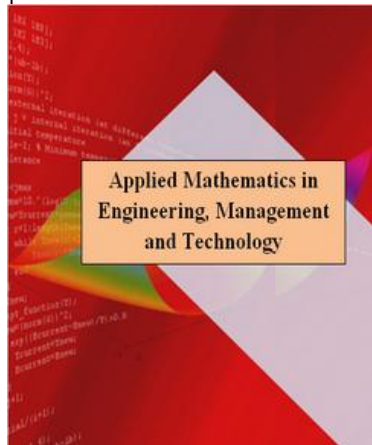


## Investigation of Chlorine and Electrical Conductivity Maps According to Pumping Tests and Groundwater Levels in The Hamedan Plain

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### Abstract

Karstic region of Alisadr is one of Goltapeh district environs of Kaboodarahang city, and is located in 75 kilometers North West of Hamedan city in western part of Iran. Karstic region of Alisadr is part of Kaboodarahang basin. Its area is about 3448 square kilometers and its elevation from sea level is about 1780 meter. This region is important for supply of water for agricultural use and drinking and tourism industry this issue shows implication for more study. The area and expansion of main alluvium aquifer is about 1350 square kilometers that is recharging by direct infiltration of rainfall, infiltration surface runoff, returned water from agricultural use, sewage and inputs underground. This aquifer will be discharging by removal of groundwater and output underground. General trend of hydrograph represents groundwater of desert according to information about the level of groundwater in past years has been descending, and represent continual reduction of ground water reservoir. In this paper, we try to review current status of aquifer of Kaboodarahang

and karstic region of Alisadr and having a prediction about future of groundwater reservoir and suggest methods of using this karstic water reservoir efficiently. As the title imply, in this paper we will investigate the issue by two different approaches. 1-quantity, 2-Geomorphology.

**Keywords:** Alisadr, underground water, a little perspective, the perspective of geo-morphology.

### 1. INTRODUCTION

Plain Kbdrahnk a range of studies Basin Cranberry tea with the size of 3448 square kilometers in the north of the province and the West of the country, where the vast plains and Bkhanh core of about 1350 square kilometers, is the most important point in urban areas, city Kabudarahang that has 3 of 3 categories in total population in the area of about 185,000 people, is the area within 60 km from the center of the province, with locations throughout '28 ° 48 to' 45 ° 48 east width '02 ° 35 to' 40 ° 35 North is located 1780 meters above sea level is located.

Zanjan and Qazvin Plain in the north, from the south lowland spring Vqhavnd, from East to West and from the plains of the study area GOLTAPEH Razan - Zarrin Abad is related to the fact that the area has the largest catchment – Hamadan province.

Given the acute crisis of safe water supply in the country and the subject of future scientific research and applications is essential. Other hand Kabudarahang Plain and the Karst Alisadr in recent years been confronted with severe problems of water supply and plains are among the proscribed areas. But the Bkhanh and pumping wells tapping underground water resources are major problems, such as severe sharp drop in water level, water quality, creating intense meetings and ... They have produced. In this study, an attempt is Review the current situation and the general recognition Bkhanh lowland karst area of Kabudarahang and Alisadr A prediction about the future use of groundwater resources proposed and studied lowland karst water sources, as is desirable.

Studies in karst area Alisadr Kabudarahang plain view of the overall potential of plain water, and taken as part of the hydraulic parameters has been Bkhanh. The most important resource and exploration operations in

general area by the water industry is responsible for the organization of a regional water – Hamadan is mentioned below:

1. Detailed exploration plan for Water Resources Studies Kabudarahang first half of 1383.
2. Geophysical Exploration Company in 1364 is Bkav.

## 2.Method

As well as cross-country research and library work has been carried out – The overall methodology Such work has been The first pumping test wells located in lowland Bkxanh hydrodynamic coefficients are calculated with data obtained As well as samples from several wells Observation and taking samples of water – karst cave Alisadr and send it to the lab The main types of anions and cations derived values and the general quality of their review and the qualitative change has been identified .And in field studies – as measured using the position of geological structures System , especially the seams Attempted to determine how these structures on karst formation process Area is .

