

TRANSFORMING THE NATIONAL CORE LIBRARY INTO A MODERN SERVICE CENTER FOR THE MINING SECTOR

By the Members of the National Core Library Initiative

BACKGROUND

The modernization of the National Core Library (NCL) and storage facility upgrade are initiatives under the National Geoscience Information Program, which is part of the ambitious Saudi Vision 2030 national program. The NCL, a division of the Saudi Geological Survey (SGS), is tasked with archiving drill cores and other geological sample materials. It also provides digital and on-site services to both external and internal stakeholders.

Modern, largely digitized drill core library, along with other extensive datasets, are considered important factors in attracting foreign investments into the exploration and mining sectors of the Kingdom of Saudi Arabia. These resources support further exploration activities. The National Geoscience Portal (NGD) will give stakeholders access to this digitized data. As the volume of digitally available data increases, the necessity for physically inspecting archived drill cores will decrease, though it will never be eliminated entirely.

COMPLETION OF PHASE 1

The development of the NCL was initiated in 2021, when the contract for Phase 1 was signed between the SGS and the Geological Survey of China (CGS). The main components of Phase 1 include:

- The complete renovation of the existing archive building to a modern and safe working environment, which was completed in June 2022
- The development of Standard Operating Procedures and QA/QC processes for all routine tasks
- The establishment of a digitalization process
 - The acquisition of geochemical data using portable XRF-analyzers (pXRF).
 - Hyperspectral scanning with the two installed hyperspectral scanners.
 - The interpretation of the hyperspectral data for mineral identification.
- The digitalization of 20 km of drill core, which was completed by the end of 2022.



H.E. Bandar bin Ibrahim Al-Khorayef, Minister of Industry and Mineral Resources, and Khalid Saleh Al-Mudaifer, Vice Minister for Mining Affairs, along with the team from SGS (headed by the CEO of SGS, Engr. Abdullah Shamrani), visited NCL following the completion of Phase 1.

Information regarding the projects that have been scanned up to this point

Project Name	Region	Mineralization Type	Number of Boreholes	Number of Boxes	Total Length(m)
Wadi Al Ghuathayra	Riyadh Region	Porphyry Copper	18	1,590	7,001
Wadi Kilwa (Wadi Khadhra)	Baha Region	Nickle	4	212	909
Umm Jafr	Riyadh Region	Copper, Gold	8	285	1,229
Muhaddad	Asir Region	Copper, Gold	10	224	935
Al Lugatah	Asir Region	Gold, Silver	18	442	2,286
Jibal Al Humrah	Riyadh Region	REE	9	487	2,089
Umm Al Birak	Madinah Region	REE	9	491	2,141
Jibal Umm Ad Damar	Madinah Region	Copper, Zinc	16	1,055	4,500
Al Gariat Awla	Asir Region	Gold, Silver	12	227	905
Hishshash Al Qunaynah	Qasim Region	Gold, Silver	30	320	1,235
Jibal Aba Ad Dud	Madinah Region	REE	20	1,429	5,927
Harat Rahat	Madinah Region	Geothermal	4	974	3,700
Albaydaa	Madinah Region	Geothermal	1	214	801
Hadabat Sharrar	Madinah Region	Geothermal	1	213	800
Jabal Dhaylan-NW	Tabouk Region	Zinc, Lead	11	478	1,837
Bi'r Tawilah	Makkah Region	Lithium	16	767	2,895
South Jibal Aba Ad Dud	Madinah Region	REE	11	1,232	4,562
TOTAL			198	10,640	43,752

- The development of database and data management applications required for the digitalization of data.
- Capacity building to enable SGS personnel to carry out further digitalization independently.

Following the completion of Phase 1, SGS staff has continued the hyperspectral scanning. As of this writing, 44 km of drill core have been scanned, which represents 18 different mineralizations of different types. The collected data has already been used by the SGS Accelerated Exploration Project (AEP).

The recent renovation of the archive building and the ongoing digitalization work have raised considerable interest in NCL. A number of delegations from KSA and other countries have visited the site, representing both government organizations and private exploration and mining companies. SGS's Accelerated Exploration Program has made use of the facilities to study legacy core from its targets.

EXPANDING BEYOND DRILL CORES

Over the next five years, NCL expects to receive ~300 km of drill cores from government projects alone. These projects include the Uranium Exploration Program and the Geothermal Energy Program. In addition to core samples, NCL will be responsible for archiving 90,000 stream sediment samples, 10,000

heavy mineral samples taken during the geochemical initiative, and 30,000 outcrop samples. NCL is also set to manage samples from future SGS projects.

