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# The Science Of Groundwater Hydrology As Depicted In The *Bṛhatsaṁhitā*

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**Abstract:**
Groundwater hydrology refers the quality of water under the earth surface. In the *Bṛhatsaṁhitā*, Varāhamihiraelaborates how underground water can be predicted in the desert and semi desert areaon the basis of different trees, rocks, ant-hills and other objects. Varāhamihira bears abundant methods which are relevant for locating underground water. This paper is an attempt to reflect the methods of exploring underground water.

**Keywords:** *Bṛhatsaṁhitā*, Varāhamihira, groundwater, hydrology.

**Introduction:**
Ancient sages were very fond of nature. They observed everything of nature very minutely. Therefore, sages of that era tried to get information from the each and everything of nature. Among the sages Varāhamihira is also very keen observer of nature. He observed and analyzed maximum subjects in a scientific way. Varāhamihira was a great astrologer and astronomer who had mastery on every topic of mankind and he expounds these knowledges on various works, such as, *PañcaSidhāntikā, Bṛhajjātaka, Laghu Jātaka, Bṛhadyātrā, Yogayātrā, Vivāhapaṭala*, *Bṛhatsaṁhitā*and *Samāsasaṁhitā*. The author Varāhamihira (505 A.D.-587 A.D.) is considered to be one of the "Nine-Jewels" adorning the court of the legendary king Vikramāditya of Ujjain.
The treatise *Bṛhatsaṁhitā* is the most famous work on astrology and astronomy. It is assumed that the work *Bṛhatsaṁhitā* was written around 560 CE. It is also said that *Bṛhatsaṁhitā* might be Varāhamihira's last creation. With one hundred and six chapters this work covers topics such as, astrology, astronomy, geography, mathematics, meteorology, planetary movements, eclipses, architecture, treatment of plants, growth of crops, omens and auguries, gems, pearls, rituals and so on. Moreover, the literary sides of this book are also prosperous. This great Sanskrit work was published in *Bibliotheca Indica* by the German Indologist, Dr. H. Kern, who has also published an English translation in the *Journal of Royal Asiatic Society* of Great Britain and Ireland (1870 AD to 1874) as a series of articles. A commentary on the *Bṛhatsaṁhitā,* named *Vivṛti*, which was written by Bhaṭṭotpala (10$^{th}$ century A.D), in explaining the prescriptions in the section on *Vṛkṣāyurveda*, has elucidated the points by certain quotations from three ancient authors, Kāśyapa, Parāśara and Sārasvata. It seems probable that the treatises ascribed to these authors were primarily concerned with the art of cultivation.
Among the all subject matters the water divination lays a great impact. Before Varāhamihira there were another sage, who had wrote on under water sources, namely, Sārasvata and Manu etc. but those compositions were lost. Water divining refers a process where someone tries to locate the presence of water from the underground. From ancient times, people have tried to extract water from underground by observing various signals and processes. In this regard great scientists Varāhamihira has made an immense contribution. He enumerates different methods and processes regarding water divination in his work *Bṛhatsaṁhitā.*

**WATER DIVINATION AS DEPICTED IN THE *BṚHATSAṀHITĀ*:**
A chapter of *Bṛhatsaṁhitā* named '*Dakārgalam'* where Varāhamihira speaks about water divination of ancient India. *Daka* is a shorter form of *udaka* meaning water, and *argala* indicates bar of bolt. Hence *dakārgala* means a branch of science dealing with water locked up or imprisoned in the bowels of the earth.[1] Simply it indicates the resources of underground water. Water divination is an important science practiced in ancient India. It is noteworthy that Varāhamihira was the first person who predicted about underground water. In his work *Pañca Siddhāntikā* he mentioned about the prediction of water on Mars.[2] In this book he has predicted that planet Mars has both water and iron present on its surface, which have now been revealed by NASA and ISRO. The *Bṛhatsaṁhitā* gives numerous hints regarding the underwater in the surface of earth. In this context Varāhamihira explains that as there are veins in the human body, likewise the earth as also lots of veins. He mentions the name of these veins and their characteristics also. These veins are named after the eight deities who preside over the eight quarters beginning with the east. These are- Puruḥūta i.e., Indra, the chief of gods; Anala i.e., Goddess of fire, Yama i.e., God of death, Nirṛti i.e., demon, Varuṇa i.e., Lord of water, Pavana i.e., God of wind, Candra i.e., Moon and Śaṅkara or Śiva. The water veins in the different directions are known by the name of their respective deities. There is a ninth vein called mahāśirā i.e., great vein in the middle of these veins. It is said that apart from these veins there are hundreds of veins branching off from these and bearing distinct appellations.[3] According to the *Bṛatsaṁhitā* such water veins are found a little below the ground. Actually, water is predicted with reference to certain trees and ant-hills. Varāhamihira, in this context expresses

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indebtedness to his teachers like Baladeva, Garga, Kāśyapa and Devala. They had also immense knowledge about this science. This science helps men to ascertain the existence of water or sources of water.

