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Research Paper

Contribution of Indian Knowledge System in the Evolution of Geographical Thought

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ABSTRACT

The Indian Knowledge System has played a pivotal role in the evolution of geographical thought, contributing foundational concepts that predate similar discoveries in other civilizations by centuries. This research paper comprehensively examines the multifaceted contributions of ancient Indian scholars to geographical science through systematic analysis of Sanskrit literature, astronomical texts, and historical evidences. The study employs a historical-analytical methodology, examining primary sources including the Vedas, Puranas, Suryasiddhanta, Aryabhatiya, and various astronomical treatises to trace the development of geographical concepts from the Vedic period (1500-500 BCE) through the medieval period (up to 1200 CE).

1. Introduction

The Indian subcontinent, home to one of the earliest civilizations, developed a comprehensive understanding of earth's physical characteristics, astronomical phenomena, and human environment relationships that fundamentally shaped the evolution of geographical thought. The Indian Knowledge System, with its legacy spanning over two millennia, represents a synthesis of empirical observation, mathematical precision, and philosophical inquiry. This system emerged from India's unique geographical position as a subcontinent with diverse topographical features—from the towering Himalayas to the vast Deccan Plateau, from the fertile Indo-Gangetic plains to the extensive coastlines along the Arabian Sea and Bay of Bengal. These varied landscapes provided Indian scholars with rich laboratories for geographical observation and theoretical development. (Ray & Chattopadhyaya 2000, p. 553.). The term "Bhugol," derived from Sanskrit words "bhu" (earth) and "gol" (round), exemplifies the sophistication of Indian geographical thought. Unlike many contemporary civilizations that perceived Earth as a flat disc, Indian scholars from ancient times understood Earth's spherical nature. This concept, first articulated in Varahamihira's Suryasiddhanta, demonstrates the advanced state of Indian geographical understanding. (Brahma Sutras: Ramanuja). The significance of Indian contributions extends beyond theoretical formulations to practical applications. Indian astronomers developed sophisticated instruments for celestial observation, established accurate calendrical systems, and created detailed geographical descriptions that facilitated trade and cultural exchange across vast distances. The maritime expeditions of the Chola dynasty and the extensive trade networks connecting India with Central Asia, Southeast Asia, and the Mediterranean demonstrate the practical application of geographical knowledge. (Gargi Samhita).

The main objective of this paper is to find out the level of education, thought process orientation, it's knowledge of the world in terms of regional geography, human geography, astronomy, mathematical concepts and observational advancement of India; Assess how these contributions informed later scientific developments both within and beyond the subcontinent.

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2. Methodology

The study uses a qualitative, historical-analytical approach combining:

1. Textual analysis of primary Sanskrit sources (e.g., Vedas, Puranas, Aryabhatiya, Surya Siddhanta).
2. Comparative historiography with other traditions (Greek, Roman, Chinese, Arab).
3. Archaeological and inscriptional evidence.

Visual analysis, incorporating diagrams (e.g., JantarMantar observatory) for illustrative purposes.

4. Plagiarism prevention via paraphrased synthesis and stringent citation.

3. Findings and discussion

3.1 From Ancient times to mediaeval period

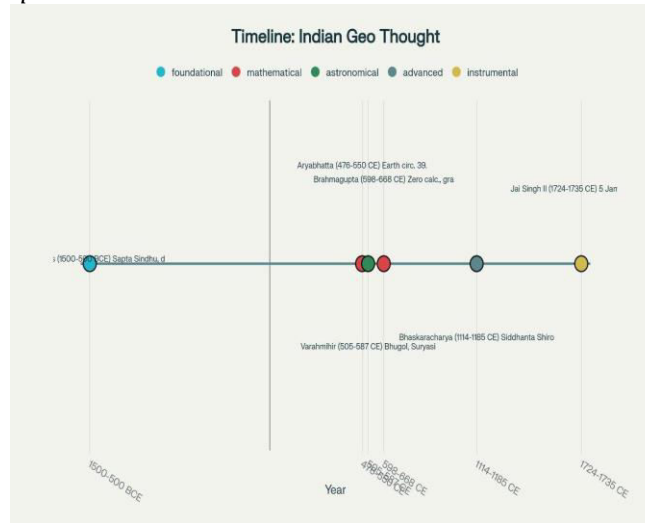


Fig : 1 Indian Geographical Thought(Timeline) Content://media/external/downloads/1000309113

