

Chapter 6: India

Subhash Kak

Our understanding of archaeoastronomical sites in India is based not only on a rich archaeological record and texts that go back thousands of years, but also on a living tradition that is connected to the past. Conversely, India has much cultural diversity and a tangled history of interactions with neighbouring regions that make the story complex. The texts reveal to us the cosmological ideas that lay behind astronomical sites in the historical period and it is generally accepted that the same ideas also apply as far back as the Harappan era of the third millennium BC.

In the historical period, astronomical observatories were part of temple complexes where the king was consecrated. Such consecration served to confirm the king as the foremost devotee of the chosen deity, who was taken to be the embodiment of time and the universe. For example, Udayagiri, located a few km from Vidisha in central India, is an astronomical site connected with the Classical age of the Gupta dynasty (320–500 AD). The imperial Guptas enlarged the site, an ancient hilly observatory going back at least to the 2nd century BC, at which observations were facilitated by the geographical features of the hill, into a sacred landscape to represent royal authority.

Indian astronomy is characterised by the concept of ages of successively longer durations, which is itself an instance of the pervasive general idea of recursion, or repetition of patterns across space, scale and time. An example of this is the division of the ecliptic into 27 star segments (*nakshatras*), with which the moon is conjoined in its monthly circuit; each of these segments is further divided into 27 sub-segments (*upa-nakshatras*), and the successive divisions of the day into smaller measures of 30 units. The idea of recursion underlies the concept of the sacred landscape and it is embodied in Indian art, providing an archaeo-astronomical window on sacred and monumental architecture.

Chronological overview

The archaeological record in the north-west of India demonstrates a continuity of tradition extending back to about 7500 BC at Mehrgarh, and some of the abundant rock art of the region may extend back to the Upper Paleolithic.

The archaeological phases of the Indus (or Sindhu-Sarasvati) tradition have been divided into four eras: the early food-production era (c. 6500–5000 BC), the regionalisation era (5000–2600 BC), the integration era (2600–1900 BC) and the localisation era (1900–1300 BC). The early food-producing era lacked elaborate ceramic technology. The regionalisation era was characterized by styles in ceramics, lapidary arts, glazed faience and seal making that varied across regions. In the integration era, there is significant homogeneity in material culture over a large geographical area and the use of the so-called Indus script, which is not yet deciphered. In the localisation era, patterns of the integration era are blended with regional ceramic styles, indicating decentralisation and the restructuring of networks of interaction.

The cultural mosaic in the third millennium BC is characterised by the integration of the Harappan civilization of north-west India, copper- and copper-bronze-age cultures of central and northern India, and Neolithic cultures of south and east India. Five large cities of the integration phase are Mohenjo-Daro, Harappa, Ganweriwala, Rakhigarhi, and Dholavira. Other important sites of this period are Kalibangan, Rehman Dheri Nausharo, Kot Diji, and Lothal.

The majority of the towns and settlements of the Harappan period were in the Sarasvati valley region. Hydrological changes, extended period of drought, and the drying up of the Sarasvati River following an earthquake in 1900 BC led to the abandonment of large parts of this area, and the Harappan phase underwent various stages of decline during the second millennium BC. A second urbanization began in the Ganga and Yamuna valleys around 900 BC. The earliest surviving records of this culture are in Brahmi script. A continuous series of cultural developments, which can be traced in the characteristic ceramic assemblages, links the two early urbanizations of India. There is also continuity in the system of weights and lengths between the Harappan period and the later historic period.

The main setting for the hymns of the *Rigveda*, which is India's most ancient literary text, is the area of Sapta Saindhava, the region of north India bounded by the Sindh and the Ganga rivers. The *Rigveda* describes the Sarasvati River to be the greatest of the rivers, flowing from the mountains to the sea. The archaeological record, suggesting that this river had turned dry by 1900 BC, indicates that the *Rigveda* is prior to this epoch. The *Rigveda* and other early Vedic literature have astronomical references that indicate epochs of the fourth and third millennium BC, which is consistent with the hydrological evidence.

The foundation of Vedic cosmology is the notion of *bandhu* (homologies or bindings between the outer and the inner). For example, in the Ayurveda, a medical system associated with the Vedas, the 360 days of the year were linked to the 360 bones of the developing foetus.

