Volume 70, Issue 2, 2026

Journal of Scientific Research

of

The Banaras Hindu University

Smartphone Geosciences

Dinesh Pandit*

Department of Geology, Institute of Science, Banaras Hindu University, Varanasi, Uttar Pradesh, India, *e-mail id: dineshpandit@gmail.com

Abstract: **Kashi Hindu Vishwavidyalaya also known as Banaras Hindu University (BHU) is the Capital of Knowledge, stands today as one of India's most celebrated and storied institutions of higher learning. The character of education and learning at the BHU in profound ways, creating an environment where academic reputation is devoted with spiritual and cultural development. The historical and philosophical foundations of the BHU, academic structure, teaching programs, physical and intellectual infrastructure that sustains it's a centennial tradition and legacy. The student life, classroom education, skill-building activities, digital challenges the university faces, and its ongoing efforts to remain relevant in a rapidly transforming world, which desires integration of innovative technologies to implemented in the education system. The incorporation of the National Education Policy (NEP) 2020's recommendations, including greater academic flexibility, multidisciplinary learning, and a focus on research from the Under Graduate level, that offers BHU both an opportunity and a mandate to modernize academic curriculum. Recently, the Department of Geology, Institute of Science, Banaras Hindu University developed and offer an innovative Skill Enhancement Course (SEC) for Under Graduate (UG) students, which is called as Smartphone Geosciences. The Smartphone Geosciences has been developed under the guidelines of the NEP 2020 that influences digital technology to transform education inside the classroom as well as field studies in remote locations. This course energetically involved in creating a "Viksit Bharat" through a knowledgeable and sustainable approach.**

Index Terms: **Banaras Hindu University, National Education Policy, Skill Enhancement Course, Smartphone Geosciences.**

I. Introduction

The National Education Policy (NEP) 2020, brought by India's Union Cabinet on July 29, 2020, is an inclusive agenda designed to renovate India's education structure to a high-quality and equitable learning system. It replaces the 1986 National Education Policy, shifting toward holistic, multidisciplinary learning, fostering critical thinking, and promoting mother tongue teaching. Reduces curriculum content to core essentials and focuses on holistic progress rather than summative assessments. Vocational education starts from undergraduate courses that include an internship (Pliz & Regel, 2021). Universities have been advised to introduce multidisciplinary courses by incorporating Skill Enhancement Courses (SECs) in undergraduate programs (Gillespie & Fairbairn, 2021; Nath, 2026). They aim to redirect the education system towards skill training that will enable comprehensive development and better employment prospects.

The NEP 2020 integrates Geosciences and environmental awareness through all levels of education. It focuses on climate change, biodiversity preservation and pollution remediation and moves from rote learning to experiential, interdisciplinary and inquiry-based relevant sustainable career development (Dey, 2026). The policy endorses environmental education from the school level to higher education, encouraging sustainable development and experiential knowledge. Ghani et al (2025) noted that Environmental Studies at the primary stage and science curricula in higher classes are designed to develop sound knowledge of nature, conservation, awareness training and sustainability. This permit, therefore, breaks the strict disciplinary separation between streams of study and allows students to come through subjects such as Geosciences together with social sciences, humanities, and arts for a holistic outlook (Christopher & Pinias, 2025). The policy also highlighted a focus on including environmental studies and sustainability as mandated undergraduate courses across its green initiatives (Rame et al., 2024). The focus of your training is field-based training, grounds-keeping, and a perspective on ecological systems, as opposed to theoretical or textbook education (Mashizi & Escobedo, 2025). The University Grants Commission (UGC) issues guidelines on mandatory environmental studies courses and urges green campus strategies. The policy aims to create a generation of learners who are sensitive to environmental issues and actively engaged in creating a "Viksit Bharat" (Developed India) through a sustainable, informed approach.

The NEP 2020 influences smartphones and digital technology to transform education through increased accessibility, equity, and quality (Fig. 1). It promotes blended learning, digital infrastructure, and educational content in regional languages to support, rather than replace, traditional classroom teaching, particularly for disadvantaged groups (Pacheco et al., 2018).

Fig. 1. Illustration of a smart digital classroom with visual effects (Courtesy: https://deepai.org/).

II. PEDAGOGY IN SKILL ENHANCEMENT

The NEP 2020 of India is a comprehensive framework intended at renovating the Indian education structure to make it evenmore holistic, flexible, multilingual, aligned with the needs of the 21st century, and aimed at fostering critical thinking and creativity (Desmet & Sternberg, 2024; Shahini et al., 2025; Han, 2026). Holistic and multidisciplinary education that promotes a broad-based, and emphasizes experiential, inquiry-based, discovery, discussion-based, and analysis-based learning (Santaolalla et al., 2020). Promotes holistic development, including physical, social, emotional, cognitive, and language skills. Reduces curriculum content to promote critical thinking in higher education and creativity in mindful pedagogy (Sweeney et al., 2025). Educational transformation away from rote memorization towards understanding and application highlights experiential learning, project-based and activity-based methods through emerging technologies (Menas-Guacas et al., 2025). Integration of technology in personalized and inclusive learning (Wang et al., 2026) that is applying digital tools, online resources and virtual technologies, with an emphasis on continuous professional development. Pedagogical training to make active learner-centred and inclusive teaching practices, which also practice values nurturing, ethics and social responsibility.

With the rapidly changing landscape of the world in recent times, continuous learning and skill development have become imperative for people who want to remain competitive in both his/her professional life and personal life. Out of all this, the SECs are a crucial instrument in fulfilling this aim as these courses provide training to develop specific skills (Kumar et al., 2019). These courses are designed to bridge the gap between academic knowledge and real-world practice, allowing newcomers to meet their objectives in less time.

Primary expert-led skill-enhancement courses are built on a foundation of hands-on learning, focusing on practical skills that can be utilized in any industry and sector (Fig. 2). These courses cater to skill-development like communication, technical skills, analytical and problem-solving abilities, leadership qualities, concept-building, and digital literacy (Alt & Raichel, 2020; Kelder et al., 2025). In the best push outsourcing world, where expertise often holds the growing industries, developed varied burning skills are much required to bring to the forefront (Wang et al., 2023). Additionally, SECs promote continuous education, encouraging a culture of ongoing learning and adaptability to evolving technological and industrial landscapes. An SEC encompasses a wide range of skills that appeal to a variety of interests and career paths. They generally fall into one of the following categories: training for technical skills such as programming, data analysis, and engineering; training for software skills related to communication and management; training for digital services, including big data, graphic design, cloud computing, social media marketing, and cybersecurity (Xin et al., 2022). Flexible learning is now available for these trainings on many online learning platforms and in many educational institutions.

Participating in SEC offers numerous benefits. Firstly, they boost confidence by enabling learners to master new competencies for holistic development (Miglani et al., 2026). Secondly, they increase employability by making individuals more attractive to employers' conceptions of qualities (Bettinson et al., 2024). Thirdly, these courses often lead to improved job performance, capabilities and digital productivity (Kelder et al., 2025). Additionally, skill enhancement fosters personal growth, helping individuals develop critical thinking, strategies for adaptability (Bhardwaj et al., 2025) and a proactive attitude toward challenges of academic resilience (Vosoughi & Ahmadi, 2025).

Fig. 2. Illustration of pedagogy in skill-enhancement practical training for electricians, plumbers, fitters, mechanics, and welders (Courtesy: https://deepai.org/).