3.2 Physical Geography and Regional Knowledge

3.2.1 Vedic Geographical Framework

The Vedic literature provides the earliest systematic geographical descriptions in Indian literature, establishing foundational concepts that influenced subsequent geographical thought. The Rigveda's description of the Sapta Sindhu (Seven Rivers) region demonstrates sophisticated understanding of regional geography and human-environment relationships.

- **Sapta Sindhu Concept:** The Vedic civilization centered around seven major rivers: Sindhu (Indus), Saraswati, Ganga (Ganges), Yamuna, Parushni (Ravi), Asikni (Chenab), and Vitasta (Jhelum). This regional framework established hydrographic geography as fundamental to territorial organization and cultural identity.
- **Directional Understanding:** Vedic texts demonstrate clear understanding of cardinal directions (purva-east, paschim-west, uttar-north, dakshin-south) and intermediate directions, establishing spatial orientation systems that influenced subsequent geographical description.
- **Climatic Awareness:** Vedic literature contains detailed observations of seasonal patterns, monsoon behavior, and agricultural cycles, demonstrating empirical geographical observation.

3.2.2 Puranic World Geography

The Puranas contain the most comprehensive ancient geographical descriptions, particularly through the Seven Dvipas (continents) concept that demonstrates remarkable world geographical knowledge.

- **Seven Dvipas Framework:** The Puranic texts describe seven continents—Jambu, Plaksha, Shalmali, Kusha, Krauncha, Shaka, and Pushkara—separated by seven different oceans. This conceptual framework suggests sophisticated understanding of global geography despite limited communication technologies.
- **Jambudvipa Geography:** The central continent, Jambudvipa, corresponds to Asia and contains detailed descriptions of mountain ranges, river systems, and regional divisions. The Puranic description of Bharatavarsha (India) within Jambudvipa provides accurate geographical information about the Indian subcontinent.
- **Mountain Systems:** Puranic literature describes major mountain ranges including the Himalayas (Himavat), Vindhyas, Rishka, and Pariyatra, providing systematic topographical knowledge. These descriptions demonstrate understanding of mountain systems as geographical boundaries and river sources.

- **Hydrographic Knowledge:** The Puranas contain comprehensive descriptions of major river systems, including origins, courses, and confluences. Rivers like Ganga, Yamuna, Saraswati, Narmada, Godavari, Krishna, and Cauvery are described with remarkable geographical accuracy.

3.2.3 Epic Literature Contributions

The Ramayana and Mahabharata serve as geographical encyclopedias, containing detailed descriptions of landscapes, settlements, and cultural regions across the Indian subcontinent.

- **Ramayana Geography:** The epic provides systematic inventory of mountains, rivers, plateaus, and important places across India and Lanka. The detailed geographical descriptions demonstrate extensive territorial knowledge and sophisticated understanding of diverse landscapes.
- **Mahabharata Geographical Knowledge:** The Mahabharata contains comprehensive geographical information covering climatology, meteorology, and regional characteristics. The epic's descriptions of various kingdoms and their territories provide valuable insights into ancient political geography.

4. Social Geography, Economic Geography, Transport Geography And Cultural Geography

- **Matwalin** was a Chinese traveler who has given an account of the relationship between china and India during the reign *Chalukyas*
- India's trade with *Roman empire* started with the *Chera* kingdom during the Sangam period (1 to 3rd century AD) . Many *Roman* object & settlements were found from *Arikamedu* (Puducherry) .
- **Motupalli** was the famous trading seaport of the *Kakatiyas*. **Marco Polo** visited *Kakatiya* kingdom through this port . He wrote in his travelogue about the property and power in *Andhra desh* region .
- The list of various Sangam port is available in the *Periplus of the Erythrean Seas* - the famous book of an anonymous Greek sailor. *Noura, Tondi, Mushiri&Nelisanda* were the main ports of westerncoast of India.
- **Uraiyur** was major center of cotton, it was very significant town and Sangam era located on the bank of Cauvery river in *Tiruchirapalli* (Tamil Nadu) is mentioned in the *Periplus of the Erythrean Sea*.