Some of the astronomical information in the Vedic texts allows them to be tentatively dated. Various of the Vedas contain lists of the 27 nakshatras, either listed directly or under their presiding deities, and one may conclude that their names have not changed. Twelve 'solar months' are also listed, implying that Vedic astronomy used a luni-solar calendar with an intercalary month being used to keep in step with the solar year. Correlations between the nakshatra segment and the 'solar month' constrain the date. Thus, nakshatra lists of the late Vedic period begin with Krittikā (Pleiades) whereas those of astronomy texts after 200 AD begin with Ashvini (α and β Arietis), indicating a transition through 2 nakshatras, or a time span of about 2000 years. The *Vedānga Jyotisha*, for instance, mentions that winter solstice was at the beginning of Shra Vishthā and the summer solstice at the mid-point of Ashleshā, which implies that this particular text dates to 1300 BC.

Texts of the Vedic and succeeding periods provide a crucial understanding of the astronomy of the historical period throughout India. This is complemented and strengthened by the archaeoastronomical evidence.

According to the *Vāstu Shāstra*, the traditional Hindu system of architectural design, the structure of a building mirrors the emergence of cosmic order out of primordial chaos through the act of measurement. The universe is symbolically mapped onto a square, *vāstu-mandala*, that emphasizes the four cardinal directions. The basic forms of this square are used as the basic plan for the house and the city. There exist further elaborations of this plan, some of which are rectangular.

The medieval period was characterised by pilgrimage centres that created sacred space mirroring conceptions of the cosmos. Over a long period, sacred temple architecture served both religious and political ends.

The instruments (*yantra*) that were used in Indian astronomy include the water clock (*ghati yantra*), gnomon (*shanku*), cross-staff (*yasti yantra*), armillary sphere (*gola-yantra*), board for determining the time from the sun's altitude (*phalaka yantra*), sundial (*kapāla yantra*), and astrolabe. The culmination of the Indian tradition of instrument-making occurred between 1724 and 1734, when the ruler of Jaipur, Maharaja Sawai Jai Singh II, built five masonry

observatories called Jantar Mantar in Jaipur, Delhi, Ujjain, Varanasi, and Mathura. Each contained several great fixed instruments, and apart from the one in Mathura, all of them survive with their instruments fairly well preserved. These instruments include Ram Yantra (a cylindrical structure with an open top and a pillar in its centre to measure the altitude of the sun), the Rashivalaya Yantra (a group of twelve instruments to determine celestial latitude and longitude), the Jai Prakash (a concave hemisphere), the Laghu Samrat Yantra (small sundial), the Samrat Yantra (a huge equinoctial dial), the Chakra Yantra (upright metal circles to find the right ascension and declination of a planet), the Digamsha Yantra (a pillar surrounded by two circular walls), the Kapali Yantra (two sunken hemispheres to determine the position of the sun relative to the planets and the zodiac), and the Narivalaya Yantra (a cylindrical dial). On Jaipur observatory itself, see Case Study 6.1.

What makes Jai Singh II's designs so important is the amalgamation of a long-lasting Islamic-Persian tradition—starting at least with the Maragha Observatory in the mid-13th century and culminating in the Samarqand Observatory in the mid-15th century (see Chapter 10)—with local traditions and personal innovations. Although Jai Singh II became acquainted with contemporary European astronomical knowledge in 1727 through his relationship with a group of Jesuit scholars—they brought to his court a Portuguese astronomer as well as La Hire's astronomical tables—the final design of his observatories remained in the Islamic-Persian tradition of monumental instruments and naked-eye observations. The Jantar Mantar observatories, forming a great network of observational sites, had a supportive role in the production of the *Zīj-i-Muhammad Shāhī*, one of the last comprehensive astronomical tables of classical astronomy.¹

Prehistoric and Harappan period

The city of **Mohenjo-Daro** (2500 BC) was a cultural and administrative centre, had as its foundation a 12 meter high platform of 400 m × 200 m. The lower city had streets oriented according to the cardinal directions and provided with a network of covered drains. Its houses had bathrooms. The city's wells were so well constructed with tapering bricks that they have not collapsed in 5000 years. The absence of monumental buildings such as palaces and temples makes the Harappan city strikingly different from its counterparts of Mesopotamia and Egypt, suggesting that the polity of the Harappan state was de-centralized and based on a balance between the political, the mercantile, and the religious elites.

