The Vijayanagara Empire: their contribution to the building of lakes, wells and canals in Karnataka, India

Arun Kumar and Anshuman Kumar

The rock types of southern Karnataka are poor for groundwater movement as they have poor porosity and permeability. Even though geologically long weathering process have produced vast formations of thick soil cover, it facilitates the sub-surface infiltration of rainwater for surface and ground water reservoirs......Geomorphology of southern Karnataka is such that it provides a good watershed region where rainwater can be accumulated in lakes. Many such water bodies are natural but many more are man-made. Many such lakes were built during the historic past, especially during the reign of rulers of the Vijayanagara Empire.

Sometimes during early November 2018, I (Arun) spent ten days visiting my friends in Karnataka, India. It was my first visit there and I spent this time travelling in and around Bangalore (Bengaluru), Mysore (Mysuru) and Vrindavan Gardens, and Tumkur (Tumkur) (Figure 1). I spent a couple of days in Bangalore with my friend Mr. C. S. Ramdas. Later Dr. B. C. Jaiprakash of Tumkur came to Bangalore to meet me and we both drove to Tumkur. I stayed with him for four days and drove around the vicinity of this town observing geology of this region dominated by several granitic hills of the Archaen age. Notable among them are a few Hindu religious shrines on top of these hills. We visited Siddarabetta hill and Heggunda Bella hill which has a Lord Ram temple on top. This hilltop is in the vicinity of BCJ’s beautiful village Bommalingaiahnapalya. One day we visited Devarayanadurga temple which is almost 35 kms away from Tumkur. This picturesque temple complex is large and nestled among the granite hills. Both Ramdas and Jaiprakash were my former colleagues in the Oil & Natural Gas Corporation of India (ONGC). Later we drove to Mysore and met my other ONGC colleagues Mr. S. N. Ramdas and Dr. M. H. Basavaraju. We stayed there for two days and visited the world famous Vrindavan Gardens and saw several places around this fascinating city. On our way back to Tumkur we also visited Pandupura Lake near Srirangapatna; which was built by the 15th century king Krishna Devaraya of the Vijayanagara Empire. We visited SriRanganatha Swami temple in Srirangapatna as well. A couple of days later BCJ drove me back to Bangalore and I boarded a train to my home in Lucknow.

This region we visited is part of southern Karnataka. During the drive I noticed mostly barren hills with little vegetation, lush green farm fields and villages. The most striking thing for us was the presence of large numbers of lakes and ponds in the rural as well as urban areas. Ponds are referred to as tanks in Karnataka. In this article we will use the term ‘lake’ instead of tank and pond. These lakes vary considerably in their size; some of them have clear water whereas several others seem to be suffering from eutrophication due to pollution. Lake shores are shallowing, and vegetation is gradually growing in them thus reducing their size. Many of these lakes are either at the base or close to the hills.
**Figure 1:** A. Location map of the state of Karnataka in India (Website 2). B. Districts of Karnataka showing locations of Bangalore, Tumkur and Mysore (website 3)

**Figure 2:** A billboard in the Cubbon Park (officially called Sri Chamarajendra Park) in Bangalore by the Geological Survey of India. This billboard marks an outcrop of the Peninsular Gneiss, one of the oldest rocks on the Earth. (Photo: Arun Kumar)
GEOMORPHOLOGY AND GEOLOGY OF KARNATAKA

Geomorphology of Karnataka can be divided into three regions: (1) the narrow coastal plains along the Arabian Sea, (2) the Malnad or mountainous region comprising the Western Ghat, and (3) the plateau region to the east. In the Peninsular Shield of India, the region covering the southern districts of Karnataka is known as Mysore Plateau; it is the southern extension of the Deccan Plateau having an average elevation of about 650 m. This region comprises of a series of narrow, linear ridges and hill ranges of schistose rocks and granitoid hills (GSI, 2006).

Karnataka occupies an area of 1,91,792 km$^2$ of which 1,86,792 km$^2$ is covered by hard rocks primarily crystalline granitic, schistose and gneissic rocks commonly called the Peninsular Gneiss Complex (Figures 2, 3 and 4). The Archean complex of the state consists of metamorphic and igneous rocks such as gneisses, schists, granites and charnockite. The oldest rocks of Karnataka occur in the Gorur area, Hassan district, that date to nearly 3300 million years. Intrusions of granites and granitoids ranging in age between 2600 to 2500 million years are common (GSI, 2006).

Figure 3: Outcrop of the Peninsular Gneiss showing exfoliation surfaces (separation of successive thin shells from massive rocks primarily results from rainfall).