III. GEOSCIENCES

Geoscience is an interdisciplinary field that includes Geology, Oceanography, Meteorology, and Environmental Science. Geosciences, perhaps the most well-known branch, studies the Earth's rocks, fossils, hard materials, minerals, and the systems that have shaped its crust over millions of years. Study of the natural processes on the Earth was related to the perception of The Theory of the Earth that was proposed by James Hutton (1726-1797), which includes investigations of natural evolution in the production of land, sea and air, and there is wisdom, system and consistency (Hutton, 1788, 1795). The Geognosy with Neptunism ideology proposed by Abraham Gottlob Werner (1749-1817) included a varied series of themes like the formation of the Earth's surface, the structure of mountains, endogenous and exogenous processes (Werner, 1787). Geology is the science that examines the successive changes that have taken place in nature (Lyell, 1830). Oceanography examines the Earth's oceanography, composition, currents, and ecosystems, revealing how they influence climate and weather patterns (Maury, 1855). Meteorology is concerned with the study of the atmosphere. This includes studying weather, trade winds, monsoons, and climate systems that can impact day-to-day life and long-term fluctuations of the environment (Halley, 1686; Kamtz, 1843). When these fields are combined, they can address challenges such as pollution, climate change and conservation.

Adams (1938) defines geoscience, or earth science, as the total study of the Earth, its structure, its system, and its history. Earth Science encompasses a variety of studies that target the Earth and the physical components of the Earth from its core to its outer atmosphere. Geoscience is essential in the field of science as it gives us knowledge of the phenomena that create the conditions of our world. It assists the management of resources and helps us cope with the emergencies that come from nature (Pachauri and Pant, 1992; Wilding and Lin, 2006; Reitsma, 2010). It will combine with other science fields, the arts, and the social sciences giving students the chance to learn the subject with Artificial Intelligence (AI) and Data Science, Remote Sensing and Augmented Reality (AR), emerging technologies, and Environmental Laws (Garg et al., 2025). The policy aims to prioritize geoscience education in a hands-on manner by focusing on practical work, labs, and fieldwork rather than on memorization. Vocational education will include mining, environmental assessment, and geotechnics.

To find and utilize geological resources such as natural fuels, including oil and natural gas, and rocks, minerals and water important to humans and industry, it is necessary to understand processes on the Earth. Geoscience plays an important role in the study of natural hazards including earthquakes, tsunamis, hurricanes and volcanic eruptions, including the development of early warning systems, hazard and disaster management strategies, and disaster risk reduction (Scheffers et al., 2009; Cremen and Galasso, 2020; Mittal et al., 2025). With climate change, geoscience has a role in studying past climates and predicting future scenarios. This knowledge drives policies and actions aimed at reducing negative effects and improving environmental sustainability.

Branches of Geoscience: Geoscience or Earth Science is the study of Earth, its materials, processes, and history (Fig. 3). It is an interdisciplinary field with several branches that together describe the Earth and its processes in a thorough manner, assisting in the understanding of the processes that shape our planet, and dealing with environmental and social concerns.

1. Geology: Geology is the study of the Earth's solid materials, including lithology and mineral properties, as well as the structure of the Earth through time (Dana, 1964; Gaikie, 1882). It includes the study of Earth's crust, volcanism, earthquakes, and how landforms are created and shaped through geological processes. This branch of the Geosciences is concerned with natural resources, natural hazards, and the Earth's history.

2. Economic Geology: The study of resource exploration and development is an important subject. Economic Geology is a branch of Geology that deals with the study of materials within the Earth's crust that are of economic importance (Ball, 1850). It plays a critical role in the discovery, extraction, and management of mineral resources essential to the industrial, technological, and everyday needs of modern society. The discipline combines principles of mineralogy, petrology, geochemistry, and engineering to assess the potential of geological deposits and guide sustainable resource development. Economic Geology is central to the global economy, as it concerns the location and evaluation of mineral deposits that support industries such as manufacturing, energy, construction, and technology (Richardson, 1913).

Minerals, including iron and manganese ores, bauxite, copper, chromite, gold, and rare earth elements, are important for making electronics, vehicles, infrastructure, and renewable energy technologies. The geology underlying these deposits is key to efficient exploration and extraction, which can lower costs and environmental impacts. Understanding the geology of these deposits can enable efficient exploration and extraction that results in both lower costs and environmental impacts.

3. Petrology: Petrology, a fundamental branch of geology, deals with the study of rocks, their classification and origins, compositions, textures, structures, and the system that is key to their formation (Pinkerton, 1811; Rutley, 1879). It plays an important role in understanding Earth's history, its crust, and the dynamic system that shapes our living planet. This essay discusses key aspects of petrology, including its subfields, importance, and the methods used by petrologists. Petrology is generally divided into three main subfields: igneous, sedimentary, and metamorphic petrology (Tyrrell, 1926). Igneous Petrology is the study of rocks formed from cooled and crystallized magma or lava, such as granite and basalt (Hatch, 1891). Sedimentary Petrology is the study of rocks formed by the accumulation of mineral and organic particles and their lithification, such as sandstone, limestone, clay and shale (Hatch & Rastall, 1913). Metamorphic Petrology is the study of rocks altered by high pressure, temperature or chemically active fluids that have become rocks such as schist and gneiss (Hise, 1898). Each subfield presents us with different geological processes and environments. Petrology is not just an academic subject. It is also important for natural resource exploration, including minerals, oil and gas.

4. Mineralogy: Mineralogy is all about emphasis on the world of minerals, those natural materials that form rocks and the crust of our planet. This field encompasses identifying different minerals and stones, delving into mineralogical systems, understanding their characteristics, and examining how they're used (Kirwan, 1784). The study of mineralogy is essential for classifying minerals and understanding their chemical makeup, which is important for resource exploration and material science (Jameson, 1816). The study of minerals is essential for understanding the history and processes of our planet (Dana, 1844). When scientists study minerals, they gain insights into how rocks formed and the geological processes that have shaped our Earth. Minerals are essential for various reasons; many are extracted for precious metals like gold, copper, and iron, as well as industrial materials like quartz and feldspar that are important for production.

5. Palaeontology: The discipline known as Palaeontology examines fossils and ancient life forms through the study of fossil remains (Gesner, 1565). The analysis of fossils enables paleontologists to reconstruct and learn about the history of the development of life on Earth, to gain an understanding of extinct species, and to provide clues to the climate and environment of Earth in the past (Cuvier, 1812; Blainville, 1822). The study of Palaeontology also provides important information regarding the evolution and extinction of species on Earth. Palaeontology is defined as the scientific study of the history of life on Earth, which is accomplished through the analysis of plant and animal fossils (Chambers, 1844). Palaeontology is an interdisciplinary field that draws from many different disciplines, including geology, botany, zoology, ecology, and physics/chemistry, in order to understand the evolutionary history and extinction of species, the history of Earth's environments, and to understand the processes that have shaped the Earth over millions of years (Darwin, 1859).

Historically, Palaeontology began with ancient and early human societies that found fossils and pondered their origins. However, the scientific process for studying fossils did not start to be developed until the 1700s and continued into the latter half of the 1800s; both the use of fossils to substantiating and supporting or informing the evolution theory as well as identification or discovery and documenting the elements of fossilization; during this period many materials were found that had been removed from the earth; including dinosaurs, dinosaurs, dinosaurs (mammals and birds), and early ancestors of humans foreshadowing (Eastman, 1912). Palaeontology has been a major element in supporting the study of advancements leading humanity through our understanding of life, and it has evolved.