The SGS and the Deputy Ministry of Industry and Mineral Resources (DMMR) are jointly finalizing the archiving rules and guidelines for drilling samples from expired or relinquished exploration and mining licenses. By the end of the 2020s, the annual volume of drill core is projected to surpass 200 km. A screening process will be introduced to reduce the amount of core to be hosted. The accepted core must meet specific criteria of representativity and economic or scientific significance. Additionally, NCL's scientific collections will be shared with exploration companies and academic institutions conducting fundamental research projects around the Arabian Shield.

SERVICES TO STAKEHOLDERS

In addition to offering the possibility to view and resample archived core or other sample materials, NCL is dedicated to providing a full range of services to external stakeholders. Companies may reserve logging space to examine their core or rent storage space for their storage. NCL staff are available for technical services, including sorting, cleaning, and metering core. Furthermore, the NCL offers hyperspectral scanning or pXRF data analyses upon customer requests.

FURTHER INFRASTRUCTURE IMPROVEMENTS

SGS is investing in new NCL buildings at its compound in Jeddah to accommodate the growth of services and collections. The new building will feature significantly larger core logging spaces, modern, fully adjustable logging tables, and warehouses with the capacity to store approximately 1,000 kilometers of

core. This capacity is expected to suffice for at least the next ten years. The scanning rooms will be designed to be adaptable, accommodating a variety of instruments to meet the evolving technical developments and diverse needs of stakeholders. The renovation of four existing warehouses is scheduled for completion in May 2024.



Mr. Ibrahim Zahrani conducted a hyperspectral scanning of the drill core.

STUDY OF CAVES IN UMM RADAMAH SEDIMENTARY FORMATION

By Mahmoud A. Al-Shanti, Nasser A. Al-Asmari

INTRODUCTION

Caves are viewed as a national treasure and hold a unique blend of economic and scientific value. Their formation and the breathtaking beauty of their internal structures are non-renewable, necessitating preservation and protection. Nations that invest in studying and utilizing these caves can unlock significant economic benefits. This is achieved by launching diverse projects in the economic, tourism, and scientific sectors.

Caves are hollow spaces located beneath the Earth's surface. The most valued are those that humans can enter, whether in the lowlands or highlands. Caves extend horizontally and branch out beneath the Earth's surface. The size of cave entrances varies, ranging from narrow, small-diameter openings to large ones. The internal dimensions of these cavities do not necessarily corre-

spond to the size of their entrances. Some caves have extremely narrow entrances, less than half a meter in diameter, yet lead to tunnels extending over thousands of meters.

The types of Caves in the Kingdom of Saudi Arabia are diverse, including limestone caves, basaltic lava tube caves, and sandstone caves.

The Umm Radamah Sedimentary Formation is a key formation where caves have been discovered and studied. It is primarily composed of limestone and dolomite rocks, with its thickness varying across different locations. The maximum thickness is approximately 490 meters in the Eastern Region. Along with its north and south-extending outcrops, this formation spans almost the entire Kingdom of Saudi Arabia, from the Northern Borders through the Central and Eastern Regions, ex-

tending southward beneath the sands of Rub Al-Khali. It is one of the Kingdom's most vital freshwater aquifers. The Umm Radamah Sedimentary Formation is characterized by its limestone rocks with hydraulic properties, high porosity, and excellent permeability. It contains numerous subterranean cavities formed due to the dissolution of limestone rocks. Due to weathering, vertical caverns, horizontal caves, and ground collapses are frequently observed in the northern and eastern parts of the Kingdom.

Research on caves and caverns within the Umm Radamah Sedimentary Formation is categorized into two primary regions:

1. The first category focuses on caves and caverns in the Northern Border Region of the Kingdom. The most notable caves and caverns studied in this region include the Black Scorpion Cave, Marzouq Cave, and Al-Wadi Cave.
2. The second category encompasses caves and caverns in the Central Region and a portion of the Eastern Borders of the Kingdom. A significant area within this scope is the Al-Samman area, which includes the Mossy Cave and Murubbeh Cave.

Caves and caverns host a variety of geological features, with stalactites and stalagmites being the most prominent. These formations differ in size and length, and their growth begins with a single water droplet. As water droplets continuously fall from the cave ceiling, they leave behind stalactites, carrying dissolved minerals, primarily calcium carbonate. These minerals are transported to the cave floor, forming circular and conical shapes known as stalagmites.

