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Geology and Aquifer Management of TangHigoon-Tangpirzal (SW of Iran)

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Abstract: In warm and dry areas low raining and irregular use of wells of water, depth ofunderground water, is gradually decreasing and in those areas,this situation has caused to make crisis of water, there are in deferent local of Iran.In this study that had done in province of Kohkiloye and BoyerAhmad, features of aquiferplan of Kalachoo and geology particulars of area and efficient of that in hydrodynamic coefficient has been studied that could gained best ways in management of water sources and artificial nourishing. First with statistical studies, hydrography and characteristic of aquifer have gained. then has beginning with geological study concerning to providing of geological sections and features of formations and lithology of geological units, geological loges of piezometer wells electrical sounding and modeling water for determining of incoming current from boundaries and situational out coming current had been used. Result showed that irregular increasing of numbers of wells of exploitation during 2003-7 years, had caused imbalance in aquifer and with planning of artificial recharge and yearly nourishing about 5 million m^3 of seasonal water in water storage underground will have been positive affected in balance of storage and increasing of depth of undergroundwater.

Key words: Aquifer · Artificial recharge · Kohkiloye-Boyerahmad · Hydrogeology

INTRODUCTION

Kalachoo plain is one of the important aquifer ofKohkiloye and Boyerahmad province. Studyof area is 490 km^2 and place in along western north- eastern south.it is located 30°, 50′- 30°, 54′norther latitude and 50°, 35′-50°, 40′ eastern longitude in western south of Kohkiloye and Boyerahmadprovince. Figure1 showed situation of boundary of casestudy. Kalachooplain is from north and western north and eastern north to Siyah mountain, TangHigoon and from south and western south to gypsum Pedi mount aside to Deasht - Pirzalroad and Toolianvillage extended from east to ZargamAbad and kooshkvillages has been ended. Thisplain has been measuredabout 1100km^2.

Raining: Studying of rang of monthly and yearly raining of Dehdasht evaporate station since beginning watering year 1961 up to end of watering year 2002 had showed that in this statistical period, average of yearly raining had been 393 mm and maximum of yearly raining was 730 mmthat had been for1996,watering year of 1971 and minimum of monthly average is about zero mm that is for June and maximum of that is 101.30 mm, that is for Jan [1]. Raining is concluded of all descending of sky such as rain, snow and hail. That with regard to every local of every raining or snowing area or both have most part of raining that in this basin is often raining and in winter is snowing and sometimes hailing in up heights. With a view to morphology, this studied area could part to two sections:

Mountains: This part has heights besides to region. Topographical is changing about 1850 meters in Siyah Mountain and 860 meters in Dastgerdvillage. Lithology variation and range of different hard ness of layers had caused that layers had not been equaled against of erosion, so carbonate sediments for more res istance cause to make mountain ridges and higher places (Siyah Mountain) and layers inclined to evaporation sediment for lower hardness make smooth parts of highest. It Seemed that Tang Higoon in north of plan had been made by being unequal erosion of Pabdeh, Gourpi, Asmari, Sarvak and Ilamformations [2].

Field: This part is result of destroying heights and carrying and filling up of sediments by superficial and torrential current of that area. Trend of Kalachooplain is almost western north - eastern south and conditional of sedimentary was caused that plan surface would be almost.