(Photo: Arun Kumar)
Figure 4: Geomorphology of the southern regions of Karnataka. Small hillocks and massive boulders of the Peninsular Gneiss outcrop all over this area showing joints and spheroidal weathering patterns. (Photo: Arun Kumar)

The north of the state has outcrops of Proterozoic age sedimentary rocks belonging to the Kaladgi, Badami and Bhima groups. Further north the topography is covered by extensive volcanic flows that are parts of The Deccan Continental Flood Basalt (DCFB) of Cretaceous - Tertiary age (GSI, 2006).

There is a narrow strip of sedimentary formations that outcrop along the Arabian Sea coastal strip. These rocks cover about 5,000 km² of Tertiary (Warkhali Beds of Mio-Pliocene age) and Quaternary sediments (GSI, 2006). One of us carried out a palynological study of shallow core sediments from Karnataka coast, and based on this study late Holocene sea-level changes were suggested on the west coast of peninsular India (Kumar, 1994).
Lakes of Karnataka

The rock types of southern Karnataka are poor for groundwater movement as they have poor porosity and permeability. Even though geologically long weathering process have produced vast formations of thick soil cover, it facilitates the sub-surface infiltration of rainwater for surface and ground water reservoirs (website 1).

According to Raj and Chandrakanth (2015) there are about 37,000 lakes spread over 6,85,000 hectares of command area in Karnataka (Figures 5 and 6). These water bodies play a significant role in the economy of the state, for example, irrigation, fishing, tourism and recreation, trade, and transport, etc. More than half of the irrigation ponds in the state are filling and most urban lakes are polluted (Figure 6D). There is a Lake Development Authority in the state which is responsible for the rejuvenation and conservation of polluted lakes and irrigation tanks that are filling with silt.

Figure 5: Man-made water tanks built for irrigating the farm fields are common throughout Karnataka. (Photo: Arun Kumar)
Figure 6: A. B. and C. Karnataka has large numbers of natural lakes surrounded by hills and upland areas. These lakes play an important part in the economy of Karnataka, for example, irrigation, fishing, tourism, trade, and transport, etc. D. A lake is being filled by algae and other organic growth covering the water surface. It is an example of eutrophication that is caused by discharge of nitrate or phosphate-containing detergents, fertilizers, or sewage into a lake. It eventually leads to the death of a lake. (Photo: Arun Kumar)

Geomorphology of southern Karnataka is such that it provides a good watershed region where rainwater can be accumulated in lakes. Many such water bodies are natural but many more are man-made. Many such lakes were built during the historic past, especially during the reign of rulers of the Vijayanagara Empire. Let us briefly examine the history of the Vijayanagara Empire and their contribution to the building of lakes and irrigation canals in southern India specially Karnataka.
VIJAYANAGARA EMPIRE: THEIR CONTRIBUTION TO BUILDING OF LAKES, WELLS, AND CANALS

The Vijayanagara empire, 1336–1646

The Vijayanagara Empire was a special period in South Indian history that promoted Hinduism as a unifying factor among its population. The empire was famous for building efficient water management systems for irrigation that included building lakes, canals and digging wells. They created many monuments all over South India in the Vijayanagara Architecture style; the best known are at Hampi in Karnataka that demonstrate their architectural innovation in the Hindu style of temple construction. Deva Raya I undertook important works of fortification and irrigation in his empire (website 7).

This empire was centered in the Deccan Plateau region of India (Figure 7) and was established in 1336 by Harihara I and his brother Bukka Raya I of Sangama Dynasty that lasted until 1646. Its political and military power began to decline after a military defeat in 1565 by the combined armies of the Deccan Sultanates. This empire is named after its capital city of Vijayanagara whose ruins surround the present-day town of Hampi in Karnataka (Figure 8). This is now a World Heritage Site. Archaeological excavations at Vijayanagara have revealed the empire's power and wealth (website 10).

The Encyclopedia Brittanica describes the development of the Vijayanagara Empire as follows: (website 9).