Caves in the Kingdom of Saudi Arabia are home to diverse organisms. These creatures dwell within the caves or near their entrances, particularly on the high ceilings. The inhabitants include wild pigeons, bats, scorpions, snakes, owls, and predators such as foxes and wolves.

Today, caves are predominantly used for recreational purposes and specialized tourism, allowing explorers and visitors to appreciate their geological features. In contrast, in ancient times, caves served as shelters, providing refuge from natural predators and extreme weather conditions, and they also served as water sources.



The entrance to the Surprise Cave, which is 20 meters deep, is located in the Al-Summan Plateau in East Central Saudi Arabia.

Nitrate, an essential component in gunpowder, was previously extracted from accumulations on cave walls, fissures, or limestone stalagmites on cave floors. Additionally, bat guano found in caves is recognized as a source of phosphate fertilizer for agricultural use.

Studies conducted by the Saudi Geological Survey (SGS) underscore the scientific significance of caves, particularly limestone caves, due to their

direct influence on the groundwater system. The limestone cave layers within the Umm Radamah Sedimentary Formation rank among the most productive aquifers (water-bearing layers) in the Kingdom of Saudi Arabia, underscoring their importance.

It's also important to note that areas located beneath limestone layers containing caves are susceptible to ground collapses and sudden subsidence.

Exploring caves and caverns is deemed risky if fundamental guidelines in this field are not followed. Cave explorers must be skilled in rock climbing, descending slippery, wet slopes, and navigating pools and water basins, particularly during rainy periods. They may encounter numerous obstacles, posing potential hazards. Certain areas may necessitate crawling through narrow, dark spaces. Additionally, it is crucial to understand the nature of cave rocks and the influence of natural factors on their mineral composition. Explorers should exercise caution when passing by or underneath unstable rock formations on cave walls or ceilings.

Cave exploration offers both adventure and surprises but can pose significant dangers. These risks are partic-



The image depicts a chamber filled with jagged limestone formations.



Several large caches of bones are found in Black Scorpion Cave.

ularly heightened when individuals fail to adhere to basic guidelines or neglect to use the appropriate equipment. Such oversights can lead to potential injuries, especially when descending into cave interiors using ropes and other specialized gear.

The Kingdom of Saudi Arabia's geological landscape is marked by an extensive spread of sedimentary rocks, mainly limestone, predominantly in the Central, Northern, and Eastern Regions. This is in addition to the Rub Al-Khali Desert, which lies beneath aeolian Quaternary sands. The limestone layers host varying sizes and characteristics of karst formations, which house natural cavities. These cavities are efficiently harnessed and have the potential to be converted into geotourism sites. The Saudi Geological Survey (SGS) has taken the initiative to explore and study these caves throughout the Kingdom, positioning itself as a leader in cave tourism. It oversees their development, monitors their condition, and ensures the sustainability of their geographical locations. Consequently, these caves can be utilized in the following ways:

- Presenting suitable sites to the Saudi investment market for potential utilization in establishing new industries and projects.
- Recognizing the potential risks that caves may present to the urban expansion of various regions and cities within the Kingdom and vital projects implemented in these areas.
- Formulating specific strategies to leverage these caves for diverse national objectives, such as their use as strategic natural storage facilities or as tourist attractions to stimulate development in the surrounding remote regions.

Caves can host over a thousand visitors daily. They present an opportunity for development at a reasonable cost without inflicting environmental harm. Caves serve as an educational portal to the largely unexplored underground environments and offer a unique recreational activity for local and international visitors. The allure of their internal beauty and the rare and exotic sites they offer make it easy to attract tourists. These sites are characterized by lower and more moderate temperatures than the prevailing surface weather, providing relief, especially during hot summer. Therefore, we advocate for protecting these natural national resources and their contents from inappropriate human interventions. We recommend preserving and developing these resources as a national heritage for future generations, linking them to the standard chronological history of humanity, and studying the paleoclimate of the Arabian Peninsula. We also encourage communication with governmental, international, and practical entities. Visitors to these caves should adhere to the cave motto: "Leave nothing but footprints, take nothing but pictures, kill nothing but time." (SGS-TR-2022-3)



The accumulation of water droplets rich in calcium carbonate forms stalagmites. This formation process can span hundreds of thousands of years.