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title: **Uzbekistan karizes and use of ancestors experience on building groundwater gallery**

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INTRODUCTION

At present time water supply at the expense of groundwater is carried out mainly by the water well intakes which use is limited by deficiency of the electric power. Therefore search of areas on which groundwater gallery operation is possible, allowing at operation to reduce electric power expenses, is the important problem for Republic Uzbekistan. Its decision will allow to improve essentially water supply of the population by potable water, to reduce electric power expenses at water intake operation. The way of the decision of this problem sees in partial transition to groundwater gallery operation, on those areas where their use will be the most effective.

Centuries-old experience of use of groundwater gallery (foggara, kariz, qanat) show on high efficiency of operation of such constructions. High vocational training of ancient builders of these constructions unmistakably defining a position of the most watery aquifers, underground constructions carrying out building in difficult engineering-geological and hydro-geological conditions amazes and admires at application only manual skills and groundwater providing a conclusion to a surface. At the heart of building of such constructions lay, intuitively exact engineering calculations. Experience of our ancestors on water supply of the population at the expense of groundwater, especially in arid areas of Republic Uzbekistan, can be successfully applied and in modern conditions.

KARIZES: HISTORY AND THE PRESENT

Outstanding achievement of hydraulic engineering since the most ancient times are groundwater galleries which in Central Asia and on Caucasus name the kariz, in Iran – the qanats (Wulff, 1988), in Africa – the foggara. Karizes were known in Assyria, Babylonia and ancient Persia, were used by Romans in Syria, then Turks in Asia Minor. They meet in Central Asia and Transcaucasia, on Near and Middle East, the North Africa and the Central Asia. In Uzbekistan kariz water supply in foothill areas was carried out since the most ancient times till 60th years of the XX-th century. So in Kushrabat area in village Aktepa there is a kariz ligament constructed at the time of Abdullahan II (1534–1598) from a dynasty Shejbanides. In Uzbekistan karizes are most extended on northern and southern slopes of Nurata mountains, especially often meet round the cities of Gazgan and Nurata. Here them is more than 100 karizes ligaments, some of which in total length more 6500m. Karizes are traced and now in the form of linearly extended relief low; radial lows from these lines; partially remained observant pits, and as places of possible exits of pits on a surface. The top part of some karizes ligaments is developed divergently in the form of the fanlike branches consisting of several galleries, incorporating more down in one gallery. Sometimes only two branches incorporate. Among them are kariz “Dushoca” in Gazgan city and kariz “Kalta” at a foot of the Nurata marble deposit. Action principles karizes are opened on the results of modern field investigation. The hydrogeological section along kariz operating earlier on a district “Akkula” is showing in Fig. 1.

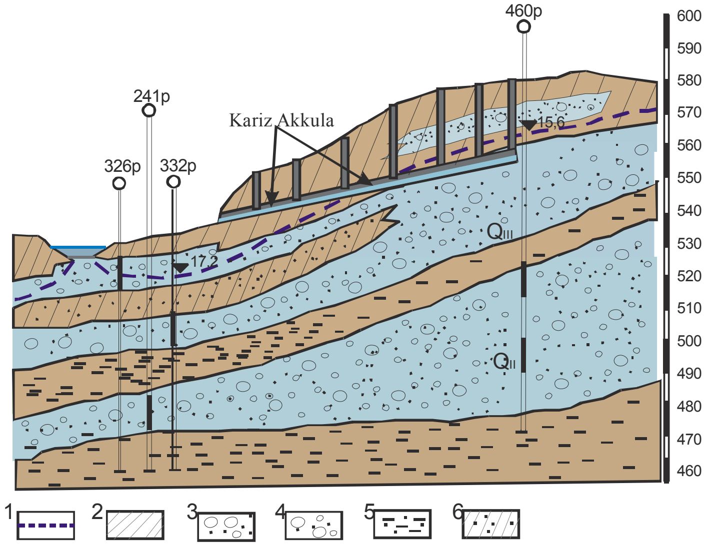

Figure 1. Schematic section along kariz Akkula of Nurata valley. 1- water table, 2- clay, 3- gravel, 4- gravel with sand, 5- loam, 6- sandy clay.

From this section it is clear that kariz collected water of their top most permeability aquifer in Pleistocene sediments (Q_{III}) and deduced it in Upper Quaternary horizon. Operation most permeability aquifer in Pleistocene sediments is characteristic for all karizes, operating earlier in the Nurata valley. Decrease in a aquifer permeability with depth for area Nurata valley is showing in Fig. 2. So at water yield to 15 L/c on the top aquifer their reduction to 6L/c on depths 100-150m and to 2L/c on depth 200m and more is observed.

