

# **A brief history of the Geological Survey of Israel**

by

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## **Introduction**

The Geological Survey of Israel (GSI) is a research institute entrusted with the study of the natural resources and natural infrastructure of Israel. It serves as a center of applied scientific knowledge focused on national needs in earth sciences. The institute maintains a close network of professional ties and cooperates with other government research institutions, industrial companies and universities in Israel and abroad. The GSI activity is carried out as part of thematic, short-term and long-term projects, in accordance with an annually updated work plan, in response to the changing state and public needs. The GSI is mostly funded by the government, but research is also supported by competitive grants from local and international science funding organizations. Other sources of support come from agreements between Israel and other governments and from national projects, which in recent years included national preparedness for earthquakes and monitoring and studying the consequences ensuing from the Dead Sea level drop. In 2020, the core of the survey's staff are 43 scientists with PhD degrees in geology and natural sciences, 50 auxiliary and administrative staff members and 25 graduate students for high

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degrees. The GSI provides expert services and independent advice to the public in all spheres of geoscience, industry and universities in Israel and abroad. Based on its scientific achievements, the GSI is presently a well-recognized research institute in Earth Sciences.

Key words: Israel, natural hazards; earthquake monitoring; seismology, geological mapping; climate change, water resources, marine geology.

## **A brief geological background**

The land of Israel, “the Holy Land”, although occupying a small area of only 22,000 km<sup>2</sup>, is highly diverse in its geological features, making it attractive for geoscience research (Fig. 1). Here are a few such attractions:

- The Dead Sea, the saltiest lake in the world, is also located at the lowest basin on the continents, - 730 m below sea level.( [Gavrieli et al., 1998](#); [Lensky et al., 2005](#))
- The Dead Sea Transform, an active plate boundary between the African and the Arabian Plates (e.g., [Garfunkel,1981](#); [Garfunkel and Ben-Avraham, 1996](#); [Beyth et al.,2017](#) ) .
- The most northern tip of the Arabian Nubian Shield, which documents the Mozambique Ocean and the East African Orogen during the Neoproterozoic (850-580 m.y), is exposed in the Elat/Timna area in southern Israel ([Beyth et al., 2014](#)).
- The Timna Valley, famous for hosting “King Solomon’s” ancient copper mines of the 11-9 century BC ([Beyth et al. 2018](#))
- The speleothems in karstic caves, widespread in the carbonate lithology, which record paleoclimate signals during Quaternary ([Bar-Matthews and Ayalon, 2011](#)).

The geology of Israel and parts of the neighboring countries are well studied and mapped. Papers, reports, books and maps are available through the library of the Geological Survey and through the GSI’s Internet site [www.gsi.gov.il](http://www.gsi.gov.il).

## The story and the people

With the establishment of the State of Israel in 1948, Prof. Leo Picard, a young geologist and a devoted Zionist, submitted a memorandum to the newly formed government, suggesting to establish the "Geological Survey of Israel" as an independent institute. Prof. Picard immigrated to Israel from Germany in 1924 and first founded the Department of Geology in the Hebrew University on Mount Scopus, Jerusalem (Picard, 1996). When the approach by Prof. Picard to the government was made, the Geological Survey, whose goal was to study the geology and the natural resources of the Land of Israel, was established as part of the Department of Geology at the Hebrew University, headed by him at that time. Since his arrival and during the British Mandate of Palestine (1920-1948), Prof. Picard studied the geology of the region (Picard, 1943), mostly its water resources and minerals like phosphates and potash. His work was sponsored by the Jewish Agency, which served as an embryonic Jewish government and played a central role in the foundation of the state of Israel. Prof. Picard's studies were published in international scientific journals. He cultivated scientific contacts with other geologists who worked in the region. These included M. Blanckenhorn, who mostly worked during the pre- World War I Ottoman period, L. Dubertret, the geologist of the French Mandate in Lebanon and Syria and during the British Mandate, also with the government geologist, G.S. Blake. These early studies mark the beginning of geological mapping in Israel, and constitute the foundation of the geological studies of the country. Moreover, during that time, Prof Picard initiated the orderly collection and archiving of maps, articles, books, rocks and fossils, which later became the national archive, presently hosted at the GSI.