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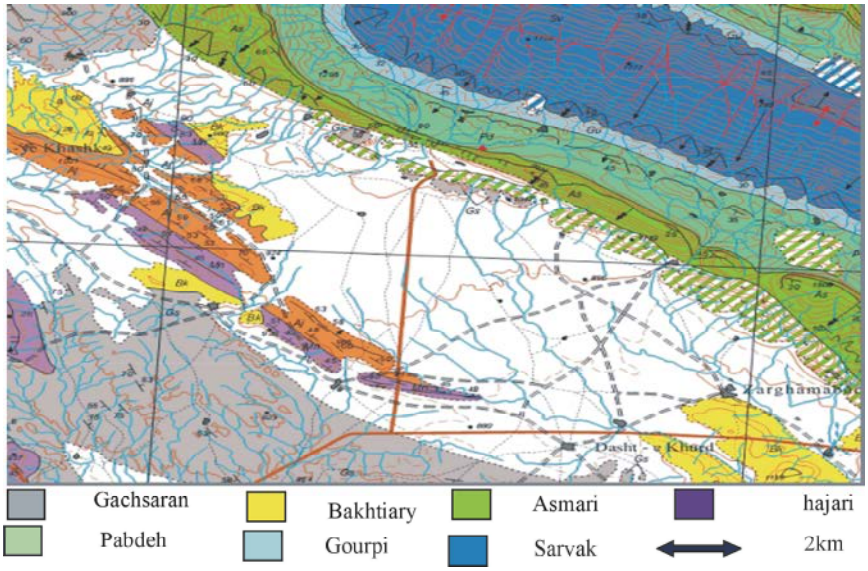

Fig 1: Geological map and situation of case study of area

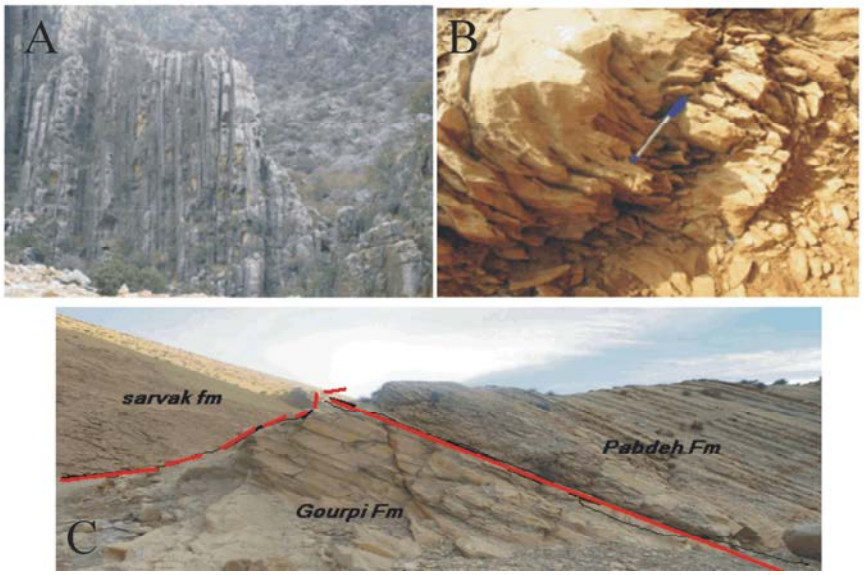

Fig. 2: Siyah Mountain anticline:A)TangPirzal location B)Limestone karst of Sarvak formation Outcrops of Pabdeh and Sarvak formation on the Gourpi formation[6].

Geology: Trend of western north and eastern south of basin is following general trend of Zagross that in Figure 2 showed. Towards Dehdasht not only folds had been stronger, but also Asmari formation had made to the extent deeper so in Dehdashtarea, the superficial layer that concluded most out crop, is Gachsaran formation. Geology studies with regard to outcrop of around (north and south), estimate that this fold is kind of general folds of Zagross area in tectonic condition result of thrust faults. Where Asmari formation with this situation is folding and covered with Gachsaran, could made hydrocarbontraps [3].