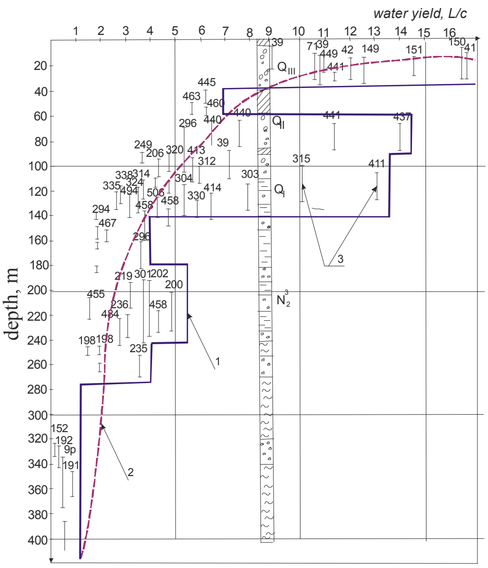

Figure 2. Integral graph showing relationship between change of deposits water yield q(L/c) and their depth for area Nurata valley. 1 – conditional sketch of deposits water yield; 2 – trend of relationship between in water yield at depths; 3 – well filter.

As a rule karizes are confined to a basic recharge source of Nurata valley groundwaters - a river Bigljarsaj which on all extent completely loses a superficial run-off during the short spring period. Only in separate years abounding in water its superficial run-off falls outside the limits a valley in desert Kyzyl Kum. Geological activity of paleoriver Bigljarsaj has generated Quaternary sediments which as a whole form the Nurata aquifer of fresh groundwater. Under discharges Nurata karizes it is possible to divide into three groups: watery — more 100 L/c; averages — 10-100 L/c; the least watery — less 10 L/c. So for example, the discharge Kalta's kariz makes to 40 L/c. Now extraction of groundwater of the Nurata deposit is carried out by wells which has lowered groundwater heads on all Nurata valley. It was reflected in activity remained karizes which are partially drained and abandoned now.

OPERATING EXPERIENCE OF GROUNDWATER GALLERIES

Making use of ancestors experience on building karizes and modern achievements of hydrogeology, in Uzbekistan are made works directed on building horizontal groundwater galleries. Examples operating horizontal groundwater galleries in Uzbekistan are: gallery of Sarycheku for water supply of mountain-metallurgical industrial complex; a gallery of Akkishlak for drinking water supply in upper courses of the river of Kata-Uradarja; a gallery in desert Central Kyzyl Kum.

The gallery of Sarycheku represents gallery shallow location, drilled in Paleozoic fractured rock in which roof faces of two operational wells settle down (Fig.3). Wells are equipped by the filter on top Quaternary aquifer. Through filters groundwater arrives in wells on which trunk flow down in gallery. Groundwater the pump established in a observation pit, moves from galleries to directly consumer.

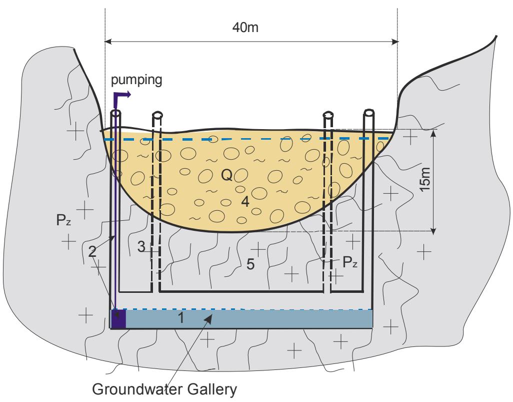

Figure 3. Schematic section along Groundwater Gallery Sarycheku. 1 — gallery, 2 — pumping from observation pit, 3 — filtration well, 4 — Quaternary aquifer, 5 — Paleozoic sediments.

The gallery discharge changes from 4 to 15 l/c. In a freshet seasons the gallery discharge increases, and in dry season for increase in the expense of the artificial lake for recharge aquifer is created. The geophysical works spent here have shown that capacity of permeability alluvial deposits makes no more 8м. Capacity of Paleozoic (Pz) crust of weathering is estimated in 30m. Fractured these deposits shows on a possible groundwater filtration on cracks that is the most probable in a narrow strip of modern development of a Paleozoic valley (Nagevich, Chebotareva, 2009).

The groundwater intakes construction of this kind operates in desert Central Kyzyl Kum. It is intended for drainage of the aquifers which are lying down on Paleozoic sediments. There is passed mine and drift from it on depth nearby 270м from an earth surface for this purpose. The drift it is passed in Paleozoic fractured sediments. From a surface of the earth to a drift roof there are drilled some tens wells. They open a total thickness of all aquifers above Paleozoic sediments and provide running off of groundwater of these aquifers in drift. Mine groundwater outflow of such design has provided drainage of a part of aquifers on depth to 110-120m from an earth surface. The groundwater outflow expense made in the beginning of its work to 1m^3/c and has gradually decreased to 0,2m^3/c. Building of this drainage construction has been in details proved by the previous hydrogeological researches.