6. Geophysics: Geophysics studies the principles of understanding the Earth's internal structure and surface phenomena based on physics. The term geophysics has been derived from the German "Geophysik" by Jules Frobel (1805 to 1893) in the 20th century (Frobel, 1834). As such, it can be considered to be an area or sub-discipline of Earth Science, which includes those related to the understanding of the physical processes occurring on the Earth. It makes use of different disciplines of study, including seismology, meteorology and mathematics, to study the Earth, including its composition, structure and movements (Noggerath, 1847). By using a combination of different observational and research techniques; Geophysicists try to find the hidden features of the Earth from the fault at the surface to its base. They use several forms of investigations to prove what is occurring on the Earth and how those forces will have an impact on the evolution of the surface features (Günther, 1899).

Geophysics has its origins rooted in the distant past when humanity began observing natural events such as earthquakes and volcanic activity. However, it was not until the 1800s and 1900s that geophysics emerged as a separate scientific discipline, driven by technological advances and the need to study natural hazards, discover new resources, and better understand how Earth develops (Good et al., 2000). Measurements taken with techniques like seismic surveys, magnetic field changes, and gravity provide an understanding of underground structure; predict earthquakes; and understand the composition of Earth's interior.

7. Geochemistry: Geochemistry studies the chemical composition of materials found on Earth and how those materials interact through different stages of the geological processes that shape the Earth's systems (Clarke, 1908). Geochemistry is essential for identifying mineral forms, the processes behind volcanic eruptions, the impacts of environmental changes, and climate change. Geochemistry is an interdisciplinary field of study that involves the chemical analysis of both terrestrial and other elements within the cosmos, including the different geochemical entities that constitute the Earth (Fersman, 1934). Geochemistry integrates principles from the fields of chemistry, geology, physics, and environmental sciences in order to analyze the dispersal and migration of the chemical constituents of matter and their compounds throughout the Earth's systems. The investigation of the Earth and its systems is one of the most important and necessary elements to understanding its past, present, future, and all processes that operate within those spheres; geochemistry is the study of the chemical composition of the Earth, the processes that create the Earth, and how these processes interact with one another. The beginnings of geochemistry date to the 19th Century, when chemical analysis of rocks and minerals began to be performed by scientists in an organized manner. One of the early pioneers of geochemistry was Victor Moritz Goldschmidt (1888-1947), who was among the first geochemists to systematically study the distribution of chemical elements in the Earth's crust and mantle (Goldschmidt, 1954). Advances in analytical methods, including mass spectrometry and chromatography, have enabled geochemists to conduct more accurate, detailed analyses and have established geochemistry as an essential scientific discipline.

8. Structural Geology: The science of Structural Geology encompasses both the alteration of strata due to deformation and their assembly into natural groups, like folds, faults, mountains and joints. Understanding the three-dimensional position and orientation of rock units, as well as how they were formed through deformation, is an essential part of Structural Geology. This discipline has provided geologists with a better understanding of the forces that have built the Earth's surface over the past few hundred million years and how those same forces continue to shape our planet today (Leith, 1913). Structural Geology investigates the deformation of rocks that has resulted in the formation of geologic structures, e.g., folds, faults, joints (Billings, 1947). The geologic structures formed by the deformation of rocks contain evidence of the stresses and strains that acted on the materials during tectonic activity and provide insight into the mechanics of the Earth's interior, thereby allowing us to reconstruct much of the Earth's geologic history (Ramsay, 1967). Geologist's study structural geology to analyze the geologic history of an area, discern potential natural hazards; and locate and evaluate mineral and hydrocarbon deposits in the ground. Structural geology plays a major role in understanding Earth's tectonic processes as well as discovering oil, gas, and mineral deposits.

9. Stratigraphy: Stratigraphy is one of the most important parts of geology, which includes the study of layered rocks or strata, how those rocks are distributed across the earth's surface, and when they formed (Smith, 1816). The study of stratigraphic characteristics provides valuable insights into the evolution of Earth and the processes that shaped it over millions of years. Stratigraphy provides geologists with important information about reconstructing past environments, understanding geological events, and establishing the order in which the Earth has developed. Although the study of stratigraphy has been around since at least the early 19th century, it was not until the pioneers of stratigraphy, such as William Smith (1969-1839), developed the practice. William Smith developed the principle of faunal succession to show that sedimentary strata contained various types of fossils. He was also able to provide a scientific method for correlating different strata and determining the ages of the rocks within them (Phillips, 1844).

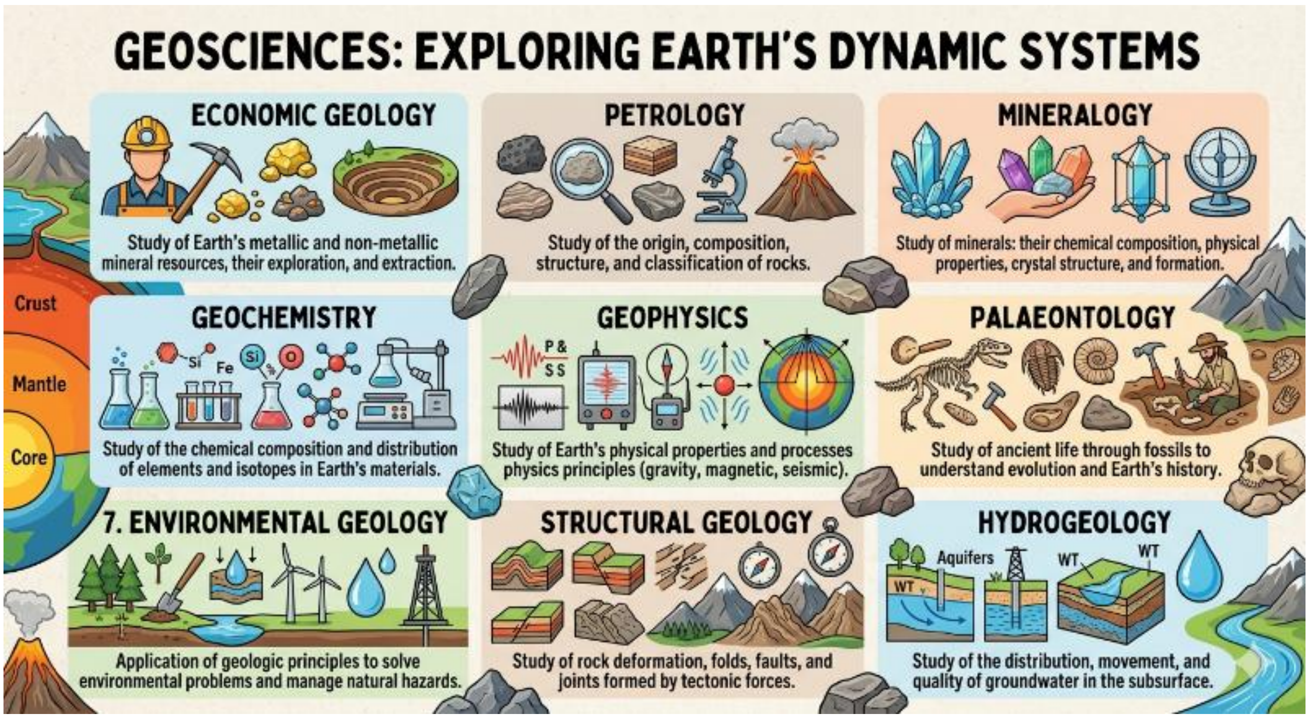

Fig. 3. Illustration of various branches of Geosciences (Courtesy: https://gemini.google.com/).