Arrange of placing of Asmari, Pabdeh, Gourpi and Sarvak formations form anticline and major figure of anticline make Sarvak formation.This anticline in period of Campaniamade an interruption in sedimentary and in result sediment of Gourpi formation with an unconformity place Ilam formation. Major lithology of that dark marls and a few marl limestone to thickness about 350 meters is in Khozestan. Age of Gourpi formation is Campania - Mastrishtian. Gourpi formation in Lorestan is gradually converting to sandstone and siltstone of Amiran formation. Form highest of Siyah mountain towards Dehdasht that includes Asmari formation and

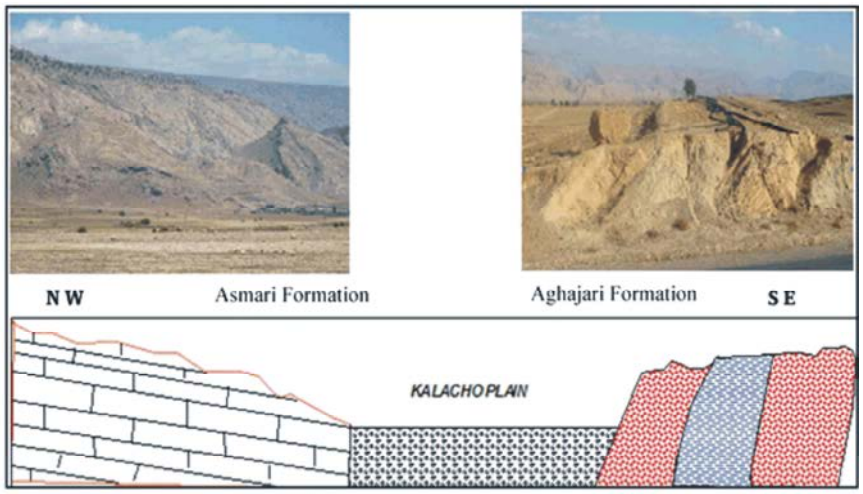

Fig. 3: Section of Kalachoo plain in TangHigoon.

Asmari replaced and then sedimentary of quaternary, Bakhtiary and Gachsaran formation on Dehdasht is more in north of Gachsaran and east and south of Dehdasht, formations of Agajari and in eastern south of Bakhtiary.

Formation oldest of area is Sarvakformation that in core has outcrop erosionanticlines.Limestones erosion of this formation made unsmooth,and there iskarstic lime stone.Mass and condensed lime stones with joint porosity merely good with grey color showed.. According to paleontologydata, the age formation is cretaceous [3]. And process of karst formed in this formation, but this do not conclude hydraulically boundaries of Kalachooplain [4, 5]. Gourpi formation marls with an erosion unconformity has placed on Sarvak formation, (Figure 2). Grey to blue marls in during folding, has been behavior of plastic, that this behavior caused unequal thickness. According to data of paleontology, age of this formation is upper cretaceous.

Pabdeh Formation: Lime and dolomite stone of Pabdeh formation erosion unconformity place on Gourpi formation. This formation separates from Gourpiformation in the edge of SiyahMountain with three layers of purplelimestone that are completely deferent. Contact of this formation with Asmari formation is completely gradual [6]. According to paleontology data, age of Pabdeh formation in this area, is not limited to Eocene and process of sedimentary has continued in Paleocene.

Asmari Formation: Creating of Asmari formation, from colored lime stone, massing and very embossing, that has porosity and fracture very much and cover Pabdeh formation, in under part of this formation, there is not any evaporate and detrital stones, when this formation place on the Pabdeh formation, according researches of paleontology, lime stone of Asmari formation, showed age of Oligocene and early and middle Miocene and according to samples of paleontology, distinguishing between lime stons of Oligocene and Miocene is very difficult [6].

Agajari Formation: Agajari formation, with gradually anddetritalfaciesinclude conglomerate lime stones lenses, grey and brown sandstones, marl with anhydrite, followed Gachsaran formation. Gradually passing of Gachsaran formation towards Agajari formation accompanied with last anhydrite layers (with thickness of 2 to 3 meters). Agajari formation after Asmari and Gachsaran formation forms most hydraulically boundary in eastern north of Kalachooplain in position of Toolian village (Fig 3). Gachsaran formation with gradual nearness has placed on Asmari formation, sometimes thickness is reaching about 50 meters and this formation has made of marl and anhydritecoloredand detrital stones such as sandstone. According to samples of paleontology, age of this unit considers middle Miocene in the area of folded Zagross. This formation has second hydraulically boundary after Asmari formationin Dastgerd village to Galehreisi. Quaternary sediments are clay to gravel. These sediments are made by erosion and destroy of highest that superficial and torrent currents carry them and in the plain surface fill up. Sediments of present period conclude major part of alluvium basin. With regard to exploratory researches, thickness of this sediment is changing so it makes more from edge towards central basin.Most thickness of these sediments assessed in westernnorth part of field. According to studied and result of

