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WATER RESOURCES IN THE HILL FORTS OF SOUTH INDIA (14-18TH CENTURY)

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An interesting feature of the peninsular plateau is the large number of isolated granito-gneissic rocks which were in former days used as hill fortresses. How in this zone, rather precarious climatically, could a garrison of several hundred men live at the top of these rock outcrops throughout the year, without sufficient supply of drinking water? This phenomenon has been examined.

When we look at the water-supply arrangements, we find that all depressions, relatively shallow, wide and flat, cavities, as well as anfractuosities, deep fissures, fractures, where water can be stored, were used, and, in the flat areas, the ground was excavated in the form of reservoirs and entirely artificial works were built.

It means that, in all these hills, water resources were appreciable and that all possible steps were taken to get rid of the seasonal fluctuations. These observations raise several important issues:

First question: how is it possible to find water beneath heaps of burning boulders or in depressions on the hills, even in summer? The evident reason for this presence is that water is stored in the foliated arrangements of the granite and reappears as springs.

The second question concerns the large ponds of the glacis. Why, during the hot season, when all the rainwater collection tanks are completely dry, water is still available in some ponds at the foot of the hills? Manifestly, old-time engineers, for building reservoirs, selected rocky depressions having a water-bearing layer of clay which could collect not only water flowing from the surface, but also water accumulated in the weathered granite through an underground drainage protecting it from evaporation, ensuring thus a dependable supply throughout the year.

It would be interesting to know about the avenues along which the water can percolate, the articulation and interconnection of the sheets of ground water in the heap of boulders and at the foot of the hills.

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Experts in hydrology are, therefore, requested to give assistance to historians so that these aspects of water management could be explained.

Key words: *Amṛtasarovara*, Artificial reservoirs, *Cakrakuḷam*, *Cettikuḷam*, *Cinnakuḷam*, Hill fortresses, Inselbergs, *Kañcakuḷam*, *Pedda bhāvī*, Underground pits, Weather pits.

Introduction

An interesting feature of the peninsular plateau, south of the Tungabhadra River, is the large number of isolated granito-gneissic rocks which are found in many parts, and which often rear their heads as stunpendus monoliths to the height of 1500 m. These granitic hills, called inselbergs by the geographers, are of different types: rounded, domed or castellated, boulder strewn residuals, rising into rocky eminences with almost sheer sides which are usually surrounded by great impassable screes of boulders, bare of any sort of soil or vegetation. This plateau is of great historical importance.

Many of these rugged and cragged elevations were in former days used as hill fortresses, with several lines of walls built at different levels up to the summit, which have been the scene of many a hard-fought battle (see Fig. 1: Gingee: Rājagiri).

Obviously, one of the main reasons for selecting the hills fit for defensive works was the presence of water.

Without water, the inselbergs of this region would have remained an assortment of heterogeneous rocky bumps, hostile to human settlements. With water, several of them have become the supports of some of the most spectacular strongholds in India.

Indeed, how in this zone rather precarious climatically, could a garrison of several hundred men live at the top of these rock outcrops throughout the year, how could they withstand the operation of a long strict blockade, without sufficient supply of drinking water?

In the following analysis, based on intense fieldwork and personal investigations carried out during several years, we will try to explain this phenomenon.

Fig. 1. Gingee: Rājagiri

1. Water-Supply Arrangements

When you climb these hill slopes, you are surprised to find springs, in all seasons and at different places, even at the top, and also natural cavities, which occur on the upper surface of rocks with gentle inclination, or in cavernous forms below the boulders, all usually full of water from November to March. In some places you see that water is collected in excavations made in the form of reservoirs with flights of steps.

Weather Pits and Artificial Reservoirs on the Fortified Hills:

All depressions, relatively shallow, wide and flat, cavities, called weather pits by geologists, *cuṇai* in Tamil and *ḍoṇe* in Kannada, as well as anfractuosities, deep fissures, fractures, where water can be stored, were used.

The weathered pits of large dimensions were enclosed by brick walls; the cavities, dyked up on the sloping side; the breaches in the anfractuosities, filled in; the inner side of the enclosures, modified for storing water; and finally, in the flat areas, the ground was excavated in the form of reservoirs and, entirely artficial works were built.