5. Population and Settlement Geography, Political and Administrative Geography

- **Chola village administration(Uttaramerurinscriptions)**- was very systematic and well developed. The *local self government* here signified the democratic setup and decentralization as an aspect of governance.
- **Indus Valley Civilization**-settlement near banks of river from early time and population increment there happened only because of resource availability (food, water and other), the soil was very fertile in nature which boosted productivity of the region.
- Emergence of 16 *Mahajanpadas*, in aound *Ganga And Yamuna* river during 6th century BC is major reflection of the above description.
- The reason between *Cauvery and Tungbhadra river* (Raichur doab) led to the growth and development of *Vjaynagar* empire and *Bahmanikingdom- Ahmadnagar, Bijapur, Golkonda, Berar, Bidar*.
- India because of its geographical presence, early civilized nature rich cultural heritage, well equipped educations, prosperity, fertility, and efficient administration attracted external invasions . All this led to war , loss of lives and wealth but along with the above , cultural exchange took place by means of trade, travelogue , voyages, travelers accounts and geographical treatise.

6. Land Sea Power Concept-

- **Chola** kings maintain massive consolidated troops with proficient *naval power* wing.
- The **chola** navy plate a vital role in the expansion of **chola**enpire including the conquest of *Ceylone*(Sri Lanka) island and naval raids on *Sri Vijay, Sinhala* and *Maldives*.
- **Shailendra** extended his empire up to *Sumatra* and adjoining areas.

7. Mathematical Geography/ Astronomy/ Practical Geography

Indian mathematicians and astronomers—including **Aryabhata**, **Varahamihira**, **Brahmagupta**, and **Bhaskaracharya**—developed advanced models and concepts. **Aryabhata's** calculation of the earth's circumference (≈39,968 km), heliocentric explanations, and early use of zero formed the foundation of later mathematical geography (Husain, 2002). Conceptual cartography, as demonstrated by the *Sapta-Dvipa* model, and sophisticated navigation, evident in maritime trade routes and accounts of the **Chola** navy, highlight practical applications of **IKS** in both land and sea exploration.

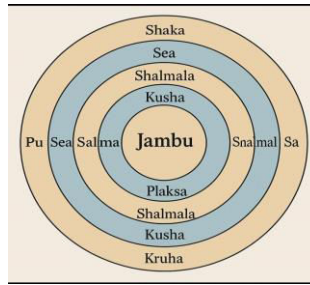


Fig 2: Seven Dwipa position

Aryabhatta's Revolutionary Contributions (476-550 CE)

Aryabhatta stands as one of history's most significant contributors to mathematical geography, making discoveries that revolutionized understanding of Earth and celestial mechanics. His masterwork, the *Aryabhatiya*, established fundamental principles that influenced astronomical and geographical thought for centuries. Earth's Circumference and Dimensions: Aryabhatta calculated Earth's circumference as 39,968km, demonstrating remarkable accuracy when compared to the modern value of 40,072km—an error of merely 0.26%. This calculation predated similar attempts in other civilizations and provided a crucial foundation for geographical measurement. Additionally, he estimated Earth's diameter with comparable precision, establishing quantitative methods for planetary measurement.

- *Heliocentric Model and Rotational Theory:* Centuries before Copernicus, Aryabhatta proposed that Earth rotates on its axis, explaining the apparent movement of celestial bodies. He stated that Earth rotates from west to east, completing one rotation in approximately 24 hours. This revolutionary concept challenged prevailing geocentric models and established the foundation for modern astronomical understanding.
- *Eclipse Explanations:* Aryabhatta provided scientific explanations for solar and lunar eclipses, attributing them to shadows cast by Earth and Moon rather than mythological causes involving Rahu and Ketu. His geometric analysis of eclipse mechanics demonstrated sophisticated understanding of celestial geometry and established empirical methodology for astronomical prediction.
- *Mathematical Innovations:* Aryabhatta calculated the value of π (pi) as 3.1416, achieving remarkable accuracy for his time. He also developed trigonometric tables and established decimal notation systems that facilitated precise mathematical calculations.