Mohenjo-Daro and other sites show slight divergence of 1° to 2° clockwise of the axes from the cardinal directions. It is thought that this might have been due to the orientation of Aldebaran (*Rohinī* in Sanskrit) and the Pleiades (*Krtikkā* in Sanskrit) that rose in the east between 3000 BC and 2000 BC at the spring equinox; the word 'rohinī' literally means rising. Mohenjo-Daro's astronomy used both the motions of the moon and the sun. This is attested by the use of great calendar stones, in the shape of ring, which served to mark the beginning and end of the solar year.

A 3rd-millennium seal from **Rehman Dheri**, showing a pair of scorpions on one side and two antelopes on the other, that suggests knowledge of Vedic themes. It has been suggested that this seal represents the opposition of Orion (Mrigashiras, or antelope head) and Scorpio (Rohini of the southern hemisphere) nakshatras. The arrow near the head of one of the antelopes could represent the decapitation of Orion. It is generally accepted that the myth of Prajapati being killed by Rudra represents the shifting of the beginning of the year away from Orion and it places the astronomical event in the 4th millennium BC.

¹ Paragraph by Tofigh Heidarzadeh

Neolithic and megalithic sites

Burzahom, Kashmir This Neolithic site is located about 10 km northeast of Srinagar in the Kashmir Valley on a terrace of Late Pleistocene-Holocene deposits. Dated to around 3000–1500 BC, its deep pit dwellings are associated with ground stone axes, bone tools, and gray burnished pottery. A stone slab of 48 cm × 27 cm, obtained from a phase dated to 2125 BC, shows two bright objects in the sky with a hunting scene in the foreground. These have been assumed to be a depiction of a double star system.

Hanamsagar, Karnataka This is a megalithic site with stone alignments pointing to cardinal directions. It is located on a flat area between hills about 6 km north of the Krishna river at latitude 16° 19′ 18″ and longitude 76° 27′ 10″. The stones, which are smooth granite, are arranged in a square of side c. 600 m with 50 rows and 50 columns (for a total of 2500 stones), with a separation between stones of about 12 m. The stones are between 1 and 2.5 m in height with a maximum diameter of 2–3 m. The lines are oriented in cardinal directions. There is a roughly square central structure known as *chakri katti*.

It has been argued that the directions of summer and winter solstice could have been fixed in relation to the outer and the inner squares. The site could also have been used for several other kinds of astronomical observations such as use of shadows to tell the time of the day, and the prediction of months, seasons and passage of the year.

The Plan of the temple

The sacred ground for Vedic ritual is the precursor to the temple. Vedic observances were connected with the circuits of the sun and the moon. The altar ritual was associated with the east-west axis and we can trace its origins to priests who maintained different day counts with respect to the solstices and the equinoxes. Specific days were marked with ritual observances that were done at different times of the day.

For ritual purposes at home, the householder employed three altars that are circular (earth), half-moon-shaped (atmosphere), and square (sky), which resemble the head, the heart, and the body of the Cosmic Man (*Purusha*). In the Agnichayana, the great ritual of the Vedic times that forms a major portion of the narrative of the *Yajurveda*, the atmosphere and the sky altars are built afresh in a great ceremony to the east. This ritual is based upon the Vedic division of the universe into three parts of earth, atmosphere and sky that are assigned numbers 21, 78, and 261, respectively. The numerical mapping is maintained by placement of 21 pebbles around the earth altar, sets of 13 pebbles around each of 6 intermediate (13×6=78) altars, and 261 pebbles around the great new sky altar called the Uttara-vedi, which is built in the shape of a falcon; these numbers add up to 360, which is symbolic representation of the year.

The temple complex at Khajuraho

The town of Khajuraho extends between 79° 54′ 30″ and 79° 56′ 30″ E and between 24° 50′ 20″ and 24° 51′ 40″ N, in Chhatarpur district, in Madhya Pradesh. The temples of Khajuraho were built in the 9th–12th centuries AD by the Chandela kings. Originally there were 84 temples, of which 23 have survived. Of the surviving temples, 6 are associated with Shiva, 8 with Vishnu, and 5 with the goddess.