## 3.Research hypotheses:

1. One of the main assumptions are discussed in relation to hydraulic exchange between the alluvium and the Karst region. In this study it has been paid.
2. The second hypothesis is the use of karst water source for drinking and irrigation Alisadr that it has been answered in this paper.
3. The third hypothesis is Svbashy relationship Alisadr Cave and the caves and the Mirage.

## 4.Hydro Karst region Alisadr

Nowadays, the water quality characteristics identified in tandem with its quantitative characterization is of particular importance – And sometimes dangerous encounter issues Such as environmental pollution has become a very important; Therefore, identification of water resources Be part of the study focuses on water quality issues This research is also not an exception under – summary of activities and experiments to determine the quality of ground water in karst region can be described Alisadr.

## 5.Alisadr physicochemical properties of water:

In order to investigate the characteristics of groundwater quality It is first necessary to identify influential elements and to determine their values, In fact, we proceed to determine the concentration of dissolved material in the water and then we estimate the impact of the calculated values. Therefore it can be used in two ways:

1. direct method for determining the concentration of minerals and salts in the way of using labs equipped with the chemistry and physics begin to break down water into its constituent elements can be single, this method is costly and time-consuming need people with expertise, but the accuracy is very good.
2. the indirect method: In this method, we measured another agent using empirical or mathematical relation between the two sets of parameters can be estimated easily and used Qrardhym such as the relationship between electrical conductivity EC and total dissolved solids TDS.

Overall, the main physical parameters measured in ground water include temperature, color, odor, taste, turbidity, pH and Ec is in the following table (table.1) Results of tests are included.

Table1. Physical test results Cave Alisadr

test	Sample 1 Outlet	Sample 2 1.5 km Input	Sample 3 2 km Input	Examples of saline springs
Altitude	1900	1900	1900	1900
Water temperature at	32 (Laboratory)	11	11	18
Ambient temperature (c)	32 (Laboratory)	13	13	12
Color	NO	NO	NO	NO
Odor	NO	NO	NO	NO
Taste	Normal	Normal	Normal	Normal
Tiff	Clear	Clear	Clear	Clear
pH	6	6	6	6
EC	350	400	340	990

The results of these tests can be deduced as follows:

1. Water temperature: The temperature ratings of any group Alisadr Astruc and Jading cave water is cold waters.
2. color, odor, taste and color of light blue cave water is very clear so some of the locations where water depth Bhdvd  $\rightarrow$  5 meters ground floor is easily visible. There is no water, no odor and the odor.
3. pH: measure  $\rightarrow$  water pH measurements at different locations indicates that the pH is close to neutral is the same in all places.

#### 6. Water chemistry Alisadr:

Chemical properties of the 4-point Alisadr Karst water sample to a lab to determine chemical properties and the results are listed in Table 2-9 But the results of this experiment are the following:

1. Based on the ratio of anions and cations in water Alisadr area, the waters of this region is part of calcic waters Bykrbnath type.
2. Alisadr the water hardness between 150-190 mg fluctuates.
3. Considering the ratio of calcium and magnesium ions at different sampling intervals can be said that the nature of the 45-meter water inlet at 300 and 500 meters of dolomitic lime is.

#### 7. Biological properties of water Alisadr:

The main symptom of infection with pathogens originating in the outer aqueous solutions of certain microbes Escherichia coli, was named general coliforms are identified by name. E. coli and fecal origin commonly found in ground water if the water is not so immediately we attempted to identify the location of contaminant spills. The accuracy attributed to the absence of E. coli in a water sample, there is another indication that the Streptokinase is tuned.

The water samples were sent to the laboratory for counting and identification of microbial pathogens the result was stated that this area is highly polluted water from microbial contaminants preceding.

Due to the karst underground water Alisadr other parameters that are conducive only this water can be used for drinking water in the area of microbial quite refined.