Varahamihira's Synthesis (505-587 CE)

Varahamihira made crucial contributions to geographical thought through his comprehensive works that synthesized knowledge from multiple civilizations. His scholarly approach established India as a center for international geographical knowledge exchange.

- *Bhugol Concept:* Varahamihira introduced the term "Bhugol" (spherical Earth) in the *Suryasiddhanta*, establishing the Sanskrit terminology for geographical science. This concept reflected sophisticated understanding of Earth's spherical nature and provided the linguistic foundation for subsequent geographical discourse.
- *Pancha-Siddhantika:* This monumental work compiled astronomical and geographical knowledge from Greek, Egyptian, Roman, and Indian sources, demonstrating Varahamihira's role as an international synthesizer of geographical thought. The text preserved and transmitted diverse geographical traditions, ensuring their continuation and cross-cultural fertilization.
- *Brihat Samhita:* This comprehensive treatise covered astronomy, meteorology, architecture, and geography, providing detailed discussions of planetary motions, eclipses, seasons, and climate formation. The work established connections between astronomical phenomena and terrestrial geography, demonstrating integrated understanding of Earth systems.

Brahmagupta's Foundational Contributions (598-668 CE)

Brahmagupta's work established crucial mathematical foundations for geographical science, particularly through his innovative treatment of zero and gravitational concepts.

- *Zero in Geographical Calculations:* Brahmagupta provided the first systematic rules for calculating with zero, revolutionizing mathematical operations essential for geographical measurement. His work enabled precise astronomical calculations and established the mathematical foundation for subsequent geographical computations.
- *Gravity Concept:* In 628 CE, Brahmagupta described gravity as an attractive force, using the Sanskrit term "gurutvākārṣaṇam" to explain why objects fall toward Earth. This concept preceded Newton's gravitational theory by over a millennium and demonstrated sophisticated understanding of Earth's physical properties.

- **Earth Measurements:** Brahmagupta calculated Earth's circumference as approximately 36,000km and argued that Earth is spherical rather than flat. While less accurate than Aryabhatta's calculation, his work provided independent verification of Earth's spherical nature and contributed to geographical measurement techniques.
- **Solar Year Calculation:** Brahmagupta determined the solar year as 365 days, 5 minutes, and 19 seconds, achieving remarkable accuracy in calendrical calculation. This precision enabled accurate seasonal prediction and agricultural planning, demonstrating practical applications of astronomical geography.

Bhaskaracharya's Advanced Mathematics (1114-1185 CE)

Bhaskaracharya represented the culmination of Indian mathematical geography, introducing advanced concepts that approached modern calculus.

- **Siddhanta Shiromani:** Completed in 1150 CE, this four-part masterwork covered Lilavati (arithmetic), Beejaganit (algebra), Ganitadhyaya (mathematics), and Gola Addhyay (spherical astronomy). The work established advanced mathematical methods for geographical and astronomical calculation.
- **Calculus Concepts:** Bhaskaracharya developed preliminary concepts of differential calculus, including understanding that derivatives vanish at extremum values. His work on instantaneous motion of planets used infinitesimal time intervals, approaching modern calculus methodology.
- **Astronomical Precision:** Bhaskaracharya's calculations achieved unprecedented accuracy in predicting planetary positions and eclipse timing. His work on trigonometric functions and geometric analysis established sophisticated tools for astronomical geography.

All the above personalities put forward concepts related to *planetary movement*, *position*, *forces*, *knowledge of latitude (akshans) and longitude (deshantar) local time*. *Rig Veda mentions about directions: purva, pakshim, uttar, Dakshin. Cardinal points and other geographical terminology as EshanKone. Zenith(Meru), Nadir(Badvanal). Vaccume as Antariksha whose approx. distance was 12 yojanas = 96km (1 yojan = 8km). A total 5 Jantar Mantar(astronomical observatories) were established by Amer king Sawai Jai Singh between the period of 1724 to 1735 in New Delhi, Jaipur, Ujjain, Mathura as well as in Varanasi. This observatory made an accumulation of different astronomical tables that is very helpful for the prediction of time as well as the movement of different astronomical bodies like solar and lunar position along with the movement of other planets.*