At the eastern edge of the temple complex are the Dantla hills, with a peak of 390 m at which is located a shrine to Shiva, which is a reference point for the temple entrances. All the temples excepting the Chaturbhujia face the east. The south-eastern edge has the Lavanya hill that is separated from the Dantla hills by the eastward flowing river Khudar. At the foothills of the Lavanya hill at a height of 244m is the shrine of goddess Durga as Mahishasurmardini.

The shrines to Shiva and Durga on the Dantla and Lavanya hills span the polarities of spirit (*Purusha*) and matter (*Prakriti*), which are bridged by the river between the hills. The temples

of Khajuraho are popular pilgrimage centres during two spring festivals: Shivaratri that falls on the new moon of Phalguna (February/March), and Holi, which falls on the full moon of Chaitra (March/April). The Lakshmana temple, one of the oldest in the complex, is considered the *axis mundi* of the site. It was built by the king Yashovarman (925–950) as a symbol of the Chandela victory over the Pratiharas and a record of supremacy of their power. This temple is oriented to the sunrise on Holi.

The groups of temples form three overlapping mandalas, with centres at the Lakshmana (Vishnu), the Javeri (Shiva), and the Duladeva (Shiva) temples. Their deviation from true cardinality is believed to be due to the direction of sunrise on the day of consecration. The temple, as a representation of the cosmos and its order, balances the *asuras* (demons) and the *devas* (gods), as well as containing in itself other polarities of existence. The conception of the sanctum is as a mandala.

The planetary deities, the *grahas*, encircle the temple. The temple is envisaged like Mount Meru, the axis of the universe, and the planets move around it.

The Udayagiri observatory

Udayagiri ('hill of [sun]-rise') is one of the principal ancient astronomical observatories of India. It is located at $23^{\circ} 31' N$ latitude on the Tropic of Cancer in Madhya Pradesh, about 50 km from Bhopal, near Vidisha, Besnagar and Sanchi. An ancient site that goes back to at least the second century BC, it was substantially enlarged during the reign of the Gupta Emperor Chandragupta II Vikramaditya (r. 375–414). This site is associated with 20 cave temples that have been cut into rock; 19 of these temples are from the period of Chandragupta's reign.

It appears that the ancient name of Udayagiri was Vishnupadagiri, or the 'hill of the footprint of Vishnu', and the name Udayagiri is after the Paramara ruler Udayaditya (c. 1070–1093). The hill is shaped like a foot. A saddle connects the northern and southern hills, and a passageway is located at the place where the northern hill meets the saddle. The Gupta period additions and embellishments at Udayagiri were concentrated around this passage. Most of the cave temples are located around the passageway.

On the day of summer solstice, there was an alignment of the sun's movement with the passageway. The day mentioned in the dated Chandragupta II Vikramaditya-period inscription in cave 6 has been calculated to be very close to the summer solstice of the year 402 AD. On this day, the shadow of the Iron Pillar of Delhi, which was originally located at the entrance of the passageway, fell in the direction of the reclining Vishnu panel.

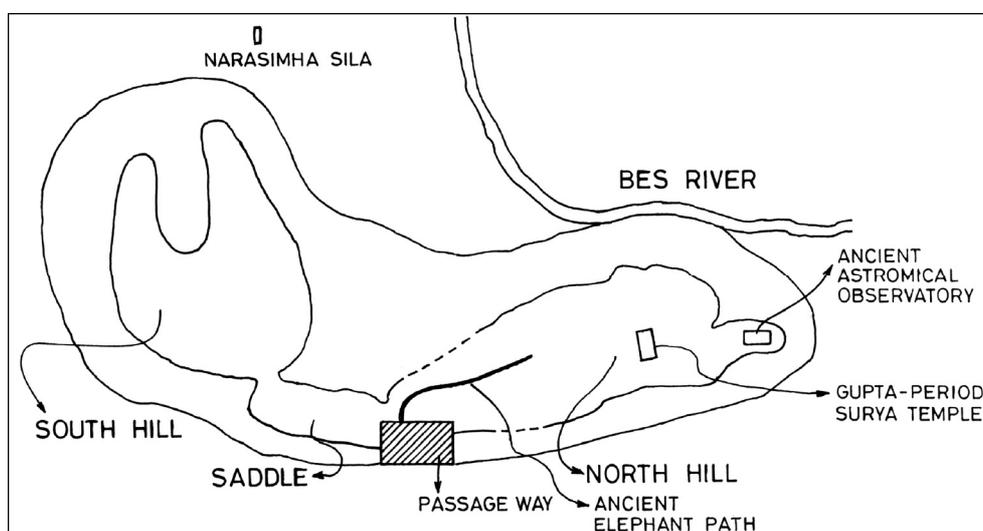


Fig. 6.0.1. The layout of Udayagiri. After R. Balasubramaniam, *Current Science* 95 (2008), 766–770.