The principles of stratigraphy form a scientific discipline based on the study and understanding of stratification, or layering, in sedimentary rock formations. This principle serves as the foundation of our understanding of Earth's age and history through precise interpretation by researchers using stratigraphy (Grabau, 1913). Applied stratigraphic principles are found in many applications, both within geology and other fields with traditional and modern concepts (Storey & Patterson, 1959). In fact, stratigraphy has been used both historically and contemporarily for various purposes in the study of Earth, such as to assist with exploration for natural resources, including oil, gas, coal, and minerals; to understand earthquake-prone areas, areas affected by volcanic activity, and the processes of mountain-building; to reconstruct past climates and changes in the environment; and to understand the process of evolution at this time in Earth's geological history.

10. Hydrogeology: Hydrogeology pertains to assessing water distribution, migration, and characteristics in the Earth's crust, as discussed by Meinzer (1923). Groundwater contributes greatly to the hydrological cycle and provides substantial quantities of fresh water. Thus, hydrogeology is critical for making responsible use of water resources, preserving the environment, and alleviating water scarcity (Tolman, 1937). Hydrogeologists analyze all components of groundwater systems relating to their physical, chemical, and biological characteristics (Todd, 1959). They research the aquifers (the water-bearing units or porous and permeable formations that contain and transmit water), aquitards (impermeable barriers that limit or impede the flow of water), and the relationship between groundwater and surface waters. Hydrogeologists employ different methods to analyze availability, quality, and flow patterns of groundwater, such as geological mapping, boring, geophysical surveys, and hydrogeochemical analysis (Walton, 1970).

Groundwater is one of the primary sources of drinking water worldwide; it is also used to irrigate crops and support industries, ecosystems, and society. Groundwater is generally more protected from contamination and evaporation than surface water, making it a reliable source of water even during drought. However, over-extraction, pollution, and climate change threaten the long-term sustainability of groundwater; therefore, effective management of groundwater resources must be based on a thorough understanding of hydrogeological characteristics. Hydrogeology provides important information about where to locate new wells or aquifers, what contamination risks exist at those sites, and how to extract groundwater sustainably (Hiscock, 2005). Hydrogeology also contributes to the cleanup of contaminated sites and the management of the effects of mining and waste disposal on local groundwater supplies.

In addition to providing guidance for water conservation policies and predicting the effects of climate variability on water supplies, hydrogeological studies also aid in managing water resources, studying subsurface aquifers, and addressing water-related environmental issues (Karandish et al., 2025). As a result, hydrogeology plays an integral role in these areas; however, it has its share of challenges such as a lack of sufficient data, complicated subsurface conditions, and a result of human influences. With new technologies (remote sensing, modeling software, and real-time monitoring), researchers can conduct more accurate studies on groundwater systems (Schmugge et al., 2002). Future research will focus on increasing the understanding of groundwater-surface water interactions; addressing groundwater contamination issues (Rajan et al., 2024); and developing sustainable management strategies to ensure continued access to this critical resource for future generations.

11. Environmental Geology: Environmental Geology has been defined as the study of the interaction between the physical components of the earth and its environment (Tank, 1983). The discipline of Environmental Science combines many fields of scientific study, including geology, hydrology, ecology, atmospheric science, and chemistry, to examine the interactions and processes of Earth's systems and the impact of human activity on those processes (Montgomery, 2011). This discipline encompasses both Earth's interactions with its environment and the impact of human activity on it. Specific to this area of focus is the assessment and mitigation of natural hazards, including those arising from contamination or environmental change caused by the depletion of geological resources or land degradation (Hansen & van den Bergh, 2024). To do this, Geoscientists will study the properties of soils and rocks to determine their suitability for construction, agriculture, and waste disposal, thereby supporting reliable land-use practices. Water is the major component of all ecosystems; therefore, Geoscientists will also study the groundwater and surface water systems to monitor the levels of pollutants, manage finite water resources, and develop ways to reduce or eliminate contaminants from those systems.

Natural hazards such as earthquakes, landslides, and volcanic eruptions are serious issues that fall under the category of Environmental Geology. By studying Earth's crust, geoscientists have been able to develop techniques for monitoring crustal movement so that they can implement early warning systems and develop policies aimed at protecting communities from natural disasters and minimizing the loss of life and damage to property (Dohman et al., 2025). In addition, Environmental Geology is essential to the study of environmental concerns related to climate change and weather forecasting. By examining geological evidence of past climates, geoscientists can help implement policies to mitigate the effects of climate change based on past patterns (Traverso, 2026). Geoscientists also research how changing sea levels, changing weather patterns, and changing temperatures impact ecosystems and human societies.

Technological advancements have greatly improved the field of geoscience. Satellite imagery, seismic imaging, and remote sensing allow scientists to access previously unreachable regions and obtain data of unprecedented accuracy/precision (Pan et al., 2025). Additionally, computer modelling can be used to simulate the Earth's processes and enhance our ability to understand complicated systems such as climate dynamics, Earth systems models, and tectonic movements (Rutten et al., 2012).

IV. SMARTPHONE TECHNOLOGY

Smartphones are portable, compact devices that combine conventional phone calls with modern computing capabilities. Smartphones can be used like computerized coolers, which puts all sorts of information at our fingertips. Smartphones have developed from not being able to use a full-featured operating system (such as Android or IOS) to being available in a variety of colors and styles. They also have touchpad interfaces and ways to connect to the internet and run programs (called "apps") that produce other types of information (Zheng & Ni, 2006). Education professionals specifically note that the two main considerations for using smartphones to improve education are that they are important for making education accessible and that they need to be used with skill and common sense to protect students (Druin, 2009). Education experts also agree that smartphones need to be used as an educational tool through positive feedback rather than punishment (Verkasalo, 2010). International Business Machines (IBM) Simon released the first smartphone in 1994, which had a resistive touchscreen that measured 4.5 inches by 3 inches (Rudzinski, 2021), but it wasn't until the release of the Apple iPhone in 2007 that smartphones became common in everyday use. The iPhone introduced consumers to the touchscreen interface, app store, and mobile internet to create the first widespread smartphone use, and other smartphone manufacturers quickly integrated their products to compete (Apple Discussion, 2022).

Smartphones are essential devices for many individuals in today's world, and they provide various tools and services (e.g., high-speed internet access, emailing, social networking (such as Facebook), hundreds of thousands of applications (supporting everything from playing games to being productive). In addition to providing high-tech features, smartphones come equipped with multiple cameras, GPS for navigation and location-based services, and music/video playback (Rout et al., 2021). One of the major effects of smartphones has been on communication. With the advent of social media and instant messaging, people can now communicate with their families and friends no matter where they are located in the world. While increased communication may be perceived as a positive thing since it has created a greater sense of community, some people (primarily psychologists) are concerned about how this increase in communication affects one's mental health and social skills (Herrero et al., 2023). There has been a huge effect on professional social work and the use of open-source knowledge due to the arrival of smartphones as a way for everyone to have access to information from a multitude of educational websites (van Kraalingen & Eriksen, 2026). As a result of this access to information and because they can be used to learn new skills and access classes via the Internet, as well as receive the latest updates on current events and trends in society (Sapci et al., 2021), smartphones have created equitable access to knowledge and education for the average person (Merchant, 2019).

