to train highly qualified scientific personnel.

The scientific programs developed, as well as the initiatives and ideas proposed within the Azerbaijan Academy of Sciences, have played a unique role in the socio-economic development of our country and in the reconstruction and advancement of various spheres of public life. The Academy has fulfilled with great responsibility its important duties in advancing the ideals of Azerbaijani national identity, preserving and enriching the Azerbaijani language, organizing the discovery and use of natural resources, shaping intellectual scientific potential, and fostering new generations of scientists.

The discovery of high-octane gasoline, which played a vital role in achieving victory in the Second World War, the emergence of the idea of extracting oil from the sea, and the foundation of the legendary Oil Rocks, known as the symbol of Azerbaijani oil, are all closely linked to the name and activity of the Academy. Based on the research of Azerbaijani scientists, our country was recognized as a major scientific center in the field of semiconductor physics. The discovery of Naftalan oil and the establishment of a health and medical complex of international status in our country on its basis are also among the achievements of academic science. The discovery and study of the Gobustan rock carvings and their presentation to our people and the world is also the merit of the Azerbaijan Academy of Sciences.

Through studies dedicated to Azerbaijan's rich natural resources, flora and fauna, economic development, and literary-cultural heritage, the Academy has contributed to the comprehensive development of our country. In particular, scientific research conducted on the establishment of the petrochemical industry in the republic, the discovery and exploitation of new oil and gas fields, and the ecology and geology of the Caspian Sea has led to important changes in the development of the republic.

The years 1969–1982, which constitute a special stage in the development of the Azerbaijan Academy of Sciences, have entered the history of our science as a period associated with the name of prominent statesman Heydar Aliyev, who led the Azerbaijan Soviet Socialist Republic at that time. Precisely in this period, the Azerbaijan Academy of Sciences was comprehensively developed, gained special prestige within the former USSR, and our republic was recognized as one of the significant scientific centers both within the Soviet Union and beyond.

The formation of scientific schools in many important directions in Azerbaijan, the increasing role of science in the economic and cultural life of our country, the creation and development of scientific research institutions in new scientific fields are among the key achievements of this historical period. During these years, the Academy functioned as a true center of Azerbaijani studies and was awarded the Order of Friendship of Peoples ("Xalqlar dostluğu") in 1975.

It was precisely during this period that, as a result of the purposeful policy pursued by prominent statesman Heydar Aliyev, the scientific elite of Azerbaijan was formed, and the national intelligentsia was elevated to the level of a leading force in society. The independence-oriented initiatives of Azerbaijani scholars also emerged during this time. The awarding of the title "Hero of Socialist Labor"—the highest distinction of the former USSR—to creative intellectuals of our country, including prominent scientists with significant contributions to science, through the support and advocacy of Heydar Aliyev, then the leader of Soviet Azerbaijan, was a historic event of this renaissance period.

At the same time, Heydar Aliyev's exceptional historical service during this era was the protection of figures in literature, art, and science—who, due to their national independence-oriented views, had crossed the ideological boundaries of the Soviet state—from the very real dangers they faced. This extraordinary support in the relationship between the state and the intelligentsia led to the emergence of scientific schools in various fields of science in Azerbaijan and ultimately to the formation of a scientific elite.

For all these reasons, 1969–1982 has entered the history of science as a renaissance period in the Azerbaijan Soviet Socialist Republic—not only in all spheres of public life, but also in the field of science, including within the Academy of Sciences.

The period from 1983 to 1993 in the history of the Academy of Sciences may be described as a time of decline and crisis. From 1983 to 1988, the Academy gradually experienced a downturn in the achievements gained during the previous stage, ultimately reaching a state of stagnation. Beginning in 1988, as in the rest of the former Soviet Union, the wave of the national independence movement also rose in Azerbaijan and expanded further between 1989 and 1991. As a result, during that historical phase, the main focus of the intellectual environment, like other areas of public life, shifted to sociopolitical processes, and the institutional functioning of the Academy of Sciences was left unattended and significantly weakened.

In the years that followed, from 1991 to 1993, representatives of the ruling political power at the time made public statements about abolishing and shutting down the Azerbaijan Academy of Sciences. A widespread brain drains from the country to nearby and distant foreign countries ensued, and a clear crisis emerged in the scientific environment.

With the return to political power of prominent statesman Heydar Aliyev, following the presidential elections held in the Republic of Azerbaijan on October 3, 1993, the Academy entered a new stage of reorganization and the building of a National Academy of Sciences. Even before his return as President, as Chairman of the Milli Majlis (National Assembly) of the Republic of Azerbaijan, Heydar Aliyev had already addressed this issue during his meeting with the country's intellectuals at the Academy of Sciences on September 21, 1993. At that meeting, he discussed the ways to overcome the crisis in all areas of public life, including within the Academy of Sciences, and made the following decisive statement, which illuminated the future of this academic institution:

"I am hearing talk that they want to shut down the Academy of Sciences, that there is an indifferent attitude towards this temple of science. We will put an end to all of this. Regardless of the state of the economy, science must develop. The Academy of Sciences is a historic achievement of the Azerbaijani people."

The historic meeting held on January 31, 1997, between prominent statesman Heydar Aliyev and the leadership of the Azerbaijan Academy of Sciences—including its Presidium, full and corresponding members, and distinguished scholars—played a crucial role in steering the development of national science, particularly the Academy, in line with the demands of the period of state independence. The following statements made by National Leader Heydar Aliyev during this historic meeting represent a conceptual roadmap for the reformation of the Academy of Sciences on the principles of the independence era: "Today, Azerbaijan is an independent state, and

the Azerbaijan Academy of Sciences is a state academy. Our Academy must have a strategy. This strategy should be based both on the existing scientific research potential of our republic and directed toward covering those fields necessary for our country, based on the results of scientific work.

... Undoubtedly, it is necessary to benefit from the valuable experiences of the past... But it would be wrong to repeat the old systems, methods, and regulations just as they were. Therefore, when defining the strategy for the development of science and the Academy, you must approach the matter based on these principles."

This period, which constitutes a distinct phase in the development of academy-building in the independent Republic of Azerbaijan, was marked by significant actions both in terms of reorganization and the legal definition of the Academy as an academic institution. First and foremost, on April 20, 1994, at a General Assembly of the Academy, the "Development Concept of the Azerbaijan Academy of Sciences," its new Charter, and the "Basic Directions for the Organization and Operation of Scientific Research Institutes" were approved.

In addition, on the basis of existing sectors and centers within the Academy, several new institutions were established: the Institute of Microbiology, the Institute of Human Rights, the Institute of Chemical Problems, the Institute of Radiation Problems, and the Institute of Information Technology.

As part of the reorganization process, new regional divisions and centers were also formed: the Nakhchivan Branch of the Academy (2002), the Ganja Regional Scientific Center (1995), and the conferral of the status of the Shaki Regional Scientific Center upon the existing Shaki Zone Scientific Base (1995).

The process of establishing the state-level supreme scientific organization of the independence era was completed when, by Presidential Decree dated May 15, 2001, the Azerbaijan Academy of Sciences was granted the status of National Academy of Sciences. Furthermore, the approval of the new Charter of the National Academy of Sciences on January 4, 2003, by President Heydar Aliyev laid the foundational framework for academy-building in independent Azerbaijan.

Thus, 1993–2003 is characterized in the history of the Academy as the stage of reorganization and the establishment of the National Academy of Sciences.

Between 2003 and 2022, the National Academy of Sciences of Azerbaijan underwent a period of modernization. In this historical phase, under the leadership of President Ilham Aliyev of the Republic of Azerbaijan, and by the country's upward trajectory of development, several reforms in the field of science were initiated. A State Commission on scientific reform was established in 2008, followed by the adoption of the National Strategy and State Program for the Development of Science in 2009.

Significant milestones of this modernization period included the establishment of the High Technologies Park of the Academy (2016), the Institute of Molecular Biology and Biotechnology (2014), the Institute of Oil and Gas (2015), and the Institute of Dendrology (2014). Additionally, new buildings for the National Encyclopedia Center and the Electronic Library were inaugurated in 2014. The approval of a new Charter of the National Academy of Sciences on December 11, 2014, opened wide opportunities for institutional restructuring and provided legal grounds for innovation activities.

The 60th and 70th anniversaries of the Academy were celebrated under Presidential Decrees issued by President Ilham Aliyev. In his deeply meaningful speeches delivered at these jubilee events, the Head of State outlined the major responsibilities for the future development of science. The following statement made by President Ilham Aliyev during the ceremony marking the 70th anniversary of the National Academy of Sciences simultaneously highlights the value of the Academy's past services and its strategic mission for the present and future:

"The Azerbaijan National Academy of Sciences plays an active role in the overall development of our country. By conducting scientific research, our scholars are contributing to the acceleration of the country's future development dynamics. I very much want Azerbaijani scientists to play an even more active role in the comprehensive development of our country in the future."

A new historical stage in the field of science in Azerbaijan was inaugurated with the Presidential Decree of July 28, 2022, titled "On Some Issues Regarding the Improvement of Governance in the Fields of Science and Education in Azerbaijan." This period is characterized as the stage of renewal and reform for the National Academy of Sciences.

As part of these reforms, scientific research institutes within the Academy that pertain to exact, technical, and natural sciences were reorganized on the basis of high technologies and incorporated into the newly established Ministry of Science and Education of the Republic of Azerbaijan. One of the key priorities of this process was the expansion of the integration between science and education.

Meanwhile, the research institutes under the Academy focusing on the humanities and social sciences redirected their research activities in line with the development strategy and national priorities of the country. Particular emphasis was placed on the development of research consistent with the ideology of Azerbaijani national identity, the promotion of national and spiritual values, and deeper integration with the Turkic world.

The Republican Seismological Service Center, which continues to operate within the Academy, not only strengthened its international collaborations in the field of seismology, but also prioritized establishing broader ties with scientific institutions of regional and Turkic-speaking countries.

In both the Ministry of Science and Education and the National Academy of Sciences, research institutions began to address new strategic tasks related to artificial intelligence, digital development, smart technologies, and green transformation—aligned with the goals of the Fourth Industrial Revolution and the high-level organization of COP29 in Azerbaijan.

The new Charter of the National Academy of Sciences, approved by the President of the Republic of Azerbaijan on November 3, 2023, provides the legal framework for a more targeted implementation of renewal and reform processes within the Academy. It opens broad prospects for comprehensive development based on the requirements of the modern era.

At the present stage, renewal processes and reforms are being steadily implemented within the Azerbaijan National Academy of Sciences (ANAS) to ensure the successful execution of the state's scientific policy. In alignment with the modern development of the independent Azerbaijani state, ANAS is conducting purposeful research and implementing well-thought-out measures on topics such as the reconstruction of the socio-cultural environment, the conceptual development of Azerbaijani national identity, the scientific foundations of the "Great Return" policy to Karabakh and Western Azerbaijan, and the advancement of integration processes with the Turkic world.

In this context, the launch of initiatives for the preparation of multi-volume editions of the Heydar Aliyev Encyclopedia and the Western Azerbaijan Encyclopedia is of significant importance as scientific projects with socio-political relevance in the era of national independence.

In response to President Ilham Aliyev's appeal during his interview with local television channels on January 10, 2024, concerning the need to define the national idea of a new historical era, scholarly discussions held within ANAS reflected the active engagement of academic science in the further development of the independent state. Following discussions with scholars in January, April, and June of the previous year, the general national idea of the new historical era was formulated as follows—a reflection of the Academy scholars' scientific outlook on contemporary trends: A stronger Azerbaijan, unity and solidarity with the Turkic world, strategic partnership with world nations, and digital development.

At the same time, reform-oriented measures have been undertaken at ANAS to align the ideological and substantive direction of Azerbaijani science with the challenges of the new historical era. One such initiative includes the development and implementation of a "return to historical and literary figures" concept to overcome the artificial notion of a "unified Soviet people" imposed during the Soviet period, which aimed to sever the Azerbaijani people from their roots by labeling noble figures as "bandits" or "exploiters." These efforts contribute to the advancement of science in the direction of independent statehood and Azerbaijani national ideology.

As a result of recent studies and publications, several significant scholarly collections have emerged: the Heydar Aliyev Studies Library, the Nizami Ganjavi Archive, and the Mohammad Fuzuli Book Series—each a testament to the reintegration of historic literary and cultural figures into national discourse. Other major events reinforcing this process include the first International Scientific Conference on Shah Ismayil Khatai, organized by the Institute of History and Ethnology named after Abbasgulu Bakikhanov; the conference on "Gasim bey Zakir and the Literary-Public Environment of Karabakh," jointly organized with Aghdam City Executive Power; and a scholarly session dedicated to academician Heydar Huseynov, one of the founders of ANAS, held by the Institute of Philosophy and Sociology. These events show that the process of returning to historic literary and philosophical figures is growing and becoming increasingly institutionalized.

Under the guidance of President Ilham Aliyev's call for prioritizing unity and solidarity among Turkic states, new departments have been established: Philosophical Heritage and Modern Philosophy of Turkic Peoples at the Institute of Philosophy and Sociology; History of Turkic Art and Cultural Heritage at the Institute of Architecture and Art; and Study of Turkic Manuscripts at the Institute of Manuscripts. Furthermore, the third International Turkological Congress was held in cooperation with Cankırı University of the Republic of Turkey, and its proceedings have been published.

One of the Academy's most notable accomplishments in its 80-year history was the discovery and publication—after 86 years—of a rare manuscript translation of Mahmud Kashgari's foundational Turkic text *Dīwān Lughāt al-Turk* by Khalid Said Khadjayev, which was printed in three volumes by the Nasimi Institute of Linguistics and formally presented on December 13, 2024, at UNESCO Headquarters in the presence of Turkologists from across the Turkic world.

Ongoing collaborative projects further underscore the Academy's growing ties with the Turkic scientific community: the joint Azerbaijan–Turkey program in partnership with the Turkish Academy of Sciences; work on the Encyclopedia of Chingiz Aitmatov with the Kyrgyz Academy of Sciences (specifically the Azerbaijani volume's glossary); the translation of the Epic of Alpamish; and the launch of a three-volume Anthology of Turkic Literatures. Preparations are also underway to commemorate the 100th anniversary of the First Baku Turkological Congress.

In line with the demands of the new historical era, scientific directions serving both national interests and global challenges are being defined and implemented, along with the restructuring and renewal of institutional departments. These efforts are aimed at enhancing the role of Azerbaijani science in shaping the country's new societal model.

In recent years, several research departments have been established within the central administration and research institutes of ANAS, reflecting the realities of the national independence period. These include: "Electronic Academy", "Philosophy of the Information Society and Digital Development", "History of the Karabakh War and the Great Return Movement", "Archaeology of the Caspian", "Forensic Archaeology", "History of Western Azerbaijan", "Folklore of Western Azerbaijan", "Research of Manuscripts of Western Azerbaijan and Karabakh", "Toponymy", "Monitoring and Linguistic Analysis", "History of Turkic Art and Cultural Heritage", "Philosophical Thought and Contemporary Philosophy of Turkic Peoples", "Philosophical-Legal Doctrines and Philosophy of Sovereignty". Each of these departments represents a new initiative

directed toward protecting the national interests of our people, supporting the sovereign development of the country, and expanding integration processes on a broader scale.

At the same time, new steps have been taken to advance science in Nakhchivan and Ganja—where the scientific departments of the National Academy of Sciences operate—as well as in Shaki, Lankaran, and Guba, where the Academy's scientific centers are located. Notably, the establishment of the journal *Scientific Works* for the first time at regional scientific centers ensures the development of Azerbaijani science not only centered in Baku but also across all regions of the republic.

The adoption of the Academy's Development Concept and Roadmap for 2025-2030 at the National Academy of Sciences' General Assembly held on February 20, 2025, mobilizes academic science toward new directions and objectives.

Purposeful measures are also being implemented to expand Azerbaijan's international scientific relations by the demands of this new era. In recent years, the National Academy of Sciences of Azerbaijan has made significant strides from bilateral intergovernmental cooperation toward full-fledged membership in international scientific organizations, thereby becoming a globally recognized scientific institution. With the Academy's election as a full voting member of major international academic bodies—such as the International Science Council, the International Academy of Interacademia Partnership, and the Association of Asian Academies and Societies of Sciences—a new chapter has commenced in the internationalization of Azerbaijani science.

The successful implementation of the electronic science movement within the National Academy creates favorable conditions for Azerbaijani science to secure a worthy place in international scientific databases and to be increasingly represented in global rankings. The creation and expansion of the unique Electronic Academy department—a pioneering initiative among world academies—has opened wide prospects for artificial intelligence and digital development within the Academy. Several of the Academy's scientific journals have been included in the JOURNAL PARK-ULAKBIM (DERGIPARK-ULAKBIM) scientific journal network of the Republic of Turkey's TÜBİTAK institution. Furthermore, for the first time, a national JOURNALPARK system was established for the Academy's journals, marking a significant achievement in the wave of electronic scientific development.

Comprehensive reforms aimed at integrating digital development and artificial intelligence, employing smart technologies, bibliometric indicators, and green transformations represent key achievements on the path of modernizing Azerbaijani science. The development of the SUFI Robot model by the staff of the Academy's Electronic Academy branch and its incorporation into the scientific research network exemplify the scientific and technical indicators of the Academy's ongoing renewal processes in artificial intelligence and digital progress.

The full and corresponding members of the National Academy of Sciences, who determine the profile and level of the country's science, are distinguished scholars who represent the national pride of our people and our science. The academic body of Azerbaijani science is the golden fund of the nation's scientific heritage. Prominent Azerbaijani scientists, including full and corresponding members of the Azerbaijan National Academy of Sciences, are chosen intellectuals who form the core of the national elite of the Azerbaijani people. The scientific elite, as the leading force of the nation's intellectual class, are the principal bearers and driving forces of statehood thinking, national consciousness, and intellectual potential in the Republic of Azerbaijan. The National Academy of Sciences and its scientific elite also hold a significant position and provide invaluable services in promoting the international recognition of the Azerbaijani people and representing our country globally.

Among the main authors of the fundamental scientific ideas, inventions, discoveries, effective proposals, new scientific concepts, and national ideals that have emerged in our republic over the past 80 years, Azerbaijani scientists—especially the full and corresponding members of the

Academy—have made substantial contributions. It is through their tireless scientific efforts that scientific schools have been established in Azerbaijan, and several generations of scientists have been trained. The figures of the Azerbaijan National Academy of Sciences stand as examples of dedication in science, serving the progress of the homeland, the development of independent statehood, and the ideological and spiritual evolution of our people.

Among the prominent scientists who created scientific schools and expanded the boundaries and horizons of the Republic of Azerbaijan science are Mir Asadulla Mirgasimov, Yusuf Mammadaliyev, Musa Aliyev, Murtuza Naghiyev, Zahid Khalilov, Ashraf Huseynov, Azad Mirjadzade, Jلال Aliyev, Zarifa Aliyeva, Hasan Abdullayev, Abdulla Garayev, Shamil Azizbayov, Heydar Huseynov, Mireli Gashgay, Hasan Aliyev, Vahab Aliyev, Musa Rustamov, Musa Musayev, Ziya Bunyadov, Mammad Arif Dadashzade, Hamid Arasli, Shafaghat Mehdiyev, Mammad Jafar Jafarov, Mammadagha Shireliyev, Feyzulla Gasimzade, Firidun Kocherli, Habibulla Shahtakhtinski, Abbas Zamanov, Valida Tutayug, Khudu Mammadov, Mahammad Huseyn Tahmasib, Budag Budagov, Teymur Bunyadov, and many others who have created glorious pages in the history of our science.

Today, the National Academy of Sciences continues to successfully operate as one of the main scientific centers of Azerbaijan together with its academic staff and new scientific generations, fulfilling multifaceted functions related to the development of independent statehood. The Azerbaijan National Academy of Sciences is the cradle of fundamental scientific research and the driving force of applied sciences.

The Academy is a great ambassador of universal scientific ideas in Azerbaijan and the primary representative of global science in our country.

The National Academy of Sciences currently performs the function of the highest state scientific institution that unites the humanities, social sciences, and seismology, and which produces distinctive and significant scientific results. The Academy is purposefully continuing its processes of renewal and large-scale reforms to meet the state interests of our country, the national priorities of our people, and the high demands of universal scientific ideas.

The 30th, 60th, and 70th anniversaries of the National Academy of Sciences have been grand celebrations of Azerbaijani science and its achievements, reflecting the high appreciation of scientific progress and the work of scholars, and illuminating the path for future development. The 80th anniversary of the Academy also represents a report on the new historical era of academic science in the epoch of independence. In this regard, the book *Azerbaijan National Academy of Sciences: Figures*, published in 2025 and encompassing the biographies and contributions of 447 academicians and corresponding members, serves as a broad scientific chronicle of Azerbaijani science in the 20th and 21st centuries. It is an encyclopedia of the founders and creators of the Academy, the architects of major scientific schools, the authors of scientific discoveries, inventions, and ideas, distinguished scholars elected to world academies—in short, the renowned figures of academic science.

Under the leadership of the President of the Republic of Azerbaijan, Ilham Aliyev, the country's science and, in particular, the National Academy of Sciences continue to fulfill their historical mission with honor and responsibility in serving the highest ideals of the new historical era of independence, mobilizing all their resources and confidently advancing toward a greater future.



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WAYS OF CREATING A CULTURAL ENVIRONMENT IN KARABAKH: BASED ON WORLD EXPERIENCE

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The restoration of cultural heritage in Karabakh, a region of Azerbaijan that has been freed from occupation, is a critical and complex task. This area, deeply connected to Azerbaijani culture, saw its historical sites, mosques, and cemeteries destroyed during the years of occupation. Azerbaijan is now focusing on restoring this cultural heritage, under the programs approved by President Ilham Aliyev. The process faces significant challenges, such as extensive minefields that delay both the return of residents and restoration efforts. Drawing on international examples, such as the reconstruction of Warsaw after World War II, Azerbaijan aims to adopt a systematic approach to revitalizing Karabakh's cultural environment. International cooperation, including with UNESCO, plays a crucial role in accelerating these efforts. By restoring religious sites, building cultural centers, and leveraging digital technologies, Azerbaijan strives not only to revive its historical heritage but also to boost cultural tourism and regional stability through this revitalization.

Keywords: Karabakh, cultural heritage, restoration, international cooperation, digital technology.

INTRODUCTION

The restoration of cultural heritage in the Karabakh region, recently liberated from occupation, is a significant part of Azerbaijan's national revival efforts. As a historic and culturally rich region, Karabakh has long held an essential place in the cultural identity of Azerbaijan. However, during the decades of occupation, numerous cultural sites-including mosques, mausoleums, cemeteries, and other historical monuments-were deliberately destroyed or neglected. Today, Azerbaijan is engaged in an ambitious and comprehensive process to revive and preserve this rich cultural legacy.

Under the leadership of President Ilham Aliyev, extensive restoration and reconstruction programs have been launched, supported by local institutions and international organizations such as UNESCO and ISESCO. Despite significant progress, this process faces considerable challenges, particularly due to landmine contamination and the scale of destruction. The successful restoration of cultural heritage in post-conflict areas such as Warsaw, Dubrovnik, and Sarajevo offers important lessons for Azerbaijan's efforts in Karabakh.

This paper explores the multifaceted strategies employed in the restoration of cultural sites in Karabakh, highlighting the role of government initiatives, international cooperation, digital technologies, and cultural diplomacy. It also examines how the revival of Karabakh's cultural environment contributes not only to national identity but also to regional peace, tourism development, and inter-generational cultural transmission. Through a combination of traditional restoration methods and modern innovations, Karabakh is on its way to becoming a symbol of resilience, cultural revival, and international collaboration in heritage preservation.

MAIN PART

The Karabakh region, liberated from occupation, has always been an integral part of Azerbaijan's culture and history. During the years of occupation, cultural monuments, mosques, cemeteries, and other valuable heritage sites in these territories were destroyed. As part of the programs for the



restoration of Karabakh, approved by the President of the Republic of Azerbaijan, Ilham Aliyev, special attention is given to the restoration of this destroyed cultural heritage. However, there are numerous challenges in carrying out these difficult and responsible tasks.

One of the main challenges in restoring culture in Karabakh is the presence of extensive minefields in the region. This danger hinders both the process of local population returning and the restoration efforts. Accelerating mine clearance work is of critical importance, as delays in this process negatively affect the restoration of cultural heritage. According to ANAMA, more than 62,000 hectares of land in Karabakh and East Zangazur were cleared of mines in 2024, with over 6,500 mines neutralized [6].

Global experience shows that restoring cultural heritage destroyed by war and occupation requires a comprehensive approach. For instance, after World War II, the cultural heritage of many European cities suffered significant damage, yet systematic efforts led to the restoration of the cultural environment in these cities. A notable example is Warsaw, Poland. During the war, nearly 85% of the city was destroyed, but with the support of the population and international organizations, Warsaw was rebuilt based on its ancient architecture.

Drawing from these experiences, it can be said that strategies for restoring the cultural environment in Karabakh should also be developed based on international practices.

Several important restoration projects have already been implemented in Shusha city under the initiatives of the Ministry of Culture and other institutions. For example, ancient architectural examples like the Yukhari Govhar Agha Mosque and the house of Mir Mohsun Navvab have been restored. The restoration of these monuments is being accelerated with the support of UNESCO and other international organizations. Azerbaijan's international cooperation in this area allows for a more effective preservation of cultural heritage.

One of the key steps for restoring cultural heritage in Karabakh is the restoration of historical monuments, mosques, and other religious and cultural sites. To expedite this process, the Azerbaijani government has implemented special programs. Collaboration with international organizations, including UNESCO and ISESCO, is essential. These organizations support the cultural restoration process by developing projects that align with international standards for heritage preservation.

Azerbaijan's experience in this area is applied not only in Karabakh but also in other historical areas. For example, the restoration practices in the Old City of Baku and the historical monuments of Sheki serve as significant models that can be applied in Karabakh. These models aim to preserve ancient architecture while also developing modern cultural infrastructure.

Another significant step towards restoring the cultural environment in Karabakh is the construction and reconstruction of cultural centers. These centers not only help preserve the historical and cultural heritage of the region but also provide opportunities for local people to engage in cultural activities. Declaring Shusha as Azerbaijan's "Cultural Capital" in 2021 was a crucial step in this direction. The "Kharibulbul" festival and other cultural events held in Shusha have strengthened its role as a center of culture and art in the region. The Khari Bulbul Music Festival, officially restored in 2022, has since been held annually in Shusha every May, reinforcing the city's image as the cultural capital of Azerbaijan [7].

Building such cultural centers in Karabakh will facilitate young people's closer engagement with culture and enable Azerbaijan's cultural heritage to be passed on to future generations. Additionally, it will attract foreign tourists to these areas, boosting the development of cultural tourism.

In many countries around the world, the restoration of cultures destroyed by war and occupation has been successfully carried out. For instance, cultural monuments, mosques, and churches destroyed during the war in Sarajevo, Bosnia and Herzegovina, were restored through the joint efforts of international organizations and the local government. These experiences can serve as an important model for the revival of cultural heritage in Karabakh. One of the lessons from Bosnia's experience is the importance of restoration based on mutual respect and cooperation between cultures.



Likewise, the city of Dubrovnik in Croatia serves as another significant example in this field. In the 1990s, the city suffered serious damage due to heavy bombardment, but with UNESCO's leadership, the old city area of Dubrovnik was fully restored. The role of international organizations in this process could be applied to the cultural restoration efforts in Karabakh.

Restoring the cultural environment in Karabakh requires a multifaceted approach. First, it is crucial to inventory historical monuments and prepare restoration plans. A comprehensive list of cultural heritage objects destroyed or damaged during the occupation needs to be compiled, clearly identifying their condition. Additionally, assessing the historical significance of these monuments and determining the technical capabilities required for their restoration are essential factors.

To achieve this, 3D modeling of monuments and the use of digital technologies should be employed. For example, creating a digital model of a historical temple in Nara, Japan, ensured technical precision during its restoration. Applying such technologies in Karabakh can facilitate more accurate and efficient restoration work.

Reconstructing the destroyed religious monuments and cemeteries in Karabakh is also a crucial element of the cultural revival. Restoration efforts should maintain their historical essence, preserving the original structures as much as possible. The restoration of the Yukhari Govhar Agha Mosque in Shusha is a successful example of this. This UNESCO-supported project contributes to the preservation of religious and historical values and to the promotion of intercultural dialogue.

The restoration of religious monuments should not be limited to physical reconstruction. It is also important to promote the cultures surrounding these monuments and to conduct religious and historical educational activities. For this purpose, the establishment of special religious-historical museums in Karabakh is recommended. These museums could serve as educational centers for both the local population and foreign tourists.

The application of modern technologies in the development of the cultural environment in Karabakh will play a decisive role in the growth of cultural tourism. Virtual tourism projects, interactive cultural programs, and digital exhibitions are effective tools for increasing interest in the Karabakh region. Through modern technologies, restored monuments and museums in Karabakh can be presented to the world.

Moreover, organizing cultural festivals and events in the ancient cities of Karabakh—especially Shusha and Aghdam—will revive the cultural life of the region. Disseminating these events widely through modern technologies and attracting artists and cultural figures who participate in international events will help speed up this process.

Based on global experience, several effective methods can be suggested for restoring the cultural environment in Karabakh. For example, the Uffizi Gallery in Florence, Italy, suffered severe damage during the Arno River flood in 1966. However, international funds were established for the restoration of these monuments, and with global cooperation, this historical monument was revived. Based on this experience, Azerbaijan could collaborate with international donor organizations for cultural restoration in Karabakh. Additionally, the creation of special cultural funds can contribute to the financing of this work.

Strategic development plans are essential for the restoration of the cultural environment in Karabakh. These plans should include short-term and long-term goals, providing detailed instructions for specific actions and activities. The coordination of activities related to cultural heritage preservation and the development of cultural infrastructure within the framework of the Karabakh restoration plans, approved by the government, is of critical importance.

To ensure the effectiveness of development plans, a continuous monitoring and evaluation system should be established. This system would monitor the progress of each project and resolve emerging issues in a timely manner. Using digital technologies, such as databases and Geographic Information Systems (GIS), can enhance the efficiency of the monitoring system. These technologies would allow the restoration process to be closely monitored and the outcomes to be assessed more accurately.



The restoration of cultural heritage should not end with the reconstruction of monuments and cultural facilities. It is crucial to implement continuous education and awareness programs for cultural preservation. Raising awareness among young people in Karabakh about the importance of culture, training specialists in heritage conservation, and learning from international experience are important steps in this direction.

For example, the Venice Cultural Heritage Academy in Italy specializes in training experts in the restoration and preservation of ancient monuments. Such educational programs could serve as a valuable model for Azerbaijan. A team of experts specifically trained for the restoration of monuments should be established and involved in this work in Karabakh.

Furthermore, public involvement in this process through awareness campaigns is essential. The role of the public is significant in reviving culture, and conducting awareness activities among the population is vital for effective implementation of this work.

International cooperation and cultural diplomacy can play a special role in the restoration of the cultural environment in Karabakh. Close collaboration with international organizations in cultural heritage preservation and restoration will enhance the effectiveness of this process. For example, Azerbaijan has successfully participated in restoration projects for monuments included in UNESCO's World Heritage List. This experience can serve as a valuable model for the restoration of cultural objects in Karabakh.

Additionally, the cultural heritage of Karabakh should be presented to the global community through international conferences and cultural events. This will aid in reviving the culture of Karabakh and increasing international support for these efforts.

The restoration of cultural heritage in Karabakh also opens up significant opportunities for the development of tourism. Karabakh, with its unique natural and cultural wealth, can become an ideal destination for ecotourism and cultural tourism. The historic cities of Shusha, Aghdam, and others could attract both local and foreign tourists.

Implementing ecotourism and cultural tourism projects will provide a new economic boost for Karabakh and contribute to increasing local employment. These projects should focus on developing tourism infrastructure in Karabakh and implementing extensive marketing campaigns to attract tourists to the region.

Securing financial support is a crucial step for the restoration of cultural heritage in Karabakh. The Azerbaijani government has allocated substantial funds for the restoration of Karabakh, but international organizations and donors also play an essential role in this process. International entities such as UNESCO, the European Union, and ISESCO can participate in cultural restoration projects in Karabakh and provide financial resources.

Public-private partnerships (PPP) are also vital for financing the restoration process. Such partnerships allow for the implementation of state-private partnership models in cultural restoration. For example, local companies have provided financial support for cultural events held in Shusha, alongside state support. The implementation of such models can make the restoration process faster and more sustainable.

Among the specific projects to be carried out in Karabakh for cultural restoration, the creation of museums and cultural centers holds particular importance. These projects will serve as key centers for preserving and presenting the history, art, and cultural heritage of Karabakh. For example, alongside the restoration of the palace of the Khans of Karabakh, the establishment of the Karabakh Historical Museum in Shusha is also planned. This museum will be an important center for preserving Karabakh's history, cultural heritage, and historical events.

Additionally, the construction of cultural centers in Aghdam and Fuzuli cities is also envisaged. These centers aim to promote cultural activities in the region, introduce new generations to culture, and pass on cultural heritage to future generations.

Cultural tourism holds significant potential for the development of Karabakh. It is essential to develop comprehensive marketing strategies to attract tourists to the region. These strategies should



present Karabakh's unique cultural heritage, historical monuments, and natural beauty to the global audience. International exhibitions, cultural events, and festivals should be utilized to expand the potential for tourism development in Karabakh.

Digital technologies play a major role in promoting tourism potential in Karabakh. Virtual tourism projects, 3D monument models, and interactive tourism routes can become projects that combine culture and tourism in Karabakh. Through these projects, information about Karabakh can be shared with a wider audience, increasing interest in the region.

The use of modern technologies and innovative approaches is crucial for accelerating the cultural restoration process. In Karabakh, the restoration process can utilize drones for mapping areas, 3D modeling, and other digital tools. These technologies will help make restoration work more precise, faster, and of higher quality.

Countries like Italy and Greece have successfully restored monuments using digital technologies after wars. In Greece, historical monuments like the Acropolis have been preserved using digital technologies [2]. Applying these technologies in Karabakh can not only preserve the original form of the monuments but also speed up the restoration process.

The restoration of cultural heritage in Karabakh is not limited to the reconstruction of historical monuments and cultural centers. This process will also have a long-term impact on various sectors of the economy. Along with the restoration of cultural objects, the development of the tourism sector, the creation of new jobs in the region, and the improvement of the living standards of the local population are among the significant outcomes of this process.

The development of cultural tourism will increase economic activity in Karabakh. Expanding tourism infrastructure in Shusha, Aghdam, and other cities, as well as organizing cultural festivals and international events, will help attract both local and foreign investments to the region. As a result of this process, Karabakh will enter a new phase of economic development, which will have a positive impact on the overall economy of the country.

The social aspects of the cultural restoration process are also highly significant. Reviving Karabakh's cultural heritage will allow the local population to reconnect with their historical and cultural values. The restoration of cultural heritage will have a strong impact on the identity and cultural awareness of local communities.

This process will also foster greater interest in culture among young people, allowing them to become familiar with national values. Through cultural centers and museums, young people will learn about culture and history, which will strengthen their respect for cultural heritage and national values. In this regard, the restoration of the cultural environment in Karabakh will play an important role in shaping the cultural identity of future generations in Azerbaijan.

The restoration and development of culture can also play a crucial role in strengthening peace and stability in Karabakh. Preserving culture and cultural heritage is an important tool for ensuring peace on an international scale. In this regard, the recommendations of UNESCO and other international organizations highlight the peacebuilding mission of culture.

The revival of culture in Karabakh will contribute to regional stability and the establishment of peace among various communities. Through the restoration of cultural sites, intercultural dialogue, and the organization of cultural events, new forms of cooperation can be developed in the region. This, in turn, will contribute to the establishment of long-term peace and stability in the region.

The ultimate goal of the cultural restoration process in Karabakh is to ensure the complete cultural revival of the region. With the combined efforts of the Azerbaijani government, international organizations, and local communities, it is possible to achieve progress in all areas of culture. Transforming Karabakh into a cultural capital will significantly contribute not only to the region but also to Azerbaijan's overall cultural policy.

In the long term, preserving and restoring the cultural heritage of Karabakh will position Azerbaijan as a leader in the field of culture on the international stage. The cultural restoration projects



implemented in Karabakh will resonate widely not only within the country but also globally. Through the development of culture and international cooperation, Karabakh will become a new cultural center, which will have a major impact on the consolidation of peace and stability in the region.

The issue of preserving historical and cultural heritage is a crucial topic not only in Azerbaijan but also globally. The successful experiences of restoring cultural heritage damaged by occupation in various countries around the world offer valuable examples for Azerbaijan. For instance, the reconstruction of Warsaw after World War II was a successful experience in the preservation of historical monuments and urban architecture. In this process, the principle of "Architectural heritage is the preservation of historical memory" was followed [1].

The restoration of the Acropolis monuments in Greece is another example. Through the use of modern technologies to preserve the original state of the monuments, the Acropolis has been reclaimed as a part of world cultural heritage [2]. These examples represent guiding principles that can be followed during the restoration of the cultural environment in Karabakh.

The use of modern technologies is a key factor in speeding up and enhancing the process of cultural heritage preservation and restoration. Thanks to 3D modeling and digital technologies, the repair and reconstruction of historical monuments can be carried out more precisely and effectively. One of the most successful experiences in this field is the creation of digital archives of the "Uffizi" Gallery in Florence. This project has allowed historical monuments to be preserved in digital resources without the risk of damage, making them accessible to researchers worldwide [3].

The restoration of cultural heritage in the liberated areas of Karabakh has also garnered international attention. This process can further strengthen Azerbaijan's position on the international stage in the field of culture. With the support of cultural and art experts from around the world, the cultural heritage of Karabakh will be reintroduced to the global community. "Cultural diplomacy is one of the most effective tools for global peace"—these words, expressed by Dr. Yonesko, a renowned cultural figure, remain relevant in the context of the restoration of Karabakh [4].

CONCLUSION

The restoration of cultural heritage in the Karabakh region represents not only a physical reconstruction process, but also a broader cultural, social, and geopolitical mission. The integration of international experience, particularly from post-war restoration models in cities such as Warsaw, Sarajevo, and Dubrovnik, demonstrates the importance of systematic planning, international cooperation, and public engagement. Azerbaijan's efforts show that cultural heritage revival in post-conflict zones can significantly contribute to national identity reconstruction, regional stability, and economic revitalization through cultural tourism.

The application of digital technologies—such as 3D modeling, GIS systems, and virtual museums—proves essential in increasing the efficiency and accuracy of restoration. Moreover, the involvement of international organizations like UNESCO strengthens the legitimacy and visibility of these efforts on a global scale. Overall, Karabakh's cultural restoration process can serve as a model for similar post-conflict regions, highlighting the role of culture in peacebuilding, sustainable development, and global cultural dialogue.

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QARABAĞDA MƏDƏNİ MÜHİTİN YARADILMASI YOLLARI: DÜNYA TƏCRÜBƏSİ ƏSASINDA

P.Ə. Əliyeva

Qarabağda mədəni irsin yenidən canlandırılması, regionun azad olunmasından sonra Azərbaycanın qarşısında duran əsas vəzifələrdən biridir. Uzun illər davam edən işğal dövründə bu ərazidəki tarixi abidələr, məscidlər və qəbiristanlıqlar dağıdılmışdır. Azərbaycan Respublikasının Prezidenti İlham Əliyevin təsdiqlədiyi proqramlara əsasən, bu dəyərli irsin bərpasına üstünlük verilir. Bu proses zamanı geniş minalanmış ərazilərin mövcudluğu kimi ciddi çətinliklərlə üzləşilir; bu da həm köçkünlərin geri qayıtmasını, həm də bərpa işlərini ləngidir. İkinci Dünya Müharibəsindən sonra Varşavanın yenidən qurulması kimi beynəlxalq təcrübələrdən ilham alaraq, Azərbaycan Qarabağda mədəni mühitin bərpası üçün strategiyalar hazırlayır. UNESCO ilə əməkdaşlıq kimi beynəlxalq dəstəklər bu prosesin sürətlənməsinə töhfə verir. Dini tikililər, mədəniyyət mərkəzləri və rəqəmsal texnologiyalardan istifadə etməklə Azərbaycan mədəni irsini yenidən canlandırmağı, mədəni turizmi təşviq etməyi və regional sabitliyi gücləndirməyi qarşısına məqsəd qoyur.

Açar sözlər: *Qarabağ, mədəni irs, bərpa, beynəlxalq əməkdaşlıq, rəqəmsal texnologiya.*

СПОСОБЫ СОЗДАНИЯ КУЛЬТУРНОЙ СРЕДЫ В КАРАБАХЕ: НА ОСНОВЕ МИРОВОГО ОПЫТА

П.А. Алиева

Восстановление культурного наследия в Карабахе, регионе Азербайджана, освобожденном от оккупации, представляет собой сложную задачу, требующую комплексного подхода. За годы оккупации были разрушены ценные исторические памятники, мечети и кладбища. Сейчас Азербайджан, следуя программам, утвержденным президентом Ильхамом Алиевым, уделяет особое внимание восстановлению этих объектов. Основные трудности включают наличие больших минных полей, что замедляет процесс возвращения населения и восстановления. Опираясь на мировой опыт, такой как реконструкция Варшавы после Второй мировой войны, Азербайджан разрабатывает стратегию восстановления культурной среды в Карабахе. Важную роль в этих усилиях играет международное сотрудничество, включая помощь ЮНЕСКО. Восстанавливая религиозные памятники, создавая культурные центры и используя цифровые технологии, Азербайджан стремится не только возродить историческое наследие, но и развивать культурный туризм и укреплять региональную стабильность.

Ключевые слова: *Карабах, культурное наследие, восстановление, международное сотрудничество, цифровые технологии.*



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<https://doi.org/10.59849/2409-4838.2025.3.21>**ARTISTIC REFLECTION OF THE POSTMODERNIST WORLDVIEW IN NARGIZ ISMAYILOVA'S MONOGRAPH "KAMAL ABDULLA AND POSTMODERNIS"****Dilara Shamil Aliyeva** 

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Postmodernism is a philosophical and aesthetic movement that emerged in the mid-20th century and has retained its influence into the contemporary period. As a multifaceted phenomenon, postmodernism has left its mark on every sphere from art to politics. While it introduced flexibility, tolerance, and plurality into modern thinking, some critics argue that it relativized values. This movement questions traditional values, the notion of objective truth, and classical structures. Kamal Abdulla has created a unique literary style by adapting the universal methods of postmodernism to the cultural codes of Azerbaijan. His works constitute a significant contribution both to the development of national literature and to the global postmodern discourse. Nargiz Ismayilova's monograph Kamal Abdulla and Postmodernism provides an in-depth analysis of these approaches, evaluating the author's oeuvre within the global postmodern context. The book emphasizes Kamal Abdulla's role as an example of the successful fusion of postmodernism with national sources in Azerbaijani literature.

Keywords: Skepticism, experimental approaches, intertextuality, time and space

INTRODUCTION

Postmodernism is a literary, philosophical-aesthetic, and cultural movement that emerged in the mid-20th century and has persisted into the contemporary era. This current is known for its critique of traditional values, classical structures, and the modernist concept of "objective truth". Key features of postmodernism include skepticism, irony, ambiguity, and openness to difference.

In postmodern thought, "truth" is considered relative and may carry different meanings for each individual or culture. This movement seeks to transcend intercultural boundaries and integrates elements of popular culture into art, literature, and architecture.

Among its primary characteristics are the following:

- **Irony and Parody:** Postmodernist works often express a critical attitude toward certain values or movements through irony and parody.
- **Fragmentation:** Events and characters are frequently presented through non-linear connections.
- **Metanarrative:** The emphasis on the work's awareness of itself as a constructed narrative essentially, a story that comments on its own storytelling.
- **Pluralism and Difference:** A valuing of multiple perspectives and a celebration of diversity.

MAIN PART

Manifestations of Postmodernism in Kamal Abdulla's Work. In the main body of the article, the research methodology and results are presented.

Postmodernism in literature has manifested through new forms and experimental approaches. Kamal Abdulla is a prominent artist who has explored the elements of postmodernist style and cont-

ributed to Azerbaijani literature by incorporating the distinctive features of this movement. His engagement with postmodernism has infused Azerbaijani literature with a new spirit, playing a crucial role in conveying national heritage, history, and values within a new context.

Kamal Abdulla is considered one of the key figures in Azerbaijan's contemporary literary and scholarly life. He distinguishes himself through works across various genres, particularly within the postmodernist style. His creative focus lies in the reinterpretation of national and cultural values, history, mythology, language, and spiritual concepts. Moreover, Kamal Abdulla delves into the deep layers of Azerbaijani culture, demonstrating how it can exist in harmony with universal values. This approach is articulated in a language that can be translated both nationally and globally, aligning with the open and polyphonic nature of postmodernism.

Kamal Abdulla's works reflect key postmodernist features such as playfulness, intertextuality, textual interconnectedness, polyphonic structures, and the blending of reality and fantasy. Intertextuality, as noted, refers to the phenomenon of a text interacting with its semiotic cultural environment—internalizing external meanings. In general, intertextuality emerges as a result of the active role that socio-cultural context plays in the processes of meaning-making and interpretation [6, p. 246].

The monograph *"Kamal Abdulla and Postmodernism"* by Nargiz Ismayilova, dedicated to postmodernism and Kamal Abdulla's literary activity, is considered a significant contribution to Azerbaijani literary criticism and cultural thought. In the book, the author analyzes the works of Kamal Abdulla an outstanding Azerbaijani writer, scholar, and public figure—within the framework of postmodernism. Ismayilova explores how the main features of postmodernism are reflected in Abdulla's works and reveals the connections between his creativity and the contemporary literary process.

The monograph pays special attention to the harmony between postmodernism and national identity in Kamal Abdulla's writing. Drawing on historical and mythical themes, he effectively represents traditional national values through postmodern approaches. His texts demonstrate "ideas such as the possibility of multiple interpretations" [5, p. 44], open-ended structures, polyphonic compositions, and dialogic relationships between author and reader.

By widely employing postmodern literary techniques in his works, Kamal Abdulla simultaneously preserves Azerbaijan's national cultural heritage, history, and literary traditions. This approach makes his writing unique and allows him to address issues related to national identity in a contemporary context. Through the transition from postmodernism to national authenticity, he emphasizes the richness of Azerbaijan's cultural and literary legacy. His creative vision demonstrates that the preservation of national identity is possible even in an increasingly globalized world. This perspective stands as a striking example of how national distinctiveness can endure in modern Azerbaijani literature during the postmodern era.

Kamal Abdulla, through his short stories, makes extensive use of postmodern literary techniques while simultaneously preserving Azerbaijan's national cultural heritage, historical memory, and literary traditions. This approach renders his work unique and presents the issue of national identity preservation in a contemporary and relevant context. Kamal Abdulla emphasizes the richness of Azerbaijan's cultural and literary legacy in the transition from postmodernism to national authenticity.

For instance, in the short story *"The Valley of Magicians"*, the author reinterprets motifs from traditional folk tales through a modern postmodern lens. The following passage is a vivid illustration of this approach: "He wasn't truly a magician, but everyone believed he was – including himself. It was as if he had been born with that name, as if the name had chosen him" [1, p. 22].

This sentence reflects both the postmodern "play of identity" and the deconstruction of mythological and heroic archetypes derived from oral and folk narratives. His literary work demonstrates that the preservation of national identity is possible even within a globalized world. This



approach serves as a striking example of how national uniqueness continues to thrive in contemporary Azerbaijani literature within the framework of postmodernism.

The monograph focuses on the core postmodernist elements found in Kamal Abdulla's texts, such as intertextuality, parody, and irony. Nargiz Ismayilova highlights how Abdulla successfully integrates traditional literature with postmodern techniques. This approach contributes to the layered meanings and complex structures found in his works.

Kamal Abdulla's postmodernist method is especially evident in one of his most renowned novels, *The Incomplete Manuscript*. In this work, the author reinterprets the ancient Azerbaijani epic *Kitabi-Dede Gorgud*, presenting its myths, legends, and spiritual values within a postmodern context. By synthesizing mythical and historical elements, he offers readers both a new perspective on the past and a fresh philosophical outlook on human existence and identity. Referring to ancient Azerbaijani history and the Dede Gorgud epic, the novel brings together past and present, myth and reality. Within this framework, concepts of national identity and cultural distinctiveness are presented through a postmodern lens; the narrative transcends the boundaries of realism and engages readers in self-reflective thought.

Philosophical and Psychological Dimensions in Kamal Abdulla's Works. Nargiz Ismayilova considers Kamal Abdulla's novel *"No One to Forget"* as one of the most notable examples of contemporary Azerbaijani literature distinguished by its philosophical depth and psychological insights. The novel foregrounds themes such as inner loneliness, the loss of memory, and confronting the past through the lens of this amnesia. It explores profound ideas regarding forgetfulness as a phenomenon that can occur at any moment in human life, as well as the inevitability of people being condemned to forget one another. One of the central themes of the novel is the loss of connection with one's past and the psychological consequences that follow.

In this work, Kamal Abdulla extensively utilizes the core techniques of postmodern literature. Elements such as intertextuality, fragmented narrative structure, non-linear representation of time, and semantic ambiguity are key features of the novel. By skillfully merging classical literary traditions with postmodern approaches, the author presents a deeply layered and multifaceted text to the reader. The novel realizes the concept of parallel worlds, which are uniquely constructed through the characters.

"F.Q. recalled the words of the Patriarch once more: One can reach the River Styx on the wings of this writing. – The true meaning of those words finally became clear to the bewildered and speechless F.Q. – The Patriarch had certainly been on the shores of the Styx" [4, p. 306].

The structure of the novel deviates from traditional linear narrative lines. By transcending the boundaries of time and space, Kamal Abdulla intertwines the past and present, fantasy and reality. This approach encourages the reader to reflect more deeply and engage in analytical interpretation. The novel is rich not only in universal themes but also in references to Azerbaijani national culture, history, and literary traditions. By alluding to Azerbaijan's cultural heritage, folk legends, historical events, and literary classics, Kamal Abdulla emphasizes the importance of preserving national identity. These aspects make the novel both modern and rooted in national heritage.

Kamal Abdulla's short story collection *"The Secret of Time or The Labyrinth of Stories"* is among the most compelling works in Azerbaijani literature that combine mystical, psychological, and philosophical elements. This book leads the reader into a labyrinth of stories that unfold across different times and places. Unlike traditional narrative styles, Abdulla's stories are filled with profound layers of meaning, extraordinary characters, and complex symbols that are sometimes difficult to decipher. Kamal Abdulla's short story collection *"The Secret of Time or The Labyrinth of Stories"* is one of the notable works in Azerbaijani literature that combines mystical, psychological, and philosophical elements. This book takes the reader on a journey through a labyrinth of stories that unfold across different spaces and times. For instance, in one of the stories from the collection, the following sentence appears: "A person wakes up from one dream only to fall into another — without even knowing which one is more real" [3, p. 185].



This expression reflects the dissolution of boundaries between reality and illusion, the depiction of the subconscious, and the embodiment of postmodern notions of relativism within the narrative. Such an approach is significant in that the author leads the reader not only through a plot, but through a labyrinth of time and space imbued with philosophical contemplation. In this work, Kamal Abdulla does more than simply tell stories — he invites reflection on the nature of time, memory, and reality itself.

Each story in the collection holds a secret and invites the reader to reflect and explore the mysterious dimensions of life. The events unfold in both real and metaphorical settings, blurring the lines between the tangible and the symbolic. Kamal Abdulla's language, rich in philosophical interpretation, demonstrates his mastery in portraying the unity of ancient and modern life. Each story addresses a distinct theme, yet all emphasize the relativity of time and space and the subtle boundary between reality and imagination.

This collection is particularly aimed at readers interested in philosophy and psychology, as well as those seeking a new and distinct narrative style in Azerbaijani prose. Through this work, Kamal Abdulla asserts his original voice in contemporary Azerbaijani literature and invites the reader to get lost—and then found again—within the labyrinth of stories.

His novel *"The Adventure of Secrets"* represents a work rich in metaphysical, philosophical, and psychological dimensions. This novel invites the reader to contemplate the mysteries of life and the human condition. The monograph emphasizes not only the artistic depth of the novel but also the investigation of mysterious and mystical occurrences, the connection between the human being and the universe, and the exploration of the deepest layers of the human psyche. Kamal Abdulla presents a metaphorical world to understand the links between knowledge and spirituality. The protagonists in the novel encounter their inner worlds through various stages of life, searching for answers to profound and mysterious questions. The language of *"The Adventure of Secrets"* is poetic and fluid, and the novel creates a platform for contemplating both the visible and invisible dimensions of existence. It ultimately serves as a literary space for reflecting on the meaning of life.

A Postmodern Labyrinth: Narrative, Time, and Identity in *The Adventure of Secrets*. In the monograph, Kamal Abdulla's novel *The Adventure of Secrets* is analyzed as a work that embodies the typical characteristics of postmodern literature and, within this context, demands deep critical examination. The novel incorporates elements such as complex narrative structures, the elasticity of temporal perception, and semantic multiplicity. Within this framework, the concepts of time and space are constructed as a postmodern labyrinth. In postmodern literature, characters are typically not one-dimensional; their identities, roles, and motivations are often filled with ambiguity and contradiction. Similarly, in *The Adventure of Secrets*, characters do not undergo development in the classical sense. Rather, their identities and actions are presented in a postmodern configuration.

The main characters of the novel do not possess clear motivations or backgrounds, as would be expected in traditional narratives. This situation complicates the reader's process of understanding the characters and transforms the pursuit of their "true" identities into a labyrinthine experience. The characters' identities are fluid and shift along with time and space, which aligns with postmodernism's rejection of the notion of a stable identity. The characters take on different roles across various temporal layers, making it impossible for the reader to place them within a single framework.

In postmodern literature, the narrative does not progress linearly through time. The concept of time in *The Adventure of Secrets* is similarly fragmented and complex, differing significantly from traditional storytelling. "Hasan teacher's office was a large and bright room. Bookshelves stood on all four sides, and bookcases hung on the walls. On one of the walls (the one where Hasan teacher's desk was placed), a map of medieval European and Asian countries was displayed" [2, p. 26]. This spatial description gives the impression that the map simultaneously evokes both the medieval and modern worlds, thus collapsing temporal boundaries. The novel shifts between different temporal



layers, often without any clear markers. This elastic and fragmented treatment of time corresponds to postmodernism's tendency to question the notions of "historical continuity" and "chronological time." By blurring the borders between past, present, and future, the novel highlights the relativity of time, thereby transforming the reader's perception of temporality and rendering the narrative more intricate.

Another hallmark of postmodern literature — polyphony is prominently featured in this novel. Multiple perspectives and stories are presented concurrently, making it impossible to reduce the narrative to a single point of meaning. The novel questions the boundaries between reality and fiction, turning the reader's search for the "real" into a labyrinthine endeavor. The monograph examines *The Adventure of Secrets* as a work that exemplifies the defining traits of postmodern literature, analyzing these characteristics in detail. Through its ambiguous character identities, its fragmented and flexible sense of time, and its multilayered themes, the novel invites the reader into a postmodern labyrinth.

Within this labyrinth, the reader is encouraged to question the boundaries between reality and fiction, while simultaneously exploring the relativity of concepts such as identity, memory, and time. The novel reflects the complex and multidimensional structure of postmodernism, offering an experience that transcends conventional storytelling.

CONCLUSION

Kamal Abdulla is an author who has successfully integrated postmodernism with national culture, significantly contributing to the development of Azerbaijani literature. His works are invaluable in terms of their application of contemporary literary techniques and the preservation of national values. Abdulla's ability to combine postmodern elements with the unique characteristics of Azerbaijani culture has made his works an essential part of modern Azerbaijani literature.

The book *Kamal Abdulla and Postmodernism* is a valuable resource for both literary scholars and readers interested in contemporary literature. This work is particularly beneficial for those who wish to gain a deeper understanding of Kamal Abdulla's creative world and explore the manifestations of postmodernism within Azerbaijani literature. Nargiz Ismayilova's analysis presents a new perspective in Azerbaijani literary criticism and makes a meaningful contribution to the advancement of modern literary studies. The book offers insightful interpretations that reflect on both the postmodern features of Abdulla's work and their connection to the broader context of Azerbaijani literary traditions.

In summary, Kamal Abdulla's works represent an exemplary fusion of postmodern literary techniques and the rich cultural heritage of Azerbaijan. His unique approach not only enriches the local literary landscape but also serves as a bridge between contemporary global trends and national identity, making a significant impact on the evolution of Azerbaijani literature.

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NƏRGİZ İSMAYILOVANIN “KAMAL ABDULLA VƏ POSTMODERNİZM” MONOQRAFİYASINDA POSTMODERNİST DÜNYAGÖRÜŞÜNÜN BƏDİİ ƏKSI

D.Ş. Əliyeva

Postmodernizm, 20-ci əsrin ortalarında yaranan və müasir dövrə qədər təsirini qoruyan fəlsəfi-estetik cərəyandır. Postmodernizm çoxşaxəli bir fenomen olaraq incəsənətdən siyasətə qədər hər sahədə iz qoyub. O, müasir düşüncəyə çeviklik, tolerantlıq və çoxmənalılıq gətirsə də, bəzi tənqidçilər onun dəyərləri nisbiləşdirdiyini iddia edir. Bu cərəyan, ənənəvi dəyərləri, obyektiv həqiqət anlayışını və klassik strukturları sorğulayır. Kamal Abdulla, postmodernizmin universal üsullarını Azərbaycanın mədəni kodları ilə uyğunlaşdıraraq, unikal bir ədəbi stil yaratmışdır. Onun əsərləri həm milli ədəbiyyatın inkişafı, həm də qlobal postmodern diskurs üçün əhəmiyyətli töhfədir. Nərgiz İsmayılovanın “Kamal Abdulla və Postmodernizm” monoqrafiyası bu yanaşmaları dərin təhlil edərək, müəllifin yaradıcılığını qlobal postmodern kontekstdə qiymətləndirir. Kitab, Azərbaycan ədəbiyyatında postmodernizmin milli mənbələrlə uğurlu birləşməsinə nümunə kimi Kamal Abdullanın rolunu vurğulayır.

Açar sözlər: *Skeptizm, eksperimental yanaşmalar, intertekstuallıq, zaman və məkan*

ХУДОЖЕСТВЕННОЕ ОТРАЖЕНИЕ ПОСТМОДЕРНИСТСКОГО МИРОВОЗЗРЕНИЯ В МОНОГРАФИИ НАРГИЗ ИСМАЙЛОВОЙ "КАМАЛ АБДУЛЛА И ПОСТМОДЕРНИЗМ"

Д.Ш. Алиева

Постмодернизм — это философско-стетическое направление, возникшее в середине XX века и сохраняющее своё влияние до наших дней. Будучи многогранным феноменом, постмодернизм оставил след во всех сферах — от искусства до политики. Несмотря на то что он привнёс в современное мышление гибкость, толерантность и многозначность, некоторые критики утверждают, что постмодернизм нивелирует ценности, делая их относительными. Это течение ставит под сомнение традиционные ценности, понятие объективной истины и классические структуры. Камал Абдулла, адаптируя универсальные методы постмодернизма к культурным кодам Азербайджана, создал уникальный литературный стиль. Его произведения являются важным вкладом как в развитие национальной литературы, так и в глобальный постмодернистский дискурс. Монография Наргиз Исмайловой «Камал Абдулла и постмодернизм» глубоко анализирует эти подходы, оценивая творчество автора в контексте мирового постмодернизма. Книга подчёркивает роль Камала Абдуллы как примера успешного синтеза постмодернизма с национальными источниками в азербайджанской литературе.