In the *Bṛhatsaṁhitā*, Varāhamihira proclaims the probability of water in the surface of the earth in a waterless tract. He mentions about some specific trees name, plants, herbs, grasses, animals, lizards, snakes, tortoise, anthills, rocks and other natural signs. These indications can be used to predict presence of underground water both in quality and quantity. Moreover, he briefly explains the complete procedure how to drain water from that specific area. The tress as he says are- rotang, jambū, Indian fig, arjuna, nirguṇḍī, jujube, pālāśa, bilva, kampillaka, śoṇāka, beleric myrobalan and so on. It is remarkable that above mentioned tress must be naturally emerge. This systematic observation of ecological indicators reflectsVarahamihira's scientific approach to understanding nature's clues to water presence. Now we discuss about the natural indicators and how they proclaim to presence of underwater hydrology:

**Tree:** Varāhamiira says that trees or plants are one of the major indications for searching underground water. He explains about numerous tress names, which give hints of underground water. According to him if in a waterless place a rotang tree i.e., vetasa is seen flourishing in a waterless tract then it can be predicted that at a distance of 3 cubits to the west of the tree and at a depth of 7½ cubits there will be water. Varāhamihira broadly mentions this process in such a way that at a depth of 2 ½ cubit there will be probability of found pale white frog, after that yellow clay and then hard stone. At the underneath of all those stuffs there will be water.[4]

If a jambū tree i.e., black plum is seen in a waterless place, an easterly vein will be obtained at a depth of 10 cubits at a distance of three cubits to its north. During the process of digging there will be available some symptoms of water existing, like the soil smelling like iron, after that pale-white clay is found, then frog can be seen coming out.[5] Moreover, in the east direction of a jambū tree, if there is an ant-hill then it is suggested that sweet water can be found after digging 10 cubits depth at a3 cubits away on the south side of that tree. It is notified that after digging 2½ cubits deep, some stuff will be found, such as, fish, dove coloured stone, blue clay respectively. After coming out of all these stuffs there will be plenty of water for a long time.[6]

Varāhamihira mentions that at a distance of 3 cubits to the west of the Indian fig tree in a waterless place and at a depth of 12½ cubits from that tree there must be water vein. Before finding the water vein at the depth of five cubits white snake and then a stone of black as collyrium are seen.[7]

Again, if in a waterless place arjuna tree has grown by naturally and ant-hill can be seen on the north side of that tree then it can be assumed that water is likely to be originated at a distance of 3 cubitsin the west direction from the arjuna tree and at a depth of 17½ cubits from there after digging the soil. There are some symptoms which can be found after dug up the soil from which it can be ensured that there will be abundant water. Those symptoms are like this- at a depth of 2½ cubits there will be a white alligator then after digging a depth of 5 cubits there will be grey, dark, yellow, white and sandy clay found respectively.[8]

Nirguṇḍī plant i.e., Chinese chaste tree also provides the possibility of having lots of water in the waterless area. Varāhamihira says that if an ant-hill is observed in the near of that plant, it means there will be sweet and undried water at a depth of 11¼ cubits at a distance of 3 cubits to the south side of that tree. So, while digging this soil and looking for water many objects or animals can be noticed, such are- red fish, red-brown clay, pale-white clay, sand mixed with gravel and lastly there will be water.[9]

Jujubi trees i.e., Chinese date also help in seeking water in a waterless area. This will be possible when an ant-hill is on the east side of jujube tree, then at a distance of three cubits to the west of the tree and at a depth of 15 cubits water will be existed. It is notable that while digging the soil at a depth of 2½ cubits a white lizard might be observed.[10] One more indication is found of jujube tree that if this tree is seen along with a palāśa tree then at a distance of three cubits to its west and at a depth 16¼ cubits water will be found. Again, there will be a symptom of non-poisonous snake at a depth of five cubits.[11]

If bilva i.e., bael tree and an Indian fig tree are seen together in a waterless area then at a distance of 3 cubits to the south of those trees and at a depth of 15 cubits there will be water. In this context it is remarkable that at a depth of 2½ cubits a black frog will be found.[12]

