

The Role of the Institute of Geological Sciences in the History of Geology in Armenia

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Abstract: The article presents a brief history of the Institute of Geological Sciences (IGS) of the NAS of RA, and the achievements of different generations of its specialists in the field of bio-stratigraphy, paleontology, regional geology, tectonics, geodynamics, geological hazards, seismotectonics, lithology, volcanism, magmatism, isotope geology, metamorphism, ore-bearing potential, metallogeny, ore geochemistry, hydrogeology, hydro-geochemistry, engineering geology, and geological informatics. The recent concepts on the geology of the RA in these different branches are based chiefly on the results of studies carried out by IGS specialists, also jointly with their foreign colleagues. Currently, the IGS of the NAS of RA is the sole institution in the RA that leads both basic and applied-science research in different directions of geological science.

Key words: IGS NAS RA, history of the IGS, results of the IGS activity.

1. Introduction

The area of the Republic of Armenia (RA) covers 29,800 km² and is situated in the northeastern part of the Armenian Plateau, taking up the central part of the Arabian-Eurasian plate collision (Fig. 1). The evolution of this area, spanning from the Proterozoic to the Quaternary, has produced sedimentary, volcano-sedimentary, magmatic, metamorphic and mineral units of different ages and types. Considering the position and features of this area, experts from different countries chose it as the subject of versatile studies led since the 19th century (Abich, Oswald) till our days. Up to the 30-40s of the last century, due to the lack of local staff, different kinds of activities had been performed mainly by the efforts of specialists from Moscow to Leningrad (Saint-Petersburg). From that time onward, preparation of local experts has allowed the country to carry on research by efforts of Armenian specialists mainly.

After the disintegration of the USSR, it became

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possible to conduct studies in various disciplines jointly with experts from France, Switzerland, Germany, Great Britain, USA, Taiwan and other countries.

The brief history of the Institute of Geological Sciences and the main results of its activity are presented below.

1.1 Establishment of the Institute—A Brief Overview

The Armenian branch of the AS of the USSR, and the Institute of Geology under it, was established by the decision of the Armenian Government of January 28, 1935 for the purposes "... of strengthening scientific research in the field of natural production capacities...". Academician F. Levinson-Lessing, a geologist of international renown, was appointed president of the Armenian branch, and H. Karapetyan, a reputed geologist, graduate of the Higher School of Mineralogy in Mons (Belgium, 1912) was appointed director of the Geological Institute.

Academician F. Levinson-Lessing had an important contribution in the formulation of the scientific directions to be pursued by the institute. Under his

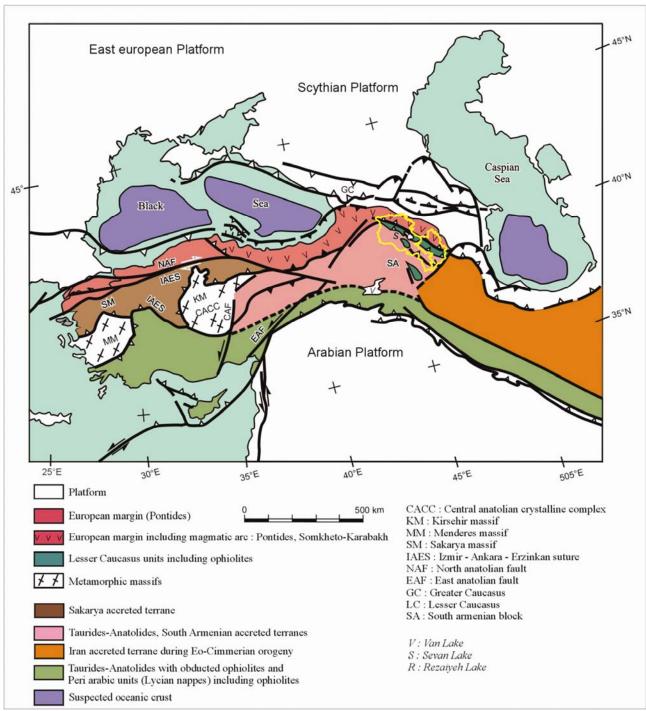


Fig. 1 Structural sketch map of the Tauride-Anatolides, the Caucasus and Iranian belts [8]. Armenian and Artsakh are outlined in yellow.