Ключевые слова: *скептицизм, экспериментальные подходы, интертекстуальность, время и пространство*



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**MADNESS AND GENIUS AS VEHICLES OF SOCIAL CRITIQUE IN THE CRITICAL
REALIST DRAMATURGY OF JALIL MAMMADGULUZADEH AND
ANTON CHEKHOV**

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*This article explores the aesthetic and philosophical functions of madness within the framework of critical realist dramaturgy, focusing on the works *The Mad Gathering* by Jalil Mammadguluzadeh and *Ward No. 6* by Anton Chekhov. Through a comparative approach, the study analyzes how the marginalized figures of the “little man” and the “surplus person” are constructed in early 20th-century Azerbaijani literature, emphasizing their symbolic roles in exposing social contradictions, ideological stagnation, and moral collapse. Madness is interpreted not as clinical deviance, but as a metaphor for resistance, ethical consciousness, and epistemological rupture. The article also provides a stylistic and semantic analysis of both authors’ dramaturgical techniques, revealing how madness functions as a critical tool for deconstructing normative behavior and institutional power. Ultimately, the study highlights the intellectual and emotional depth of critical realism and its ongoing relevance as a mode of social and artistic critique.*

Keywords: critical realism, madness, little man, surplus person, tragicomedy, dramaturgy.

INTRODUCTION

The emergence of critical realism as a literary movement in Azerbaijani literature at the beginning of the 20th century marked a significant stage in the evolution of modern literary thought. Unlike Enlightenment realism or romanticism, which either idealized the world or sought moral uplift through rationality and didacticism, critical realism aimed to confront reality as it was — unvarnished, contradictory, and deeply shaped by socio-political forces. It sought to analyze and represent life not through abstraction or allegory, but through the concrete experiences of ordinary individuals embedded in complex societal structures.

Critical realism, as a phase within the broader realist tradition, did not emerge as a mere reaction against previous movements. Rather, it functioned as a transformative continuation of them. While Enlightenment realism sought to educate and uplift through reason and morality, critical realism recognized the limitations of such ideals in addressing the entrenched inequalities and moral contradictions of the time. The shift from Enlightenment realism to critical realism thus stemmed from the historical realization that education and moral guidance alone were insufficient to dismantle the structural injustices of society.

One of the most defining features of critical realism is its dual nature — both literary and philosophical. From a philosophical standpoint, it was deeply invested in constructing a worldview grounded in objective reality while acknowledging the organic, social, and spiritual dimensions of human existence. As certain philosophical interpretations assert, realism operates at three interconnected levels: the organic (natural existence), the social (historical and communal life), and the spiritual (individual consciousness and values). The human being becomes the central point that binds these layers together, serving as the lens through which the world is both experienced and interpreted.

From a literary-theoretical perspective, critical realism distinguishes itself through its method of social cognition. It does not merely portray life passively but seeks to critically analyze the socie-



tal conditions, contradictions, and moral decay that shape individual destinies. In doing so, it systematically rejects excessive romanticization, sentimentality, and mysticism. The critical realist writer becomes not only an artist but also a social thinker, a diagnostician of cultural and political maladies. This approach renders the writer's work both a form of literary expression and a vehicle for socio-political critique.

Importantly, critical realism did not aim to completely erase the influence of past aesthetic movements. As Yashar Garayev notes, *Enlightenment realism continues to coexist with critical realism for a long time, and on the other hand, critical realism itself is not completely cleansed of enlightenment ideology and motives* [5, p. 126]. This coexistence allowed critical realism to retain elements of moral concern and humanist values while moving toward a deeper engagement with the contradictions of modern life. The plurality of literary movements within Azerbaijani literature during this period further enriched the aesthetic and ideological landscape, enabling mutual influence and hybridization.

The rise of critical realism was also conditioned by broader historical processes: scientific and technological advancements, economic shifts, political upheavals, and the rise of revolutionary-democratic ideologies. Literature, as a reflection of its time, inevitably absorbed and responded to these forces. Thus, the development of critical realism can be seen as both a product of and a response to the social tensions, aspirations, and transformations of the early 20th century.

Despite its depth and richness, the historical-evolutionary approach to studying critical realism remains underdeveloped in some respects. While this method allows for a schematic and accessible understanding of literary processes, it sometimes lacks the nuance needed to capture the ideological complexity of the movement. Future research, therefore, must continue to address these gaps by examining critical realism not only as a literary style but also as a cultural and philosophical paradigm that shaped — and was shaped by — its historical moment.

MAIN PART

A core achievement of critical realism in Azerbaijani literature is its profound reorientation of narrative focus — away from the elite, the idealized, or the heroic, and toward the ordinary, the disempowered, and the socially invisible. This literary shift reflects not only a change in character typology but a radical rethinking of the moral, philosophical, and ideological purpose of literature. The “**little man**” (*kiçik adam*) and the “**surplus man**” (*artıq adam*) emerge in this framework as emblematic of both structural marginalization and inner human fragmentation. These figures serve not merely as representations of personal misfortune but as aesthetic symbols of a society in moral and ideological crisis.

The “little man” in critical realist literature is frequently a member of the lower social strata: a peasant, a petty clerk, a religious devotee, or a struggling worker. However, his smallness is not simply material or occupational — it is epistemological and existential. He is small because he has been rendered so by the structures of oppression around him: by ignorance institutionalized through clericalism, by poverty reproduced through feudal or colonial economies, and by powerlessness normalized through cultural submission. His existence is marked by dependency, silence, and spiritual stagnation.

In Jalil Mammadguluzadeh's works, these “little” characters populate almost every corner of his fictional world. Yet they are not merely objects of pity — they are the instruments through which the writer critiques the cultural, religious, and political systems that manufacture passivity and ignorance. In *The Mad Gathering* (*Dəli yığıncağı*), for example, we see an entire setting dominated by confused, blindly obedient, or superstitious characters whose perceptions of reality are shaped by false sheikhs and fake moralists. Their condition is not individual weakness, but collective blindness — a blindness produced by the very institutions that claim to enlighten them.

Importantly, Mammadguluzadeh's portrayal of the “little man” is not romanticized. He does not imbue these characters with latent heroism or idealistic virtue. Rather, he presents them with



psychological realism and satirical edge. The tragedy lies in their inability to see their own degradation — or worse, in their willingness to participate in the structures that degrade them. As Mammadguluzadeh suggests through his biting irony, ignorance is not only a result of social conditions but is often culturally internalized and voluntarily reproduced.

Distinct from the “little man” is the figure of the “surplus person” — often a more educated, introspective, or morally sensitive character who finds himself ideologically disconnected from both the ruling elite and the subjugated masses. This figure is deeply alienated: he is too aware to be content, but too isolated or powerless to effect change. His tragedy is not material poverty but intellectual and existential futility [4, p. 46].

This type of character resonates with the broader tradition of the “superfluous man” (*лишний человек*) in Russian literature — found in the works of Turgenev, Lermontov, and Dostoevsky — yet in the Azerbaijani context, it acquires a uniquely postcolonial and cultural specificity. The Azerbaijani surplus person is not just ideologically lost; he is also linguistically and spiritually displaced. He stands at the intersection of East and West, tradition and modernity, nationalism and submission. His words are often unheard, his insights unvalued, his actions ridiculed.

The existential crisis of the surplus person finds powerful expression in characters such as Molla Abbas in *The Mad Gathering*, whose internal lucidity is masked under a public performance of madness. He speaks the truth — but in a language no one understands. He critiques the society — but from within a role that society has already declared insane. The performativity of madness thus becomes a mechanism of both survival and resistance. Molla Abbas may be deemed “crazy” by his peers, but it is precisely through that label that he is allowed to speak freely. He becomes a prophet in a world that only permits prophecy under the cover of delirium.

Jalil Mammadguluzadeh often unites the “little man” and “surplus man” within a single tragicomic frame. The tragicomic genre — one of the most innovative forms in Azerbaijani critical realism — allows for the juxtaposition of absurdity and insight, pain and laughter, clarity and chaos. Characters such as Molla Abbas embody this duality. On one hand, they belong to the “little people” in terms of social class and powerlessness. On the other, they possess a moral and intellectual insight that places them outside the herd. Their madness is not mental illness but a poetic strategy — a way of being different without being destroyed.

In this sense, the tragicomic structure serves a dual function. It disarms censorship by framing truth as absurdity, and it deepens audience engagement by evoking both laughter and unease. It asks the reader not merely to sympathize with the character but to question the world that labels such characters as irrational. This aesthetic strategy becomes a subtle form of ideological resistance.

The inclusion of these marginalized typologies is not only a matter of character development — it is an ideological and epistemological intervention. Through them, Mammadguluzadeh and other critical realists seek to diagnose a society suffering from what might be called a “poverty of consciousness.” They do not blame individuals for their fate, but they hold society accountable for the structures that prevent enlightenment. Literature, in this view, becomes not a mirror of the ideal but a scalpel that dissects the real.

Moreover, these typologies challenge the traditional heroic paradigm that dominated earlier literary movements. Instead of glorifying sacrifice, idealism, or divine justice, critical realism presents ambiguity, paralysis, and internal struggle as legitimate literary subjects. This opens the door to a more human, complex, and historically grounded literature.

Ultimately, the “little man” and the “surplus person” function as complementary lenses through which critical realism examines the moral, psychological, and social fabric of Azerbaijani society. They are not simply characters; they are diagnostic tools. Their voices — confused, repressed, ironic, or defiant — articulate the deep fractures of a society in transition. Through them, literature transcends description and becomes critique; fiction becomes thought. Their presence in Azerbaijani critical realism is thus not merely a stylistic choice, but a moral necessity.

The motif of madness in critical realist dramaturgy, particularly as represented in the works of Jalil Mammadguluzadeh and Anton Chekhov, transcends its conventional clinical or psychopathological meanings. In these works, madness is not merely a symptom of personal instability but an aesthetic strategy — a deliberate narrative and philosophical device used to interrogate the moral contradictions, political hypocrisies, and ideological stagnation of normative society. Within the framework of critical realism, madness is functionalized as a counter-discourse: a symbolic language through which unspoken truths about the individual, society, and the state are laid bare.

Traditionally, madness in literature has been treated either as a source of comic relief or as an expression of internal psychological torment. In critical realism, however, it becomes something far more powerful: a form of epistemological rebellion. It serves to destabilize hegemonic narratives and to challenge normative categories of rationality and morality. Madness in this context is not what separates the character from reality — it is what enables the character to perceive reality more clearly than those considered “sane.”

In *The Mad Gathering* (*Dəli yığıncağı*), Jalil Mammadguluzadeh creates a microcosm of society populated by characters who either feign madness to survive or are so consumed by ideological, religious, or moral delusion that they have lost touch with human reason. The play becomes a powerful indictment of a society where true sanity is indistinguishable from madness, and where the truly mad are often the only ones who speak the truth.

Molla Abbas, a central character in the play, epitomizes this inversion. Outwardly, he appears eccentric and erratic, but his monologues reveal a sharp, ironic awareness of the sociopolitical absurdity around him. In a pivotal scene, his address to Sona — filled with pain, irony, and philosophical reflection — culminates in his declaration: “By God and by all that is holy, we have fallen into a true ‘the mad gathering’” [6, p. 387]. In this context, madness is not the issue; it represents reality itself. His “madness” acts as a protective mask, a survival mechanism, and, most importantly, a narrative strategy to reveal the hidden contradictions within the system.

Anton Chekhov’s *Ward No. 6* employs a structurally different but thematically parallel approach. The protagonist Ivan Dmitritch is initially presented as a psychologically unstable inmate [8]. However, through his philosophical dialogues with Dr. Ragin, it becomes increasingly evident that his “madness” is a form of lucid resistance — an uncompromising moral response to a corrupt and indifferent world. His inability to reconcile with the injustices of society places him at odds with institutional norms, and thus he is diagnosed as mad. The ward in which he is confined becomes a metaphorical space — a prison for truth in a world ruled by ethical decay and social cruelty.

Dr. Ragin, on the other hand, embodies the figure of moral passivity and intellectual surrender. Despite his education and position, he fails to act, fails to intervene, and eventually becomes a victim of the very system he upheld. His descent into the very madness he once diagnosed reflects the impossibility of remaining neutral in a world that demands moral positioning. Thus, both madness and sanity are reversed: the “patient” is the philosopher; the “doctor” is the fool.

In both plays, madness is not only a state of mind — it is a **performative identity**. The mad characters use speech, gesture, irony, and silence as tools to navigate and challenge the boundaries imposed by society. Their dialogues are often more coherent and philosophically profound than those of the supposedly rational characters. This subversion forces the audience to reconsider what it means to be “sane.”

In *The Mad Gathering*, Molla Abbas uses body language, exaggerated emotion, and contradictory statements to confuse his interlocutors, but his purpose is always to protect truth and integrity. His refusal to conform to expected patterns of discourse — his laughter, his sudden cries, his gestures — all serve to undermine the rigid, oppressive moral codes around him. His madness is theatrical, but it is also revolutionary. He is not mad in spite of his clarity; he is clear because he is mad.



Similarly, in *Ward No. 6*, Ivan Dmitritch's philosophical monologues mirror classical Socratic dialogues. His madness is marked by self-reflection, ethical rigor, and a refusal to accept injustice. His perceived mental instability is, in fact, a critique of society's collective madness — its cruelty, apathy, and hypocrisy. Chekhov does not portray Ivan as a caricature but as a tragic intellectual whose only mistake is to feel too deeply and think too independently [1, p. 143].

What both authors ultimately reveal is that madness is not a deviation from the norm — it is a literary metaphor for those who refuse to accept false norms. The societies depicted in these works are themselves insane: guided by dogma, fear, corruption, and illusion. Those who appear mad are, in fact, morally awake and spiritually conscious. Through this aesthetic inversion, Mammadguluzadeh and Chekhov position madness as an ethical stance, not a psychological failure.

This theme resonates especially in colonial or semi-colonial contexts like early 20th-century Azerbaijan. The madman becomes a national allegory — a symbol of the oppressed voice that refuses to be silenced. He is the truth-teller disguised as a fool, the philosopher misread as a lunatic. The space of madness becomes a refuge from social conformity and a platform for critical engagement.

Moreover, both playwrights use the spatial metaphor of confinement — whether a madhouse, a village, or a ward — to signify the limits of free thought in their societies. The physical boundaries echo the ideological restrictions of the time. Inside these confined spaces, characters transcend their limitations and express truths that are unspeakable in the outer world. The madhouse thus becomes a paradox: a place of captivity that grants intellectual liberation.

Despite differences in style and tone, Mammadguluzadeh and Chekhov share significant intertextual parallels. Both plays feature protagonists who are socially isolated, morally intense, and intellectually active. Their monologues serve as counter-discourses to the silence, repression, or stupidity of their surroundings. Both plays juxtapose madness with institutional power — whether religious in Mammadguluzadeh or medical in Chekhov — and reveal how these institutions control knowledge, label dissent, and perpetuate injustice [7].

Stylistically, Mammadguluzadeh employs satire, grotesque imagery, and tragicomedy. His language is hyperbolic, filled with irony and performative intensity [5, p.125]. Chekhov, in contrast, adopts a subdued, introspective tone, rich with psychological nuance and ethical ambiguity. Yet both styles converge in their use of madness as critique: one loud and theatrical, the other quiet and devastating.

In critical realist dramaturgy, madness becomes both a mirror — reflecting the contradictions and cruelties of society — and a weapon — destabilizing dominant ideologies and speaking truths that cannot be spoken otherwise. It is through the voices of the mad that we hear the clearest critiques of injustice. *It is through their gestures that we see the deepest wounds of conscience* [9].

For Mammadguluzadeh and Chekhov, the madman is not an outcast to be pitied or corrected. He is a prophet, a thinker, a survivor. He inhabits the margins of language, space, and reason — but from there, he sees what others refuse to see. His madness is not a fall from humanity but a different form of it. In this way, both authors reimagine dramaturgy as a space not only for narrative, but for resistance — not only for story, but for truth.

In the dramaturgical landscapes of Jalil Mammadguluzadeh and Anton Chekhov, madness transcends its literal meaning to emerge as a symbolic construct — a semantic vessel through which deeper social, moral, and existential meanings are encoded. Far from representing psychological illness alone, madness functions as a signifier of collective trauma, ethical decay, and societal absurdity. It is in this capacity that madness in critical realist literature becomes both a metaphor and a method, enabling authors to critique dominant ideologies, challenge epistemic norms, and unveil the often-hidden structures of repression.

In semiotic terms, madness in *The Mad Gathering* and *Ward No. 6* serves as a cultural sign — a coded expression of abnormality that is socially constructed rather than medically diagnosed. It operates within a binary system: sanity vs. madness, reason vs. irrationality, conformity vs. devian-



ce. However, both authors subvert this binary. In their dramatic universes, those labeled as “mad” often exhibit greater moral clarity and existential insight than those accepted as “sane.” Thus, madness is deconstructed and re-signified — transformed from a pathological condition into an epistemological privilege.

This subversion of meaning challenges the authority of institutional discourse. In Chekhov, the psychiatric ward becomes a linguistic regime: it defines what can be said, by whom, and with what consequences [2]. Ivan Dmitritch’s articulate critiques are dismissed not because they lack logic, but because they threaten institutional authority. His classification as mad is not an objective observation but a politically motivated silencing.

In Mammadguluzadeh’s dramaturgy, madness is similarly a weaponized label. Molla Abbas’s behavior violates social norms — not due to delusion, but because he refuses to participate in the collective performance of hypocrisy. His monologues *carry layers of irony, indirect criticism, and moral disgust* [3]. The more sharply he speaks the truth, the more readily he is declared mad. Here, madness is a semiotic shield, protecting the speaker from censorship while simultaneously granting them a license to critique.

While both authors use madness to critique their respective societies, their stylistic approaches differ markedly.

The speech patterns of his mad characters, especially Molla Abbas, blend lyrical emotion with cutting sarcasm. These characters laugh, cry, gesticulate, and interrupt themselves — not out of incoherence, but as a deliberate dramatization of their moral urgency. His madness is performative, theatrical, and often confrontational. Through comic exaggeration, he constructs a moral grotesque that mirrors the monstrous contradictions of society itself.

Thus, while Mammadguluzadeh’s stylistic approach externalizes madness — making it visible, loud, and symbolically loaded — *Chekhov’s style internalizes it, using madness as a lens to explore alienation, isolation* [1, p. 32], and the erosion of personal agency.

In both authors’ works, madness is not only a metaphor but an ethical stance. It marks the individual’s refusal to remain complicit in a world that has normalized injustice. By declaring the morally sensitive as mad, society absolves itself of guilt and suppresses dissent. Therefore, madness becomes a space of ethical resistance.

From an aesthetic perspective, madness provides a form of narrative liberation. It frees characters from the constraints of rational discourse and allows playwrights to invent new modes of speech, new symbolic structures, and new emotional registers. In the hands of Mammadguluzadeh, madness becomes a poetic mask that unveils truth; in Chekhov, it becomes a philosophical veil that deepens ambiguity.

Additionally, both authors blur the boundaries between madness and performance. Their characters often adopt madness strategically, as a means of communicating with an unhearing world. This introduces a meta-theatrical layer to the plays: the audience is forced to ask whether madness is real, performed, or both — and whether, in a world so unjust, madness may actually be the most rational response.

The semantic and stylistic deployment of madness in the dramaturgy of Jalil Mammadguluzadeh and Anton Chekhov functions as a complex literary tool that goes beyond individual pathology. It becomes a symbol of truth in exile, a voice of resistance, and a mirror of collective dysfunction. Through divergent styles — one satirical and public, the other introspective and private — both authors elevate madness into a language of its own.

Critical realism, in this context, proves itself not only as a method of social depiction but as a vehicle of semantic subversion and ethical imagination. It challenges what society deems normal, decent, or rational, and reveals that beneath these facades often lies violence, corruption, and hypocrisy.



In this dramaturgical cosmos, madness is not the end of reason — it is its rebirth. Not a fall from truth — but a desperate grasp for it.

CONCLUSION

Through an in-depth analysis of Jalil Mammadguluzadeh's *The Mad Gathering* and Anton Chekhov's *Ward No. 6*, this article has demonstrated that madness in critical realist literature is not a sign of personal instability, but rather a philosophical and aesthetic response to systemic injustice. Both authors use the motif of madness to challenge institutional authority, redefine rationality, and critique the moral contradictions of their respective societies. The typologies of the “little man” and “surplus person” serve to expose the alienation and disempowerment of individuals trapped in a morally bankrupt world. The stylistic contrasts between Mammadguluzadeh's satirical grotesque and Chekhov's introspective realism reflect different yet complementary approaches to representing existential crisis. Ultimately, the article affirms that critical realism — far from being a dated literary style — remains a powerful lens through which to interrogate the relationship between the individual and society, especially in times of ideological decay and cultural transformation.

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DƏLİLİK VƏ DAHİLİK TƏNQİDİ REALİST DRAMATURGIYADA SOSIAL TƏNQİD MOTİVİ KİMİ: CƏLİL MƏMMƏDQULUZADƏ VƏ ANTON ÇEXOVUN YARADICILIĞI ƏSASINDA

Ş.Ş. Əliyeva

Məqalədə tənqidi realizmin dramaturji çərçivəsində “dəlilik” obrazının estetik və fəlsəfi funksiyaları araşdırılır. Cəlil Məmmədquluzadənin *Dəli yığıncağı* və Anton Çexovun *Palata №6* əsərləri əsasında aparılan müqayisəli təhlildə “kiçik adam” və “artıq adam” tipajlarının 20-ci əsrin əvvəlləri Azərbaycan ədəbiyyatında necə formalaşdığı və onların sosial ziddiyyətlərin, ideoloji iflasın və mənəvi tənəzzülün simvolu kimi təqdim olunduğu izah edilir. Dəlilik burada klinik pozuntu yox, müqavimətin, əxlaqi oyanışın və biliyə qarşı çıxışın metaforası kimi şərh olunur. Məqalədə hər iki yazıcının dramaturji üslubu və semantik yanaşmaları təhlil edilir və dəlilik obrazının normativ davranışa və institusional gücə qarşı necə kritik alət kimi istifadə olunduğu göstərilir. Nəticədə, tənqidi realizmin intellektual və estetik dərinliyi vurğulanır və onun bu gün də aktual bir ədəbi-bədii təhlil üsulu olduğu təsbit edilir.

Açar sözlər: *tənqidi realizm, dəlilik, kiçik adam, artıq adam, tragikomediya, dramaturgiya*



БЕЗУМИЕ И ГЕНИАЛЬНОСТЬ КАК ЭСТЕТИЧЕСКИЕ ФОРМЫ СОЦИАЛЬНОЙ КРИТИКИ В ДРАМАТУРГИИ КРИТИЧЕСКОГО РЕАЛИЗМА НА ПРИМЕРЕ ДЖАЛИЛА МАМЕДКУЛИЗАДЕ И АНТОНА ЧЕХОВА

Ш.Ш. Алиева

В статье рассматриваются эстетические и философские функции мотива безумия в рамках критического реализма, на примере пьес «Собрание безумцев» Джалиля Мамедгулузаде и «Палата №6» Антона Чехова. В ходе сравнительного анализа исследуется, как в азербайджанской литературе начала XX века формируются типажи «маленького человека» и «лишнего человека», раскрывающие социальные противоречия, идеологическое обессиливание и моральный упадок общества. Безумие интерпретируется не как клиническое отклонение, а как метафора сопротивления, этического пробуждения и разрыва с навязанной рациональностью. Особое внимание уделяется стилистическим и семантическим особенностям драматургии обоих авторов, где безумие выступает как инструмент критики норм поведения и институциональной власти. В результате подчеркивается глубина интеллектуального и эмоционального воздействия критического реализма и его актуальность как метода художественного осмысления общества.

Ключевые слова: критический реализм, безумие, маленький человек, лишний человек, трагикомедия, драматургия



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THE CONCEPT OF GOPUZ IN TURKIC AND HUNGARIAN FOLKLORE

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Folklore exists due to the nations who create, preserve, and enrich it, embedding their unique national characteristics and identity. Each example of the folklore has a creator and it becomes popular by passing "from tongue to tongue" between the individuals of this separate nation. Furthermore, these samples spread among other nations transcending beyond the borders, making new versions possible to appear. This is the case with the nomadic Turkic and the neighbour peoples lived together with them. Gopuz is one of the famous folkloric element of nomadic Turkic people which was inherited by the other nations like Hungarians.

This article addresses the historical roots of the Gopuz, examining its role in traditional rituals, epic narratives, and cultural symbolism. Special attention is given to the historical interactions and exchanges between Turkic tribes and Hungarian peoples, which significantly influenced Hungarian folk music and cultural practices. A comparative analysis highlights similarities and differences between the Turkic Gopuz and its Hungarian counterpart, the Koboz, considering their roles in spiritual, ceremonial, and secular contexts. Additionally, contemporary initiatives aimed at preserving and promoting the Gopuz and Koboz in both Turkic and Hungarian cultures are discussed, underscoring their importance for cultural heritage and identity.

Keywords: Ahmad Jafaroglu, folklore, Hungarian, Turk, gopuz, koboz, Turkic culture, Turkic-Hungarian relations, nomadic traditions

INTRODUCTION

The folklore of each nation is closely related to its lifestyle, living conditions, mindset, aspirations, and cultural memory, reflecting their historical background comprehensively. Hence it directly signifies itself in the context of historical and social conditions. Therefore, folklore is an essential key to understanding the socio-cultural history and collective memory of nations. The uniqueness and cultural identity of each historical period are encapsulated within folklore samples. The fact that folklore has represented the socio-cultural space inhabited by people for centuries makes it necessary to work on it. The study of relations between nations could not be feasible without touching their folklore traces. Thus it is possible to see the similarity of elements and ideas in the comparative analysis of national folklore samples - folk tales, songs, myths, legends, proverbs and parables. From this point of view, it should be noted that the similarity of leitmotifs is easily cognised in the folklore cultures of the nomadic Turkic people and the Hungarian people who lived together with them for some time, then migrated to the west.

The Hungarians' involvement in regional conflicts further influenced their migratory movements. The westward migration of the Hungarian tribes under the leadership of Árpád in the late 9th century was a complex process influenced by various socio-political pressures and interactions with neighboring nomadic Turkic tribes, leading to significant cultural exchanges and mutual influences.

The Hungarians, whose main homeland was Eurasia, lived side by side with the Turks in the steppes between the Ural and Altai mountains and in the 4th century, as a result of Hun influxes, settled in the Middle Volga region. They called these areas "Magna Hungaria". In 894, under the leadership of Arpad, they moved west and set up their home in the Carpathian basins. Pechenegs,



Alans and Kumans, who came to Hungary as early as the 10th century, organized the formation of the Hungarian people in the 13th and 14th centuries by "becoming Hungarian" and changing their religion to Christianity. It was at this time that many Turkish words began to be used in the Hungarian language [7, p. 3-4]. The Khazars exerted considerable influence over the Hungarians, evident in the adoption of certain political and military structures. For instance, the Hungarian leader Levedi was offered a position of prince by the Khazar Khagan, which he declined, recommending instead Álmos or his son Árpád for the role. This episode underscores the intertwined leadership structures and the depth of their interactions.

MAIN PART

The influence of the Turkic peoples' culture could be found in a wide range of areas of the Hungarian folklore, from Hungarian folk music to ethnography even including the Hungarian language. This impact has been studied for more than a hundred years. The relationships between Hungarians and Turkic nations influenced Hungarians' political alliances, military strategies, cultural practices, and linguistic development. The legacy of these interactions is still evident in various aspects of Hungarian culture today, underscoring the enduring impact of these early connections.

Not only in the works, articles and speeches of local turkologists, but also Hungarian scholars and researchers like Ignác Kúnos, György Hazai, Sandor Takats, Gyula Németh, Lajos Ligeti, László Rásonyi, Edina Dallos, Eva Csaki, János Sipos and others, this efficacy was highlighted.

Prominent Azerbaijani scholar Bakir Chobanzada, while studying the Turkic oral folk literature specially emphasized the influence of Turkic folk literature to the other nations: "Turkic-Tatar folk literature has not stopped influencing the literature of other nations. Such is the influence of Turkic folklore on Hungarian, Greek, Russian, Armenian, Persian ... folk literature" [5, p. 193]. An important part of Bakir Chobanzada's research is the folklore of Turkic tribes and relations of Turkic and other nations. The author advised that most of the Turkish words used in the language and folk literature of these nations come from the contact with the Turks and this fact is irrefutable. Similarly, Hungarian linguist Zoltán Gombocz (1877-1935) contributed significantly to understanding Turkish loanwords in Hungarian, providing deeper linguistic context to these cultural exchanges.

While analyzing the relationship between Hungarians and Turkic people, it is possible to observe the influence of the Turkic peoples' culture from Hungarian folk music to their ethnography. In this picture, the importance of folk music should be particularly emphasized. An integral part of Turkic music has been the gopuz musical instrument, which is considered one of the first musical instruments used among Hungarians. According to Ahmad Jafaroglu's research, starting with Hun Turks, gopuz was widely used in Europe by Hungarians, Czechs, Poles, Lithuanians, Russians, Ukrainians, Finns, the local population of Africa and the Balkan nations. Music was perceived as a force that helps people to free themselves from the difficulties and sufferings of the world, promises a happy life and future, and creates a connection between people and the other world [2, p. 203].

Ahmad Jafaroghlu, a distinguished Azerbaijani-Turkish linguist and scholar, made significant contributions to the study of Turkic languages and cultures. His research extensively covered the Gopuz, an ancient stringed musical instrument integral to Turkic folklore and musical traditions. In his seminal articles titled "Cihan Edebiyatında Türk Kobuzu" ("The Turkish Kobuz in World Literature"), published in *Ülkü* journal in 1936 and 1937, Caferoğlu delved into the historical and cultural significance of the Gopuz. He traced its origins in Central Asia and examined its evolution and dissemination across various regions, including its influence on neighboring cultures such as the Hungarians. Jafaroghlu highlighted the instrument's role in the oral traditions of Turkic peoples, emphasizing its use by bards and minstrels in narrating epics and conveying communal values. Furthermore, Jafaroghlu's research underscored the Gopuz's symbolic importance, portraying it as more than a musical instrument. He identified it as a vessel of cultural transmission, embodying the spiritual and social ethos of Turkic communities. His meticulous documentation and analysis have



been instrumental in preserving the legacy of the Gopuz, offering valuable insights into its construction, variations, and the contexts in which it was traditionally played.

It is possible to show a lot of resemblances between Hungarian and Turkic folklore where we could emphasize the similarity of folk music. Thus, the Turkic peoples who settled in Central Asia had distinct musical customs. In various ceremonial contexts such as hunting, battle, weddings, and mourning, minstrels performed songs accompanied by the gopuz, entertaining or comforting the community. In wedding, praise and post-hunting ceremonies, the song-poetry recitations were accompanied by dances.

As a result of these pre-Islamic customs, the oral music played a great role in the formation and spread of epics, folk songs and folktales among the people. The musical presentation of ideas and themes was easily engraved to the memories. Undoubtedly, ideas and traditions that have changed over the years have not lost their attachment to their roots and are reflected in legends, narratives and epics. Musical instruments have a special place in the spread of this kind of folk songs and tales that glorify the national spirit and values.

In his monograph “Ozan-aşıq sənəti” (The Art of Ozan-Ashiq), M. Gasimli also addresses the influence exerted by the gopuz on Armenian and Georgian cultural traditions: “Since Arabic served as the language of science, Persian as the language of written literature (particularly poetry), and Turkic as a lingua franca for folklore across the entire Eastern world and regions influenced by the East during ancient and medieval times, it is natural that the “kopuz player” gained prominence within the cultural and spiritual environments of Armenian, Georgian, Ukrainian, and other neighboring peoples under names such as “gusan”, “gosan (mgosan)”, and “kobzar”” [11, p. 58].

In studies carried out to determine the origin of gopuz, it has been observed that the historical presence of the instrument can be traced back approximately one thousand years. According to sources, the earliest known text where the word “gopuz” is explicitly used as the name of a musical instrument dates back to the Uyghur period. In Old Uyghur texts, particularly in the narrative of “Edgü Ögli Tigin and Ayıg Ögli Tigin” (The Prince with Good Thoughts and the Prince with Evil Thoughts), the term “gopuz” clearly appears as the name of a musical instrument [9]. The most comprehensive source providing information about the meaning, characteristics, and usage areas of the term gopuz in Turkish cultural life that has reached the present day is the *Dîvânü lugâti't-Türk*. In this work, Mahmud al-Kashgari specifies that the word kubuz refers to an instrument similar to the lute (ud).

In general, gopuz has been an important tool in the spread of Turkish spiritual history and folklore. The influence of the Turkish gopuz can be seen in the sympathy shown to folk poets and the importance given to music in the court of the western rulers. Gopuz, as “a Turkish relic that entered the life and literature of the eastern and western nations at the earliest”, was able to preserve its existence even if it underwent minor changes in the folk creativity of other nations [3, p. 411]. The Gopuz embodies both the cultural memory and heroic ethos of Turkic communities, functioning as a powerful symbol of unity, bravery, and spiritual guidance.

Dede Gorgud, the symbol of Turkishness of the Turkic peoples, used to walk around with his hands like a saint, decide the fate of peoples by singing songs, give names to the brave, and try to convey to the people the differences between good and bad, brave and cowardly. It was an indicator of the value given to gopuz among the peoples. In legends related to this subject, it is narrated that when Dede Gorgud began to play the kopuz, the wind ceased to blow, birds stopped flying and the waters ceased to flow. Hence, “Book of Dede Gorgud” can be considered the primary source that reflects the importance of gopuz in Turkic cultural life.

The role of Gopuz in Turkic culture can be significantly expanded by examining specific Turkic epics, notably the epic of “Alpamysh” and the other “Oghuz epic” traditions. In the epic of Alpamysh, the Gopuz is depicted as a spiritual instrument that grants the hero strength, wisdom, and guidance through difficult times, symbolizing a divine connection and moral authority. The Al-



pamysh epic (also known as Alpamiş or Alpamis) is a renowned heroic epic widely celebrated among Turkic-speaking peoples in Central Asia, including the Kazakhs, Uzbeks, Karakalpaks, and others. The epic revolves around the adventures of Alpamysh, a legendary hero known for his bravery, loyalty, and moral strength. Alpamysh faces numerous challenges, battles formidable foes, and demonstrates profound wisdom and courage throughout the narrative. The Gopuz holds special significance within the Alpamysh epic, symbolizing spiritual guidance, cultural heritage, and moral authority. It is frequently depicted as empowering the hero, providing both spiritual support and inspiration. According to Karl Reichl, the instrument also serves as a tool for preserving the oral tradition, ensuring the transmission of cultural values and moral teachings from one generation to another [13, p. 138].

The Turkish influence in Hungarian music was manifested in the court of Attila, whom the Hungarians call their father. The traditions of Attila's court were later organized in the court of the Hungarian kings. The organization of feasts similar to those held at Turkic courts, the recitation of heroic epics by bards (ozans), and songs recounting the bravery and deeds of Attila, kings, and knights, as well as praises performed during these occasions, highlight the significant impact of Turkic folk songs and epic poetic traditions on Hungarian folk epics and songs.

An interesting note about this is also shown in the book “Turkishness in History” by the prominent Hungarian Turkologist Laszlo Rásonyi (László Rásonyi (1899-1984)). The 5th century Greek historian and rhetorician Priscus of Panion (Priscus(5th century)) made a diplomatic visit to the palace of the Hun emperor Attila as part of the Byzantine embassy in 448/449. When he talks about the Huns in his notes, he states that they have Turkic songs and heroic epics. So, when Attila enters the palace, Hun girls meet him with Turks. While sitting at the table together with the representatives of the embassy, two Hun singers sang songs about his heroism, victories and bravery in battles with gopuz [12, p. 35].

It was accepted as a national custom and tradition to present musical instruments to the guests in the palaces of the Hun-Turks before Christmas [2, p. 204]. Music was given special value, and musical instruments were sent as valuable gifts to palace guests and kings of other countries. For example, we can show the information that Attila sent the Hun Orchestra as a gift to the king of Burgundy [8, p. 290].

According to the information of Sándor Takáts (1860-1932), folklore elements such as saz, türkü and fairy tales were developed in Turkish and Hungarian societies in the 16th century. Thus, saz poets, instrumentalists, singers and many soldiers who were captured in wars traveled from forts to forts, from palaces to palaces, and conveyed their stories of bravery through songs, tales, and epics, and the culture of both nations merged and mixed with each other. Hungarian saz poets and singers increased during the Turkish period (after the Battle of Mohács (1526, August 29, Hungarians were under the influence of the Turks for a while), and in general, like the Turks, they performed songs with oud, drums, and bow instruments [15, p. 215-217]. For example, the Hungarian singer Tinadi recited the battles between the Ottomans and the Hungarians, the events in the fortresses and the borders, and chanted through the oud with using hand gestures in rhythm with the song [6, p. 6].

According to Zoltán Gombocz (1877-1935), Hungarians got acquainted with gopuz through the Kipchaks in the 13th century [3, p. 411-412]. In the 14th century, there were musicologists among the Hungarians who played gopuz. In one of the editions printed in Hungary in 1604, “gopuz” is indicated as “kobos” or “kobz” (“pondura”, “lyra”). In another dictionary from 1647, it is expressed as “koboz” (“lyra”). Ármin Vámbéry proposed the idea that the names of the musical instruments used in the Hungarian language are related to Turkish culture. For example, cseng in Hungarian has the same meaning as zeng = Turkish chengi, yatek (Mac.) = bed (Altay), koboz (Mac.) = Turkish-Tatar gopozu [3, p. 412].

Dr. Fuad Köprülü referencing Gyula Mészáros notes that the term “koboz” appeared in Hungarian language usage at the beginning of 1327. The musicians who played this instrument were



called “kobzos” and the names like Yohan and Nikolavus were in historical records as early examples [10, p. 249]. In different sources, we could encounter a minstrel named Kobzos Miklos. Hence, sources generally agree that “koboz” entered Hungarian via the Cuman or Pecheneg languages.

In another note of Ahmet Jafaroglu, it is stated that in the first half of the 17th century, Schödel played the historical songs of the Hungarians with an instrument called “kobza” in their mother tongue [3, p. 413].

In Central Asian Turkic communities, the gopuz was used by bards known as “bahşı” both as an accompaniment while performing lyrical poems, laments, songs and as an instrument to ward off evil spirits, invoke benevolent spirits, heal illnesses, and perform semi-religious rituals. According to Ármín Vámbéry, these bards were proficient in treating diseases, often healing their patients by mesmerizing them with music played on the instrument called “kobuz”[16].

CONCLUSION

In general, the similarity in pronunciation, and rhyme is proof of the antiquity of Turkish-Hungarian relations. The comparison between the Gopuz and Koboz can be deepened further by detailing differences in their construction, playing techniques, tonal characteristics, and cultural roles. The Turkic Gopuz typically features a deep, resonant tone suited for spiritual and ritualistic contexts, often associated with shamanistic ceremonies and epic recitations. Conversely, the Hungarian Koboz, while structurally similar, generally produces a brighter tone more suitable for narrative storytelling and secular performances. Historically, Koboz has been employed in courtly entertainment and folk music contexts, whereas Gopuz is heavily embedded in Turkic shamanistic and spiritual traditions.

Recent initiatives and programs to preserve and promote Gopuz and Koboz have been significantly expanded. UNESCO has recognized elements related to Turkic and Hungarian folk music as intangible cultural heritage, emphasizing the instruments' cultural and historical importance. Additionally, various international music festivals, such as the World Nomad Games and the Hungarian Folk Music Festival, prominently feature performances of these instruments, promoting broader awareness and appreciation. Academic conferences and workshops focusing on ethnomusicology regularly discuss these traditions, contributing scholarly attention towards understanding, preserving, and revitalizing traditional folk music and instruments in both Turkic and Hungarian cultures.

In conclusion, the Gopuz is an ancient historical relic deeply embedded in the spiritual and cultural traditions of the Turkic peoples. Due to extensive historical interactions and shared cultural heritage between the Turkic and Hungarian communities, the Gopuz (and its Hungarian variant, Koboz) has become profoundly integrated into Hungarian folklore and artistic traditions. The instrument has prominently featured in epic narratives, ceremonial rituals, and communal performances, reinforcing cultural identity and historical memory. Historically, skilled gopuz and koboz players have often emerged from warrior ranks, emphasizing the instruments' symbolic association with bravery, leadership, and moral guidance. The enduring presence of Gopuz within these cultures highlights the significance of music as a powerful tool for cultural preservation and intercultural dialogue, bridging ancient traditions with contemporary expressions and reaffirming its vital role in sustaining the cultural heritage of both Turkic and Hungarian peoples. As ethnomusicologist János Sipos points out, the structural and stylistic similarities between the Turkic and the Hungarian music are indicative of deeper musical and cultural interactions between the two peoples, stemming from shared nomadic roots [14].

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TÜRK VƏ MACAR FOLKLORUNDA QOPUZ ANLAYIŞI

R.Q. Cahangirli

Folklor onu yaradan, qoruyub saxlayan və zənginləşdirən xalqlar sayəsində yaşayır və inkişaf edir. Bu zaman həmin xalqların milli xüsusiyyətləri və kimlikləri məhz folklor nümunələrinə sirayət edir. Hər bir folklor nümunəsinin ilkin yaradıcısı olur və bu nümunələr zamanla həmin nümunələrin yaradıcısı olan xalqın nümayəndələri arasında “dildən dilə” keçərək geniş məşhurlaşır. Bundan əlavə, bu nümunələr sərhədləri aşaraq başqa xalqlar arasında da yayılmağa başlayır ki, nəticədə onların da müxtəlif versiyaları meydana gəlir. Bu köçəri türk xalqları və onlarla yanaşı yaşayan qonşu xalqlar üçün də keçərli haldır. Qopuz köçəri türk xalqlarının zəngin folklor irsinə məxsus tanınmış musiqi alətlərindən biridir ki, zaman keçdikcə macarlar kimi başqa xalqların mədəniyyətinə də sirayət etmişdir. Məqalədə qopuzun tarixi kökləri araşdırılır, onun ənənəvi mərasimlərdə, dastanlarda və mədəni simvolizm sistemindəki yeri təhlil edilir. Araşdırmada türk tayfaları ilə macarlar arasında yaranmış macar xalq musiqisinin formalaşmasında və mədəni təcrübələrin inkişafında mühüm rol oynamış tarixi və mədəni əlaqələrə xüsusi diqqət verilir. Müqayisəli təhlil əsasında türk qopuzu ilə macar kobozu arasında bənzərliklər və fərqlər ortaya qoyulur və onların dini, mərasim və gündəlik həyatdakı funksiyalar da nəzərdən keçirilir. Bundan başqa, araşdırmada həm türk, həm də macar mədəniyyətində Qopuz və Kobozun qorunması və təbliği məqsədilə həyata keçirilən müasir təşəbbüslər təhlil olunur və bu musiqi alətlərinin mədəni irsin davamlılığı və milli kimliyin formalaşmasındakı əhəmiyyətinə xüsusi diqqət yetirilir.

Açar sözlər: Əhməd Cəfəroğlu, folklor, macar, türk, qopuz, koboz, türk mədəniyyəti, türk-macar əlaqələri, köçəri ənənələr.



ИНТЕРПРЕТАЦИЯ ГОПУЗА В ТЮРКСКОЙ И ВЕНГЕРСКОЙ ФОЛЬКЛОРНОЙ ТРАДИЦИИ

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Фольклор существует благодаря народам, которые его создают, хранят и обогащают, придавая ему свои уникальные национальные черты и самобытность. Каждое произведение фольклора имеет своего создателя и становится популярным, переходя «из уст в уста» среди представителей одного народа. Со временем такие образцы преодолевают границы и распространяются среди других народов, приобретая новые формы и вариации. Это характерно для кочевых тюркских народов и их соседей, живших рядом с ними. Одним из ярких элементов тюркского кочевого фольклора является гопуз музыкальный инструмент, который был воспринят другими народами, в частности, венграми. В статье рассматриваются исторические корни гопуза, его роль в ритуалах, эпических повествованиях и культурной символике.

Особое внимание уделяется историческим контактам между тюркскими племенами и венграми, оказавшим значительное влияние на венгерскую народную музыку и культурные традиции. Сравнительный анализ выявляет как сходства, так и различия между тюркским гопузом и венгерским кобозом, особенно в духовном, обрядовом и светском контексте. Также освещаются современные инициативы, направленные на сохранение и популяризацию гопуза и кобоза в тюркской и венгерской культурах, подчеркивая их значение как части культурного наследия и идентичности.

Ключевые слова: *Ахмед Джафароглу, фольклор, венгры, тюрки, гопуз, кобоз, тюркская культура, тюрко-венгерские связи, кочевые традиции.*



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THE PROBLEM OF TRADITION AND INNOVATION IN MEHMET AKİF ERSOYS POEMS

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The article is dedicated to the issue of tradition and innovation in Turkish poetry. The theme of tradition and innovation in Turkish poetry reflects different periods of rich literary history and different approaches of writers. The preservation of traditional values and the creation of innovations in literature were characteristic of that period. These two processes played an important role in the development of Turkish poetry. Poets began to express their personal feelings, the realities of life, and the social issues of the modern era in their poems, in addition to the issues of previous periods. In the works of their poets, lyrics, artistic images and symbolic language were in the foreground. Poets brought their personal feelings and individual experiences to the fore. All these innovations ensured the development of Turkish poetry in a more modern direction after classical, romantic and realism. They used symbolic language and images to reflect the various layers of life and the depths of the human soul. This led to literature becoming not only entertaining, but also a deeply thought-out and analyzed art form. The development of new poetic forms, along with innovations in content and quality in poetry, is one of the most striking moments of this period. The gradual acquisition of a leading role in poetry, along with the traditional forms of classical literature, stemmed from the need for a more intensive expression of artistic thought. Therefore, many poets who wrote excellent poetic works in the new-free poetic form have grown up in both Azerbaijani and Turkish literature. One of them was Mehmet Akif Ersoy.

Keywords: *Türkiye, poems, poetry, tradition, innovation, modernism.*

INTRODUCTION

From the researches about Turkish poetry, it is known that in the end of the 19th century and the beginning of the 20th century, there were examples of new spirit and ideological-artistic courage in poetry. The most productive and contradictory and difficult period of Turkish literature was the 19th and 20th centuries. It is obvious that there is no literature outside of socio-political processes to one degree or another. Along with content and quality innovations in poetry, the formation of new poetic images is one of the most remarkable moments of this period. In addition to the traditional forms of classical literature, free verse gradually acquired a leading role in poetry. It is from this point of view that dozens of poets who created excellent poetic works with a new form of poetry in both Azerbaijani and Turkish literature grew up. In terms of the development and transformation of Turkish poetry, the concepts of tradition and innovation are very important. In fact, innovation always means criticism of tradition or the search for innovation, but it is not only manifested in the external signs of poetry. Innovation is considered as a literary concept that is reflected in the attitude to the subject, direction of ideas and new form features. [4, p. 5]. Traditional poetry forms were more based on the traditional and classical features of poetry, divan poetry. Of course, the forms of divan poetry, such as radif, rhyme, and various verse structures, served as the foundation of this tradition. Repetition of traditional themes was also considered characteristic for that period. Themes in poetry were usually based on two lovers, romantic relationships, philosophical thoughts, love for the world and nature, as well as the spiritual world of man. These



themes were repeated over time without any innovation. The language of divan literature was mainly influenced by Arabic and Persian language and poetry. Although the works created in traditional poetry could not be understood by the entire population over time, their poetic value was high in all periods. The concept of innovation is an approach that has shaken the previous traditions in Turkish poetry. The main features of innovation in poetry, which began to spread from the end of the 19th century, determined the creation of new forms of poetry. Poets who wrote in an innovative style did not write in traditional forms, but in new ways and free verse forms. The innovative poetry aimed to move away from the influence of the previous palace and aristocratic culture and create a more modern and democratic style. Modernist poets writing in this style tried to enrich their creativity with innovations and modern trends. At this time, benefiting from the influence of European literature, they expanded the boundaries of poetry. There were different approaches to the concepts of tradition and innovation. Many poets and writers were more oriented towards this direction in their works, while a group strongly opposed it and preferred tradition. For example, Mehmet Akif Ersoy (1873-1936), known only as a national poet, regarded the innovations that the Western imperialists tried to introduce in the name of "culture" as provocations and strongly protested:

An iron-armored wall surrounds the west;
I have a border like a faith-filled root.
My nation, do not be afraid! How to suppress such a faith
The lone wolf I call "culture"? [2, p. 15].

His most famous work "Independence March" was adopted as the national anthem of Türkiye. Here, love of country, struggle for national unity and independence were in the foreground. He turned poetry into a kind of means to awaken the spirit of the people. With those innovations Mehmet Akif Ersoy brought to poetry, he played an important role not only in the literary field, but also in the formation of national consciousness. His poems were written not only for aesthetic pleasure, but also for the purpose of awakening people and drawing attention to the problems of society. In this regard, he is considered one of the greatest innovative poets of the period of transition from Ottoman to modern Turkey. The metaphors used by Akif in his poems when talking about both individual and social problems give the reader the opportunity to derive a deep meaning. Akif used the concepts of freedom and independence in poetic language, metaphors and symbols in his works such as "Independence March". He developed a style of expression in which separate emotions were mixed together in his poems written with an innovative approach. Both individual sufferings and social inequalities were formed as a single whole in his poems.

Akif not only appealed to individual emotions, but also managed to explore the mood of society. That technique made his poetry powerful both on a personal and social level. Mehmet Akif's language had both simple and deep meanings. His language was quite rich and literary, but never compromised on comprehensibility. Akif Ersoy's ability to connect with the public and intellectuals through the language he uses is the key to his literary success. In his poems, he connected with old Turkish poetry and also contributed to modern Turkish poetry. In addition to reflecting the cultural heritage of the Turkish people, he also talked about universal issues such as freedom and justice in his poems. The technical perfection in Mehmet Akif Ersoy's poems is one of the elements that reveal his literary power. [2, p. 15]. Akif became a name that left a mark in Turkish poetry with its rhyme and verse, depth of meaning, metaphors, richness of language and social criticism. His poems were written with great skill both in terms of form and content, and they carried different meanings every time they are read. As a technically perfect poet, Akif left deep traces in the world of literature.

Four continents
Beshar found a statue of himself
Even if I don't listen, I dedicate the whole day to God



I used to live under this idol, still
The swelling is torn from me: Long live the exquisite soul
I ran and stopped to show you a light
Oh, my life partner in all my turbulent life
Whether it's falling or not, I always overcame it, but
This time, I will carry the kendi that hits my wrinkled forehead
Are you in Lamekan, where are you, O absent God?
Dönerim's passion has been afaki since eternity
Those drops of light sprinkled and filled the dome
It's the traces of my age looking for you everywhere
There is only one truth, yes, from the world you know,
Even if I've been there for 50-60 years, I'm still surprised
We are all in love with ourselves
A simple snake can't be drawn to this strange love [2, p. 115].

Mehmet Akif Ersoy's poem "Four Continents" occupies an important place in his literary world and has deep layers of meaning. The poem especially talks about human inner conflicts, existential questions and metaphysical searches. The poet asked important questions both on the individual and social level, and tried to reach the depths of the human soul. When conducting a literary analysis of the poem, we can consider the following elements: The poem deeply talks about the contradictions in the inner world of a person, the search for God. From the first verse, man's battle with "idols" and "nafs" is described. Mehmet Akif talked about the fight against the evil inside a person and how that fight turned into a battle of "self-mockery". "It is a statue of itself that humanity worships." This line is a symbol of a person actually worshiping his "whole". Man has become a slave of his soul, his worldly soul. Here, Akif called for transcending one's ego and ego. In the poem, the obstacles that people face on the way of life and their struggle to overcome these obstacles are depicted with symbolism. The lines "Is it a mountain that confronts me, I will always overcome it" symbolize the difficulties of life, the resistance felt against these difficulties. Akif portrayed a person who did not give up in the face of life's difficulties [3, p. 115].

- This time it was my own stone that hit my wrinkled forehead...

Let's analyze Mehmet Akif's works. - Words and expressions related to religious values and moral issues: In his works, he gives a lot of space to the Islamic religion, morality and national-spiritual values. In this regard, religious terms and verse-paraphrases are often encountered. Quotations from the Quran are written or religious terms are mentioned. The thoughts that people say in prayers are brought into poetry:

O Allah, send us your guidance...

- Amen!

Which is the right path, show it to the nation...

- Amen! [3, p. 420].

- Words and expressions in a language that the people can understand: As we know, Akif Ersoy's famous work "Sefahat" consists of 7 volumes and is a collection of realistic and factual poems dedicated to social and religious topics. The language in this work combines both the classical style and the simple, that is, the folk style. Because Akif Ersoy loved his nation, wrote and created for it, and for this reason, he attached great importance to sincere communication with the people in poetry. This led him to avoid difficult and artificial language in his poetry and try to choose a style that the people could understand. Because the purpose of his poetry was also facilitation, propaganda and enlightenment.

-You listened, you saw it, my son. What a corrupt upbringing we have!

-What should we do, we should teach humanity.



- Words and expressions of Arabic and Persian origin: Akif Ersoy, as a writer of the Ottoman period, gives extensive space to words of Arabic and Persian origin in his works. Also, considering that Akif Ersoy was a very careful observer, he understood well that the choice of these expressions for the intelligentsia of the people would also sound like an appeal to their souls. This was especially noticeable when the poet wrote works on religious and philosophical topics. It should be noted that there are also differences between the first printed copy of the work "Safahat" and the last printed copy. More precisely, these differences appear as development. This development also reveals the poet's development in the fields of language, thought and literature. That is why another reason to study his works is the need to study this development. Of course, the basis of this need is to see and examine the landscape of that period through the eyes of poetry. Thus, a close acquaintance with the poet's poetry makes it possible to clearly perceive the changes that took place in society and the social environment at that time. There are also enough lines in the poet's work that arise from the combination of his dreams with the influence of the real environment. The poet, as if not coming to terms with the current situation, displays his ideas for a better future under artistic expressions:

-A song, a curtain that you hear,

-In the cradle, then on the thresholds, then at school [3, p. 63].

All the passion and all the turbulent expressions in Akif Ersoy's poems stemmed from his love for his homeland. He was convinced that his society and nation deserved a better life and called for liberation from the suffering they suffered. In all these loves, the concept of self-love and respect that was unique to Mehmet Akif was also felt. This is seen in the poet's short artistic expression called "The Only Truth". Akif Ersoy's purpose in his poetry reveals how different and unique he was. In the small poem he wrote to his son Mehmet Ali on the first page of "Safahat", he expresses his love for poetry, emphasizes from the first lines that he has learned all the intricacies of this art of words that he loves so much, and uses the phrase "they say tears for poetry."

This line describes the individual facing their own inner problems and struggles. Here, Akif meant that obstacles in a person's life sometimes arise from his own internal conflicts. The poem also talks about the reality that people are looking for and the efforts they make to find it. Akif emphasized the idea that God was the only truth that people seek. The only thing that is real is its existence, everything else is temporary compared to this reality. "There is only one truth, yes, from the world you remember" This clause means that everything a person encounters in the world is temporary and the real truth can only be found in God. Akif urged people to turn away from worldly things and turn to spiritual values. The poem also talks about both worldly and spiritual dimensions of love. When Akif said that a person was in love with himself, he meant that this love was both personal love and spiritual love for God. Man looks for love and presence not outside, but within himself. It is enough to pay attention to one of his works so that it is possible to express an opinion about Mehmet Akif Ersoy. Mehmet Akif Ersoy was a national poet and writer who has a great place in Turkish literature and culture. Akif's poems and writings symbolize the people's fighting spirit and national identity, and also offer deep thoughts on the social and cultural problems of his time. The poets and writers who wrote and created in that period understood well that a certain determination to fight for innovations is necessary and they were able to give this determination in their works against the background of the political landscape of the time. For this reason, it is possible to understand the poetry scene of that period on the basis of newly created poems in 1920-1960 [3, p. 42]. For example, when we pay attention to the work of poets of that period, the image of the Motherland acted as a lyrical hero and was an example of new emotions and a new form of vision. Social issues were used in his poems, mostly to explain the history, identity and culture of Turkish nationality. National values in his poetry were the basis of Yahya Kemal's understanding of nationalism. He made great contributions to Turkish literature and embodied the Turkish identity in his poetry.



Bayatli was also an innovative poet. He updated his poetry in the content he used and the way he used language in accordance with the requirements of the modernism trend. Bayatli experimented in the name of purifying and simplifying his language and tried to overcome the boundaries of traditional poetry. Innovative elements such as symbolism, mystical thinking and free expression find their place in his poems. One of the most important features of Yahya Kemal Bayatli's poems is his combination of sensibility and modernity with classical style. This shows that he was both a traditional and a modern poet. He created rich and deep meanings by combining both ancient poetry styles and new literary trends in his works. In general, the main idea of Yahya Kemal Bayatli's poems is the creation of compatibility between the concepts of "nationalism" and "modernism" in his works. He played an exceptional role in the process of modernization of Turkish literature, developing his national identity with the inspiration he received from Western culture. Yahya Kemal Bayatli, influenced by Western culture in his literature and outlook, but combining it with his own national values, created an exceptional world of art. When he went to Paris in 1903, he was an admirer of the West and a supporter of the Young Turk movement, but over time, especially after 1912, he became more aware of his Turkish identity and began to express it more in his poetry. The main idea in Yahya Kemal's poem was to strengthen the culture, history and identity of the Turkish people by using the experience and methods obtained from the West and to express them artistically. In Yahya Kemal's poems, the concept of nationalism and nationalism is very important. He put Turkish history and culture at the center of his poetry, and used the symbols of history, geography and people in order to protect and develop this national identity. In his concept of nationalism, there is a realistic approach instead of ideal nationalism. In Yahya Kemal's understanding, the Turkish nationality first exists as a historical and geographical reality, and it is necessary to continue the existence of a nation formed on the basis of this reality. Turkish history occupies a central place in Yahya Kemal's poem. He interpreted Turkish nationality, unlike many other poets, not only with a romantic understanding, but in a more objective and local way. The brilliant periods of Turkish history, as the most important and valuable heritage, played a major role in the establishment of national identity. Yahya Kemal glorified the life and culture of a nation that arose in Anatolia after 1071, accepting Turkish history as "pre-history". This approach also incorporated the geographical limits of Turkish nationality. Yahya Kemal's concept of nationalism is also related to geographical reality. He accepted the concept of real nationalism as opposed to Ziya Gökalp's idealistic Turanian nationalism. That is, he accepted that the Turkish nationality is a real structure formed only in the geography of Anatolia, and he glorified that reality in his poems. Turkish nationality and culture continued to exist in this geography, especially as a result of the history and culture that arose after 1071. Yahya Kemal is known for his education in Paris and his admiration for Western culture, but over time he decided to use the knowledge and experience he gained from the West only as a tool. Inspired by Western poets and literary trends, for example, Parnassianism and Romanticism, he covered these influences in his poetry with a national character. Borrowing the forms and dimensions of poetry from Parnassism, he tried to express the feelings, history and self of the Turkish people in these poems. Yahya Kemal's poems have very little social and economic themes. Unlike other Marxist poets, he did not deal extensively with social issues such as the poverty of the people. Instead, he more glorified national and cultural themes. Social issues are used in his poems, mostly to explain the history, identity and culture of Turkish nationality.