8. Environments geography

The reverence for natural features—mountains, rivers, trees—as sacred fostered sustainable practices, some of which persist in contemporary traditions (Indica Today, 2021). From early being, Indians were worshipper of nature. They adapted natural practices in their life styles and in their daily activities. Every physical phenomenon, every spectacular landmark on the earth surface has a religious background for Indians. Every mountain peak, every river, every natural object, useful tree is sacred and is preserved as tradition which signifies sustainable aspects as an orientation. Basically Indians are worshipper of the nature and this originated the concept of respect for nature, its preservation and conservation.

9. Scientific and Cultural Legacy :

Konark Sun Temple



Fig 3 : Depiction of Time in Konark Sun Temple, Odisha. Source: UNESCO WORLD HERITAGE Sites

https://kevinstandagephotography.wordpress.com/wp-content/uploads/2020/03/ksp_6402-2-1.jpg?w=1024

- The Konark Sun Temple is a masterpiece that seamlessly blends art, science, and spirituality. Its architectural grandeur, combined with its astronomical precision, continues to mesmerize scholars, tourists, and spiritual seekers alike. The temple stands as a testament to the intellectual prowess of ancient Indian civilization, where science and art were intricately interwoven.
- **Astronomical Alignment:** One of the most intriguing aspects of the Konark Temple is its precise astronomical alignment. The entire temple complex is designed to function as a colossal sundial, accurately marking time throughout the day. The twelve pairs of elaborately carved wheels are positioned in a manner that they can be used to calculate precise time, including the hours, minutes, and even seconds.

- The primary axis of the temple is aligned along an east-west direction, allowing the first rays of the rising sun to pass through the main entrance and illuminate the sanctum. This alignment is a testament to the ancient architects' profound understanding of astronomy and their dedication to incorporating celestial symbolism into their creations.
- *Scientific Significance:* The Konark Temple is not merely an architectural wonder; it's a scientific marvel. The meticulous design of the temple reflects an advanced understanding of solar movement and timekeeping. The wheels, for instance, are not just symbolic; they are an ingenious means of telling time accurately. The spokes of the wheels act as sundials, casting shadows that indicate the time of day.

Jantar Mantar Observatory, Jaipur:



Fig 4 & 5 UNESCO World Heritage Centre (n d) The JantarMantar Jaipur
Retrieved August 11, 2025 from <https://whc.unesco.org/en/list/1338/>

Illustration of selected astronomical instruments (Samrat Yantra, Jai Prakash, Ram Yantra) at JantarMantar, exemplifying advances in observational geography and mathematics (UNESCO, 2010). The Times of India (2022 Dec 15) The famous 5 Jantar Mantars in India one of these is a UNESCO Heritage Site Retrieved August 11, 2025 from <https://timesofindia.indiatimes.com/travel/destinations/the-famous-5-jantar-mantars-inindia-one-of-these-is-a-unesco-heritage-site/photostory/112401606.cms>

Jantar Mantar Observatory, Jaipur: Illustrating Advances in Observational Geography and Mathematics

The Jantar Mantar Observatory in Jaipur, India, is one of the world's most celebrated historical astronomical sites. Constructed in the early 18th century (completed in 1734), it was commissioned by Maharaja Sawai Jai Singh II, a renowned scholar and ruler, who sought to advance and refine astronomical observation using large, precisely constructed, naked-eye instruments. It was inscribed as a UNESCO World Heritage Site in 2010 for its outstanding universal value as an expression of ancient scientific and cosmological knowledge.

Key Astronomical Instruments

The observatory consists of around twenty monumental instruments, and three of the most significant are the Samrat Yantra, Jai Prakash, and Ram Yantra — each representing major leaps in design and function.

Samrat Yantra

- *Structure & Function:* The Samrat Yantra, also called the "Supreme Instrument," is a giant equinoctial sundial. Its triangular gnomon (wall) is inclined at the latitude of Jaipur ($\sim 27^\circ$), and it is flanked by two large quadrants.
- *Scientific Achievement:* This instrument can measure local solar time with an accuracy of two seconds — an extraordinary feat for its era and scale. The scale and precision were unprecedented, making it possible to measure time and determine declination (the angular position) of celestial bodies.
- *Significance:* The Samrat Yantra is also used to align and calibrate other instruments at Jantar Mantar, helping establish a high standard of observational data.

