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THE SIGNIFICANCE OF ACADEMICIAN HABIBULLA AKBAROV’S SCIENTIFIC SCHOOL IN THE FIELDS OF GEOLOGY AND MINING

Abstract

This article provides a comprehensive analysis of the formation and profound historical significance of the scientific school established by Academician Habibulla Asatovich Akbarov, a preeminent figure in the fields of geology, mineralogy, and mining within the Academy of Sciences of Uzbekistan. The author delves into Akbarov’s fundamental research, particularly his pioneering work on the geological-structural types of ore fields and his revolutionary methods for metallogenic forecasting. A central focus is placed on the methodological frameworks developed by H. Akbarov, which proved instrumental in the discovery of major deposits within the Tien Shan and Chatkal-Kurama mountain systems. By integrating structural analysis with prognostic modeling, his school played a decisive role in expanding the mineral resource base of the Central Asian region, ensuring long-term economic stability and industrial growth. Furthermore, the article evaluates the scientific school’s contribution to the academic-pedagogical ecosystem, highlighting its success in cultivating generations of highly qualified researchers and engineers. Special emphasis is given to the integration of theoretical geological principles with industrial application, a hallmark of Akbarov’s legacy that continues to influence the curriculum and research priorities of the University of Geological Sciences in Tashkent. The study concludes that the Akbarov school remains a cornerstone of regional geosciences, bridging the gap between classical structural geology and modern predictive exploration technologies.

Keywords: Habibulla Akbarov; geology; mining; scientific school; metallogeny; ore field structure; forecasting; Central Asia; mineral resource base.

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ГЕОЛОГИЯ ЖӘНЕ ТАУ-КЕН ІСІ САЛАСЫНДАҒЫ АКАДЕМИК ХАБИБУЛЛА АКБАРОВ НЕГІЗІН ҚАЛАҒАН ҒЫЛЫМИ МЕКТЕПТІҢ МАҢЫЗЫ

Аңдатпа

Бұл мақалада Өзбекстан Ғылым академиясының геология, минералогия және тау-кен ісі саласындағы көрнекті тұлғасы, академик Хабибулла Асатович Акбаров негізін қалаған ғылыми мектептің қалыптасуы мен терең тарихи маңызына жан-жақты талдау жасалған. Автор Х. Акбаровтың іргелі зерттеулерін, атап айтқанда, кен алаңдарының геологиялық-құрылымдық типтері бойынша жаңашыл еңбектері мен металлогендік болжаудың революциялық әдістерін егжей-тегжейлі қарастырады. Академик әзірлеген методологиялық негіздерге ерекше назар

аударылады, олар Тянь-Шань және Шатқал-Құрама тау жүйелеріндегі ірі кен орындарын ашуда шешуші рөл атқарды. Құрылымдық талдауды болжамды модельдеумен ұштастыра отырып, оның мектебі Орталық Азия аймағының минералды-шикізат базасын кеңейтуде, ұзақ мерзімді экономикалық тұрақтылық пен өнеркәсіптік өсуді қамтамасыз етуде маңызды рөл атқарды. Сонымен қатар, мақалада ғылыми мектептің академиялық және педагогикалық экожүйеге қосқан үлесі бағаланып, жоғары білікті зерттеушілер мен инженерлердің бірнеше буынын тәрбиелеудегі жетістіктері атап өтіледі. Теориялық геологиялық принциптерді өндірістік қолданумен интеграциялауға баса назар аударылады – Х. Акбаровтың бұл мұрасы Ташкенттегі Геология ғылымдары университетінің оқу бағдарламалары мен зерттеу басымдықтарына әлі де ықпал етуде. Зерттеу Акбаров мектебі классикалық құрылымдық геология мен заманауи болжамды барлау технологиялары арасындағы алшақтықты жоя отырып, аймақтық жер туралы ғылымдардың іргетасы болып қала береді деген қорытындыға келеді.

Түйін сөздер: Хабибулла Акбаров; геология; тау-кен ісі; ғылыми мектеп; металлогения; кен алаңдарының құрылымы; болжау; Орталық Азия; минералды-шикізат базасы.