In the famous "Mysore hill forts," in Karnataka, some significant examples are found. At Jagadevidurga (Fig. 2), water is stored in huge fractures and crevices. At Sāvandurga (Fig. 3), several types of pits are found, from

Fig. 2. Jagadevidurga

Fig. 3. Sāvandurga

small hollows to larger ones, elliptical or circular in plan; at the summit of Rāmagiridurga and Hutridurga (Figs. 4 & 5) there are rhomboidal depression, and, on the eastern slope of this last site, three *ḍoṇe*, one above the other, are interconnected by spilling over.

Naturally, the best reservoirs are seen on flat-topped hills. At Krishnagiridurga (Fig. 6), on the northern side of the hill, are four big reservoirs which consist of pits edged with brick walls and provided with

Fig. 4. Rāmagiridurga

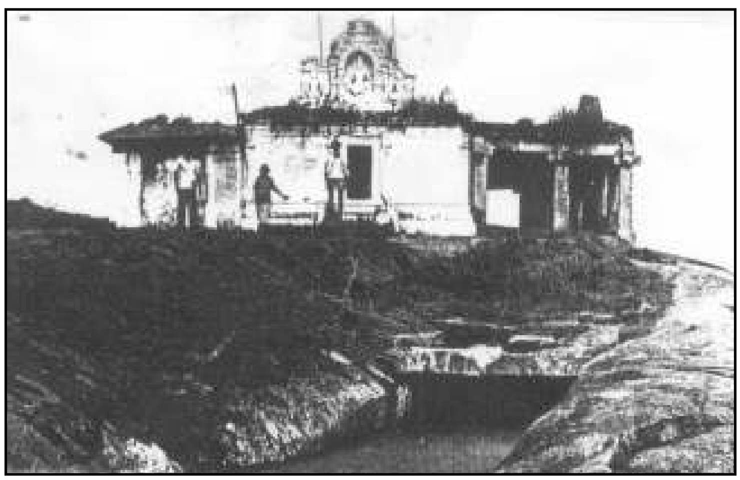

Fig. 5. Hutridurga

staircases. At Tattakkāldurga (Fig. 7), inside the parapet of the enclosure, six works of this type have been built in natural depressions. In the same way, on the flat side of the dissymetrical inserlberg of Rāyakottai (Fig. 8), the stone enclosure of the fort is used as a barrier where water is confined and, on gently inclined bounding slope, are armchair-shaped hollows surrounded with strong walls.

In some places are found depressions in which large square or rectangular reservoirs have been dug up, with stone tiers and peristyle. The

Fig. 6. Krishnagiridurga

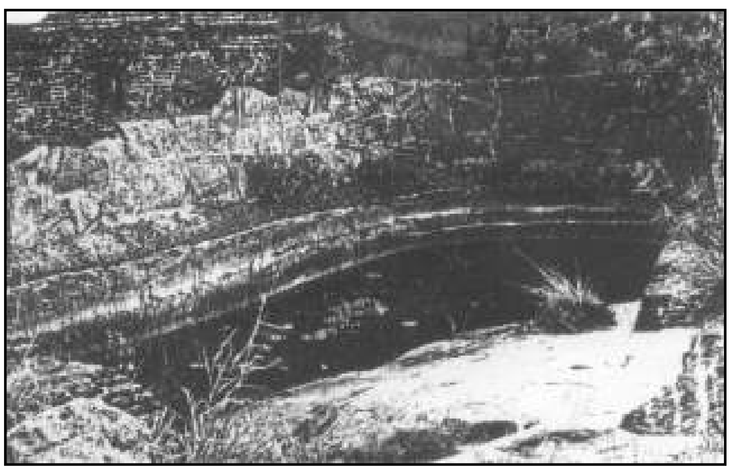

Fig. 7. Tattakkāldurga

most imposing is at Nandidurga (Fig. 9). There, the *Amṛtasarovara*, the main source of water supply on the hill, is a fine large large stone built pond, about 60 m square, with stone slabs on the sides which form several series of steps.