During the 1948 war of Independence Mt. Scopus, that was the home of the Department of Geology of the Hebrew University, became an enclave surrounded by Jordanian military. As a result, the university as a whole, including the department of geology, was forced to move to the Jewish held part of Jerusalem. At this stage, all the materials of the Mandatory Geological Unit were also transferred to the new site. The collection included, among others, the new geological map of southern Israel in 1: 250,000 scale, published at the end of the British Mandate by the British government geologist S.H. Shaw, and the comprehensive book on the geology and water sources of Palestine by G. S. Blake and M. J. Goldschmidt (1947).

In 1953, Picard's idea of an independent Geological Survey, finally became a reality. The Geological Survey was separated from the Department of Geology of the Hebrew University and became a government institute under the Ministry of Development. The new institute was housed at St. John's Hospital, in Hebron Road St., Jerusalem. The building still stands and today it is part of the Mount Zion Hotel. From 1953 to 1955, the institute was headed by F. Brotzen, a paleontologist who previously served as the director of the Swedish Geological Survey. It was in this early period that the internal structure of the survey was established, with departments focused on oil, water, geochemistry, paleontology, mineralogy and mapping. They were all headed by young geologists that we can refer to today as "the founding generation": Dr. Peretz Grader (oil), Zeev Shiftan (water), Dr. Zeev Bodenheimer (geochemistry), Prof. Zeev Rice (micropaleontology), Uri Wurzburger (minerals), and Dr. Natan Shalem (Quaternary geology).

Prof. Y. K. Bendor headed the GSI from 1955 to 1966. During this period the GSI established its status as an advisory body to the government and to the governmental companies dealing with natural resources. These included the water resources companies Tahal and Mekorot, the phosphates, oil shales, Iron and copper company, Israel Minerals, the Dead Sea minerals (potash and bromine) company Dead Sea Works, and the government-owned oil companies Nafta and Hana. In addition, the Geological Survey had a leading role in advising private companies in the cement industry (Nesher), in building materials (Clay and Pure Sand Co), and ceramics, as well as various other national projects. In the early 1950's, Prof. Bendor, who also held an appointment at the Geology Department of the Hebrew University, with his students and colleagues, in particular A. Vroman, studied the potential of mineral resources in the Negev desert in southern Israel. This important study was carried out in the framework of the newly formed GSI. The products of their studies were published as series of 1:100,000 geological maps and explanatory notes (e.g., [Bendor and Vroman, 1960](#)).

Later in the 1950's, the GSI became also active in limnological and oceanographic research. The first important limnological study was carried out by Dr. D. Neev and Prof. K. O. Emery on the Dead Sea and was published as a GSI Bulletin ([Neev and Emery, 1967](#)) that provided the scientific base for all subsequent Dead Sea lake studies. They also carried out pioneering oceanographic studies of the Mediterranean and its coast ([Emery and Neev, 1960](#)).

As Israel and the region around it have been known for earthquake activity, mostly related to the Dead Sea Transform, a nucleus seismological unit was established within the Geological Survey. This unit included a seismic station at the Hebrew University and was a continuation of a similar station established earlier by the British Mandate.

In the early 1960's, the Geological Survey initiated scientific collaborations with various developing countries. GSI scientists shared their expertise with local geologists in Africa, Asia and South America. Several such projects focused on water resources especially in arid lands, such as the Casvin district of Iran. Other overseas projects included surveying raw materials in Colombia and consulting to countries such as Madagascar, Greece, and Turkey. In Ethiopia, in the late 1960's and early 1970's, a team of GSI geologists assisted the local government, to establish the Ethiopian Geological Survey and conducted geological mapping and prospecting of northern Ethiopia.