With the advent of smartphone technology, the way that people interact with one another, conduct their business, and enjoy leisure activities has drastically changed. In the past twenty years, smartphone technology has evolved from simple mobile phones that allow people to communicate via voice and text to powerful multifunctional computers that help individuals go about their daily lives (Shin et al., 2011). The development of smartphone technology began in the early 1990s, when portable, machine-like devices such as IBM's Simon Personal Communicator combined mobile phone and personal digital assistant features. However, the launch of the Apple iPhone in 2007 caused a watershed moment in the smartphone industry by introducing an entirely new approach to user interaction through a touch screen interface; an application (app) store providing an ecosystem for users to download applications; and advanced capabilities for multimedia content consumption, thereby creating the benchmarks for all subsequent smartphones and mobile apps used for e-learning tools (Pauli et al., 2020). Following the introduction of the iPhone, other technology companies such as Samsung, Google, and Huawei quickly entered the smartphone market and began creating their own devices, resulting in unprecedented competition and accelerating the pace of technological change.

High-end smartphones today come with cutting-edge processors, high-quality screens, a multitude of cameras and plenty of storage options (Fig. 4). The advent of new wireless technologies (e.g., 4G and 5G) has provided consumers with markedly improved data rates and connectivity, allowing for uninterrupted music or video streaming, video conferencing and instant information retrieval (Moysen & Giupponi, 2018). The incorporation of artificial intelligence has created an enhanced user experience through personalized recommendation systems, voice-controlled digital assistants (e.g., Siri and Google Assistant) (Grabara, 2025) and facial recognition capability in mobile cameras (Choudrie et al., 2023). Biometric security techniques, such as fingerprint recognition and facial identification, also provide greater protection to end-users' devices.

Fig. 4. Illustration displays various components of a smartphone (Courtesy: https://gemini.google.com/).

The advent of smartphones has significantly changed the landscape of human interaction and their ability to share information across various platforms, promoting social networking and allowing individuals to communicate regardless of their geographical distance or physical infrastructure (Gong et al., 2025). The influence of mobile-based social networking applications on culture, politics and societal movements difficult to understated. In addition to connecting individuals instantaneously through the internet, smartphones have also opened new markets and created job opportunities across the business sector in various ways, including application development and mobile commerce (Mehra et al., 2022). Their effect on the banking, healthcare, and education industries cannot be ignored, as they enable the dissemination of services to the masses through technology.

Despite their advantages, Smart Phones present many challenges, such as privacy issues, dependence on technology, and negative influences from the environment due to e-waste associated with Smartphones. Predictions show that future Smartphones will have features such as folding screens, enhanced AI capabilities; and greater integration with the Internet of Things (IOT) (Wheatley & Hervieus, 2024). Technological innovations will further impact how these devices are used in entertainment, education, training, and daily life by adding capabilities such as ML (Machine Learning), Big Data, VR (Virtual Reality) and AR (Zhao et al., 2024). However; there are many negative aspects resulting from Smart Phones' impact on society. The continuous availability of information, along with one's need to be connected at all times, has resulted in increased amounts of stress and anxiety (Weiss & Bonell, 2025).

Many individuals feel compelled to be available and constantly "on", which can negatively impact their productivity and contribute to burnout. Along with this rise in "always-on" availability of individuals, the prevalence of smartphone use has increased the level of concern adolescents experience regarding addiction, social isolation and loneliness (Carthaigh et al., 2020; Sarman & Ciftci, 2024). With the constant influx of notifications/updates sent to smartphones, individuals can easily become addicted to them, thereby reducing direct contact with others and diminishing feelings of loneliness. Additionally, there has been increased concern about the impact of smartphone use on both physical and mental health (Bertocchi et al., 2026). Extended periods of screen time utilization via smartphones have been associated with an array of health-related conditions, such as sleep disturbances, vision problems (eye strain), and a decrease in physical activity (Subramaniam et al., 2024). Furthermore, the convenience of ordering food and other temptations on a smartphone has increased the incidence of unhealthy eating habits and weight gain (Kehribar et al., 2026).

V. RESULTS: SMARTPHONE GEOSCIENCES

As we live in a technologically-driven era of rapid development and competition at a global scale, there is a need for the ability of individuals to undertake ongoing education and skills development. The SECs have become an important method for bridging the gap between theory and practice/experience. SECs are courses that are designed to help students or professionals develop specific competencies at a more advanced level than they would have learned in their foundational courses (i.e., higher than what was learned in their original educational setting) and are typically short in duration (i.e., weeks to months, depending on the level of the course), often offered by universities, colleges or associations. In recognition of the significance of SECs in the context of the Choice Based Credit System (CBCS) to the university system in India, the UGC provides formal recognition for certain skill enhancement courses, thus encouraging the integration of skill enhancement courses into undergraduate and graduate program curricula at higher education institutions.

Courses offered in the discipline of Geoscience, which include the following areas: Geology; Economic Geology; Geophysics; Petrology; Hydrogeology; Remote Sensing; and Environmental Geology, are vital components in developing industry-competent, adaptive, and industry-oriented professionals. The education and training obtained by new graduates seeking specialization and those experienced practitioners leading up to maintaining their competitive status are by far the SECs in Geoscience will be a transformative investment in human capital, and while all forms of educational institutions, as well as learning, are important to society, providing a basis for long-term national development.

An enhanced way of accessing information, business, and communication is provided by the small and convenient electronic device known as a smartphone, which has changed our way of living, working, and interacting with one another. This device has made many philosophical changes in what we call today's world, because we use these devices to provide us with access to the information we need in order to connect and navigate the world. The goal of this investigation was to provide an understanding of the e-learning and educational application of smartphones, including their technological characteristics (hardware/software/applications), benefits to the academic community, and how smartphones are impacting cultural benefits to society. This study will also provide an insight into how smartphones have changed the academic culture of today's society.

In the last decade, rapid advancements in smartphone technology have dramatically transformed most areas of science; Geosciences is no exception. Smartphones contain many impressive sensors, high-resolution cameras, GPS capabilities, and internet connectivity; therefore, today's smartphones are multifunctional devices suitable for use in the classroom, in outdoor field education, and in the laboratory for research purposes. As such, there are innumerable opportunities to enhance student learning through smartphone technology. The Department of Geology, Institute of Science at Banaras Hindu University is already offering a course on Smartphone Geosciences, especially for undergraduate students. This course is one example of an innovative SEC that has placed a systematic emphasis on the development of digital literacy and skills development, combining with traditional education experiences to graduate students.

VI. DISCUSSIONS

Geoscience is an important field that helps us understand the physical characteristics of Earth and the processes that occur on it. The knowledge gained through geoscience is key to managing natural resources, reducing risk from natural hazards, and solving environmental problems. As we move forward into a time of uncertainty due to climate change and environmental degradation, geoscience will play an important role in helping us develop sustainably and ensure the ongoing health of our planet for future generations. Stratigraphy is a key part of the geosciences because it allows scientists to gain insight into Earth's history by studying layers of rock. The fundamental concepts and methods of stratigraphy enable scientists to understand Earth's history, geological processes, and the locations of natural resources. As technology advances, stratigraphy will continue to evolve, allowing for even greater insight into the ever-changing world we live in.