The same types of cavities, the capacity of which could be increased by the addition of masonry works or by further excavation, are seen in all the other hill forts of South India. The largest are located at Gutti, in Andhra Pradesh; there, on the main hill, a series of great rock-cut reservoirs follow

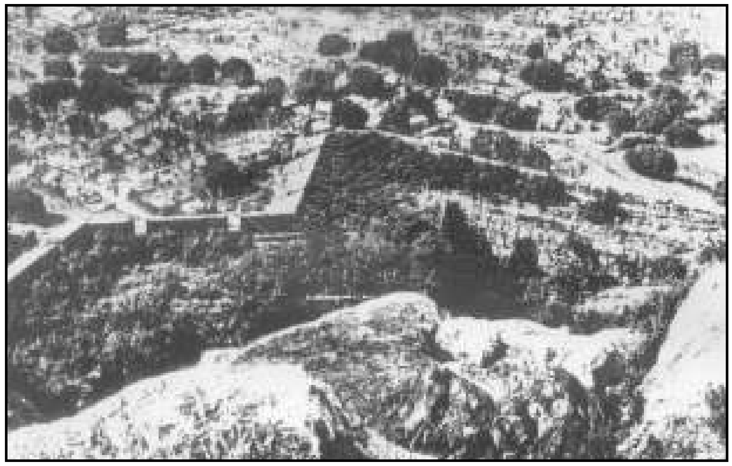

Fig. 8. Rāyakottai

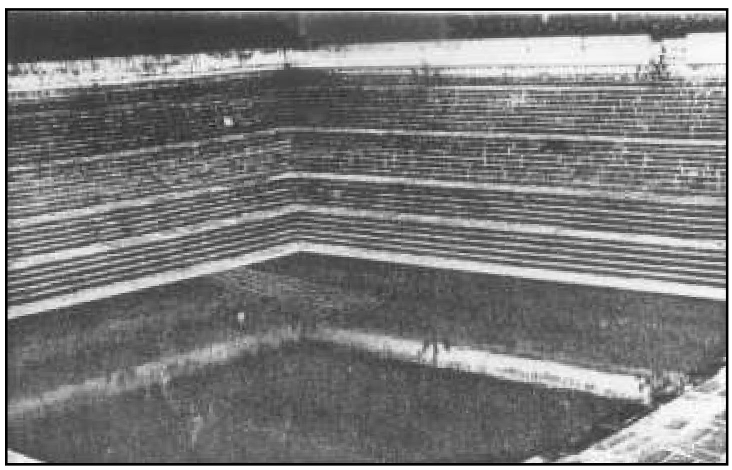

Fig. 9. Nandidurga: *Amṛtasarovara*

one another, particularly a depression, 150 m in diameter, called *Pedda bhāvī* (Fig. 10).

Large Tanks of the Glacis:

On the glacis, there are artificial tanks. Some are small ponds located in natural hollows, others, situated in places more favourable to the accumulation of water, are of large dimensions and, often, are surrounded with earth embankments or masonry walls. All are equipped with distribution channels.

Fig. 10. Gutti: *Pedda Bhāvī*

At the foot of the hiils, in the hollows made by erosion, or in the areas lower than the surrounding surface, step-tanks called *kuḷam* in Tamil, have been built. The most imposing are found in the zones of natural drainage where they are closed by an embankment.

Thus, at the stronghold of Gingee, in the Tamil country, there is, inside the outer fort, two large *kuḷams*: the *Cetti*- and the *Cakra-kuḷams* (Figs. 11 & 12): In the first one, water is retained, downstream by an enormous earth-embankment, roughly 60 m wide (Fig. 12), with a distribution of water made through a system of sluice fitted with a kind of portico; it is never dry, though the water level decreases greatly during the hot season.

Nearby, to the west, but at a higher level (6 to 7 m), the second one, with perennial water (Fig. 11, foreground), is accessible, at both extremities, by short flights of steps.

To the north-west of the stronghold, two ponds get also water throughout the year and this phenomenon must have struck local people, since they call the hamlets, located nearby, by the name of *kañca-kuḷam* (tank which never dries); the first one, called *Cinna-kañcakuḷam* (Fig. 13), is a square tank, made up of irregular rubble stone; the second one, named *Periya-kañcakuḷam* (Fig. 14), is revetted with better stone blocks. (As regard

Fig. 11. Gingee: *Cakra* & *Cetti-kuḷams*

Fig. 12. Gingee: *Cettikuḷam*

wells which usually provide the primary source of domestic supply, only a few of them are found at the foot of the inselbergs).