Following the recommendations of a government committee, known as the Prof. Efraim Katchalski (Katzir) Committee (Prof., Katzir, was a professor at the Weizman Institute and the president of Israel (1973-1978)), the GSI received the formal government recognition in 1968 as a research institute. This formal definition as a research institute greatly improved the academic stature of the GSI and helped attract Earth scientists at the highest academic level. In order to synchronize between all governmental institutes dealing with earth sciences, and to ensure the overall efficiency of the government's earth-science research, the Earth Sciences Research Administration (ESRA) was established in 1980 by Dr. Y. Vardi, the director general of the Ministry of Energy and Infrastructure. Its first director was U. Wurzburger. This reorganization also followed the recommendations of the "Katchalski Committee", as well as that of the subsequent "Yiftach Committee" for the organization of the government research institutes in all fields of earth sciences. The government's research system for Earth Sciences included the Geological Survey of Israel (GSI), the Institute for Petroleum and Geophysics (later called the Geophysical Institute of Israel, GII), established in 1957 and the Israel Oceanographic and Limnologic Research (IOLR), established in 1967.

After the 1967 six-days war, the geological Survey, headed by E. Zohar (1967-1979), also conducted studies and mapping projects in the Sinai and the Judea and Samaria.

During the 1990's, a review committee headed by Prof. I. Dostrovsky, former president of the Weizmann Institute of Science and a member of the Israel National Academy of Sciences, was appointed by the ESRA to evaluate the GSI. The main recommendation of the committee was to end the situation in which GSI was an integral part of the Ministry of Energy and Infrastructure. Instead, the GSI was to become an independent organization, which is only supervised by the ministry. This recommendation was implemented in 1998, greatly contributing to the transformation of the GSI into a leading applied geosciences research institute, with an important role in the short and long term government planning of national projects.

Earlier on as a research institute, the GSI adopted the concept of a regular change in its leadership, with a fixed term of 5 years for its director. Since 1979, when it was first implemented, the GSI was headed by Dr. Uri Kafri, Dr. Yosef Bartov, Dr. Yaakov Mimran, Dr. Amos Bein, Dr. Gideon Steinitz, Dr. Binyamin Begin, Dr. Itai Gavrieli, Dr. Rivka Amit and Dr. Yoseph Yechieli. All these directors are geologists by training and have the government's academic level equivalent to that of full professor.

Only in the early 1960's the GSI moved to its semi-permanent site in Jerusalem, within a previous British military camp at the historical site of the Schneller Orphanage. In 2019 the GSI moved at last to a new, custom-designed, modern building, planned to facilitate the present and future research activities of the GSI near the Givat Ram campus of the Hebrew University, adjacent to the Earth Sciences Institute of the Hebrew University (Fig. 2). This move greatly improved the infrastructure for supporting the GSI's state-of-the-art instrumentations and laboratories that include among others: X-Ray Diffraction Laboratory, Organic Analytical Laboratory, MC and CPMS devices, Stable Isotope Laboratory, Scanning Electron Microscope (SEM), ICP-OES and ICPMS facilities, GPS, Remote sensing lab; ground Lidar, mapping lab; Laser diffraction for particle size; digital and classical library; archives (e.g., national water and oil core archive); seismological lab and the HUB for Israel's early warning system for earthquakes. In addition, its proximity to the Earth Science Institute, the largest earth sciences academic department in Israel, led to increased cooperation, which in turn, increased the productivity of both of these leading geological research organizations.

## **Strategic goals of the GSI through time.**

Over the years changes in the research directions taken by the GSI were dictated by the national needs of the state as it developed. As the population grew from less than 1 Million in 1948 to more than 9 million in 2020, the country became densely populated, resulting in a constantly increasing needs of natural resources, and multitude of environmental problems related to geoscience. In addition, recent global hazards like climate change, sea-level rise and more, had to be taken into consideration in the GSI's strategic plan.