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ЗНАЧЕНИЕ НАУЧНОЙ ШКОЛЫ АКАДЕМИКА ХАБИБУЛЛЫ АКБАРОВА В ОБЛАСТИ ГЕОЛОГИИ И ГОРНОГО ДЕЛА

Аннотация

В данной статье представлен всесторонний анализ формирования и глубокого исторического значения научной школы, основанной академиком Хабибуллой Асатовичем Акбаровым – выдающейся фигурой в области геологии, минералогии и горного дела в системе Академии наук Узбекистана. Автор подробно рассматривает фундаментальные исследования Х. Акбарова, в частности его новаторские работы по геолого-структурным типам рудных полей и революционные методы металлогенического прогнозирования. Центральное внимание уделяется методологическим основам, разработанным академиком, которые сыграли ключевую роль в открытии крупных месторождений в горных системах Тянь-Шаня и Чаткало-Курамы. Благодаря интеграции структурного анализа с прогностическим моделированием, его школа внесла решающий вклад в расширение минерально-сырьевой базы Центральноазиатского региона, обеспечив долгосрочную экономическую стабильность и промышленный рост. Кроме того, в статье оценивается вклад научной школы в академическую и педагогическую экосистему, подчеркиваются успехи в подготовке поколений высококвалифицированных исследователей и инженеров. Особое внимание уделяется интеграции теоретических геологических принципов с промышленным применением – наследию Х. Акбарова, которое продолжает определять учебные программы и исследовательские приоритеты Университета геологических наук в Ташкенте. В исследовании делается вывод, что школа Акбарова остается краеугольным камнем региональных наук о Земле, преодолевая разрыв между классической структурной геологией и современными технологиями прогнозирования месторождений.

Ключевые слова: Хабибулла Акбаров; геология; горное дело; научная школа; металлогения; структура рудных полей; прогнозирование; Центральная Азия; минерально-сырьевая база.

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AKADEMISYEN HABIBULLA AKBAROV’UN JEOLOJI VE MADENCILIK ALANINDAKI BILIMSEL EKOLÜNÜN ÖNEMI

Özet

Bu makale, Özbekistan Bilimler Akademisi bünyesinde jeoloji, mineraloji ve madencilik alanlarında seçkin bir figür olan Akademisyen Habibulla Asatoviç Akbarov tarafından kurulan bilimsel ekolün oluşumunun ve derin tarihsel öneminin kapsamlı bir analizini sunmaktadır. Yazar, Akbarov'un temel araştırmalarını, özellikle cevher sahalarının jeolojik-yapısal tipleri üzerine öncü çalışmalarını ve metalojenik öngörü konusundaki devrim niteliğindeki yöntemlerini derinlemesine incelemektedir. Akademik odak noktası, H. Akbarov tarafından geliştirilen ve Tanrı Dağları (Tyan-Shan) ile Çatkal-Kurama dağ sistemlerindeki büyük yatakların keşfinde etkili olan metodolojik çerçeveler üzerine yapılandırılmıştır. Yapısal analizi öngörücü modelleme ile birleştiren bu ekol, Orta Asya bölgesinin maden hammadde tabanının genişletilmesinde belirleyici bir rol oynayarak uzun vadeli ekonomik istikrar ve endüstriyel büyümeyi güvence altına almıştır. Ayrıca makale, bilimsel ekolün akademik ve pedagojik ekosisteme katkısını değerlendirerek, nesiller boyu yüksek nitelikli araştırmacı ve mühendis yetiştirmedeki başarısını vurgulamaktadır. Teorik jeolojik prensiplerin endüstriyel uygulama ile entegrasyonuna özel bir önem atfedilmiştir; Akbarov'un bu mirası, Taşkent’teki Jeoloji Bilimleri Üniversitesi'nin müfredatını ve araştırma önceliklerini etkilemeye devam etmektedir. Çalışma, Akbarov ekolünün klasik yapısal jeoloji ile modern öngörücü arama teknolojileri arasındaki boşluğu doldurarak bölgesel yer bilimlerinin temel taşı olmayı sürdürdüğü sonucuna varmaktadır.

Anahtar Kelimeler: Habibulla Akbarov; jeoloji; madencilik; bilimsel ekol; metalojeni; cevher sahası yapısı; öngörü; Orta Asya; maden kaynakları tabanı.

Introduction

The global transition towards advanced industrialization and the escalating demand for strategic mineral resources have placed geological science at the forefront of national economic security. In the context of Central Asia, particularly Uzbekistan, the systematic evolution of geological thought has been profoundly shaped by distinguished scientific schools that bridged the gap between classical Soviet geomineralogy and modern predictive modeling. Among these, the scientific school established by Academician Habibulla Asatovich Akbarov stands as a cornerstone in the advancement of structural metallogeny and the methodology of mineral exploration.

The significance of Akbarov’s school is rooted in its holistic approach to the geodynamic and structural evolution of ore-forming systems. Historically, mineral exploration relied heavily on empirical observations; however, Academician Akbarov revolutionized this process by introducing the structural-facies analysis of ore fields. This methodology posits that the localization of polymetallic, precious, and rare-earth deposits is not a stochastic phenomenon but a result of precise spatiotemporal intersections between tectonic architectures and lithological environments.