Turkish poetry in the 1920s-1960s is characterized by a number of new aspects. This, first of all, appeared with the attitude of the poets who wrote and created in that period to people, the world, and society. The view of the typical social-political, cultural-spiritual landscape of that period was reflected in different forms in the poem. Although the sphere of influence of figurative poetic imaginations expanded in newly created poems, in many poems this aspect was manifested either at the level of rhetorical pathos or pure praise. As an example, if we pay attention to the



poems of Cahit Sıtkı Tarancı (1910-1956), we can feel in the images the comfortable psychological state that was typical for that period and prevailed in the society. Cahit Sıtkı Tarancı is one of the most important poets of Turkish literature and is considered one of the most important names of modern Turkish poetry. His poems have both modern and traditional elements. Tarancı's poems generally focus on universal themes such as the transience of life, human loneliness, love, death and existence, but also bear traces of traditional Turkish poetry. In the poet's poem "I want a country", the image of the homeland appears clearer and brighter, it promises peace to a person.

Many symbols and images are used in the poem: Blue, green, yellow colors: They symbolize the beauty of nature and the yard. Each color represents a different aspect of life—the freedom of the sky, the nurturing power of trees and nature, and the fertility of the soil. The tone of the poem has hope, love and desire. The homeland, which is the poet's dream, was described as a blessed and peaceful place. Each sentence is generally an expression of deep hope and desire. The poet wanted not only the nature of his homeland, but also the social and emotional state to be perfect. Tarancı used simple but effective language. The words in each line of the poet have the ability to think and influence the reader. The vivid language in the description of colors and nature connects the reader with the beauty and harmony of the homeland. Cahit Sıtkı Tarancı's poem "I want a country" is full of deep attachment to the country and idealism. The poem describes that the homeland is not only a geographical place, but also a place of people's relationships, living conditions and mutual love. This image of the ideal homeland created by the poet emphasizes both the beautiful nature and the harmony between people.

In general, his poems reflect both poetic sensibility and deep thinking about the inner world of man. Tarancı worked on the themes of existence, death, time, loneliness, love and homeland. In his poems, he explored the inner world, psychological state and meaning of life. Elements of romanticism and modernism appear together in the poet's poems. Although innovative tendencies were noticed in the creations of poets, the use of tradition was equally evident. However, in the examples of literature written in traditional methods for that period, the creative approach attracts more attention [4, p. 8]. The dialogue between tradition and innovation in Turkish poetry was an ongoing process. Poets made Turkish poetry an important field of art both nationally and internationally by preserving the rich literary values of the past and turning to modernist styles. Even today, the conflict and harmony between tradition and innovation continues in Turkish poetry. Modern poets combine both new styles and classical forms to create different poetic experiences. Innovative approaches are brought to the themes and structure of traditional poetry, and social and philosophical issues become poetry in a more relevant way. In short, the period 1920s-1960s, which is defined by the concepts of tradition and innovation, characterizes Turkish poetry as a stage where different ideologies and experiences meet. One of the important aspects that conditioned his poetry with innovations and was characteristic for that period was the establishment of the Republic and social changes. The 1920s was a period when Turkey became a modern state and the society began to be reconstructed. The collapse of the Ottoman Empire paved the way for the formation of a new Turkish identity, language and culture. These changes also affected poetry. For example, the first literary group of the Republic period is "Yeddi mashala" [1, 5]. The members of this group, named after the magazine "Yeddi Mashala" published in 1928, included Muammer Lütfi Bahşi (1903-1947), Kenan Hulûsi Koray (1906-1943), Sabri Esat Siyavuşgil (1907-1968), Ziya Osman Saba (1910-1957), Yâşar Nabi Nayır (1908-1981), Vasfî Mahir Kocatürk (1907-1961), Cevdat Gûdrat Solok (1907-1992) opposed the poem of "Five Syllables" and wrote that it was time to open new horizons for Turkish poetry. In addition to being inclined towards Europe, the main goal of these young artists who benefited from French poetry was to create innovation in poetry. One of the characteristic features of that period was the creative use of tradition. It also meant to enrich the well-known folk poetry motifs, classical content and subjects, not to modernize them at the same level or to repeat them in a weaker way, but to add something to them either in terms of content or



form. That was also shown in relation to classical forms [6, p. 42]. When artistic pieces written in traditional forms are enriched with new and original poetic images, that form itself acquires a new essence. As a result, poetry as a whole genre develops and enriches. It should be noted that innovative poetry makes the reader think, breaks traditions and opens new artistic horizons, modern poetry tradition necessitated the introduction of new forms and themes in Turkish poetry. For this reason, it is necessary to pay more attention to the analysis of the new trends and trends in the works of the poets who wrote and created in that period, to examine the connection, closeness and differences between traditional poetry and modern poetry.

CONCLUSION

Between the 1920s and 1960s, Turkish poetry went through great changes and stages of development. This period was both a period in which the connection with tradition was maintained. During this period, the concept of innovation was also strengthened. Also, political, social and cultural changes had a direct impact on poetry. Therefore, many poetic movements and poets emerged during this period. In poetry, the concepts of tradition and innovation represent two main directions of literary development. These concepts determine the approaches and esthetic positions of poets in terms of form, content, language, and means of expression in poetry. Tradition (i.e., literary tradition) is adherence to the poetic rules, subject and form characteristics, style and means of expression of previous periods. Tradition is a literary heritage. Traditional poetry is poetry written according to the rules of classical literature or folklor poetry. Innovation (i.e., innovation) is an attempt to challenge or renew poetic tradition. It is the creation of new forms and contents, taking into account the poet's individual thinking and the socio-political demands of the time. Innovative poetry is a poetic style that breaks with traditional rules, is based on an individual worldview, and is free expression. When poems are written in traditional and innovative forms, they differ in terms of form, meaning, language, style of expression, and approach. These two directions are the main paths of development of the literary process.

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MEHMET AKİF ERSOYUN ŞEİRLƏRİNDƏ ƏNƏNƏ VƏ NOVATORLUQ PROBLEMİ

A.B. Şeydayeva

Məqalə Türkiyə poeziyasında ənənə və novatorluq kimi aktual məsələyə həsr edilmişdir. Türkiyə poeziyasında ənənə və novatorluq mövzusu, zəngin ədəbiyyat tarixinin müxtəlif dövrlərini və şairlərin şeirə fərqli yanaşmalarını əks etdirir. Ədəbiyyatda həm ənənəvi dəyərləri qoruyub saxlaması, həm də yeniliklərin tətbiqi həmin dövr üçün xarakterik idi. Bu iki proses ümumi olaraq türk poeziyasının inkişafında mühüm rol oynamışdır. Bu dövrdə şairlər daha əvvəlki dövrlərdəki mətləblərin yanında, şəxsi duyğularını, həyatın reallıqlarını və müasir dövrün sosial məsələlərini də şeirlərində ifadə etməyə başladılar. Şairlərinin əsərlərində lirika, bədii təsvirlər və simvolik dil ön planda olmuş, şairlər şəxsi duyğularını və fərdi təcrübələrini daha çox önə çıxartmışlar. Bütün bu yeniliklər türk şeirinin klassik, romantik və realizmdən sonra daha modernist bir yönə doğru inkişaf



etməsinə təmin etmişdir. Onlar həyatın müxtəlif qatlarını və insan ruhunun dərinliklərini əks etdirmək üçün daha çox simvolik dil və obrazlardan istifadə etmişlər. Bu, ədəbiyyatın yalnız əyləndirici deyil, həm də dərinlən düşünlmüş və təhlil edilən bir sənət forması olmasına səbəb olmuşdur. Poeziyada məzmun və keyfiyyət yenilikləri ilə yanaşı yeni şeir şəkillərinin təşəkkül tapması bu dövrün ən diqqətçəkən məqamlarındandır. Klassik ədəbiyyatın ənənəvi formaları ilə yanaşı poeziyada sərbəst şeirin gətirdiyə aparıcı rola yiyələnməsi bədii fikrin daha intensiv şəkildə ifadə olunması zərurətindən irəli gəlirdi. Məhz bu baxımdan istər Azərbaycan, istərsə də Türkiyə ədəbiyyatında yeni-sərbəst şeir şəkli ilə mükəmməl poetik əsərlər yaradan onlarla şair yetişmişdir. Onlardan biri də Mehmet Akif Ərsoy idi.

Açar sözlər: *Türkiyə, poeziya, ənənə, yenilik, modernizm.*

ПРОБЛЕМА ТРАДИЦИИ И НОВАТОРСТВА В ПОЭЗИИ МЕХМЕТА АКИФА ЭРСОЯ

А.Б. Шейдаева

Статья посвящена вопросу традиции и новаторства в турецкой поэзии. Тема традиций и новаторства в Турецкой поэзии отражает разные периоды богатой литературной истории и разные подходы писателей. Для этого периода были характерны сохранение традиционных ценностей и создание новаций в литературе. Эти два процесса сыграли важную роль в развитии Турецкой поэзии. Поэты вынесли на первый план свои личные чувства и индивидуальный опыт. Все эти нововведения способствовали развитию турецкой поэзии в более модернистском направлении после классицизма, романтизма и реализма. Они использовали символический язык и образы, чтобы отразить различные слои жизни и глубины человеческой души. Это привело к тому, что литература стала не только развлекательным, но и глубоко продуманным и анализируемым видом искусства. Одним из наиболее ярких аспектов этого периода является развитие новых поэтических форм, а также нововведений в содержании и качестве поэзии. Возрастающая роль свободного стиха в поэзии, наряду с традиционными формами классической литературы, возникла из-за потребности в более интенсивном выражении художественной мысли. Поэтому как Азербайджанская, так и Турецкая литература дала миру немало поэтов, создавших прекрасные поэтические произведения в новой форме свободного стиха. Одним из них был Мехмет Акиф Эрсой.

Ключевые слова: *Турция, поэзия, традиция, новаторство, модернизм.*



UDC: 781

<https://doi.org/10.59849/2409-4838.2025.3.50>**THE MANIFESTATION OF MODE-INTONATION FEATURES IN VASIF ADIGOZALOV'S "24 PRELUDES" SERIES****Nigar Nizami Abasova** 

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The presented article is dedicated to the analysis of mode-intonation features related to mugham in Vasif Adigozalov's piano cycle "24 Preludes". In the introduction, general information is provided about Vasif Adigozalov's creative work and the genre of the prelude. The main section explores the similarities and differences between the tonal plan and musical language of the preludes of this cycle created with reference to the traditions of the composer's teacher, Gara Garayev and Garayev's own preludes. Furthermore, aspects of mugham are examined in the structure, content, and expressive means of the preludes. The analysis of their mode foundation and intonational characteristics is supported by musical notation examples. In the conclusion, it is emphasized that each composer possesses an individual musical style and demonstrates a unique approach to the use of mugham. It is also noted that the fusion of mode-intonation features closely tied to the composers' creative imagination with the major-minor system opens the way to enriching the musical language.

Keywords: Vasif Adigozalov, composer, creativity, piano music, prelude, mugham, mode-intonation.

INTRODUCTION

The creative legacy of prominent Azerbaijani composer Vasif Adigozalov, known for his multifaceted work, began to take shape during the 1950s and 1960s. His compositional output includes operas, operettas, symphonies, symphonic poems, cantatas, oratorios, concertos for piano and symphony orchestra, piano and folk instrument orchestra, violin and orchestra, cello and orchestra, as well as songs, romances, and music written for films and dramatic productions [1].

Special mention must be made of the composer's piano music. He is the author of a piano sonata, various pieces for children, the cycle "24 Preludes" and other works. The "24 Preludes" cycle stands out as one of the finest examples of his piano compositions.

Interestingly, the prelude genre in Vasif Adigozalov's work assumes a somewhat different role compared to its earlier usage. The word *prelude* (or *preludia*) originates from Latin and means "introduction". In the time of J.S. Bach, the prelude served as an introductory movement to fugues and suites. It was also composed as an independent piece for organ or harpsichord. F. Chopin was the first to create a complete cycle in this genre. His "24 Preludes" cover all major keys and their relative minors, following the circle of fifths. Chopin endowed the genre with deep expression and rich content, masterfully portraying a range of emotions and imagery in short pieces. The tradition initiated by Chopin was later continued by many other composers in the realm of music literature. Notable examples of "24 Preludes" cycles can be found in the works of C. Debussy, S.V. Rachmaninoff, A.N. Scriabin, D.D. Shostakovich, D.B. Kabalevsky, and others.

The prelude genre also holds an important place in the piano music of Azerbaijani composers. Many of them have turned to this genre. Smaller cycles consisting of two, four, six, ten, and other numbers of preludes are found in the works of Fikret Amirov, Elmira Nazirova, Tofiq Guliyev, Arif



Melikov, Javanshir Guliyev, Sardar Farajov, Aziz Azizli, Aydin Azimov, Azar Dadashov, and others [5].

Among these, Gara Garayev's "24 Preludes" cycle and Vasif Adigozalov's "24 Preludes" cycle are particularly noteworthy.

MAIN PART

General Characteristics of the Cycle

In the four-book cycle, Vasif Adigozalov draws upon the traditions of his teacher, Gara Garayev [2]. Similar to Garayev's *Preludes*, Adigozalov's pieces alternate based on contrasts in tempo, character, artistic imagery, and musical language. This principle creates the effect of vivid, ever-changing musical tableaux unfolding before the listener. However, it is important to note that the tonal structure of the cycle differs from that of Garayev's *preludes*. As is well known, the tonal progression in Garayev's cycle follows a circle of fifths logic, alternating between parallel major and minor keys. In contrast, the tonal order of Adigozalov's *preludes* does not follow any strict system.

The musical language of the *Preludes* contains many interesting elements. In this cycle, we have studied features related to mugham, analyzing mode-intonation characteristics.

In the foreword to the 2001 edition of the cycle, distinguished pianist and professor Farhad Badalbeyli highlights the uniqueness of the work:

"...The cycle '24 Preludes' stands out in two distinct ways. Vasif Adigozalov is a gifted pianist with an innate musical intuition. His deep familiarity with the subtleties of the piano, stemming from his experience as a pianist, is vividly reflected in the treatment and technical content of the preludes. The second aspect is the richness of imagery within the preludes. These works, which overall express a lyrical-emotional atmosphere, are imbued with a refined variety of expressive imagery and content. The cycle spans a wide emotional range—from profound psychological depth to vivid genre scenes. The deep lyricism derived from the Azerbaijani mugham tradition, the improvisational development style of mugham, and the inclusion of ashig intonations are all seamlessly fused with modern rhythmic, textural, and harmonic approaches. The synthesis of national traditions and modernity is the key to the great success of the '24 Preludes' cycle" [7]. These remarks by the work's most prominent performer shed valuable light on the musical language of the cycle.

In Vasif Adigozalov's 24 *preludes*, the influence of mugham manifests itself through musical expression. Professor Imruz Afandiyeva, in her monograph "*Vasif Adigozalov*," provides a general analysis of the cycle, writing:

"In this cycle, special emphasis is placed on the principle of mugham-improvisational development, which is integrated into a strict structural framework. In his attempt to capture the subtle contours of mugham intonations, the composer employs extraordinary timbral and register techniques to evoke the sound of national instruments" [6].

In several preludes, features rooted in mugham are evident both in the emotional content and in the means of musical expression. These include a meditative character, lyrical-philosophical depth, and distinct features of melodic development.

Adigozalov's preludes are generally structured in ternary (three-part) form. In this form, the outer sections are similar, while the middle section is marked by extensive development. Such a structure mirrors the progression of mugham, which rises in stages from the *maya* (tonic) to a climax, then returns to the *maya*. Another mugham-related feature is the increasing complexity of the melodic line as the musical material develops a trait particularly prominent in instrumental mugham performance.

The connection to mugham is also evident in the exploration of the mode foundation of the *preludes*. One important aspect here relates to the musical language of Gara Garayev's *preludes*. In his works, Garayev merges the major-minor system with national mode-intonation elements and makes use of the twelve-tone system.

Analysis of the Preludes

Prelude I in D major – is based on D-tonic rast mode-tonality. The melody carries a tasnif character. However, segah mode-intonations are also present, and we can already observe this from the very first bars. The fact that the theme begins from the third degree of the D major triad — the note “Fis” — and ends on the tonic “D” is based on the functional structure of the rast mode, and at the same time is characteristic of the segah mode. Especially, the reference to the third degree and the motion of thirds and seconds around this tone brings the segah mode-intonations to the forefront. However, the prominent presence of the harmonic foundation of the melody emphasizes the leading role of the rast mode.

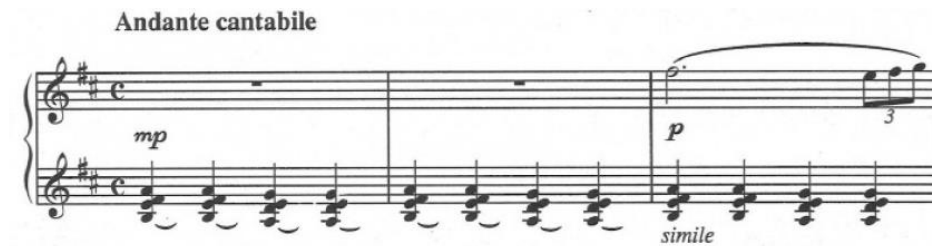


Sample 1. Prelude I [7]

The melody possesses a narrow range and is constructed through ascending–descending motion within the interval of a fifth. Beginning from the note “Fis”, the melody initially revolves around this tone through an upward leap of a third, then descends stepwise toward the note “D”. In the subsequent development of the melody, movement around the supporting tones is revealed in the second between “E” and “D”. This type of motion and the prolonged wandering (extending up to six measures) derive from the melody’s connection with mugham. In the accompaniment, arpeggio-like motion is based on the harmonic structure of both the major scale and the Rast mode with the same tonic. Thus, in the prelude, we observe the fusion of D-major and Rast modal foundations with Segah mode-intonation elements. This aspect is highly characteristic of mugham melodies. Specifically, Rast–Segah modulations in a major third relationship are commonly seen in mugham and tasnif melodies based on the Rast mode.

In the third prelude, we must note the significant role of “Fis” Shur mode intonations alongside the tonality of h-moll. Here, the minor scale and the Shur mode are juxtaposed within the interval of a fifth — that is, within the dominant tonal framework of h-moll. This is clearly evident in both the harmonic and melodic structure of the prelude.

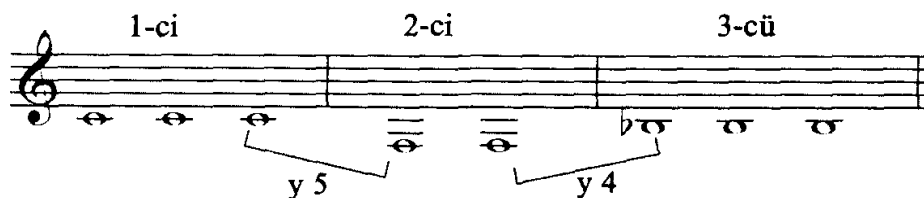
The prelude begins with a calm organ-point texture presentation of the chord “h–e–fis–a” in vertical structure.



Sample 2. Prelude III [7]

From the very first sounds, this chord draws attention. It can be interpreted in several ways. On one hand, it corresponds to the general tuning of the ashik saz; on the other hand, it aligns with the “Shur” mugham tonic used on the tar instrument.

T. Mammadov, who explains the tunings of the saz instrument, writes the following about the general tuning: “The first tuning is referred to by ashiks as the “Garachi koku” (also known as “Sah parda koku” or “umumi kok”), and it consists of fifth and fourth intervals” [4].



Sample 3. General tuning of the saz [4]

As can be seen, this tuning of the saz forms a chord consisting of fourth and fifth intervals. From this perspective, the four-note chord that forms the harmonic foundation of the prelude is interpreted as a combination of the intervals “h–e” and “h–fis.” The upper voice “a” also participates in the chord structure, encompassing the functional degrees of the mode. The “Shur” mugham tonic consists of the same harmonies.

We observe that the superimposed sounds “h–e–fis” remain stable throughout the prelude as an ostinato sonority, while the upper voice “a” is mobile.

The melodic theme of the prelude is based on movement revolving around the support degrees “fis” and “a” (the tonic and upper third of the Shur mode).



Sample 4. Prelude III [7]

The melody gradually develops and becomes enriched with undertones. All of this evokes an imitative expressive style characteristic of mugham performance.

The modal basis of the fifth prelude is C major and the functional foundation of the Rast mode with tonic “c,” formed through their interrelation. In this piece, the octave passages in the bass that create the accompaniment background rely on the support tones “c” – “g” and other degrees of the mode. Against this background, the thematic material is presented in a chordal manner. The Rast modal basis is prominently manifested in chords mostly constructed as quart-sixth chords. A key feature of this is the use of the note “b.”

Here, the C major scale and the “c” tonic Rast mode largely overlap, but the note “b,” which appears in the scale of the Rast mode, stands out as a distinctive element [3]. The composer explicitly emphasized the reference to the Rast mode by incorporating this distinctive tone into the chordal texture.



Sample 5. Prelude V [7]

In the process of developing the musical theme of the piece, we observe changes in the chordal structure and the inclusion of chromatic tones, which enrich the sound with colorful nuances.



Sample 6. Prelude V [7]

As can be seen, the composer, by employing both the shared and contrasting aspects of the functional structure and scale of the major and rast modes as the modal basis of the piece, achieves a fuller expression of the musical language.

The **seventh prelude** draws attention with its complex texture. Here, the composer uses the contrast between registers to bring out a striking sonic opposition. For this reason, the musical material is written across four staves, which indicates that each melodic line plays a significant role in revealing the musical content of the piece.

The melodic lines within the texture, both individually and in their interwoven form, reflect numerous aspects related to mugham expression. From this perspective, several features that manifest themselves from the very first bars should be noted.

B-dur stands out as the primary mode-tonality of the prelude. However, this tonality undergoes a number of modal shifts. Specifically, in the second and third staves of the texture, the main theme of the piece is heard. Yet, as a point of tonal support for the theme, the tonic sixth chord (T6) of B-dur features the tones “f” and “d”. Through a triplet-like motion between these tones (“c–d–c”),



emphasis is placed on the tone “d,” which indicates a modulation towards a new mode — specifically, a movement toward “d” Segah.



Sample 7. Prelude VII [7]

Overall, the expressive manner of the theme evokes the performance characteristics of mugham on the tar. In tar playing, the Segah mode is typically introduced through a sixth-chord structure, followed by melodic motion around the tonic.

In the development of the prelude’s musical material, we should note the increasing complexity of the modal foundation as chromatic tones are gradually introduced. Alongside melodic and harmonic features, this process also reveals changes in rhythmic structure. These shifts become particularly evident during the climax in the middle section of the piece.



Sample 8. Prelude VII [7]

As can be seen, this stage is not only unstable in terms of modal foundation, but also reveals changes in both texture and rhythmic structure. However, in the third section of the piece, the initial expressive style returns.

In the **ninth prelude**, mugham like features are once again evident. This can be explained from several angles: the structure of the theme itself, its development through melodic and rhythmic variation, as well as the ostinato nature of the accompaniment all highlight a strong connection to mugham.

The theme of the prelude is constructed in the lower voice, centered around the tone “d”. This reference degree is surrounded by both lower and upper leading tones, foregrounding the structure of the Segah mode. The descending motion toward the tonic reinforces and accentuates its presence.



In the upper voice, descending quartal progressions are given across the degrees of the mode: “c–g–d”, “b–f–c.” Interestingly, these progressions remain unchanged throughout the entire piece.



Sample 9. Prelude IX [7]

Gradually, the range of motion around the reference degree is expanded. New reference degrees — first “b,” and later the tone “cs” — come to the forefront.



Sample 10. Prelude IX [7]

Alongside melodic expansion, rhythmic changes also become evident. This corresponds to the melodic-rhythmic variation of a theme within a mugham section.



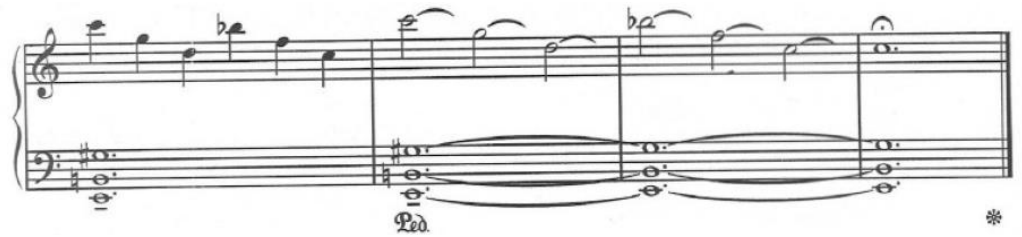
Sample 11. Prelude IX [7]

Such variation of the musical material is accompanied by the emergence of a more complex texture. The structure of the piece also reveals the enrichment of the melodic line with chromatic tones.



Sample 12. Prelude IX [7]

One of the notable features in the musical content of the prelude is the presentation of an unstable harmonic chord “c–h–gis” between the sections of the form and at the end.



Sample 13. Prelude IX [7]

The composer's inclusion of this chord within the context of the Segah mode imparts a sense of contrast to the sound.

The **eleventh prelude**, due to its musical structure, evokes the *tasnif* genre. Among mugham-related genres, *tasnif* is characterized as a vocal-instrumental form where vocal and instrumental accompaniment interact closely, with rhythmically based accompaniment playing a significant role. From this perspective, the feature is distinctly manifested in the prelude under consideration. This is clearly observed in the texture of the piece. In its multilayered texture, one can perceive the characteristic sound of a mugham ensemble — the performance traits of percussion instruments, tar, and kamancha are followed. At the same time, the melody is performed in a high register reminiscent of mugham singing.



Sample 14. Prelude XI [7]

The modal foundation of the piece possesses interesting characteristics. Throughout the prelude, several modal shifts occur. As seen from the example, at the beginning, the vertical harmonic structure “es–a–b–d” over the support tones “g–d” reflects the tonic degrees of the Shur mode. These degrees carry tonal significance within the musical material, which leads to modal changes during the development process. This can be noted during the transition to the main theme after the introductory bars. Here, in the bass, the harmonic structure of Es-dur based on “es–g–b–c” with support on the tone “es” serves as the harmonic background, while modal variability is manifested through melodic motion revolving around the tone “a” in a mugham style. This small-range melodic movement concludes with a descending motion to the tone “fis,” which results in a change of the mode-intonation and harmonic foundation. In the structure based on the support degree “d,” the harmonic core of D-dur emerges. On the basis of such modal-tonal variability, the musical material develops through several stages and eventually returns to the initial state.

One of the main features that attracts attention in the **fifteenth prelude** is the methods of thematic development, which can be characterized as stemming from mugham performance techniques. The first presentation of the theme relies on a mugham-like melody in the lower voice against a background of leaping passages held in the upper voice. The primary support tones of the melody are “h” and “f.” Chromatic descending passages around these degrees introduce instability into the modal basis. Nevertheless, the overall structure of the melody, with its improvisatory character, remains close to the melodic traits of mugham.



Sample 15. Prelude XV [7]

In the subsequent development of the theme, wave-like passages reminiscent of virtuosic tar playing emerge, particularly emphasizing motion around the support degrees with descending melodic figures that notably reference the tone “h”.



Sample 16. Prelude XV [7]

Another method derived from mugham performance in the prelude is related to the rhythmic variation of melodic motifs. In the texture, chords are initially expressed in dotted rhythms, later appearing as triplets, eighth notes, and sixteenth notes. This type of rhythmic variation can also be characterized as a feature originating from mugham.

CONCLUSION

The analysis of Vasif Adigozalov’s preludes demonstrates that the composer had a deep understanding of the modal-intonational, melodic, rhythmic, and performative characteristics of mugham. He successfully reflected all of these elements within the framework of a small-scale instru-



mental genre. A number of mugham-related features are evident in the preludes: mode-intonation traits, methods of thematic development, melodic and rhythmic variation, among others.

Thus, the works examined contribute to clarifying various aspects of the incorporation of mugham into the context of piano music within the composer's oeuvre. Of course, just as each composer's musical style is unique, the approach to using mugham also reveals individual interpretation. Nevertheless, the study of mugham's mode-intonation usage in these compositions reveals certain regularities. The modal basis becomes a significant expressive means in the musical language of the piece and is closely linked to the deeper layers of the composer's musical thinking. In this regard, the composer's relationship with mugham and the way he draws inspiration from it directly influences the selection of expressive tools in the musical work. At the same time, the fusion of mode-intonation features with the major-minor system is connected to the creative imagination of the composer and opens the way toward enriching the musical language.

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VASİF ADIGÖZƏLOVUN “24 PRELÜD” SİLSİLƏSİNDƏ MƏQAM-İNTONASIYA XÜSUSİYYƏTLƏRİNİN TƏZAHÜRÜ

N.N. Abasova

Təqdim olunan məqalə Vasif Adıgözəlovun fortepiano üçün “24 prelüd” silsiləsində muğamla bağlı məqam-intonasiya xüsusiyyətlərinin təhlilinə həsr olunmuşdur. Öncə giriş bölümündə Vasif Adıgözəlovun yaradıcılığı və prelüd janrı haqqında ümumi məlumat verilmişdir. Daha sonra əsas hissədə bəstəkarın müəllimi Qara Qarayevin ənənələrinə istinad edərək yaratdığı bu silsilədə prelüdlərin tonal planı və musiqi dilində Q.Qarayevin prelüdləri ilə oxşar və fərqli cəhətləri üzə çıxarılmışdır. Həmçinin prelüdlərin forma, məzmun, ifadə vasitələrində muğamdan gələn cəhətlər araşdırılmış, onların məqam əsası, intonasiya xüsusiyyətlərinin təhlilin not nümunələri əsasında aparılmışdır. Nəticə bölümündə isə hər bir bəstəkarın fərdi musiqi üslubuna malik olub, muğamdan istifadə baxımından fərdi yanaşmasının mövcudluğu qeyd olunmuşdur. Eyni zamanda bəstəkarların yaradıcılıq təxəyyülü ilə bağlı olan məqam-intonasiya xüsusiyyətləri ilə major-minor sisteminin qovuşmasının musiqi dilinin zənginləşdirilməsinə yol açdığı vurğulanmışdır.

Açar sözlər: *Vasif Adıgözəlov, bəstəkar, yaradıcılıq, fortepiano musiqisi, prelüd, muğam, məqam-intonasiya.*



**ПРОЯВЛЕНИЕ ЛАДО-ИНТОНАЦИОННЫХ ЧЕРТОВ В ЦИКЛЕ «24 ПРЕЛЮДИИ»
ВАСИФА АДЫГЕЗАЛОВА**

Н.Н. Абасова

Представленная статья посвящена анализу ладо-интонационных особенностей, связанных с мугамом в цикле «24 прелюдии» для фортепиано Васи́фа Ады́гезалова. Сначала во вступительном разделе даются общие сведения о творчестве Васи́фа Ады́гезалова и жанре прелюдии. Далее, в основной части, выявляются сходства и различия между тональным планом и музыкальным языком прелюдий этого цикла, созданных композитором с опорой на традиции своего учителя Гара Гараева, и прелюдиями Г. Гараева. Также рассмотрены аспекты прелюдий по форме, содержанию и средствам выражения, которые исходят от мугама, а также проанализированы их ладо-интонационные особенности на основе нотных образцов. В заключительном разделе отмечено, что у каждого композитора индивидуальный музыкальный стиль и индивидуальный подход в плане использования мугама. При этом подчеркивалось, что сочетание ладо-интонационных особенностей, связанных с творческим воображением композиторов, и мажорно-минорной системы проложило путь обогащению музыкального языка.

Ключевые слова: *Васиф Адыгезалов, композитор, творчество, фортепианная музыка, прелюдия, мугам, ладоинтонация.*



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ARTISTIC-TECHNICAL FEATURES OF GEOMETRIC MOTIFS IN AZERBAIJAN

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The main feature of geometric motifs in medieval Azerbaijani tile art is mathematical accuracy, systematicity and the construction of the ornament on symmetry. These motifs started from simple shapes such as squares, triangles, rhombuses, and became more complex and updated to star and polygonal lattices. Geometric ornaments, lattice systems of various shapes symbolize the ideas of infinity, harmony and aesthetic balance on architectural surfaces.

The girih technique was widely used in architectural monuments such as Momina Khatun (1186) of Nakhchivan, Goy Günbez (1194-1196), and the Olcaytu tomb of Tabriz (1307-1313) in the 12th-15th centuries. Girih ornaments were prepared in close connection with architectural projects, more precisely, they were executed by architects and tile masters with a mathematical approach.

What distinguishes tiles with geometric motifs from floral motifs is that they are built on a more mathematical accuracy and a certain systematicity. If the artist's feeling and taste are at the forefront in floral ornaments, planning, calculation and mathematical composition play a key role in geometric ornaments. For this reason, geometric tiles were mostly used in monumental religious architecture such as mosques and tombs.

Keywords: Azerbaijan, tile art, geometric motifs, artistic-technical features, decorative-applied art

INTRODUCTION

The history of the emergence of tile art has left a deep mark on the culture of ancient civilizations. According to historical data, tile art was first used in the Sumerian temple located in the city of Ur in Mesopotamia (IV millennium BC). Sumerian masters applied simple geometric motifs by covering the surface of bricks with layers of colored engobe and glaze. These compositions often resembled patterns typical of the art of weaving.

The tradition of using geometric motif ornaments in Azerbaijan dates back to ancient times. Architects, taking advantage of the knowledge and skills of tile masters with rich experience in this field, systematically applied ornamental elements in the artistic design of buildings. As a result of this approach, ornaments became not only a decoration, but also the main means of expression that determined the rhythm of the architectural structure.

According to the general laws of decorative and applied art, the development process in all its fields progresses from simple forms to complex structures. This principle is also clearly observed in medieval Azerbaijani ceramics. Thus, the decorative systems observed in ceramic samples of that period are distinguished by their unique style of expression. This is also confirmed by the results of existing research. According to research, in the tiles produced in the Middle Ages, simple but aesthetically effective geometric ornaments - flat, circular, square, rhombus-shaped patterns - were widely used as the main decorative elements. As a result of placing these simple elements on decorative surfaces in various combinations and variations, it is observed that the tiles reached a high level in terms of artistic quality.



When the structure of geometric ornaments is examined in more depth, it becomes clear that this system used in medieval tile art was mainly based on three main structures: square, triangular and ray-shaped elements. Various compositional units - rhombus, parallelogram, polygonal ornaments were created from these main forms. More complex decorative patterns were mainly built on the basis of ray-shaped networks. Arabesque-like girih compositions created by this method began to be widely used, especially from the 11th-12th centuries.

One of the factors that increased the possibilities of artistic expression of this process is the richness of the composition created through the repetition and improvisation of ornaments. Such compositions, combined with the bright and dynamic nature of the color palette used, gave the tiles a special aesthetic. For example, the analysis of ceramic samples discovered in the ancient Ganja and Orangala territories shows that local craftsmen creatively arranged ornaments that gave the effect of squares and chessboards along the surface, achieving a special decorative rhythm on dishes and tiles that were different in both form and function [6, p. 49].

What distinguishes tiles with geometric motifs from floral motifs is their construction on a more mathematical accuracy and a certain systematicity. If the artist's feeling and taste are at the forefront in floral ornaments, planning, calculation and mathematical composition play a key role in geometric ornaments. For this reason, geometric tiles were mostly used in monumental religious architecture such as mosques and tombs.

MAIN PART

In Azerbaijan, geometric motif tiles reflect mathematical harmony and structured artistic order by their very nature. They mainly consist of symmetrical combinations of square, rhombus, triangle, polygon, octagonal star, parallelogram, etc. elements. These elements combine to form knotted structures called girih. The unique feature of this geometric structure system called "girih" was that the patterns were subject to strict mathematical and symmetrical rules. The entire composition was formed by the precise intersection of lines and the combination of appropriate geometric elements (star-shaped, polygonal and their parts). The symbolic meaning of these ornaments is characterized in the Islamic world as an expression of the idea of infinity and perfection. Girih compositions were often applied to brick, mud, stone and tile facings. As an example, we can cite the wall surface of the Momina Khatun tomb (1186), which is considered a masterpiece of Nakhchivan architecture, as well as the decorative geometric ornament systems of the Goy Günbez tomb (1194) in Maragha. In these monumental architectural examples, both the technical accuracy and aesthetic depth of the girih ornaments are an indicator of the rich artistic design of the monument.

The fragments of buildings discovered as a result of archaeological research of medieval urban culture show that local craftsmen actively used decorative geometric motifs in brickwork - including zigzag, rectangular, meander-type patterns. Among the brick decorations, the symmetrical geometric ornament system called "girih" with a complex structure stands out. The facing bricks with various reliefs and shapes, prepared for the artistic design of architectural elements - wall surfaces, arches and portals, prove the high level of artist imagination. In this regard, the examples of facing bricks with a cut geometric pattern discovered during excavations in the city of Beylagan clearly reflect the regional characteristics of the tile technology [3, p. 78].

The development of tile and brick decor in Azerbaijani architecture gave impetus to the creation of complex "girih" networks on late-brick ornamental plates. These plates were prepared near the construction site before construction and attached to the wall surfaces in a ready-made form. One of the first concrete examples of the application of such facing tile plates is observed in the construction of the tombs of Yusif Kuseyir oglu and Momina Khatun, which belong to the 12th century Nakhchivan architecture. The ornamental plates used in these monumental monuments, which are approximately 12 cm thick, consist of repeating elements and form the rhythm of the entire composition. The polished and smooth textured surface of the plates makes the monument even mo-



re attractive in terms of technical and aesthetic aspects. This demonstrates that decoration is not only used for the purpose of creating external beauty, but also as an artistic and ideological manifestation in architecture.

“Nakhchivan architecture attracts attention with its unique original features. Architectural ornaments made of baked bricks and colorful tiles in geometric motifs and monumental compositions delight with their elegance and high artistic design” [2, p. 52].

In the arch compositions placed on the surface of the ten-sided body of the Momina Khatun tomb, each of them is decorated with a tile mosaic of different girih ornaments. The geometric elements used in this monument, in addition to aesthetics, are symbolically associated with the structure of the universe, the ideas of infinity and harmony. Polygonal stars act as a symbolic symbol of cosmic systems.

“The ornamentation on the tomb of Momina Khatun shows that the artist has an inexhaustible imagination. The ornamentation of all surfaces is diverse. The artist did not allow repetition. However, his skill lies in the fact that, despite the diversity, he created all the ornaments in the same character and thus was able to maintain the overall unity of the monument. The basis of the geometric ornament of the surfaces is a multi-pointed star and cavalry lines emanating from it. Here we encounter 5-, 6-, 8-pointed stars and 6.8-angled structures” [1, p. 47].

Momina Khatun's tomb is evaluated as a rare architectural example in terms of surface dynamism and artistic richness with its figured brickwork. The artistic distinction of nine different niches in this tomb, which has a ten-sided body, served to create unity in the diversity of the composition. Each of these niches had different decorative solutions regarding the structure of the ornament, forming the aesthetic multi-planarity and rhythmic structure of the monument as a whole. In addition, the placement of tiles made in the majolica technique on the surface of the monument increased the depth of the multi-faceted cylindrical body and gave the surface vitality with the effect of light and shadow. This artistic arrangement reflects not only the technical skill of the artist, but also his aesthetic attitude to the plasticity of the architectural surface. Thus, the correct selection of tile material and its appropriate application in its place became not only a decoration of the monument, but also a means of revealing its idea and aesthetic meaning.

The development achieved in the field of ceramic production in Azerbaijan in the 12th century created conditions for the use of glazed tiles as a decorative material in wall decoration. At the same time, it is clearly seen that at the end of the 12th century, especially in South Azerbaijan, the art of tiles developed both technically and aesthetically. One of the examples that embodies this development is the Round Dome Tomb in Maragha, built in the 12th century. This monument, which has a cylindrical body, belongs to the group of tower-shaped tombs and reflects the innovative features of its time in terms of architecture. The cylindrical surface of the tomb is formed on the basis of a horizontal arrangement of ordinary baked bricks, and glazed parts are placed between these arrangements to create decorative accents. The arch, one of the most striking parts of the monument, is distinguished by its large size and rich decoration. In this part, the tiles are harmoniously combined with inscriptions written in Kufic script and complex geometric ornaments, which determines the artistic nature of the composition.

Another feature of geometric ornaments is their modular and repeatable structure. This creates a certain sense of fluidity and balance on large surfaces. Such a composition is also reflected in the Goy Günbez tomb in Maragha (1196).

Starting from the 13th century, the use of tiles in architectural monuments expanded further, and in the following centuries there was a certain turning point in the formation of this art form. In some cases, entire facades of buildings were completely covered with tiles, which indicates the high technical and aesthetic skill of the tile masters. Studies show that these features are reflected in the Barda, Karabakhlar, Salmas and Khoy tombs (14th century), as well as in the Goy Mosque in Tab-



riz (15th century). According to researchers, the architectural decoration of the Goy Mosque was based on two main ceramic decorative methods, which were highly artistic:

- Compositional arrangement of large-sized star-shaped and multi-rayed tiles;
- Application of patterned panels made of small-sized, standard-shaped mosaic-type tiles.

In addition, it is emphasized that decorative epigraphic elements written in Kufic and Naskh script played an important role in the architectural decoration of the monument [5, p. 97]. These inscriptions, along with their aesthetic value, had a symbolic meaning and had a great influence on the artistic development of tile art.

"The Blue Mosque of Tabriz is a valuable work of art that embodies the high production culture of architects, calligraphers, sculptors, and tilers who added maximum creative power to the work of Azerbaijani architecture. The construction was led by a person named Izzeddin Qapichi" [4, p. 33].

The deep mastery of mathematical knowledge by engineers and architects, in addition to allowing them to work with high technical precision in the design and construction of buildings, created an environment of close cooperation with tile masters working in the field of tile mosaic. In other words, the decorative projects of tile mosaic were drawn up based on the architectural-composition plan prepared by the architects. As a result of this interaction, the monumental structure of domes, portals and arches seemed both technically solid and aesthetically complete.

Among the examples attributed to the high aesthetic stage of Azerbaijani architecture, monuments with intricate girih patterns decorated with turquoise-colored tiles stand out. This type of monument, especially with its geometric ornamented tile mosaics placed on the arch and facade surface, is distinguished both in terms of decorative richness and harmony.

One of the monumental monuments of the country, which has a unique place in the tile art of the Elkhaniid period and is located in the city of Sultaniye, is the tomb of Olcaytu Khudabande (1307-1313), built according to the design of the Tabriz architect Ali Shah. This tomb is distinguished not only by its architectural solution, but also by its rich tile decoration system, fully reflecting the artistic possibilities of its time. Turquoise tile covering was applied to the dome of the tomb, the decorative elements of its arches in the form of stalactites, the arch and its interior. The turquoise tile elements used on the dome surface created a strong glow in the sunlight, making it stand out even from a distance. This indicates that in addition to the decorative nature of the tile material, it also has a symbolic and effective function.

Tile mosaic was widely used in the facade parts of the arch, in the tympanum zones of the arches, in the friezes above the stalactites, and the interior surfaces were decorated with dark blue, turquoise and white tile elements. The decorative system was not limited to simple geometric mosaics, but was also enriched with tile compositions with curved lines and complex contours. This demonstrates how much the technical possibilities of tile processing developed during the Elkhaniid period and the richness of the artist's imagination in form. This artistic and decorative system, covering both the internal and external surfaces of the Oljaytu Khudabende tomb, creates a broad impression of the high development of tile art in the monuments of that period. This complex decoration was also effective in the following centuries, and was especially used in the architectural decorations of the Sultaniye Mosque (first half of the 16th century). Here, large-sized borders called "Seljuk chain" made of brick and enriched with geometric motifs were used on the surface of the arch and minaret. At the same time, the compositional motifs consisting of eight-pointed stars and cross-shaped elements found in the tympanum of the arch were also adapted here. Complex star-shaped motifs assembled from this type of tile ornaments decorated the general structure of the arch and the borders above the arch, creating a dynamic and complex spatial effect.

The fact that traces of the Seljuk chain style are found in many architectural monuments of the 14th century confirms that it was a decorative system that was widespread in the region and had a long-lasting impact. As a continuation of the craftsmanship of this period, we can mention the



tomb designed by Ahmad Yusif oglu, a representative of the Nakhchivan architectural school, and built in Barda in 1322. The monument is in the form of a cylindrical tower, topped with a conical dome. The surface of the building is made with the figured masonry technique, where ordinary baked bricks and glazed brick elements are combined to create a complex structure. While the horizontally arranged ordinary bricks play the role of a background, turquoise glazed bricks are placed vertically, based on the principle of a square grid, and an ornamental composition is formed by repeating the word “Allah” written in Kufic script two hundred times on these grids. This example shows how high the synthesis of writing and tile art is in Islamic ornaments, and how the artistic and aesthetic impact is manifested in unity.

In the Middle Ages, the process of making tiles was usually carried out by specialized artists, calligraphers and ceramic masters, usually based on the project of professional architects. This cooperation formed not only the technical execution, but also the artistic and aesthetic concept of tile decoration. As a result, tiles have become one of the main means of expression that give rhythm, symbolic meaning and artistic richness to the architectural structure of the monument. It should be noted that the advantage of glazed tiles in terms of protection and durability is due to the fact that their surface is covered with layers of glaze. In this regard, the turquoise glazed facing bricks of the Barda and Karabakhlar tombs are remarkable examples that combine both protective and aesthetic functions.

CONCLUSION

In conclusion, it should be noted that Medieval Azerbaijani ceramics gained importance not only with their widespread use in everyday life, but also with their application as an aesthetic component in architecture. Throughout history, craftsmen who built buildings with various functions were not satisfied only with the constructive elements of the architectural solution, but also paid special attention to increasing the aesthetic value and impact of these buildings. More precisely, their goal was not only the rationality of form and structure, but also the attractiveness of the appearance and the breadth of artistic expression possibilities. In this regard, the application of tile decorations as a means of artistic expression has been one of the most effective methods of increasing the aesthetic value of monuments.

Medieval buildings, while being attractive in terms of their external appearance and architectural solution, are distinguished by the extensive use of tile in their interior design. In other words, the sense of beauty of medieval craftsmen was reflected not only in terms of practicality, but also in terms of artistic thinking at a high level. This shows that both household ceramics and tile art have already entered the classical stage.

One of the main reasons for the development of geometric-motif tile mosaics in Azerbaijan at such a high level is the deep knowledge of technical and theoretical sciences, especially mathematics and geometry, of the craftsmen, architects and masters of decorative and applied arts working in this field.

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AZƏRBAYCANDA HƏNDƏSİ MOTİVLİ KAŞILARIN BƏDİİ-TEXNİKİ XÜSUSİYYƏTLƏRİ

A.N. Xəlilova

Orta əsrlər Azərbaycan kaşı sənətində həndəsi motivlərin əsas xüsusiyyəti riyazi dəqiqlik, sistemlilik və ornamentin simmetriya üzərində qurulmasıdır. Bu motivlər kvadrat, üçbucaq, romb kimi sadə formalardan başlayıb, ulduzlu və çoxbucaqlı girih şəbəkələrə qədər mürəkkəbləşərək yenilənmişdir. Həndəsi ornamentlər, müxtəlif formalı girih sistemləri memarlıq səthlərində sonsuzluq, harmoniya və estetik tarazlıq ideyalarını simvolizə edir.

Girih texnikası XII-XV əsrlərdə Naxçıvanın Möminə Xatun (1186), Göy Günbəz (1194-1196), Təbriz Olcaytu türbəsi (1307-1313) kimi memarlıq abidələrində geniş istifadə edilmişdir. Girih ornamentləri memarlıq layihələri ilə sıx əlaqədə hazırlanır, daha dəqiq desək, riyazi yanaşma ilə memarlar və kaşı ustaları tərəfindən icra edilirdi.

Həndəsi motivli kaşıları nəbati motivlərdən fərqləndirən cəhət onların daha riyazi dəqiqlik və müəyyən sistemlilik üzərində qurulmasıdır. Əgər nəbati ornamentdə sənətkarın hissi və zövqü öndədirsə, həndəsi ornamentlərdə planlaşdırma, hesablama və riyazi kompozisiya əsas rol oynayır. Bu səbəbdən, həndəsi kaşılar daha çox məscid və türbə kimi monumental dini memarlıqda tətbiq olunurdu.

Açar sözlər: *Azərbaycan, kaşı sənəti, həndəsi motivlər, bədii-texniki xüsusiyyət, dekorativ-tətbiqi sənət.*

ХУДОЖЕСТВЕННО-ТЕХНИЧЕСКИЕ ОСОБЕННОСТИ ГЕОМЕТРИЧЕСКОЙ ПЛИТКИ В АЗЕРБАЙДЖАНЕ

А.Н. Халилова

Главной особенностью геометрических мотивов в средневековом азербайджанском изразцовом искусстве является математическая точность, системность и построение орнамента на симметрии. Эти мотивы берут начало от простых форм, таких как квадраты, треугольники, ромбы, и усложняются, совершенствуясь до звездчатых и многоугольных сеток гирих. Геометрические орнаменты, системы гирих различных форм символизируют идеи бесконечности, гармонии и эстетического равновесия на архитектурных поверхностях.

Техника гирих широко применялась в XII–XV веках в таких архитектурных памятниках, как Момине-хатун в Нахчыване (1186), Гёй Гюнбёз (1194-1196) и гробница Олджайту в Тебризе (1307-1313). Орнаменты гирих создавались в тесной связи с архитектурными проектами, а точнее, выполнялись архитекторами и изразцовыми мастерами с использованием математических методов. Геометрические мотивы плиток от растительных отличаются большей математической точностью и определённой систематичностью. Если в растительном орнаменте на первый план выходят чувство и вкус художника, то в геометрических орнаментах ключевую роль играют планирование, расчёт и математическая композиция. Поэтому геометрические мотивы чаще всего использовались в монументальной религиозной архитектуре, такой как мечети и гробницы.

Ключевые слова: *Азербайджан, изразцовое искусство, геометрические мотивы, художественно-технические особенности, декоративно-прикладное искусство.*



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THE FATE OF AZERBAIJANI STUDENTS IN GERMANY DURING 1918-1920 (BASED ON GERMAN ARCHIVES)

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This article examines the fate of Azerbaijani students sent to Germany during the brief existence of the Azerbaijan Democratic Republic (1918–1920). Based on extensive archival research conducted at the Freiberg Mining Academy, Humboldt University in Berlin, Darmstadt Technical University, and Munich Academy of Fine Arts, the study explores both the financial and social challenges these students faced, as well as their notable academic achievements [4, p. 9-12], [6, p. 1], [10, p. 1-3]. The article highlights the activities of the Azerbaijani Students' Committee in Berlin, its transformation after the Soviet Revolution, and how the inclusion of Communist Party members led to increased surveillance and repression. This surveillance contributed to the exile of many repatriated students, despite their dedication to their homeland. Additionally, the article sheds light on compatriots from northern Azerbaijan who emigrated to Germany during the Russian Empire era to pursue higher education. Despite the hardships, Azerbaijani students successfully defended their theses and made significant contributions to their fields. The author concludes by emphasizing that archival research is ongoing and hopes this work will encourage further studies into the historical connections between Azerbaijan and Germany during this pivotal period.

Keywords: Students of the Azerbaijan Democratic Republic, Mining Academy of Freiberg, Archives of Berlin Universities, History of the Homeland, Academy of Fine Arts Munich, Technical University of Darmstadt.

INTRODUCTION

After the creation of the ADR in 1918, one of the key tasks was to promote the education system in Azerbaijan. Upon the proposal of M.A. Rasulzadeh (one of the founders of the Azerbaijan People's Republic, Chairman of the National Council), it was decided to send students abroad, particularly to European countries. As noted in the archives regarding the activities of the Azerbaijan Democratic Republic (ADR), students were sent to countries such as the United Kingdom, Italy, France, Russia, and some students to Germany. One of the students studying in Germany at the time, A. Aliyev, wrote: “In Germany, we were divided as follows: - 10-12 in Berlin, 13-15 in the Grand Duchy of Baden, 7 students were in Freiburg with me” [3, p. 47]. The archival documents about the Republic list varying numbers of students studying in Germany – 100, 60, or 50 people. It is also mentioned that the tuition fees, according to some archival documents, were covered by the millionaire and businessman Haji Zeynalabdin Tagiyev [11, p. 6]. Of course, H.Z. Tagiyev, who took on this charitable mission and responsibility, also had his own conditions:

Each student would receive 50 marks per month during their studies. The travel and accommodation costs for summer holidays to and from the Caucasus would also be covered.

After completing their studies, each student would be required to return to their homeland and serve the country.

The student would not marry a non-Turk or non-Muslim.

After graduation and entering professional life, the student would repay the money received from H.Z. Tagiyev in a lump sum or in installments to charitable organizations.



Of course, when editing the conditions set by H.Z. Tagiyev, the point regarding marriage to a non-Turk or non-Muslim was removed. This point was perhaps removed due to the democratic structure of the republic at that time and the legal state ideas of the period. It should be considered that the parliament also had ample representation from non-Muslim peoples, such as Armenians, Russians, and Jews. In this context, the issue of marriage was silently bypassed. The main goal was to promote education and place the students in various positions. It should also be mentioned that many of our successful compatriots received their education with financial support from H.Z. Tagiyev. Prominent statesmen like Nariman Narimanov and Aziz Aliyev serve as examples of this. Aziz Aliyev studied at the Higher Military Medical Academy in Petrograd (Russia) with financial support from H.Z. Tagiyev, the "Father of the People" (as he was called by the Azerbaijani people). The great political leader mentioned in his biography the financial support from Tagiyev when he was Deputy Chairman of the Council of Ministers of the Azerbaijan SSR. Naturally, it was a great achievement for Azerbaijani students to study at the prestigious universities in Germany, with their high educational standards, but unfortunately, this success was short-lived. After the collapse of the Republic, and despite all the efforts of the prominent statesman N. Narimanov, the tuition fees were reduced to a minimum. Some students abandoned their studies, while others were forced to work to continue their education. The students in Germany founded the "Student Union Society" in Berlin in the first months of their studies [5, p. 1-29]. Later, additional branches of this organization were established in Dortmund, Freiburg, and Leipzig. The time when our students immigrated to Germany coincided with political changes in Germany, when the Weimar Republic was established. Our students tried to adapt to the political changes in German society. However, the collapse of the republic shattered the students' hopes. Due to the ideological orientation of Bolshevism, many of the students studying abroad were labeled as "spies." As a result, many hesitated to return to their homeland after completing their studies. The news that returning students were labeled as "enemies of the people" and exiled to Siberia shook the emigrant students. Some of the returned students, however, achieved great success and were able to work in high positions. Nevertheless, they were constantly monitored and were under state control [2, p. 1-8]. Some of the graduates, who faced hardships during the "Stalinist Repressions" and whose paths to the homeland were closed, died longing for their homeland. The prominent scholar Mammad Jafarli provided information about some of the Azerbaijani students in his book *Political Terror and the Fate of Azerbaijani Germans* [3, p. 3-47]. The book was published in Germany, and a Russian version is also available in Azerbaijan. Professor N. Tahirzade also provides information about some of the students who studied in Germany during the republic [11, p. 3-6]. By using these two sources, we can draw certain conclusions about the fate of the students who studied in Germany during the republic. As mentioned earlier, their number was about 50 or 100 [3, p. 3-47].

MAIN PART

When addressing the future fate of the students sent to Germany for education, two main questions arise. The first question is: Did our students who studied at German universities receive a diploma upon completing their studies? The second question is: Does the list of students sent to Germany for education, as presented by the two authors, represent the complete list, or are there other students whose names are not included in this list? When we speak of Azerbaijani students, we are referring not only to ethnic Azerbaijanis but also to representatives of other peoples who lived in Azerbaijan at that time. Since its founding, the ADR, which presented its democratic views to the world, also sent young people from other nations to Europe, including Germany, for education, as they were also considered Azerbaijanis. Considering that members of the Azerbaijani parliament included representatives of Jewish, Russian, and other nations, it is not surprising that these questions are raised. To find answers to these questions, we decided to take a scientific research trip to Darmstadt, Germany, to examine the archival documents of the Technical University of Darmstadt

from the 1920s. In doing so, we aimed to investigate the subsequent fate of the Azerbaijani students who were sent to this city for education. It should be noted that we have contacted the archives of all the German universities where Azerbaijani students were educated, and we will investigate these in our future articles.

In general, the city of Darmstadt in Germany is very historical and hosts one of the universities, Darmstadt Technical University. Through the examination of archival materials, we were able to gather detailed information about 15 Azerbaijani students. Of the sources mentioned above (Prof. Mammad Jafarli and Prof. Narmin Tahirzade), only three of these students (Rizazade Iskander, Huseynzade Bahram, Mammadov Gahraman) were mentioned, while no information was available about the other 12 students. These new findings belong to the author. Five of these students were ethnically Azerbaijani, while seven others were Azerbaijanis of different ethnic origins. However, it should be noted that even for the three students mentioned earlier, only limited information was available, so we added the new information from the archival documents.

I: Rizazade Iskander – In Mammad Jafarli's book *Political Terror* [3, p. 51], the following is written about this compatriot: (Translation into Azerbaijani) "In 1920, he was sent to Germany for studies by the National Parliamentary Government of the ADR (the city is unknown). After his return to Azerbaijan, he worked as an engineer in the department of the Academy of Sciences of the USSR in Azerbaijan."

Our Research:– Rizazade Iskander Khan (the full name is provided in the Darmstadt archive) was born on 05.11.1897 in Tehran. He studied at the Faculty of Electrical Engineering at Darmstadt Technical University. In 1925, he defended his thesis in this field. The Darmstadt Technical University archive indicates that he completed his further studies at Nancy Technical University in France (Archive number: TH12/01 No. 196-9).

II: Huseynzade Bahram bey – (Huseynzade Bahram Ismayıl) – The archive document states that he studied at the Faculty of Electrical Engineering at Darmstadt Technical University from 1922 to 1926 and defended his thesis in 1926. Further details align with the first sources (Archive number: TH-12/01 No. 106-7).