directorship, large-scale and important studies of the geology of Armenia, useful minerals, and water and land resources of the country were conducted by experts from Moscow to Leningrad (today's Saint-Petersburg) in 1927-1932. The institute started

its activity under rather limited capabilities in terms of staff, consisting of 22 employees only, with ten researchers not having any scientific degree. In 1936, the AS Presidium of the USSR considered H. Karapetyan's outstanding achievements and, avoiding

the common procedure of thesis defense, took decision to award him the degree of doctor of geological and mineralogical sciences and professor's title.

Up to the 1940s, in view of the lack of local specialists, various types of geological studies in Armenia had been led mainly by experts from Moscow to Saint-Petersburg. The scientific potential of the institute was strengthened considerably by experts of Armenian origin who had moved to Yerevan from Tbilisi and Baku since late 1930s, and even earlier (1925) from France. Department of geology and geography established at the Yerevan State University in 1934 (divided into two separate departments—one for geology and one for geography in 1941) and establishment of the mining department at the Yerevan Polytechnical Institute in 1949 played an important role in the training of local geologists.

During the years of World War II (1941-1945), the staff of the institute had been engaged mainly in the study of metal deposits in Armenia, primarily the copper-pyrite deposits of Kapan, Alaverdi and Shamlough, which were supplying copper concentrate to the copper-smelting factory of Alaverdi. Important studies were conducted in Syunik, addressing the copper-molybdenum mineralization and clarifying the prospects it might ensure. In the meantime, applied-science and local studies were performed in hydrogeology and engineering geology: mineral springs were identified and studied comprehensively, and resorts were later built in the largest spring areas such as Arzni, Jermouk, Dilijan and Hanqavan.

The next stage in the history of the institute (1945-1974) started from the early post-war years with research developing in the field of ore-bearing potential and metallogeny, tectonics, and bio-stratigraphy. It is important to emphasize the contribution of Academician H. Maghakyan in the theory of mineral formations and metallogeny. His studies on the typology of mineral units and metallogeny pioneered both in the USSR and beyond its borders [1, 2].

In 1950-1960, the institute staff was supplemented with big number of graduates from higher education institutions of the Republic, who helped to develop research in bio-stratigraphy, lithology, tectonics, magmatism, metamorphism, mineralization, geochemistry, recent volcanism, hydrogeology, engineering geology and other disciplines.

To foster links with the realm of production and to address promptly the needs of the main ore regions, affiliated research facilities of the institute were established at Kajaran, Vardenis and Alaverdi.

Activities aimed at studying dangerous geological phenomena (landslides, rock falls and other) in Dilijan, the Aghstev river basin and over other areas of the country, and at developing protective counter-measures were given the priority.

In the 1980s, the institute was one of the largest research institutions in the system of the Academy of Sciences of Armenia. In 1985, it had a staff of 420, including 10 researchers holding the title of Doctor of Science, 80 researchers titled Candidates of Science, and 130 engineers. The scientific capacity of the institute allowed implementation of studies under the most important lines of geological science.

The disintegration of the USSR, with consequent significant reduction of the budget the institute had been allocated from the state and from the contractual funding since 1992, changed both its research priorities and the organizational structure. Taking into account the lessons learned from the disastrous 1988 Spitak earthquake, the laboratory of geodynamics and the laboratory of hazardous geological effects and monitoring were established at the institute and the research led by those units has attained top priority among the research themes.

In the meantime, under the new independent state of Armenia, the institute got its first ever opportunity to establish direct contacts and carry on joint studies in different directions with research institutions from France, Switzerland, Germany, UK, USA, Italy, Taiwan and Iran, taking advantage of their advanced

analytical capabilities. The studies implemented with contribution of those institutions with the support of various international granting initiatives (CRDF, INTAS, PICS, NATO, LIA, MEBE, SCOPES, IRG, DARIUS and other) produced new important results in different fields of geology.

2. Main Results of Institute's Activity

The outcome of research carried out by several generations of the institute staff, independently and jointly with experts from different countries, has formed the basis for the recent concepts on the geology of Armenia. Considering this, below we dwell on the main results generated in different geological disciplines.