In the post-independence era of Uzbekistan, the revitalization of this scientific school acquired strategic importance. As the nation sought to affirm its economic sovereignty, the rational exploitation of its vast mineral wealth – ranging from the world-class gold deposits of the Kyzylkum to the massive polymetallic belts of the Tien Shan – demanded a rigorous scientific framework. Akbarov’s school provided this framework by developing high-precision predictive-prognostic models that significantly increased the efficiency of geological exploration (GE) expeditions, such as the Hisar and Chatkal groups.

Furthermore, the academic legacy of Habibulla Akbarov transcends mere technical innovation. It represents a paradigm shift in how "ore-controlling factors" are synthesized. By integrating lithological control, stratigraphic positioning, and tectonic-magmatic correlations, his school established a complex criteria system that remains the primary operational guide for contemporary geological services. This introduction seeks to elucidate the historical trajectory of this school, analyze its conceptual contributions to the study of endogenous ore fields, and evaluate its enduring impact on the socio-economic development and industrial stability of “New Uzbekistan”.

Through this lens, the article examines how the synthesis of theoretical geological paradigms with practical industrial application has secured Uzbekistan’s prominent position in the global mineral resource market, while simultaneously fostering a new generation of high-caliber academic personnel.

Following the attainment of national independence, Uzbekistan prioritized the enhancement of its economic potential through the rational exploitation of natural resources and the strategic expansion of its mineral resource base. Central to this national development policy were comprehensive reforms in the geological sector, characterized by the integration of advanced scientific-technical methodologies and the systematic improvement of exploration and appraisal efficiency.

In recent years, global economic volatility has significantly catalyzed the demand for essential commodities of the mining-metallurgical, electrotechnical, machine-building, and nuclear industries – specifically gold, uranium, copper, and silver. Consequently, leading global producers are intensifying efforts to optimize production cycles and implement innovative technologies and management systems to secure their positions in international rankings [1, 5]. Within this framework, elucidating the geological architecture of the Earth’s crust and the distribution patterns of mineral deposits remains a paramount objective of contemporary geological science. Given the escalating global demand for mineral resources, the development of scientifically rigorous methodologies for forecasting and exploring concealed deep-seated ore deposits has acquired profound strategic significance. The complex geodynamic evolution and immense metallogenic potential of the Central Asian region, particularly Uzbekistan, have provided a robust foundation for the establishment of distinguished scientific schools in this field.

Following the attainment of national independence, the restoration of a truthful history of Uzbekistan and the cultivation of historical memory within the public consciousness became tasks of paramount importance. Among the issues of significant scientific and practical relevance is the history of the mining industry and geological-mineralogical exploration. Mining production, which originated from the needs of primitive society, has evolved through several historical stages. As a vital economic sector, it has played a crucial role in the socio-political and economic life of society across all eras, particularly during ancient and medieval times [2, 5]. Indeed, the strength of a society has historically been determined by the availability and efficient utilization of diverse subsoil resources.

Uzbekistan stands as one of the most economically robust nations in Central Asia, consistently implementing measures to establish and expand the raw material base for its extraction and processing industries. The development of its mining and metallurgical sectors has been instrumental in ensuring sustainable economic growth, garnering significant international attention. Independence catalyzed the advancement of numerous industrial branches, among which mechanical engineering, electric power, natural gas, chemicals, ferrous and non-ferrous metallurgy, and gold mining occupy central positions [3, 31]. Nature has endowed Uzbekistan with vast mineral resources essential for its socio-economic development and the improvement of its citizens' quality of life. Currently, the nation ranks among the global leaders in the reserves of gold, silver, copper, lead, zinc, tungsten, and natural gas.

As President Shavkat Mirziyoev emphasized: “Geology is as vital to the economy as water and air. In recent years, we have focused on reviving scientific schools, training personnel, introducing advanced scientific methodologies, and installing modern laboratory equipment. Now, it is time to work for results” [4].

Methodology.

One of the most recognized fundamental directions in this field is the scientific school founded by Academician Habibulla Asatovich Akbarov, who made a monumental contribution to the development of Uzbekistan's geology and mining sectors. The emergence of this school is intrinsically linked to the advancements in regional geology, structural metallogeny, and deposit geology during the late 20th and early 21st centuries. At the core of Academician Akbarov's research lies the analysis of structural conditions in ore fields and deposits, serving as a basis for developing innovative and effective metallogenic forecasting methods.