“The kingdom of Vijayanagar was founded by Harihara and Bukka, two of five brothers (surnamed Sangama) who had served in the administrations of both Kakatiya and Kampili before those kingdoms were conquered by the armies of the Delhi sultanate in the 1320s. When Kampili fell in 1327, the two brothers are believed to have been captured and taken to Delhi, where they converted to Islam. They were returned to the Deccan as governors of Kampili for the sultanate with the hope that they would be able to deal with the many local revolts and invasions by neighbouring Hindu kings. They followed a conciliatory policy toward the landholders of the area, many of whom had not accepted Muslim rule, and began a process of consolidation and expansion. Their first campaign was against the neighbouring Hoysala king, Ballala III of Dorasamudra, but it stagnated; after the brothers reconverted to Hinduism under the influence of the sage Madhavacarya (Vidyaranya) and proclaimed their independence from the Delhi sultanate, however, they were able to defeat Ballala and thereby secure their home base. Harihara I (reigned 1336–56) then established his new capital, Vijayanagar, in an easily defensible position south of the Tungabhadra River, where it came to symbolize the emerging medieval political culture of south India. The kingdom's expansion in the first century of its existence made it the first south Indian state to exercise enduring control over different linguistic and cultural regions, albeit with subregional and local chiefly powers exercising authority as its agents and subordinates.”

“Vira Narasimha was succeeded by his brother Krishna Deva Raya (reigned 1509–29), generally regarded as the greatest of the Vijayanagar kings. During his reign the kingdom became more powerful than ever before, and internal consolidation reached a new peak. Krishna Deva spent the first 10 years of his reign solidly establishing his authority over his subordinate chieftains and governors while fending off invasions from the northeast.”

“During most of his reign Krishna Deva maintained a mutually advantageous relationship with the increasingly powerful Portuguese, whereby he retained access to trade
goods, especially to horses from the Middle East, while the Portuguese were allowed to trade in his dominions. The accounts from this period by the Portuguese travelers Domingos Pais and Duarte Barbosa depict a thriving city and kingdom under a highly venerated and capable ruler. Krishna Deva Raya’s scholarship and patronage of Telugu and Sanskrit literature have become symbols of Telugu pride and cultural traditions.”

“About 1524–25 Krishna Deva abdicated and had his young son crowned king. His son died shortly thereafter, however, reportedly poisoned by the jealous former chief minister. Krishna Deva imprisoned the minister and his family and dealt successfully with a serious rebellion three years later—when one of the minister’s sons escaped—as well as with Ismāʿīl ʿĀdil Shah’s attempt to take advantage of Krishna Deva’s troubles to recoup his position. Krishna Deva’s death in 1529 ended the period of the kingdom’s greatest military and administrative success.”

“Decline of Vijayanagar: It is likely that the sultans of Golconda and Ahmadnagar, who had lost much at the hands of Rama Raya, were primarily responsible for the formation of an alliance that destroyed Vijayanagar’s power forever. By 1564 at least four of the five sultans (Berar is questionable) had begun their march on Vijayanagar, which resulted early in 1565 in the disastrous defeat of the Vijayanagar forces in the Battle of Talikota and in the subsequent sack and destruction of much of the city of Vijayanagar. Rama Raya was captured and killed, but his brother Tirumala escaped to the south with the king and much of the royal treasure.”

![Image A](image1.png)

**Figure 7:** A. Geographical extent of the Vijayanagar Empire that covered most of the Indian Peninsular region (website 4). B. Panoramic view of the natural fortification and landscape at Hampi, central Karnataka. This photograph was taken by Dinesh Kannambadi at Hampi, Karnataka in June 2004 (website 5)
Figure 8: Monuments built by the Vijayanagara Empire in Hampi are now UNESCO World Heritage Sites; Hampi is in central Karnataka.

A. Huge stone wagon, 2.4 m high stone horses and a row of 11 domed elephant stables.
B. The ruins of ancient town of Hampi and the landmark temple as seen today.
C. The temples with intricate carvings.
Irrigation system and construction of lakes, canals, and wells

The capital city of Vijayanagara was completely dependent on the water supply systems built to channel and store water; this ensured water supply throughout the year. Large water tanks were built for water storage. Archaeological excavations reveal several well-connected water distribution systems built within the royal enclosure and the large temple complexes. They built channels using gravity and siphon system to transport water through pipelines as well. The public waterworks were of large water tanks that collected annual monsoon water, and some were fed by local springs. In the farming regions near the Tungabhadra River, canals were dug to carry river water into irrigation tanks. These canals were connected by channels to control the water flow. Wells were dug to harness ground water (website 7).

Morrison (1992) examined the structure of land use and agricultural production in and around the city of Vijayanagara. This city supported a large urban population through a diverse and intensive agriculture. These conclusions are based on archaeological surveys, quantitative and qualitative analyses of historical documents, and analysis of pollen and microscopic charcoal. Pollen and microscopic charcoal analyses were conducted on a stratified sediment core of a Vijayanagara-period reservoir that revealed distinct patterns of vegetation change through time during the Vijayanagara period.

