



RESEARCH ARTICLE

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## THE MEASURE OF TIME IN THE II MILLENNIUM BC - WATER CLOCK

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### ARTICLE INFO

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### ABSTRACT

The article deals with two ways of utilization of water clocks found during the excavations in Kultepe in ancient Azerbaijan (Nakhchivan Autonomous Republic).

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## INTRODUCTION

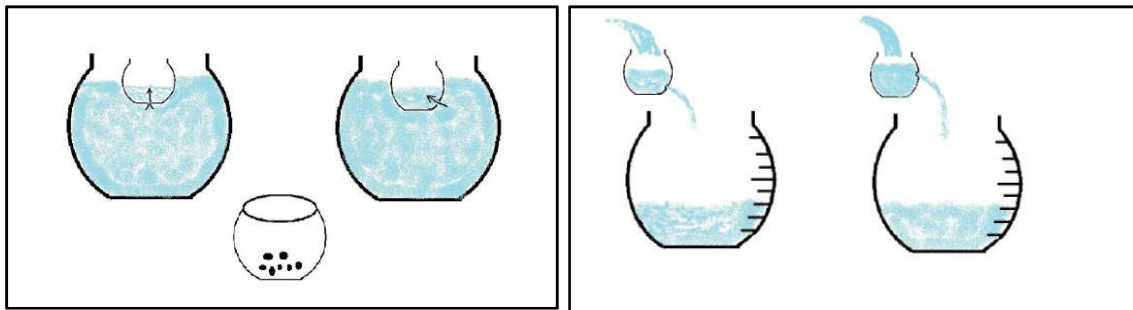
The space and time is the actual problem of all period of mankind. Some scientists believe that the space and time doesn't exist. It is invented by people for coordination of objects and phenomena. Other scientists consider the space and time as independent entity consisting along with matter free from it. It is easier in certain extent to understand in space than in time. Even in the ancient times the nomadic tribes had to be oriented in their travel and they learned to do it according to the Sun, the moon and the stars. The primitive farmers had to take into account the beginning of different seasons of the year during field work and they noted that change of seasons is associated with meridian height of the Sun, with appearance of certain stars in night sky. Further development of human society caused the need in measurement of time and the calendar (making the calendar). Time is considered as the measure of change. It is divided into past, present and future. The past no longer exists, the future will be even, but now is the moment. Time is one - dimensional and irreversible. Using the sun, our ancestors devised a sun dial, the stars helped to make sidereal clock. Since primitive astrolabes, people began to give the geographical, astronomical coordinates of objects and calculate the time. The ancient culture of Azerbaijan people keeps a lot of secrets.

Our ancient and holy holiday Novruz is the beginning of the new year - March 20 -21 - the day of the vernal equinox. Shift of this day was calculated and specified with the help of star watches and astrolabes. Novruz Days were determined by water clocks too. Sun dials were simple and reliable indicators of time, but there was a big problem - depending on the weather and nature. These clocks worked in the midday, but at night they didn't work. Bad weather prevented them to work. Working of sun dials was related with sunny weather and with limited period of work - from sunrise to sunset. People began to look for other methods of measuring time not associated with observation of celestial bodies. They got liquid, sand, air, fire and others clocks. After the sun dials, the second chronometric device measuring time in the history of mankind was water clock. Like a sun dial, they had different forms in various parts of the world, but with the same function. Where and when water clocks were invented for the first is not known and considering their antiquity, it is difficult to determine it. Exploring the archaeological findings the scientists claim that the appearance of the first water clock refers to the beginning of the IV millennium BC. in China, then in India, in the II millennium BC in Egypt, Persia, and later in Greece and so on. Archaeological excavations begun in 1951 in Kultepe near Nakhchivan (Azerbaijan Republic) gave findings dating back to the II millennium BC. Arched bottom bowl with standard accurate hole (hole) ( $d = 0,5; 1 \text{ cm}$ ) at the bottom and near the middle ware was among them. They can be attributed to the water clock, working in different ways.

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Archeological finds in Kültepe



I variant

II variant

It is possible that the Persian water clocks "Finjan» (findjaan) and "vat Finjan» (khanehfindjaan). This is one of the first primitive, practical and accurate water clocks for its time. The first vat finjan was made of clay, later of copper and bronze. They were also the main tools for determining the holy days Novruz. Water Clock Finjan worked in two ways - the inflow of water into a dish and outflow from the dish. The unit of time on the sun dial was taken from the rotation of the earth and its movement around the sun. It was necessary to create an artificial standard of time unit for water clocks, for example, in the form of the time interval required for inflow or outflow of certain amount of material in a chronometric device. The first version was the method of inflow of water into the bowl. The empty small bowl with an aperture (hole) on the bottom or near the lower part (Finjan) was placed into a large bowl with water. The small bowl was called as float by the experts. It was gradually filled with water through the hole and drowned into the large bowl. Pulling out the small bowl, the accumulated water was poured out from it and the process was repeated – the small empty bowl was put on the surface of the water in the large bowl. One small bowl filled with water was an "hour". The number of bowls was determined by the number of stones collected in another bowl. The duration of day and night was determined so. Change of the duration of day and night was noted throughout the year. Water clocks were enough simple and convenient yardsticks of time. The number of bowls for the whole day was the same. Changing the number of bowls occurred relative to the length of day and night. The longest day, the shortest night and vice versa – the shortest day and the longest night was noted. All of these changes occurred during the year, change of the seasons.

The number of cups of day and night was the same on Novruz day - the day of the vernal equinox. The year was completed. Then the process was repeated. These measurements for establishing certain primitive laws lasted for years, even centuries. There were errors, but at that time they were considered insignificant.

#### Such kind of water clocks was used during irrigation

The second version is the method of outflow of water from the small bowl. These watches were also made of a small cup, but with a hole closer to the bottom or in the middle and a large bowl inscribed with divisions. One division - the volume of small bowl was an "hour" (the number of divisions on the large bowls was different - three divisions, five, seven ...). The water flew into the large bowl from natural water conduit. But there was a problem - the water flow rate changed frequently. The small bowl with a hole in the side was used in the form of speed regulator. The bowl was placed between the water flow and the big bowl. At the beginning the hole was sealed with wax. After filling the small cup with water, the hole was opened and at that time the water flowed into the large bowl with constant speed. The filled large bowl changed in certain numbers within a day depending on the number of divisions therein. The water clocks - finjan, vat finjan reached to the sufficient level of accuracy for its time comparable to today's measure of time-keeping. Time is an independent, continuous entity. "Time flows" - the expression reached to us from our ancestors has ancient roots. As noted above, the water clock was one of the first primitive, but more accurate method of measuring time. The water flows. A man measuring time by

water clock notes the turnover of time. The water clock included the water flow and time.

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