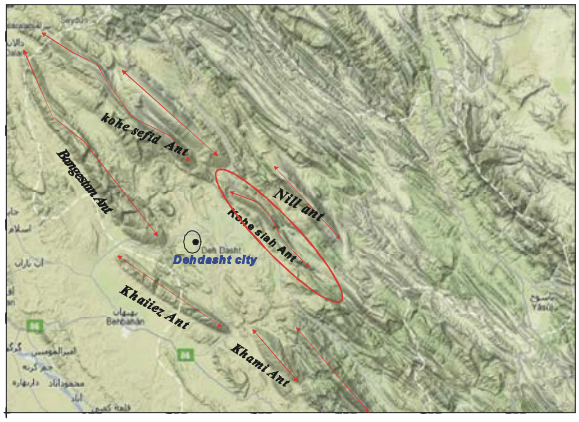

Fig. 4: Structural elements are NW-SE trend and Siyah Mountain is located north of plain.

excavations, material of alluvium specified of grainsize limestone, cherty and sand stone that size of them is changing between granular and clay [7, 8].

Structural Geology: Geologically Kohkiloye and Boyerahmadprovince is placed inZagross high-folded belt. Performance of Alpianorogeny caused to make several thrust faults in this region. So with act of these faults made high heights and scarps.Also performance of these fault caused that in eastern north part of areaold formations had more outcrop.

In deformation analysis of study area had studied three large anticline of koviz, Bangestan and SiyahMountain. For lack of existence of movement marked grain structure from marked of large structure such as different between slope and sliming of forehead, folds of unsymmetrical medium size and also back moves of thrust used in movement analysis of area.Results showed that these folds have driving side towards south- western south and accompanied with to side of driving of thrust faults. Geometrical analysis of these anticlines are according to geometric parameters of them such as ramp grade, grade between limbs and rate of slimming or making thickness of limbs showed that Koviz and Bangestan anticline are geometrical and from kind of folds of resulted of distribute of thrust fault and anticline of Siyah Mountain is showing geometrical of resulted folds from bending of driving fault (Fig 4). Relatively high thickness and a few kilometers of rock unites is features of folded, thrust parts of Zagross and spatially for ehead part. Mechanically behavior of these rock unites during deformation, could divided them to two groups of competent and incompetent.Succession of these competent and incompetent unites had affected in expansion, geometric and style of fold concerning with thrust fault in this part of Zagross folded belt very much. In study area, competent group is forming of two down part competent that is concluded of Pabdeh, Gourpi and Asmari formation and upper part competent is concluded of Mishan, Agajari and Bakhtiyary formation. Between this tow competent part place incompetent and moving part of Gachsaran formation. Not only Gachsaran formation is a factor in forming of style of structural deformation of area but also caused to rising of synclinal of area (Fig 4).

Thrust faults and folding, together with thatare major structures of area. Trend of these structures is western north- eastern south and are co trend with existence structures in belt of Zagross folded belt.Folds are large scale and grade between limbs of folds, relatively are open and have remarkable extension. Major structures, from south to north, conclude:Behbahanthrust fault, Koviz anticline, Bangestan anticline and in eastern north of this anticlinethere areDehdash plain and arising synclinal. In north east, large anticline of SiyahMountain, Sarvak formation conclude figure of SiyahMountain anticline and lime Asmari made principal figure of Koviz and Bangestan anticlines and Pabdeh and Gourpi formation have outcrop in core of Koviz and Bangestananticlines.