The concept of "creating structural-geological models of ore fields", proposed by Akbarov, marked a turning point in increasing the efficiency of geological exploration. Through years of rigorous research, he scientifically demonstrated the correlation between tectonic disturbances, magmatic processes, and the lithological environment in the distribution of polymetallic, gold, and other rare metal deposits across Central Asia. These theoretical paradigms served not only as fundamental scientific milestones but also as practical frameworks for expanding the raw material bases of industrial giants such as the Navoi and Almalyk Mining and Metallurgical Combinates, which define the country's economic power.

This article provides a systematic analysis of the historical formation of the scientific school founded by Academician H. Akbarov, his conceptual innovations in geological science, and their historical significance within the mining industry. Furthermore, the role and future prospects of the research currently being conducted by the scientist's successors and colleagues are examined.

In the effort to expand the lead and zinc mineral resource base, the development of forecasting (prognostic) principles and methodologies plays a crucial role alongside the search for new deposits. These methods are predicated on the results of studies regarding the geological-genetic characteristics of ore formation, the patterns of deposit genesis, and the structural-geological conditions of ore localization. The analysis of these findings has enabled the identification of key ore-controlling factors, mineralogical-geochemical indicators, and the geophysical and geodynamic features of the ore deposition process.

At present, there are over ten recognized methods for forecasting lead-zinc mineralization, each differing in their prognostic principles and criteria (as established by D.I. Gorzhevsky, G.V. Ruchkin, P.V. Pankratyev, H.A. Akbarov, A.P. Titova, U.A. Asanaliev, V.A. Korolyov, V.A. Nevsky, E.M. Nekrasov, A.D. Shmulev, and others) [5, 188]. Their stratigraphic levels are determined by their specific positions within the regional stratigraphic sequence. For instance, the Uchkulach deposit corresponds to the lower level, while Mirgalimsay is associated with the middle Famennian level. Researchers include lead and zinc deposits such as Kalkonota, Sumsar, Uchkulach, Shalkiya, Mirgalimsay, and Achisay within this formation group. For these deposits, carbonate rocks (dolomites) serve as the lithological control factor, exploration indicator, and forecasting criterion [5, 189].

According to data from Z.S. Rumyanseva, P.V. Pankratyev, A.P. Titova, H.A. Akbarov, and others, a broad range of structural controls is characteristic of this group of deposits. Accordingly, various exploration indicators have been identified: ancient consolidated structures (the South Uchkulach fault-thrust); tectonic depressions (for the accumulation of sedimentary ores); folds; longitudinal and transverse faults (the Dalniy sector of the Uchkulach deposit); and stratabound bedding-plane cavities [5, 189].

The technical cornerstone of this school lies in the dynamic synthesis of structural geometries and sedimentary facies. Academician Akbarov's core thesis posits that ore localization is a deterministic outcome of "tectonic traps" meeting "reactive lithologies". By mapping the spatial intersection of fault-thrust systems with specific carbonate sequences, his methodology shifted the focus from broad-scale geological surveying to high-precision predictive modeling. This shift allowed for the identification of blind or concealed deposits that were previously invisible to conventional exploration techniques.

Main content.

The genesis of Academician Habibulla Akbarov's scientific school is intrinsically linked to the critical transition of Uzbekistan's geological industry from a centralized Soviet system to a sovereign national framework. During the latter half of the 20th century, Akbarov identified that the traditional exploration methods required a more rigorous academic foundation to address the complexities of the Tien Shan metallogenic belt. His school became a bridge, preserving classical mineralogical traditions while pioneering a transparent, results-oriented approach that aligned with the strategic interests of an independent Uzbekistan.

The structural-facies analysis methodology, developed by Academician Habibulla Akbarov's scientific school, represented a revolutionary advancement in the forecasting of base metal deposits, such as lead and zinc. In his seminal work, "Geological-Structural Types of Polymetallic Ore Fields and Deposits in Central Asia and Certain Issues of Their Exploration and Appraisal", Akbarov categorized geological-structural types into four distinct groups: folded, disjunctive (fault-related), contact-related, and complex types. This work provides a comprehensive exposition of the structural characteristics of endogenous polymetallic ore fields and delineates specialized strategies for their exploration and appraisal [6, 187].

The essence of Akbarov's approach lies in the paradigm that mineral deposits are not random occurrences but are localized at the intersection of specific geological structures (faults, folds) and facies (the composition and formation environment of rocks).

Structural Control: This involves the geometric analysis of faults, thrusts, and folds within an ore field. Akbarov scientifically demonstrated that specific structural elements – such as fault intersections or fold hinges – act as "traps" for hydrothermal ore-bearing solutions.