When the GSI was first established, its main challenge was to begin a systematic geological mapping campaign of the country, to evaluate the potential of its natural resources, particularly water resources, and to help the state in planning its infrastructure. Accordingly, the initial structuring of the GSI in the early 1950's, included the traditional mapping, oil and water departments, as well as a mineral prospecting department. This department was tasked with engaging and developing construction materials for the housing of the many immigrants that flocked into the country, and other economically interesting minerals, such as phosphates, potash, bromine and copper, to help the then fragile economy.

A gradual change in the work of the GSI, resulting from increasing environmental pressure of the growing population was associated with a change in its structure into five more environmentally focused divisions: Engineering and Geological Hazards; Stratigraphy and Subsurface; Geology and Geochemistry; Water Resources; Geological Mapping.

The growing involvement of the GSI in environmental issues, established it as a key player in the long-term planning of sustainable development and effective utilization of natural resources in Israel. The GSI also became deeply involved in the formulation and integration of national policies on infrastructure, like the feasibility study for building artificial offshore islands, as well as the planning and development of proper preparedness for natural and man-made risks. As a result, new environmental topics, such as climate change, geological hazards, neotectonics and paleoseismology, became an important part of the work carried out by the GSI. Many of these projects are interdisciplinary, often carried out together with ILOR and universities. In other projects, the cooperation was with government organizations, such as the Ministry of the Interior, the Ministry of Environmental Protection, the

Ministry of Construction and Housing, the national interior planning department, the Nature Reserves Authority and additional government companies.

These new directions in the work of the GSI became possible by the upgrade of the staff level and research facilities after the survey was recognized as a research institute and transformed into an independent organization. These two formal changes enabled the GSI to recruit scientists at the highest scientific level, who in turn, introduced to the GSI new and more modern research methods. The formal independence also enabled GSI to upgrade its facilities, in particular analytical instruments, required for ensuring that it is in the forefront of the research in geosciences.

In October 1994, the peace treaty between the State of Israel and the Hashemite Kingdom of Jordan was signed. It brought about collaboration with the Natural Resources Authority of Jordan (NRA) in areas such as seismology, regional structural geology ([Sneh et al., 1998](#)), water resources, Dead Sea-Red Sea Canal and sinkholes hazard around the Dead Sea.

Recently, a project was initiated to disseminate the information on some of the unique geological attractions in the country, for tourists, students and amateur geologists. The publications on the Elat/Timna area is an example of this initiative. The stratigraphy and structure of the well-exposed rocks in the extreme arid desert climate of the Elat/Timna area, document the geologic evolution of this area from Neoproterozoic to the Holocene, making the geology of this area so attractive. Therefore, this area was extensively studied and has turned into a field laboratory for geoscience students. The published studies of the Elat/Timna area support the dissemination of the geological data to the public, making it into a national and international field school for geology ([Beyth and Calvo, 2015](#)).

### **Few recent achievements of the GSI**

In recent years, the GSI upgraded its mapping division with the most modern equipment, and published geological maps of almost the entire country at 1:50,000. GIS-formats of these sheets are now available by request through the GSI website.

According to governmental decision from 2012, the GSI monitors and studies the consequences of the Dead Sea level drop. These studies are an immense contribution to the limnologic research of salt lakes in general, and to the understanding of geomorphological and hydrological changes in response to fast and dynamic lake level changes. They were done partly in collaboration with IOLR, and focused on the geochemistry and hydroclimatology of the Dead Sea water body (e.g., [Lensky et al., 2018](#)). Also, they looked into the response of the coastal infrastructure to rapid sea level drop, in particular the formation of sinkholes in the exposed Dead Sea bed. In addition, a pioneering feasibility study of the Red-Dead Seas Canal was conducted, in collaboration with the Hashemite Kingdom of Jordan, under the umbrella of the World Bank ([Gavrieli et al., 2011](#)). At present, intensive research is conducted by at least 20 researchers studying issues related to hydroclimate, geochemistry of the Dead Sea water body and the geomorphology of the Dead Sea coasts. In this framework the GSI team is also developing an Early Warning System for sinkholes ([Nof et al., 2013](#); [Abelson et al., 2018](#); [Arnon et al., 2019](#)). A notable milestone in the study of the Dead Sea was the international scientific ICDP Dead Sea Deep Drilling Project conducted in 2010-2011. At the center of the Dead Sea, at a water depth of 300 m, drilling yielded a continuous core of 720 m. The study of the core contributed greatly to the understanding of the environmental conditions in the region between the Pleistocene to the Holocene ([Stein et al., 2010](#); [Goldstein et al., 2020](#)).