MATERIALS AND METHODS

In this study used 14 piezometer wells and 14 deep wells, for distinguishing of aquifer in different placesin parts of basin. And that result:

Thickness of Alluvium: In order to study and distinguish of alluvium sediments, both map of alluvium thickness of Kalachooplain was provided and according to this map was showed that alluvium thickness decreases from edge to center of plan so that in center of plan reaches to 75m.Regarding to map, alluvium thickness has evaluated about 120 m that is the most alluvium sediments thickness in western north parts of plain.

For providing of physical boundary of model of providing topography map is needed from surface of aquifer, so with regard to taking of height of wells in gathering statistic time by Total administration of water affairs ofKohkiloye and Boyerahmad province and also with using of topographical map of area, regarding to topographical map of surface, it is distinguished that topographically there are not different between western

north parts and outcome parts that is south areas of field very much, so from approximate level is 870 m in outcome areas of plan, that is beginning and up to 950 m reaches in western north of area [1].

Topographical of Basement: Topographical map of basement of aquifer by excavating wells log provided and showed that floor of aquifer has positional and local folding.With use of excavating wells log, structure of basement has not variety of lithology very much. Material of basement in outcome area of underground water is kind of colored marls and in material of north and western north area is limestone sediments and in continuing towards field center and towards alternative outcome is from marls and shill sediments and towards Dastgerd village that is eastern south of area is anhydrite and shale.

Physicalcharacteristics and Topographical of Basin: Knowing of physicalcharacteristics and topographical of basin has major role in determining of its hydrological parameters. For studying hydrological characteristics of aquifer was used topographical map with scale of 1:50000, [1]. According to available information and data Kalachoo plain, it ends from north and western north to Basin of Maroon River, from south and eastern south to kairabadbasin and CharamRiver.The most important rivers in studied plan is river of Zargamabadandkooshk, that after receiving of surplus water and following water of raining, spring and karizes, it is joining to Charam river by outcome of plan [3]. This river is from sources of Kairabadriver. According to received statistic and information from Total Administration of water affairs of Kohkiloye and Boyerahmad province, total range of following water in two sub basin imminent to plain had measured at2005-6 and it is 13.6 million m^3.

Existence Development Wells in Study of Area: Taking statistic from area wells did at 2011 and according to existence reports and files of area wells are 264 wells ring that in this region had excavated that pumped water of them is using for watering majorly. For studying a determining of characteristics and features of studied area development wells used to receive statistic informationfrom Total Administration of water affairs of Kohkiloye and Boyerahmad province. Also regarding to developed wells file, most numbers wells excavated in 2011. Total characteristics range of water taking from existence wells accounted 121 million m^3, that majorly it is using for watering and some using for industry.

Unit Hydrograph: According to aquifer unithydrograph, staticwater table specified that extremely affected by changes of regional conditions, specifically raining in the area. In other wise following to a raining in the surface of field, trend of hydrograph go up and then surface of water goes down. Regarding toaquiferunithydrograph specified that in study area, water table had beenextremely affected by raining, so with increasing of raining in during 2001-2, hydrograph goes up and with decreasing of raining -spatially in few recent years- hydrograph goes down. 12 numbers wells ring of piezometer excavated in the field. Researching of geological log of these wells shows that material of sediments to depth of 80 meters is from gravel and sand and clay and basement is from green marl. Also stratigraphy column of this wells shows that aquifer layers place on the basement is forming so seldom is kind of gravel and sand that alternation and repeat of silt and clay and layers with compound of gravel, sand and clay in them is little and for accounting of storage coefficient of transfer of water treasure of Kalachooplain from result of pumping of 5 wells with use of result of pumping tests, capability transfer map of specific yieldfor accounting of total of undergroundwater.

Storage Coefficient: Storage coefficient that is volume of water that from surface unit ofhydro genic layer to one unite of changes of volume of water make free or take and is not any dimension [9-11]. Regarding to this definition, storage coefficient is for tables is fenced and amount of that is followed to capability of elastic of material of water table and water itself and it is between 3-10 to 7-10 changes.Amount of storage coefficient with use of result of pumping tests has accounted in exploration wells is between 2 to 8 percent in case study and map of storage coefficient had traced that is according to took data of pumping tests.