III: Mammadov Gahraman – The name of his father is not mentioned in either source. The first source states that he was sent to Germany by the ADR in 1920 for studies. It is also mentioned that he returned to Baku in 1927 and worked at the Azerbaijan State Design Institute.

Our research shows that Mammadov Gahraman was born on 25.09.1898 in Baku. He studied from 1924 to 1928 at the Faculty of Civil Engineering at Darmstadt Technical University and defended his thesis in this field in 1928. Our compatriot continued his education at the Technical University of Berlin. It was documented in the archival materials that he defended his thesis under the supervision of Professor Kippingen in 1926. The archive materials also note that he created the "Urban Planning, Road Construction, and Foundation Engineering Plan for 3,000 Families as part of the Spendings Municipality Project." In the Darmstadt Technical University archive, we came across information about **Aschurov Aga**, whose name is not mentioned in any source. He was born on February 24, 1886, in Baku. The "Russian Secondary School" he attended was most likely the Seminary School in Tbilisi. The archive documents state that he had a seven-year schooling. From 1907 to 1910, he studied at the Faculty of Electrical Engineering at Darmstadt Technical University and defended his thesis in 1910 with exceptional approval from the German Ministry of the Interior. In M. Jafarli's book *Political Terror and the Fate of Azerbaijani Germans*, there is mention of students who studied at Darmstadt Technical University, including Seyidzade Mirismayıl and Schikhiev Useyn. It is only assumed that they returned to Baku in 1927 and later went back to Germany. To obtain accurate information about these students, we contacted Darmstadt Technical University and received the following response: "Unfortunately, we must inform you that the individuals mentioned were not found in the examination records of Darmstadt Technical University." This response was sent on December 16, 2024, by Simon Gollch, an archivist at the university. It can be conc-



cluded that these students could not complete their studies due to financial difficulties and did not defend their theses. Another student at Darmstadt Technical University was **Alisade Javad**, born on May 15, 1908, in Baku. He studied from 1928 to 1931 at the university and defended his thesis in 1931 in the field of electrical engineering. The archive materials indicate that he, like many other students, faced financial difficulties. Since his parents lived in the Soviet Union, Alisade Javad could not carry out his thesis defense on time. Another archive document describes that he had to postpone his thesis defense due to financial issues. Another interesting detail concerns his compatriot **Alizade Rahim**, who also faced financial difficulties and lived an extremely stressful and challenging life. Another document confirms that Alizade Rahim defended his thesis in 1931 in the field of electrical engineering. He defended his thesis at the Faculty of Electrical Engineering. In the minutes of the meeting of the Faculty of Electrical Engineering from November 20, 1925, it is noted that at the request of Huseynzade and Rızazade, the Azerbaijani state scholarship recipients, the examination fees were reduced. As previously mentioned, Alizade Rahim was also faced with financial difficulties. He was born on October 6, 1905, in Baku. From 1925 to 1935, he studied mechanical engineering at Darmstadt Technical University and defended his thesis in 1931. Another compatriot, **Mahmudbeyov Aghalar**, was born on January 14, 1879, in Shamakhi. He studied from 1903 to 1904 at the Faculty of Electrical Engineering at Darmstadt Technical University, but there is no information about the defense of his thesis in the archive records. **Huseynzade Huseyn**, born on April 15, 1904, in Baku, studied from 1926 to 1929 at Darmstadt Technical University and defended his thesis in 1929 in the field of mechanical engineering and aeronautical engineering. Now, we would like to answer the initial questions. As seen in the example of Darmstadt Technical University, not everyone had the privilege of completing their studies there with a diploma. The biggest obstacle was certainly the financial situation. In order to be allowed to defend their theses, additional payments were required. Some students were able to make these payments and defend their theses, while others, who could not afford it, were unable to complete their studies. It is still difficult to give precise numbers, but this is the reality. After the collapse of the Azerbaijan Democratic Republic, the situation for students significantly worsened.

The research has shown that the fate of many of these students is still not fully researched and clarified. As mentioned earlier, not only Azerbaijanis but also non-Azerbaijanis were among the students at the Darmstadt University of Technology, who studied in various years and defended their theses. Here is some additional information:

- **Varonin Salamon**, born on January 17, 1890, in Baku, studied at Darmstadt University of Technology from 1924 to 1925, but there is no information about his thesis defense.
- **Sundström Lars**, born in Baku, studied from 1941 to 1942 at the Faculty of Paper Technology/Printing Technology and defended his thesis in 1942 (Archive number: TH 12/01 Nr. 247-25).
- **Tapken Peter**, born on October 11, 1885, in Baku, studied at the Faculty of Electrical Engineering in 1908 and defended his thesis in 1908 (Archive number: TH 12/01 Nr. 248-38).
- **Gierse Eugen**, born on May 28, 1909, in Baku, studied mechanical engineering from 1930 to 1932 and defended his thesis in 1932 (Archive number: TH 12/01 Nr. 72-4).
- **Neporent Osip**, born on August 14, 1886, in Baku, studied at the Faculty of Electrical Engineering in 1910 and defended his thesis in 1910 (Archive number: TH 12/01 Nr. 169-38). It is also noted that he additionally studied at the University of Kharkiv, but the year is unknown.
- **Seiz Alvin**, born on August 8, 1879, in Baku, studied at the Faculty of Electrical Engineering from 1901 to 1904 and defended his thesis in 1904 (Archive number: TH 12/01 Nr. 231-22).

- **Lentch Valter**, born on February 8, 1883, in Baku, studied mechanical engineering from 1906 to 1909 and defended his thesis in 1909. Additionally, he received a certificate from the Technical University of Charlottenburg in Berlin.

The next fellow citizen also comes from a German family. His family moved from the town of Göppingen in the Baden-Württemberg region to Helenendorf, now known as Khanlar, in 1819. The family is listed in the German archives under number 100 of the people resettled to Helenendorf. The head of the family, Schock Georg Heinrich, is mentioned there [8, p. 1-8]. From Helenendorf, the young Emil Schöck went to Munich to study at the Academy of Fine Arts, at the Faculty of Painting. He is recorded in the academy's archive book under number 00088. He was admitted for the winter semester and studied from 1922 to 1923. Contact with the archives regarding his later fate is ongoing. His paintings are now kept in collections and museums as part of the Munich School (this information comes from the archive of the Academy of Fine Arts Munich) [9, p.1-8]. Another interesting point concerns our fellow citizen Merkurov Sergius, who later became one of the outstanding sculptors of the Soviet Union. He was born in the western Azerbaijani region, the present-day city of Gjumri (formerly Alexandropol) in the Republic of Armenia. He later studied in Tbilisi. According to sources, he was born on November 7, 1881, in Alexandropol (Gjumri). He died on June 8, 1952, in Moscow. Russian sources indicate that his heritage was Greek-Russian. In the Munich Academy archive, he is listed as follows: Registration number 02603, admitted to the Faculty of Sculpture on May 13, 1903. The sources provide the following details: The son of a Greek entrepreneur and the nephew of Georg I. Gurdjieff, Merkurov attended high school in Tbilisi, graduated in 1901, and continued his studies at the Kyiv Polytechnic Institute. However, due to political unrest, he was soon expelled from this institution. In the fall of 1902, he continued his education at the Faculty of Philosophy at the University of Zurich in Switzerland, where he met Lenin. Merkurov was a student of Swiss sculptor Adolf Meyer. On his recommendation, he went to Munich to study under Wilhelm von Rümmer at the Academy of Fine Arts, where he stayed until 1905. Afterward, he lived and worked in Paris until 1907, where he developed a new style through the works of Auguste Rodin and Constantin Méniér, becoming known as a sculptor. In 1907, he returned to the Russian Empire, living initially in Tbilisi and then in Yalta. In the fall of 1910, he moved to Moscow. In November 1910, he was invited to create a memorial mask of Tolstoy. Later, he created memorial masks of prominent figures such as Hovhannes Tumanyan, Lenin, Nadezhda Krupskaya, Maxim Gorky, and Vladimir Mayakovsky. Between 1911 and 1913, he created the statue "Thinking," which was later placed on the grave of Alexander Opekushin at the New Maiden Cemetery in 1956. After the October Revolution, Merkurov, as director of the Pushkin Museum, restored the marble statue of Catherine II, which had been placed in front of the Moscow City Duma in 1896, and saved it from destruction. From 1944 to 1950, Merkurov served as the director of the Pushkin Museum in Moscow. In 1984, the Merkurov Museum was opened in Gjumri in the house of Merkurov's grandfather. In Moscow, a monument to Merkurov was erected at the site of the summer house where he lived and worked until his death in 1920 [11, p. 6].

The book *Political Terror and the Fate of Azerbaijani Germans*, carefully compiled by Dr. Mammad Jafarli, a professor of philology (2003), is based on investigative materials from the archive of the National Security Service of the Republic of Azerbaijan. In this book, the author describes the tragic fate of the students sent to Germany and, for the first time, presents not only the number of students trained in Germany but also those sent to other European countries, as well as Russia and Turkey. A valuable aspect of the book is its portrayal of the sad fate of the Germans residing in Azerbaijan at that time [3, p. 47].

In 2016, the book *The Students of the Azerbaijan Republic* (authors: Adalat Tahirsade, Oguz Togrul Tahirli) was published in an elegant design. It covers not only the founding history of the Azerbaijan Republic but also the general attitude of the time toward education, as well as the fate of the students and their life paths. The book includes the number and lists of students sent to Europe-



an countries, along with available information about each individual [11, p. 6-11]. The information published in both books, along with reports from contemporary press on the study experiences of the dispatched students—especially the difficulties they faced during their studies and whether they successfully defended their dissertations despite these challenges—led us to consult the archives of several German universities. In addition to sending students abroad, the Republic also established its own representations in foreign countries. In the archives of Humboldt University in Berlin, we found correspondence between the "Central Committee of Azerbaijani Students" and German universities [1, p. 89].

I. Letter: *Azerbaijani Student Association in Germany*, February 27, 1924, No. 15, Berlin, Confirmation: With this letter, we confirm that Mr. Mirza Hajisade is to represent the Azerbaijani Student Association in Berlin in the Committee of Foreign Students.

Chairman: I. Sultanov

Secretary: M. Hajiyev

P.S. His address: Pariser Str. 60/4, Berlin, Apartment 15, Pfbg 6-27 [4, p. 19]

II. Letter: *Azerbaijani Students in Germany*, February 27, 1924, No. 16, Berlin, Confirmation: This letter confirms that Engineer Mir Ismayıl Seyidsade is to represent the Azerbaijani Student Association in the Committee of Azerbaijani Students in Berlin.

Chairman: I. Sultanov

Secretary: I. Hajisade [4, p. 18]

III. Letter: *Central Committee of Azerbaijani Students*, June 24, 1924, No. 79, Berlin: Based on your letter from June 13, 1924, the Central Committee of Azerbaijani Students informs that Mr. Nüs-rat Bra has been designated as the representative of the Committee of Foreign Students at the University of Berlin to represent foreign students.

Secretary: A. Iskandarli

Address: Berlin 40, Neues Tor, 1, No. 111

Committee Address: Iskandar Sultanov

Charlottenburg, Berlin, 158, Pension Wütle [4, p. 16]

In the city of Freiberg, Germany, we came across the name of the student Seyid Kamil Sadıkhov, who studied at the Mining Academy. What particularly caught our attention was his first-degree diploma, which he received on November 27, 1925. However, the path to this diploma was marked by significant hardships. In a letter he wrote on May 30, 1925, in German to the rector of the university, we learn of his difficulties: "I am submitting six drawings, six reports, and three pictures in a folder, but I kindly ask you to exempt me from the payment of 30 marks for the defense of my thesis, as I only receive 68 marks per month."

The archive documents also include a letter of recommendation sent from Baku for his student activities, as well as a mention of his work as a department head in a munitions and rifle factory during the years 1918-1919 (Ministry of Transport, Certificate No. 157). The letter was notarized on May 9, 1920, in Dresden. After completing his education and returning to his homeland, we also came across a letter from Kamil Sadıkhov, which he wrote on June 8, 1925. In the letter, he stated: "Since I have lost my diploma, I kindly request a copy of it. I will ask someone coming from Baku to Germany to pick up a copy of the diploma I received on November 27, 1925, based on my request." It is strange that the copy of the diploma was not sent at that time, as we also found another letter written in Dresden in 1945, in which he again requested a copy. It was only after this letter that the copy of the diploma was provided to him [4, p. 6].

Another of our fellow countrymen is the student Surkhay Schakhsovarov. He enrolled at the Mining Academy in Freiberg on April 13, 1920, and completed his studies on June 15, 1925. While reviewing the documents, we came across a particularly distressing letter. In it, he wrote to the rector: "Dear Rector, my financial situation is very bad. I have not been able to pay my rent for several months, and therefore I kindly ask you to grant me an extension to pay the semester and library fees

until my final examination." The letter also reveals that the student had already submitted his thesis six weeks earlier, but was not allowed to defend it due to the non-payment of the required fees. In another letter to the rector dated July 22, 1924, he wrote: "I kindly ask you to exempt me from paying the 30 marks for the defense of foreign students' theses, as I have spent 50 marks on medicine due to illness and still owe 80 marks." Despite all these difficulties, Surkhay Schakhshvarov managed to successfully complete his studies at the Freiberg Mining Academy on June 15, 1925, with a first-degree diploma [9, p. 8-12].

We came across archival materials regarding our fellow countryman, the student Huseyn Nagiyev, who studied in Berlin. He wrote a letter to the rector of the Royal Agricultural College in Berlin, which is part of the official collection of documents "ACTA" (published from September 1924 to December 1924). In his letter dated May 9, 1923, he wrote:

"Berlin, May 9, 1923, Neusses Tor 1A – Huseyn Nagiyev. Dear Rector, I kindly ask you to allow me to take the diploma examination according to the new regulations, which will take place in July. I was born on March 13, 1897, in Ganja (Caucasus), and graduated in 1917 from the Russian 8-grade Gymnasium in this city. After that, I studied for one year at the Polytechnic Institute in Kyiv. Due to unrest in Russia, I could not continue my studies and returned to my homeland. In 1920, I was sent by the Azerbaijani state as a scholarship holder to Germany to study agriculture. Since 1920, I have been an official student at the Royal Agricultural College in Berlin. In 1922, I already passed my diploma examination according to the old examination regulations."

He attached his high school graduation certificate and scholarship certificate to the letter. The letter was approved on June 30, 1923, and the Secretariat marked in the lower corner of the document: "Diploma, request for early admission to the examination (Huseyn Nagiyev, Azerbaijani citizen, according to the new examination regulations)." We also found several other letters from Huseyn Nagiyev in the archive of the Agricultural College in Berlin. These revealed that he was successful in his studies. On October 14, 1923, he requested an extension of 14 days from the rector to complete an internship and familiarize himself with agricultural machinery. He also highlighted that life in Berlin was very expensive. Another letter from him to the rector discussed the difficulties he faced as a Turk: "Since I am a citizen of a foreign country of Turkish descent, it is very difficult for me to study the relevant scientific literature. Therefore, I am progressing slowly. Additionally, I lost eight days due to my participation in an exhibition in Hamburg. I kindly ask you to consider this." The rector responded positively to this letter and granted him an extension [7, p. 22-26].

The archival materials and letters of Azerbaijani students who studied in Germany during the 1920s show a largely positive attitude from university administrations toward their concerns, although financial matters were occasionally problematic. The letters sent by students to the rectors and faculties do not document any instances of rejection or negative responses, except in cases where payment of the required fees was concerned. Even so, there was understanding of the difficult financial and personal circumstances many of them faced. This highlights the commitment and support of German universities for educating foreign students during this time.

However, the harsh reality for many of these students upon returning home after their studies was tragic. Despite their education and expertise, they were often viewed by the Azerbaijani government, which was investigating the loyalty and "welfare contribution" of returning citizens after the Soviet takeover, as enemies of the state. Many of these students were persecuted, exiled, or even executed, as they were falsely seen as traitors or threats to the new political regime. These tragic fates reflect the difficult political circumstances of the time and reveal the discrepancy between the academic and professional recognition of these students and their fate in their homeland.

One notable case among these students is that of Mirza Hajisade. He was one of those sent to Europe for studies by the government of the Azerbaijan Democratic Republic in 1920. In his letters to the university and professors, his dedication and determination to return to his homeland as not only a professional but also as a teacher to contribute to the training of new specialists is evident.



The entire process he went through, from enrollment in Naples to transferring to Berlin, illustrates the uncertainty and challenges he faced. Particularly his request for admission to the teaching examination shows that the government of the Azerbaijan Republic was not only interested in training professionals but also in training teachers who could pass on knowledge and skills to the next generation.

Hajisade, born on September 12, 1897, in Ganja, began his education at the "Ganja Oglan Gimnaziyası" (Boys' Gymnasium) and later continued at various agricultural institutions, including the "Novoaleksandriya Agricultural Institute" in Russia and the "Neapolitan Agricultural Institute" in Italy, before going to Berlin in 1920 to continue his education. The university in Berlin was an important educational institution for many of these students, providing them the opportunity to continue their studies after political unrest in Russia and other parts of the Caucasus had destroyed educational institutions. Hajisade himself describes in his biography how political turmoil interrupted his education, but he was ultimately able to continue his studies in Europe and become a teacher in the field of agriculture.

The archival materials related to Mirza Hajisade and other Azerbaijani students who studied in Germany highlight the variety of challenges they faced, which were not only financial but also related to language barriers. Particularly for those who did not speak German or had limited language skills, it was difficult to adapt to academic requirements and pass the necessary exams. Mirza Hacisade himself seems to have faced these challenges, as evidenced by a document from 1922 that confirms his treatment at a hospital in Berlin. It is reported that he successfully defended his thesis and demonstrated his extensive knowledge in the field of agriculture. In 1924, he completed his studies at the Berlin Agricultural University and obtained his degree as an agricultural specialist.

Another document concerning a different student sheds light on the language difficulties that foreign students faced. For example, Alakber Aliyev attended a German language course for foreigners in Berlin in 1920. The certificate of completion states that he participated in the course from June 8 to July 26, 1920, and had sufficient German language skills to be admitted to the university. These types of language courses were crucial for many foreign students, as they facilitated access to academic life in Germany and helped students overcome language barriers. It is noteworthy that such language programs, organized by institutions like the "Deutsches Institut für Ausländer" between 1908 and 1945, played an essential role in integrating foreign students into the academic community. This support helped many Azerbaijani students complete their studies successfully and establish themselves, despite the challenges they faced.

The archival materials concerning Azerbaijani students in the years following the independence of the Azerbaijan Democratic Republic and during the Soviet era offer valuable insights into the profound challenges these students faced. Notably, alongside financial and language difficulties, political shifts and institutional changes played a significant role.

The case of Ashraf Aliyev, a mining engineer from the Freiberg Mining Academy, illustrates the resilience of many students. Despite significant financial burdens and academic challenges, he successfully submitted his thesis and graduated in 1925. This determination reflects the commitment of many Azerbaijani students who, despite adverse circumstances, achieved their academic goals.

However, the political situation after the fall of the Azerbaijan Democratic Republic and the Soviet takeover had dramatic effects on Azerbaijani students in Europe. Original student organizations, such as the "Association of Azerbaijani Students in Germany," were replaced by Soviet-controlled organizations like the "Central Bureau of South Caucasian Students." These organizations were quickly dominated by Armenians, leading to further political and social divisions among the students. The shift in power within these student organizations is a notable expression of the political tensions that also affected the academic and social integration of Azerbaijani students abroad.



The impact of these political and social upheavals, as seen in the documents and letters cited above, demonstrates how nationalist and political interests influenced the academic and social development of Azerbaijani students. It is significant that, despite these difficult political circumstances, many students resisted and continued their academic careers. They not only contributed to the development of their homeland but also left a lasting legacy in the history of the Azerbaijani diaspora. Their story highlights how political changes and personal resistance are deeply intertwined and how these students successfully pursued their academic mission despite the adverse conditions.

The founding of the "Turan Student Union" in Berlin in 1924 and the political and social tensions that accompanied it illustrate the complex situation of Azerbaijani students in 1920s Germany. Particularly noteworthy is the influence Armenians had on the organizations of South Caucasian students, especially after 1920. The influence of these Armenian leaders, supported by Soviet institutions, affected not only Azerbaijani students in Germany but also the political and social situation in the students' homeland.

The transfer of archives to Humboldt University after World War II and the fact that some important documents concerning Azerbaijani students are now stored in the university's archives presents another challenge for research. The political and social restructuring that took place after the war and the division of Germany led to many of the historical materials being stored in locations that are difficult for researchers to access. Nevertheless, examining these archives remains crucial in order to gain a comprehensive picture of the experiences and fates of Azerbaijani students who studied in Germany in the 1920s and faced a variety of challenges upon returning to their homeland.

CONCLUSION

The fact that Azerbaijani students, despite these difficulties, not only continued their education but also served as role models for future generations of professionals in Azerbaijan shows their determination and resilience against the political and social upheavals of their time.

During the time of the Republic, the students sent to Germany maintained a fighting spirit despite the challenges they faced and achieved great successes in their education, despite material deprivation as well as physical and moral strain. Through our archival research, it has been documented that, although bureaucratic correspondence and certain delays occurred regarding the defense of their theses, the students we mentioned and listed in the archival materials did indeed obtain their diplomas, with some even receiving a first-class degree.

At the same time, we encountered the issue that the "Student Union Committee" in Berlin, originally led by Azerbaijani students, later fell under the control of the Communists. This development further exacerbated the financial and moral difficulties faced by the students. However, we are confident that our future research will uncover many more details about the fates of our compatriots, and we will be able to report more about this in upcoming articles.

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AZƏRBAYCANLI TƏLƏBƏLƏRİN ALMANİYADA TALEYİ ALMAN ARXİVLƏRİNDƏ TƏDQİQAT

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Bu məqalədə Azərbaycan Xalq Cümhuriyyəti dövründə (1918–1920) Almaniyaya göndərilmiş azərbaycanlı tələbələrin taleyi araşdırılır. Freiberg Dağ-Mədən Akademiyası, Berlin Humboldt Universiteti, Darmstadt Texniki Universiteti və Münhen Gözəl Sənətlər Akademiyasında aparılmış geniş arxiv tədqiqatlarına əsaslanaraq, bu tələbələrin qarşılaşdıqları maddi və sosial çətinliklər, eləcə də onların mühüm elmi uğurları təhlil olunur. Məqalədə Berlində fəaliyyət göstərmiş Azərbaycan Tələbə Komitəsinin fəaliyyəti, Sovet inqilabından sonra bu komitənin transformasiyası və Kommunist Partiyası üzvlərinin komitəyə daxil olması ilə müşahidə və repressiyaların güclənməsi izah olunur. Bu nəzarət nəticəsində vətənə qayıtmış bir çox tələbələr sürgünə göndərilmişdir – onların vətənpərvərliyinə baxmayaraq. Məqalədə həmçinin Rusiya imperiyası dövründə yüksək təhsil almaq məqsədilə Almaniyaya köç etmiş şimali azərbaycanlı həmvətənlərimizin həyatı da işıqlandırılır. Bütün çətinliklərə baxmayaraq, azərbaycanlı tələbələr tezislərini uğurla müdafiə etmiş və ixtisasları üzrə mühüm töhfələr vermişlər. Müəllif qeyd edir ki, arxiv tədqiqatları davam edir və ümid edir ki, bu iş Azərbaycanla Almaniya arasındakı tarixi əlaqələrin bu mühüm dövründə daha dərinlən öyrənilməsinə təkan verəcəkdir.

Açar sözlər: *Azərbaycan Demokratik Respublikasının tələbələri, Freiberg Mining Academy, Berlindəki Universitetlərin Arxivləri, Vətən Tarixi, Münxen İncəsənət Akademiyası, Darmstadt Texniki Universiteti.*

СУДЬБА АЗЕРБАЙДЖАНСКИХ СТУДЕНТОВ В ГЕРМАНИИ ИССЛЕДОВАНИЕ В НЕМЕЦКИХ АРХИВАХ

В.С. Абдуллаев, М.В. Алиева

В статье рассматривается судьба азербайджанских студентов, отправленных в Германию в период краткого существования Азербайджанской Демократической Республики (1918–1920). На основе обширных архивных исследований, проведенных в Горной академии Фрайберга, Берлинском университете имени Гумбольдта, Техническом университете Дармштадта и Мюнхенской академии изящных искусств, в исследовании анализируются как финансовые и социальные трудности, с которыми сталкивались студенты, так и их заметные академические достижения. В статье освещается деятельность Комитета азербайджанских студентов в Берлине, его трансформация после Советской революции и то, как включение членов Коммунистической партии привело к усилению слежки и репрессий. Эта слежка способствовала ссылке многих вернувшихся студентов, несмотря на их преданность Родине. Кроме того, в статье рассказывается о соотечественниках из Северного Азербайджана, эмигрировавших в Германию в эпоху Российской империи с целью получения высшего образования. Несмотря на трудности, азербайджанские студенты успешно защищали свои диссертации и внесли значительный вклад в различные области. Автор подчеркивает, что архивные исследования продолжаются, и выражает надежду, что эта работа послужит стимулом для дальнейшего изучения исторических связей между Азербайджаном и Германией в этот важный период.

Ключевые слова: *Студенты Демократической Республики Азербайджан, Шахтная академия Фрайберга, Архивы университетов Берлина, История родины, Академия изобразительных искусств Мюнхен, Технический университет Дармштадта.*



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MIRZA FAZLALI AGHA IRAVANI'S PARTICIPATION IN THE FORMATION OF RELIGIOUS AND SOCIO-POLITICAL THOUGHT DURING THE CONSTITUTIONAL PERIOD

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The religious, social, and political processes that took place in Iran and South Azerbaijan in the late 19th and early 20th centuries were characterized by a rich and complex dynamic. During this period, the Constitutional (Mashruteh) movement resonated widely across various societal strata, intensifying the interaction between traditional religious structures and modern socio-political ideologies. In particular, significant steps were taken towards establishing new forms of governance in the relationship between religion and state, as well as applying democratic principles. Scholars and public figures from Iravan also voiced their opinions and played a leading role in the development of society.

Mirza Fazlali Agha Iravni stands out as one of the prominent jurists, theologians, writers, and public figures of this era. His religious knowledge, scientific works, and public activities, especially his involvement in the first term of the Iranian National Assembly, are significant both for preserving traditional religious concepts and for the formation of new democratic ideologies.

This article thoroughly examines Mirza Fazlali Iravani's scholarly and religious activities, his role in the Constitutional movement, his participation in the Iranian parliament, his views on the relationship between religion and state, as well as his activities in the later years of his life in Berlin. The aim is to contribute to a deeper understanding of his personality and socio-political stance and to further the study of his contributions to the religious and social processes during the Constitutional Revolution.

Keywords: Religious studies, Religious scholars from Western Azerbaijan, Mirza Fazlali Agha Iravani, religious-social activity, Constitutional Movement, religion-state relations.

INTRODUCTION

The religious, social, and political processes that took place in Iran and South Azerbaijan during the late 19th and early 20th centuries were marked by rich and complex dynamics. During this period, the Constitutional Movement (Mashrutah) created a wide resonance across various social strata, intensifying the interaction between traditional religious structures and modern socio-political ideologies. In particular, significant steps were taken toward the establishment of new forms of governance and the application of democratic principles in the relationship between religion and the state. Religious scholars and public figures from Iravan (Yerevan) played an important role in this process, contributing to the development of society. One of the most prominent religious scholars of Iravan, who actively participated in the religious and social processes of the Middle East, was the distinguished jurist, mujtahid, as well as a writer and philologist, Fazlali Iravani.

When the Constitutional Movement emerged, Iranian and South Azerbaijani society was confronted with new ideas. The clergy, as the main leading force of society, had to respond to these



new religious and social challenges. At that time, there were mainly two viewpoints on the issue: one faction rejected any kind of change, while the other attempted to accept the new ideas through interpretation and exegesis. The second faction's approach led to the emergence of new proposals regarding the form of governance in society. Among the pioneers of this approach was Mirza Fazlali Agha Mujtahid Iravani [8, p. 30]. He was one of the leading religious' scholars and public figures of his time.

MAIN PART

The Life of Mirza Fazlali Agha Iravani

Mirza Fazlali Agha Mujtahid Iravani was born into the family of the prominent Iravan (Yerevan) scholar and Azerbaijani Mollabashi, Sheikh Abdulkarim Iravani. He was born in Tabriz in 1855 (H. 1272) [18, p. 125] or, according to another source, on November 16, 1861 [20, p. 449]. He passed away on February 8, 1921 (H.1339) in Berlin, where he was buried in the Muslim cemetery of the city [20, p. 450].

He received his early education from his father in Tabriz. After successfully completing his studies in subjects like Arabic grammar (sarf, nahv), rhetoric (ma'ani), literature, poetry, prosody, and rhyme, as well as mathematics, he continued his studies in Islamic jurisprudence and principles (fiqh and usul) under Mirza Muhammad Hasan Mujtahid Zanzudi [9, p. 487]. To deepen his knowledge, he traveled to Najaf, Iraq, where he studied under various prominent scholars, including his fellow countryman Fazil Iravani, Sheikh Zaynulabidin Mazandarani Hairi, Sheikh Muhammad Hussein Kazimi Najafi, Mulla Muhammad Fazil Sharabiyani, and Sheikh Ali Yazdi Hairi, eventually attaining the rank of a high-level mujtahid [20, p. 449]. As a result, he obtained ijazah (certification) for ijtiḥad from the following scholars: Fazil Sharabiyani, Fazil Iravani, Ardekani, and Sheikh Zaynulabidin Mazandarani [12, p. 432].

In 1890, he returned to Tabriz, where he taught courses in fiqh, usul, and tafsir, and authored several books. Among his works, the most significant is Hada'iqul-Arifin, which contains explanations and commentaries on certain hadiths from the seven major hadith collections of Shia Muslims [18, p. 125]. The first volume of the book, published in 1324 AH (during the author's lifetime), addresses discussions on the topics of "Reason and Ignorance." In the second volume, he continues the discussion on the themes of "Knowledge and Ignorance," completing these sections in a clear and explanatory style [10, p. 360].

He also authored several other works in Arabic, such as Hashiyat al-Riyaz al-Masa'il, Ahkam al-Arad al-Kharajiyya, and others, which dealt with fiqh and theological topics [12, p. 433].

His works can be listed as follows:

1. Ahkam al-Arad al-Kharajiyya
2. Ahkame Waba' wa Ba'da Tarbiyyat An
3. Istishab
4. Amr al-Amir ma'al-Ilm bintifash al-Shart
5. Bada' wa al-Taqiyya
6. Hashiyat al-Riyaz al-Masa'il, a commentary on Seyyid Ali Tabatabai's Riyaz al-Sualat
7. Hada'iqul-Arifin (This work contains commentary on various verses of the Quran and selected hadiths from seven major hadith sources: Kafi, Man la Yahzurul Faqih, Tahzib, Istibsar, Wafi, Wasa'il, and Bihar)
8. Riyaz al-Azhar (An anthology of poetry)
9. Safarnama-i Europa (Travelogue of Europe)



10. Kelid al-Danish (Key to Knowledge)

11. Misbah al-Huda fi Haqiqati al-Taqiyya wa al-Bada (The Lamp of Guidance on the Reality of Taqiyya and Bada')

12. Qasida (A collection of odes on various subjects)

13. Munjizat al-Mariz (The Cure for the Ill)

14. Al-Nafhul Anbari fi Ahwali al-Sayyid al-Himyari [20, p. 450].

Mirza Fazlali also composed poetry under the pen name "Safa." He compiled a Divan consisting of poems written in Arabic and Persian [6, p. 608].

In 1918, due to health-related issues, he traveled to Europe and received treatment in Berlin [18, p. 125]. He passed away there in 1921 and was buried in the Muslim cemetery of Berlin [6, p. 608].

The children of Mirza Fazlali Iravani also played an active role in the religious and social life of their community. His son, Ali Mowlavi, was an Islamic scholar, and it is reported that he authored a book titled Misbahud-da'i [14, p. 102]. Another son, Mirza Muhammad Ali Nizam al-Islam Mowlavi, was born in Tabriz in 1880. During the reign of Reza Shah, he was elected as a member of parliament eight consecutive times. He died in 1956 at the age of 76 [13, p. 1566]. Another son, Muntakhab al-Dawla Mowlavi, served as a member of the electoral council, while yet another son, Yadollah Mowlavi, was known as a mystic and a poet [10, p. 358]. His grandson, Mirza Muhammad Ali Mowlavi, is recognized as one of the distinguished contemporary figures in the fields of science and literature [23].

Fazlali Iravani's father, Molla Abdulkarim Iravani Qazvini, who was renowned by the title "Mollabashi," was born in the historical and ancestral Azerbaijani city of Iravan (Yerevan) on the 9th of Dhu al-Hijjah, 1220 AH (February 28, 1806 CE), or according to some sources, between 1790 and 1795 [1, p. 38]. Through his religious and social activities, he became one of the prominent jurists and eminent Islamic scholars of his time. Shaykh Mollabashi Abdulkarim Iravani died in the city of Tabriz on January 29, 1877, at the age of 74 (or 76). He was buried in the mausoleum that he had commissioned prior to his death [12, p. 339].

The Constitutional Revolution and Mirza Fazlali Agha

Mirza Fazlali Iravani engaged in extensive and noteworthy religious and social activities. His early public involvement began with promoting national products. Prior to the Constitutional movement, he, along with several preachers and imams, founded an organization named the "Tabriz Islamic Society," in which Shaykh Salim, Mirza Fazlali Agha, and Mirza Ali Akbar Mujahid were regarded as prominent members. During Muharram ceremonies, they delivered speeches encouraging the use of local goods and discouraging the consumption of luxurious European products [22, p. 24].

He actively participated in the Constitutional Revolution and was elected in 1906 as one of the official representatives of Azerbaijan to the first Supreme National Assembly, playing a significant role in the formation of the new political order [8, p. 30]. It is noted that he was nominated for this position by the Shaykhi order [18, p. 125]. He is also mentioned as a member of the Shari'a Appellate Court [9, p. 487]. One may reasonably argue that his election to such a high public office was facilitated by the trust the people had long placed in his family, who had traditionally held the title of "Mollabashi."

The Mollabashi family, to which Mirza Fazlali Iravani belonged, was inclined toward Sufism. They were also involved in the polemics between the Shaykhis and the Usulis (Mutasharri'a), which had become one of the major religious-political disputes of the time. The family, known for



its conciliatory and just stance, gained respect from both sides and defended the path of mysticism [18, p. 125]. His nomination to the Majlis by the Shaykhi order resulted from a compromise in which the Usuli majority among the Tabriz representatives agreed to allow the Shaykhis to choose a single representative. Consequently, Haji Mirza Fazlali was elected as the representative of the Shaykhis, while Haji Mirza Yahya, the Friday prayer leader of Khoy, was chosen to represent the Usulis. Thus, the Tabriz delegation to the Majlis ultimately consisted of seven members, one of whom was Mirza Fazlali Iravani [16, p. 152].

In 1908, Mohammad Ali Shah Qajar dissolved the parliament, leading to persecution and pressure against constitutionalists. During this period, the house of Mirza Fazlali was also subjected to looting. Nevertheless, he was later appointed as a member of the Judicial Council of the Ministry of Justice [20, p. 449].

Many sources have confirmed that Mirza Fazlali Agha Iravani participated closely in the Constitutional movement. However, his role in the revolution, as well as his religious and sociopolitical views, are rarely, if ever, addressed in academic studies or scholarly works conducted in our country. To date, no dedicated research has been carried out on his life or intellectual contributions, leaving a notable gap in the field. Although Mirza Fazlali was not a political figure per se, his actions and speeches reflect a distinctive mode of religious and social thought. This outlook may be interpreted as an attempt to reconcile traditional and modern concepts, and to ground democratic principles within an Islamic framework. Possessing original views, he was also remembered for his important contributions and speeches during the first term of the National Assembly of the Constitutional Revolution.

Mirza Fazlali Agha Iravani's Visit to Baku

The representatives elected from Azerbaijan to the National Assembly traveled to Tehran by railway. For this purpose, they boarded the train in Julfa, proceeded to Tiflis, and from there arrived in Baku. The delegation, which included Mustashar al-Dawla, Safa al-Dawla, Hidayatullah Mirza, Haji Mirza Fathi Agha, Haji Mirza Ibrahim Agha, Mirza Hasan Khan (Ahsan al-Dawla), and Mirza Fazlali Iravani, reached Baku on January 19, 1906 [2, p. 83].

The guests were received in Baku with great sincerity and hospitality and, during their stay, were under the special care and attention of Haji Zeynalabdin Taghiyev. Among those who welcomed them were prominent figures such as Qadi Mir Karim Agha Bakuvi, Akhund Yusif Talibzadeh (the brother of Abdulla Shaig), Mehdi Bey Hajinski, and others [2, p. 84].

As part of this visit, during a meeting held at the Sabunchu Mosque, Mirza Fazlali Iravani addressed a group of southern Azerbaijanis working as laborers in Baku. In his speech, he said:

"The Azerbaijanis are sending us as representatives to the National Assembly, and we are setting out, ready to risk our lives. We will fight against any opposition. You too must unite and stand with us. Only through unity can you achieve your goals" [3, p. 124].

The expressions used by Fazlali Iravani - *"we are setting out, ready to risk our lives"*, *"we will fight against opposition,"* and *"unite"* - reflect the atmosphere of struggle and turmoil that defined the era, embodying the spirit of the time. These words not only underscore the active role played by Azerbaijanis in the socio-political processes of the region but also clearly articulate the principles of representation, self-sacrifice, and the ideology of national unity that characterized the era. Mirza Fazlali's speech emphasized both national identity and societal solidarity, demonstrating that the Azerbaijani community has historically been the initiator, active participant, and driving force behind political transformations.



While in Baku, the Azerbaijani representatives were hosted at the home of Haji Zeynalabdin Taghiyev. This event stands as a vivid example of the attention and respect shown toward the prominent national, religious, and social figures of the time. That evening, Haji Taghiyev presented each of his guests with a portrait of himself and a copy of the two-volume work *Himam al-Rijal* and assured the deputies that they could rely on his support in their endeavors [2, p. 84–85].

The Arrival of Mirza Fazlali Iravani in Tehran as a Parliamentary Deputy

Following the issuance of the Constitutional Decree and the establishment of the first National Assembly (Majlis), Mirza Fazlali Agha Iravani departed for Tehran as a representative elected from among the ranks of scholars. Upon his and the other Tabrizi delegates' arrival in Tehran, they were met with an unprecedented welcome by the city's population. In his memoirs, Fazlali writes:

"Although the weather was cold and the streets and roads were covered with mud and snow... two to three hundred carriages and carts had come out to greet us, reaching as far as one farsakh from the city. Numerous sacrificial animals were slaughtered" [4].

Ahmad Kasravi, describing the arrival of the Azerbaijani representatives in Tehran, writes:

"That day, Tehran witnessed another kind of festivity. As mentioned, the representatives of seven provinces arrived in Tehran. People came out in crowds onto the streets, greeting the newcomers with joy and affection. Tehran was experiencing one of its rarest days. At that time, Azerbaijan's name was being proclaimed louder than ever. The people considered the arrival of the seven provinces' representatives a victory for the Majlis. Artisans lined up at the city gates. As soon as the delegates arrived, the people of Tehran slaughtered animals beneath their feet in celebration." [17, p. 216].

Mirza Fazlali's Participation in the Majlis

Due to the growing influence and mounting pressure of the Azerbaijani representatives, the leadership of the Majlis was compelled to comply with the laws. According to one contemporary participant of the parliamentary sessions:

"...The conquest of this citadel is linked with the names of the Azerbaijani deputies. The people of Tehran referred to them as the 'Baltic force (fleet),' a designation that alluded both to their united movement and their arrival from the Caucasus region" [2, p. 87].

Mirza Fazlali's name was mentioned in the parliament for the last time in the list of "absentees from the previous session," with the note that he was unable to attend due to illness. He was later diagnosed with an incurable ulcer and did not return to parliamentary work again [21, p. 71].

After Mohammad Ali Shah Qajar shelled the Majlis, Mirza Fazlali Agha's residence was looted as well. However, when the judiciary was later re-established, he was invited by Mohtasham al-Saltaneh Mirza Hasan Khan to serve as a member of this newly formed institution [21, p. 18].

Among the Azerbaijani deputies, Mirza Fazlali Iravani had made significant efforts to calm the people of Tabriz and to promote the signing of the constitutional decree. During his time in Tehran, he joined the Anjoman-e Adamiyat (Society of Humanity), where he engaged in consultations on national affairs and defended the constitution. He was considered one of the progressive scholars of the first parliamentary term. However, over time, his political alignment diverged from that of the other Azerbaijani deputies. He especially clashed with the radical Azerbaijani members of the Majlis, whose actions he believed were detrimental to the new system [21, p. 10].

Three Azerbaijani deputies refused to include him among their ranks, accusing him of supporting Sad al-Dowleh. On August 19, 1907, Mushir al-Dowleh wrote a letter to the Tabriz cleric Thiqatu'l-Islam in which he referred to Mirza Fazlali as "two-faced" and a "hidden opponent." It was noted that Fazlali had held secret meetings with Mohammad Ali Shah, after which his opponents —



including Sayyid Hasan Taqizadeh and three other Azerbaijani deputies — accused him of irreligiosity. The letter further states:

“Through these actions, he gradually lost his influence and credibility in the eyes of the people, rendering himself worthless” [16, p. 201].

Taqizadeh described Mirza Fazlali Agha Tabrizi as a moderate and conciliatory figure. However, he lacked a stable and consistent political stance — a factor that led the Azerbaijani deputies to part ways with him [8, p. 31].

Later, Mirza Fazlali was subjected to extreme provocations and aggressive actions. In his memoirs, he wrote about Taqizadeh:

“Before Taqizadeh and his followers arrived in Tabriz, there was no unrest or bloodshed in the city. As a result of their misconduct, the city descended into chaos. At night, they would knock on doors, extorting large sums of money from people through force and intimidation... Scholars, prominent individuals, and the general public are now greatly troubled by Taqizadeh and his associates. People suspect them of irreligiosity and accuse them of constantly inciting turmoil” [15].

Mirza Fazlali Iravani's View on the Constitutional Movement

The essence of constitutionalism (mashrutiyat) lay in favoring a parliamentary system in which people's representatives would be elected through free elections to carry out legislative functions and the implementation of state decisions. This democratic vision fundamentally conflicted with mashru'iyat, the doctrine advocating the dominance of Islamic law (shari'a) within the political and legislative system. Mirza Fazlali Iravani was a constitutionalist cleric. He did not see the National Assembly and its authority merely as a means to limit the monarch's absolute power. Rather, he opposed the idea held by certain clerical circles who sought to establish a council of religious scholars with the purpose of supervising secular decisions of the Majlis and aligning them with Islamic law.

Mirza's innate sense of justice and his scholarly depth did not confine him within the boundaries of strict religious law; rather, he also sought solutions to broader societal issues. His reformist and freedom-oriented spirit transformed him into a moderate and reform-minded religious figure [4].

It appears that Mirza Fazlali played a historically significant role, particularly during the drafting of the new constitution, in strengthening and spreading the idea of constitutionalism. The intellectual environment of Tabriz, where his thought developed, was closely connected on one side to the Ottoman Empire and its Tanzimat - era reforms, and on the other side to the cultural transformations and ties with the Caucasus region. At the time, the Caucasus served as a conduit for European connections and Enlightenment ideas. One of Fazlali Agha's enduring contributions to the formation of the legal structure of the constitution was his intellectual exchange and dialogue with Talibov. Talibov himself had been elected as a deputy to the Majlis from Tabriz, but refused to travel to Tehran and participate in the sessions due to accusations of “heresy and apostasy.” Nonetheless, he agreed to discuss matters of the Majlis with Fazlali via telegraph.

Mirza Fazlali was the only deputy who publicly defended Talibov against such accusations, publishing articles in support of him in the Nida-yi Vatan and Islamiyyah newspapers [4].

There is no direct evidence indicating whether Mirza Fazlali had read the works of Western thinkers. However, it is known that during that period, the writings of Western and Egyptian intellectuals had a wide readership in Tabriz. A library had been established there at the initiative of Taqizadeh and Tarbiyat circle, which contained a sufficient volume of books to spark an intellectual revolution among the people of Tabriz. These books influenced many clerics, including Siqat al-Is-



lam of Tabriz. There are letters from Mirza Fazlali Iravani requesting advice from Siqat al-Islam. These letters, along with his correspondence with figures like Siqat al-Islam and Talibov both before and after the constitutional period, indicate that even if indirectly, he benefitted from exposure to modern ideas [8, p. 32].

Mirza Fazlali's Views on the Relationship Between Religion and State

There are various opinions regarding Mirza Fazlali Iravani's religious and social positions and thoughts during the parliamentary period. Certain groups considered some of his views radical and dangerous for the newly established constitutional regime. These forces labeled Fazlali as a "reactionary" or "supporter of despotism" due to his amicable relations with the existing authorities [7, p. 18]. However, evidence clearly shows that Iravani was one of the religious intellectuals who played a significant historical role, particularly during the drafting and implementation of the new constitution, in shaping and promoting constitutional ideas.

Mirza Fazlali was a staunch defender of the separation of religion from the state and opposed the secular laws being exempt from Sharia supervision. When, at the insistence of Sheikh Fazlullah Nuri, a provision regarding clerical oversight of parliamentary laws was added to the constitution, his opposition to this article was of historic importance. The English correspondent Smart, who was present at the time, wrote: *"Under pressure from the clergy, the Assembly was forced to include this article in the constitution. According to the article, all draft laws must be presented to a committee consisting of five mujtahids before approval; this committee was to determine whether the drafts contained any provisions contrary to Islamic law. Mirza Fazlali Agha, the representative of Tabriz, opposed this proposal"* [4].

Mirza Fazlali Iravani opposed the idea of adding a condition of conformity with Sharia to the constitution. It is likely that he believed, following Akhund Khorasani, that legitimate religious governance was only possible during the time of the infallible Imam. Nevertheless, he was counted among the constitutionalists and regarded constitutionalism as the best model for governance during the occultation period under any circumstances. It appears that Mirza Fazlali did not recognize the authority of jurists over socio-political affairs. This stance likely stemmed from his affiliation with the Shaykhi school of thought, which did not consider the mujtahid a complete intermediary between the community and the infallible Imam, and instead posited the necessity of a more perfect and systematic divine guidance. Accordingly, based on this fundamental Shaykhi belief, Mirza Fazlali did not accord the jurist a high status akin to a vicegerent (wilayah) appointed by the Imam in the general affairs of Muslims [19].

It is also useful to examine his views on taxation and Sharia financial resources (khums, zakat, etc.), which are among the intersections of religion and state. As a parliamentarian, he was required not only to act theoretically but also to make decisions based on existing conditions and problems. Like Siqat al-Islam, he did not consider paying taxes contrary to Sharia. Since Sharia provides financial resources for the benefit of Muslims, the imposition of taxes was not inconsistent with Sharia. If Sharia funds were insufficient, Muslims should supply the necessary funds to maintain the system. Scholars and wise men might recommend this course. Thus, with the consent of religious scholars and the wise in parliament, the state has the right to levy taxes and collect funds from the people for public needs. For example, Kashiful-Qita permitted Fath Ali Shah to collect taxes to cover the expenses of the Iran-Russia war. All Sharia revenues, including kharaj and incomes, should be utilized to the extent necessary. Essentially, this statement justified taxation to meet state financial needs within the framework of Islam [8, p. 34].



The role of women in society was another topic of discussion at the time. Mirza Fazlali took a dual approach to this issue, neither fully affirming nor denying women's right to complete freedom and equal rights with men. He believed that women could become instruments of mischief in the hands of ill-intentioned individuals, which could ultimately undermine the religious and social foundations. Thus, although he did not completely deny women's right to participate in activities, he regarded such activity as subject to potential misuse by those with negative intentions [5, p. 428].

Mirza Fazlali's Journey to Berlin

Mirza Fazlali Iravani, troubled for many years by leprosy, sought treatment abroad during the height of World War I. On February 23, 1916, he traveled through Baku and Petrograd, proceeding to Stockholm, London, and The Hague for medical care. When his treatment did not yield positive results, he relocated to Berlin, where he settled. During his final years in Berlin, Fazlali Agha did not cease his efforts to uphold the values of constitutionalism, collaborating with numerous societies. He participated in literary and scientific gatherings and contributed articles to the journal Kave. Letters addressed to him by Taghizadeh, Mohammad Qazvini, and Jamalzadeh were found among manuscripts and memoirs related to his activities in Berlin. The collection of these documents attests to the high esteem and respect he garnered during this period, even among Azerbaijani activists who had once labeled him a "despot" and "reactionary" [4].

He was a participant in the Berlin Literary Assembly, where his scholarly works and poetry enriched the audience. Due to his leprosy, part of his face was disfigured; to cover the affected area, he wore a black veil, which he maintained during gatherings [11].

Ultimately, his illness, which intensified from 1918 onwards, claimed Mirza Fazlali Agha Iravani's life. In accordance with his will, he was buried in the Muslim cemetery of Berlin [6, p. 608].

CONCLUSION

Mirza Fazlali Agha Iravani emerged as a prominent figure in the late 19th and early 20th centuries within the socio-cultural and religious-political environment of the Near East, particularly in Iran and Southern Azerbaijan. His scholarly achievements, development as a jurist and mujtahid, as well as his extensive knowledge as a writer and philologist, established him among the renowned intellectuals of his time.

At the onset of the Constitutional Movement, Mirza Fazlali Iravani exhibited a stance that was simultaneously reformist and protective of traditional religious values in response to emerging socio-political challenges. He advocated for the harmonious preservation of religious and national identities within Iranian and Southern Azerbaijani societies, promoting the use of national goods and adopting a cautious attitude toward European influences. Actively participating in the Constitutional Revolution, he was elected in 1906 as one of the Azerbaijani representatives to the first Iranian National Assembly and played a significant role in the establishment of the new order.

Mirza Fazlali's political activity focused on fostering coordination among national and religious groups in Tehran, Baku, and other locations, as well as instilling a spirit of unity and sacrifice within society. His participation in parliament contributed to the increased influence of Azerbaijani deputies and played an important role in advancing political processes on a legal basis. However, his moderate and conciliatory approach sometimes conflicted with more radical deputies, resulting in pressure and criticism against him.

Regarding the relationship between religion and state, Mirza Fazlali strongly advocated for the complete separation of religion from the state while emphasizing the necessity of laws being compatible with Sharia. He opposed the introduction of a supervisory mechanism of Sharia within



the parliament, considering it contradictory to the principles of constitutionalism. While he valued the formation of governance within the framework of Islamic law, he did not support granting full political authority to jurists. Simultaneously, he defended the necessity for the state to adopt financial and taxation policies in accordance with Islamic law.

His ambivalent stance on the role of women in society reflected a pragmatic approach to contemporary social issues; although he did not entirely deny women's right to participation, he was wary of potential misuse and socio-political risks.

His prolonged medical treatment led him to Berlin, where his continued engagement demonstrated the persistence of his active socio-political and literary positions. Even there, he strived to restore and promote the ideals of constitutionalism, gaining respect within the Azerbaijani and Iranian national-cultural milieu.

In conclusion, Mirza Fazlali Agha Irvani was a distinguished religious scholar, public figure, and intellectual who played a vital role in the development of the Constitutional Movement. He was among the rare enlightened personalities striving to synthesize traditional religious values with modern democratic principles.

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MİRZƏ FƏZLƏLİ AĞA İRƏVANININ MƏŞRUTƏ DÖVRÜNDƏ DİNİ-İCTİMAİ DÜŞÜNCƏNİN FORMALAŞMASINDA İŞTİRAKI

H.Ə. Ağamoğlanov

XIX əsrin sonları və XX əsrin əvvəllərində İran və Cənubi Azərbaycan bölgəsində baş verən dini-ictimai və siyasi proseslər zəngin və mürəkkəb dinamikaya malik olmuşdur. Bu dövrdə Məşrutə (konstitusiya) hərəkəti cəmiyyətin müxtəlif təbəqələrində geniş rezonans doğurmuş, ənənəvi dini quruluşlarla müasir ictimai-siyasi ideyaların qarşılıqlı təsiri intensivləşmişdir. Xüsusilə, din və dövlət münasibətlərində yeni idarəçilik formalarının qurulması və demokratik prinsiplərin tətbiqi istiqamətində mühüm addımlar atılmışdır. Bu proseslərdə irəvanlı din alimləri və ictimai xadimləri də öz sözlərini demiş, cəmiyyətin inkişafında aparıcı rol oynamışlar.

Mirzə Fəzləli Ağa İrəvani həmin dövrün görkəmli fəqih, müctəhid, ədib və ictimai xadimlərindən biri kimi diqqəti cəlb edir. Onun dini bilikləri, elmi əsərləri və ictimai fəaliyyəti, xüsusilə İran Milli Məclisinin ilk dövründəki iştirakı, həm ənənəvi dini anlayışların qorunması, həm də yeni demokratik ideyaların formalaşması baxımından əhəmiyyətlidir.

Məqalədə Mirzə Fəzləli İrəvaninin elmi və dini fəaliyyəti, məşrutə hərəkətindəki rolu, İran parlamentində iştirakları, din və dövlət münasibətlərinə dair baxışları, həmçinin ömrünün son illərdə Berlindəki fəaliyyəti geniş şəkildə araşdırılmışdır. Məqsəd onun şəxsiyyətinin və ictimai-siyasi mövqeyinin anlaşılması və Məşrutə inqilabı dövrünün dini-ictimai proseslərindəki fəaliyyətlərinin tədqiqinə töhfə verməkdir.

Açar sözlər: *Dinşünaslıq, Qərbi azərbaycanlı din alimləri, Mirzə Fəzləli Ağa İrəvani, dini-ictimai fəaliyyət, Məşrutə hərəkəti, din-dövlət münasibətləri.*

УЧАСТИЕ МИРЗЫ ФАЗЛАЛИ АГА ИРЯВАНИ В ФОРМИРОВАНИИ РЕЛИГИОЗНО- ОБЩЕСТВЕННОЙ МЫСЛИ В ПЕРИОД КОНСТИТУЦИОННОГО ПЕРИОДА

X.A. Ağamoğlanov

Конец XIX — начало XX века в Иране и Южном Азербайджане было временем, когда происходили сложные и многогранные религиозные, социальные и политические процессы. В этот период Конституционное (Машрута) движение вызвало широкий резонанс среди различных слоев общества, усилив взаимодействие между традиционными религиозными структурами и современными социально-политическими идеями. Особенно важными стали шаги по созданию новых форм управления в отношениях между религией и государством, а также внедрение демократических принципов. В этих процессах также активно участвовали



религиозные деятели и общественные активисты из Эривана, которые играли ведущую роль в развитии общества.

Мирза Фазлали Ага Иревани выделяется среди значимых ученых, факихов, богословов, писателей и общественных деятелей того времени. Его религиозные знания, научные работы и общественная деятельность, особенно участие в первых заседаниях Иранского национального парламента, имеют большое значение как для сохранения традиционных религиозных представлений, так и для формирования новых демократических идей.

В статье широко исследуются научная и религиозная деятельность Мирза Фазлали Ага Иревани, его роль в Конституционном движении, участие в иранском парламенте, его взгляды на отношения между религией и государством, а также его деятельность в последние годы жизни в Берлине. Целью статьи является понимание его личности и общественно-политической позиции, а также внесение вклада в исследование его роли в религиозно-социальных процессах периода Конституционной революции.

Ключевые слова: *Религиоведение, религиозные учёные из Западного Азербайджана, Мирза Фазлали Ага Иревани, религиозно-общественная деятельность, Конституционное движение, отношения религии и государства.*



PHYSICS-MATHEMATICS AND TECHNICAL SCIENCES





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PHOTOMETRIC AND SPECTRAL STUDY OF THE STAR AS 442

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The results of long-term spectral and photometric observations of the AeBe Herbig-type star AS 442 were analyzed. Based on more than 1300 measurements taken in UBVR filters at the Maidanak Observatory in Uzbekistan in 1982-1996, the light curve and color dependence curves of the star were constructed, and the periodicity of these changes in different seasons was checked by applying statistical Fourier analysis. It was shown that no stable periodicity was detected in the changes in brightness and colors. The star is bright in most cases, but large-amplitude eclipses were detected in three seasons.

Spectral observations of the star were carried out at the 2 m telescope of the Shamakhi Astrophysical Observatory during 2020-2024. It was shown that the spectrum of the star exhibits serious changes. Various structural changes detected in the H β line can be explained by the ejection and accretion of matter in the circumstellar disk. Such profiles exhibit a stable structure over the observation season.

Keywords: *young stars, circumstellar disks, photometry, spectroscopy, object – AS 442.*

INTRODUCTION

The star AS 442 (SpB8-A0, V $\sim$ 11 mag) was first discovered by [14] as an object with a medium-intensity H α emission line. In [15], the spectral class of the star was B9 or A0, and a weak emission component in the H β line was found using low-resolution spectra. [2] first showed that the equivalent width (Ew) of the H α emission line in the star's spectrum was -23 Å, and that it had an infrared (IR) emission excess, and it was included in the AeBe Herbig star catalog.

The first data on the physical parameters of the star were given in [12, 13]. It was shown that the H α emission line and the D NaI doublet lines in the star's spectrum show strong variations. The authors determined the star's spectrum to be B8, its mass to be 3.5 M $_{\odot}$, the equivalent width of the H α line to be EW = -32.7 Å, and the width at 10% of the line intensity to be H α W10 = 646 km/s, and determined that the H α line profile is IIIB according to the classification [1]. The H α line has two emission peaks, one of which is less than half the intensity of the other. In addition, the HeI 5876, D NaI, [OI] 6300 and 6363 Å lines were detected in the star's spectrum. In [11], the star's temperature was determined to be 11000 K, the distance to the star to be 826 pc, the age to be 1.5 Myr, and the interstellar reddening coefficient A $_v$ =3.85 [9].

UBVR photometric observations of the star were mainly performed at the Maydanak Observatory in Uzbekistan, and the obtained materials were collected in the Strasbourg CDS archive [3, 5]. Based on this material, the photometric variations of the star were studied [10]. It was shown that the brightness of the star shows small amplitude variations around the value close to the maximum, but in some years the brightness decreases sharply. Such variations are characteristic of UXOR-type stars. The search for periodic variations in this work did not yield any results.

In recent years, several studies have determined the physical parameters of the star AS 442 [4]. In [17], it was shown that it forms a visual binary system with a B component at a distance of 4.75'' from the bright star A in the center.



In this work, the results of a long-term photometric and spectral study of the star are presented for the first time.

MATERIAL AND METHODS

Broadband UBVR photometric observations of the star were carried out at the Maydanak Observatory in Uzbekistan using the ROTOR program. The results are collected in the Strasbourg CDS archive Herbst et al. (1994), Grankin et al. (2007). The photometric archive of young stars is located at <http://cdsweb.u-strasbg.fr/cgi-bin/qcat?J/A+A/461/183>. Observations of the AeBe Herbig-type star AS 442 were carried out regularly for 14 consecutive years during JD2445879-2450791 (1984-1997). In different years, 60-150 measurements were taken per year. During this period, stellar magnitudes of the star AS 442 in the U and R bands were determined by more than 1300 BV and slightly less than this. Typical measurement errors for the star AS 442 are ± 0.01 mag in the BVR filters and 0.05 mag in the U filter.