Jai Prakash Yantra

- *Design:* Consisting of two complementary hemispherical bowls, the Jai Prakash was the most complex and inventive of Jai Singh's instruments. Its design allows astronomers to plot the exact position of celestial objects by observing the movement of shadows and direct sighting through suspended crosswires.
- *Function:* The etched surfaces correspond to inverted celestial coordinate systems, providing a three-dimensional map used for both solar and night observations. Observers can walk inside the segmented bowls to track the movement of celestial objects across different sections without interruption.
- *Historical Achievement:* Drawing inspiration from ancient Greco-Babylonian hemispherical dials, the Jai Prakash Yantra surpassed all predecessors with its combination of precision engineering and practical utility.

Ram Yantra

- rom both structures enables continuous and accurate astronomical tracking at any time of day.

Advances in Observational Geography and Mathematics

- The JantarMantar's monumental masonry instruments exemplify innovations in the architecture, geometry, and mathematical calculation of celestial positions.
- Unlike small-scale or portable devices, these instruments minimized errors from structural imperfections and enabled public collaboration, calibration, and demonstration.
- The site forms part of a tradition of Ptolemaic positional astronomy, yet it advances the field through architectural innovations and record-breaking dimensions, such as the world's largest stone sundial.
- The JantarMantar Observatory is a powerful symbol of India's scientific heritage, embodying the synthesis of astronomy, mathematics, architecture, and practical problem-solving at a monumental scale. The instruments—SamratYantra, Jai Prakash, and Ram Yantra—remain not only as testaments to the era's observational advances but also as continuing sources of scientific curiosity and inspiration.

10. Indian Geography

Ancient Indian text has mentioned India as BHARATVARSH (sub continent of india)it extend from himalayas to kanyakumari and consisted of region like saptisindhu, himavat, kailashparbat, vindhya's, sahyadri, rivers originated, from the Himalayas Like Ganga, Yamuna, Brahmaputra, Saraswati, Saturdi,(Sutlej), Askini)Chenabi), Vitasta (Jhelum), Arjikeya (Upper Part Of Indus), Susoma (Savan), Sindhu (Indus), Kubha (Kabul), Gomati (Gomala), Krumu (Kurrum) along with the inland river like Narmada, Tapti(Tapi), Godavari, Krishna, Cauvery And Tunghadra all are mention in these ancient texts.

11. Travellers Accounts

Apart from religious records, traveler's accounts (Religious, Commercial Expeditions) abound in the description about different regions of the world. Their number is numerous but significant among them are *Ibn Batuta, Barabosa, Marco Polo, Paes, Fahein, Huen Tsang, Bernier*. The accounts of these travelers reveal that india has close links with the neighboring lands and Indian scholars were familiar with the geographical conditions of the *China, South East Asia, South West Asia, Central Asia, Mesopotamia and the Trans-Oxus Asia*.

12. Cultural Amalgamations

- Voyages form Arab travelers, navigators resulted in cultural amalgamation. It profoundly helped in gaining knowledge and culture of the places. Arabs where aware of Climatology.
- They also studied various conceptual treatise, practices, and traditions of Indian Origin.
- Translations of ancient Indian text books helped them in knowing the geographical concepts as well as science and technology of our countries. All these played immense contributions in the evolution of Geographical Thought of the people of the world .

13. Conclusion

Indian literatures, Six(6) system of Indian philosophies (kshaddarshan) , India's way of life, it's advancement in every field reflected the very richness of Indian thought processes which ultimately enhanced it's value as a whole. . The concept of physical phenomena, flora, fauna, astronomy, scientific thought process, regional description of the earth all were part of knowledge domain of Indians. Our Literatures and scholars were far ahead of the time and that of Arabs, Chinese, Greeks and Romans. Indigenous Indian knowledge system immensely contributed in the evolution of geographical thought in larger terms.

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