Percolated Water Volume of Atmospheric Quenches (QP): Regarding to meteorologydata station of area, height of raining in water year at 2001-2 measured 298 mm. and it is 23 percent of this amount of raining considered as percolating to aquifer, so regarding to this percent of percolating, about 68.54 mm of raining that at2001-2measured, it considered as result of raining for accounting of area, range of percolated water is equal with:

$$(QP) = 36.8Km^2 \times 68540000m = 2500000m^3 \quad (1)$$

Percolated water volume of Radial flow (QR): Thisregion, totally imminent heightsto plan divide to three sub basins. According to this information, rang of water flowing of incame to field had totally assessed to 11.17 million m^3 that included of raining and melting of snow. Regarding to percolation coefficient equal with 25 percent,then range of in came water to water treasure is equal with:

$$(QR) = 11171000 \times 0.25 = 2790000\ m^3 \quad (2)$$

Incoming Underground Flow Volume to Boundary (QUI): To use of map, average water level had specified that was being incoming water to boundary model by about 10 underground channels and one channel in out coming part of field that water evacuate. To use of Darcy'sformula,range of incoming and out coming flow assesses [12, 13]:

$$Q = \mathrm{T.I_l}\frac{dh}{L1}.t \quad (3)$$

In this formula:q: incoming or out coming water discharge by every channel according in m^3/ year and T: transmission coefficient of one of channels according in m^2/ day and $\frac{dh}{L1}$: hydraulicgradient and*t*: water balance time that is equal of one year and l_l: every channel width according to meter.

Evacuated Water Volume by Kinds of Exploitation Wells (QEX)

Evacuate by Agricultural Wells: Regarding to existence lands in studied area that they have good fertility and most of them cultivate in dry period, then taking water by farming wells is the important stress to studied water treasure. According to existence statistic and information, range of evacuated water by farming wells in 2001-2accounted and is equal to 19.4 million m^3.

Regarding with Kalachooplain statistic, total of evacuated water by springs and karizes considered equal to zero with reason of drying of karizes and lake of spring in this field during 2001-2.

Volume of out Coming Underground Water (Q_{qi}): According to data evacuating of under groundwater just is by channel 10. To use of Darcy law,volume of evacuating water by this channel had assessed about 0.044 million m^3 at 2001-2.

Lack of natural and artificial drainage in study area, also placing level of water under ground in depths more than evaporate and transpiration depth (3 meters), caused that this two parameters in water balance accounting of underground water of studied area is considering equal to zero. Regarding to explain parameters in accounting of water balance of underground water table provided. Soaquiferat2001-2 volume of missing of treasure accounted to 3.504 million m^3. To uses of results of underground water balance of studied area and using of following formula, could account average of storage coefficient [8]:

$$\Delta v = \Delta h.A,S \Rightarrow \frac{\Delta v}{A.\Delta h} = \frac{3504000}{3680000 * 1.9} = 0.095 \quad (4)$$

Future Situation of Aquifer with Continuing of Presently Process: With irregularly increasing of numbers of exploitation wells caused to increase of evacuating of aquifer and so made imbalance in nourishing and evacuating of aquifer. According to receiving statistic in viewpoint of excavating, most wells excavated during 2005-6. Also plainunit hydrograph show increasing procedure of downing of hydrological level, so with suppose of presently nourishing and excavating procedurefrom aquifer, hydrological level researched in two position and for five and ten years, after 2005-6 (Fig 5). To use of results of this forecasting could specify proper locals for excavating of farming wells, in other wise field center has good potential for excavating of exploitation wells in comparison with other points of plain. Being true of this forecasting is observable in studyarea, so after several years from premeasuring of model, decreasing of dischargelevel of exploitation does not observe in central plan wells.