On the northern hilltop, there exists a flat platform commanding a majestic view of the sky. Several astronomical marks have been identified at this platform, indicating that this was the site of the ancient astronomical observatory.

Medieval pilgrimage complexes

Medieval pilgrimage centres fulfilled many functions, including that of trade and business. They were important to the *jyotishi* (astrologer) who would make and read the pilgrims' horoscope. The better astrologers were also interested in astronomy and this knowledge was essential for the alignment of temples and palaces.

Every region of India has important pilgrimage centres, some of which are regional and others pan-Indic. The most famous of the pan-Indic centres are associated with Shiva (Varanasi), Krishna (Mathura, Dwarka), Rama (Ayodhya), Vishnu (Tirupati), and the 12-yearly rotation of the Kumbha Mela at Prayag, Haridwar, Ujjain, and Nashik. The question of temple alignments to the cardinal directions or to direction of the sun on major festivals has been studied by scholars at pilgrimage centres such as Chitrakut, Gaya, Madurai, Varanasi, Vindhyaachal, and Khajuraho.

The sun temples of Varanasi

Varanasi is an ancient city dating from the beginning of the first millennium BC, whose Vedic name is Kashi (Sanskrit for 'radiance'), a name that continues to be used together with Banaras. Of its many temples, the most important is Kashi Vishvanath Temple, or 'Golden Temple', dedicated to Lord Shiva, the presiding deity of the city. Because of repeated destruction by the sultans and later by Aurangzeb, the current Vishvanath is a relatively modern building. It was built in 1777 by Maharani Ahilyabai of Indore, and its *shikhara* (spire) and ceilings were plated with of gold in 1839, which was a gift from Maharaja Ranjit Singh.

Shiva represents both the axis of the universe as well as that of one's inner being. One of the great festivals celebrated in Varanasi is Shivaratri, which is celebrated on the 13th day of the dark fortnight of the Phalgun month (February-March). On that day, the sun can be seen rising in the east with the new moon just above it, which is represented iconographically by Shiva (as the sun) wearing the moon on his head.

There are several pilgrimage circuits in Varanasi for circumambulating the city. The Pan-chakroshi circuit has 108 shrines on it, and the four inner circuits have a total of 324 shrines. The city is also known for the circuit of the Aditya shrines. The Adityas are the 7 or 8 celestial gods, although their number is reckoned as 12 in later books. In Puranic India, they are taken to be the deities of the twelve solar months. The Aditya temples were also razed during the centuries of Muslim rule, but have been re-established at the same sites and are now part of the active ritual landscapes.

Several Aditya shrines have been located with the aid of descriptions in the *Kashi Khanda* and pilgrimage guides (Singh and Malville, 1995; Singh, 2009a and 2009b). Six of these lie along one sides of an isosceles triangle with a base of 2.5km. The triangle surrounds the former temple of Madhyameshavara, which was the original centre of Kashi. Pilgrims walking along the triangle are symbolically circumambulating the cosmos.

Sacred cities

There are numerous sacred cities in the Indian sub-continent that were either built to an archetypal master-plan or grew organically by virtue of being connected to a specific celestial

deity. Some of the important sacred cities are Varanasi, Vijayanagara, Ayodhya, Mathura, Bhaktapur, Tirupati, Kanchipuram, Dwarka, and Ujjain.

Robert Levy viewed the Indian sacred city as a structured ‘mesocosm’, situated between the microcosm of the individual and the macrocosm of the culturally conceived larger universe. Such a city is constructed of spatially connected mandalas, each of which is sustained by its own culture and performance. The movements of the festival year and rites of passage constitute a ‘civic dance’, which defines the experience of its citizens.