If there is an ant-hill near an Kākodumbara tree i.e, opposite-leaved fig tree there will be a westerly water vein flowing at a depth of 16¼ cubits. The symptoms are pale yellow clay, white stone, white rat.[13] If a Kampillaka tree i.e., kamala tree is seen in a waterless place, there will be a water vein flowing in a southerly direction at a distance of 3 cubitsto the east direction from the kampillaka tree at a depth of 16 ¼ cubits. There will be some symptoms, which indicate the availability of under water. As Varāhamihira states when digging the soil at first there will be blue coloured clay and then dove coloured clay will be seen. At a depth of one cubit there will be a fish which smelling like goat and beneath that a little blackish water.[14] In this context Utpala the commentator of the *Bṛhatsaṁhitā* mentions the same view of Sārasvata.[15] Again, a water vein which is named *kumudā* flows at a distance of two cubits north-west of a śoṇāka tree in a waterless tract and at a depth of 15 cubits.[16]

Besides these Varāhamihira mentions many more names of the tree, where at a depth of definite cubits and the definite side from the tree, water will be available. It is noteworthy that Varāhamihira also mentions about the ant-hill nearby someparticular trees. The name of these trees are- karañja tree i.e., grey bonduc tree,[17] madhūka i.e., bassia tree,[18] tilaka, kadamba tree,[19] palm tree,[20] wood-apple tree,[21] jujube tree,[22] dāru haldi tree i.e., tree turmeric,[23] āmrātaka i.e., spondias, varuṇa i.e., tapia, bhallātaka i.e., nut tree, tinduka i.e., a sort of ebony, aṅkola i.e., walnut, piṇḍāra, śirīṣa, añjana,

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parūṣaka, vañjula i.e., bayas and atibalā.[24] The names of some creepers and grass also mentioned, which indicates the availability of waters.

**Ant-hill:** Ant-hill is a nest of ants or termites in the form of a mound. By observing of the location of ant-hill, it can be easy to identifying the underground water vein. As Varāhamhira says in his *Bṛhatsaṁhitā* that if there is an ant-hill in the south direction of the beleric myrobalan tree, then at a distance of two cubits to its east direction from the tree and at a depth of 7½ cubits water vein will be found. Again, if there is an ant-hill in the west direction of the same tree then in the north side of that tree at a distance of one cubit and at a depth of 22 ½ cubits there will be a water vein. In the north-east direction of a kovidāra tree i.e., mountain ebony tree if there is an ant-hill which is darkened by the holy grass, then in between the tree and the ant-hill at a depth of 22 ½ cubits water will be explored. When saptaparṇa tree i.e., echites tree is covered with ant-hill, it is expected that at a depth of 25 cubits and at a distance of one cubit to its north there must be water and also at a depth of 2 ½ cubits there will be found northerly vein carrying good water.[25]

Desert is a very dry and wide area. The amount of rainfall here is very low. Therefore, the water shortage is very high in desert area. Hence, people of that area collect water from different sources, such as, rainfall, rivers, lakes, oases, groundwater etc. The above motioned processes are applicable in jungle and watery regions. Hereafter the author mentions about the processes of water divination which are applicable only for desert area. He also tries to speak up how people of that time clear up the water scarcity issue. According to him in the desert region water veins are located on very deep of the ground and water veins run below the surface of earth in the shape of the neck of a camel.
According to the author in the desert region if there is a pīlu tree i.e., arak tree and in the north-east direction of this tree there be an ant-hill then at a distance of 4½ cubits to the west of the tree and at a depth of 25 cubits there will be found a water vein.[26] One more reference is found of pīlu tree that when ant-hill is situated at the east of that tree it indicates about the availability of water at the distance of 4½ to the south and at a depth of 35 cubits. If actually this place has having water then during digging there are a few hints, such as, black snake, brackish water etc.[27]
According to him in semi desert region if there is an ant-hill near by jambū tree, trivṛt, maurvī, śiśumārī, sārivā, śivā, śyāmā, vārāhī, jyotiṣmatī, garuḍavegā, sūkarikā, māṣaparṇī or vyāghrapadā creeper, then at a depth of 25 cubits and at a distance of 3 cubits to the north of the ant-hill there will be water.[28]