#### 8. Chemical analysis of groundwater plain Kabudarahang

The results of the analysis of plain water are listed in Table 65, it can be deduced from these results and tables include:

1. Electrical conduction (EC) in the plains in the last few years have witnessed an increasing But the accumulation of salts in the center of the city near the prairie region Kabudarahang output of more than 2200 Mikrvmhvs on cm the solute.
2. TDS evaporation residues in the plains of the EC formula is as follows, and the relationship between the EC TDS = 650 EC units ( $\mu\text{S} / \text{cm}$ ) is. TDS also have the highest rates in the output fields.
3. Plain water PH level is very good and mean it 83/7 is.
4. The bicarbonate and carbonate plain is divided into two halves: the northern half of carbonate and bicarbonate is higher than the southern half because there are layers of limestone in the northern region.
5. Of chlorine ( $\text{Cl}^-$ ) is plain good condition and can say only in the western and southwestern desert near the entrance (exit Prairie Spring) reaches the maximum value.
6. The presence of calcium ions ( $\text{Ca}^+$ ) plain average about 6 mm equivalent grams per liter is the highest in the North West.
7. Sodium ( $\text{Na}^+$ ) in the plain of the rate of 8/1 mm equivalent grams per liter, which is near its maximum output, is a plain center.

In order to verify the experimental results it is better to use the following equation:

$$\% E = [(A-C)/(A+C)] \times 100$$

Above E error rate in% and A, C is the sum of anions and cautions are

Cautions = Sodium, calcium, magnesium

Anions = chloride, sulfate, bicarbonate

That should be the percentage error is less than 5 percent. That this error tests in the plains below 1%. Figure 1 below is plotted the relationship between EC, TDS display we've seen is an increase in EC on the TDS has also been added and almost between the two is given by the equation changes summarize TDS = 0.66 EC.

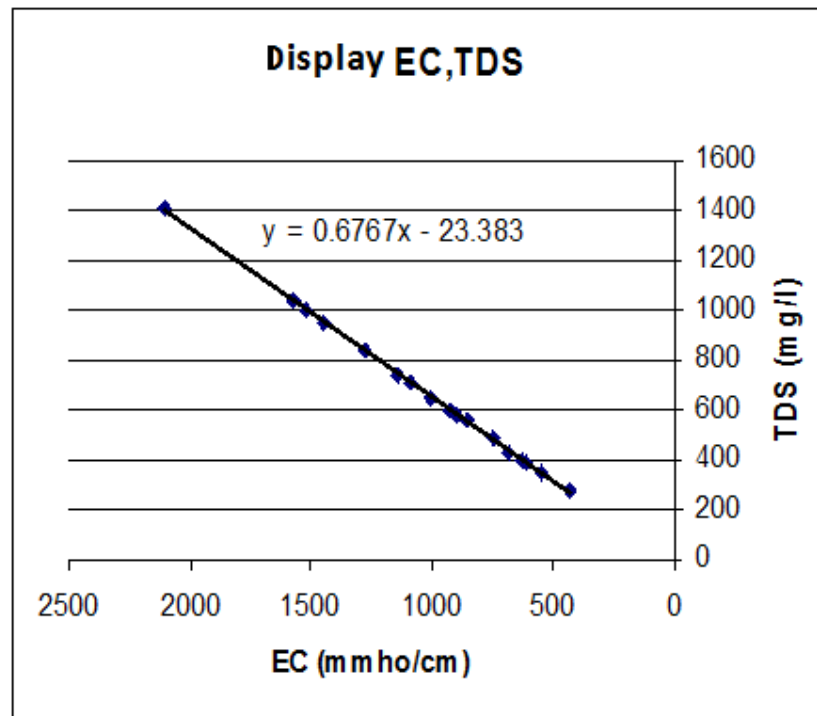


Figure 1. Relationship between EC, TDS

### 9. Chloride maps and trend Plain Kabudarahang:

Chloride is one of the most important characteristics of groundwater It is precisely the presence of these ions represent the main effects of salinity and water quality in the area is presented.