Facies Control: This examines the lithological composition and thickness of ore-hosting rocks (e.g., dolomites). It identifies which lithotypes are chemically predisposed to react with ore solutions, thereby facilitating metal precipitation.

Synthesis (Integration): The methodology integrates these two factors. In predictive mapping, areas where favorable structural traps coincide with favorable lithological environments are designated as high-priority targets for discovery [7, 220].

In deposits like Uchkulach or Mirgalimsay, this method shifts the focus from merely identifying the presence of a specific rock type (e.g., "there is dolomite") to pinpointing where tectonic disturbances intersect those layers. This precision directs drilling operations toward high-probability targets, significantly reducing the costs associated with unproductive exploration.

Academician Akbarov's research, centered on the genesis and localization patterns of endogenous ore deposits, established a multifaceted complex of forecasting criteria [8, 257]:

Stratigraphic Criterion: Localization of ore within specific age-defined strata (e.g., $D_2 – C_1$).

Lithological Criterion: The association of ore with particular rock types (primarily carbonates).

Structural Criterion: The concentration of ore within faults or interstratification cavities.

This methodology remains the primary guide for geological services across Central Asia for exploring stratiform lead-zinc deposits. Lithological control is particularly evident in the localization of these deposits within Lower Carboniferous volcanogenic-sedimentary sequences. Researchers such as T.Sh. Shayakubov (1976), P.V. Pankratyev (1981), and H.A. Akbarov (2006) emphasized the critical role of regional deep-seated faults, volcanic structures, and interformational detachments (srivs) in ore formation. These factors are prominently displayed in the Khandiza and Chakchar ore fields [9, 306]. Based on Akbarov's 2006 findings, deep faults and interformational dislocations in the Khandiza deposit acted as "conduits" for the ascent of mineralizing fluids.

In the context of "New Uzbekistan", the objective study of historical processes – including the historical management and confidentiality of national mineral resources – is essential for restoring historical truth. Re-evaluating industrial and technological history through the lens of national interests allows for a deeper understanding of Soviet-era resource distribution and infrastructure development.

Beyond theoretical paradigms, the Akbarov school functioned as a strategic consultant for Uzbekistan's industrial sector. The expansion of the mineral-resource bases for the Navoi and Almalyk Mining and Metallurgical Combinates was directly facilitated by the school's prognostic maps. By establishing clear stratigraphic markers for polymetallic mineralization, the school provided a scientific roadmap that minimized the financial risks associated with deep-level drilling. This industrial integration transformed geological theory into a tangible driver of national GDP and resource self-sufficiency.

Academician Habibulla Akbarov's scientific school is not only a bastion of geological research but also a vital guardian of Uzbekistan's mineralogical heritage. The school's activities possess profound economic significance: the discovery of new deposits enhances industrial potential and facilitates job creation. Furthermore, it promotes the rational utilization of natural resources and ecological preservation. By providing a scientifically grounded evaluation of Uzbekistan's mineral potential, this school has contributed to improving regional social infrastructure, fostering a culture of geological-mineralogical awareness, and enhancing ecological consciousness among the local population [10, 332].

Conclusion

In conclusion, the scientific school established by Academician Habibulla Akbarov during the years of independence has elevated the operations of geological exploration expeditions to a qualitatively new level, both in substance and methodology. These expeditions evolved beyond mere operational bases for exploration and surveying; they transformed into modern hubs of scientific excellence where innovative analytical approaches were systematically integrated into field practice.

The school's activities have played a pivotal role in augmenting the nation's mineral resource base, catalyzing new economic potential, and advancing the frontiers of national geological science. The scientific expertise and empirical achievements of the Hisar expedition, in particular, continue to serve as a robust and reliable foundation for the strategic identification and sustainable exploitation of mineral resources.

The modern relevance of the Akbarov legacy is best observed in its pedagogical impact. By establishing a "school of excellence", Academician Akbarov fostered a generation of specialists capable of integrating multi-disciplinary data-from geophysics to geodynamics. Furthermore, his school introduced a shift toward more sustainable resource management, emphasizing that scientifically-grounded exploration is the first step toward minimizing the environmental footprint of mining. Today, this legacy continues to define the ethical and professional standards of the geological services across Central Asia.

Furthermore, the enduring legacy of Akbarov's school lies in its holistic approach-bridging the gap between theoretical metallogeny and industrial application. By fostering a new generation of geologists equipped with advanced predictive modeling techniques, the school ensures that Uzbekistan remains competitive in the global mineral market. Ultimately, the integration of structural-facies analysis into state-of-the-art exploration protocols remains a cornerstone of the country's geological sovereignty and long-term industrial stability.

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