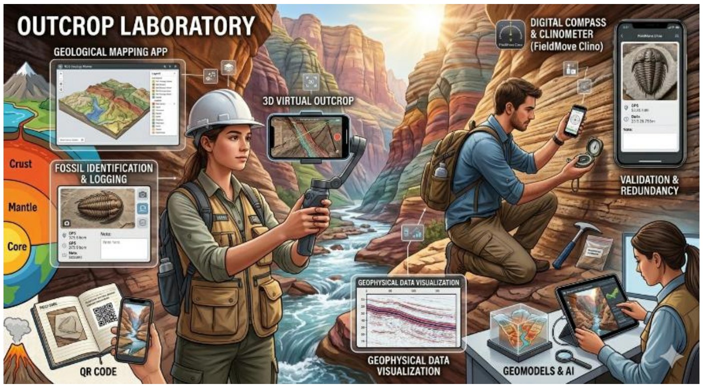

Fig. 5. Illustration displays various applications of Smartphone Geosciences (Courtesy: https://gemini.google.com/).

Conventionally, geological investigations have included transporting bulky field instruments like Brunton compasses, handheld Global Positioning System (GPS) devices, paper-based topographic maps, analogue-style clinometers, and large field notebooks to their respective field sites until they could be successfully utilized in the field. The inclusion of all these tools on a single smartphone platform (or device) provides geoscientists with an unprecedented opportunity to gather, document, and convey their findings in a completely different manner than before. An expanding diversity of ongoing development of specialist-oriented mobile applications represents yet another extension of the capabilities of smartphones by providing an ever-increasing range of functionality for geosciences (e.g., real-time mineral identification to live seismic data acquisition via remote sensing).

The smartphone has created a profound influence on our modern society, changing the way we live, work, and communicate with one another. Although smartphones offer a variety of advantages (such as connectedness and a wealth of information), there are also concerns over addiction, social isolation, and physical and mental well-being due to the use of smartphones. Going forward, it's important that we remain mindful of how smartphones affect us, as well as take measures to minimize harmful consequences.

Even though smartphones can be great tools for geologists, they do have their limitations as geology tools. One of the biggest limitations of using a smartphone as a geology tool is that battery life becomes an issue when working in remote areas where you expect no charging opportunities, as GPS tracking uses a lot of battery, high brightness screens consume a lot of battery power, and anything that requires constantly syncing can use battery fairly quickly. Portable battery packs do reduce this issue to some degree, but they add weight to your pack and require their own charging. With the advances in artificial intelligence and machine learning will likely also improve how accurate and how many different types of rocks or minerals you can identify with a smartphone geology app. In the future, it is possible that smartphones and other devices could be used to identify not just common minerals, but also rarer minerals, alteration products, and even other forms of economic ore mineralogy by pulling some of these very large training data sets, which can be found in geological museums and research institutions around the world.

Conclusions

The SEC is extremely important in today's ever-changing world. It acts as the bridge between theory and practical skills; thus, it allows people to deal with problems that occur in real life. As a result of studying this course, students will have the ability to recognize new possibilities for themselves, achieve their professional goals, and help improve their society. Skill improvement becomes both a means to achieve individual success and a tool for national growth and development.

The impact of smartphone technology in today's world is quite evident; there are innovations happening due to it. In the coming years, with more advancement in this technology, we may see changes that could be beneficial as well as pose certain problems. It is important to ensure sustainable growth with the use of smartphones. In the domain of geosciences, smartphones have become one such tool that has brought revolution. With all the capabilities of a GPS receiver, compass, camera, map reader, and field notebook combined in one handy device, smartphones have helped geologists with their job of data gathering and analysis much easier. The development of smartphone applications continues with the growing needs of professional geologists and concerned citizens.

Although smartphones provide advantages such as portability and cost-effectiveness, several challenges persist, including limitations in data accuracy, battery life, connectivity, and user training. This study also highlights the potential of emerging technologies, such as augmented reality and AI-based applications, to further enhance field-based learning. In summary, the integration of smartphones offers a practical and scalable strategy for modernizing geoscience field excursions, increasing interactivity, accessibility, and alignment with current educational requirements.

Smartphones are transforming geoscience education by facilitating efficient data collection, real-time analysis, and increased student engagement during field excursions. This study investigates the opportunities, challenges, and future prospects associated with integrating smartphone-based tools, including

GPS mapping, geospatial applications, and digital field recording, into geoscience fieldwork. Aligned with the objectives of the National Education Policy (NEP) 2020, the Department of Geology, Institute of Science, Banaras Hindu University (BHU), has introduced a Skill Enhancement Course (SEC) titled "*Smartphone Geosciences*" for undergraduate students. The course aims to integrate digital technologies into field-based learning, particularly in remote and resource-constrained environments.

Acknowledgments

The author is thankful to the Head of the Department, Department of Geology, Institute of Science, BHU, for making available all the facilities required. DP acknowledged the BHU-IoE sponsored SEED Grant and the BHU-IoE sponsored Professional Development Fund (PDF) for financial assistance.

References

Adams, F.D. (1938) The Birth and Development of the Geological Sciences. Baltimore, USA, The Williams & Wilkins Company, p 1-530.

Apple Discussions (2022). Complete list of iPads, release year and current iOS /iPad Os version they can run. - Apple Community. [online] discussions.apple.com. Available at: https://discussions.apple.com/docs/DOC-250001726.

Ball, V. (1850) A Manual of The Geology of India: Part III: Economic Geology. Geological Survey of India, Government of India, Calcutta, p 1-663.

Bertocchi, F.M., Lucchetti, G., De Oliveira, A.P., Martins, L.C., Duarte de Oliveira, M.E., Gomes de Oliveira, V.M. and Lucchetti, A.L.G. (2026) Association between smartphone use and mental health outcomes among community-dwelling older adults: a 2-year follow-up study. Computers in Human Behavior, 176, 108868. https://doi.org/10.1016/j.chb.2025.108868.

Billings, M.P. (1942) Structural Geology. Prentice-Hall, Englewood Cliffs, New Jersey, p 1-473.

Blainville, H.M. Ducrotay de (1822) Analyse des principaux travaux dans les sciences physiques, publiés dans l'année 1821. Journal de Physique, de Chimie et d'Histoire naturelle, 94, v-lxxvij.

Carthaigh, S.M., Griffin, C. and Perry, J. (2020) The relationship between sleep and problematic smartphone use among adolescents: a systematic review. Developmental Review, 55, 100897. https://doi.org/10.1016/j.dr.2020.100897.

Chambers, R. (1844) Vestiges of the Natural History of Creation. London, John Churchill, Princes Street, Soho, p 1-390.

Choudrie, J., Manandhar, N., Castro, C. and Obuekwe, C. (2023) Hey Siri, Google! Can you help me? A qualitative case study of smartphones AI functions in SMEs. Technological Forecasting & Social Change, 189, 122375. https://doi.org/10.1016/j.techfore.2023.122375.

Clarke, F.W. (1924) The data of Geochemistry. United State Geological Survey Bulletin, p 1-770.