Chloride (Cl) in terms of the type and amount of salt and water is important both in terms of types, The category is indirectly involved in agriculture, but the concentration of these ions in water should be carefully examined and controlled Because high levels of this ion toxicity and reduced crops and damage to plants. Sodium Kabudarahang plain average 5/3 Aki Whelan mg per liter and southwestern region due to concentration of mg / L 250 are:

- The input and output fields, naturally, because it is a plain spring flows from upstream to downstream, we have witnessed the accumulation of salts in this section.
- Plain from north to south (upstream to downstream) aggregation of finer sediments below the water so the water flow is sufficient time to dissolve minerals.
- Plain water is traveling long distances to exits locations on solute is added to it along the way.
- In the western half of the southern plains and the hill up the city's sanitation and focus Kabudarahang industries such as factories and small workshops and disposal of their waste, excess chloride is found.
- Concentration of population in the Southeast and West Plains is also increasing solute.

#### 10.How to communicate in plain chlorine and conductivity Kabudarahang:

Due to the fact that there is a rational connection between the main causes of water quality Therefore, we can conclude that the Cl, EC is also available communication The EC added that whatever the amount is we're also seeing an increase in the same proportion that the relationship between chlorine in the plain function is as follows:

$$Cl = 0.0032 EC - 1.2526$$

Formula of linear regression relationship between chloride and conductivity is due to better visibility can this relationship can be seen in Figure 2.

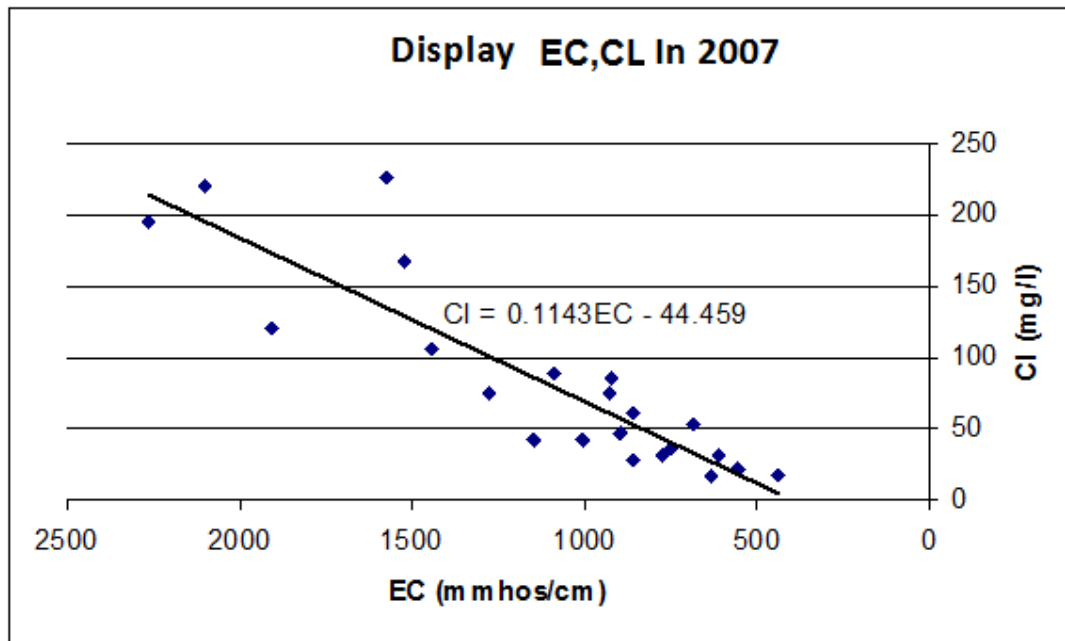


Figure 2. Relationship Cl, EC Plain Kabudarahang

In order to show the changes in the last 15 years is better Relationship Chart EC, Cl 1371, we also depict the work done and In Figure 3 is shown in relation to the EC, Cl by the equation:  $Cl = 0.1107EC - 33.618$  can be expressed.