One of effective and useful factors in renewal of water underground sources and compensation of some part of downing in water level is artificial recharge [14, 15]. There are several ways for artificial recharge such as small basin ways, natural open channel of horizontal gallery, artificial recharge wells, waving irrigation, artificial nourishing cavities, storing and nourishing dames and using of nourishing and official ways that definition of all of thesecases is more than this research. Artificial recharge, spatially superficial nourishing depends on superficial penetrating and touching duration of soil to water [13, 16, 17]. Usually for nourishing of underground water table of some places have penetrable superficial and

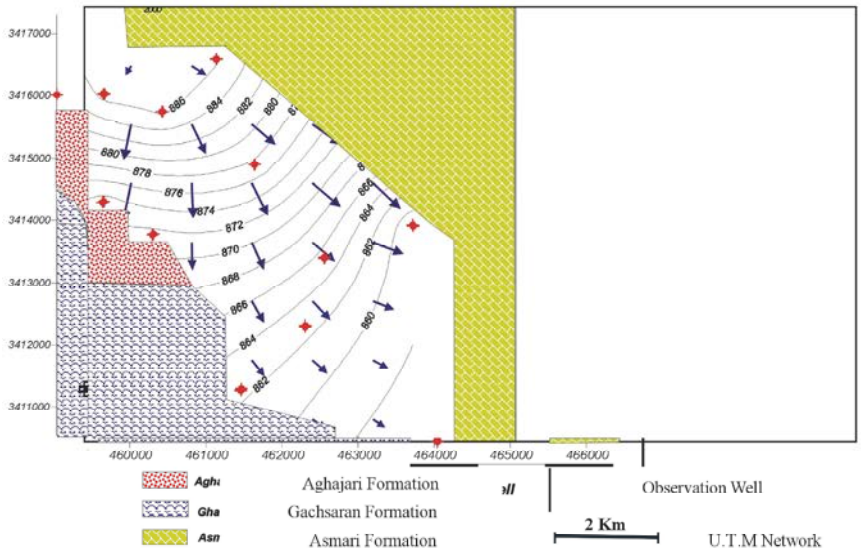

Fig. 5: Water table and underground water flow of study area.