2.1 Bio-stratigraphy, Paleontology and Regional Geology

The layout of bio-stratigraphic subdivision of the sedimentary and volcano-sedimentary units was compiled for the Phanerozoic (the Middle Devonian-Pleistocene) on the basis of the findings contained in monographs addressing studies of individual fauna groups [3, 4]. The results of the listed studies paved the ground for the preparation of regional and specialized geological maps at different scales.

In 1971, the schematic geological map (edited by S. Mkrtchyan) was prepared for the ArmSSR area at the scale of 1:600,000.

2.2 Tectonics, Geodynamics, Paleoseismology and Seismic Hazard

Features of the geology and tectonics of the RA and adjacent regions were identified and geodynamic models explaining their development were proposed [5-8]. The GPS network of 7 continuous and 32 session-based observation stations was deployed over Northern Armenia (Karakhanyan and Levonyan).

Active faults were identified in the area of the RA and adjacent countries, and rates of their recent activity were estimated [9, 10]. The Pambak-Sevan-Syunik

fault was identified as a single-whole tectonic structure and characterized, seismic hazard assessment was conducted for its main segments [11]. Surface paleo-ruptures were identified in different regions of the RA, their kinematics and displacement size, magnitude and time of the related earthquakes were estimated.

Jointly with experts from the USA, probabilistic assessments of the volcanic and seismic hazards were conducted for the site of the existing ANPP and its designed unit [12, 13]. This study was highly appraised and approved by the IAEA.

The map of active tectonics of the RA and adjacent regions was prepared; seismic hazard and risk were evaluated for selected settlements and areas of the country (A. Karakhanyan et al.).

2.3 Lithology

The age, material composition, lithological and paleo-geographic conditions of formation, features of origin and evolution, potential fields of use, as well as the oil- and gas-bearing potential were identified for the Phanerozoic sedimentary and volcano-sedimentary units [14-16].

The lithology map of the ArmSSR area was compiled at the scale of 1:500,000 (1985, editor-in-chief—A. Aslanyan, editor-in-charge—M. Satian).

2.4 Volcanism

Armenia is a classical province in terms of manifestations of volcanism, especially of its recent stage (Late Pliocene-Quaternary), the products of which cover about two thirds of its area.

As part of the paleo-volcanism studies, the Mesozoic (J- K_2) and Cenozoic (${P_2}^2$ - ${N_2}^1$) volcanic units were subdivided into individual age complexes, their material composition was determined, main regularities of volcanic evolution were revealed, evolution models and geodynamic settings of

development were proposed, and their contribution in the ore formation process was discussed [17, 18].

The age, features of distribution, structure, morphology and material composition of the young volcanism products (Late Pliocene-Holocene) were analyzed, types of volcanism and active volcanoes were identified, volcanic hazard was assessed, petrological and geodynamic models were proposed to explain their formation [17, 19-21].

A catalog of recent volcanism was compiled (in three volumes). It includes detailed information on the distribution, structure, morphological features, types and composition of products of the volcanoes [22].

The geological map of the Pliocene-Quaternary volcanic units in the RA area was prepared at the scale of 1:100,000 in 2007 (Jrbashyan, S. Karapetyan, Ghoukassyan, Kharazyan).

2.5 Magmatism and Metamorphism

Typology charts based on the age, formation and geochemistry were developed for magmatic and metamorphic formations in the RA; geodynamic settings of their origin and features of material composition, as well as ore-bearing capacity, were clarified and corresponding petrological models were proposed [17, 18, 23].

In the framework of French-Armenian cooperation, structural-geology, petrology and geodynamics models were developed to describe the evolution of the Lesser Caucasus ophiolitic association based on new geological, paleontological and isotope age data [24, 25].

The map of magmatic and metamorphic complexes within the area of the ArmSSR was prepared at the scale of 1:200,000 in 1975 (edited by Aslanyan and B. Meliksetyan).

The crystalline basements of the Pan-African and the Herzinian consolidation were discovered and identified according to the *Rb-Sr*, isochrone age estimations, their initial composition was determined, as well as the geodynamic and P-T settings of formation [26].