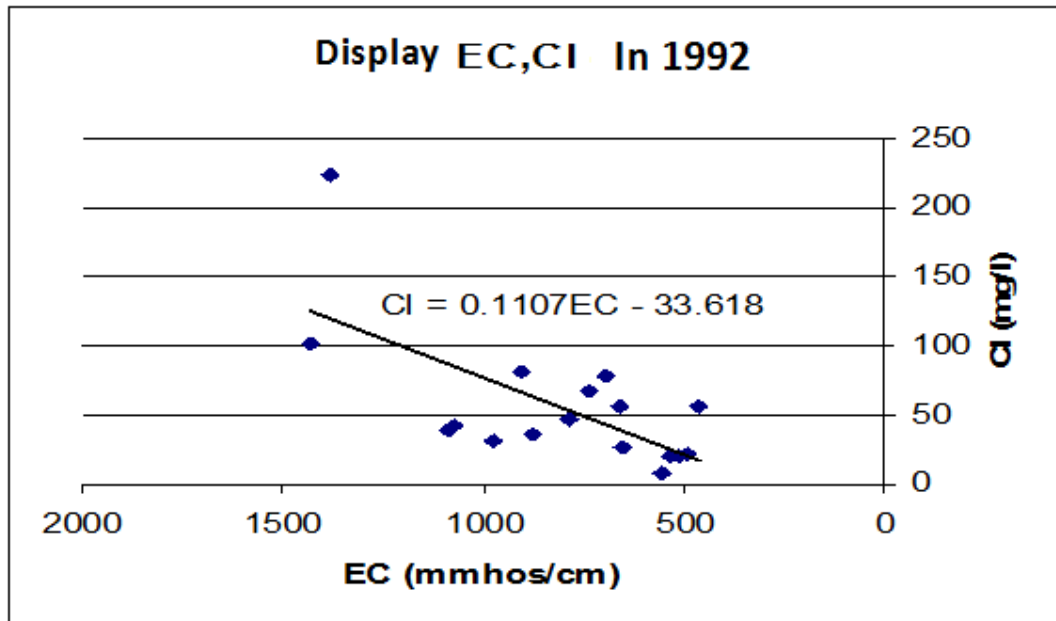


Figure 3. Relationship Cl, EC Plain Kabudarahang

### 11. General geomorphology of the area

This chapter describes his first title of the season and then in the second part of the evolution of karst areas described and the third part is based on a type of karst evolution and classification presented in Section IV Karst region have attempted to introduce complications and problems.

Geomorphology Geomorphology is the Persian translation of it (the body of the earth) have adopted the Greek language and consisted of three words have been included (Geo) means land (Murphy) literally poured (log) comprises means understanding 's.

Geomorphology is the scientific roughness shapes created in the earth crust and includes discussion of structure factors, defined shapes created and classify them to study.

Among the factors causing the earth's crust forms and structures can be defined by two main factors, which include:

1. Internal processes: the origin of the internal forces of the earth is the most important tectonic movements. In fact, these factors have to try to create height and organics these factors can be found in volcanoes, organic processes, faults, folds and ... Named.
2. External processes: the origin of this agent in the solid crust of the earth is in stark contrast to the role of internal processes this means that the agent tries to damage and corrosion heights and the resulting impact of these factors eroded highlands and the lower cannot develop. The most important of these factors can be weathering (physical, chemical and biological), erosion (water and wind) noted. Among these factors are the most important role in the destruction of water infrastructure, transport eroded material is deposited materials. The main factors that control these processes are dynamic forces, mineralogical characteristics and climatic factors are.

### 12. Karst forms:

Karst is difficult to provide a precise definition of the term because the term implies, is a complex process that is composed of different factors this situation can be said that a series of karst geological processes and phenomena of the surface and underground shed.