Cuvier, G. (1812) Recherches sur les ossements fossiles de quadrupèdes (Researches on quadruped fossil bones). Paris, Chez Deterville, Libraire, Rue Hautefeuille.

Dana, J.D. (1844) A System of Mineralogy. New York and London, Wiley & Putnam, p 1-633.

Dana, J.D. (1864) Text Book of Geology. Philadelphia, Published by Theodore Bliss & Co. p 1-354.

Darwin, C.R. (1859) On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life (First Edition) London, John Murray.

Dohman, K., Blum, P., Braun, A., and Fernandez-steeger, T.M. (2025) Landslide-triggered tsunamis – a review. Natural Hazards (2025) 121:22341–22373. https://doi.org/10.1007/s11069-025-07551-2

Druin, A. (2009) Mobile Technology for Children: Designing for Interaction and Learning. Morgan Kaufmann Publishers, Elsevier, Amsterdam, p 1-353.

Eastman, C.R. (1913) Text Book of Paleontology. MacMillan and Company Limited, p 1-839.

Fersman, A.E. (1934) Geochemistry for Everyone. Leningrad, ONTI-Himteoret (in Russian).

Frobel, J. (1834) Entwurf eines Systemes der geographischen Wissenschaften [Design of a system of geographic sciences]. Mitteilungen aus dem Gebiete der Theoretischen Erdkunde, Volume 1, 1–99; and Volume 2, 121–132.

Garg, N., Kaur, A., Ahmad, F. and Dutta, R. (2025) Augmenting Education: The Transformative Power of AR, AI, and Emerging Technologies. Human Behavior and Emerging Technologies, 5681184. doi.org/10.1155/hbe2/5681184.

Geikie, A. (1882) Text Book of Geology. London, MacMillan and Co. p 1-971.

Gesner, C. (1565) De omni rerum fossilium genere (On all kinds of fossil objects).

Goldschmidt, V.M. (1954) Geochemistry. Edited by Alex Muir, Clarendon Press, Oxford.

Gong, M., Wei, Z., Chen, S., Yu, W. and Wang, F. (2025) A survey of existing attacks on 5G SA. Computer Networks, 270, 111545. https://doi.org/10.1016/j.comnet.2025.111545.

Good, G.A. (2000) The Assembly of Geophysics: Scientific Disciplines as Frameworks of Consensus. Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics, 31, 259-292. https://doi.org/10.1016/S1355-2198(00)00018-6.

Government of India (2020) National Education Policy 2020. Ministry of Education. Retrieved from https://www.education.gov.in.

Grabara, D. (2025) Selling Artificial Intelligence: How AI changes the rules of online smartphone offer presentations. Procedia Computer Science, 270, 1312–1320. https://doi.org/10.1016/j.procs.2025.09.252.

Grabau, A.W. (1913) Principles of Stratigraphy. New York, A. G. Seiler and Company, p 1-1182.

Gunther, S. (1897) Handbuch der Geophysik (Handbook of Geophysics). Volume 1, p 1-648 and Volume 2, p 1-1009. Stuttgart: Enke, Second Edition, 1897 and 1899.

Halley, E. (1686) Meteorological observation. An historical account of the trade winds, and monsoons, observable in the seas between a near the Tropicks, with an attempt to assign the physical cause of the said winds. Philosophical Transactions, The Royal Society, 16, 153-168. https://doi.org/10.1098/rstl.1686.0026.

Hansen, O.W. and van den Bergh, J. (2024) Environmental problem shifting from climate change mitigation: A mapping review. PNAS Nexus, 3, pgad448. https://doi.org/10.1093/pnasnexus/pgad448.

Herrero, J., Rodfriguez, F.J. and Uruena, A. (2023) Use of smartphone apps for mobile communication and social digital pressure: A longitudinal panel study. Technological Forecasting & Social Change, 188, 122292. https://doi.org/10.1016/j.techfore.2022.122292.

Hiscock, K.M. (2005) Hydrogeology: Principles and Practice. Blackwell Publishing, Malden, USA, p 1-389.

Hutton, J. (1788) Theory of the Earth; or an Investigation of the Laws observable in the Composition, Dissolution, and Restoration of Land upon the Globe. Transactions of the Royal Society of Edinburgh, 1 (Part 2). Royal Society of Edinburgh, 209–304. doi:10.1017/S0080456800029227.

Hutton, J. (1795) Theory of the Earth. Volume 1 and 2. Edinburgh.

Jain, M. (2021) The new education policy: A reform for the future of India's education system. Journal of Education and Practice, 12 (4), 15-22.

Jameson, R. (1816) System of Mineralogy. Edinburgh, Neill & Company, Archibald Constable and Company, p 1-537.

Kamtz, F.L., Martins, C.F., Lalanne, L. and Walker, C. (1845) A complete course of meteorology. London XXII, p 1-598. Translation from Friedrich Ludwig Kamtz (1836) Cours complet de météorologie. Translate and annotated by Charles Frederic Martins, with an appendix by Leon Lalanne (Paris: Paulin, 1836).

Karandish, F., Liu, S. and de Graaf, I. (2025) Global groundwater sustainability: A critical review of strategies and future pathways. Journal of Hydrology, 657, 133060. https://doi.org/10.1016/j.jhydrol.2025.133060.

Kehribar, D.Y., Baraz, L.S., Taktuk, S. Gunduz, S., Mistik, F.N. Demircioglu, B., Ucar, B., Degirmendioglu, E., Simsek, S., Caylak, A.O., Karakaya, S., Karaaslan, U., Kirik, A.B.T., Zanbakci, B., Ataca, E. and Ozgen, M. (2026) Smartphone screen time and eating disorder tendencies in obese and normal-weight adults: a cross-sectional study from Turkey. Journal of Eating Disorders, 14, 46. https://doi.org/10.1186/s40337-026-01527-8.

Kirwan, R. (1784) Elements of Mineralogy. London, Elmsly.

Leith, C.S. (1913) Structural Geology. New York, Henry Holt and Company, p 1-169.

Lyell, C. (1830) Principles of Geology. Volume I. John Murray, Albemarle-Street, London.

Mashizi, A.K. and Escobedo, F. (2025) The role of traditional ecological knowledge and ecosystem quality in managing ecosystem services. Scientific Report, 15, 31510. https://doi.org/10.1038/s41598-025-17611-z.

Maury, M.F. (1855) The Physical Geography of the Sea. Harper and Brothers, New York, p 1-274.

Mehra, A., Rajpur, S. and Paul, J. (2025) Determinants of adoption of latest version smartphones: theory and evidence. Technological Forecasting & Social Change, 175, 121410. https://doi.org/10.1016/j.techfore.2021.121410.

Meinzer, O.E. (1923) The occurrence of ground water in the United States, with a discussion of principles. Water Supply Paper 489. United States Geological Survey, p 1-321.

Merchant, G. (2019) Schooling the smartphone. Learning, Culture and Social Interaction, 21, 194-495. https://doi.org/10.1016/j.lcsi.2019.03.010.

Montgomery, C.W. (2011) Environmental Geology. McGraw Hill, New York, p 1-511.

Moysen, J. and Giupponi, L. (2018) From 4G to 5G: Self-organized network management meets machine learning. Computer Communications, 129, 248-268.

Nöggerath, J.J. (1847) Das Erdbeben vom 29 Juli 1846 im Rheingebiet und denbenachbarten Ländern, Bonn, p 1-60.