The short list of water works given here shows that, in all these hills, water resources were appreciable and that their management was one of the primary concerns of the *qil'ahdārs* who strove hard to harness it: everywhere,

Fig. 13. Gingee: *Cinnakañcakuḷam*

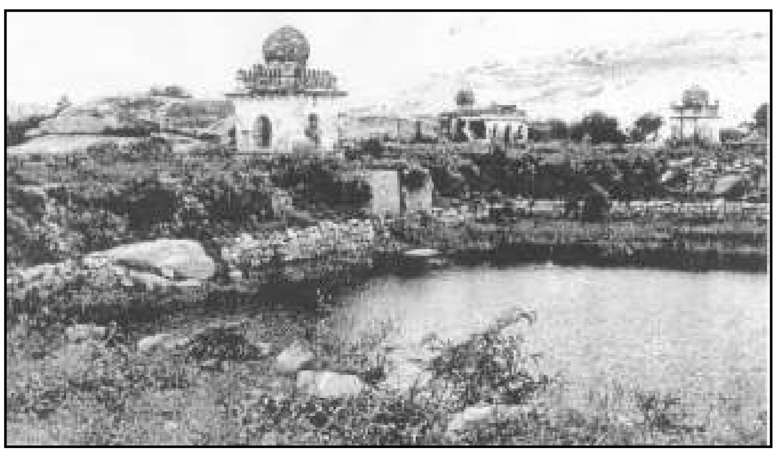

Fig. 14. Gingee: *Periyakañcakuḷam*

from the top of the hills to the ditches and the plateau, traces of their skilful water-supply arrangements are found.

All possible steps have been taken to get rid of the seasonal fluctuations and, thus, obtain, in the course of the year, the best balance between the water sources and the water requirements, which permitted the development of human settlements.

These observations raise several important issues.

2. Origin of Water

Percolating rain water:

First question. How is it possible to find water beneath heaps of burning boulders or in depressions on the hills, even in summer?

The evident reason for this presence is that water is stored in the foliated arrangements of the grantie and reappears as springs.

On the bare rock and the slabs sloping down steeply, water flows and does not percolate; on the other hand, in the weathered and shattered granitic masses, covering the summit or the sides of the inselbergs, water flowing off the surface is negligible, but infiltration is strong. The grantie displays several types of texture and varies in the degree of desintegration and alteration variation, but it acts as a kind of sponge which absorbs water and filters it, permitting an important accumulation of ground water which comes out through internally fissured joint blocks and other fractures. This explains why we find springs flowing, throughout the year, along the hill slopes, and certain cavities or reservoirs, at the foot of the inslebergs, having clear water even in the hottest part of the year.

The second question concerns the large ponds of the glacis.

Why, during the hot season, when all the rainwater collection tanks are completely dry, water is still available in some ponds at the foot of the hills?

Manifestly, old time engineers, for building reservoirs, selected rocky depressions having a water-bearing layer of clay which could collect not only water flowing from the surface, but also water accumulated in the weathered granite, through an underground drainage protecting it from evaporation, ensuring thus a dependable supply throughout the year.

The *Cettikuḷam* is fed by surface drainage coming from the catchment basin of the two southern hills. and also by the water stored in the fractured granite of these elevations.

The *Cakrakuḷam*, located at the foot of the rock debris surrounding Rājagiri, is fed mostly by the water accumulated in the fissured joint blocks of this inselberg.

As for the *Periya*- and *Chinna-kañcakuḷams*, situated at a certain distance of the hills, on fallow lands, we are bound to believe that both of them, beside surface water, are also fed, thoughout the year, by water accumulated in the weathered granite and carried to these points of the plateau; otherwise they would be completely dry in summer.

Unexplained Underground Drainage:

It would be interesting to know about the avenues along which the water can percolate, the articulation and interconnection of the sheets of ground water in the heap of boulders and at the foot of the hills.

A recent examination, carried out in a village situated at 5 kms to the west of Gingee, shows that inselbergs are at the origin of important run-off, as testified by the dense network of channels which feed tanks, and that the quantity of stored water can be roughly estimated, but it also shows that the observation of the chaotic heaps of boulders and debris does not permit to know to which extent water percolates and to which depth it really flows and that, therefore, we cannot quantify this hydrological phenomenon.*

In fact, almost all the modern studies on water resources in granito-gneissic regions deal with water used for irrigation, with agricultural supply systems, networks of wells and rainwater collection tanks. This is why no examination has been carried out regarding the water resources of these abandoned old hill forts.