The GSI continuously monitors the natural coastal processes that affect Israel's Mediterranean coastline. These include the processes that drive the retreat of the coastal cliff and their response to natural, as well as anthropogenic environmental changes. A key objective of these studies is to provide policy makers, at the national and local levels, with the information required for planning and mitigation ([Almagor and Perath, 2016](#); [Katz and Mushkin, 2013](#); [Barkai et al., 2017](#); [Mushkin et al., 2019](#)).

In recent years, the government of Israel approved a project, initiated by the GSI, to establish an Earthquake Early Warning System (EEWS) for the country. The GSI leads this high-profile national project, which includes a network of 120 seismic stations along the Dead Sea Transform and the Carmel Fault that will be connected to a national alarm system for civil defense (e.g., [Kurzon et al., 2020](#)). Geodetic investigation, GPS measurements of the interseismic deformation along two neighboring sections of the Dead Sea

Transform in Israel, were conducted by the GSI for about 20 years (e.g., [Hamiel et al., 2016](#)).

The GSI pioneered a study of the regional Quaternary climate, based on variations in high resolution speleothem records in caves (e.g., [Bar-Matthews and Ayalon, 2011](#)). Paleoclimate reconstruction of the region by the GSI, is also based on studying proxies such as soils, loess, coral reefs, deep marine and lake cores (e.g., [Amit et al., 2006](#); [Crouvi et al., 2008, 2009](#); [Stein et al., 2010](#); [Vacks et al., 2007](#)).

The GSI has also been deeply involved in groundwater studies, including monitoring and modelling ground water levels, geochemical identification of pollution sources and studies of deep-drilled wells for geothermal potential and radioactive waste disposal. The results of these studies support the national water management and help finding solutions to the common droughts (e.g., [Shalev et al., 2016](#)).

As a result of the recent gas findings in the Mediterranean Sea, the GSI leads a project focused on geological hazards management in the Mediterranean Sea. This work integrates studies of salt tectonics with active tectonics and marine shelf instability associated with slumps and canyons formation (e.g. [Gvirtzman and Steinberg, 2017](#); [Gvirtzman et al., 2017](#); [Katz et al., 2016](#); [Zuker et al., 2020](#)).

Funding of research at the GSI through national and international competitive grants is on the rise in recent years. In many of these grants, students from the various Israeli universities, are supervised by GSI researchers, together with their university mentors.

Finally, several GSI scientists received notable awards. These include its past directors, Prof. L. Picard and Prof. Y. K. Bendor, who received the highest Israel Award for Earth Sciences, Dr. M. Bar-Matthews and Prof. M. Stein received the Goldschmidt Award of the Geochemical Society and Dr. R. Amit received the Geological Society of America Farouk El Baz Award for desert research.

## Summary

Throughout the years, the GSI had an important role in developing both the country's infrastructure and its research infrastructure in geology and related fields. An important factor for the success of the GSI in helping the country to develop its natural resources and infrastructure, has been its ability to synchronize its activity with the changing national priorities related to geosciences. The most important achievement of the GSI, as an applied science organization, has been its continuous supply of independent, objective and professional advice in response to the country's ever-developing challenges related to geosciences. At the same time the GSI was successful in becoming a top geoscience research organization, by devoting part of its effort to basic research funded by competitive national and international grants. The knowledge gained in these studies directly helped GSI in fulfilling the task of supporting the national needs of the country. It also helped recruit top scientists and advanced-degree students, which in turn, helped bring GSI to where it stands today as an internationally recognized geoscience organization.