In Figure 1, the light curves obtained over the entire observation period of the star are shown in different colors. As can be seen, the change in the brightness of the star is on average 0.7 mag in the U filter, 0.4 mag in the B filter, and 0.3-0.4 mag in the V and R filters.

Overall, the brightness of the star during different seasons exhibits chaotic variations around approximately the same average value. Only during 3 different seasons does the star JD 2447677-2448588 (1989-1991) show deep minima of the UX Ori type. Each of these minima clearly shows short-term variations during the day (Figure 2).

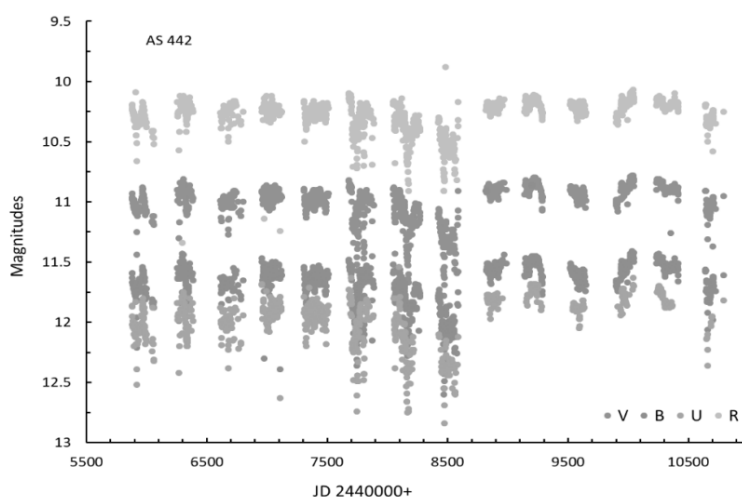


Fig. 1. 14-year light curves in the UBVR bands of the star AS 442. Different colors indicate stellar sizes in different filters

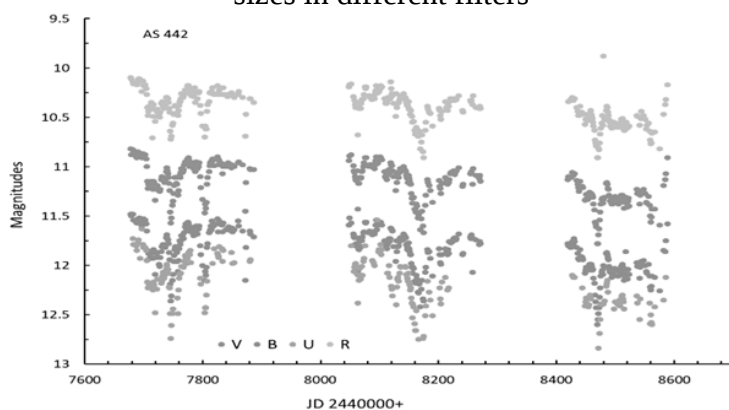


Fig. 2. 3 different minima obtained during 1989-1991 are given

Figure 2 shows that in each of these 3 seasons the star's brightness periodically showed deep minima. The time intervals between the minima occur at approximately the same date in all filters, and the time interval between two adjacent minima varies from 27 to 96 days. The amplitudes of the brightness decrease are as follows: $\Delta U \sim 1$ mag, $\Delta B \sim 0.8$ mag, $\Delta V \sim 0.70$ mag, and $\Delta R \sim 0.4$ mag. Since the brightness change in all filters is of the same nature, we will focus on the V light curve from now on.

Figure 3 shows the general light curve and the time-dependent color curves in the V filter. As can be seen, the average color values remain constant in different seasons: $\langle U-B \rangle = 0.3$ mag, $\langle B-V \rangle = 0.55$ mag, $\langle V-R \rangle = 0.74$ mag. Note that the color indices change as in the case when there are no deviating minima, even during the period of sharp brightness decrease. Figure 4 shows the dependence of the star's color indices on the brightness V. As can be seen, the B-V and V-R colors show a linear variation with brightness, albeit slightly, throughout all seasons.

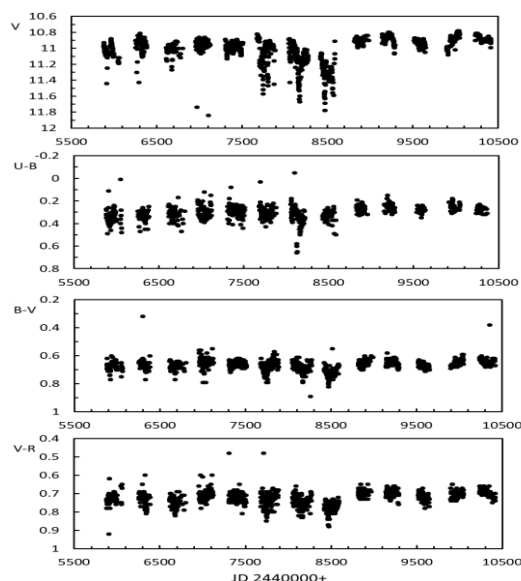


Fig. 3. Top-down-V light curve, U-B, B-V, and V-R color indices change over time

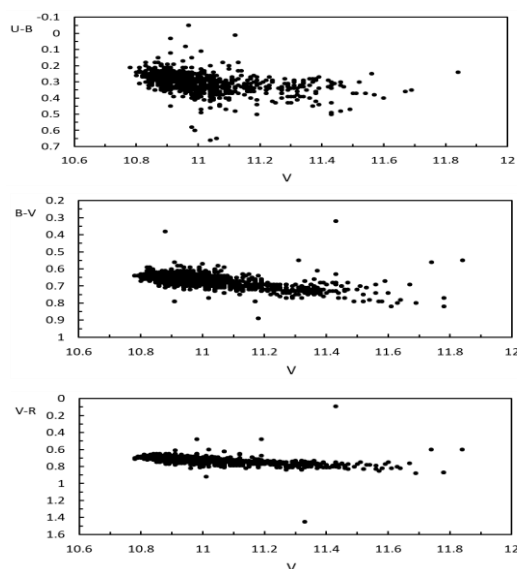


Fig. 4. The dependence of the color indices of the star AS 442 on the brightness



Although a linear change is also observed in the U-B color, the deviation from linearity is relatively large compared to other colors.

As can be seen from Figure 4, as the brightness of the star decreases, all color indices decrease proportionally. This feature proves that the decrease in brightness in the corresponding bands is mainly due to shielding. A certain deviation from linearity in the U-B color indicates that other physical phenomena are involved in the color change in addition to shielding.

In order to detect a periodic component in the brightness of the star AS 442, we divided the results that make up the general light curve into separate arrays. The main purpose of doing this is that it would be more expedient to search for all the points obtained over a period of 14 years in different arrays rather than in a common array. In this case, the distortion of the stochastic components present in the brightness variation would be minimized. In Table 1, the first column shows the serial number of the array, the second column shows the time interval during which that array was obtained, and the third column shows the number of points obtained in each array. In the table, seasons in which three consecutive deep eclipses occurred are shown in bold.

To search for periodicity in the brightness variation, we used the Period 04 program [7], which was developed based on the method of [8] and [16]. The program is based on the determination of the most probable periods in the power spectrum by applying Fourier analysis.

Figure 5 shows examples of power spectra obtained for different arrays. The study showed that several periods are repeatedly detected in individual arrays. Of these, periods of 50 ± 3 days (in 4 arrays), 76 ± 2 days (in 4 arrays), and 80 ± 2 days (in 2 arrays) were obtained. However, none of these periods are detected in all other arrays. Therefore, we conclude that these observational results do not allow us to separate the periodically varying part of the brightness from the stochastic component that causes chaotic variation.

Table 1.

Distribution of observation results by arrays

№	JD 2440000+	N
1	5879.523 - 6061.115	76
2	6255.196 - 6383.209	68
3	6613.389 - 6802.127	54
4	6957.335 - 7124.144	96
5	7307.331 - 7507.074	149
6	7677.447 - 7887.073	137
7	8048.43 - 8271.116	138
8	8419.426 - 8588.207	104
9	8819.373 - 8986.133	86
10	9140.46 - 9289.133	92
11	9517.446 - 9647.151	82
12	9897.444 - 10046.147	83
13	10234.394 - 10415.101	76
14	10641.417 - 10791.122	46

As can be seen from Figure 5, in most cases the most probable periods for different arrays fall within the range of 50-80 days. However, such periods, which appear in some arrays, are not observed in most other arrays.

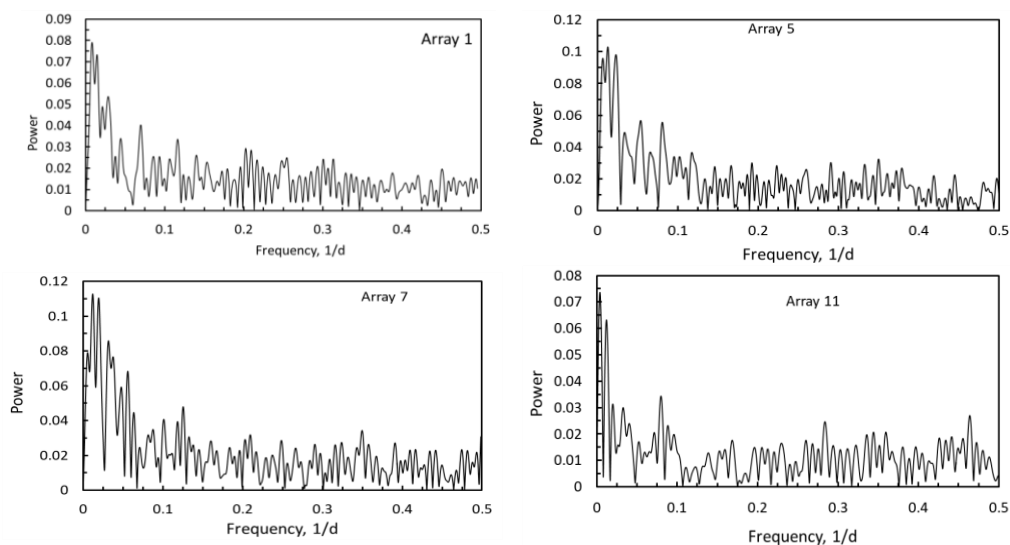


Fig. 5. Examples of power spectra across different arrays

Spectral observations of the star AS 442 were performed on the Universal Astro Grid Spectrograph (UAGS) spectrograph set at the Cassegrain focus of the 2 m telescope of the SHAR. An Andor CCD camera (ikonL-936-BEX2-DD) with a number of elements of 2048x2048 and a size of one element of $1\text{px}=13.5\text{ }\mu\text{m}$ was used as a light receiver. A Canon FF ($f=200\text{ mm}$, $f/2$) high-power lens was used to adapt the CCD camera to the spectrograph. The focal lengths of the collimator and the camera in the spectrograph were $F_{\text{coll}} = 1100\text{ mm}$, $F_{\text{cam}} = 200\text{ mm}$, and the incidence and scattering angles were 27.5° and 20.5° , respectively. Since the resolution in the focal plane of the camera is determined by the size of two pixels, the monochromatic width of the spectrograph slit in the case of binning 1x1 is $S' = 2\text{ px} = 0.027\text{ mm}$. The Cassegrain focus of a 2 m telescope is $F = 29500\text{ mm}$, and the scale in the focal plane is $\mu = 6.99''/\text{mm}$. Then we take $0.99''$ for the width of the entrance slit. Accordingly, for 2x2 binning we take the same parameter as $1.99''$. In such a complex, the spectra of weak variable stars, galaxies and nebulae can be obtained [6].

A diffraction grating with 651 lines/mm was used in the spectrograph. In the first arrangement, the linear inverse dispersion in the case of binning 1x1 is $144\text{ }\text{\AA}/\text{mm}$ ($D = 1.9\text{ }\text{\AA}/\text{mm}$), and the spectral range is $\lambda\text{ }3600\text{--}8000\text{ }\text{\AA}$. In other words, the average spectral resolution in the $\text{H}\alpha$ ($\lambda\text{ }6563\text{ }\text{\AA}$) region is $R = 3400$. A more detailed description of the spectrograph is given in [6].

For the grading of the images obtained on the spectrograph, auxiliary frames – flat, bias, dark and ThAr lamp spectra were also recorded during each observation. The obtained materials were processed using the DECH package program (Galazutdinov G., <http://www.gazinur.com/DECH-software.html>). The processing process was carried out by a standard method. Based on measurements made on standard stars, the errors in various lines for radial velocities are $\pm 3\text{--}5\text{ km/s}$, and for hydrogen lines in A0-A6 class stars for equivalent widths $\pm 0.5\text{--}0.6\text{ }\text{\AA}$. Table 2 gives the observation log of the star AS 442. The columns, from left to right, list the observation date, Julian date, exposure time, UT (Universal Time), binning, and signal-to-noise parameters next to the $\text{H}\alpha$ line in the spectrum.



Table 2.

Spectral observation table of the star AS 442

Tarix	JD 2450000+	Eksp.vaxti(san)	UT	Binning	S/N
16.07.2020	9047.446	300	22:43	3x3	80
19.07.2020	9050.455	700	22:55	2x2	95
24.07.2020	9055.479	700	20:05	2x2	87
19.08.2020	9080.339	700	20:08	2x2	85
05.08.2021	9432.341	700	20:12	2x2	84
06.08.2021	9433.276	700	18:28	2x2	89
10.09.2021	9468.331	700	19:58	2x2	77
13.09.2021	9471.298	700	19:05	2x2	68
21.06.2022	9752.406	1200	21:49	1x1	127
30.06.2022	9761.345	1200	20:17	1x1	113
01.07.2022	9762.383	1200	21:12	1x1	128
25.08.2022	9817.276	2400	18:38	1x1	133
26.08.2022	9818.255	2000	18:08	1x1	120
27.08.2022	9819.253	1800	18:05	1x1	121
28.08.2022	9820.24	1800	17:46	1x1	114
29.08.2022	9821.238	1800	17:45	1x1	116
30.08.2022	9822.242	1800	17:49	1x1	115
31.08.2022	9823.251	1800	18:02	1x1	110
16.09.2022	9839.3104	1800	19:27	1x1	120
02.10.2022	9855.225	2400	17:25	1x1	118
04.10.2022	9857.244	2400	17:52	1x1	120
08.09.2024	10562.214	1500	17:29	1x1	115

Figure 6 shows an example of the overall appearance of the spectra of the star obtained on 21.06.2022 and 30.06.2022, and a fragment of the spectrum in the range λ 3700-4500 Å on a larger scale. As can be seen, in the spectrum, along with the lines of the strong Balmer series, D Na I, He I, Ca I, K CaII, Fe II 4924, etc. lines are observed. The change in the absorption spectrum on the two dates given on the same scale is clearly visible: the absorption lines on 21.06.2022 are more intense.

RESULTS AND DISCUSSION

Figure 7 shows graphs of the change in the equivalent widths (open circles) and semi-widths (black circles) of the hydrogen lines during the observation period. The H α line is emission, and the H β , H γ and H δ lines are absorption lines. As can be seen from Figure 6, the average value of the equivalent widths of the H α line increases during 2020-2022, and decreases in 2024. The equivalent width and semi-width of the H α line change in opposite directions. At the same time, as the H α emission line strengthens, the equivalent widths of other hydrogen lines decrease. As the emission spectrum strengthens, the emission components arising in the absorption lines also appear, so a decrease in the equivalent widths is observed.

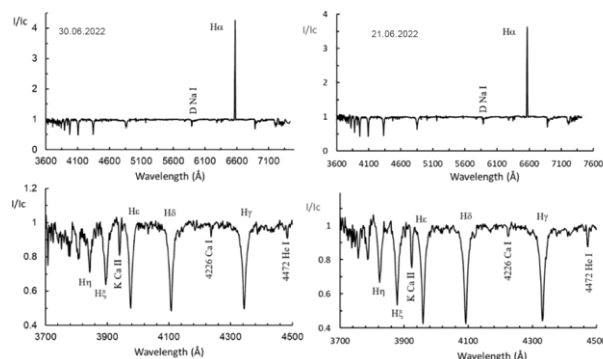


Fig. 6. An overview of the spectrum of the star AS 442 is shown for the dates 21.06.2022 and 30.06.2022. The panels below show a larger-scale representation of the spectrum on those dates in the range λ 3700-4500 Å.

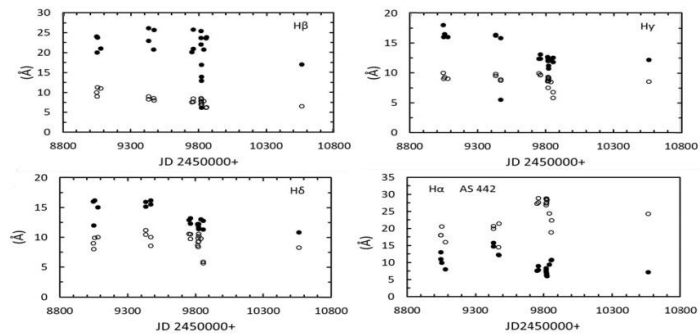


Fig. 7. Variation of the equivalent widths (open circles) and semi-widths (black circles) of the H α -H δ lines with time. The H α line is a strong emission line, the remaining lines are absorption lines.

Figure 8 shows the profiles of the H β line and the Fe II 4924 line located on its right wing, taken at different times. As can be seen, one or two emission peaks are observed in the H β line at different times. This variation remains constant throughout the season.

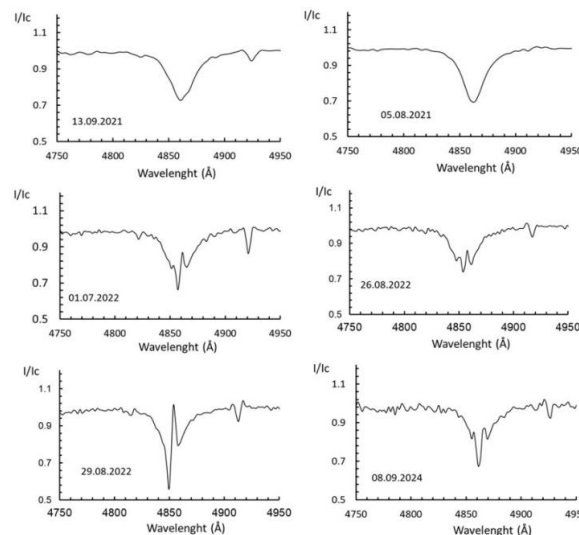


Fig. 8. Change in the profile of the H β line. The profile of the Fe II 4924 line is also clearly visible on the right wing of the H β line

CONCLUSION

In this work, a photometric and spectral study of the Herbig AeBe type star AS 442 with a complex circumstellar structure was performed. The photometric results were performed with 1300 measurements on each filter taken in UBV filters in 1982-1996. Statistical Fourier analysis was applied based on the measurement results taken in different seasons and it was shown that no periodic variation observed in all arrays is detected. The obtained photometric variations occur as a result of the shielding of the star's radiation by optically thick gas-dust fragments present in the circumstellar disk.

Spectral studies of the star were performed on the basis of spectra obtained with a resolution of $R=3400$ on a 2 m telescope at the SHAR during 22 nights in 2020-2024. It was shown that although the absorption and emission spectrum of the star remains stable within different observation seasons, it shows serious changes over the years. It has been shown for the first time that the radiation component observed in the H β line is the ejection and return of matter in the circumstellar disk towards the observer. This confirms that active dynamical processes are occurring in the stellar disk.



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AS 442 ULDUZUNUN FOTOMETRİK VƏ SPEKTRAL TƏDQIQI

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İşdə AeBe Herbiq tipli AS 442 ulduzunun uzunmüddətli spektral və fotometrik müşahidələrinin nəticələri təhlil edilmişdir. 1982-1996-cı illərdə Özbəkistanın Maydanak rəsədxanasında UBVR süzgəclərində alınmış 1300-dən çox ölçmə əsasında ulduzun işıq əyrisi və rəng göstəricilərinin parlaqlıqdan asılılıq əyriləri qurulmuş, statistik Furiye analizinin tətbiqi ilə müxtəlif sezonlarda bu dəyişmələrin periodik olub-olmaması yoxlanılmışdır. Göstərilmişdir ki, parlaqlıq və rənglərin dəyişməsində sabit qalan hər hansı periodiklik aşkar edilmir. Ulduz əksər hallarda parlaq halda olur, lakin üç sezonda böyük amplitudlu tutulmalar aşkar olunmuşdur.

Ulduzun spektral müşahidələri 2020-2024-cü illər ərzində Şamaxı Astrofizika Rəsədxanasının 2 m teleskopunda yerinə yetirilmişdir. Göstərilmişdir ki, ulduzun spektri ciddi dəyişmələr nümayiş etdirir.



H β xəttində aşkar olunmuş müxtəlif strukturlu dəyişmələr ulduzətrafi diskdə maddənin atılması və akkresiyası ilə izah edilə bilər. Bu cür profillər müşahidə sezonu daxilində sabit struktur nümayiş etdirir.

Açar sözlər: *cavan ulduzlar, ulduzətrafi disklər, fotometriya, spektroskopiya, obyekt – AS 442.*

ФОТОМЕТРИЧЕСКОЕ И СПЕКТРАЛЬНОЕ ИССЛЕДОВАНИЕ ЗВЕЗДЫ AS 442

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Проанализированы результаты многолетних спектральных и фотометрических наблюдений звезды типа AeBe Хербига AS 442. На основе более 1300 измерений, проведенных в фильтрах UBVR в Майданакской обсерватории в Узбекистане в 1982-1996 годах, построены кривая блеска и кривые зависимости цвета звезды, а также проверена периодичность этих изменений в разные сезоны с применением статистического анализа Фурье. Показано, что устойчивой периодичности в изменениях блеска и цвета не обнаружено. Звезда яркая в большинстве случаев, но в трех сезонах были обнаружены затмения большой амплитуды.

Спектральные наблюдения звезды проводились на 2-метровом телескопе Шамахинской астрофизической обсерватории в течение 2020-2024 годов. Показано, что спектр звезды демонстрирует серьезные изменения. Различные структурные изменения, обнаруженные в линии H β , можно объяснить выбросом и аккрецией вещества в околозвездном диске. Такие профили демонстрируют стабильную структуру в течение сезона наблюдений.

Ключевые слова: *молодые звезды, околозвездные диски, фотометрия, спектроскопия, объект – AS 442.*



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PHASE EQUILIBRIA IN THE MnSb_4Te_7 – MnBi_4Te_7 SYSTEM AND CHARACTERIZATION OF TETRADYMITTE-TYPE LAYERED SOLID SOLUTIONS

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Phase equilibria and structural evolution in the MnSb_4Te_7 – MnBi_4Te_7 system were systematically investigated to understand the formation and stability of tetradymite-type layered solid solutions via X-ray diffraction (XRD), differential thermal analysis (DTA), and scanning electron microscopy (SEM) and its T - x diagram was plotted. XRD analysis confirmed that all synthesized $\text{MnSb}_{4-x}\text{Bi}_x\text{Te}_7$ ($0 \leq x \leq 4$) alloys crystallize in a single-phase trigonal structure ($P\bar{3}m1$), with no evidence of secondary phases. The gradual substitution of Sb^{3+} by the larger Bi^{3+} ions resulted in a monotonic increase in lattice parameters which determined via Le Bail method, indicating the formation of a continuous solid solution. SEM imaging further confirmed the homogeneous microstructure of the samples, with no visible phase separation or compositional inhomogeneity. The T - x diagram of system is characterized by peritectic transformations. Due to MnSb_4Te_7 and MnBi_4Te_7 melt incongruently, pseudobinary behavior was observed only in the subsolidus region. The findings highlight the potential of these solid solutions for desired properties, essential for applications in magnetic topological insulators and quantum materials.

Keywords: phase diagram, tetradymite-type structure, layered chalcogenide, solid solutions, crystal structure, magnetic topological insulator.

INTRODUCTION

Tetradymite-type layered metal chalcogenides are a versatile class of materials characterized by their unique layered structures and diverse properties which makes them highly valued for various applications, particularly in thermoelectrics and topological insulators (TI) [1-4]. Their distinct structural features and the potential for property optimization via chemical modifications position them as a fascinating focus of study novel properties. Recent studies have highlighted that ternary compounds in the $\text{ATe-Sb(Bi)}_2\text{Te}_3$ (A - Mn, Sn, Ge and Pb) pseudobinary systems exhibit structural features derived from the tetradymite family and possess 3D TI properties [5-8]. Special attention are focused on manganese antimony and bismuth tellurides since these layered phases show magnetic order and topological insulator properties at the same time [9-16]. The discovery of MnBi_2Te_4 as the first intrinsic antiferromagnetic TI has opened new avenues for research since coexistence of these two features have huge potential applications in spintronics and quantum computing [16].

Despite the promising intrinsic magnetic properties of these TI, the realization of quantum anomalous Hall effect typically requires extremely low temperatures due to small magnetic gaps and thermal excitation of bulk carriers. Obtention of substitutional solid solutions based on MnBi_2Te_4 or MnSb_2Te_4 not only modifies the electronic structure but also influences the magnetic interactions within the material. Studies have shown that substituting bismuth (Bi) with antimony (Sb) can effectively tune the Fermi level, which is crucial for achieving desired electronic properties. Specifically, the introduction of Sb leads to a transition from n-type to p-type conductivity, thereby altering the magnetic state of the system [17]. Similarly, the comparative analysis of the magnetic properties of MnBi_4Te_7 and MnSb_4Te_7 demonstrates their role as materials that bridge magnetism and topological phenomena.



Although extensive studies in the literature have explored the effects of doping and alloying on these layered phases [18-21], comprehensive phase equilibria data remains scarce, or even entirely absent, despite its critical importance for guiding material synthesis and optimizing functional properties. Given that ternary compounds in the pseudobinary $\text{MnTe-Sb(Bi)}_2\text{Te}_3$ system form peritectic cascades within a narrow temperature interval [22, 23], a detailed investigation of the phase equilibria in the relevant pseudoternary systems and their vertical sections is essential. This study aims to provide a comprehensive understanding of the phase relationships and solid solution formation in this system, contributing to the rational design of materials with tailored properties for potential applications in spintronics and quantum technologies.

In this work, we investigate the phase relationships in the $\text{MnSb}_4\text{Te}_7\text{-MnBi}_4\text{Te}_7$ vertical section of the $\text{MnTe-Sb}_2\text{Te}_3\text{-Bi}_2\text{Te}_3$ pseudobinary system and characterize tetradymite-type layered solid solutions via X-ray diffraction (XRD), differential thermal analysis (DTA), and scanning electron microscopy (SEM).

EXPERIMENTAL PART

Starting binary compounds - MnTe , Sb_2Te_3 , and Bi_2Te_3 were synthesized using manganese pieces, tin lumps, bismuth shots, and tellurium lumps. Table 1 presents detailed information on the source and purity of all starting materials and synthesized compounds. The weighted pure elemental starting materials were sealed in cleaned silica tubes under a residual pressure of 0.001 Pa and melted in a muffle furnace at 1200, 700, or 650 °C, depending on the binary compounds, then held at these temperatures for 8 hours.

Table 1.

Provenance and purity of the materials used in this study

Chemical	Mass fraction of purity	Source	CAS No	Form	Purity analysis methods
Mn	0.9999	Thermo Scientific Chemicals	7439-96-5	pieces	As stated by the supplier
Sb	0.99999	Thermo Scientific Chemicals	7440-36-0	lump	As stated by the supplier
Bi	0.99999	Thermo Scientific Chemicals	7440-69-9	shots	As stated by the supplier
Te	0.99999	Alfa Aesar	13494-80-9	lump	As stated by the supplier
MnTe	0.999	synthesized by us	12025-39-7	ingot	DTA, XRD
Sb_2Te_3	0.999	synthesized by us	1327-50-0	ingot	DTA, XRD
Bi_2Te_3	0.999	synthesized by us	1304-82-1	ingot	DTA, XRD

MnSb_{4-x}Bi_xTe₇ alloys compositions with $x=0;0.4;0.8;1.2;1.6$ and 2 were synthesized using pre-synthesized binary compound was prepared by the abovementioned method. Synthesis process was carried out at temperatures of 800-1100 °C depending on the composition and subsequently quenched in ice water. At the first stage, MnTe-rich alloys were annealed at 700 °C, while the others were treated at 600 °C for 2 weeks. This was followed by a second heat treatment at 500 °C for 6 weeks for all alloys.

In developing the synthesis methodology, we assumed that bulk layered phases obtained via the common fusion method do not reach equilibrium, even after prolonged annealing (2000–3000 hours). This is likely due to the slow interlayer diffusion in van der Waals phases formed under non-equilibrium conditions, such as melt cooling. To prevent large crystal formation, we quenched the alloys from the melt, with subsequent annealing promoting the formation of equilibrium phases.

All equilibrated alloys were examined using DTA, XRD and SEM techniques Phase transformation temperatures were determined by DTA using the LINSEIS HDSC PT1600 system (heating rate: 10 °C/min) and a multichannel DTA device with a TC-08 Thermocouple Data Logger. In the first system, measurements were conducted under a continuous flow of inert helium, while samples were placed in evacuated quartz tubes in the second. To prevent peak overlap, smaller samples (~20 mg) were used. Phase analysis was performed on a Bruker D2 PHASER diffractometer with CuK α radiation, scanning from $2\theta = 5^\circ$ to 75° . The XRD data were analyzed with Match!3 Crystal Impact software, and the PDF-2 and COD databases. Microstructural studies were carried out with a Tescan Vega 3 SBH SEM. Backscattered electron (BSE) imaging was used for detailed analysis. Samples were polished with progressively finer abrasives to achieve a smooth surface and cleaned in an ultrasonic cleaner to remove any residual debris.

RESULTS AND DISCUSSION

A total of seven samples were synthesized and homogenized for this investigation, each corresponding to 20 mol% intervals across the system. General analysis of the XRD patterns confirms that all diffractograms are monophasic, showing no evidence of residual or secondary phases. Representative XRD patterns of selected alloys are shown in Fig. 1. As can be seen, the diffraction peaks of all intermediate compositions qualitatively resemble those of the end-member ternary compounds. However, the substitution of the smaller Sb³⁺ ion with the larger Bi³⁺ ion in the crystal lattice leads to a systematic shift of all peaks toward lower 2θ angles, without introducing additional reflections. Analysis of the diffraction patterns indicates that all peaks can be indexed to a trigonal crystal structure with space group $P\text{-}3m1$ (#164). The lattice parameters of the solid solutions were determined from the powder XRD data using the Le Bail refinement method. Fig. 2 presents the final refinement for the alloy with 60 mol% MnSb₄Te₇, showing the observed and calculated diffractograms along with the residual line. The refined lattice parameters are listed in Table 2.

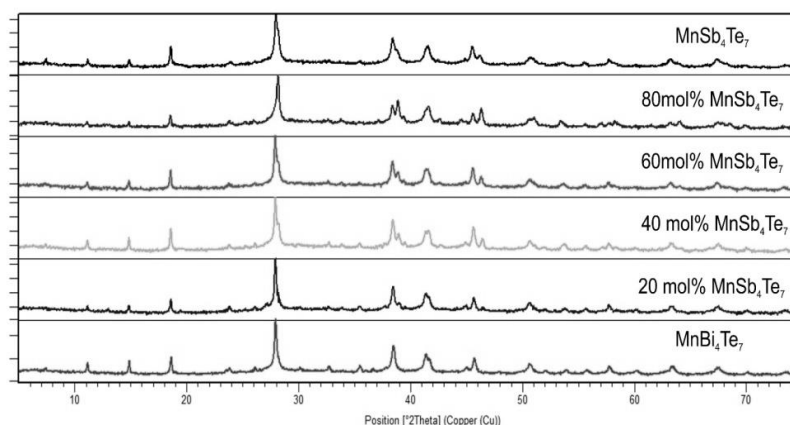


Fig. 1. Powder XRD patterns of MnSb_{4-x}Bi_xTe₇ solid solutions

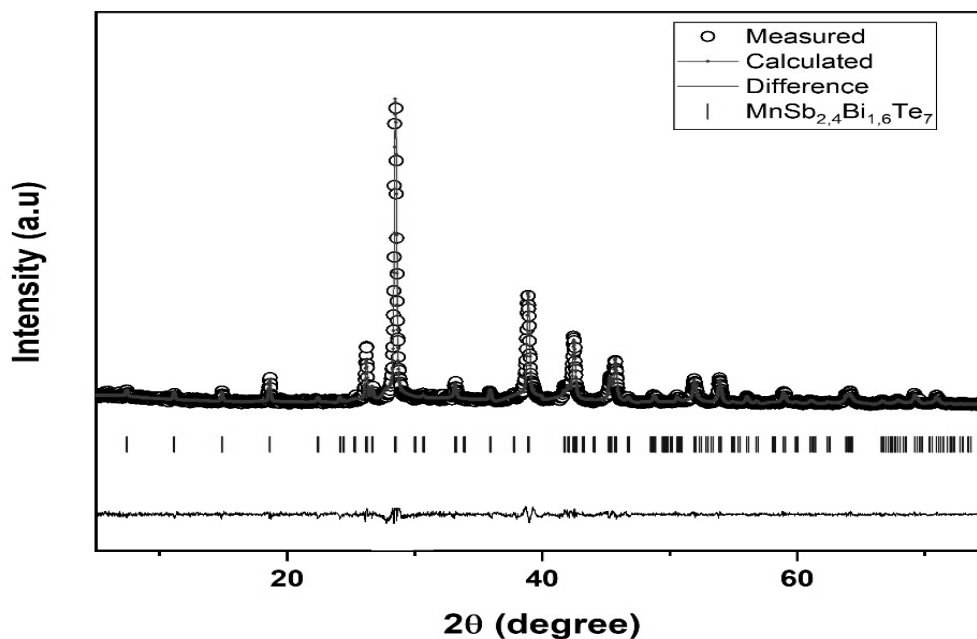


Fig. 2. Full-profile Le-Bail profile for alloy with composition of 60 mol% MnSb_4Te_7 .

Table 2.

Refined lattice parameters for $\text{MnSb}_{4-x}\text{Bi}_x\text{Te}_7$ solid solutions

Composition, mol%	Space Group	Lattice parameters, Å		Ref.
		<i>a</i>	<i>c</i>	
<i>x</i> =0 (MnSb_4Te_7)	<i>P</i> -3 <i>m</i> 1	4.2513(3)	23.761(4)	[23]
<i>x</i> =0.8	<i>P</i> -3 <i>m</i> 1	4,2789(4)	23,776(2)	This work
<i>x</i> =1.6	<i>P</i> -3 <i>m</i> 1	4,2989(2)	23,788(6)	This work
<i>x</i> =2.4	<i>P</i> -3 <i>m</i> 1	4,3127(5)	23,795(3)	This work
<i>x</i> =3.2	<i>P</i> -3 <i>m</i> 1	4,3369(2)	23,809(3)	This work
<i>x</i> =4.0 (MnBi_4Te_7)	<i>P</i> -3 <i>m</i> 1	4.355(1)	23.815(1)	[22]

The single-phase nature of the synthesized materials was further confirmed by SEM method. SEM images of representative samples demonstrated homogeneous microstructures with no evidence of secondary phases or compositional inhomogeneity. For example, the alloy with the nominal composition $\text{MnSb}_{2.4}\text{Bi}_{1.6}\text{Te}_7$ exhibited uniform contrast and morphology as seen in Fig. 3, supporting the XRD findings.

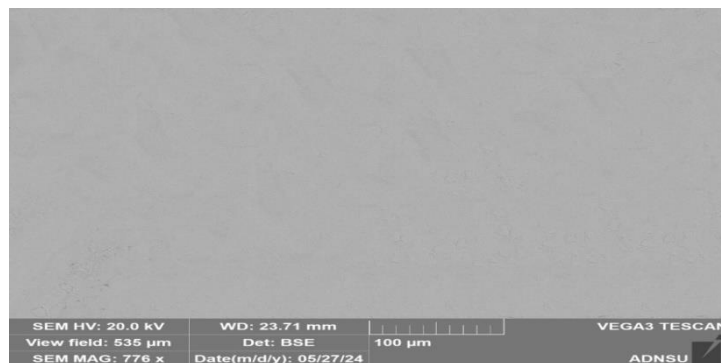


Fig. 3. SEM image of alloy with composition of 60 mol% MnSb_4Te_7

The concentration dependence of the lattice parameters for the $\text{MnSb}_{4-x}\text{Bi}_x\text{Te}_7$ solid solution series ($0 < x < 4$) was established based on the values listed in Table 2. As shown in the graph (Fig. 4(a)), a systematic increase in both lattice parameters a and c is observed with increasing Bi content following Vegard's law. This trend is attributed to the progressive substitution of smaller Sb^{3+} ions by larger Bi^{3+} ions. The continuous and monotonic change in lattice dimensions across the composition range confirms the formation of a complete solid solution without phase separation.

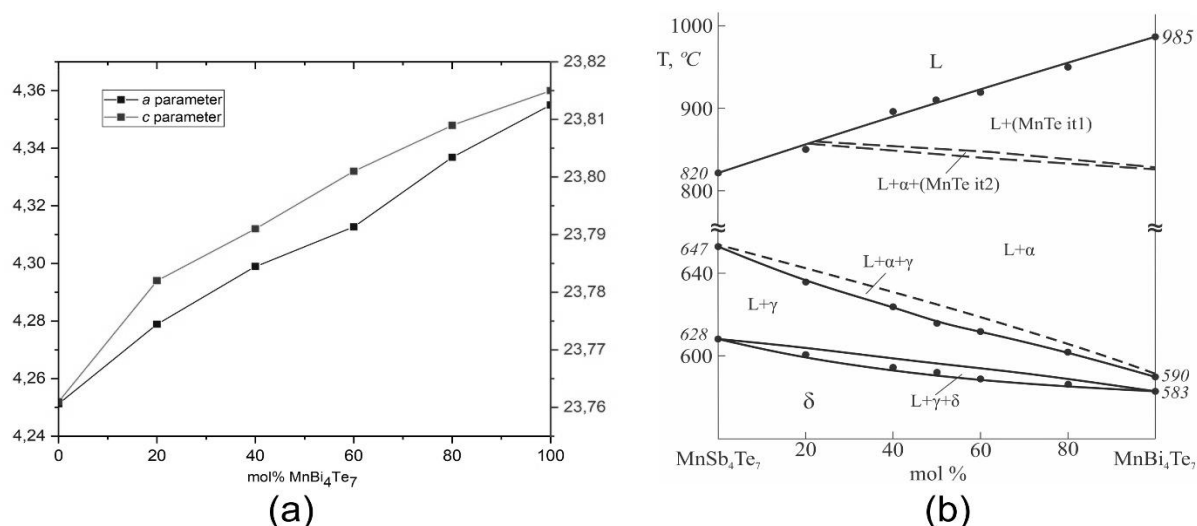


Fig 4. The concentration dependence of the lattice parameters for the $\text{MnSb}_{4-x}\text{Bi}_x\text{Te}_7$ solid solutions (a) and phase diagram of MnSb_4Te_7 – MnBi_4Te_7 system (b). In (b), MnTe it2 and it1 – solid solutions based on different modifications of MnTe; α – a solid solution based on MnTe rt; γ – $\text{MnSb}_{2-x}\text{Bi}_x\text{Te}_4$ solid solutions, δ – $\text{MnSb}_{4-x}\text{Bi}_x\text{Te}_7$ solid solutions

The phase diagram of MnSb_4Te_7 – MnBi_4Te_7 system were plotted using DTA results of homogenized alloys and literature data of MnTe – Sb_2Te_3 , as well as MnTe – Bi_2Te_3 pseudobinary systems. The constructed diagram (Fig. 4(b)) shows that the system cannot be considered pseudobinary overall, as both end-member ternary compounds form incongruently. However, pseudobinary behavior is observed in the subsolidus region. As can be seen, solid solutions based on various MnTe structural modifications (rt, it2, it1) are the first to crystallize from the melt. Due to the presence of peritectic cascades involving the ternary compounds at both ends—each occurring within narrow temperature intervals—the monovariant peritectic curves along this system replace one another sequentially. Upon cooling below the liquidus, the initial reaction $L + \alpha \rightleftharpoons \gamma$ takes place. Once the α phase is fully consumed, a twophase area $L + \gamma$ forms. This is followed by another monovariant reaction, $L + \gamma \rightleftharpoons \delta$, which completes the crystallization process, resulting in a homogeneous δ -phase in the subsolidus range.



CONCLUSION

A comprehensive investigation of the MnSb_4Te_7 – MnBi_4Te_7 system has been conducted to establish the phase equilibria and structural behavior of tetradymite-type layered solid solutions. XRD analysis confirmed that all synthesized $\text{MnSb}_{4-x}\text{Bi}_x\text{Te}_7$ compositions ($0 \leq x \leq 4$) form a continuous solid solution with a trigonal $P\bar{3}m1$ structure, obeying Vegard's law. Lattice parameters were refined using Le Bail method. SEM imaging verified the microstructural homogeneity of the alloys, while DTA results enabled the construction of phase diagram. The system is characterized by peritectic transformations and incongruent melting at both ends, with pseudobinary behavior observed in the subsolidus region. The crystallographic and thermal data reported here offer essential insights for the targeted development and tuning of magnetic topological materials based on Mn-containing layered chalcogenides.

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MnSb_4Te_7 - MnBi_4Te_7 SİSTEMİNDƏ FAZA TARAZLIQLARININ TƏDQIQI VƏ TETRADİMİTƏBƏNZƏR LAYLI QURULUŞLU BƏRK MƏHLULLARIN XARAKTERİZƏ EDİLMƏSİ

S.B. İzzətli, K.V. Əmirmətova, E.N. Oruçlu

Tetradimitəbənzər laylı quruluşlu bərk məhlulların əmələ gəlməsi və sabilliyinin tədqiqi üçün MnSb_4Te_7 – MnBi_4Te_7 sistemində faza tarazlıqları və quruluş dəyişiklikləri rentgenfaza, differensial termiki analiz və skanedici elektron mikroskopu ilə öyrənilmişdir və sistemin T-x diaqramı qurulmuşdur. RFA nəticələri sistemdə $\text{MnSb}_{4-x}\text{Bi}_x\text{Te}_7$ ($0 \leq x \leq 4$) formuluna malik triqonal quruluşda (P-3m1) kristallaşan bircins bərk məhlulların əmələ gəlməsini təsdiqləyir. Le-Bail analizi nəticələri göstərir ki, bərk məhlullarda kristal qəfəsdə Sb^{3+} ionunun daha böyük Bi^{3+} ilə əvəz olunmasına görə qəfəs parametrləri xətti qanunla artır. SEM nəticələri ərintilərin tərkibinin bircins olmasını təsdiqləyir. Sistemin faza diaqramı peritektik keçidlərlə xarakterizə olunur. MnSb_4Te_7 və



MnBi_4Te_7 birləşmələri inkongruent əridikləri üçün, sistem yalnız subsolidusda kvazibinardır. Aşkar olunan nəticələr bu bərk məhlulların maqnetik topoloji izolyatorlar və kvant materialları kimi tətbiqlər üçün lazım olan xüsusiyyətlərə malik olduğunu vurğulayır.

Açar sözlər: *faza diaqramı, tetradimitəbənzər quruluş, laylı xalkogenidlər, bərk məhlullar, kristal quruluş, maqnetik topoloji izolyatorlar.*

ФАЗОВЫЕ РАВНОВЕСИЯ В СИСТЕМЕ MnSb_4Te_7 – MnBi_4Te_7 И ХАРАКТЕРИСТИКА СЛОИСТЫХ ТВЕРДЫХ РАСТВОРОВ ТЕТРАДИМИТОВОГО ТИПА

С.Б. Иззатли, К.В. Амирметова, Э.Н. Оруджлу

Фазовые равновесия и структурная эволюция в системе MnSb_4Te_7 – MnBi_4Te_7 были систематически исследованы для понимания формирования и стабильности слоистых твердых растворов типа тетрадимита с помощью рентгеновской дифракции, дифференциального термического анализа и сканирующей электронной микроскопии. Была построена Т-х диаграмма системы. Анализ РФА подтвердил, что все синтезированные сплавы $\text{MnSb}_{4-x}\text{Bi}_x\text{Te}_7$ ($0 \leq x \leq 4$) кристаллизуются в однофазной тригональной структуре (P-3m1), без признаков вторичных фаз. Постепенная замена Sb^{3+} более крупными ионами Bi^{3+} привела к монотонному увеличению параметров решетки, что было определено методом Ли Бэйла, что указывает на образование непрерывного твердофазного раствора. СЭМ-изображения дополнительно подтвердили однородную микроструктуру образцов без видимого разделения фаз или композиционной неоднородности. Диаграмма Т-х системы характеризуется перитектическими превращениями. Поскольку MnSb_4Te_7 и MnBi_4Te_7 плавятся неконгруэнтно, псевдобинарное поведение наблюдается только в подсолидусной области. Полученные результаты подчеркивают потенциал этих твердых растворов для достижения желаемых свойств, необходимых для применения в магнитных топологических изоляторах и квантовых материалах.

Ключевые слова: *фазовая диаграмма, структура типа тетрадимита, слоистый халькогенид, твердые растворы, кристаллическая структура, магнитный топологический изолятор.*



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PURIFICATION OF COMMERCIAL AND MODEL DIESEL FUELS BY DEEP EUTECTIC SOLVENTS

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DESs composed of glycerol and chloroacetic acid/[TEAH]⁺[ClCH₂COO]⁻ were prepared and studied as extractants of nitrogen-, sulfuric- and aromatic compounds. Denitrification, desulfurization and dearomatization of model diesel fuels were conducted at room temperature. The LLE times were chosen as 1 and 3 hours. The oxidative desulfurization of diesel fuel was studied at 90°C temperature in 3 hours of mixing times. The results showed that, quinoline was separated completely by Glycerol/6 chloroacetic acid. Aniline and cresol derivatives of model fuels were cleaned with 100% rates by Glycerol/6 chloroacetic acid and Glycerol/6[TEAH]⁺[ClCH₂COO]⁻. Both DESs are selective for the commercial diesel as a desulfurization agent. All extraction processes were controlled by ¹H NMR.

Keywords: DES, extraction, purification, NMR, diesel

INTRODUCTION

The combustion of fossil fuels (coal tar, fuel, natural gases) is one of the significant sources of air pollution. The burning of motor fuels with high content of aromatic and heteroaromatic compounds causes SO_x, NO_x and CO_x emissions. Sulfur oxides contribute to acid rains, smog and eutrophication. CO₂, N₂O and NO₂ play a role in the depletion of the ozone layer [1-7]. The production of ultra-low sulfur, nitrogen and aromatic containing fuels are the basic aim of many fuel industries. The content of sulfur and nitrogen compounds has been limited to 10 ppm and 0,1 ppm [8]. Industrially, the purification process of gasoline, diesel fuels called hydrogenation. This technology needs higher temperature, pressure, costly catalysis and hydrogen consumption. On the other side, poly aromatic hydrocarbons are not separated completely from the fuels in hydrotreating. It is so difficult to remove them [9, 10]. Therefore, the study on the removal of organonitrogen, -sulfur and aromatic hydrocarbons from liquid fuels with the alternative methods are the most important issue.

The discovery of deep eutectic solvents promoted to prepared new environmentally purification methods. Liquid-liquid extraction with DESs is the main separation method for the cleaning fuels [11]. Deep eutectic solvents are new type of green extraction solvents which formed one and more hydrogen bond donors and hydrogen bond acceptors. The resulting DESs (*Deep Eutectic Solvents*) showed high thermal and chemical stability. They are cheap and eco-friendly solvents [12-15].

In this study, we reported a new type of deep eutectic solvents for the extraction of nitrogen, sulfuric and aromatic compounds from the model diesel/diesel fuels. Chloroacetic acid and [TEAH]⁺[ClCH₂COO]⁻ are selected as hydrogen bond acceptors and glycerol as hydrogen bond donor of DESs. The molar ratios of HBA/HBD were chosen as 1:6. Quinoline {1,7%}, aniline {1,7%}, indole {1,7%} were as nitrogen, dibenzothiophene {2%} as sulfuric and fluorenone {3,5%}, m-, p- and o-cresols {3,5%} were aromatic compounds of model diesel fuels. The liquid-liquid extraction processes were carried out at room temperature in 1 and 3 hours. The desulfurization of real diesel fuels was conducted at 90° C temperature. All analysis were controlled by ¹H NMR.



EXPERIMENTAL PART

2.1 Chemicals

All chemicals which used in the experiments were obtained from Sigma-Aldrich (Germany). $[\text{TEAH}]^+ [\text{ClCH}_2\text{COO}]^-$ was synthesized and confirmed by ^1H NMR analysis.

2.2 The preparation of DESs

The hydrogen bond donor of deep eutectic mixture was selected glycerol. Chloroacetic acid and $[\text{TEAH}]^+ [\text{ClCH}_2\text{COO}]^-$ were chosen as hydrogen bond acceptors. All DESs were synthesized at room temperature. HBA (a molar ratio) and HBD (6 molar ratio) was mixing till a homogenous bright yellow liquid appeared.

2.3 The preparation of model fuels

Hexadecane and n-decane was chosen as the components of model diesel fuels. Quinoline, aniline and indole were added 1,7% in the mixture of n-decane and hexadecane. The percentage of aromatic compounds was 3,5 % in the model fuel. Dibenzothiophene was selected as sulfuric compound with 2%. The volume ratios of n-decane/hexadecane was 1:1.

2.4 The liquid-liquid extraction

LLE processes were conducted at room temperature in 1 and 3 hours of mixing time. The volume ratios of DESs/model fuels were as 1:1. The desulfurization of commercial diesel fuel was studied at 90° C temperature. The processes were continued in 3 hours of mixing.

2.5 NMR analysis

The LLE processes were controlled using of NMR spectrometer (UltraShield Magnet) AVANCE 300 MHz (300 MHz for the ^1H).

RESULTS AND DISCUSSION

3.1 Characterization of DESs

The physical properties of DESs were shown in the Table 1. As we know, deep eutectic solvents also called “designer solvents”. Their physical and chemical properties can be tailored by the changing of HBA and HBD [16, 17].

Table 1.

The physical properties of DESs

The physical properties	Types of DESs	
	DES1	DES2
Density at 20° C, g/cm ³	2,01114	1,93941
Viscosity at 20° C, mm ² /s	67,877	98,475
Viscosity at 40° C, mm ² /s	19,473	31,551

3.2 Liquid-liquid extraction process

Two types of DESs were selected and investigated as extractive solvents of model diesel/diesel fuels. The components of DES1 consist of chloroacetic acid (1) and glycerol (6) molar ratio. $[\text{TEAH}]^+ [\text{ClCH}_2\text{COO}]^-$ (1) and glycerol (6) are formed DES2. Liquid-liquid extraction of heteroaromatic and aromatic compounds of model fuels studied at room temperature. The mixing times were 1 and 3 hours.

As can be seen from the Table 2, quinoline and aniline were extracted completely by DES1 in 1 hour. The high separation efficiency of indole was observed in 1 hour with 28%. o- and m-cresols were purified with 92% and 100%. DBT and fluorenone showed the lowest extraction results in both mixing times.

**Table 2.**

The extraction of heteroaromatic/aromatic compounds by DES1 at room temperature

DES1[ClCH₂COOH/6Glycerol]			
The number of aromatic/heteroaromatic compounds	<i>LLE conditions</i>		Separation efficiencies, %
	DES: Fuel (Volume ratios)	Time (hour)	
Quinoline {1,7%}	1:1	1	100
Aniline {1,7%}	1:1	1	100
Indole {1,7%}	1:1	1	28
Indole {1,7%}	1:1	3	22
Fluorenone {3,5%}	1:1	1	4
Fluorenone {3,5%}	1:1	3	6
Dibenzothiophene {2%}	1:1	1	2
Dibenzothiophene {2%}	1:1	3	4
o-cresol {3,5%}	1:1	1	92
p-cresol {3,5%}	1:1	1	20
p-cresol {3,5%}	1:1	3	35
m-cresol {3,5%}	1:1	1	82
m-cresol {3,5%}	1:1	3	100

From the Table 3, among the nitrogen compounds, the highest purification rates of quinoline, aniline and indole were achieved in 1 hour at room temperature. The LLE with DES2 for the cresol derivatives was 95% and 100%. The same separation results of fluorenone and DBT were obtained by [TEAH]⁺[ClCH₂COO]⁻/6Glycerol as DES1.

Table 3.

The extraction of heteroaromatic/aromatic compounds by DES2 at room temperature

DES2[[TEAH]⁺][ClCH₂COO]⁻/6Glycerol]			
The number of aromatic/heteroaromatic compounds	<i>LLE conditions</i>		Separation efficiencies, %
	DES: Fuel (Volume ratios)	Time (hour)	
Quinoline {1,7%}	1:1	1	73
Quinoline {1,7%}	1:1	3	57
Aniline {1,7%}	1:1	1	100
Indole {1,7%}	1:1	1	51
Indole {1,7%}	1:1	3	27
Fluorenone {3,5%}	1:1	1	3
Fluorenone {3,5%}	1:1	3	3
Dibenzothiophene {2%}	1:1	1	4
Dibenzothiophene {2%}	1:1	3	7
o-cresol {3,5%}	1:1	1	95
p-cresol {3,5%}	1:1	1	100
m-cresol {3,5%}	1:1	1	100

The deep oxidative desulfurization of commercial diesel was carried out in 3 hours of mixing time with 30% H₂O₂. The sulfur content in diesel fuels was detected according to ASTM D1266 standard.

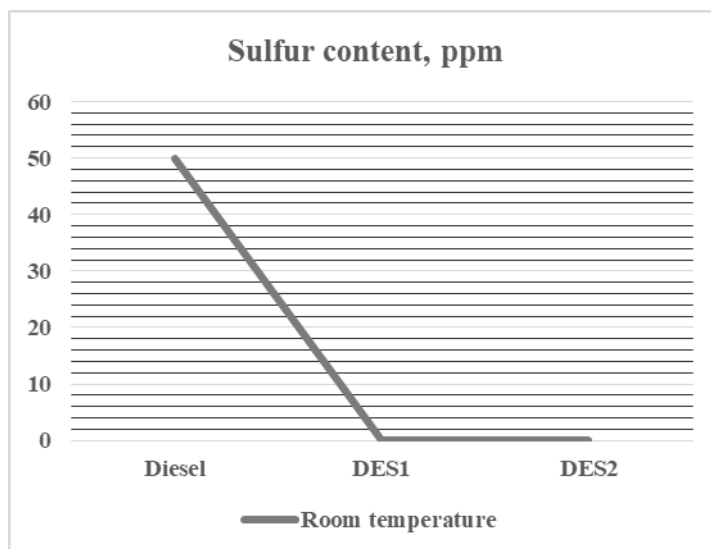


Fig. 1. The sulfur content in diesel fuels after LLE at 90° C temperature by DESs

As seen from the Figure 1, 2 sulfuric components from the commercial diesel fuel were cleaned by both DESs.

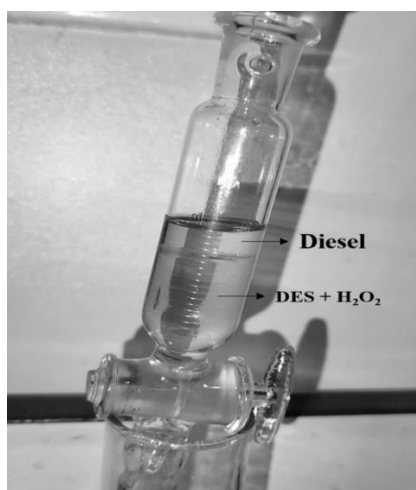


Fig. 2. ODS of the commercial diesel by DES2

CONCLUSION

Glycerol-based DESs were prepared and investigated as a greener extractive agent for the purification of model diesel/diesel fuels. This review summarizes the application of DESs for the separation of quinoline {1,7%}, aniline {1,7%}, indole {1,7%}, dibenzothiophene {2%}, fluorenone {3,5%}, and m-, p- and o-cresols {3,5%} from the model fuels. On the other side, oxidative desulfurization (ODS) of commercial diesel fuels was also studied by eutectic solvents and detected according to ASTM standard.

LLE of model fuels was carried out at room temperature. The mixing times of extraction processes were chosen as 1 and 3 hours. DES1, which is consist of ClCH₂COOH/6Glycerol separated quinoline, aniline, and o-cresol from the model fuel in 1 hour of mixing time. M-cresol was purified completely in 3 hours with same DES.

The highest extraction efficiencies of aniline and cresol derivatives were also observed with DES2 at 1 hour. The higher purification of quinoline and indole was exhibited in 1 hour with 73% and 51% rates.



ODS of commercial diesel was studied at 90° C temperature in 3 hours with both DESs. H₂O₂ was an oxidative agent with 30%. ¹H NMR analysis and the results of laboratory experiments according to ASTM standards showed that the sulfur content (ppm) of diesels decreased up to zero by the purification with DES1 and DES2.

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DƏRİN EVTEKTİK HƏLLEDİCİLƏR İLƏ DİZEL VƏ MODEL DİZEL YANACAQLARININ TƏMİZLƏNMƏSİ

S.Ə. Niftullayeva, Y.V. Məmmədova, İ.Q. Məmmədov

Qliserin və monoxlorsirkə turşusu/trietilammonium monoxlorasetatdan ibarət DEH-lər hazırlanmış və azotlu, kükürlü və aromatik birləşmələrin ekstragenti kimi öyrənilmişdir. Model dizel yanacaqlarının azotsuzlaşdırılma, kükürdsüzləşdirilmə və aromatisizləşdirilməsi otaq temperaturunda aparılmışdır. Maye-maye ekstraksiya müddətləri 1 və 3 saat kimi seçilmişdir. Dizel yanacağına oksidləşdirici kükürdsüzləşdirilməsi isə 3 saat qarışdırılma müddətində 90°C temperaturda öyrənilmişdir. Nəticələr göstərir ki, qliserin/6monoxlorsirkə turşusu ilə xinolin tamamilə ayrılmışdır. Qliserin/6monoxlorsirkə və qliserin/6 trietilammonium monoxlorasetat ilə isə anilin və krezol törəmələri 100% göstərici ilə təmizlənmişdir. Hər iki DEH dizel yanacağının kükürdsüzləşdirici agentini kimi selektivdir. Bütün ekstraksiya prosesləri ^1H NMR ilə izlənilmişdir.

Açar sözlər: DEH, ekstraksiya, təmizlənmə, NMR, dizel.