City of Vijayanagara

The capital city of the Vijayanagara Empire was founded on the banks of the Tungabhadra River in the early 14th century. The city had an excellent layout and had magnificent forts, palaces, gardens and temples (Figure 8). Major irrigation works during the 15th century were constructed under Emperor Deva Raya and Emperor Krishna Deva Raya during the early 16th century. The Portuguese traveler Domingo Paes described the city as "there are many groves of trees within it, many orchards and gardens of fruit trees and many conduits of water which flow in the midst of it, and in places there are lakes." (website 8).

The rocky hillocks had watch towers and a presence of granite boulders were the raw material for temple construction. South of the river is a flatland where large and small temples complexes were built. Bigger populations inhabited the south of the irrigated flatlands that were watered by a system of ducts and dams. All available arable land was irrigated and a significant proportion of the population was involved in agriculture, making the capital city self-sufficient for food (website 8).

Numerous canals were dug to provide a perennial water supply to the narrow strip of fertile land bordering the Tungabhadra River. Surprisingly, many of these canals are still used, for example, the Kamalapura water storage tank. Excavation in the area shows the presence of sixty water reservoirs and numerous check dams, erosion control walls and wells leading to a system of a complex agricultural landscape of the diverse topography and resources (website 8).

Krishnadeva Raya (1509-1529 A.D.)

Krishnadeva Raya belonged to the Tuluva dynasty and was the most famous king of the Vijayanagara Empire. According to Domingo Paes, a Portuguese traveler, "Krishnadeva Raya was the most feared and perfect king there could possibly be." He conquered Sivasamudram in 1510 A.D. and Raichur in 1512 A.D., and captured Orissa and Warangal in 1523 A.D. His empire extended from the River Krishna in the north to River Cauvery in the south, the Arabian Sea in the west to the Bay of Bengal in the east. He was an able administrator.
and built large tanks and canals for irrigation. He developed the naval power and maintained friendly relationships with the Portuguese and Arab traders. He patronized art and architecture and was a great scholar (website 11).

Acknowledgements: I (Arun) would like to thank my friends and former Oil & Natural Gas Corporation (ONGC) colleagues Mr. C. S. Ramdas, Dr. B. C. Jaiprakash, Mr. S. N. Ramdas and Dr. M. H. Basavaraju. C. S. Ramdas hosted me in Bangalore and took me around this fascinating and beautiful metropolitan city of India; Dr. Jaiprakash hosted me in Tumkur and drove me to various places in Karnataka mentioned in this article and discussed geology and history of the state prompting me to write this article. S. N. Ramdas and Dr. Basavaraju met us in Mysore and made my journey enjoyable and informed me of the local geology and history.

REFERENCES


Web references

Website 1. Chapter 2; Karnataka Geology
https://shodhganga.inflibnet.ac.in/bitstream/10603/36421/5/chapter%202.pdf

Website 2. Location map of the state of Karnataka in India.
https://www.mapsofindia.com/maps/karnataka/karnatakalocation.htm

Website 3. Districts of Karnataka showing locations of Bangalore, Tumkur and Mysore.

Website 4. Geographical extant of the Vijayanagar Empire that covered most of the Indian Peninsular region.
https://en.wikipedia.org/wiki/Vijayanagara_Empire#/media/File:South_India_in_AD_1400.jpg

Website 5. Panoramic view of the natural fortification and landscape at Hampi, Karnataka. This photograph was taken by Dineshkannambadi at Hampi, Karnataka in June 2004. https://commons.wikimedia.org/w/index.php?curid=3056342

Website 6. Monuments built by the Vijayanagar Empire in Hampi are now UNESCO World Heritage Site, Hampi is in central Karnataka. (downloaded on January 9, 2020)

Youtube videos about the Vijayanagara Empire

https://www.youtube.com/watch?v=yN7P2qefiFk
https://www.youtube.com/watch?v=m97tCVD53aQ
https://www.youtube.com/watch?v=RyCl3bRRkY
https://www.youtube.com/watch?v=icF4uuppzTU

ABOUT THE AUTHORS

Dr. Arun Kumar is former Adjunct Professor, Department of Earth Science, Carleton University Ottawa-Carleton Geoscience Centre. 1125 Colonel By Drive, Ottawa, Ontario K1S 5B6, Canada

Email: arunkumarlko@hotmail.com

Mr. Anshuman Kumar works with the Canada Border Security Agency (Commercial and Trade Branch, HQ) and lives with his family in Ottawa. History is his favourite subject and enjoys reading about Indian History.