Slavic languages have their roots in the word Karst region. In the North West it is called Yugoslavia, and the general definition of this word for the first time the area has to offer, So now to all similar effects in other places it is called.

Karst areas indicate special characteristics which are soluble rocks can be seen that the effect of geological processes, climate and hydrological control.

### **12.1. Karst forms Surface Area**

In fact, the forms and effects of karst environments that separate it from other shapes commonly called roughness is called karst. Thus the main definition of a regional karst complications that only specific areas of special geological and hydrological conditions caused.

For convenience, the karstic effects on the basis of their position relative to the earth's surface into two general categories are classified under the category of each division and karstic effects can be expressed:

### **12.2. Karst forms of extrinsic (external or superficial):**

In the Karst region, Karst side Alisadr located on the ground will not enhanced efficiency and limit slots of the dissolution and liquidation of small cavities in rocks is dissolution.

These forms can be easily seen on the surface and the changes in the regulatory regions of karst topography are seen. This category contains a variety of forms that can be classified into three main categories, and then based on the scale, depth and action to be divided into various groups.

### **12.3. Of linear shapes and small-scale grooves (cracks):**

These are mostly small-scale karst forms, and the most basic and most common forms of karst and karst development is the main factor. The main types of groups can be seams, Karen (Lapyhs) and slots created by the stone. A major complication in the study area and the abundance of karst ground level of this group are in the area. The most important factor in the development of these forms the tectonic forces that cause a variety of large and small joints are.

The size and frequency of symptoms developed karst areas karst Karen and Karen the other hand, the frequency and depth of the surface area is greater than is greater potential for creating a more stable water regime.

Karen has become more developed over time, eventually interfering with Karen together with the subsequent development of karst areas created Karnhay cross and a wider cross towards creating bigger problem like Devlin or bars and ... It is on this basis that complication by karstic call toll founder Karen.

### **12.4. Describe the morphology of the cave Alisadr:**

Alisadr cave consists of two floors at a height of approximately 3.8 meters high crossing is the main passage of the cave is located. Crossing the upper floor is now for ordinary people is difficult, but with the use of the specialized equipment – is part visited. The path of passages and corridors filled with water to 2 meters wide - and in some places it reaches 50 to 60 meters and a height of 10 to 20 reaches the cave roof, as seen through the corridors and hallways Community Grid are related to each other (this is similar to ant nests.)

Middle vast field with a cave 350 meters away and dock area is approximately 750 meters from the local branch of the cave begins. During one of these branches by boat, crossing over the 5/2 km. At the end of the dry branches, there is some panache to the island in the middle of the water.

On the other hand this kind of cave passages they can appear only where the slope is too little water, This means that the formation of this type of environment of the caves has a water flow rate is very small The same applies to the Blue Grotto Alisadr we also can see that there is no evidence for a direct flow of water.

### 13. Outline of the cave:

According to the previously described situation, complications can now be created by the dissolution of limestone cave phenomenon of water flow pay for it.

Approximate area of about 15 hectares of water surface in the cave Alisadr (doc Mr. Asghari public relations Alisadr Cave). Looking at the Cave of the effects of water (Daghab) near the cave ceiling easily see that it shows the high water level inside the cave in the remote past and the past means that the cave was quite Immersion in water but over time, the volume of water inside the cave, and as of today has been reduced, Based on the signs of the last drop of the water level inside the cave, which is about 10 meters in Hall effect can be seen in the third and Azadi Square.

Today, the water surface slope where the cave is very low and there is a strong current, but before the fourth island voice intense flow of water can be heard from the upper wall that disappears after a few meters away.

Water level inside the cave with seasonal fluctuations that average about 70 to 80 cm of wet and dry periods between 0.5 to 1 m will change. On the other hand it seems that the groundwater level is based on the ground water level inside the cave.