Pan, X., Chen, D., Pan, B., Huang, X., Yang, K., Piao, S., Zhou, T., Dai, Y., Chen, F. and Li, X. (2025) Evolution and prospects of Earth system models: Challenges and opportunities. Earth-Science Reviews, 260, 104986. https://doi.org/10.1016/j.earscirev.2024.104986.

Pauli, P., Koch, A. and Allgower, F. (2020) Smartphone Apps for Learning Progress and Course Revision. IFAC PapersOnLine, 53-2, 17368–17373. https://doi.org/10.1016/j.ifacol.2020.12.2088.

Phillips, J. (1844) Memoirs of the William Smith, author of the “Map of the Strata of England and Wales.” London, John Murray, Albemarle Street, p 1-150.

Pinkerton, J. (1811) Petralogy: A Treatise on Rocks (2 Volumes). London: White, Cochrane.

Rajan, M., Karunanidhi, D., Jaya, J., Preethi, B., Subramani, T. and Aravinthasamy, P. (2024) A comprehensive review on human health hazards due to groundwater contamination: A global perspective. Physics and Chemistry of the Earth, Parts A/B/C, 135, 103637. https://doi.org/10.1016/j.pce.2024.103637.

Ramsay, J.G. (1967) Folding and Fracturing of Rocks. McGraw-Hill, New York, p 1-568.

Richardson, C.H. (1913) Economic Geology. McGraw-Hill Book Company, New York, p 1-320.

Rout, A., Nitoslawski, S., Ladle, A. and Galpern, P. (2021) Using smartphone-GPS data to understand pedestrian-scale behavior in urban settings: A review of themes and approaches. Computers, Environment and Urban Systems, 90, 101705. https://doi.org/10.1016/j.compenvurbsys.2021.101705.

Rudzinski, D. (2021) Technology: Where it started and where its going. Editors: Mary Kate Fidler and Yang Wu, Clemson University STS 1010 Fall 2021 Students, South Carolina. https://opentextbooks.clemson.edu/sts1010fidlerfall2021/chapter/smartphone/

Rutten, N., van Joolingen, W.R. and van der Veen, J.T. (2012) The learning effects of computer simulations in science education. Computers & Education, 58, 136–153. https://doi.org/10.1016/j.compedu.2011.07.017.

Sahoo, S. (2021) National Education Policy 2020: A Paradigm Shift in Indian Education System. International Journal of Scientific Research and Management, 9(8), 1317-1320.

Sapci, O., Elhai, J.D., Amialchuk, A. and Montag, C. (2021) The relationship between smartphone use and students` academic performance. Learning and Individual Differences, 89, 102035. https://doi.org/10.1016/j.lindif.2021.102035.

Sarman, A. and Ciftci, N. (2024) Relationship between smartphone addiction, loneliness, and depression in adolescents: a correlational structural equation modeling study. Journal of Pediatric Nursing, 76, 150–159.

Schmugge, T.J., Kustas, W.P., Ritchie, J.C., Jackson, T.J. and Rango, A. (2002) Remote Sensing in Hydrology. Advances in Water Resources, 25, 1367-1385.

Sharma, R.C. (2021) Transforming Indian Education System through National Education Policy 2020. Journal of Research in Humanities and Social Sciences, 9(3), 123-129.

Shin, D.H., Shin, Y.J., Choo, H. and Beom, K. (2011) Smartphones as smart pedagogical tools: Implications for smartphones as u-learning devices. Computers in Human Behavior, 27, 2207–2214.

Smith, W. (1816) Strata identified by organized fossils, containing prints on colored paper of the most characteristic specimens in each stratum. London, W. Arding, Corey Street.

Storey, T.P. and Patterson, J.R. (1959) Stratigraphy – traditional and modern concepts. American Journal of Science, 257, 707-721.

Subramaniam, M., Koh, Y.S., Sambasivam, R., Samari, E., Abdin, E., Jeyagurunathan, A., Tan, B.C.W., Zhang, Y., Ma, S., Chow, W.L. and Chong, S.A. (2024) Problematic smartphone use and mental health outcomes among Singapore residents: the health and lifestyle survey. Asian Journal of Psychiatry, 98, 104124. https://doi.org/10.1016/j.ajp.2024.104124.

Swaminathan, S. (2021) Implications and Challenges of National Education Policy 2020. Journal of Educational Research and Practice, 11(1), 35-44.

Talman, C.F. (1922) Meteorology: The Science and Atmosphere. Popular Science Library, Volume 1, p 1-384. New York, P F. Collier and Son Company.

Tank, R.W. (1983) Environmental Geology. Oxford University Press, New York – Oxford, p 1-549.

Todd, D.K. (1959) Groundwater Hydrology. John Wiley & Sons, p 1-556.

Tolman, C.F. (1937) Ground Water. New York: McGraw-Hill.

Traverso, A. (2026) An engineering perspective on climate change: Mitigation or adaptation? Energy Nexus, 21, 100646. https://doi.org/10.1016/j.nexus.2026.100646.

Tyrrell, G.W. (1926) The Principles of Petrology. Chapman and Hall, London, p 1-349.

van Kraailingen, I. and Eriksen, J.W. (2026) Teaching and learning with smartphones in tertiary outdoor studies programs. Journal of Outdoor and Environmental Education, 29, 73–92. https://doi.org/10.1007/s42322-025-00196-6.

Verkasalo, H., Lopez-Nicolas, C., Molina-Castillo, F.J. and Bouwman, H. (2010) Analysis of users and non-users of smartphone applications. Telematics and Informatics, 27, 242–255. https://doi.org/10.1016/j.tele.2009.11.001.

Verma, R., Verma, K., Verma, J., Singh, T. and Bisen, P.S. (2024) Indian rural development: a review of technology and society. SN Social Sciences, 4, 42. https://doi.org/10.1007/s43545-024-00831-x.

Walton, W.C. (1970) Groundwater Resource Evaluation. New York: McGraw-Hill, p 1-664.

Weiss, H.A. and Bonell, C. (2025) Smartphone use and mental health: going beyond school restriction policies. The Lancet Regional Health – Europe, 51, 101237. https://doi.org/10.1016/j.lanepe.2025.101237.

Werner, A.G. (1787) Kurze Klassifikation und Beschreibung der verschiedenen Gebirgsarten. In English, Dresden Walter (1971) Short Classification and Description of the Various Rocks (translated by A.M. Ospovat). Hafner, New York.

Wheatley, A. and Hervieus, S. (2024) Comparing generative artificial intelligence tools to voice assistants using reference interactions. The Journal of Academic Librarianship, 50, 102942. https://doi.org/10.1016/j.acalib.2024.102942.

Zhao, S., Li, S., Ramos, J., Luo, Z. Jiang, Z., Dey, A.K. and Pan, G. (2019) User profiling from their use of smartphone applications: A survey. Pervasive and Mobile Computing, 59, 101052. https://doi.org/10.1016/j.pmcj.2019.101052.

Zhao, T., Wang, S., Ouyang, C., Chen, M., et al. (2024) Artificial intelligence for geoscience: Progress, challenges, and perspectives. The Innovation, 5(5), 100691. https://doi.org/10.1016/j.xinn.2024.100691.

Zheng, P. and Ni, L. (2006) Smart Phone & Next Generation Mobile Computing. The Morgan Kaufmann Series in Networking, Elsevier, Amsterdam.