Absence of such purposeful researches can lead to negative results: an example from a groundwater gallery of Akkishlak for drinking water supply in upper courses of the river of Kata-Uradarja (Fig.4). Here trench was excavated by depth in 3-4m and extent several hundreds meters. In trench are put perforated pipes of the big diameter 1000mm, which were overhand fallen asleep earlier extracted by soil.

Figure 4. Groundwater gallery of Akkishlak in upper courses of the river of Kata-Uradarja.

However groundwater drainage was not reached, and gallery turned out to be dry on all its length. This area belongs to a narrow modern valley of the mountain river. The top Quaternary aquifer is characterized by a high permeability (water yield have made 18-25 L/c at drawdown to 6m, the hydraulic conductivity - 5-25m/d). However depth groundwater table makes 8-10m from a flood plain surface. Low on a depth Cretaceous limestone, clay, sandstones lie down. Sandstones are characterized by a low a permeability (water yield have made less 1L/c at drawdown more 20m), but has high artesian heads (near to an earth surface). The wells drilled in flood plain of the river on this Cretaceous aquifer, are artesian. Pumping rate their very low less 0,01L/c. Hydrogeological investigation on this area has been executed under a groundwater well intake on the top water-bearing horizon. Such hydrogeological system is reflected in Fig.5. However the developed incorrect illusion about permeability all aquifers, including and a zone of aeration by capacity to 10m, has led to unreasonable recommendations about building of superficial groundwater gallery. This example convincingly testifies to an obligatory hydrogeological substantiation of building of groundwater gallery.

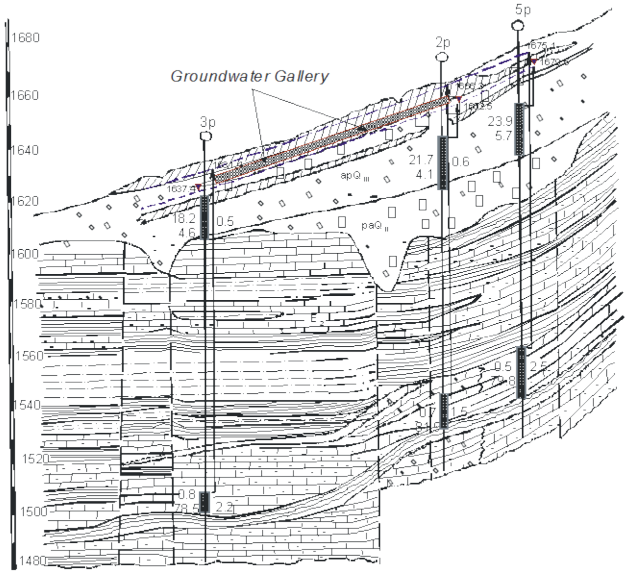

Figure 5. Schematic section along groundwater gallery of Akkishlak.

THE CONCLUSION

Groundwater gallery can be maintained in following conditions:

- foothill plains (kariz type);
- river valleys;
- channel lenses;
- low-power seasonal rivers.

Objects of researches at the decision of a question of groundwater gallery application are: A – areas of alluvial and proluvium sediments; B-areas of a local congestion of groundwater (Nagevich, Chebotareva, 2010). A areas characterized by following characteristics: to hallow groundwater table; high aquifer properties; high quality water. B areas of a local congestion of the groundwater, belong to proluvium deposits of temporarily currents rivers in foothill zones. The groundwater of small productivity aquifer (to 10 L/c) can be successful operation and is deduced on a surface without application of the pump equipment and the electric power.

Leaning against the modern techniques, experience and knowledge of hydrogeological aquifer properties building of gallery both deep hole similar karizes, and shallow horizontal hole, is quite possible. Certainly expenses for their building will essentially above, and the time of recovery of outlay of constructions is much longer, than at wells water intakes constructions. However profitability gallery water intakes constructions at operation allow to consider them as alternative to wells water intakes constructions.

REFERENCES

Nagevich PP., Chebotareva OV., 2009: *Present state of fresh ground water occurrences and their productive reserves re-estimation: approaches, demands and grounds (in Russian).* Tashkent, 103p.

Nagevich PP., Chebotareva OV., 2010: *Stages of alluvial deposits development and their hydraulic properties.* Global Groundwater Resources and Management. Selected Papers from the 33rd International Geological Congress (33rd IGC), Oslo, Norway, Aug.2008. Scientific Publishers, India, 15p.

Wulff HE., 1988: *The Qanats of Iran.* Scientific American.

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