### 14. Sectional area of the cave passages and corridors Alisadr:

Alisadr determined that the cave was initially flooding the streets with a drop in water level, the water level of the free groundwater was created. The overall shape of the full cross section of deep water passages are not clear, but in some areas due to shallow water, the walls more clearly seen. A variety of grade levels can be detected in a cave, which consists mainly of the cross section is elliptical and Canyon.

Factor in the formation of elliptical sections of the cave flooding has a major role, while Canyon cross section can be seen as a result of the flooding and water free. The passageways were detected with specific sections of which can be, for example, at the end of the corridor crawl; there is a fourth island ferry to cross the floor of the cut easier.

Several factors such as joint systems faults, layered surfaces, slopes and levels involved in the formation Layers are effective, but other factors contribute to the evolution of the card that parts and blocks of stone from the roof collapse they gathered on the floor of the cave, and is cut cross-section shape having undergone major changes.

In some cases, the creation and development of karst forms of carbonates deposited in changing and shaping the effective cross section of growth and the stalagmites and stalactites Changes are caves that form the floors and ceilings, with further growth of these two changes, the most severe form of street cross-sections and various forms of self-display.

One other important factor carbonates deposited in the walls of the cave passages These factors also caused by the roughness of the wall surface, creating ripples on the amount deposited by the intensity Different and must be deposited in the sediments transported by ground And the way it deposits on the cave floor, but in a limited and specific local forms are also named.

### 15. Form of deposits or carbonate cave deposits:

The dissolution process progresses carbonated water saturated and cannot absorb more Therefore, when the water flow causes changes in carbonate dissolution may be Water-soluble carbonate material itself leaves a deposit. The most important cause water carbonate deposition phenomena in the context of a carbon dioxide pressure of the water flow.

When water comes into contact with the well with the changes in pressure and precipitation will immediately begin. In fact, when your water stone surface, ceiling or wall and floor plans that measure precipitation.

Below we describe the main types of cave deposits Alisadr Cave:

1. **Cressets:** This kind of problem due to low flow and a drop of water falling from the ceiling and the floor of the caves are caused by free surfaces. The most common and most serious forms of karst caves, which are divided into the following sections two main types:



- a) **Stalactites:** A form of water-soluble carbon deposits on the ceiling of the cave and into the hollow. Where the water drops from the roof cave in, while abstracts gradually and very slowly began to excrete bicarbonate. The solution is to reduce the pressure of the fluid drawn. Initially stalactites are hollow, reedy. Over the possible closure of the rounded tip (Figure 4) and (Figure 5).
- b) **Stalagmite:** When a drop of water from the cave roof top or bottom Stalactite Still contain some residual carbonate solution was treated on the floor of the cave, some of the leaves. The volume of deposits will be added gradually. Polymorphs or par agenesis stalactites stalagmite is actually the difference between the former and the latter on the roof of the cave floor is created.
2. **Column:** Stalactite and abstracts a large growth on top of each other, these two effects will eventually be connected column-like symptoms caused by the column on the yen are very unhealthy. Alisadr cave at the two cave deposits are among the most common forms. Stalactite and stalagmites and columns of calcareous shells are concentric to the growth rings are seen in cross-section and pore is contained within them. Alisadr stalactites in the cave are about 5 to 6 m in length and course is to continue the growth trend to replace the force of their extra weight and the effects of gravity to fall. Stalagmite the largest stalagmite in the world and also the Alisadr in Hamedan nearly 5 meters in length that stretches up to the age of about 8/4 million estimate.
3. **Flowstones:** flowstones caves are the most massive secondary deposits and drooling on the floor, walls and caverns are formed. Is usually layer, due to the formation of a new layer of surface water infiltration during the wet and the dry cave and stop the growth layers in the course of.
4. **Draper:** drapers are another common problem is Alisadr Cave. In terms of the structure of the karst forms intermediate between Icicle and flowstones know. Appellation for a curtain karst landscape that makes it complicated to exactly resemble folded drapers. This type of karst forms is created mostly on steep walls, Curtain width to the size of a single crystal and therefore are transparent a scene tape and make the case that it is called Bacon.
5. **Crust:** Cover the walls of the caves are formed by water flowing pourer.
6. **Shelf stone:** Usually these kinds of situations that make cave deposits containing supersaturated water and lack of impurities in it. In the case of single crystals of calcite are continuing to grow. The team of researchers from the deposition of calcite deposits on the surface as dust particles. Sometimes these small dams, sediment basins and water hit the hairy power up and the loss of carbon dioxide CO<sub>2</sub> and evaporation, causing the precipitation of calcite cement, and the floating Klsythay the Spar causes the formation of niche.
7. **Shield:** The way stalactites are similar to the two-dimensional case. This bug has been shaped plate structure – grow outward from the walls of caves. Karst forms with a diameter of a few centimeters to several meters to several tens of centimeters thickness arrive. The pairing of two concentric shields, which are separated by a gap will be created.