ОЧИСТКА КОММЕРЧЕСКОГО И МОДЕЛЬНОГО ДИЗЕЛЬНОГО ТОПЛИВА С ИСПОЛЬЗОВАНИЕМ ГЛУБОКОЭВТЕКТИЧЕСКИХ РАСТВОРИТЕЛЕЙ

С.А. Нифтуллаева, Я.В. Мамедова, И.Г. Мамедов

Глубокоэвтектические растворители (ГЭР), состоящие из глицерина и хлороцетовой кислоты/[TEAH]+[ClCH₂COO]⁻, были синтезированы и исследованы в качестве экстрагентов для удаления азотсодержащих, серосодержащих и ароматических соединений. Процессы денитрификации, десульфуризации и деароматизации модельных дизельных топлив проводились при комнатной температуре. Время проведения жидкостно-жидкостной экстракции составляло 1 и 3 часа. Окислительная десульфуризация дизельного топлива исследовалась при температуре 90 °С в течение 3 часов перемешивания. Результаты показали, что хинолин был полностью удалён с помощью ГЭР на основе глицерина и 6 моль хлороцетовой кислоты. Анилиновые и крезольные производные модельного топлива были удалены с эффективностью 100 % с помощью как глицерин/6 хлороцетовая кислота, так и глицерин/6[TEAH]+[ClCH₂COO]⁻. Оба ГЭР проявили селективность в отношении коммерческого дизеля как десульфуризирующие агенты. Все процессы экстракции контролировались с использованием ЯМР ^1H .

Ключевые слова: ГЭР, экстракция, очистка, ЯМР, дизельное топливо.



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LIQUID-PHASE HYDROGENATION OF BENZENE OVER HYBRID NICKEL AND PALLADIUM NANOCATALYSTS

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The present work is devoted to the process of benzene hydrogenation to cyclohexane using nanocatalysts based on the natural mineral clinoptilolite, as well as transition metals nickel and palladium on a polymer support. Polymer-immobilized metal complexes show high efficiency and better reproducibility. Hybrid nanocomposites based on the natural mineral and metal-organic polymer complexes are expected to exhibit higher efficiency due to their polyfunctionality. Besides, the addition of the mineral clinoptilolite to the structure of the metal-polymer complex can probably improve the selectivity of the reaction, increasing the yield of the target product. In this work, the catalytic activity of catalysts of the following composition was investigated: 1) polyvinylpyrrolidone (PVP) – clinoptilolite (Kpl) (primary, decationized (DKKlp), dealuminated (DAKpl); 2) PVP-Kpl-Ni (5, 10, 15%); 3) PVP-Kpl-Pd (5, 10, 15%). It is shown that on DKKlp the yields of products, as well as the process rate, increase. On dealuminated forms of clinoptilolite, an increased rate is observed, but the catalyst activity decreases over time. On catalysts of the Ni/PVP-Kpl and Pd/PVP-Kpl compositions, better results were obtained with a metal content of 10%. Among all those studied, the catalyst based on palladium showed the highest result.

Keywords: metal-polymer complexes, hybrid nanocomposites, polyvinylpyrrolidone (PVP), clinoptilolite (Kpl), transition metals, catalytic hydrogenation, benzene, cyclohexane.

INTRODUCTION

The unquenchable interest of scientists in modern chemical science and industry is aimed at developing new, more effective catalytic systems with increased selectivity and the goal of obtaining more valuable products. One of the most important catalytic processes is the selective hydrogenation of benzene.

The benzene hydrogenation reaction requires highly active and selective catalysts due to the high stability of the aromatic ring. Although it is an old topic, the conversion of benzene to cyclohexane still attracts much attention because the most suitable catalyst is urgently needed for practical implementation [1].

Furthermore, taking into account low economic efficiency of a number of processes in various industries (due to high temperatures and pressures, low selectivity of catalysts used in obtaining target products), the development and advancement of new hypotheses in this direction, and, as a consequence, the synthesis of new, more efficient catalysts, is becoming an increasingly urgent task.

The hydrogenation of benzene involves six sequential hydrogen addition steps, each of which creates a C–H bond (Figure 1). Among these steps, the identity of the reactive hydrogen species at

each step and the sequence of their addition can vary depending on the local reaction environment at the catalyst surfaces. These mechanistic details at the molecular scale remain largely unknown, but such details are essential for the development of efficient catalytic processes [1-3].

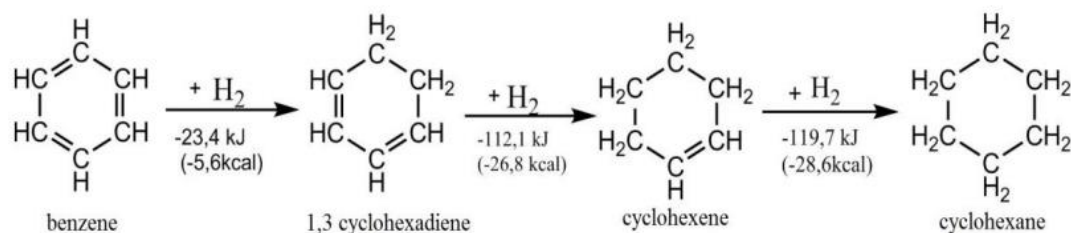


Fig. 1. Stages of benzene hydrogenation to cyclohexane [2]

In general, the benzene hydrogenation reaction is a typical heterogeneous, catalytic reaction that goes through a number of successive stages: external diffusion of benzene molecules to the catalyst surface; adsorption of hydrogen and benzene by the catalyst surface; internal diffusion of reagents in the catalyst grain; catalytic conversion on the active catalyst surface; and, finally, desorption of the reaction products (cyclohexane from the catalyst surface). The most complex process is the addition of the first pair of hydrogen atoms, which leads to disruption of the aromatic structure. Subsequent reactions proceed rapidly with increasing temperature and pressure (Figure 2). The direction of benzene hydrogenation depends on the degree of adsorption on the catalyst surface and the reaction conditions.

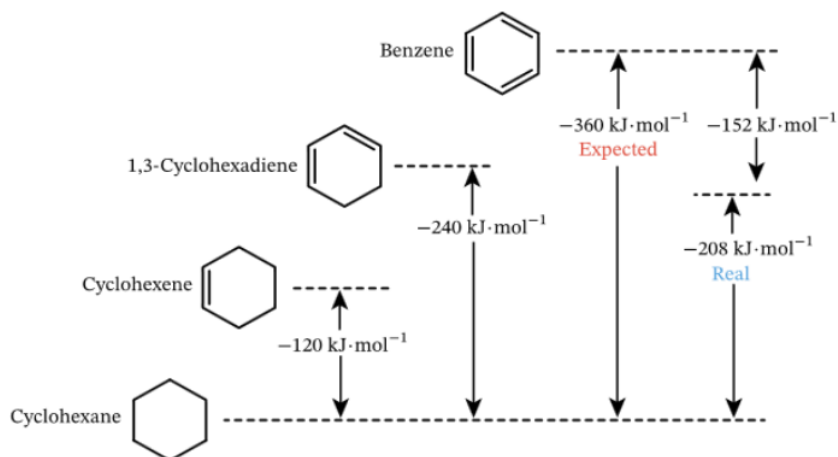


Fig. 2. Heats of hydrogenation of benzene and its derivatives [1-4]

Liquid-phase hydrogenation of benzene is shown by a scheme of three routes. If to consider benzene and cyclohexane as a hydrogenating unsaturated compound, then according to the Horiuti-rule, the proposed scheme can be a two-linear independent route. Moreover, cyclohexane is formed as a result of benzene hydrogenation, and it will also be correct if to consider that the adsorption of desorbed cyclohexane is in a new stage. The value of benzene conversion to cyclohexane shows that the reaction of selective hydrogenation of benzene occurs with the formation of cyclohexane and cyclohexene in parallel. The main task in benzene hydrogenation reactions is the choice of route [3-4].

A wide range of catalysts are used to carry out the hydrogenation reaction. The platinum group metals: platinum, palladium, rhodium and ruthenium are quite active [5]. Non-precious metals such as nickel, copper, molybdenum and cobalt are offered as economical alternatives.

It should be noted that platinum group metals, especially palladium, are considered the best catalysts, but have a significant drawback - high cost. Despite this, there are a number of works de-

voted to this group of catalysts [6-9]. Due to the high cost of palladium, it becomes necessary to develop cheaper catalysts that do not contain platinum metals. A number of studies have been carried out to compare nickel, palladium and platinum based catalysts. In this case, the attention of researchers is most often attracted by nickel catalysts [9-12], due to its availability and efficiency.

There are many known works aimed at the synthesis of hydrogenation catalysts on the base of nickel [9-12], however, in recent years, more and more studies have been conducted with bimetallic and trimetallic catalysts containing nickel.

It is worth noting that the catalytic characteristics of any catalysts depend significantly on the method of their preparation, at which it is should also take into account sulfur impurities in the catalytic system. [13]. The presence of small amounts of sulfur in the gas phase, typical for industry, creates a serious problem: sulfur will adsorb on the surfaces of transition metals and interfere with the process, changing the electronic properties of metal surfaces and destroying the ensembles of metal sections [2].

Special attention should be given to metal-polymer nanocatalysts. In this case, polymers simultaneously act as both a matrix and a stabilizer, regulating the size of metal nanoparticles during their synthesis [9, 10, 14]. The advantages of polymer carriers are confirmed in a number of studies. For example, Kompaniets et al. [14] studied the catalytic properties of palladium catalysts with the following carriers: polyaniline (PAN); PAN doped with H_2SO_4 ; activated carbon or aerosil (SiO_2) coated with PAN or PAN doped with H_2SO_4 ; PAN after heat treatment at 300°C in an H_2 atmosphere. The authors also prepared a sample by in situ polymerization of aniline in the presence of Pd^{2+} . The authors tested the catalytic activity of the catalysts using the example of the hydrogenation reaction of quinoline to 1,2,3,4-tetrahydroquinoline. The authors found that doping of PAN/ H_2SO_4 /C or thermal treatment of PAN before applying Pd lead to a significant increase in the catalytic activity of the composites [14]. In work [7], nanocatalysts, based on nickel immobilized on a copolymer of chitosan and polyacrylic acid, were synthesized. The synthesized catalyst was then used in the hydrogenation of benzene with a significant yield of the target product.

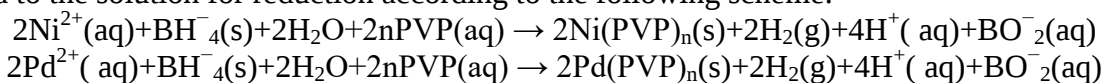
It is known that the combination of components with different chemical nature leads to the formation of materials with better characteristics compared to the components used separately. Such materials consisting of organic (polymer) and nanodispersed mineral phases are called "hybrid nanocomposites", "nanohybrids", "nanostructured composites", sometimes - "metal-matrix composites", "multiphase hybrids". As a rule, hybrid nanocomposites reflect the properties of synergy of the original substances, have mechanical strength, thermal stability, optimal thermal conductivity, high thermochemical, rheological, electrical and optical properties. Thus, the use of hybrid nanocomposites as selective hydrogenation catalysts is quite an urgent and important task in the modern chemical industry, which is our goal in this work.

MATERIAL AND METHODS

2.1. Synthesis of metal-polymer complexes

Nanocomposites based on polyvinylpyrrolidone (PVP) and nickel Ni (II) and palladium Pd (II) transition metals were synthesized with a metal content of 5, 10 and 15% relative to the polymer.

For the synthesis of the complexes, 1 gram of the polymer was dissolved in 25 ml of distilled water and the appropriate amount of salt was added. After stirring for 2 hours, sodium borohydride was added to the solution for reduction according to the following scheme:



The solution was stirred for 1 hour and washed successively with diethyl ether, acetone and distilled water, after which the precipitate was separated from the solution by centrifugation. The crosslinking agent N,N'-methylene-bis-acrylamide was added to the centrifuged part. After stirring



for some time, the samples were dried and placed under a UV lamp for crosslinking. The structures of the crosslinked metal-polymer nanocomposite samples were determined using IR spectroscopy.

2.2. Synthesis of nanohybrids based on zeolite and metal-polymer complexes

Based on the obtained metal-polymer nanocomposites, nanohybrid metal-polymer-mineral complexes were synthesized using the hydrothermal method. Zeolite clinoptilolite (Azerbaijan deposit, Aydag), pre-purified with hydrochloric acid to remove foreign impurities, was used as a natural mineral. Diffraction patterns of treated and untreated samples were obtained and compared, after which nanohybrids were synthesized.

2.3. Catalytic hydrogenation of benzene

The reaction was carried out directly in a laboratory experimental setup of a static type, in a fixed catalyst bed of a quartz reactor, at atmospheric pressure, in the temperature range of 25-80°C and at a molar ratio of $C_6H_6-H_2 = 1:3$. A catalyst sample of 0.8 cm³ in volume with a grain size of 0.25-0.63 mm was placed in the reactor. The reactor was placed on a magnetic stirrer of the "MC-5" brand with heating. The heating temperature was regulated by a contact thermometer. The temperature was maintained constant throughout the reactor and during the experiment.

The reagents and reaction products were analyzed by gas chromatography. The reaction products were analyzed on an Agilent 7890 B chromatograph with a 30 m HP-5 column.

Based on the obtained experimental data, the yield, selectivity and conversion were calculated using known formulas [14]:

$$\begin{aligned}\text{Conversion (X, \%)} &= \frac{\text{Mole of BZ reacted}}{\text{Mole of initial BZ}} \times 100\% \\ \text{Selectivity (S, \%)} &= \frac{\text{Mole of cyclohexane}}{\text{Mole of FAL converted}} \times 100\% \\ \text{Yield (\%)} &= \text{Conversion} \times \text{Selectivity}\end{aligned}$$

RESULTS AND DISCUSSION

3.1. Synthesis of metal-polymer complex

Ni-PVP complex is one of the most widely used metal-polymer complexes. This compound has important catalytic properties and useful applications in many different branches of industry. When mixing nickel chloride salt ($NiCl_2 \cdot 6H_2O$) and aqueous PVP solutions, nickel ions bind to the oxygen atoms of the carbonyl groups of PVP and form a Ni-PVP complex. Ni-PVP complexes have a wide range of applications due to their high strength, catalytic activity and thermal stability. It has proven itself mainly in catalytic processes. Their catalytic efficiency is explained by the stability of nickel in the active state and the even distribution of nickel ions in the polymer matrix. Part of the structure of the Ni-PVP complex is shown below (Figure 3).

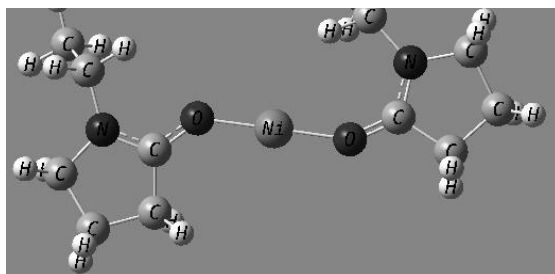
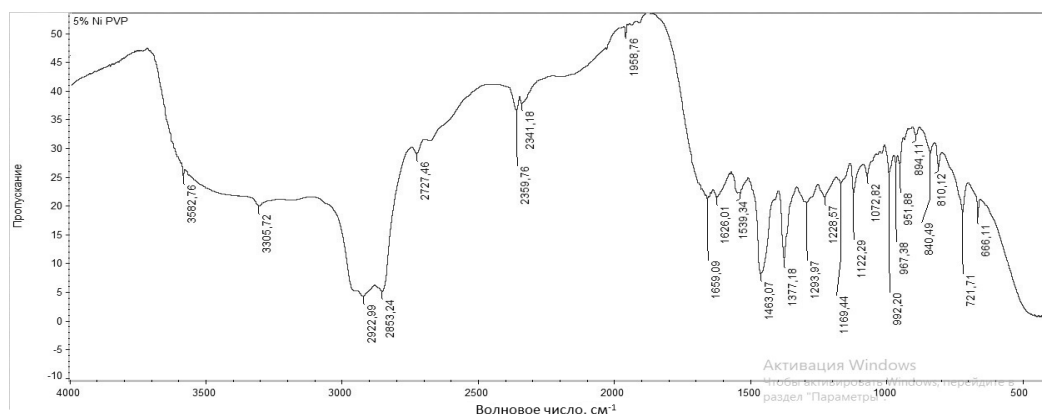
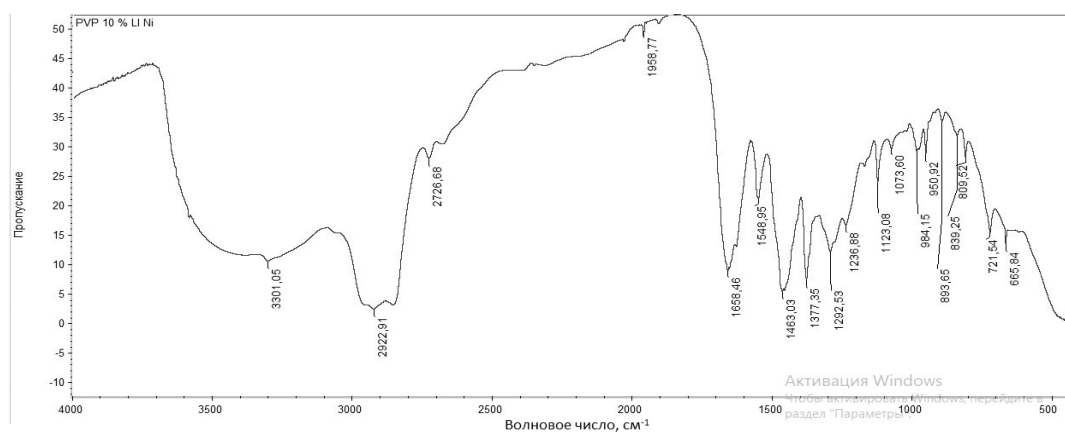
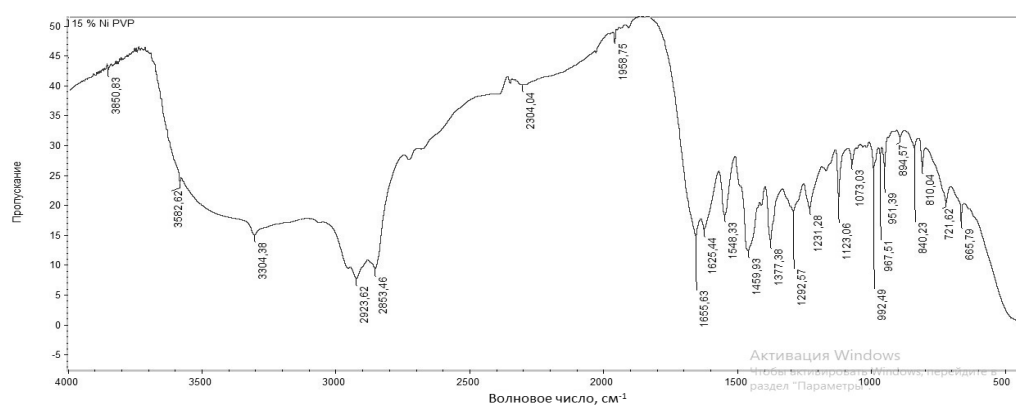


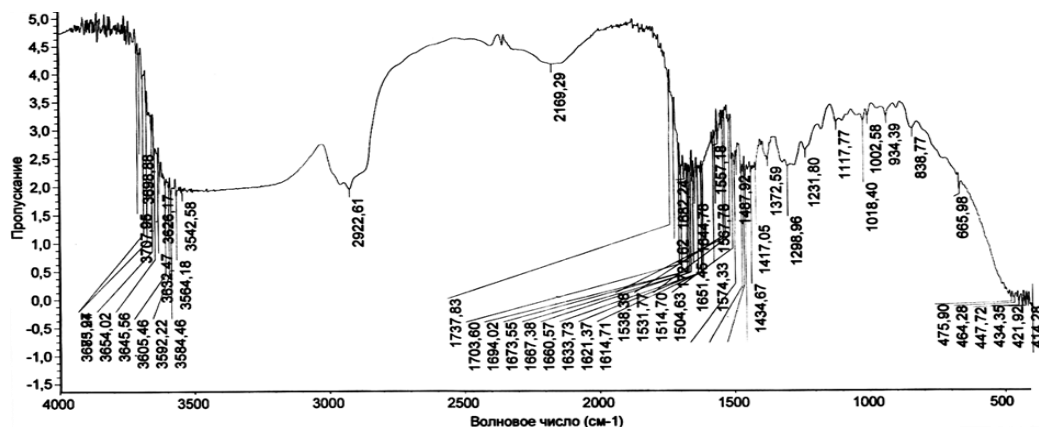
Fig. 3. The structure of Ni-PVP complexes

Based on the IR spectra presented below (Figure 4), the SEM study of metal-containing polymers showed that the characteristic peak of C=O interaction becomes asymmetric after the addition of a metal salt, which is a clear example of a strong polymer-metal bond. The IR spectra at 3454



and 3407 cm^{-1} of the polymer itself and the metal-containing samples show absorption bands characteristic of each sample. The absorption band characteristic for the carbonyl group of the polymer is located at 1655 cm^{-1} in the lactane ring, which is expanded due to the $\text{C}=\text{N}$ double bond. In the metal-polymer complex, this absorption band shifted to 1651 cm^{-1} . The observed difference in the IR spectra of the polymer and the metal-polymer complex indicates a strong donor-acceptor interaction between the oxygen atom and the metal ions in the polymer ligand.

**Ia****Ib****Ic**



II

Fig. 4. IR spectra of synthesized metal-polymer complexes: Ni 5% - PVP (I a), Ni 10% - PVP (I b), Ni 15% - PVP (I c); Pd – PVP (II).

Part of the Pd-PVP structure is presented as follows (Figure 5).

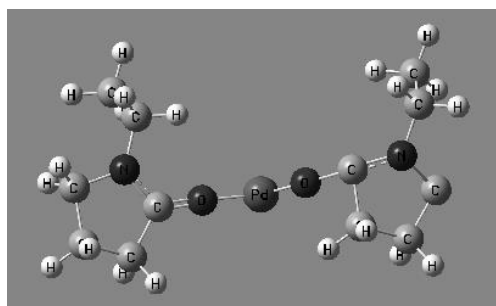


Fig. 5. The structure of Pd-PVP complexes

3.2. Synthesis of nanohybrids based on zeolite and metal-polymer complexes

Clinoptilolite, which is used as a mineral, has a complex formula: $(\text{Na}, \text{K}, \text{Ca})_2\text{-}3\text{Al}_3(\text{Al}, \text{Si})_2\text{Si}_{13}\text{O}_{36} \cdot 12\text{H}_2\text{O}$ and has ion-exchange properties, so it is of great interest to scientists. At the first stage of the research, purification and confirmation of the structure of this mineral was carried out. Based on X-ray diffraction, it was found that the percentage of crystallinity of the purified substance (Figure 6) increased compared to the original sample.

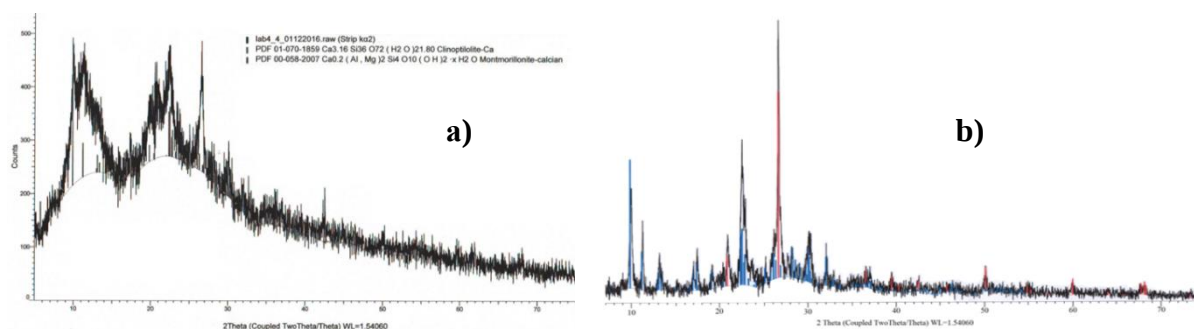


Fig. 6. Diffraction pattern of the original (a) and purified (b) clinoptilolite

Metal-polymer nanocomposites with clinoptilolite were obtained by hydrothermal synthesis. The diffraction patterns of the obtained products (Ni-PVP-clinoptilolite, Pd-PVP-clinoptilolite) are presented below (Figure 7).

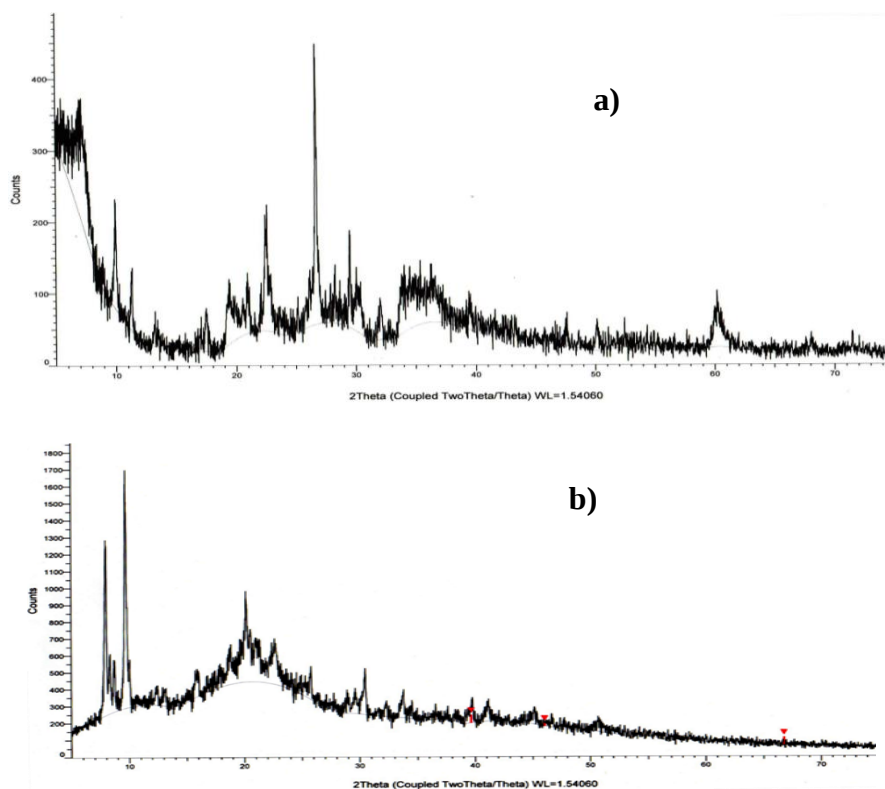


Fig. 7. Diffraction patterns of Ni-PVP-clinoptilolite (a) and Pd-PVP-clinoptilolite (b) complexes

As can be seen from the Figure 7, after construction we observe an increase in the crystalline phase and the production of a system with a more regular structure.

Based on research, it is believed that metal-polymer-mineral complexes have a number of properties that allow them to act as more effective catalysts and adsorbents in various chemical processes.

3.3. Carrying out the process of catalytic hydrogenation of benzene

As a result of the conducted research, it was found that the catalytic activity of the obtained catalyst samples in the studied reaction significantly depends on the properties and structure of metals, polymer, and zeolite, on the reaction conditions (temperature, etc.) as well.

It has been established that the effect of the obtained metal/polymer-mineral nanocatalysts on the benzene conversion reaction proceeds in the following direction: hydrogenation of benzene; formation of carbonyl compounds. The yield of the reaction product is influenced by the nature of the metals, the properties of the polymer and the porous structure of the zeolite, the physical and chemical composition, and the reaction conditions.

The results of research carried out on benzene hydrogenation on other catalysts showed that depending on various factors, such as polymer properties, structural properties, as well as the type of zeolite, and reaction conditions. As a result of the reaction, along with the target product - cyclohexane, cyclohexadiene and cyclohexene compounds are formed.

In order to determine the nature of the influence of the structural properties of the polymer and zeolite on the benzene hydrogenation reaction, the initial catalytic activity of polyvinylpyrrolidone and primary zeolite in the benzene hydrogenation reaction was studied, the results obtained are presented in Table 1. The Table shows the results of experiments on primary alkaline and alkaline earth cationic forms of zeolite.



Porous zeolites are characterized by a small internal surface area (8.0–20.0 m²/g) and small pores (4.2–4.9 Å). These types of zeolites help in the selective conversion of benzene to cyclohexane in the benzene hydrogenation reaction. It is known from Table 1 that among the ionic structures of porous zeolite, the yield of cyclohexane is higher in dealuminated clinoptilolites. 15.8% cyclohexane is obtained with a selectivity of 76.7% on dealuminated clinoptilolite zeolite at temperature of 50°C and a molar ratio of benzene to H₂ = 1:3.

Table 1.

Hydrogenation of benzene on nanocatalysts based on polyvinylpyrrolidone and clinoptilolite
(T=50°C, benzene-H₂=1:3, τ=6 h)

Catalyst	X, %	S, %	Yield of reaction product, %	
			C ₆ H ₁₀	C ₆ H ₁₂
Polyvinylpyrrolidone	—	—	—	—
Clinoptilolite	11.5	16.5	9.6	1.9
PVP/5%Clp	15.3	18.3	12.5	2.8
PVP/5%DCClp	17.7	63.8	6.4	11.3
PVP/5%DAClp	20.6	76.7	4.8	15.8

X - benzene conversion; S - process selectivity with respect to cyclohexane;
DCClp - decationized clinoptilolite; DAClp - dealuminated clinoptilolite

In many processes of heterogeneous hydrogenation, the activation of hydrocarbon molecules by their dissociative adsorption with the participation of the main centers is considered a weak stage. Active centers play the role of the main center, formed on the surface of the catalyst. A review of the catalytic properties of PVP/Clp and PVP/DCClp shows that these catalysts are characterized by low selectivity and low activity in the reaction of partial hydrogenation of benzene. Decationization of zeolites leads to an increase in the specific surface area, the size of the inlet windows and the number of Brønsted acid centers of the catalyst, which, in addition to hydrogenation reactions, exhibit activity in processes of acid-base type, especially in the disproportionation of intermediate products of benzene hydrogenation. Decationized zeolite samples are obtained by treating primary Na-forms with 10% aqueous solution of NH₄Cl or 2% solution of HCl, followed by washing to remove chloride ions, drying at 110–120°C and calcination at 500–550°C for 5 hours. Figure 8 shows that higher yields of hydrogenation products were obtained on decationized natural clinoptilolite than on the initial clinoptilolite sample, which is caused by the mixture of Meⁿ⁺ ions. An increase in the degree of decationization leads to an increase in the rate of benzene hydrogenation reaction.

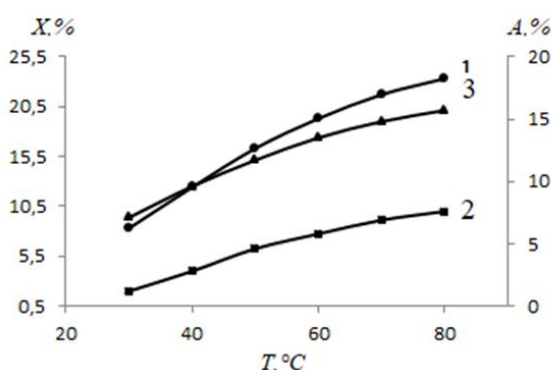


Fig. 8. Temperature dependence of benzene conversion (1) and the yield of reaction products: cyclohexene (2) and cyclohexane (3) (A). (benzene-H₂=1:3; PVP/5%DCClp).

Further studies were carried out on dealuminated forms of zeolite for a detailed analysis of the reaction results (Figure 9).

Due to the inclusion of dealuminated forms of zeolite in the composition of known hydrogenation catalysts, the rate of the hydrogenation process increases and higher results are achieved. A study of the dynamics of the rate of formation of benzene hydrogenation products shows that their activity decreases rapidly with time, and the selectivity of the reaction for unsaturated and saturated hydrocarbons exceeds the maximum.

Catalytic systems obtained on dealuminated forms of clinoptilolite have high selectivity in the benzene hydrogenation reaction.

The optimal ratio of components in the indicated catalytic systems was found by keeping the amount of one of the substances constant and changing the amount of the other one.

As a result of the conducted research, a nanocomposite containing natural dealuminated zeolite clinoptilolite and synthetic polymer polyvinylpyrrolidone in various mass quantities was synthesized as an effective catalyst for selective hydrogenation of benzene to cyclohexane. The optimal mass fraction of clinoptilolite (5%) included into the catalyst composition and optimal reaction conditions ($T = 50^{\circ}\text{C}$, $\text{C}_6\text{H}_6\text{-H}_2 = 1:3$) were selected. The yield of cyclohexane was 15.8%, the conversion of benzene was 20.6% and the selectivity was 76.7%.

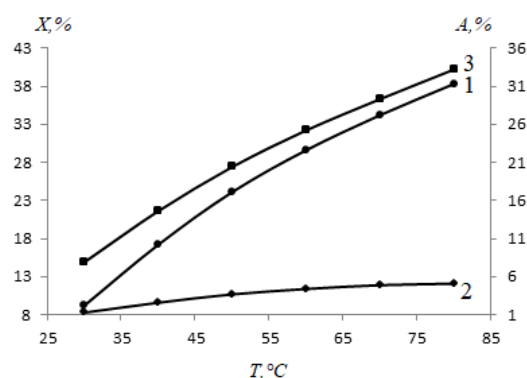


Fig. 9. Temperature dependence of benzene conversion (1) and the yield of reaction products: cyclohexene (2) and cyclohexane (3) (A, %). ($\text{C}_6\text{H}_6\text{-H}_2=1:3$; PVP/5%DAClp)

In addition, the catalytic properties of the synthesized metal-containing catalysts were studied in the selected reaction. The results obtained are presented in Table 2.

Table 2.

Hydrogenation of benzene on nanocatalysts based on Ni/polyvinylpyrrolidone-clinoptilolite ($T=50^{\circ}\text{C}$, $\text{C}_6\text{H}_6\text{-H}_2=1:3$, $\tau=6$ hours)

Catalyst	X, %	S, %	Yield of the reaction product, %	
			C_6H_{10}	C_6H_{12}
5%Ni/PVP-Clp	29.5	65.7	10.1	19.4
10%Ni/PVP-Clp	37.9	67.5	12.3	25.6
15%Ni/PVP-Clp	21.5	61.4	8.3	13.2

X - benzene conversion; S - process selectivity with respect to cyclohexane

As can be seen from the Table 2, 25.6% of cyclohexane is obtained with a selectivity of 67.5% with respect to the Me/PVP-clinoptilolite catalyst containing 10% Ni at 50°C and a molar ratio of $\text{C}_6\text{H}_6\text{-H}_2=1:3$. At that time, the conversion was 37.9%.

Analyzing the results obtained in the course of the benzene hydrogenation reaction carried out on the Pd/PVP-clinoptilolite catalyst, it was found that, unlike the nanocatalyst containing metallic Ni, the sample of the nanocatalyst containing Pd showed a higher result in the selected object. Thus,



on the Me/PVP-Clinoptilolite catalyst containing 10% Pd at temperature of 50°C and a molar ratio of $C_6H_6-H_2=1:3$, 34.3% cyclohexane is obtained with a selectivity of 69.8%. This time, the conversion was 49.1% (Table 3).

Table 3.

Hydrogenation of benzene on nanocatalysts based on Pd/PVP-clinoptilolite
($T=50^\circ C$, $C_6H_6-H_2=1:3$, $\tau=6$ hours)

Catalyst	X, %	S, %	Yield of the reaction product, %	
			C_6H_{10}	C_6H_{12}
5%Pd/PVP-Clp	37.3	66.2	12.6	24.7
10%Pd/PVP-Clp	49.1	69.8	14.8	34.3
15%Pd/PVP-Clp	25.7	63.4	9.4	16.3

X - benzene conversion; S - process selectivity with respect to cyclohexane

However, the activity of catalysts in the working process decreases over time, which is associated with a change in the phase composition and coking of the catalyst surface. All systems exhibit activity in reactions of mild, destructive and deep hydrogenation.

CONCLUSION

The work investigated the catalytic activity of hybrid nanocomposites based on a natural mineral and organometallic polymer complexes in the catalytic hydrogenation of benzene to cyclohexane. The catalysts studied were: 2) PVP – Kpl (primary, decationized, dealuminated); 3) PVP-Kpl-Pd (5, 10, 15%). As a result of the carried out experiments it was established, that the yield of cyclohexane in the considered reaction of benzene hydrogenation with participation of polyvinylpyrrolidone and clinoptilolite with silicate module $SiO_2/Al_2O_3=8.68$ at temperature of 50°C, with a molar ratio of $C_6H_6-H_2=1:3$ was 15.8%, the selectivity of the process for the target product was 20%, benzene was 76.7% at conversion of 0.6%, 25.6%, 37.9% and 67.5% in PVP/Clp containing 10% Ni^0 . On the PVP/Clp nanocatalyst containing 10% Pd, these values were 34.3%, 49.1% and 69.8%. Moreover, after the regeneration process of the synthesized catalysts due to coking, the catalysts were retested and a repetition of the initially obtained results was observed. This is an apparent indicator of the efficiency and effectiveness of the synthesized catalysts. In the future metal-saving ultra-dispersed nanocatalysts on a polymer-mineral base can be studied in other chemical processes (oxidation, hydrogenation, oxidative dehydrogenation).

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BENZOLUN HİBRİD NİKEL VƏ PALLADIUM NANOKATALİZATLARI ÜZƏRİNDƏ MAYE FAZASINDA HİDROGENLƏŞDİRİLMƏSİ

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Hazırkı iş benzolun tsikloheksana hidrogenləşdirilməsi prosesinə həsr olunmuşdur. Prosesdə təbii mineral olan klinoptilolitə və polimer əsaslı keçid metallarına – nikel və palladiuma əsaslanan nanokatalizatorlardan istifadə olunmuşdur. Polimerə immobilizə olunmuş metal kompleksləri yüksək effektivlik və daha yaxşı reproduktivlik nümayiş etdirir. Təbii mineral və metal-polimer komplekslərinə əsaslanan hibrid nanokompozitlərin çoxfunksionalılığı səbəbindən daha yüksək katalitik aktivlik göstərəcəyi gözlənilir. Bundan əlavə, metal-polimer kompleksinin quruluşuna klinoptilolit mineralının əlavə olunması reaksiyanın selektivliyini artıraraq hədəf məhsulun çıxımını yaxşılaşdırır. Bu işdə aşağıdakı tərkibə malik katalizatorların katalitik aktivliyi araşdırılmışdır: polivinilpirrolidon (PVP) – klinoptilolit (Kpl) (ilkin, de-kationlaşdırılmış (DKKpl), de-alüminləşdirilmiş (DAKpl)); PVP-Kpl-Ni (5, 10, 15%); PVP-Kpl-Pd (5, 10, 15%). Tədqiqat göstərmişdir ki, DKKpl üzərində həm məhsulun çıxımı, həm də prosesin sürəti artır. De-alüminləşdirilmiş klinoptilolit formalarında sürətin artması müşahidə olunur, lakin zaman keçdikcə katalizatorun aktivliyi azalır. Ni/PVP-Kpl və Pd/PVP-Kpl tərkibli katalizatorlarda isə metalın 10%-lik miqdarında daha yaxşı nəticələr əldə edilmişdir. Tədqiq olunan bütün nümunələr arasında ən yüksək nəticə palladium əsaslı katalizator tərəfindən göstərilmişdir.

Açar sözlər: *metal-polimer kompleksləri, hibrid nanokompozitlər, polivinilpirrolidon (PVP), klinoptilolit (Kpl), keçid metalları, katalitik hidrogenləşmə, benzol, tsikloheksan.*



ЖИДКОФАЗНОЕ ГИДРИРОВАНИЕ БЕНЗОЛА НА ГИБРИДНЫХ НИКЕЛЕВЫХ И ПАЛЛАДИЕВЫХ НАНОКАТАЛИЗАТОРАХ

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Настоящая работа посвящена исследованию процесса гидрирования бензола в циклогексан с использованием нанокатализаторов на основе природного минерала клиноптилолита, а также переходных металлов никеля и палладия на полимерном носителе. Полимерно-иммобилизованные металлокомплексы демонстрируют высокую эффективность и лучшую воспроизводимость. Ожидается, что гибридные наноконпозиты на основе природного минерала и металлоорганических полимерных комплексов будут проявлять более высокую эффективность благодаря их полифункциональности. Кроме того, добавление минерала клиноптилолита в структуру металлополимерного комплекса, вероятно, может повысить селективность реакции, увеличивая выход целевого продукта. В работе исследована активность катализаторов следующего состава: 1) поливинилпирролидон (ПВП) – клиноптилолит (КПл) (первичный, декатионированный (ДККПлп), деалюминированный (ДАКПл)); 2) ПВП-КПл-Ni (5, 10, 15%); 3) PVP-Kpl-Pd (5, 10, 15%). Показано, что на ДККлр выходы продуктов, а также скорость процесса увеличиваются. На деалюминированных формах клиноптилолита наблюдается увеличение скорости, однако активность катализатора снижается со временем. На катализаторах составов Ni/PVP-Kpl и Pd/PVP-Kpl лучшие результаты получены при содержании металла 10%. Среди всех исследованных катализатор на основе палладия показал наивысший результат.

Ключевые слова: металлополимерные комплексы, гибридные наноконпозиты, поливинилпирролидон (ПВП), клиноптилолит (КПл), переходные металлы, каталитическое гидрирование, бензол, циклогексан.



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RADIOCARBON, ESR AND THERMOLUMINESCENCE (TL) DATING OF ARCHEOLOGICAL MONUMENTS IN AZERBAIJAN

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This study sought to enhance the precision of C-14, ESR and TL dating of archaeological monuments in Azerbaijan. The charcoal samples were collected from various sites (Polutepe, Shomutepe, Goytepe, Pahsatepe, Boyukdash-Anazaga, Burugtepe, Alkhantepe, Gebele-Selbir, Uzun Reme) for C-14 measurements. The counting vial was transferred into the liquid scintillation analyzer Tri-Carb 3100TR and allowed to count for a period of 300 to 1000 minutes depending on the size, age, and precision requirements. As a scintillation solution, 1 ml of commercially available SIGMA-ALDRICH liquid scintillation mixture PPO/POPOP in toluene was added. In this study the Radiocarbon dating method was used to date the age of charcoal samples from the archaeological monuments in Azerbaijan. Calibration results were calculated with 68% and 95% probability ($\sigma=1950$). Teeth and pottery samples were collected from the following archaeological sites: Jalilabad-Polutepe, Fuzuli-Leletepe, Ismayilbeytepe, Agstafa-Hesensu, Berde-Emirli-3, Jalilabad-Pashatepe, Gobustan-Anazaga, Gobustan-Boyukdash, Gobustan-Kichikdash, Jalilabad-Khudutepe, Chukur-Gebele, Mingechevir, Jalilabad-Elikomektepe, Gebele-Galayeri, and Yardimli-Arvana. The ESR and TL methods were employed to ascertain the age of the samples obtained from the aforementioned sites.

Keywords: dating, ESR, TL, Azerbaijan, archeology, radiocarbon

INTRODUCTION

Radiocarbon (^{14}C) dating is a fundamental technique used to identify the age of carbon-bearing materials up to about approximately 40,000-50,000 years [1]. However, its application to oil, a substance formed from ancient organic material millions of years old, presents unique challenges and opportunities [2–10]. This paper discusses the applications of ^{14}C dating related to the analysis of samples up-taking carbon from various periods in Azerbaijan. We have collected samples from the monuments of Polutepe, Shomutepe, Goytepe, Pahsatepe, Boyukdash-Anazaga, Burugtepe, Alkhantepe, Gebele-Selbir, Uzun Reme in Azerbaijan. Thermoluminescence (TL) dating and Electron Spin Resonance (ESR) dating are both methods used to date minerals and artifacts based on their exposure to radiation. While they share some similarities, they operate on different principles and are suited to different types of materials and dating ranges. Here's a comparison of both methods. TL dating is useful for artifacts and sites where the material has been exposed to heat or sunlight, while ESR dating excels in dating fossil teeth and marine deposits over much longer time spans. Both methods (Table 1) contribute significantly to archaeology, geology, and understanding human evolution [1]. The objective of this study was to enhance the precision of ESR and TL dating of archaeological monuments in Azerbaijan [2–10]. The artefacts were gathered from a range of archaeological locations and their chronological age was established. This process provides valuable information on the sequence of events at different locations, helping to construct a broader understanding of historical or prehistoric activities across various sites.



Table 1.

Comparison of TL and ESR Dating

Aspect	Thermoluminescence (TL) Dating	Electron Spin Resonance (ESR) Dating
Principle	Measures light emitted during heating to release trapped electrons	Measures trapped electrons based on their magnetic resonance
Materials	Ceramics, heated rocks, sediments	Tooth enamel, shells, quartz, corals
Age Range	Up to ~500,000 years	100,000 to 5 million years
Clock Reset	Last heating or exposure to sunlight	Initial formation or last exposure to sunlight
Accuracy	Can be less precise than ESR for older samples	Suitable for dating much older samples, including fossils
Applications	Archaeology, ancient pottery, and sediments	Paleoanthropology, dating human fossils and ancient teeth

Table 1 shows the comparison of TL and ESR dating methods.

MATERIAL AND METHODS

The benzene synthesis line for radiocarbon dating from the sample's original state to benzene is schematically described [11–16]. As many laboratories we also use silica-alumina catalysts for the cyclization of acetylene to benzene. The catalyst can be readily reactivated by heating in air at 570°C, which causes the oxidation of the Cr(III) and Cr(IV) to Cr(VI).

The assumption in carbon-14 dating is that the analyzed sample has undergone only radioactive decay within the years since it ceased interaction with the biosphere. However, the archaeological artifacts and geological specimens are usually found embedded in or contaminated by other carbon-containing materials, which affect the carbon-14 content of samples. The reliability of the dating of old charcoal samples depends on the chemical treatment of the sample to remove any external ¹⁴C while leaving reliable fractions for dating. Charcoal samples of 25 grams were treated by an acid-alkali-acid (AAA) pretreatment [17–21] method after removal of visible contaminants. The concentration of the acid (HCl) and alkali (NaOH) -0.5% .

Benzene production was carried out by the following reactions:

- $2C + 2Li = Li_2C_2$
- $Li_2C_2 + H_2O = C_2H_2 + Li_2O$
- $3C_2H_2 = C_6H_6$

In order to remove possible ammonia compounds, acetylene is passed through phosphoric acid. A chromium activated alumina-silica catalyst was used for conversion of acetylene to benzene at room temperature. Benzene was then evaporated out of the catalyst at 120°C and collected in a vacuum at liquid nitrogen temperature. The synthesized benzene [22–26] was transferred into 20 ml low-potassium glass counting vials and increased to 3 ml volume by adding petroleum-derived benzene. As a scintillation solution, 1 ml of commercially available SIGMA-ALDRICH liquid scintillation mixture PPO/POPOP in toluene was added. The counting vial was then be transferred into the liquid scintillation analyzer Tri-Carb 3100TR and allowed to count for a period of 300 to 1000 minutes depending on the size, age, and precision requirements. Radiocarbon dating by TriCarb 3100TR is a well-established absolute dating technique widely used in different areas of research for the analysis of a wide range of organic materials. Precision levels of the order of 0.2–0.3% in the measured age are nowadays achieved while several international intercomparison exercises have shown the high degree of reproducibility of the results.

The following diagram illustrates the configuration of the vacuum line employed in the synthesis of benzene. The benzene synthesis proceeds from left to right (Figure 1).

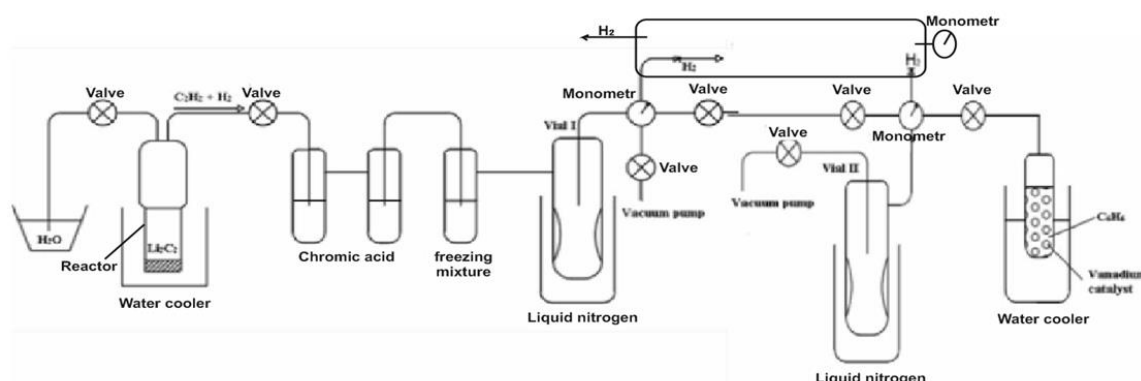


Fig. 1. Vacuum line employed in the synthesis of benzene

The charcoal was converted with 95% efficiency to carbide by the reaction (a) in the reactor. Reaction proceeded readily at 700C for 15 min. and then the temperature was raised to 900C. At a final temperature of 900C the production of carbide [27–32] was completed. After that, the hydrolysis of the lithium carbide was carried out in the reactor, which was running water-cooled, by feeding distilled water at a rate of about 100ml/min. It proceeded with a quantitative yield according to reaction (b). The excess lithium always reacts with the evolution of hydrogen gas, which is not needing in our procedure.

The gases which develop from the hydrolysis reaction are passed through the following group of traps. The first of the two traps on the right of the reactor which are consist of chromic acid are for keeping the excess gases. In the third trap, which is cooled with a freezing mixture consisting of acetone and dry ice, gases are almost completely dried. Passing through these following three traps, the acetylene is perfectly dried and can be ready for condens in the following “cold finger”, which is liquid nitrogen-cooled. At that point, the hydrogen gas, which is cannot freeze at the temperature of “cold finger”, is pumped with vacuum pump [33].

An alternative approach to the dating of ancient artefacts is electron spin resonance (ESR) analysis, which permits the imposition of a longer time limit than is possible with traditional radiocarbon dating. The capacity to identify paramagnetic centres in materials as ancient as 1×10^6 years, due to their extended mean life (approximately 1×10^8 years), offers significant potential for addressing a number of issues in geology, archaeology, and paleoanthropology [1]. Moreover, the ESR method can be employed as a supplementary technique for cross-referencing and/or verifying the results of the radiocarbon dating method. The foundation of ESR dating is the realization that certain materials, particularly dental enamel with its extended lifespan, generate paramagnetic centers when subjected to natural ionizing radiation. The sample preparation and ESR measurement procedures were conducted in accordance with established standard techniques (Figure 2). As illustrated in the accompanying illustration, the enamel was initially removed from the teeth using a dental drill and water cooling.

The 2-3 mm mean thickness enamel was then placed in a 30% NaOH solution for one day to disinfect it and separate any remaining dentine [2–10]. A dental drill was used to strip around 55 ± 5 μm from inside and outside of the enamel surface to ensure that alpha radiation had no effect. In total 1.2 gr. enamel was collected and it was air-dried at room temperature for three days.

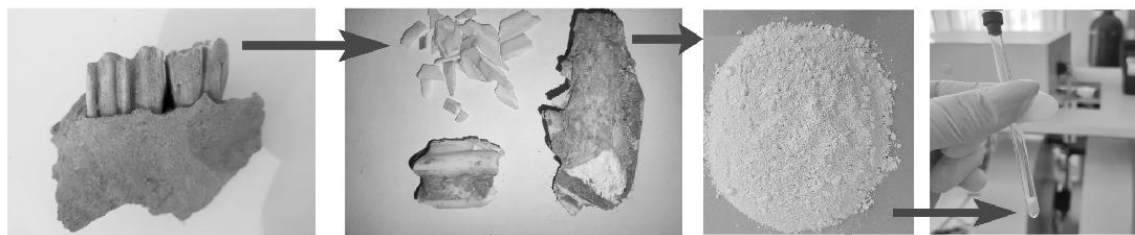


Fig. 2. Tooth sample preparation for ESR dating

Enamel powder was divided into six equal parts and each aliquot was placed inside glass tubes (Suprasil) for irradiation [11–16]. This area is designated for the preparation of samples, which are processed under controlled lighting conditions. The physical preparation area is equipped with the requisite materials for the optimal treatment of the samples prior to chemical preparation, including saws, dentist's drills, agate mortars, sieves, mills, hot plates, scales, and a magnetic separator, among other items [17–21]. The chemical preparation area has fume hoods along with all other laboratory material necessary for acid attacks or the separation of minerals through dense liquids.

Conversely, the Quartz inclusion method is utilized for the purpose of TL dating. The Harshaw TLD 3500 Manual Reader is employed for the measurement of TL characteristics of samples. The dose rate of the ^{60}Co source was determined by the Magnostech Miniscope MS400 EPR Spectrometer using individually wrapped, barcode-labeled BioMax Alanine Dosimeter Films (developed by Eastman Kodak Company) [22–26]. The irradiated samples were weighed to 5 ± 0.5 mg and read out after one day in an N_2 atmosphere in a Harshaw 3500 manual reader using the linear heating rate of 5°C/s .

In order to determine the natural dose rate soil samples were collected in close proximity to the pottery sample. Uranium, Thorium and Potassium concentrations in soil were measured by gamma spectrometry Canberra GR4520 which has a low-level gamma spectrometry [27–32] system with 15 cm lead shielding and high-resolution GeHP hyper-pure germanium detector [33], having 43.5% resolution efficiency for 661.6 keV. Dose rates and age calculations were conducted using the online DRAC version 1.2.

RESULTS AND DISCUSSION

Table 2 shows the results of the C-14 measurements of the monuments in Azerbaijan. Calibration results was calculated with 68% and 95% probability (0=1950).

Radiocarbon dating was performed on charcoal samples collected from nine archaeological sites. Calibrated dates span a wide chronological range (Table 1), confirming long-term habitation across different cultural phases (Table 2):

Neolithic and Early Chalcolithic (7th–5th millennia BC): Goytepe (7746 ± 88 BP; 6646–6476 cal BC) and Shomutepe (5801 ± 96 BP; 4783–4542 cal BC) confirm early farming and sedentism. Polutepe samples (6220 ± 85 BP and 6380 ± 99 BP) and Pahsatepe (6704 ± 88 BP) align with intensive Chalcolithic occupation.

Late Chalcolithic to Early Bronze Age: Burugtepe (6888 ± 31 BP) and Alkhantepe (5079 ± 29 BP) fall within this transitional phase. Upper Paleolithic: Boyukdash-Anazaga yielded the oldest radiocarbon age (12644 ± 210 BP; 13413–12514 cal BC), indicating early human presence during the terminal Paleolithic. Iron Age and Historical Periods: Uzun Reme (3390 ± 26 BP; 1732–1631 cal BC) corresponds to the Late Bronze–Early Iron Age. Gebele-Selbir (1105 ± 11 BP; 899–988 cal AD) represents early medieval activity.

Dose rates and age calculation results of TL and ESR measurements are illustrated (Table 3) as follow.



Table 2.

Ages of various monuments in Azerbaijan

Sample name	¹⁴ C age (BP)	± error	Cal BC(68%) 1-sigma	CalBC(95%) 2-sigma	Material
Polutepe (sample 1)	6220	85	5303 – 5052	5364-4951	charcoal
Polutepe (sample 2)	6380	99	5473 – 5224	5531-5069	charcoal
Shomutepe	5801	96	4783-4542	4901-4446	charcoal
Goytepe	7746	88	6646 – 6476	6906-6422	charcoal
Pahsatepe	6704	88	5713-5556	5749-5477	charcoal
Boyukdash-Anazaga	12644	210	13413-12514	13681-12210	charcoal
Burugtepe	6888	31	5796-5726	5877-5714	charcoal
Alkhantepe	5079	29	3952-3805	3959-3796	charcoal
Gebele-Selbir	1105	11	899-988	893-993	charcoal
Uzun Reme	3390	26	1732-1631	1750-1613	charcoal

Table 3 shows the results of the TL and ESR dating measurements of the monuments in Azerbaijan.

TL dating was conducted on ceramic artifacts and fired soil from 11 sites, producing ages ranging from ~15,000 BP to ~2,200 BP (Table 3):

Upper Paleolithic: Gobustan-Anazaga (15013±1324 BP) confirmed very early human activity, matching nearby radiocarbon results. Chalcolithic to Bronze Age (8th–3rd millennia BC): Sites such as Fuzuli-Leletepe (7919±455 BP), Agstafa-Hesensu (7913±324 BP), Jalilabad-Pashatepe (7826±513 BP), Ismayilbeytepe (6908±117 BP), and Jalilabad-Polutepe (6400±530 BP) showed strong consistency, suggesting widespread Chalcolithic settlement. Gobustan-Boyukdash (6835±383 BP) and Kichikdash (5655±233 BP) further support long-term cultural continuity. Late Periods: Chukur-Gebele (2230±510 BP) reflects Iron Age to historical occupation based on dating of a ceramic water pipe.

The TL dates strongly correlate with the C-14 chronology, especially at sites like Polutepe and Boyukdash, enhancing confidence in the results.

ESR dating was applied to 18 samples, including tooth enamel, deer antler, and mollusc shells. The results demonstrate a wide chronological range, offering additional insights into occupational phases: Chalcolithic and Early Bronze Age (8th–3rd millennia BC): Polutepe samples (7421±130, 7774±129, 7960±146 BP), Agstafa-Hesensu (8432±416 BP), Berde-Emirli-3 (7937±258 BP), and Khudutepe (8225±123 BP) confirm consistent early occupation across the region.

Table 3.

TL and ESR Ages of various monuments in Azerbaijan

Sample name	TL age (BP) ± error	Material
Jalilabad-Polutepe	6400±530	Ceramic
Fuzuli-Leletepe	7919 ± 455	Ceramic
Ismayilbeytepe	6908 ± 117	Ceramic
Agstafa-Hesensu	7913 ± 324	Ceramic
Berde-Emirli-3	8189 ± 850	Ceramic
Jalilabad-Pashatepe	7826 ± 513	Ceramic
Gobustan-Anazaga	15013 ± 1324	Fired soil
Gobustan-Boyukdash	6835 ± 383	Ceramic
Gobustan-Kichikdash	5655 ± 233	Ceramic
Jalilabad-Khudutepe	7116 ± 343	Ceramic
Chukur-Gebele	2230±510	Ceramic water pipe
Sample name	ESR age (BP) ± error	Material
Jalilabad-Polutepe (sample 1)	7421±130	Tooth
Jalilabad-Polutepe (sample 2)	7774±129	Tooth
Jalilabad-Polutepe (sample 3)	7960±146	Tooth
Agstafa-Hesensu	8432±416	Tooth
Berde-Emirli-3	7937±258	Tooth
Gobustan-Boyukdash	1894±97	Tooth
Gobustan-Boyukdash	14402±267	Mollusc shell
Gobustan-Kichikdash	2620±304	Tooth
Gobustan-Kichikdash	4233±364	Deer antler
Jalilabad-Khudutepe	8225±123	Tooth
Chukur-Gebele	2550 ± 200	Tooth
Mingechevir	275800 ± 10390	Tooth
Jalilabad-Elikomektepe (sample 1)	5959±122	Tooth
Jalilabad-Elikomektepe (sample 2)	5782±118	Tooth
Gebele-Galayeri	5514± 124	Tooth
Yardimli-Komani	4775±664	Tooth
Yardimli-Saribulag	5356±199	Tooth

Bronze to Iron Age: Elikomektepe (5959±122 and 5782±118 BP), Galayeri (5514±124 BP), and Komani (4775±664 BP) support continued settlement into the later Bronze and early Iron Age. Multiple Phases at Gobustan Sites: Gobustan-Boyukdash shows two very different ESR ages: a relatively recent 1894±97 BP (tooth) and an ancient 14402±267 BP (mollusc shell), indicating long-term or stratigraphically complex occupation. Gobustan-Kichikdash likewise reflects multiple use phases with a 2620±304 BP (tooth) and 4233±364 BP (deer antler). Historical and Early Medieval Periods: Chukur-Gebele (2550±200 BP) aligns with Iron Age occupation. Pleistocene Occupation: The most surprising result comes from Mingechevir, where a tooth sample yielded an ESR age of



275,800±10,390 BP. This suggests a much earlier, possibly Middle Pleistocene occupation. While requiring further validation, it opens new possibilities for early hominin presence in the region.