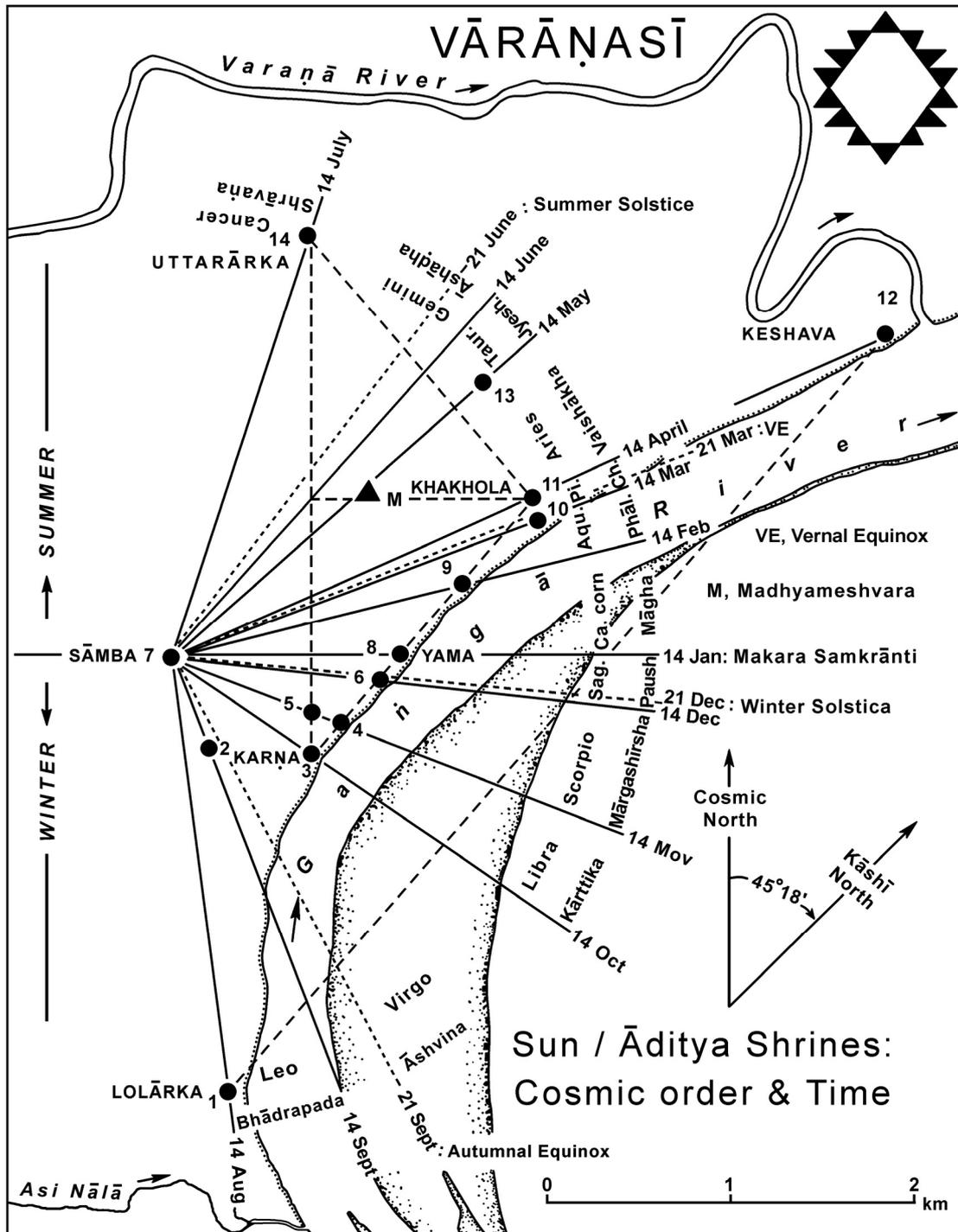


Fig. 6.0.2. Sun shrines at Varanasi: cosmic order and the cyclic orientation of time. After Rana P.B. Singh, *Banaras, Making of India’s Heritage City*, Newcastle: Cambridge Scholars Publishing, 2009.

The life-cycle passages and festivals dedicated to the gods affirm the householders' moral compass, identities and relationships. But there also exist other deities, represented generally by goddesses, who point to the forces of nature outside of moral order. These are brought into the larger order through Tantric invocations and amoral propitiatory offerings. Performances invoking the goddess are the responsibility of the king and the merchants.