Figure 4. limestone cave deposits Alisadr (cauliflower coral tissue) form of stalactites or Stalactite



Figure 5. Stalactite cave stalactites or roof cave deposits Alisadr (Eagle Claw)





Figure 6. Set of stalactites and stalagmite, columns and curtains Alisadr Cave

## 16. Conclusion

According to investigations, the drop in the water table of the House of alluvial plains Kabudarahang started in 1983 and despite its stabilization period of 70 to 75, are continuing.

The main items affecting the continued loss of home water include:

1. Overdraft of groundwater consumers, increasing the number of wells in the plains.
2. Drought in the past few years, that has inflicted huge losses on home water. So that the average loss during the regular 1.5 meter, but in dry years the amount of loss is measured 3 to 4 meters.
3. Atmospheric effects in response to a respite home water occurs in approximately 15 months.
4. If current trends continue operations, assuming a normal rainfall of 325 mm, the feed rate of 35 million cubic meters of water in homes that still have a deficit tank. So the next 8 years will be used to house all the stored water.
5. Fortunately Prairie evaporite formations in the absence (less than 10 ohms resistance geophysical evidence of evaporite formations such as salt, gypsum, etc.) General water quality is suitable for home. But the decline of groundwater levels is exceeded; the water quality will be reduced.
6. According to surveys and qualitative studies and look at the map and type of water is perfectly clear trend Most of western and south-eastern areas of change that has come out of the plain. However, on average, about 5 percent of the Plains quality over the past 15 years has been calculated.
7. The study of the geomorphology of the region as well as the ability to map out transition And increasing water cut in some wells in the Midwest so the The Water House Water Karst limestone houses are currently Hydraulic Exchange Water and seasonal rainfall Home karst, alluvial water supply to the house.

8. The investigations of the geomorphology and chemical analysis of water caverns and caves Mirage Alisadr It should be noted that there is no doubt that these two caves are hydraulically connected with each other.

Applicable to major operations including operational controls, procedures and reconstructive procedures home water reform that should be considered by authorities to be given.

### 17.Operational control procedures

- a) control the water flow volume : All licenses issued by the measured discharge at the site should be monitored and evaluated and discrepancies between the two is clear , according to the plan .second, some of the wells exceeded contrary to withdraw , so the best possible installation of smart meters , and control volume and the amount of the allowable harvest .
- b) Operational control by blocking unauthorized wells: in the wake of recent droughts in 1999 and 2007 tractors and compressors spread unfortunately, unauthorized excavation, so the sooner you can take action to block such unauthorized wells.
- c) Controls the operation of the electric pump wells: Currently, a large number of wells to extract water use diesel propulsion, Control over the flow rate and the consumer does not recognize any amount that is harvested, But in addition to the power advantage in reducing maintenance costs and reduce environmental pollution and less consumption of energy, with a rate constant for this property is important and cannot be modified.
- d) Control of consumer information and justification: if consumers during the crisis should be plain and justify their performance was compared to a more suitable position arises.
- e) Police formed water and more stringent laws to be formed to control water police units patrolling constantly created and in case of violations and abuse of judicial institutions should introduce them to consumers.

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