CONCLUSION

This study successfully applied a multi-method dating approach—Radiocarbon (C-14), Thermoluminescence (TL), and Electron Spin Resonance (ESR)—to establish a comprehensive and reliable chronological framework for key archaeological sites across Azerbaijan. The integration of these scientific methods allowed for the cross-validation of results and revealed a long sequence of human occupation, ranging from the Upper Paleolithic to the early medieval period.

Radiocarbon dating of charcoal samples confirmed continuous habitation during the Neolithic and Chalcolithic periods, particularly at sites such as Goytepe, Shomutepe, and Polutepe. TL dating of ceramics further supported these findings, while ESR dating of teeth and other materials expanded the chronological range and confirmed activity during the Bronze and Iron Ages.

Significantly, some ESR and TL results—especially from Mingchevir and Gobustan—suggest much earlier, potentially Pleistocene, human presence in the region. These findings underscore the archaeological richness of Azerbaijan and highlight the importance of continued excavation, sample contextualization, and advanced dating analysis.

Overall, the study demonstrates the effectiveness of combining radiometric and luminescence dating techniques in archaeological research. It provides a solid foundation for understanding the cultural development and settlement patterns of ancient populations in the South Caucasus and opens new possibilities for exploring deeper prehistoric layers in future investigations.

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AZƏRBAYCAN ƏRAZİSİNDƏ YERLƏŞƏN ARXEOLÖJİ ABİDƏLƏRİN RADIOKARBON, EPR VƏ TL METODLARLA TARİXLƏNDİRİLMƏSİ

A.S. Əhədova

Təqdim olunan iş Azərbaycan Respublikası ərazisində yerləşən arxeoloji abidələrin C-14 metodu ilə mütləq tarixləndirilməsinə əsaslanır. C-14 ölçmələri üçün müxtəlif ərazilərdən (Polutəpə, Şomutəpə, Göytəpə, Pəhsətəpə, Böyükdaş-Anazağa, Buruqtəpə, Alxantəpə, Qəbələ Səlbir, Uzun Rəmə kömür nümunələri toplanmışdır. Hesablayıcı flakon Tri-Carb 3100TR Maye Sintilyasiya Analizatoruna yerləşdirildi və ölçüdə və dəqiqlik tələblərindən asılı olaraq 300 ilə 1000 dəqiqə arasında dəyişən müddət ərzində hesablandı. Toluolda 1 ml SIGMA-ALDRICH PPO/POPOP maye sintillyasiya qarışığı (kokteyl) sintilasiya məhlulu kimi əlavə edildi. Bu tədqiqatda Azərbaycanda arxeoloji ərazilərdən alınan kömür nümunələrinin yaşını təyin etmək üçün radiokarbon tarixləndirmə üsulundan istifadə edilmişdir. Kalibrəmə nəticələri 68% və 95% (0=1950) ehtimalı ilə hesablanmışdır. Digər tərəfdən, Azərbaycanda arxeoloji abidələrin ESR və TL tarixləndirmə üsulları ilə də mütləq yaşları tədqiq olunmuşdur. Dış və saxsı nümunələri aşağıdakı arxeoloji ərazilərdən toplanmışdır: Cəlilabad-Polutəpə, Füzuli-Lələtəpə, İsmayılbəytəpə, Ağstafa-Hesensu, Bərdə-Əmirli-3, Cəlilabad-Paşatəpə, Qobustan-Anazağa, Qobustan-Böyükdaş, Qobustan-Kiçikdaş- Xudutəpə, Çukur-Gəbələ, Mingəçevir, Cəlilabad-Elikoməktəpə, Qəbələ-Qalayeri və Yardımlı-Arvana. Yuxarıda qeyd olunan yerlərdən alınan nümunələrin yaşını təyin etmək üçün ESR və TL metodlarından istifadə edilmişdir.

Açar sözlər: tarixləndirmə, EPR, TL, Azərbaycan, arxeologiya, radiokarbon

ДАТИРОВАНИЕ АРХЕОЛОГИЧЕСКИХ ПАМЯТНИКОВ АЗЕРБАЙДЖАНА С ПОМОЩЬЮ РАДИОУГЛЕРОДНОЕ ЭСР И ТЕРМОЛЮМИНИСЕНТА

A.C. Ахадова

Представленная работа была попыткой повысить точность датирования археологических памятников Азербайджанской Республики по методу C-14. Образцы древесного угля были собраны из различных мест (Полутепе, Шомутепе, Гейтепе, Пахсатепе, Беюкдаш-Аназага, Буругтепе, Алхантепе, Гебеле-Сельбир, Уzun Реме) для измерений C-14. Счетный флакон был помещен в жидкостный сцинтилляционный анализатор Tri-Carb 3100TR и оставлен для подсчета в течение периода от 300 до 1000 минут в зависимости от размера, возраста и требований к точности. В качестве сцинтилляционного раствора был добавлен 1 мл коммерчески доступной жидкостной сцинтилляционной смеси SIGMA-ALDRICH PPO/POPOP в толуоле. В этом исследовании метод радиоуглеродного датирования был использован для датирования возраста образцов древесного угля из археологических памятников Азербайджана. Результаты калибровки были рассчитаны с вероятностью 68% и 95% (0=1950). Другой целью данного исследования было повышение точности датирования археологических памятников Азербайджана методами ESR и TL. Образцы зубов и керамики были собраны со следующих археологических памятников: Джалилабад-Полутепе, Физули-Лелетепе, Исмаилбейтепе, Агстафа-Хесенсу, Берде-Эмирли-3, Джалилабад-Пашатепе, Гобустан-Аназага, Гобустан-Бёюкдаш, Гобустан-Кичикдаш, Джалилабад-Худутепе, Чукур-Гебеле, Мингечевир, Джалилабад-Эликомектепе, Гебеле-Галаери и Ярдымлы-Арвана. Методы ESR и TL были использованы для определения возраста образцов, полученных с вышеупомянутых памятников.

Ключевые слова: датирование, ЭСР, ТЛ, Азербайджан, археология, радиоуглерод.



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COMPARATIVE ANALYSIS OF THE MECHANICAL PROPERTIES OF CLAY- AND CARBON BLACK-REINFORCED HNBR VULCANIZATES OBTAINED BY THERMAL AND THERMO-RADIATION VULCANIZATION

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This study investigates the mechanical and thermal properties of clay- and carbon black-reinforced hydrogenated nitrile butadiene rubber (HNBR) vulcanizates prepared by thermal and thermo-radiation vulcanization. The effects of different irradiation doses (100, 200, 300, and 400 kGy) on the crosslink density, gel content, swelling, and mechanical properties were analyzed. The results show that radiation vulcanization significantly improves the crosslinking efficiency, with 300 kGy being the optimal dose. Carbon black-filled samples exhibit higher mechanical strength, lower swelling, and better thermal stability compared to clay-containing samples due to improved network formation. Thermogravimetric analysis (TGA) confirms that radiation vulcanization shifts the onset of thermal degradation to higher temperatures, especially at 300 kGy, while excess irradiation at 400 kGy leads to degradation of the structure at lower temperatures. Fourier transform infrared spectroscopy (FTIR) further reveals the molecular changes induced by radiation. The results highlight the importance of filler type and radiation dose selection to optimize the properties of HNBR elastomers in high-performance applications.

Keywords: HNBR, radiation, clay, carbon black, cross-linking, rheology, vulcanization

INTRODUCTION

Hydrogenated nitrile rubber (HNBR), introduced by Bayer in the early 1980s, is widely known for its high resistance to heat, oils, ozone, and chemicals, even under extreme operating conditions and can be formulated with varying acrylonitrile contents and degrees of hydrogenation. Due to its rich polymer structure and highly polar acrylonitrile groups, HNBR vulcanizates can be reinforced with traditional fillers, similar to other synthetic elastomers [1-5]. Reinforcing fillers are aimed to enhance mechanical, thermal, and physical properties.

Organic-inorganic hybrid vulcanizates have significant potential for the development of new materials due to their ability to combine the unique properties of both organic and inorganic compo-



nents at the nanoscale. These materials often exhibit synergistic improvements in physical and chemical properties, making them desirable in a variety of industrial applications [6-8].

Nanocomposites based on elastomers and layered silicates have attracted considerable attention from both academia and industry, as even a small amount of nanofiller can significantly improve the physicochemical properties of the material compared to traditional microscale composites [9-12]. The high-performance characteristics of elastomer-clay composites are due not only to the uniform distribution of clay particles in the matrix, but also to the strong interaction between the polymer molecules and the silicate layers. To enhance this interaction, various cationic surfactants with functional groups are used that modify the clay through ion-exchange reactions.

Modifications of the physicochemical properties of polymers by radiation largely depend on the interaction of the radiation with the specific polymer [13-18]. The two main effects of radiation on polymers are excitation and ionization, which lead to competing processes such as chain scission and cross-linking, depending on the chemical structure of the polymer. Various tests have been conducted to analyze the effects of ionizing radiation on polymers. From a practical and economic point of view, it is important to optimize the radiation dose to achieve the desired properties of elastomers.

With the advancement of nanotechnology, the incorporation of nanofillers such as clay and carbon black into hydrogenated nitrile butadiene rubber (HNBR) has emerged as a promising strategy for developing high-performance elastomeric materials. These materials are particularly relevant for demanding industries like automotive and aerospace, where excellent heat resistance and long service life are essential. Despite the potential of clay as a sustainable and cost-effective filler, its impact on the mechanical properties and aging behavior of HNBR, especially under aggressive environmental conditions, remains insufficiently explored. This study aims to evaluate whether the inclusion of organoclay can enhance HNBR's resistance to mechanical stress, using comprehensive characterization techniques. Unlike previous research [19] that mainly focused on different crosslinking agents, this work specifically investigates the influence of 2,4-dimethylphenylmaleimide (DMFM) and sulfur as crosslinking agents.

The primary objective is to compare the mechanical and thermal properties of HNBR vulcanizates reinforced with carbon black and clay, prepared by thermal and thermo-radiation vulcanization. To assess the effects of filler type and vulcanization method, the samples were subjected to varying radiation doses (100, 200, 300, and 400 kGy). Key parameters such as crosslink density, gel content, and tensile properties were analyzed to determine optimal processing conditions for the development of durable, high-performance elastomers.

EXPERIMENTAL PART

MATERIAL AND METHODS

The composition of the studied elastomer mixtures is presented in Table 1. The main component, HNBR 3606, an acrylonitrile (ACN) and 1,3-butadiene copolymer with an ACN content of 36.5%, a Mooney viscosity ML at 100 °C of 66 and an iodine number of 8.8 mg/100 mg was obtained from Alfa-FTOR LLC. It is an analog of Zetpol 2000 L and Therban 3406.

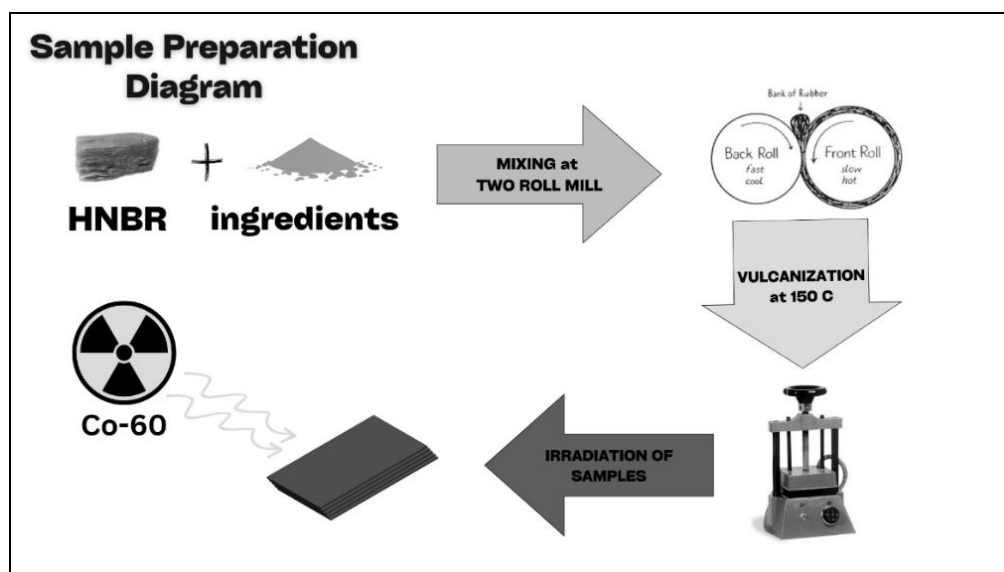


Fig. 1. Flowchart diagram illustrating the sample preparation

An elastomer mixture based on HNBR was produced on laboratory rollers in sheet form with thickness of 2 mm. The thermal vulcanization process was carried out at 150 °C for 20 minutes. Radiation vulcanization was carried out on a Co⁶⁰ γ-radiation source at a dose rate of 140.126 Gy/s in an air environment at 20 °C. The absorbed dose in the studied samples was calculated by comparing the electron densities of the studied and dosimetric systems. Radiation-thermal vulcanizates were obtained by preheating in an electric press (Technoflux vulcanizing press) at 150 °C for 5 minutes and then materials are exposed to 100, 200, 300 and 400 kGy doses of radiation. Fig.1 shows the sample preparation process diagram including all steps.

Table 1.

Composition of HNBR based elastomer mixtures

Composition	Content in the mixture, parts by weight			
	Thermal		Thermo-radiation	
HNBR	100	100	100	100
Stearic acid	3,0	3,0	3,0	3,0
DMFM	1,0	1,0	1,0	1,0
Zinc oxide	5,0	5,0	5,0	5,0
Sulphur	2,0	2,0	1,0	1,0
Carbon black	-	30,0	-	30,0
P 324	30,0	-	30,0	-
Clay	-	-	-	-

Weight examination of vulcanizates

Impact of the high temperatures and synthetic oil on the weight changes was investigated and samples were prepared in rectangular form with 25 mm in length, 25 mm in width, and 2 mm in thickness. Samples were exposed to synthetic motor oil (10W-40) for 60 days and weight changes over time were tracked by electronic microbalance. Only thermally vulcanized samples are used in this part of study [20-22].

After exposure, the samples were taken out of the oil at chosen intervals. Their surfaces were thoroughly cleaned with analytic alcohol to eliminate any residual oil and then dried at room



temperature before measuring weight changes. The percentage increase in weight (WI) was determined using Equation (1):

$$WI = (W_2 - W_1) / W_1 \times 100 \quad (1)$$

where W_1 represents the initial weight of the specimen in air, and W_2 is the weight of the specimen after aging in air.

Calculation of cross-linking density by sol-gel analysis in an organic solvent (Flory-Rehner)

The Flory-Rehner [23] equation was used to determine the crosslinking density of the compounds. Each sample, approximately 0.25 ± 0.05 g, was weighed and immersed in toluene, where they were kept in the dark for five days or until equilibrium swelling was reached. After removal, the samples were dried to remove excess solvent and reweighed. They were then placed in an oven at 80°C for 24 hours and weighed again. Using these weight values, the crosslinking density was calculated based on the Flory-Rehner equation (Equation 2). The following parameters were used in the calculations: molar volume of toluene (V_0) – $106.4 \text{ cm}^3/\text{mol}$ and Flory-Huggins interaction parameter (χ) – $0.39.17$

$$\nu = \frac{-(\ln(1 - V_r) + V_r + \chi V_r^2)}{\rho_0 V_0 (V_r^{\frac{1}{3}} - \frac{V_r}{2})} \quad (2)$$

Where: ν : Cross-linked density (mol cm^{-3}); V_0 : molar volume of the solvent; V_r : rubber volume fraction of the swollen form; χ : polymer-solvent interaction parameter (Flory parameter); ρ_r : rubber density.

Study of pre-vulcanization properties

Pre-vulcanization characteristics of elastomer samples were also investigated by Mooney viscometer according to ASTM D1646-19a standard [24]. Scorch time and cure rate was obtained from analysis and results are discussed later in result section.

Determination of gel content

The gel content was determined by the following method [25-28]. A 0.2 g specimen was accurately cut and weighed. Then, sample added to flask with 50 mL of toluene inside and placed magnetic stirrer and stirred in the dark for 24 hours until samples weight stabilized. Further, gel-containing solution was filtered through 400-mesh stainless steel filter bag. Then residue remaining on filter was weighed with filter bag, and the gel content was found by following equation Eq. (3):

$$\text{Gelcontent} / \% = \frac{(M_2 - M_0) \bullet 100}{M_1} \% \quad (3)$$

where M_0 , M_1 , and M_2 are the weights of filter bag, the sample and dried residue with the filter bag, respectively. Analysis was carried out twice and the average value was taken.

Tensile strength and compressive residual stress test

In order to investigate tensile and tear properties of the materials, all test are done using Liyi 1000N Universal Tensile Testing Machine (Dongguan Liyi Environmental Technology Co., Ltd.) with tensile rate of 500 mm min^{-1} . Samples were cut according to ISO 37 type 2 (thickness = 2.0 mm) and dimensions [29] shown in Fig.2. For each material two identical specimens were prepared

and tests were performed twice. Stress at elongation (300 %), tensile strength and elongation at break were also recorded.

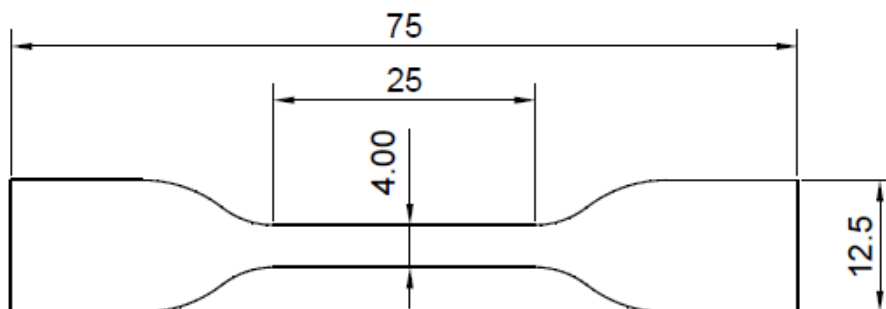


Fig. 2. Specimen geometry and dimensions

Thermogravimetric analysis (TGA)

TGA was performed using a “PerkinElmer” STA 6000 device and samples were heated from room temperature to 600 °C. During the process, system was filled with argon gas to prevent combustion of the samples [30, 31]. The heating rate was 10 °C/min.

FTIR spectra of vulcanizates

Fourier Transform Infrared (FTIR) spectra were acquired using VARIAN 640-IR FTIR spectrophotometer. Changes in the molecular structures of HNBR after vulcanization and irradiation were assessed by spectroscopy. The spectra were recorded in the range of 650–4000 cm^{-1} . The interpretation of the spectra was performed on the basis of correlation tables and recommendations contained in the manual on the physical and mechanical properties of radiation vulcanized materials, in accordance with the existing literature [32–35].

RESULTS AND DISCUSSION

Weight change examination after swelling

Analysis of mass change due to swelling in motor oil highlights the influence of filler type and vulcanization method on oil absorption in HNBR vulcanizates. According to results in table 2. thermally vulcanized samples (0 kGy) showed higher oil absorption in clay vulcanizates (13.9%) compared to carbon black vulcanizates (12.5%) due to the porous, hydrophilic nature of the clay. Carbon black, being a reinforcing material, forms a denser network, which limits oil penetration.

Swelling generally decreased with increasing radiation dose (100–400 kGy) due to improved cross-linking. The lowest mass change was recorded at 300 kGy, 8.2% for clay vulcanizates and 5.3% for carbon black vulcanizates, indicating optimum oil resistance. However, at 400 kGy, a slight increase in swelling was observed, indicating possible chain scission and microcracks occurred on the surface of the samples at a dose of 400 kGy, which may also affect their properties.

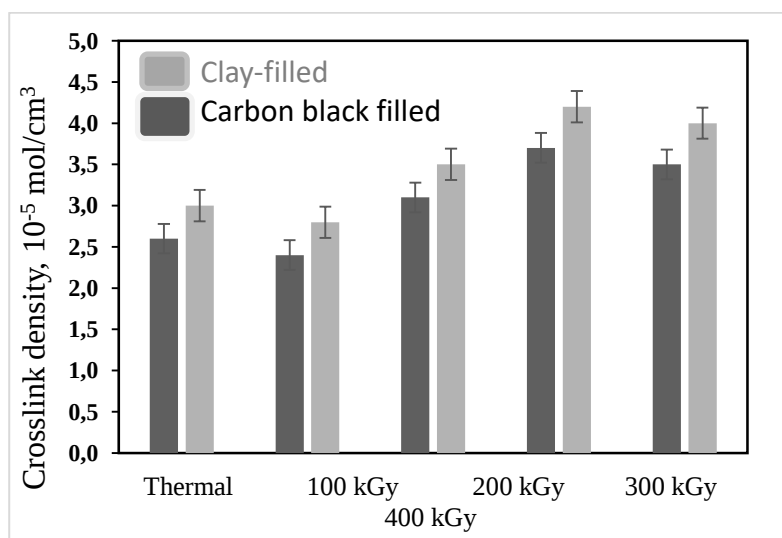
Overall, the carbon black-based vulcanizates showed better oil resistance due to a denser network, while the clay-based samples remained more susceptible to swelling. The best balance between cross-linking and swelling resistance was achieved at 300 kGy.

Table 2.
Swelling Behavior of HNBR Vulcanizates – Weight Change Over Time

Samples	Doses (kGy)	1 day	3 days	5 days	1 week	4 weeks
HNBR/Clay	0(thermal)	5.4	7.5	9.5	11.1	13.9
	100	4.5	6.2	7.8	9.2	11.5
	200	3.8	5.5	6.8	8	9.8
	300	3.2	4.8	5.8	6.7	8.2
	400	3.5	5.2	6.2	7	8.5
HNBR/Carbon black	0(thermal)	4.9	6.8	8.2	10.3	12.5
	100	3.5	4.8	5.8	6.8	8.5
	200	3.3	4.2	5.3	7.1	10.8
	300	2.4	3	3.8	4.5	5.3
	400	2.7	3.4	4.3	5	6

Crosslink density

The crosslink density of the HNBR vulcanizates varied depending on the filler type and vulcanization method, with carbon black-containing samples showing higher values than clay-filled samples. In thermally vulcanized samples, the crosslink density of HNBR with carbon black ($3.0 \times 10^{-5} \text{ mol/cm}^3$) was higher than that of HNBR with clay ($2.6 \times 10^{-5} \text{ mol/cm}^3$), indicating a more pronounced reinforcing effect. After irradiation, the crosslinking density initially decreased at 100 kGy but then increased with increasing dose, reaching maximum values at 300 kGy ($4.2 \times 10^{-5} \text{ mol/cm}^3$ for carbon black and $3.7 \times 10^{-5} \text{ mol/cm}^3$ for clay), indicating optimal formation of the crosslinked structure. A slight decrease was observed at 400 kGy, probably due to the scission of polymer chains during over irradiation. These results mentioned in fig. 3 confirm that radiation curing improves the crosslinking efficiency, with 300 kGy being the most optimal dose, and carbon black remains a more effective filler, providing a denser and more interconnected polymer network compared to clay.


Fig. 3. Crosslink density of HNBR vulcanizates filled with clay and carbon black at various radiation doses

Gel content

The gel content of the HNBR vulcanizates showed a similar tendency with a crosslink density, while the samples filled with technical carbon exhibited higher values compared to samples containing clay. In thermally vulcanized materials, the gel content in HNBR with technical carbon was 65%, while in clay-filled HNBR this indicator was slightly lower - 63%. With radiation irradiation, the gel content increased with dose, reaching the maximum values at 300 kGy (81% for technical carbon and 78% for clay), which indicates the optimal formation of the network structure. However, at 400 kGy there was a slight decrease (79% for technical carbon and 75% for clay), which indicates a possible partial degradation of the network structure due to excessive irradiation. These results (fig. 4) confirm that radiation vulcanization significantly increases the crosslinking efficiency, while the dose of 300 kGy provides the best balance between the formation of the network and the stability of the structure. Carbon black remains more effective filler that provides stronger vulcanized structure compared to clay.

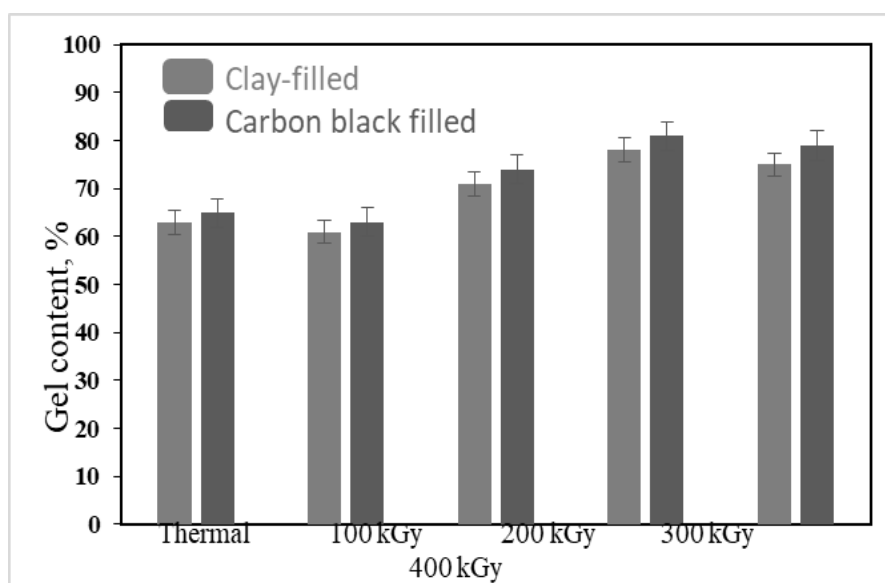


Fig. 4. Gel content (%) of HNBR vulcanizates with clay and carbon black as a function of radiation dose

Pre-vulcanization properties

It can be seen from obtained results which shown in table 3, exposure to the irradiation reduces the vulcanization time for both elastomer mixtures. Generation of the free radicals during the irradiation, which accelerate crosslinking process and enhances overall vulcanization efficiency. Moreover, it is observed that clay-filled HNBR samples require a longer time to fully compared to carbon black-filled samples.

This suggest that the interaction between the clay particles and the polymer matrix slows down the crosslinking reaction. Carbon black, however, demonstrates a noticeable effect, yielding shorter vulcanization times compared to clay, likely due to its higher surface area and better dispersion within the rubber matrix. This optimizes crosslinking efficiency by facilitating the generation of free radicals and improving the interaction between the filler and rubber, which ultimately accelerates the vulcanization process.

Table 3.

Influence of the fillers on the vulcanization process during heating and irradiation exposure
by Mooney viscometer at 150°C

Samples	Doses (kGy)	τ_5 (min)	$\tau_{35}-\tau_5$ (min)
HNBR/Clay	0(thermal)	5.6	8.2
	100	5.3	8.0
	200	5.1	7.6
	300	4.8	7.3
	400	4.5	7.0
HNBR/Carbon black	0(thermal)	5.4	7.8
	100	5.1	7.5
	200	4.8	7.1
	300	4.5	6.9
	400	4.3	6.6

Tensile Testing

The mechanical properties of the samples are also investigated and the results are mentioned in fig. 5. As it can be seen from the results, tensile strength increases with the increasing radiation dose, but elongation at break decreases due to crosslinking. It is obvious that radiation-induced crosslinking in the polymer matrix results in a significant increase in tensile strength (TS) at doses up to 300 kGy, optimum dose. Radiation can either promote chemical crosslinking between polymer molecules or cause chain scission and degradation, which destroys the molecular structure. Although both processes occur simultaneously during irradiation, at higher radiation doses chain scission becomes more pronounced. Thus, at 400 kGy slight decline is noticed due to over-irradiation. The findings indicate the superior performance of the carbon black over clay in enhancing the mechanical properties of HNBR vulcanizates.

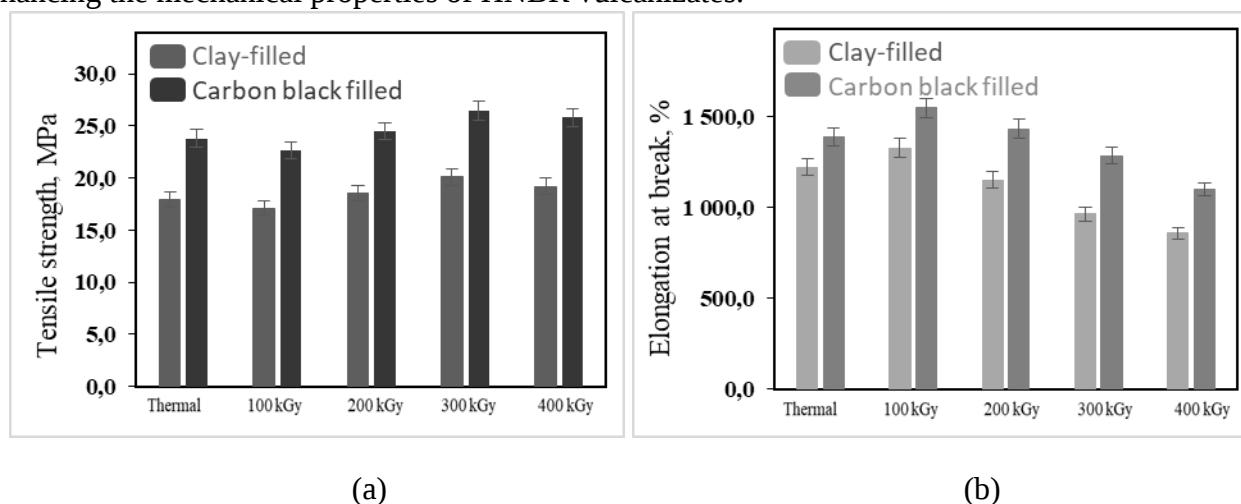


Fig. 5. (a) Tensile strengths and (b) elongation at break of HNBR vulcanizates with clay and carbon black at different radiation doses

Effect of absorbed dose on thermal stability of HNBR vulcanizates

Thermogravimetric analysis (TGA) shows the thermal degradation characteristics of carbon black- and clay-filled HNBR elastomers. Both materials undergo a multi-stage degradation process, with the most significant weight loss observed in the temperature range between 350–500°C. According to the results (Figure 6), clay-filled samples show a higher residual weight, which is explained by the presence of inorganic components that are resistant to combustion. In contrast, carbon black contributes to improved thermal stability by promoting char formation. Radiation vulcanization improves the thermal stability of elastomers by shifting the onset of degradation to higher temperatures, with 300 kGy proving to be the most effective dose. However, at 400 kGy no significant improvement is observed, likely due to the saturation of crosslinking processes and possible degradation caused by excessive irradiation. Carbon black filled HNBR samples have higher thermal stability than clay filled samples, confirming its more pronounced strengthening effect.

Thus, the conducted study shows that radiation vulcanization, especially at 300 kGy, improves the thermal stability of HNBR elastomers, with carbon black providing a more significant improvement compared to clay. These results highlight the importance of filler type and vulcanization method selection in optimizing the thermal performance of HNBR composites.

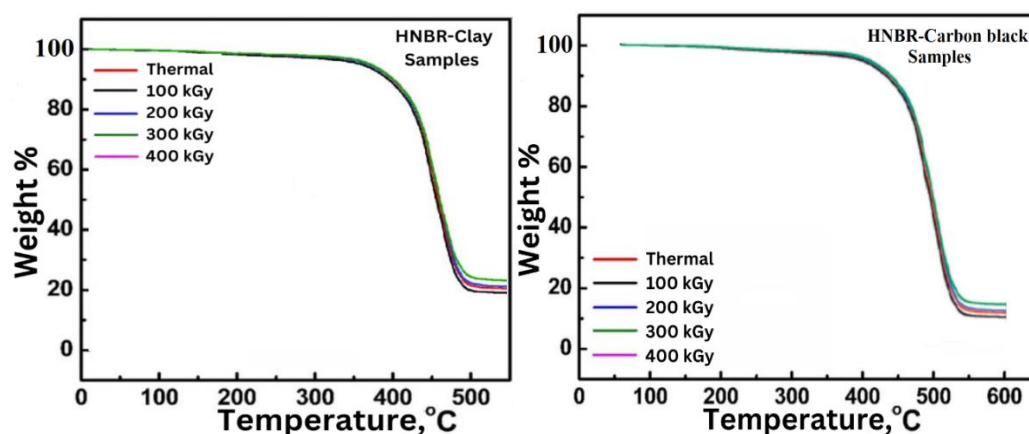


Fig. 6. TGA curve for clay filled (a) and carbon black filled HNBR vulcanizates showing weight loss (%) with increasing temperature (°C)

Fourier transforms infrared (FT-IR) spectroscopy

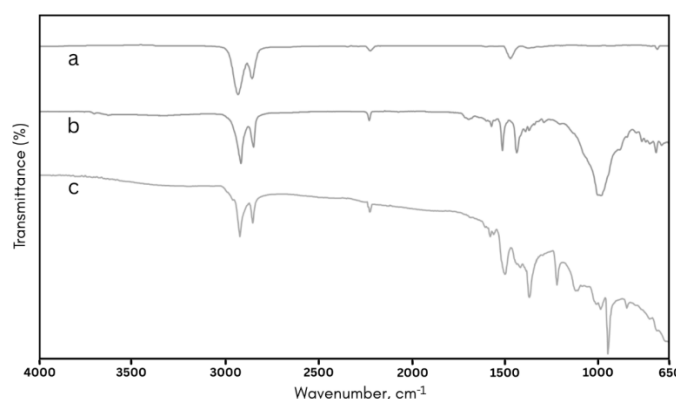


Fig. 7. FTIR spectra of (a) raw hydrogenated nitrile butadiene rubber (HNBR), (b) clay-filled HNBR vulcanizate and (c) carbon black-filled HNBR vulcanizate irradiated at 300 kGy

According to the results shown in fig. 7, FTIR analysis of raw hydrogenated nitrile butadiene rubber (HNBR), as well as thermo-radiation vulcanized HNBR filled with clay and carbon black at 300 kGy, reveals significant structural modifications induced by filler incorporation and the combined effects of thermal and radiation vulcanization. The spectrum of raw HNBR is characterized by absorption bands at 722 cm^{-1} , 1460 cm^{-1} , 2236 cm^{-1} , 2860 cm^{-1} and 2928 cm^{-1} , which correspond to the CH_2 rocking, CH_2 bending, the stretching vibration of nitrile group ($\text{C}\equiv\text{N}$) and the stretching vibration of C-H of aliphatic groups, respectively, confirming its fundamental molecular structure. In the clay-filled vulcanizate, the appearance of a distinct band at 1013 cm^{-1} , associated with the stretching vibrations of the Si-O bond in bentonite clay, indicates the presence of a silicate filler, while a slight shift of the CH_2 deformation vibration band to 1463 cm^{-1} and the appearance of new bands at 1538 cm^{-1} (characteristic of carboxylate COO^- stretching vibrations, likely resulting from oxidative processes during vulcanization) and 1596 cm^{-1} hydrogen bonding interactions between the electron-deficient nitrile groups of HNBR and surface hydroxyl functionalities of the clay. Moreover, the retention of the absorption band of nitrile groups at 2236 cm^{-1} , along with small shifts in the region of C-H stretching vibrations (2850 cm^{-1} , 2917 cm^{-1}), indicates that, despite the interaction of the polymer with the filler, significant degradation of the polymer backbone does not occur. In contrast, the spectrum of the vulcanizate filled with carbon black shows characteristic absorption bands at 872 cm^{-1} , 971 cm^{-1} , 1010 cm^{-1} , 1142 cm^{-1} and 1241 cm^{-1} , which correspond to C-H wagging, stretching of aromatic C-C bonds and surface oxidation functionalities of carbon black, confirming its successful distribution in the polymer matrix. Furthermore, the presence of bands at 1515 cm^{-1} and 1595 cm^{-1} indicates specific interactions between the polymer chains and the carbon species, probably related to π - π stacking or dipole interactions. A slight shift of the nitrile stretching band to 2232 cm^{-1} and small changes in the C-H stretching region (2848 cm^{-1} , 2916 cm^{-1}) suggest that carbon black affects the local electronic environment of the polymer chains, potentially increasing the crosslinking density and changing the chain mobility. These spectral changes confirm the efficient integration of both fillers into the HNBR matrix, indicating their influence on the chemical structure and intermolecular interactions of the vulcanized composites. The observed shifts and new vibrational bands provide valuable information on the influence of fillers on the crosslinking density and polymer-filler interactions, which further confirms the improved mechanical, thermal and anti-aging properties of vulcanizates.

CONCLUSION

This comprehensive study demonstrates that thermo-radiation vulcanization significantly enhances the mechanical, thermal, and swelling resistance properties of HNBR composites reinforced with clay and carbon black, with 300 kGy identified as the optimal radiation dose. Carbon black-filled vulcanizates showed superior performance, including higher tensile strength (26.5 MPa, peaking at 300 kGy), greater crosslink density ($4.2 \times 10^{-5}\text{ mol/cm}^3$), improved thermal stability (shifted degradation onset), and lower oil swelling (5.3% weight gain), attributed to carbon black's dense network formation and π - π interactions with the HNBR matrix. In contrast, clay-filled composites showed moderate reinforcement, with higher swelling susceptibility (8.2%) due to their hydrophilic nature, though they retained competitive thermal stability from inorganic silicate content. FTIR analysis confirmed effective filler integration, revealing polymer-filler interactions (e.g., hydrogen bonding with clay and π -stacking with carbon black) without backbone degradation. Notably, excessive radiation (400 kGy) induced chain scission, diminishing properties. These findings underscore the critical roles of filler type and radiation dose in optimizing HNBR vulcanizates for high-performance applications, with carbon black emerging as the preferred filler for demanding mechanical and thermal environments, while clay offers a viable alternative for cost-sensitive uses. Future work could explore hybrid filler systems to synergize their advantages.

**Key findings:**

- Optimal Dose: 300 kGy radiation maximizes crosslinking and properties.
- Filler Superiority: Carbon black outperforms clay in mechanical strength, thermal stability, and oil resistance.
- Mechanisms: FTIR reveals interfacial interactions (hydrogen bonding, π -stacking) drive performance enhancements.
- Limitation: Excessive radiation (400 kGy) degrades the polymer network.

This study provides a foundational framework for advancing radiation-vulcanized elastomers in high-performance industries.

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TERMİKİ VƏ TERMO-RADİASIYA ÜSULU İLƏ VULKANLAŞMIŞ, GİL VƏ TEXNİKİ KARBON İLƏ DOLDURULMUŞ HBNK ELASTOMERLƏRİNİN MEXANİKİ XÜSUSİY-YƏTLƏRİNİN MÜQAYİSƏLİ ANALİZİ

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Bu tədqiqatda, termiki və termo-radiasiya üsulu ilə vulkanlaşmış, gil və texniki karbon ilə doldurulmuş hidrogenləşmiş butadien nitril kauçuku (HBNK) vulkanizatlarının mexaniki və termal xüsusiyyətlərini araşdırılmışdır. Müxtəlif şüalanma dozalarının (100, 200, 300 və 400 kGy) cərgəli əlaqələrin sıxlığına, gel fraksiyanın miqdarına, şişmə dərəcəsinə və mexaniki xüsusiyyətlərə təsiri təhlil edilmişdir. Nəticələr göstərir ki, ionlaşdırıcı şüaların təsiri ilə vulkanlaşma tikilmə prosesinin effektivliyini əhəmiyyətli dərəcədə artırır və 300 kGy optimal doza kimi müəyyən olunur. Texniki karbon ilə doldurulmuş nümunələr, şəbəkə quruluşunun daha yaxşı formalaşması nəticəsində, gil tərkibli nümunələrlə müqayisədə daha yüksək mexaniki möhkəmlik, daha az şişmə və daha yaxşı termal sabitlik nümayiş etdirir. Termogravimetrik analiz (TQA) göstərir ki, radiasiya ilə vulkanlaşma, xüsusilə 300 kGy dozada, termal parçalanmanın başlanğıc temperaturunu daha yüksək səviyyəyə çəkir, lakin 400 kGy kimi artıq dozalar strukturun daha aşağı temperaturlarda parçalanmasına səbəb olur. Fourier transform infraqırmızı spektroskopiyası (FTIR) isə radiasiyanın səbəb olduğu molekulyar dəyişiklikləri aşkar edir. Nəticələr göstərir ki, HBNK elastomerlərinin yüksək keyfiyyətli tətbiqləri üçün doldurucu növü və radiasiya dozasının düzgün seçilməsi mühüm əhəmiyyət kəsb edir.

Açar sözlər: HBNK, radiasiya, gil, texniki karbon, tikilmə, reologiya, vulkanlaşma



СРАВНИТЕЛЬНЫЙ АНАЛИЗ МЕХАНИЧЕСКИХ СВОЙСТВ ВУЛКАНИЗАТОВ ГБНК, НАПОЛНЕННЫХ ГЛИНОЙ И ТЕХНИЧЕСКИМ УГЛЕРОДОМ, ПОЛУЧЕННЫХ МЕТОДОМ ТЕРМИЧЕСКОЙ И ТЕРМО-РАДИАЦИОННОЙ ВУЛКАНИЗАЦИИ

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В данном исследовании изучаются механические и термические свойства вулканизатов на основе гидрированного бутадиен-нитрильного каучука (ГБНК), наполненных глиной и техническим углеродом, полученных методом термической и термо-радиационной вулканизации. Проанализировано влияние различных доз облучения (100, 200, 300 и 400 кГр) на плотность сшивки, гелевое содержание, степень набухания и механические свойства. Результаты показали, что радиационная вулканизация значительно повышает эффективность сшивания, при этом оптимальной дозой является 300 кГр. Образцы, наполненные техническим углеродом, демонстрируют более высокую механическую прочность, меньшую степень набухания и лучшую термическую стабильность по сравнению с образцами, содержащими глину, благодаря более совершенному формированию структуры. Термогравиметрический анализ (ТГА) подтверждает, что радиационная вулканизация смещает начало термического разложения к более высоким температурам, особенно при 300 кГр, в то время как избыток облучения при 400 кГр приводит к разложению структуры при более низких температурах. Дополнительно, ИК-спектроскопия выявляет молекулярные изменения, вызванные облучением. Полученные результаты подчёркивают важность подбора типа наполнителя и дозы радиации для оптимизации свойств эластомеров на основе ГБНК в условиях высоких нагрузок.

Ключевые слова: *ГБНК, радиация, глина, технический углерод, сшивание, реология, вулканизация*



EARTH SCIENCES





THE STUDY OF LANDSLIDES IN THE NAKHCHIVAN AUTONOMOUS REPUBLIC BASED ON THE STATISTICAL FREQUENCY RATIO METHOD

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A methodological approach has been developed for the geospatial analysis of landslide resilience in the Nakhchivan Autonomous Republic using satellite and ground-based data. Within this methodology, the systematic mapping and assessment of various factors determining landslide susceptibility, including slope steepness, slope aspect, elevation zones, river basins, and vegetation index, have been carried out. As a result of the study, it was found that the territory of the autonomous republic falls within the main active landslide zones. The high risk of landslides in these zones poses a potential threat to the region's infrastructure and population. The analysis emphasizes the importance of developing appropriate strategic measures and monitoring systems to reduce the likelihood of landslide occurrences. Thus, the obtained results provide essential information for enhancing safety measures in the Nakhchivan Autonomous Republic.

Keywords: Satellite images, Landsat 9, ASTER radiometry, statistical frequency ratio, pixel classes

INTRODUCTION

Satellite images have been actively used in the study of landslides since the 1990s. Satellite imagery data is used both for the identification and mapping of landslides, as well as for the monitoring and analysis of the dynamics of landslide objects and processes. Recently, landslide monitoring has been conducted in the radio range of satellite imagery, as radar interferometry allows for the detection of the relief structure of the Earth's surface. Currently, satellite images in both visible (optical) and radio ranges are a vital source of data for landslide detection [3, 6, 10-11].

A landslide is a hazardous natural event that occurs when a mass of soil and layered rocks detaches due to erosion and moves down a slope under the influence of gravity [11]. Landslides are among the most dangerous natural disasters worldwide, often resulting in significant economic damage and loss of human lives [3, 6]. In the Nakhchivan Autonomous Republic, especially in the northern mountainous regions, landslides sometimes lead to human casualties and material losses. Geological and geomorphological features, the density of river basins, and anthropogenic factors can all influence the occurrence and activation of landslides. To minimize the damage caused by landslides, studying the factors that drive landslide processes and landslide susceptibility remains a relevant issue [7, 12].

The purpose of the present study is to determine landslide susceptibility in areas of the Nakhchivan Autonomous Republic that are active landslide zones and to develop landslide susceptibility maps for these regions. Experience shows that landslide processes are statistically associated with several factors. As a result, when analyzing landslide susceptibility, statistical approaches are most commonly used. To assess landslide susceptibility and create maps of potential landslide development, we used the Frequency Ratio (FR) method and the Landslide Susceptibility Mapping (LSM) approach [3, 7]. A landslide susceptibility map is the process of determining and classifying the spatial distribution of land units according to their susceptibility to landslides.



STUDY AREA

The Nakhchivan Autonomous Republic is located in an isolated region in the southwestern part of the country. Two-thirds of its territory consists of mountainous areas with elevations above 1000 meters. The main part of the autonomous republic is made up of the Lesser Caucasus mountain ranges and their mid- and low-altitude branches, stretching toward the Araz River valley (Figure 1).

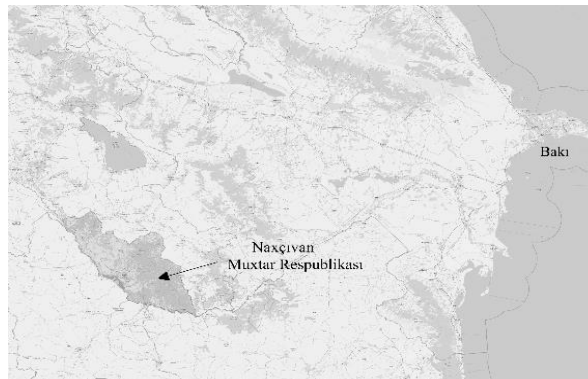


Fig. 1. Nakhchivan Autonomous Republic

The climate of the autonomous republic is predominantly dry and sharply continental. The absolute minimum temperature is -31°C (Dərvişlər), and the absolute maximum temperature is $+44^{\circ}\text{C}$ (Culfa). The climate conditions in the mountainous and high mountainous areas (northern part) differ significantly from those in the lowland areas, mainly along the Araz River [7]. This sharp contrast in natural and climatic conditions is also reflected in the vegetation cover. The region exhibits deserts and semi-deserts, steppe vegetation, mountain meadows and steppes, subalpine and alpine meadows, forests (in patches), oases, and small forests along riverbanks [12].

MATERIAL AND METHODS

The study of landslide processes utilizes satellite and sub-satellite (subspace) complex data, as described below. Complex satellite and sub-satellite data are currently used for environmental monitoring research. Satellite and sub-satellite data complement each other [8]. Such data allow for the reliable and rapid detection of landslide locations and provide detailed insights into their characteristics [2, 5].

The satellite materials for landslide detection consist of data obtained from multispectral and radar studies. The initial satellite multispectral data are raw, unprocessed data. Processed digital satellite images are used to address thematic issues such as remote sensing of landslide locations. Multispectral images obtained from the Landsat 9 satellite were used to assess the normalized NDVI (Normalized Difference Vegetation Index). The accuracy of these images has been enhanced by utilizing panchromatic channel images. The calculation of NDVI from Landsat 9 images is based on the comparison of radiation absorption by plants in channel 5 and radiation reflection in channel 4 [4]. To obtain satellite data on the structure of the relief, radar imagery distributed in GeoTIFF format in the WGS84 coordinate system from NASA's Terra satellite's ASTER radiometer was used [9, 10].

The statistical frequency ratio method is a simple and useful model for assessing landslide susceptibility. This approach is based on observed relationships between the factors associated with landslide distribution. In the study area, this method allows for determining the connection between the locations where landslides occur and the factors that cause them. According to the frequency ratio method, each causative factor is divided into several classes. Based on satellite images, landslide susceptibility is calculated using the following formula [3, 6]:



$$FR_i = \frac{S_i/P_i}{S/P}, \quad (10)$$

Here, FR_i – frequency ratios;

S_i – the number of landslide points (pixels) in class;

P_i – the number of points (pixels) in class;

$S = \sum S_i$ – the total number of landslide points (pixels) on the map of the study area;

$P = \sum P_i$ – the total number of points (pixels) on the map of the study area.

The landslide susceptibility index is calculated using equation (10) by summing the frequency ratio values of the classes of each factor:

$$LSI = \sum_1^n FR_i, \quad (11)$$

Here, LSI – landslide susceptibility index.

RESULTS AND DISCUSSION

The main objective of the frequency ratio methodology is to create a landslide susceptibility map. The mapping of slope process manifestations can be accomplished by interpreting multispectral images obtained through both field studies and remote sensing. In the territory of the Nakhchivan Autonomous Republic, it seems appropriate to use the following geospatial data to draw an electronic digital landslide map:

- Slope steepness,
- Slope aspect,
- Elevation zones,
- River basins,
- Vegetation index.

The results of landslide formation using the frequency ratio method are presented in map form in Figure 2 and summarized in the table below. The types of landslides depicted in Figure 2 were identified through years of field research. The mapping of slope steepness, slope aspect, elevation zones, and river basin factors was conducted using the global digital elevation model (GDEM) from the Terra satellite's ASTER radiometer (with spatial resolution capable of 1 arc second, approximately 30 meters horizontally) [1]. The mapping of the normalized vegetation index was based on Landsat 9 satellite data.

In Figure 2, the cartographic data is divided into five classes: Class 1 - very low, Class 2 - low, Class 3 - moderate, Class 4 - high, Class 5 - very high risk indicators. Class 4.5 corresponds to the active zone depicted in the first image of Figure 2. As practical results indicate, when the FR value exceeds 1.0, there is a stronger correlation between landslide frequency and landslide susceptibility factors. Conversely, when the FR value is less than 1.0, it suggests a weaker relationship between landslide frequency and the landslide factors [6, 9].

As shown in the cartographic data in Figure 2, the territory of the Nakhchivan Autonomous Republic is located in a potential zone for landslide development, except for a very narrow flat foothill zone extending from east to west (shown as Class 1 in the table). The mountainous and foothill areas, which constitute the main part of the republic, are subject to high landslide processes. Remote sensing methods provide reliable and timely information about the distribution of local landslides in these areas.

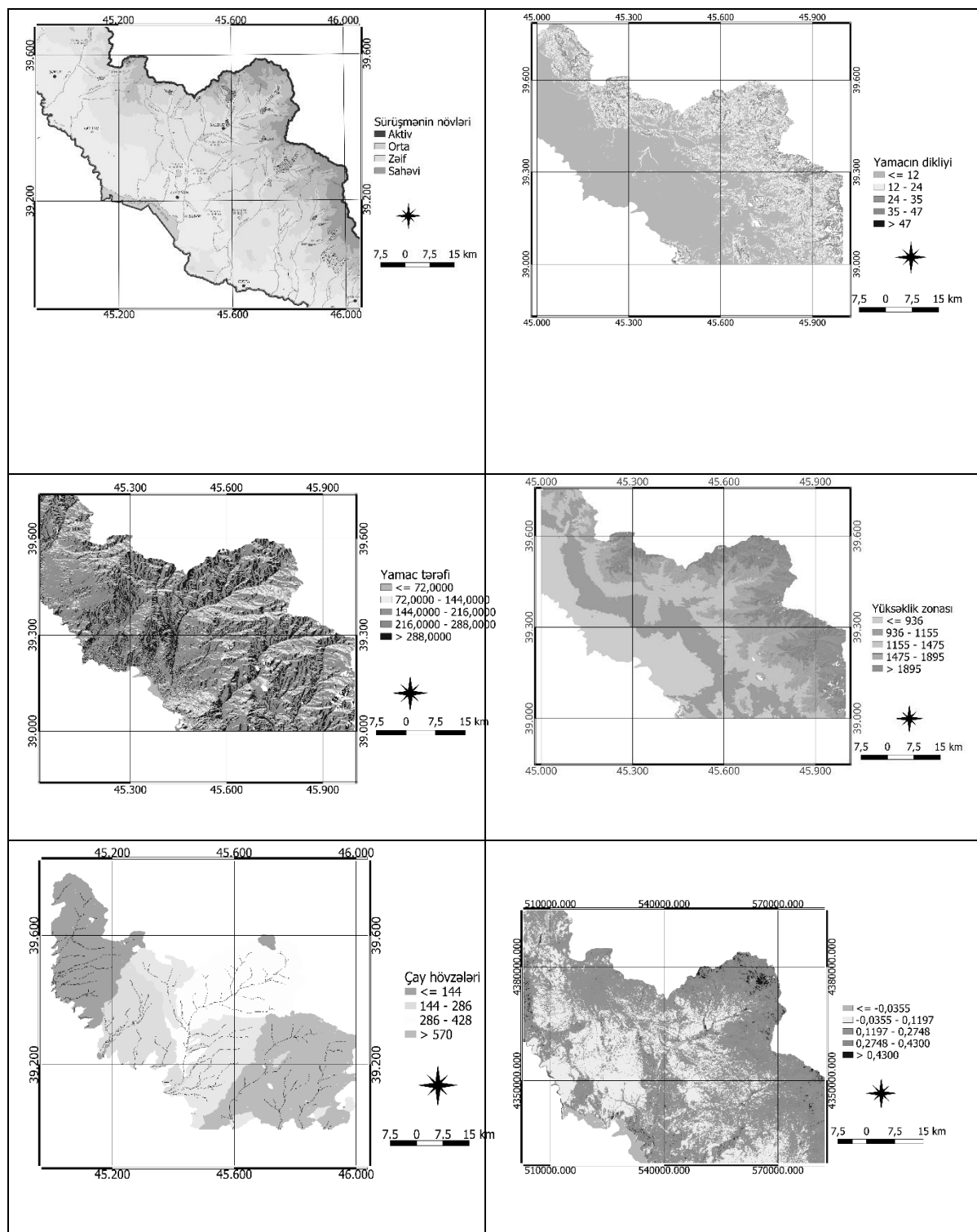


Fig. 2. Results of mapping the factors contributing to landslide formation

**Table**

Results of calculations using the frequency ratio method for factors contributing to landslide formation

Slope steepness, angle in degrees.					
Pixel classes	P_i	S_i	$\sum P_i$	$\sum S_i$	FR_i
<= 12	376000	4615	722300	12782	0.6936
12-24	180000	3640			1.1427
24-35	86000	2829			1.8589
35-47	59000	1048			1.0038
>=47	21300	650			1.7245
Slope aspects, angle in degrees (from north direction)					
Pixel classes	P_i	S_i	$\sum P_i$	$\sum S_i$	FR_i
<= 72	4900	1760	33664	13067	0.9254
72-144	5040	3622			1.8514
144-216	9360	3749			1.0319
216-288	12240	2874			0.6049
>=288	2124	1062			1.2881
Elevation zones, (m)					
Pixel classes	P_i	S_i	$\sum P_i$	$\sum S_i$	FR_i
<= 935	105000	4708	292710	17118	0.7667
936-1155	79310	4128			0.8900
1155-1475	49500	3453			1.1928
1475-1895	35000	2819			1.3772
>=1895	23900	2010			1.438
River basins, (km^2)					
Pixel classes	P_i	S_i	$\sum P_i$	$\sum S_i$	FR_i
<= 144	43200	3100	142600	14111	0.7252
144-286	28400	2642			0.9401
286-428	42600	4755			1.1280
>=570	28400	3614			1.2860
Vegetation index (NDVI)					
			$\sum$	$\sum$	
Pixel classes	P_i	S_i	$\sum P_i$	$\sum S_i$	FR_i
<=-0,355	5000	450	267500	73328	0.3283
-0,355-0,1197	85000	30901			1.3262
0,1197-0,2748	142500	29115			0.7453
0,2748-0,4300	22000	11962			1.9835
>=0,4300	13000	900			0.2526

CONCLUSION

The issue of landslide processes is particularly relevant for the Nakhchivan Autonomous Republic. Based on the potential for the development of landslide processes, zoning of the autonomous republic's territory, assessment of landslide hazard, and operational warning based on satellite data are urgent matters. In this regard, the current study investigates the distribution and classification of



local landslide areas in the Nakhchivan Autonomous Republic, the mapping of landslide factors, and landslide susceptibility using satellite and ground-based complex data.

In the study area, cartographic data are divided into five classes based on the degree of landslide potential: very low, low, moderate, high, and very high. The high mountainous, mountainous, and foothill areas, which constitute the main part of the republic's territory, fall into active landslide zones.

The results of the conducted research are crucial for assessing landslide hazards and determining landslide risks in the studied area. The findings can be utilized to evaluate landslide potential in various regions of the Nakhchivan Autonomous Republic.

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NAXÇIVAN MUXTAR RESPUBLİKASI ƏRAZISİNDƏ SÜRÜŞMƏLƏRİN STATİSTİK TEZLİK NİSBƏTİ METODU ƏSASINDA TƏDQIQI

Q.H. Qurbanov

Peyk və yerüstü məlumatlardan istifadə edərək Naxçıvan Muxtar Respublikasında sürüşməyə davamlılığın geoməkan analizi üçün metodoloji yanaşma hazırlanmışdır. Bu metodologiya çərçivəsində, sürüşməyə həssaslığı müəyyən edən müxtəlif amillərin, o cümlədən səth yamacının dikliyi, yamacın baxarlığı, yüksəkliklər zonası, çay hövzələri və bitki örtüyünün indeksi,



sistemli şəkildə xəritələşdirilməsi və qiymətləndirilməsi həyata keçirilmişdir. Tədqiqat nəticəsində, muxtar respublikanın ərazisinin əsas aktiv sürüşmə zonalarına daxil olduğu məlum olmuşdur. Bu zonalarda sürüşmə riskinin yüksək olması, regionda infrastruktur və əhali üçün potensial təhlükə yaradır. Analiz, sürüşmə hadisələrinin baş vermə ehtimalını azaltmaq üçün müvafiq strateji tədbirlərin və monitoring sistemlərinin inkişaf etdirilməsinin vacibliyini vurğulayır. Beləliklə, əldə edilən nəticələr Naxçıvan Muxtar Respublikasında təhlükəsizlik tədbirlərinin artırılması üçün zəruri məlumatlar təqdim edir.