Sacrality and royal power at Vijayanagara

The city of Vijayanagara (also known as Hampi) was founded in the 14th century and sacked in 1565. The best-known kings associated with Vijayanagara are Harihara I and II and Bukka Raya I (c. 1336–1404), and Krishnadevaraya and his half-brother Achyutadevaraya (1509–1542). From the mid-14th century to 1565, the city was the capital of the Vijayanagara Empire. According to the Persian ambassador Abdur Razaq (1442): 'The city of Vijayanagara is such that the pupil of the eye has never seen such a place like it, and the ear of intelligence has never been informed that there existed anything to equal it in the world'.

Hampi had been an important pilgrimage city for centuries owing to its mythical association with the river goddess Pampā and her consort Virupaksha, or Pampāpati. An inscription dated 1163 records a *mahādāna*, a religious offering in the presence of Lord Virupaksha of Hampi by the Kalachuri King Bijjala. The region was part of the kingdom of Kampiladeva until 1326 when the armies of Mohammed Bin Tughlaq defeated the king and imprisoned the two sons of Sangama, Hukka and Bukka. Some years later, the Sultan sent the two as governors of the province. In 1336 they broke free from the Tughlaq allegiance and established the Sangama dynasty with its capital at Vijayanagara.

The destruction of Vijayanagara in 1565 was complete and cruel: in a few days a magnificent and prosperous city was reduced to ruins, its population slaughtered.

Hampi has a strong association with the Ramayana and the names of many sites in the area bear names mentioned in the epic. These include Rishimukha, Malyavanta hill and Matanga hill along with a cave where Sugriva is said to have kept the jewels of Sita. The site of Anegundi is associated with the kingdom of Angad, son of Vali. The Anjaneya Parvata, a hill to the west of Anegundi, is the fabled birthplace of Hanuman.

Each year, in the month of Chaitra (March-April), the marriage of Hampi to Lord Virupaksha (or Shiva) is re-enacted, with the priests of Virupaksha temple devoutly performing every ritual from Phalapūjā (betrothal) to Kalyānotsava (marriage) in the temple.

The Sacred Centre of the city lies south of the Tungabhadra River, and is dominated by the four large complexes of the Virupaksha, Krishna, Tiruvengalanatha (Achyutaraya) and Vitthala temples. The major temples are either close to cardinality, departing by an average of 10', or are oriented to major features of the sacred landscape.

Further south of the Sacred Centre is the Royal Centre, which is divided into public and private realms. The dividing axis runs north-south and passes almost precisely between the king's 100-column audience hall in the east and the queen's large palace in the west. The Ramachandra temple pierces the axis and connects the private and the public domains. In the homology of the king and the deity, the royalty and divinity of Rama are inseparable.

The Virabhadra temple is on the summit of Matanga hill, which is the centre of the *vāstumandala* and the symbolic source of protection that extended outward from it along radial lines. As viewed from a point midway between the audience hall and the queen's palace, the *shikhara* of the Virabhadra lies only 4' from true north. From the ceremonial gateway in the corridor west of Ramachandra temple, the summit of Matanga hill is just 0.6' from true north.

The orientations of the major axes of the small temples, shrines, and palaces of the urban core are in marked contrast to these. The smaller structures deviate from cardinality by 17°, suggesting that they were influenced by the position of the rising sun on the morning when it crosses the zenith.

Prospects for the future

Interest in archaeoastronomy and art, as connected to temples and ancient monuments, has blossomed in India as the country's prosperity has increased. This new interest also owes much to the major archaeological discoveries that have been made in the past few decades and to the importance of temple tourism. The interest of the Indian authorities in astronomical heritage is clearly manifested by the 2009 nomination of the Jantar Mantar of Jaipur (see Case Study 6.1) for the World Heritage List, with a reasonable chance of gaining recognition from the Committee. The intention was to make a serial nomination with other Jantar Mantar of Northern India.

The principal authority over significant sites is the Indian Archaeological Survey of India (ASI) and its sister institutions that function at the state level as Departments of Archaeology and Museums. In 1976, the Indian government initiated projects to excavate three great medieval cities: Fatehpur Sikri in Uttar Pradesh, Champaner in Gujarat, and Vijayanagara in Karnataka, which are UNESCO World Heritage sites. The wealth of discoveries made in these cities is strengthening the movement to expose and preserve other sites in the country. Excavation, conservation, and research work can only be expected to increase. In particular, greater attention will be given to the archaeoastronomical aspects of the monuments.

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