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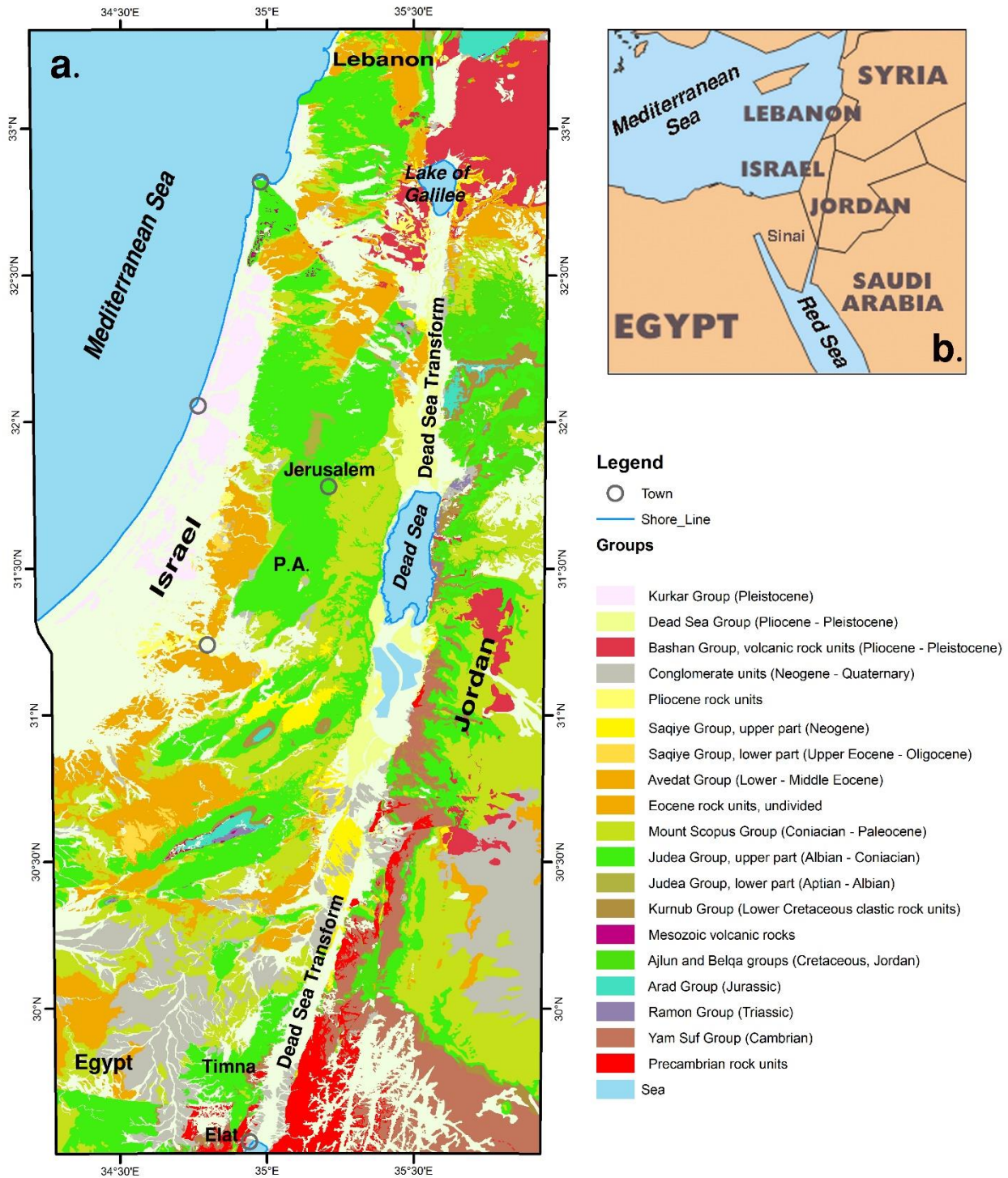


Fig. 1 General geology and location map. P.A. Palestinian Autonomy.



Fig. 2. The new Geological Survey of Israel building at Givat Ram, Jerusalem.