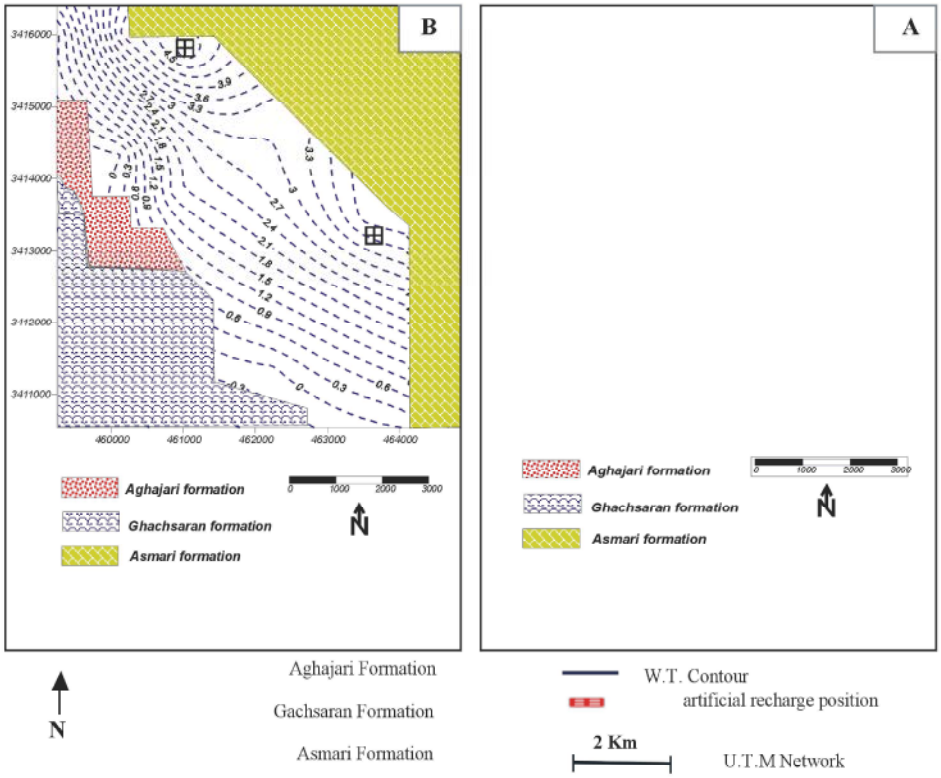

Fig. 6: Forecast for reduce of water table during 5 years (A) and 10 years (B).

sub superficial, could use with method of aquiferrecharge, deep saturation and groove. Settling of solid material that is in water, retentionof weather in pores, distributing and swelling of clays, sediment of problematic salts and iron hydroxide, increasing of bacteria and creating chemical materials are samples of artificial nourishing problems that should take action to solve of them [11]. According to studies that had done by power ministry, they take action to performing of controlling process of distributing of flood-water of Tang Higoon by deviating band and 5 basin in north of plan (seasonal dry river of Tang Higoon) [1]. This dry river is the largest seasonal

Fig. 7: Artificial recharge plan in TangHigoon.

floodway and has the most upper water coming basin that superficial water flows conduct to water coming basin of plain. Also regarding to showing place map of development wells, the most numbers of wells and exploitation of them, place in lower of plan of artificial recharge and this subject in the light of decreasing of water level underground, emphasized to necessity of performing of plan. Target of plan performing, regarding to needs of area, planning of deviating band and taking sediment basin and yearly nourishing and injecting, more than 5 million m^3 seasonal water, that is result of superficial water flows and atmospheric raining had been to water underground table.This matter caused in spite of sediment of fine grains of clay and silt that resulted of water flow and flood in the floor of deviating band and decreasing of penetrability, proper times of artificial rechargemissed and during recently controlled, in spite of being high temperature and evaporate even up to 20 days after flood in the area, yet there were water back of deviating band and this subject is showing to decrease of penetrating of deviating band and a few number of wells.

Irregular increasing of development wells and not controlling of wells of studied area and also decreasing average of raining in year caused to come down underground water level more than average of long time in few recent years, in other words, during 13 years, average of decreasing assessed 0.365 meter in every year, so just during 2001-2, average of downing assessed 1.9 meters for decreasing of raining.

CONCLUSION

- In order to increase penetrability and artificial recharge, it emphasizes on cleaning of floor of deviating dam and upper basins. In the most important problems of plan artificial recharge and emphasis of building of petrochemical factory of Dehdasht are in near and down of artificial recharge basins that it could percolate chemicalmaterial in Kalachooplain and vital risk threat aquifer.
- Studying of isobar map and three dimensional figure of surface of water underground during 5 years after performing of recharge(TangHigoon andTangSapoo) shows that changing of water level in deferent distances from local of plain performing is deferent so superficially efficiency of recharge of TangSapoo, recharge more surface of water reassure. Regarding to great extension of plan and not being enough of resulted of pumping tests of exploratory wells, used result of pumping tests in farming wells, that with due regard to acceptable errors of could use result of tests. Studying of water level trend shows in several consecutive years that center field has relatively good potential for increasing dischargr of development wells. On the contrary of this subject, in edge areas of limitation, spatially in west of plan (Dastgerd village) decreasing of water level caused to decrease of development wells discharge.

Suggestions:

- Great extent of plan and not being enough exploratory wells caused for searching hydrodynamic coefficients of aquifer of underground water flow, would use result of pumping tests on farming wells, so drilling of exploratory wells and doing pumping tests for more accurate account of hydrodynamic coefficients would need in study area.
- For approval of building of Dehdasht petrochemical factory in very improper situation (between two artificial recharge situations) studying of plan contamination model isvery need and necessity and

if possible displacement of place of this factory consider very necessity for underground water table and residents of area.

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