Açar sözlər. *Peyk şəkilləri, landsat 9, ASTER radiometri, statistik tezlik nisbəti, piksel sinifləri.*

ИЗУЧЕНИЕ ОПОЛЗНЕЙ В НАХЧИВАНСКОЙ АВТОНОМНОЙ РЕСПУБЛИКЕ НА ОСНОВЕ МЕТОДА СТАТИСТИЧЕСКОГО ОТНОШЕНИЯ ЧАСТОТНОСТИ

Г.Х. Гурбанов

Разработан методический подход для геопространственного анализа устойчивости к оползням в Нахчыванской Автономной Республике с использованием спутниковых и наземных данных. В рамках этой методологии проведено систематическое картографирование и оценка различных факторов, определяющих склонность к оползням, включая крутизну склонов, экспозицию склонов, зоны высот, речные бассейны и индекс растительности. В результате исследования было установлено, что территория автономной республики входит в основные зоны активных оползней. Высокий риск оползней в этих зонах представляет собой потенциальную угрозу инфраструктуре и населению региона. Анализ подчеркивает важность разработки соответствующих стратегических мер и систем мониторинга для снижения вероятности возникновения оползней. Таким образом, полученные результаты предоставляют важную информацию для улучшения мер безопасности в Нахчыванской Автономной Республике.

Ключевые слова: *спутниковые изображения, Landsat 9, радиометрия ASTER, статистическое частотное соотношение, классы пикселей.*



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ENVIRONMENTAL ASPECTS OF RADIONUCLIDE CONTAMINATION OF THE OKCHUCHAY TRANSIT RIVER IN THE REPUBLIC OF AZERBAIJAN

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Radionuclide contamination is becoming a significant environmental concern, especially in transboundary rivers such as the Okchuchay, which flows through the Republic of Azerbaijan and Armenia. This study evaluates the extent, sources, and impacts of radionuclide contamination in the Okchuchay River, focusing on cesium-137, strontium-90, uranium, and thorium. Extensive field sampling and analytical techniques reveal contamination levels posing serious risks to ecosystems and human health. The findings call for effective regulation, international cooperation, and innovative remediation strategies, including phytoremediation and advanced wastewater treatment. By synthesizing lessons from contamination cases such as Chernobyl and Fukushima, this study provides actionable recommendations for mitigating radionuclide pollution in the Okchuchay River and similar transboundary water systems.

Keywords: environment, ecological aspects, radionuclide contaminations, river ecosystem, Okchuchay.

INTRODUCTION

Radionuclide contamination is a major environmental issue with long-term effects on ecosystems and human health. This problem is particularly concerning in transboundary water systems where pollutants cross national borders, complicating remediation efforts. The Okchuchay River, a transit river in the Republic of Azerbaijan, has drawn increasing attention due to rising concerns about radionuclide contamination [20]. The Okchuchay River is vital for both Armenia and Azerbaijan, flowing through economically and ecologically important areas. However, its role as both a natural watercourse and an industrial waste conduit highlights the urgency of addressing pollution from upstream industrial activities. Specifically, Armenia's mining operations in Kapan and Kajaran release significant quantities of heavy metals and radionuclides into the river, threatening its ecological balance and the health of downstream communities [3-4]. This study explores the sources, impacts, and mitigation strategies for radionuclide contamination in the Okchuchay River, emphasizing the need for international cooperation and strict environmental policies [1].



Picture 1: Kapan region

Picture Source: news.am – "News Article 312482" [accessed from news.am/eng/news/312482.html]

Environmental aspects

The environmental impact of radionuclide contamination in the Okchuchay River is extensive, affecting aquatic ecosystems, soil health, and biodiversity [3, 21]. Extensive research indicates that the accumulation of radionuclides is strongly influenced by the physicochemical properties of water and sediments, which facilitate the binding of contaminants to fine particulates [11].

1. **Aquatic Ecosystems:** Radionuclides such as cesium-137 and strontium-90 accumulate in aquatic organisms, disrupting food chains and reducing biodiversity. Sediment-bound radionuclides degrade water quality, making the river uninhabitable for many species [6].
2. **Soil Contamination:** Irrigation with contaminated water leads to radionuclide accumulation in agricultural soils, altering soil chemistry and reducing fertility. Long-lived radionuclides such as uranium remain in the soil, complicating land restoration [13].
3. **Cross-border Pollution:** The transboundary nature of the Okchuchay exacerbates environmental challenges, as contaminants released upstream Armenia impact downstream ecosystems and communities in Azerbaijan, requiring international intervention [8].
4. **Long-term Persistence:** Radionuclides persist in the environment for decades or even centuries, necessitating sustainable management strategies to minimize long-term damage [21].

Overview of the Okchuchay river

The Okchuchay River, also spelled Oxçuçay, is a tributary of the Aras River and flows through both Armenia and Azerbaijan. It originates from the Zangezur mountain range at Mount Kaputjugh at an elevation of 3,285 meters. The river spans a length of 85 kilometers and has a drainage basin of 1,140 square kilometers. Hydrologically, the river's flow is supported by snowmelt (46%), groundwater (44%), and rainfall (10%). The river experiences a very strong seasonal flow variation, with the highest flows occurring during spring and summer, accounting for more than 80% of the annual flow. On average, a river discharge of 8.90 cubic meters per second is measured.

In the Zangilan district of Azerbaijan, it plays a vital role in irrigation and in the supply of local water. Its ecological sustainability and economic potential have been highly compromised by industrial pollution coming from upstream (Picture 1). The stretch of the river in Armenia, referred to as the Voghji River, receives huge amounts of industrial wastes from mining and metallurgical industries.



Picture 2: The Okchuchay River

Picture Source: Aze.Media. "The Okchuchay River's Plight Amidst Cross-Border Pollution." Published February 21, 2024. Retrieved from <https://aze.media/the-okchuchay-rivers-plight-amidst-cross-border-pollution/>.

MATERIAL AND METHODS

With a view to study the extent and effects of radionuclide contamination in the Okchuchay River, some complex field samplings were performed, along with analytical methodologies. This section describes the strategy of sampling, laboratory analysis, and data interpretation techniques [14].



Study area and sampling

Water, sediment and biota were collected from multiple sites along the Okchuchay River (upstream, midstream and downstream segments) to assess spatial variation. Sampling was carried out in different seasons (e.g. spring and autumn) to capture hydrological differences. At each site, surface-water grab samples (~1–2 L) were collected in pre-cleaned, acid-washed polyethylene bottles. Sediment samples (~1 kg) were taken from the river bed (top ~0–10–20 cm) using a stainless-steel grab sampler. Selected biota (aquatic plants and/or fish) were also collected by netting or hand-picking, rinsed with deionized water, and stored in clean containers. Water samples were immediately filtered through 0.45 µm membrane filters and acidified to pH ≈2 (using concentrated HNO₃) to preserve dissolved radionuclides. Sediments were kept cool and biota samples were stored frozen during transport. GPS coordinates were recorded for each sampling point to enable spatial mapping.

Sample preparation

In the laboratory, water samples were mixed and aliquots were prepared for analysis. Sediment and biota samples were oven-dried (110°C) to constant weight. Large debris and stones were removed by sieving (stones >5 mm discarded). Dried sediments were gently disaggregated and ground (to ~0.5–2 mm particle size), then homogenized in an agate mortar. Aliquots of sediment (typically 200–300 g) and biological tissue were then ashed in a muffle furnace: the temperature was slowly raised to ~300 °C and held, then heated to 600 °C for several hours to remove organic matter. The ash was weighed and digested in acid as needed for radionuclide extraction. For example, ash or sediment powders were treated with concentrated HNO₃ (and HF when required) under reflux or microwave digestion. After digestion, samples were evaporated to near-dryness and reconstituted in appropriate dilute acid. Sub-samples of processed material were retained to determine moisture content and for repeat analyses. All sample containers and bottles had been pre-soaked in 5% HNO₃ and rinsed with ultra-pure water prior to use.

Analytical techniques

A combination of radiometric and spectrometric methods was used:

- **Gamma spectrometry (HPGe):** Gamma-emitting radionuclides (e.g. ¹³⁷Cs, ⁴⁰K, U/Th decay products) were measured using high-purity germanium (HPGe) detectors (coaxial, low-background) in a shielded counting chamber. Efficiency calibrations were performed with standard multi-nuclide sources in the same geometry as samples. Spectra were collected until the statistical uncertainty was <5%. This approach follows established practice.
- **Inductively Coupled Plasma Mass Spectrometry (ICP-MS):** Non-radioactive elements (and total U and Th concentrations) were determined by ICP-MS. An Agilent 7700 quadrupole ICP-MS (USA) was used under standard operating parameters (RF power ~1300 W, gas flows, etc.). Samples were introduced via a quartz nebulizer into an argon plasma. Multi-element calibration standards (NIST traceable) were run bracketing sample concentrations.
- **Alpha spectrometry:** Long-lived alpha emitters (e.g. ²³⁸U, ²³⁴U, ²³²Th, ²³⁰Th, ²¹⁰Po) were measured by alpha-particle spectrometry after radiochemical separation. For example, U/Th was separated by anion-exchange and micro-precipitated onto stainless steel disks, then counted in a vacuum alpha-spectrometer. The sample processing followed standard procedures (tracers added, coprecipitation, electrodeposition). Although no direct citation is given here, this method is routine for environmental U/Th analysis.
- **Liquid Scintillation Counting (LSC):** β-emitting radionuclides were measured by LSC. Tritium (³H) in water was determined by distilling a fraction of the acidified sample (preventing Rn or ¹⁴C carryover) and counting the collected fraction in scintillation cocktail. Strontium-90 (⁹⁰Sr) was analyzed by first separating Sr via a Sr-specific resin (e.g. Sr-Spec) after Ca-phosphate coprecipitation. The purified ⁹⁰Sr (and ⁹⁰Y daughter) was then

mixed with scintillator and counted. Calibration for LSC efficiency was done using ^3H and $^{90}\text{Sr}/^{90}\text{Y}$ standards.

- **Screening for gross α/β :** As recommended by WHO, an initial screening of gross alpha and beta activity was performed by evaporating aliquots of water on planchets and counting the residues (P-type Si(Li) detector for α , gas-flow counter for β). This allowed quick identification of samples exceeding WHO screening levels ($\alpha > 0.5 \text{ Bq/L}$, $\beta > 1 \text{ Bq/L}$).

Calibration and Quality Control

All instruments were calibrated against certified reference materials. For gamma spectrometry, energy calibration used mixed gamma sources and efficiency was checked using IAEA reference soils and water standards. For ICP-MS, calibration curves were generated from multi-element standards. Radiochemical yields were monitored by adding known tracer nuclides (e.g. ^{236}Pu , ^{242}Pu , ^{243}Am for actinide series; stable Sr carrier for ^{90}Sr) before chemical separation. System blanks, laboratory blanks and duplicate splits were analyzed with each batch to check for contamination or loss. Duplicate and triplicate analyses were routinely performed (especially for key samples) as part of QA/QC. Internal precision (replicates) was typically $< 5\text{--}10\%$. The accuracy was verified by analyzing certified reference materials (river water, sediment) and by inter-laboratory comparisons. All results were checked against international guidelines: for example, measured water concentrations were compared to WHO drinking-water reference levels. Quality assurance followed IAEA and WHO recommendations for radionuclide monitoring in the environment, including documentation of procedures and data quality.

Data analysis and mapping

Activity concentrations were decay- and background-corrected. Spatial distribution maps were created using GIS software to visualize trends along the river. Statistical analyses were performed using software (e.g. R or SPSS). One-way ANOVA (and non-parametric tests, as appropriate) tested for significant differences among sites and seasons (significance at $p < 0.05$). If data did not meet normality assumptions, Kruskal–Wallis tests were applied. Trends in radionuclide levels were evaluated both qualitatively and by regression analysis. Finally, all measured concentrations were interpreted against international safety standards (WHO Guidelines for Drinking Water Quality and IAEA criteria) to assess compliance and potential risk.

Sources and Causes of Contamination

The principal sources of radionuclide pollution of the Okchuchay River are mining operations in the Armenian regions of Kapan and Kajaran (Picture 2) [10, 11]. There are large-scale mining activities, particularly in the extraction of copper and molybdenum, with resultant huge masses of tailings and wastewater. Very often, these by-products contain radioactive substances like uranium, thorium, cesium-137, and strontium-90 [2]. Due to poor treatment and disposal methods, these contaminants find their way into the river ecosystem.

Other than the mining activities, natural processes make a large contribution to the dispersion of radionuclides [9]. Erosion, leaching, and sediment transportation during seasonal flooding encourage downstream dispersal of radioactive materials. These radionuclides tend to sorb onto fine particulate matter, which makes remediation processes difficult and prolongs environmental exposure time [18].

RESULTS AND DISCUSSION

Spatial and Temporal Distribution of Radionuclides

Field analysis along the Okchuchay River revealed a distinct spatial gradient in radionuclide concentrations. Upstream areas near Armenia showed relatively moderate contamination levels, while midstream and particularly downstream sites—especially those in Azerbaijan's Zangilan district—exhibited significantly higher levels of cesium-137 (^{137}Cs), strontium-90 (^{90}Sr), uranium (U), and thorium (Th) [11, 21]. This distribution aligns with the known industrial discharge zones in Kapan and Kajaran, Armenia, where heavy mining of copper and molybdenum takes place [2].



Seasonal monitoring showed radionuclide concentrations peaking during spring and early summer, coinciding with snowmelt and increased discharge [21]. These seasonal fluctuations promote mobilization of contaminated sediments and enhance downstream transport.

Radionuclide Behavior in Environmental Matrices

Each radionuclide exhibited specific environmental behavior depending on its chemical properties:

- **Water samples** had elevated levels of ^{137}Cs and ^{90}Sr at mid- and downstream sites, in some cases exceeding WHO safety thresholds [World Health Organization, 2021].
- **Sediments** were the primary sink for uranium and thorium due to their strong affinity for fine particles [20].
- **Biota**, such as fish and aquatic plants, accumulated ^{137}Cs and ^{90}Sr via trophic transfer, posing serious ecological and human health risks [12].

Similar behavior has been documented in post-accident river systems around Chernobyl and Fukushima, where radionuclides remained persistent in sediments and bioaccumulated in aquatic food chains [22].

Comparison to International Case Studies

A comparative analysis shows Okchuchay's contamination profile resembles Chernobyl and Fukushima in key aspects (table 1). While Okchuchay's radionuclide sources are industrial rather than nuclear, environmental consequences are comparable and warrant urgent mitigation [9].

Table 1.

Comparison of Radionuclide Impacts in Different Regions

Region	Primary Radionuclides	Key Impacts	Mitigation Strategies
Okchuchay	Cesium-137, Uranium	Loss of biodiversity, contaminated water	Advanced treatment, phytoremediation
Chernobyl	Cesium-137, Strontium-90	Soil contamination, health risks	Buffer zones, waste containment
Fukushima	Cesium-137, Iodine-131	Long-term agricultural impact	Soil washing, community engagement

Source: [21]; retrieved from Anthropocene, DOI: 10.1016/j.ancene.2013.07.001. Note: The information in this table is based on comparative studies of nuclear contamination events worldwide.

Ecological Impacts

The river's ecological integrity is under severe threat. Observed effects include:

Aquatic biodiversity collapse due to toxic concentrations (table 2) of ^{137}Cs , ^{90}Sr , and heavy metals [12, 21]

Disruption of food chains, especially among primary producers and consumers [5].

Sediment-bound contamination hotspots, which continue releasing radionuclides over time [18].

This mirrors conditions observed in the Dnieper and Danube Rivers, where fine sediments acted as long-term reservoirs for contamination [22].



Table 2.

Key Radionuclides in the Okchuchay River

Radionuclide	Source	Environmental Impact	Health Risks
Cesium-137	Mining tailings, industrial waste	Bioaccumulates in aquatic organisms	Increases cancer risk, genetic mutations
Strontium-90	Mining, soil erosion	Binds to sediments, affects soil fertility	Accumulates in bones, causes leukemia
Uranium	Mining activities	Contaminates groundwater	Kidney damage, carcinogenic
Thorium	Industrial discharge	Persistent in soil and water systems	Carcinogenic

Note: The data presented in this table are based on environmental monitoring reports and scientific studies conducted in the Okchuchay River region.

Source: [21]; retrieved from the PANGAEA dataset (<https://doi.org/10.1594/PANGAEA.928594>) .

Agricultural and Human Health Risks

The use of contaminated Okchuchay water for irrigation introduces radionuclides into agricultural soils, from which they can be taken up by crops (table 2) [15]:

- **Uranium and thorium** disrupt soil microbial balance, reducing fertility [11].
- **⁹⁰Sr**, being chemically similar to calcium, accumulates in human bone tissue, increasing the risk of leukemia [22].
- **¹³⁷Cs**, similar to potassium, concentrates in muscles and organs, raising soft tissue cancer risks [23].

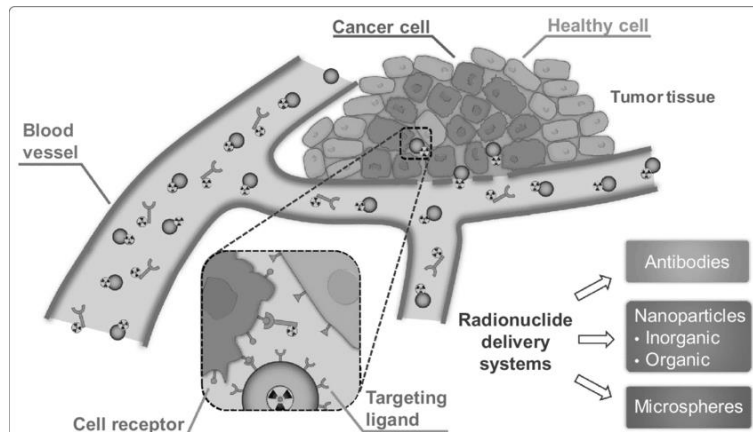
Populations in the Zangilan region are at heightened risk due to chronic exposure through drinking water, food, and skin contact [7, 16].

Implications and Recommendations

Based on the findings: Joint Armenian-Azerbaijani environmental monitoring should be initiated under international frameworks [17, 19].

- **Phytoremediation** with species like *Helianthus annuus* (sunflower) and *Brassica juncea* (Indian mustard) has proven successful post-Chernobyl and can be implemented in Okchuchay [9].
- **Sediment dredging and stabilization** with phosphate compounds or biochar should be considered at identified hotspots [18].
- **Public health screening** and cancer surveillance must be initiated downstream [23].

International regulatory support (similar to the Danube Convention) could ensure data transparency, cross-border cooperation, and enforcement [7].

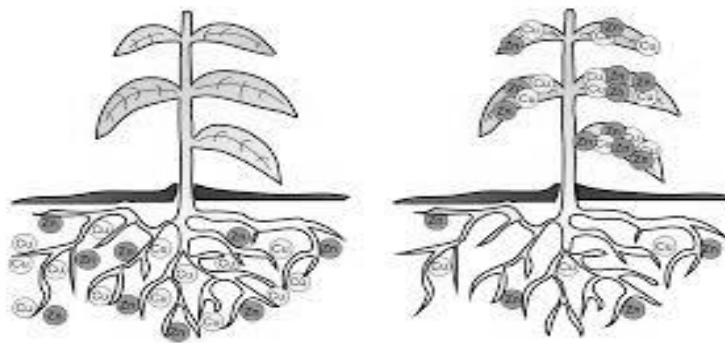


Picture 3. The cases of cancer

Source: [23]. Current outlook on radionuclide delivery systems: from design consideration to translation into clinics. *Journal of Nanobiotechnology*, 17, 90.

Proposed Mitigation Strategies. Mitigation strategies for radionuclide contamination include:

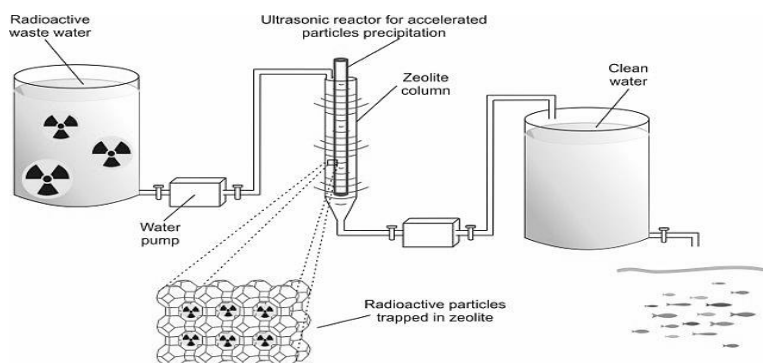
1. Phytoremediation: The use of hyperaccumulator plants like *Helianthus annuus* (sunflower) and *Brassica juncea* (Indian mustard) to extract and stabilize radionuclides. This method, initially proposed by Chaney [1983], has been successfully applied in Chernobyl and Fukushima. For instance, after the Chernobyl disaster, sunflowers were planted in contaminated water bodies to absorb cesium-137 and strontium-90, demonstrating phytoremediation's potential for large-scale remediation [9, 24] (Picture 3, 4).
- 2.



Picture 4. Phytoremediation

Source: Wikipedia – "Phytoremediation." Retrieved from Wikipedia

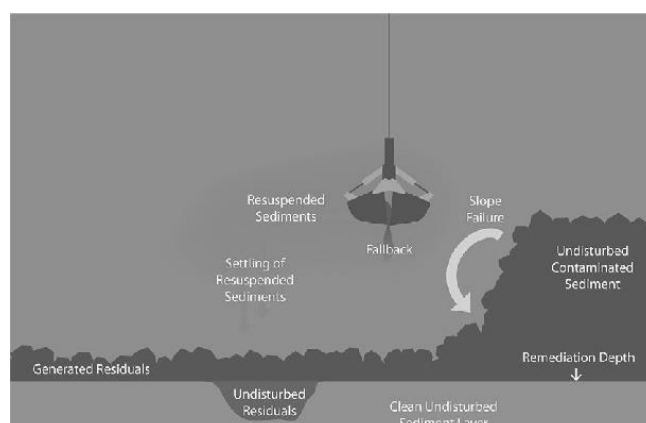
3. Advanced Wastewater Treatment: Reverse osmosis and ion exchange techniques have been effectively used to remove radionuclides from wastewater. These technologies were first implemented in nuclear facility effluent treatment during the 1970s and have since been widely applied in industrial wastewater management. For example, the treatment of mining effluent in the Colorado River Basin successfully reduced uranium and heavy metal concentrations, providing a model for Okchuchay's remediation [7] (Picture 5).



Picture 5. Waterman Australia - "Ion Exchange Treatment of Radioactive Wastewater."

Source: Retrieved from Waterman Australia

3. Sediment Dredging and Stabilization: Removing contaminated sediments from riverbeds has been a proven method in large-scale cleanup projects. The Hudson River cleanup project demonstrated the effectiveness of dredging in removing PCB-contaminated sediments. Similarly, adding biochar and phosphate compounds to stabilize contaminants in river sediments has been successfully tested in the Danube River region [18] (Picture 6).



Picture 6. Sediment Dredging

Source: [24]. Environmental Dredging Residual Generation and Management. Integrated Environmental Assessment and Management, 14. <https://doi.org/10.1002/ieam.4032>.

4. International Agreements and Policy Enforcement: Regulatory measures and international-cooperation play a crucial role in mitigating transboundary pollution. The European Union's Water Framework Directive has been instrumental in reducing industrial waste discharge across member states. A similar agreement between Azerbaijan and Armenia, modeled after the Danube River Protection Convention, could lead to improved monitoring, pollution control, and long-term remediation efforts [17].

CONCLUSION

The Okchuchay River is a vivid example of the disastrous ecological consequences of uncontrolled industrial activity. In particular, radionuclide pollutants give a twofold threat to both the ecosystems of the river and the health and livelihood of its adjacent populations. Urgent interventions are needed to reduce these negative impacts through strengthened regulatory frameworks, global cooperation, and active participation by the community. It will also draw on the experience of similar incidents around the world, such as Chernobyl and Fukushima, to develop a



broad long-term plan for the remediation and restoration work on the Okchuchay River and its surroundings

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AZƏRBAYCAN RESPUBLİKASINDA OKÇUÇAY TRANZİT ÇAYININ RADIONUKLİDLƏ ÇİRKŁƏNMƏSİNİN EKOLOJİ ASPEKTLƏRİ

R.Ə. Sadıqov, Y.Z. Vəliyev

Radionukloid çirklənməsi, xüsusilə Azərbaycan və Ermənistan ərazilərindən axan transsərhəd çaylar, o cümlədən Oxçuçay üçün ciddi ekoloji problemə çevrilməkdədir. Bu tədqiqat Oxçuçay çayında radionukloid çirklənməsinin miqyasını, mənbələrini və təsirlərini qiymətləndirir və əsas diqqəti sezium-137, stroncium-90, uran və torium elementlərinə yönəldir. Aparılan sahə tədqiqatları və analitik üsullar çirklənmə səviyyələrinin ekosistemlər və insan sağlamlığı üçün ciddi risklər yaratdığını göstərmişdir. Nəticələr effektiv tənzimləmə, beynəlxalq əməkdaşlıq və fitoremediasiya, qabaqcıl tullantı sularının təmizlənməsi kimi innovativ təmizləmə strategiyalarına ehtiyac olduğunu vurğulayır. Çernobıl və Fukusima kimi çirklənmə hadisələrindən çıxarılan dərsləri nəzərə alaraq, bu tədqiqat Oxçuçay və digər transsərhəd su hövzələrində radionukloid çirklənməsinin azaldılması üçün praktiki tövsiyələr təqdim edir.

Açar sözlər: *ətraf mühit, ekoloji aspektlər, radionukloid çirklənməsi, çay ekosistemi, Oxçuçay.*

ЭКОЛОГИЧЕСКИЕ АСПЕКТЫ РАДИОНУКЛИДНОГО ЗАГРЯЗНЕНИЯ ТРАНЗИТНОЙ РЕКИ ОКЧУЧАЙ В АЗЕРБАЙДЖАНСКОЙ РЕСПУБЛИКЕ

Р.А. Садыгов, Ю.З. Велиев

Радионуклидное загрязнение становится серьезной экологической проблемой, особенно в трансграничных реках, таких как Окчучай, протекающая через Республику Азербайджан и Армению. В этом исследовании оцениваются масштабы, источники и последствия радионуклидного загрязнения реки Окчучай, уделяя особое внимание цезию-137, стронцию-90, урану и торию. Обширные полевые отборы проб и аналитические методы выявляют уровни загрязнения, представляющие серьезные риски для экосистем и здоровья человека. Результаты требуют эффективного регулирования, международного сотрудничества и инновационных стратегий рекультивации, включая фиторе медиацию и современную очистку сточных вод. Обобщая уроки из случаев загрязнения, таких как Чернобыль и Фукусима, это исследование дает действенные рекомендации по смягчению загрязнения радионуклидами в реке Окчучай и аналогичных трансграничных водных системах.

Ключевые слова: *окружающая среда, экологические аспекты, радионуклидное загрязнение, речная экосистема, Окчучай.*



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CHANGES IN THE GRANULOMETRIC COMPOSITION OF EROSIONED MOUNTAIN GRAY-BROWN SOILS IN THE GOBUSTAN REGION DEPENDING ON THE DEGREE OF EROSION

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The soils of the study area are mainly mountain gray-brown type soils, and the resistance of these soils to erosion is quite weak. Therefore, it is important to take preliminary measures to increase the resistance of these soils to erosion. The morphological structure and morphometric indicators of mountain gray-brown soils formed in complex relief conditions are diverse. Basically, these indicators vary depending on the slope and other geomorphological parameters. These characteristics of the soils were observed in all areas of the study area. These characteristics vary depending on the degree of soil erosion. Our studies have considered these issues.

The granulometric composition of ordinary mountain gray-brown (chestnut) soils is heavy, mainly clayey and heavy clayey types prevail. The amount of silt particles in the upper layer is $27 \pm 3.2\%$, and the amount of physical clay is $60 \pm 4.5\%$. In some regions, the amount of physical clay increases to 72%. The amount of silt particles is higher in the middle part of the profile, which causes the appearance of signs of clay formation in this horizon. The mineralogical composition of the soils has similar characteristics to other subtypes.

Keywords: mountain gray-brown soils, erosion, granulometric composition, diagnostic indicator.

INTRODUCTION

The relief of the southeastern slope of the Greater Caucasus is very complex, and steep slopes are widespread here. The rocks distributed in this area are mainly of sedimentary origin, with a marine-derived silty, clayey, and sandy granulometric composition [1, p. 309], [7, p. 340].

The erosion process affects the morphological structure of soils, their diagnostic indicators [6, p. 38]. It is known that each size of granulometric composition indicator has its own physicochemical properties [4, p. 388-396]. The amount of these sizes also changes the fertility properties of the soil. Many studies have already shown that granulometric indicators, along with the physicochemical properties of the soil, play an important role in the formation of its agronomic properties [8, p. 137].

The increase in the amount of large particles in the soil typically leads to a reduction in humus and biogenic elements, as coarser particles have a lower capacity to retain organic matter and nutrients compared to finer particles. Consequently, the granulometric composition becomes a key factor influencing the progression of the erosion process, and it changes in response to the degree of exposure to erosion. As erosion intensifies, larger particles tend to be more easily removed, leaving behind finer particles that are more resistant to transport.

On the other hand, an increase in the proportion of fine silt particles within the soil can enhance its fertility. Fine silt particles have a greater surface area, which allows for better retention of nutrients, water, and organic matter, all of which contribute to soil fertility. However, it is not only the granulometric composition that determines soil fertility. The presence of humus, as well as biogenic elements like nitrogen, phosphorus, and potassium, are essential components that further enhance soil fertility.

Therefore, both the physical structure of the soil, reflected in its granulometric composition, and the chemical properties, such as the amount of humus and biogenic elements, play a vital role in deter-



mining the overall fertility and productivity of the soil. Researchers have determined that the physical and water-physical properties of clay soils are often considered unfavorable [2, p. 344], [11, p. 416]. Therefore, soils with a heavy granulometric composition are considered to be poorly fertile soils.

The high carbonate content of soils in the study area plays a pivotal role in shaping their physical and chemical properties. These carbonates, which have a lithogenic origin, are primarily derived from the parent rock material, meaning they are inherited directly from the surrounding bedrock through weathering and mineral transformation processes. Lithogenic carbonates, such as calcium carbonate (CaCO_3), are often present in high concentrations in regions where the underlying rock is rich in carbonate minerals.

As the distance from the parent rock decreases, the concentration of carbonates in the soil increases. This is a key feature of lithogenic carbonate-rich soils, where the proximity to the bedrock directly influences the amount of carbonates present in the soil profile. The greater the amount of carbonate material in the soil, the more it affects the soil's structure and erosion resistance.

The presence of this composition, especially in the development of ravine erosion, increases the likelihood of erosion processes [5, p. 626-629].

The composition of the soil is a mixture of elementary particles consisting of various minerals and small amounts of organic residues. These particles are elements present within the soil structure and are called granulometric composition. These elementary particles, which have different sizes, are considered the main indicator of the granulometric properties of the soil. Granulometric particles are divided into categories such as stone, sand, dust and silt according to their size [10, p. 162-163]. These composition indicators, in addition to affecting various properties of the soil, are one of the factors that play a major role in its erosion.

MATERIAL AND METHODS

The research work was carried out on mountain gray-brown soils in the Gobustan region, which is part of the economic region of the Upper Shirvan region, at an absolute altitude of 650-840 m. In 2017, sections were made in the soil area where we conducted the experiment and soil samples were taken. Analysis of morphological profiles of eroded mountain gray-brown soils shows that leaching creates an unfavorable environment in the soils. In particular, the granulometric composition, water-physical properties, porosity, aggregate composition are significantly transformed. Moisture indicators, density and many other properties are changed. The granulometric composition was determined using the N.A. Kachinsky scale by decomposition with sodium pyrophosphate.

RESULTS AND DISCUSSION

According to the granulometric composition, clayey and heavy clayey types prevail in mountain dark gray-brown (chestnut) soils and the differentiation of the profile is clearly observed [9, p. 31]. Signs of clay formation are clearly visible in the middle parts of the profile (B2, B/C horizons). Clay formation has metamorphic properties and montmorillonite and hydromica minerals are dominant in the composition of clay minerals in these soils.

These soils do not show signs of salinization. Although the general chemical composition of the genetic layers is close to each other, the amount of oxides is somewhat higher. Most of the dark mountain gray-brown (chestnut) soils are located outside the irrigation zone and are mainly used for rainfed agriculture (grain, orchards, vineyards) [9, p. 30-31]. However, only a small part of these soils is located in the plume zone and is used under irrigated crops.

In the experimental field, a consistent trend is observed regarding the change in granulometric composition of the soils along the profile, which remains relatively the same regardless of the degree of erosion. This trend shows a clear and noticeable increase in the amount of physical clay as the soil depth increases. This observation is evident across all soil sections examined, and it strongly suggests a relationship between the soil's granulometric composition and the underlying geological formations.



The increase in clay content with depth points to a natural process of soil development influenced by the parent rocks. In the region of the Greater Caucasus, including its southeastern slope, clayey rocks are dominant in the bedrock. The soil's characteristics, therefore, appear to be a direct result of the composition and texture of these parent rocks. Clay minerals, being fine-grained and highly weatherable, tend to accumulate in the soil profile over time, particularly as deeper horizons form and the soil undergoes various processes of mineral weathering and leaching. The clay content increases with depth likely due to the fine particles of clay being less mobile compared to coarser particles such as sand or silt. As water moves through the soil profile, the finer clay particles tend to remain in place, while larger particles are often transported downward or removed by water movement. This results in a higher concentration of clay at greater depths, which can also be influenced by the slow process of clay illuviation — the downward movement of clay from upper soil layers to lower horizons.

It can thus be concluded that the changes in the soil's granulometric composition along the profile are strongly linked to the parent rocks of the region. The predominance of clayey rocks in the Greater Caucasus and its southeastern slope is a key factor in determining the texture and structure of the soils in the area. The accumulation of clay in the deeper soil horizons is a direct reflection of the lithological characteristics of the bedrock, which has a lasting influence on soil formation processes in this region [3, p. 216]. Thus, as the depth increases along the profile, the amount of physical clay also increases. The ratio of the amount of physical clay in the rocks to the amount of physical clay in the soil was 1.15 in non-eroded soils, 1.58 in slightly eroded soils, and 1.36 in moderately eroded soils [5, p. 626-629].

Table

The change in granulometric composition of soils in the study area depending on the degree of erosion

Degree of erosion	Genetic layers, in cm	Hygroscopic moisture, in %	Particle size (mm)						
			1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
Non-eroded N40°31' 31',0" E48° 53' 28,2"	AYca0-22	5,11	0,78	23,62	23,60	15,20	17,60	19,20	52,00
	ABca22-46	5,06	0,84	25,16	23,20	14,40	16,00	20,40	50,80
	Bca 46-72	6,31	0,21	20,99	11,60	25,60	23,20	18,40	67,20
	BCca72-98	6,78	2,26	9,34	12,80	19,20	30,40	26,00	75,60
	Cca98-135	5,95	0,17	17,03	22,40	11,60	30,00	38,80	70,40
Slightly eroded soil N40°31' 35',9" E48° 53' 38,8"	AYca 0-16	4,92	0,65	23,75	25,20	21,20	17,60	12,60	45,40
	ABca16-30	5,06	0,65	21,35	25,60	20,80	17,20	14,40	43,40
	Bca 30-51	5,00	0,74	18,46	29,20	21,20	16,40	14,00	50,60
	Bcca51-68	6,91	0,16	9,44	17,20	15,20	13,60	24,40	65,20
	Cca68-98	7,03	0,50	4,70	15,60	12,40	14,80	32,00	62,10
Moderately eroded N40°31' 04',5" E48° 53' 56,0"	AYca 0-10	4,85	0,69	25,31	24,40	20,00	17,20	9,40	34,60
	ABca10-20	5,23	0,52	22,28	24,80	21,20	17,60	10,60	32,40
	Bca 20-44	6,05	2,00	7,60	25,20	12,40	37,60	10,20	43,20
	BCca 44-68	6,13	3,35	7,85	21,60	14,80	15,20	16,20	53,20
Moderately eroded N40°31' 46',2" E48° 53' 53,4"	AYca0-8	4,48	1,18	34,82	20,00	17,20	13,20	7,60	32,00
	ABca 8-18	4,95	1,56	13,24	36,00	17,20	18,80	10,20	30,20
	Bca 18-29	6,07	1,83	6,17	25,20	6,00	21,20	10,60	42,80
	Bcca29-40	6,98	0,35	7,65	20,80	11,60	22,40	17,20	51,30

The particle diameters, soil density, and structure shown in table describe the soil characteristics. The sizes of soil particles vary significantly across different degrees of erosion, reflecting the extent to which erosion has impacted the soil's structure. In non-eroded soils, the particle diameters typically range from less than 0.001 mm to 0.25 mm. These values indicate that the majority of the soil consists of fine and small particles, particularly clay, silt, and very fine sand. Such particles are crucial for maintaining soil structure and fertility, as they have a larger surface area that can retain moisture, nutrients, and organic matter.



The predominance of fine particles in non-eroded soils is a key feature that contributes to their high water retention capacity and overall soil health. These fine particles, especially clay and silt, provide the soil with a stable texture that supports plant growth, allows for better aeration, and retains essential nutrients. They also help improve the soil's ability to resist erosion because smaller particles are more likely to stay in place, forming a cohesive structure that can better withstand external forces like wind and water.

As erosion progresses, however, the proportion of these fine particles in the soil decreases, replaced by coarser particles, which can negatively impact the soil's physical properties. The removal of fine particles reduces the soil's ability to retain water and nutrients, leading to a decline in fertility and an increased susceptibility to further erosion. Therefore, understanding the particle size distribution in soils and its relationship to erosion is critical for developing effective soil conservation strategies and ensuring sustainable land use.

In moderately eroded soils, the particle sizes are more diverse, as the erosion process alters the soil structure, leading to the formation of larger particles. In slightly eroded soils, the largest particle size typically ranges between 0.25 mm and 0.05 mm. This is because, in these soils, the erosion process has been minimal, meaning that the finer particles have not been significantly washed away. As a result, the soil maintains a greater proportion of larger particles, such as sand and coarse silt. The relatively larger particle sizes help to preserve the structural integrity of the soil, allowing it to retain its natural texture and composition. These soils tend to be more stable and less prone to the erosion process, which helps in maintaining their fertility and overall soil health.

In contrast, in non-eroded soils, hygroscopic moisture levels are relatively high, ranging between 5.11% and 6.78%. Hygroscopic moisture refers to the water that is tightly bound to soil particles, particularly the fine particles like clay and silt. This high level of hygroscopic moisture indicates that the soil has a strong ability to retain water. The presence of finer particles, such as clay and silt, increases the soil's surface area, allowing it to hold more water compared to coarser soils. Soils with high water retention are more capable of maintaining moisture for plant roots, especially during dry periods, which can enhance soil fertility and support plant growth.

These characteristics are closely linked to the soil's ability to support vegetation. Soils with higher water retention and larger particle sizes typically have better aeration and root development conditions. This is particularly important in non-eroded soils, where the minimal impact of erosion allows for a balance of soil moisture retention and drainage, making it suitable for healthy plant growth. Conversely, slightly eroded soils, with a predominance of larger particles, may not retain water as effectively, requiring more careful management of irrigation and soil moisture.

In moderately eroded soils, the hygroscopic moisture content typically ranges from 4.85% to 6.05%. This is a noticeable decline compared to non-eroded or slightly eroded soils, indicating that as erosion progresses, the soil's ability to retain water decreases. Erosion tends to remove finer particles, such as silt and clay, which are essential for holding water. As a result, the remaining soil becomes coarser, with a higher proportion of sand and larger particles that have a reduced capacity to retain moisture.

In slightly eroded soils, the hygroscopic moisture content varies between 4.92% and 7.03%. This range is slightly higher than in moderately eroded soils, reflecting the still-present influence of fine particles like clay and silt, which contribute to the soil's higher water retention capacity. Despite the erosion, these soils still maintain a better balance of particle sizes, allowing them to hold more moisture than their more eroded counterparts.

The decrease in water retention capacity in eroded soils suggests that erosion not only affects the physical structure of the soil but also its hydrological properties. As the finer particles are removed by erosion, the soil becomes less capable of retaining water, which can lead to reduced soil fertility and diminished plant growth. This loss of water retention capacity further exacerbates the impacts of erosion, as the soil becomes more prone to drying out during periods of low rainfall. Consequently, soil conservation measures become even more critical in eroded areas to mitigate water loss, restore soil structure, and maintain agricultural productivity.



CONCLUSION

According to the table, soil erosion has a significant impact on the physical properties of the soil. Non-eroded soils have the highest productivity and water retention capacity, while moderately and slightly eroded soils lose these characteristics, resulting in decreased soil fertility. Combatting erosion, implementing effective soil conservation measures, and reducing the adverse effects of erosion are crucial steps in maintaining soil health and ensuring long-term agricultural productivity. As discussed earlier, changes in the granulometric composition of soils are deeply tied to the soil formation process, which in turn is influenced by the granulometric composition of the parent material. The interaction between the parent material and the weathering processes that shape the soil over time determines the proportions of sand, silt, and clay particles in the final soil profile.

Given this direct relationship between the parent material and the resulting soil texture, it becomes evident that when soil cultivation and land management practices are carried out, a comprehensive understanding of the key indicators of the granulometric composition is essential. These indicators, which include the relative amounts of sand, silt, and clay, should be carefully assessed and taken into account during soil preparation, tilling, and cropping decisions.

By considering the granulometric composition of the soil, agricultural practices can be tailored to the soil's specific texture, enhancing its capacity for water retention, nutrient uptake, and overall resilience against erosion. For example, finer soils with higher clay or silt content may benefit from specific erosion control techniques, such as contour plowing or the use of cover crops, to prevent soil loss and enhance fertility. Meanwhile, coarser soils may require different approaches, such as the addition of organic matter or the use of mulching, to improve moisture retention and protect against wind erosion.

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QOBUSTAN RAYONUNDA EROZIYAYA UĞRAMIŞ DAĞ BOZ-QƏHVƏYİ TORPAQLARIN QRANULOMETRİK TƏRKİBİNİN EROZIYA UĞRAMA DƏRƏCƏSİNDƏN ASILI DƏYİŞİLMƏSİ

Ü.R. Qədiyeva

Tədqiqat ərazisinin torpaqları əsasən dağ boz-qəhvəyi (kaştanozems) tipli torpaqlardır və bu torpaqların eroziyaya qarşı davamlılığı olduqca zəifdir. Buna görə də bu torpaqların eroziyaya qarşı davamlığını artırmaq üçün ilkin tədbirlər görülməsi vacibdir. Mürəkkəb relyef şəraitində formalaşan dağ boz-qəhvəyi torpaqların morfoloji quruluşu və morfometrik göstəriciləri müxtəlifliyə malikdir. Əsasən bu göstəricilər meyillik və digər geomorfoloji parametrlərdən asılı olaraq dəyişir. Tədqiqat ərazisinin bütün sahələrində torpaqların bu xüsusiyyətləri müşahidə edilmişdir. Bu xüsusiyyətlər torpaqların eroziyaya məruz qalma dərəcəsindən asılı olaraq dəyişir. Bizim apardığımız tədqiqatlar bu məsələləri nəzərdən keçirmişdir.

Adi boz-qəhvəyi (şabalıdı) torpaqların qranulometrik tərkibi ağır olub, əsasən gilli və ağır gillicəli növlər üstünlük təşkil edir. Üst qatdakı lil hissəciklərinin miqdarı $27\pm 3,2\%$, fiziki gilin miqdarı isə $60\pm 4,5\%$ -dir. Bəzi bölgələrdə fiziki gilin miqdarı 72% -ə qədər yüksəlir. Lil hissəciklərinin miqdarı profilin orta hissəsində daha yüksəkdir, bu da həmin horizontda gilləşmə əlamətlərinin yaranmasına səbəb olur. Torpaqların mineraloji tərkibi digər yarımtiplərlə oxşar xüsusiyyətlərə malikdir.

Açar sözlər: *dağ boz-qəhvəyi torpaqlar, eroziya, qranulometrik tərkib, diaqnostik göstərici.*

ИЗМЕНЕНИЕ ГРАНУЛОМЕТРИЧЕСКОГО СОСТАВА ЭРОЗИОННЫХ ГОРА СЕРО-БОРОЧНЫХ ПОЧВ В ЗАВИСИМОСТИ ОТ СТЕПЕНИ ЭРОЗИИ В ГОБУСТАНСКОМ РАЙОНЕ

У.Р. Гадиева

Почвы района исследований представлены в основном гора серо-коричневыми (каштаноземами) типами, эрозионная устойчивость этих почв довольно слабая. Поэтому важно принять предварительные меры по повышению устойчивости этих почв против эрозии. Морфологическое строение и морфометрические показатели гора серо-бурых почв, сформировавшихся в сложных рельефных условиях, разнообразны. В основном эти показатели меняются в зависимости от наклона и других геоморфологических параметров. Данные характеристики почв наблюдались на всех участках исследуемой территории. Эти характеристики изменяются в зависимости от степени эрозии почвы. Наше исследование решило эти вопросы.

Гранулометрический состав обыкновенных гора серо-бурых (каштановых) почв тяжелый, преобладают преимущественно глинистые и тяжелозернистые типы. Количество илистых частиц в верхнем слое составляет $27\pm 3,2\%$, количество физической глины – $60\pm 4,5\%$. В некоторых регионах количество физической глины возрастает до 72% . Количество илистых частиц выше в средней части профиля, что обуславливает признаки заиливания этого горизонта. Минералогический состав почв имеет сходные характеристики с другими подтипами.

Ключевые слова: *гора серо-бурые почвы, эрозия, гранулометрический состав, диагностический индекс.*



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PHENOLOGICAL CHARACTERISTICS OF SOME VARIETIES AND FORMS OF PISTACHIO (*PISTACHIA* L.) PLANT

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*The article studies the phenological characteristics of some varieties of Pistachio (*Pistachia* L.) plant introduced to the Absheron Experimental Base of the Scientific Research Institute of Fruit Growing and Tea Growing. During the research, the following varieties and forms were selected: Bina 1/91, Bina 2/92, Narinj, Khanim 17/85, Parvin 14/84, Aylin, Buzovna 65/84, Mardakan 19/95, Bulbula. As a result, well-flowering varieties and forms, phenological groups, and vegetation period were determined. The studied varieties and forms underwent normal vegetation in the soil-climatic conditions of Absheron, the duration of vegetation varied between 224-226 days depending on the varieties and forms. Based on phenological groups, the varieties and forms Bina 1/91, Narinj, khanum, Parvin, Buzovna 65/84 were attributed to the ML group, Bina 2/92, Aylin, Mardakan 19/95, bulbula to the LL group. The flowering rate was evaluated as 3 points in Bina 1/91, Bina 2/92 varieties, and 4 points in Kalam varieties.*

Keywords: phenology, pistachio, Absheron, variety, form

INTRODUCTION

Pistachio (*Pistachia* L.) is the most widely used industrial and food plant in the world. Pistachio is long-lived and has the ability to grow in difficult environments, and is drought-resistant. Some varieties of this plant are cultivated in large areas in many countries of the world. Although some valuable varieties and forms of pistachio are cultivated in Azerbaijan, especially in the Absheron region, they do not cover very large areas. In this regard, the main goal of the research work is to select varieties and forms of pistachio that are better suited to the Absheron region, expand the cultivation areas, establish large gardens and introduce them to the world market. In this regard, the topic under study is very relevant.

Pistachio grows naturally in many areas of East and Central Asia, South and North America. There are large forests of this plant in areas such as South America, Mediterranean coastal countries, Iran, Italy, Syria, Spain, China, Japan, and Turkey [1, 2, 3].

In almost all countries where pistachios have been cultivated for centuries, new large-fruited, productive pistachio varieties have been obtained through natural selection and folk selection [4]. J.Mammadov, A.Maharramov, A.Arabzade studied some developmental features of the pistachio plant. They conducted research on the establishment of new pistachio orchards, selection of promising varieties and forms for this, propagation and grafting of rootstocks in the territory of the Absheron Experimental Base [5].

World scientists A. Kader [6], D.H. Maggs [7] studied some bioecological features, evolution, and prospects of pistachios, R. Polat, A. Jevat [8] studied the physical and mechanical properties of



pistachios. Z. Siyahnouri, M. Bullo et al. [9] determined the content and amount of minerals in pistachios, and investigated their health effects. Studying phenological characteristics in plants allows us to determine how they have adapted to the conditions in which they were introduced.

MATERIAL AND METHODS

During the research, the following varieties and forms were selected: Bina 1/91, Bina 2/92, Narinj, Khamim 17/85, Parvin 14/84, Aylin, Buzovna 65/84, Mardakan 19/95, Bulbula. The experiments were conducted at the Absheron Experimental Base of the Scientific Research Institute of Fruit Growing and Tea Growing of the Ministry of Agriculture of the Republic of Azerbaijan.

The soils of the research area are gray-brown, and the climate is mainly temperate-hot and dry subtropical in flat areas, semi-desert type. Summer is dry, winter is relatively mild [10].

Phenological studies on the studied varieties and forms of pistachio plants were carried out by N.I.Beideman [11], P.I.Lapin [12], I.N.Elagin, A.I.Lobanov [13] and the generally accepted methods of the Main Botanical Garden of Russia [14]. Research work was carried out from early February to late November. Thus, records were made twice a week in the summer months and once every 10 days in June-September. Finally, the duration of vegetation and phenological groups were determined for each variety and form.

RESULTS AND DISCUSSION

Phenological observations were conducted on pistachio varieties and forms previously introduced from different areas to the collection area of the Absheron Experimental Base. The experiment lasted simultaneously in the morning at 8:00-10:00 and in the evening at 17:00-19:00, for 1.5-2.0 hours. The northern part of the tree canopy was taken as experimental branches, these branches were numbered, and records were made annually. In each variety and form, the swelling of shoots, budding, flowering, fruiting, and leaf fall were recorded.

According to the observations conducted every year, the beginning, end and duration of phenological phases in winter and spring were different depending on the climatic conditions.

The observations conducted show that in Absheron conditions, depending on the climate, the vegetation of pistachio varieties and forms begins in late March or early April at a temperature of $+10+12^{\circ}\text{C}$, bud opening at $+12+14^{\circ}\text{C}$; flowering at $+15+17^{\circ}\text{C}$; fruit ripening at $+22+27^{\circ}\text{C}$.

The beginning and end of vegetation in all varieties and forms were almost the same. Bud swelling and opening were recorded in the first decade of April, flowering at the end of April, and the end of flowering at the beginning of May (Table 1).

Usually, generative buds open 7-10 days earlier than vegetative buds. In general, male and female flowers opened at the same time in the studied varieties and forms. However, in some forms (Bina 1/91, Bina 2/92), male flowers opened earlier than female flowers. Flowering usually lasted 20-22 days in male flowers and 15-18 days in female flowers. The strength of flowering was measured using a 5-point system (Figure 1).

**Table 1.**

Phenological observations on varieties and forms in the pistachio (*Pistacia L.*) experimental garden of the Absheron Experimental Base

№	Sorts and forms	Bud swelling		Bud opening		Flowering				Flowering rate	Fruit ripening		Leaf fall	
						Start		Massive						
		Vegetive	Generative	Start	Massive	Female	Male							
1.	Bina 1/91	10.04	02.04	04.04	07.04	16.04	12.04	24.04	02.05	3	23.05	26.08	14.10	20.11
2.	Bina 2/92	12.04	03.04	04.04	07.04	17.04	11.04	24.04	03.05	3	24.05	27.08	16.10	22.11
3.	Narinc	08.04	01.04	05.04	08.04	13.04	13.04	23.04	01.05	4	22.05	25.08	13.10	19.11
4.	Khanim 17/85	10.04	02.04	06.04	08.04	14.04	14.04	24.04	02.05	4	23.05	26.08	14.10	21.11
5.	Parvin 14/84	09.04	01.04	04.04	09.04	13.04	13.04	23.04	01.05	4	22.05	25.08	13.10	19.11
6.	Aylin	11.04	03.04	05.04	08.04	15.04	15.04	25.04	03.05	4	24.05	27.08	16.10	22.11
7.	Buzovna 65/84	09.04	01.04	05.04	08.04	15.04	15.04	25.04	03.05	4	24.05	27.08	16.10	22.11
8.	Mardakan 19/95	12.04	02.04	06.04	09.04	14.04	14.04	24.04	02.05	4	23.05	26.08	14.10	21.11
9.	Bulbula	11.04	03.04	05.04	08.04	16.04	16.04	26.04	03.05	4	24.05	27.08	16.10	22.11



1



2



3

Fig. 1. Flowers and fruits of the pistachio plant. 1. Male flowers. 2. Female flowers. 3. Fruits

Fruit formation began in the second decade of May, and fruit ripening began in the third decade of May. Full fruit ripening was completed by the end of August. Starting in October, leaves be-



gan to fall, and in November they were completely shed, and vegetation ended. The duration of vegetation in different varieties and forms varied between 224-226 days.

The studied varieties and forms of pistachio were divided into phenological groups based on the start and end of vegetation: those with a medium-early vegetation period (ML), those with a late-early vegetation period (LL). Those whose vegetation began from March 20 to April 10 were grouped as medium-early, and those whose vegetation began after April 10 were grouped as late-early. Those that shed their leaves by November 10 are classified as early-early, and those that shed their leaves after November 10 are classified as late-early (Table 2).

Table 2.

Placement of varieties and forms in phenological groups

№	Sorts and forms	Phenological groups	Vegetation length (in days)
1.	Bina 1/91	ML	225
2.	Bina 2/92	LL	226
3.	Narinc	ML	224
4.	Khanım 17/85	ML	226
5.	Parvin 14/84	ML	224
6.	Aylin	LL	226
7.	Buzovna 65/84	ML	227
8.	Mardakan 19/95	LL	225
9.	Bulbula	LL	226

Based on phenological groups, varieties and forms were divided into 2 groups: medium-early, late-ending (ML) and late-early, late-ending (LL). Bina 1/91, Narinc, khanum, Parvin, Buzovna 65/84 varieties and forms were attributed to the OG group, Bina 2/92, Aylin, Mardakan 19/95, bulbula to the LL group. The vegetation period was 224-226 days.

In conclusion, it was determined that the studied varieties and forms were well adapted to the soil and climatic conditions of Absheron and had a normal vegetation period.

CONCLUSION

1. During phenological observations, well-flowering varieties and forms were identified. These are Narinc, Khanım 17/85, Parvin 14/84, Aylin, Buzovna 65/84, Mardakan 19/95, Bulbula varieties and forms. The flowering rate was evaluated as 3 points in Bina 1/91, Bina 2/92 varieties, and 4 points in Kalam varieties.

2. Based on phenological groups, Bina 1/91, Narinc, Khanım 17/85, Parvin 14/84, Buzovna 65/84 varieties and forms were attributed to the ML group, Bina 2/92, Aylin, Mardakan 19/95, Bulbula to the LL group.

3. The studied varieties and forms underwent normal vegetation in the soil-climatic conditions of Absheron, and the duration of vegetation varied between 224-226 days depending on the varieties and forms.



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**PÜSTƏ (*PISTACHIA* L.) BİTKİSİNİN BƏZİ SORT VƏ FORMALARININ
FENOLOJİ XÜSUSİYYƏTLƏRİ**

A.Ə. Ərəbzadə

Məqalədə Meyvəçilik və Çayçılıq Elmi Tədqiqat İnstitutunun Abşeron Təcrübə Bazasına introduksiya olunmuş Püstə (*Pistachia* L.) bitkisinin bəzi sortlarının fenoloji xüsusiyyətləri öyrənilmişdir. Tədqiqatlar zamanı Binə 1/91, Binə 2/92, Narınc, Xanım 17/85, Pərvin 14/84, Aylin, Buzovna 65/84, Mərdəkan 19/95, Bülbülə sort və formaları götürülmüşdür. Nəticədə yaxşı çiçəkləyən sort və formalar, fenoloji qruplar, vegetasiya müddəti müəyyən olunmuşdur. Yaxşı çiçəkləyən sort və formalar Narınc, Xanım 17/85, Pərvin 14/84, Aylin, Buzovna 65/84, Mərdəkan 19/95, Bülbülə sort və formalarıdır. Fenoloji qruplara əsasən Binə 1/91, Narınc, xanım, Pərvin, Buzovna 65/84 sort və formaları OG qrupuna, Binə 2/92, Aylin, Mərdəkan 19/95, bülbülə GG qrupuna aid edilmişdir. Çiçəkləmə dərəcəsi Binə 1/91, Binə 2/92 sortlarda 3, qalan sortlarda isə 4 balla qiymətləndirilmişdir. Öyrənilən sort və formalar Abşeronun torpaq-iqlim şəraitində normal vegetasiya keçirmişlər, vegetasiyanın davam etmə müddəti sort və formalara görə 224-226 gün arasında dəyişmişdir.

Açar sözlər: *fenologiya, püstə, Abşeron, sort, forma.*



ФЕНОЛОГИЧЕСКИЕ ХАРАКТЕРИСТИКИ НЕКОТОРЫХ СОРТОВ И ФОРМ РАСТЕНИЯ ФИСТАШКА (*PISTACHIA* L.)

А.А. Арабзаде

В статье изучены фенологические особенности некоторых сортов растения фисташка (*Pistachia* L.), интродуцированных на Абшеронской экспериментальной базе Научно-исследовательский институт плодводства и чаеводства. В ходе исследований были отобраны следующие сорта и формы: Бина 1/91, Бина 2/92, Нариндж, Ханым 17/85, Парвин 14/84, Айлин, Бузовна 65/84, Мардакян 19/95, Бульбуля. В результате были определены хорошо цветущие сорта и формы, фенологические группы и период вегетации. Изучаемые сорта и формы прошли нормальную вегетацию в почвенно-климатических условиях Абшерона, продолжительность вегетации в зависимости от сорта и формы колебалась в пределах 224-226 дней. По фенологическим группам сорта и формы Бина 1/91, Нариндж, ханум, Парвин, Бузовна 65/84 были отнесены к группе СП, Бина 2/92, Айлин, Мардакян 19/95, бульбуля к группе ПП. Интенсивность цветения оценена в 3 балла у сортов Бина 1/91, Бина 2/92 и 4 балла у сортов Калам.

Ключевые слова: фенология, фисташка, Абшерон, сорт, форма.

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