2.6 Ore Formation, Metallogeny and Ore Geochemistry

Main regularities of the distribution of metal deposits within the RA were determined and structural-metallogenic zoning and typology of formation of the deposits were proposed. The age, material composition and individual features of fluids were analyzed for some of the deposits; the deposits were classified by genetic types and models of their development were proposed [27-34], et al. The issue if any different, island-arc and orogenic, mineable Cu-Mo porphyry deposits existed in the RA area was clarified and their primary differences were demonstrated. The contribution of sea water in the process of development of the island-arc Cu-Mo porphyry deposits was identified for the first time [35], et al. Regularities of distribution of rare and noble elements over the ore formations of Armenia were established [36].

The presence of *Te*, *Bi*, *Re*, *Ge*, *As* and *Cd* minerals, and those of some noble and rare metals was discovered [37].

Large-scale geology, structural geology and prognostic metallogeny maps were prepared for the main ore districts, mineral fields and mineral deposits; promising sites were identified and evaluated.

2.7 Hydrogeology and Hydrogeochemistry

Main mineral springs (Arzni, Jermouk, Dilijan, Hanqavan) were discovered, comprehensively studied and classified [38-40]. Health resorts were constructed in the largest spring areas.

Hydro-geochemical descriptions were prepared for the drinking fresh waters, mineral waters, ore, lake, underground and surface water flows, which formed the basis for the assessment of their efficient utilization capabilities [41, 42]. The environmental impacts of mining industry in the mining regions were assessed; recommendations on the improvement of the environmental situation and water use were given [43].

Scientific provisions for the development of national

standards to set the contents of chemical elements in fresh water were formulated [44].

The map of mineral waters of Armenia at the scale of 1:600,000 was prepared in 1967 (Doloukhanova).

The landscape-geochemistry map of Armenia at the scale of 1:200,000 was prepared in 1980 (Kaplanyan).

2.8 Engineering Geology

Susceptibility to deep sliding of slopes was identified and studied [45]. Engineering geology zoning was established for certain regions and river basins, and recommendations on counter-landslide measures were given. Engineering geology maps were developed at different scales for individual cities and settlements, instructions to undertake measures against hazardous landslide effects were issued for some sites [46, 47].

The 1:200,000 landslide map was prepared for the area of the RA; recommendations on measures to protect against landslide effects were developed for selected settlements (H. Baghdassaryan, A. Karakhanyan).

2.9 Geological Informatics

Specialized GIS model for geological data was developed and established [48]. A new coding system was proposed for water resources, along with hydrology maps and water resources management GIS for the RA, GIS for the RA population census, and strong earthquake modeling GIS for the Yerevan city; natural disaster risk assessments were conducted for selected areas.

3. Conclusions

The present-day concepts about the geology of the area of the RA are based mainly on the results of activity led by several generations of scientific staff at the IGS, also in cooperation with experts from other countries. Currently, research activities are realized at 10 laboratories of the institute: (1) laboratory of paleontology and stratigraphy; (2) laboratory of

regional geology and lithology; (3) laboratory of geodynamics and hazardous geological effects; (4) laboratory of geo-monitoring and geo-archeology; (5) laboratory of volcanism; (6) laboratory of petrology and isotope geology; (7) laboratory of useful minerals, (8) laboratory of hydro-geochemistry; (9) laboratory of geo-informatics; and (10) laboratory of chemistry.

The Geological Museum after H. Karapetyan, and the Geological Library have been active under the institute since 1937.

Currently, the institute employs a staff of 155, with 10 doctors of science (among them 2 academicians and 1 corresponding member to the NAS of the RA), 38 PhD holders and 35 engineers.

The results produced in diverse geological disciplines were published in the Earth Science Bulletin of the NAS of RA, reputable international journals and volumes (Tectonophysics, Lithos, Geodynamica Acta, Geophysical Research, Geology, J. Archaeological Sciences, J. of Asian Earth Sciences, Geological Society Special Volume, Chemical Geology, J. of Volcanology and Geothermal Research and other).

Presently, the Institute of Geological Sciences of the NAS of RA is the only organization in the RA leading both basic and applied scientific studies in the priority fields of geology.

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