Experts in hydrology are, therefore, requested to give assistance to historians so that these aspects of water management could be explained.

CONCLUSION

To emphasize the importance of this type of research, we will conclude our analysis with a few significant historical examples which show that, until the begining of the 19th century, water stored in the inselbergs had a crucial influence on the growth and decline of kingdoms in South India!

In fact, with perennial expanses of water these natural fortresses were almost impregnable.

* See A. Bossy (1985), page 31, the diagram shows the process: rainfall, vaporization, run-off, infiltration in the fractures of the non weathered zone, run-off in the channels or on the glacis, finally, percolation through the weathered granite on contact between inselberg and glacis.

At Nandidurga in Karnataka, in 1770, the Marathas could withstand the siege of the fort by Haidar Ali for three years, as there was always enough water in the reservoirs of this extensive plateau sloping gently towards the west and favorable to human settlements from the earliest period.

At Gingee, in 1690, the Mughals had to wait seven years to capture the large sronghold from the Marathas and, in 1761, the French, who had stayed there for ten years, could not be dislodged by the troops of the East India Company: the garrison surrendered only after all the French settlements in India were already in British hands. In both cases, one of the principal reasons for the resistance capacity of the defenders was that the assailants could never control the lower fort where the main supply of perennial water was located.

However, a protracted blockade during the hot summer could be critical for the besieged, especialy when a part of the water supply was in the hands of the enemy.

It is what happened, to the fort of Gutti, in Andhra Pradesh.

At that place, there are, on the glacis, a few large tanks, and, at the foot of the hills, in the lower fort, several wells, one of which does not dry, even in the height of summer. On the main hill or citadel are the large reservoirs we have mentioned. This fort, renovated by the famous Murari Rao, was considered unassailable.

Unfortunately, in the begining of 1776, Haidar Ali, while laying siege to the town, succeeded in taking the lower fort and the main water reservoirs, compelling the Marathas to depend only on the hill reservoirs and the water still available from the previous year's failed monsoon.

Murari Rao adopted the improvident measure of admitting within the walls of the citadel an immense number of followers, of horses, camels and even cattle. Although, with ordinary precautions, the reservoirs of water were sufficient, this strange absurdity reduced the besieged to the utmost distress. Soon, both men and animals started dying of thurst.

The Maratha chief was then forced to sign a sort of truce and sent several hostages among whom was one of his ministers, called Pale Khan. Haidar Ali treated his "guest" with such a consideration that the young man was thrown off his guard and revealed that Murari Rao would have never agreed to the truce terms if the fort had not been reduced to only three days' water supply. Haidar Ali, knowing that there was no hope for them, jumped at this opportunity and carried on with the blockade. By March, the last drop of water was exhausted in the fort, Murari Rao had to surrender.

Appendix: The Problem of Drinking Water

Since water was used for domestic purposes, it would be interesting to know what was the quality of water in these reservoirs.

Ground water is always pure bacteriologically because it is found at a greater depth. Now, as said above, the weathered granite acts as a gigantic filter, which guarantees the quality of drinking water (colourless, tasteless, odourless, cool). This is why, even today, people, without hesitation, drink the water from the *cunai*, which, on the slopes or at the top of the inselbergs, are protected from the sun by enormous boulders.

On the other hand, surface water is subject to temporary or permanent contaminations. Exposed to sunlight, it has the disadvantage of a high temperature; evaporation is active and photosynthesis allows the development of vegetal microorganisms (fungus, algae) or animal (bacteria, protozoa), often pathogenic, which are the cause of water-born diseases. However, even today, shepherds drink the perennial water stored in the *kuḷams*. Apparaently the microorganisms develop less in these reservoirs; in that case it is probably due to the fact there is a continuous flow of water from the weathered granite unless this water has physico-chemical properties which slow down the development of microorganisms.

In any case, most probably, in the absence of microbiological knowledge, the quality of water was not tested and thus water which today would be classified as non drinkable was considered as potable!

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