**Snake Abode:** If there is a snake's abode to the west of a kadamba tree, then water will be found to the south of the tree. The water vein lies at a depth of approximately 28 cubits below the surface, at a horizontal distance of 3 cubits southward from the tree.[29] If a snake's dwelling is located to the south of a kapitha i.e., wood-apple tree, then itis assumed that there is water to the north. After digging, 7 cubits from the tree, at a depth of 25 cubits water will be found.[30] According to Varāhamihira if there is a snake's dwelling i.e., ant-hill to the north of a karīra tree, then it can be predicted that there is sweet water to the south of the tree, at a distance of 4 ½ cubits and at a depth of 50 cubits. In this context Bhaṭṭotpala cites the *Sarasvata* tradition, affirming that the presence of an ant-hill near the karīra tree indicates water and provides further digging guidelines.[31] In similar way Varāhamiira gives some other references of exploring underwater by observing snake abode, viz., snake abode near aśmantaka tree,[32] rohītaka tree[33] and suvarṇaka tree.[34]
**Soil:** In the *Bṛhatsaṁhitā*, Varāhamihira enumerates some characteristics of soil that indicate the presence of groundwater at specific depths. Varāhamihira provides guidance on locating groundwater based on temperature variations in the soil and certain natural signs, particularly in semi-desert or watery regions. According to him if there is an isolated cold spot in warm ground or a warm spot in cold ground, then it suggests the presence of groundwater beneath.[35] Varāhamihira mentions that color and composition of soil can indicate the quality and taste of groundwater.[36] He says that if the soil has a copper hue and is mixed with gravel**,** the water is likely to be astringent in taste i.e., somewhat bitter or puckering due to high mineral content. Again, if the soil is red-brown**,** it indicates the water will be brackish i.e., slightly salty or unpleasant to taste. It may be due to the presence of certain salts or minerals. Pale white soil is the indication of salty water and it may not be suitable for drinking. But blue color soil suggests that the water will be sweeti.e., fresh and drinkable. Such kind of knowledge can help to search suitable well sites, drinking water. So that people would be able to avoid unpleasant drinking sources.As he says soft, low, sandy and emitting sound can give the indication of underground water at a depth of 25 cubits.[37] Varāhamihira says that if the soil seems to be heat or if there are any smoke blowing without fire then it means that in the 10 cubits deep of the soil there must be a water vein.[38] Moreover, in the waterless place if the ground produces some loud and pleasant sound when someone hits it then make sure at a depth of 17½ cubits there will be found the northerly water-vein.[39] The availability of water in the semi desert region is seen at a depth of 7 ½ cubits where the earth goes down being trodden upon or at a place where numerous insects are spotted without their abode.[40]

**Rock:** By observing the colour, size of the rock the availability of under water can be predicted. Varāhamihira mentions that if the colour of a rock resembles to beryl, green gram, cloud, dark gem, ripe fig, bee or collyrium, brown, pigeon, honey, ghee, silken cloth or the Soma creeper, moonlight, vermilion, rays of the rising Sun, minerals viz., crystal gem, pearl, gold, sapphire, yellow orpiment then there must be found under water.[41] Hence, here Varāhamihira elaborates on ancient methods for locating underground water by observing the surface of rocks, particularly their color and size. His observation shows that how certain types of rocks and colors can give information of the presence of water beneath the

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earth. By analyzing these specific hints ancient practitioners could estimate the presence of water and quality of underground water. These kind data reflect a resourceful approach of ancient India.

**Miscellaneous:** In addition to the abovementioned sources of the underwater vein, many more symptoms about the underwater search are mentioned in the *Bṛhatsaṁhitā*. The size or unusual changes of trees, the crop conditions of the farm etc. are also some other indications for searching the underground water. Availability of water in the underground can also be ascertained by monitoring the crops of the fields. According to *Bṛhatsaṁhitā*, in the crop field if all the cultivation is going to destroy then it is predicted that there will be water vein. Even if there is found a lot of cultivation it also means that there are abundant of underground water.[42] Again if a single branch of a tree is remain bent in one direction and if it also be colourless then it can be predicted that there will be water vein at a depth of 15 cubits of that specific branch.[43] Above all these, the unusual formation of fruit flowering tree,[44] the structure of thorny trees,[45] date tree[46] also can provide the hints of the availability of underground water. Moreover, the author also mentions about some tress which are grow conjointly, and near that trees underwater can be enact.[47]
These are the processes of draining water from the underground as depicted in the *Bṛhatsaṁhitā* by Varāhamihira. These are the method how water can be extracted from the ground by noticing various symptoms and monitoring different trees, ant-hills, snake abode, soil, rocks and other objects.

**Conclusions:**
From the above discussion it must be conclude that ancient Indian scientist or sages were very proficiency in hydrogeology through keen environmental observation. This early knowledge likely influenced the construction of India's stepwells, reservoirs, and advanced irrigation techniques. This field of studying groundwater sources reflects the scientific investment in water management, in such type of country where agriculture depended heavily on the understanding of seasonal water availability. Since Sarasvata's and Manu's works are lost, Varāhamihira's descriptions in the *Bṛhatsaṃhitā* are rare and significant source of ancient Indian hydrological knowledge. His work provides a systematic approach to locating and managing water resources, which became a part of India's long tradition of advanced water management practices. This ancient knowledge helps to building effective water systems, influencing structures like wells, ponds, and embankments. Today, Varāhamihira's insights are still valuable to architects and engineers interested in sustainable, traditional methods of water sourcing. His work reflects a combination of careful observation and practical science, and shows how ancient Indian knowledge systems were highly coordinated to ecological balance and environmental sustainability.

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