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Identification of Potential Groundwater Zones Using RS and GIS

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ABSTRACT

Objective: Exploration of groundwater resources requires recognition of regions and their potential sources. Because of high importance in the karstic regions and their significant role in providing needed water, efforts to explore new sources of Karst, is inevitable. Checking discontinuities is always an important issue in karst studies. Because of high discontinuities in rock masses, permeable areas will be created, they cause appropriate groundwater paths to flow **Methodology:** Recognition of these regions is possible through geophysical methods based on physical characteristics of these areas such as density or resistivity. Using geophysical methods in water and geotechnical methods has less history to oil field investigations and mining exploration, but has been accelerated in recent years. **Results:** In this research we have tried to investigate the usage of various geophysical methods, such as how to detect and identify underground water using these methods. **Conclusion:** We can noted of geophysical applied methods for groundwater potentiometric such as geoelectric methods, ground penetrating radar, electromagnetic, gravitometry, magnetic and seismic surveys.

1. Introduction

Exploration of groundwater resources requires recognition of regions and their potential sources. Because drinking water can be provided for about 25% of the world population of available water resources in karstic rocks, one of the most important areas to form aquifer are karsts [1-3]. The technical term for corrosion and dissolution of carbonate rock masses (limestone and dolomite) is called karst, which can result in forming a groundwater system. In this context, many sources of good water exist as karstic aquifers [4,5].

Because of high discontinuities in rock masses, permeable areas will be created, they cause appropriate groundwater paths to flow is important. Recognition of these regions is possible through geophysical methods based on physical characteristics of these areas. Geophysical applied methods are used to measure the physical properties of subsurface rocks employing the devices which are often on the earth's surface. Geophysics in exploratory studies is one of the indirect methods which could reduce exploratory costs and increase efficiency [6,7].

2. Materials and methods

The Geophysical methods are of great variety and they can be used in various fields. Figure 1 illustrates the usual geophysical methods and their application [8].

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Application										Geophysic Method
10	9	8	7	6	5	4	3	2	1	
_	s			s	s	s	s	p	p	Gravity
_	p	p	_	m	_	s	p	p	p	Magnetic
_	_	_	_	s	s	p	m	p	p	Refraction Seismic
_	_	_	_	m	s	s	m	p	p	Reflection Seismic
_	p	s	p	p	p	p	p	m	m	Resistivity
		m	m	m	p	m	p		_	SP
m	m	m	m	s	m	p	m	m		IP
m	p	p	p	p	p	p	p	p	s	Electromagnetic
_	m	m	s	s	s	m	p	m	m	VLF
p	p	p	s	p	p	p	m	_	_	GPR
_	_	_	_	_	m	m	p	p	s	MT

Oil Exploration	1
Geology Study	2
Mine Exploration	3
Engineering Stude	4
Hidrogelogy Study	5
Cavity Exploration	6
Finding Pollution	7
Archeology	8
Finding Ancient Body	9
Mass Recognition	10

Inappropriate :- m: Applicable s: Supplement Method p: Rootin Method

Figure 1. Application of Geophysic Methods in Different Science [8].

2.1 Geoelectric methods

The main geophysical methods for groundwater studies and water exploration is electrical methods in which by using the difference between the electrical resistivity of the subsurface and ground water. finding water potential is done. Electrical methods are included variety of different methods that almost in all of them the basic physical parameter is conductivity or resistivity of the subsurface strata. A few of these methods use the natural fields of earth (autogenic potential and magneto telluric) and in most of them, the fields generated by the transmitter system are used. Next, an explanation is provided for each electrical methods.

2.2 Resistivity method

This method is usually done in association with the injection continuous current by two electrodes to the earth. Emission electrical current between two electrodes is done through the charged ions present in water ground or conducting minerals underground of some of the stones and the resulted potential difference is measured by using a two electrode of potential and as a result the impedance of earth is obtained. According to measuring, we can present three

A -Preparing profile or maps of changing in apparent resistivity in specified depth

B - Investigating variation of apparent resistivity in depth (using probing)

C -The combination of these two methods to create images of the subsurface classes resistivity

This method is used for vertical and horizontal discontinuities studies in the earth electrical properties and also in exploring abnormal mass conductors and even today, it is applied extensively in the hydrologic studies and investigations in order to examine subsurface and to explore ground water tables, in particular [2].

2.3 Electromagnetic method

In this way, the electromagnetic field induced by the coil is sent to land and as a result that second field is established in conductive sub surfaces like conductive metallic deposits which are received by receiver coils. Using the changing frequency of sent currents, depth of different influences is considered. Method MT is a measuring method of natural electromagnetic field with low frequency. VLF method or very low frequency can be regarded as a kind of static method in which a single receiver device is required. These electromagnetic methods are numerous based on variety of devices and used arrangements and thus in disruptions, hydrogeological studies and mineral deposits have many applications. In these methods expect the MT method, depth of studies is not high.

2.4 Induced polarization method (IP)

This method is based on conductivity variations or resistivity with frequency change. In the time domain or a continuous flow technique, the ground is charged under an electric current then with current interruption during discharging at the land, the potential is measured. In the frequency domain or intermittent current, Resistivity variations and frequency are measured. This method is used mainly in the study of metallic deposits, but in recent years its use has been accelerated in the hydrogeological studies.

2.5 Ground penetrating radar method (GPR)

This method is actually the electromagnetic method in which the high frequency range (100MHz to 10GHz) is used. At these frequencies instead of ground conductivity, their dielectric permeability is dominant parameter. Sent electromagnetic energy causes scattering and reflection in bordering layers with different electrical permeability. Water has a high dielectric coefficient, but this coefficient is small for stones. Thus, this method is used mainly for studies of water and geologic discontinuities.

2.6 Application of electrical methods in water exploration

The main geophysical method for water exploration, is geo electrical method. We can name one of its application as identifying the boundary of fresh and saline water, investigation of pollution in groundwater, identification of ground water levels and recognition of properties such as porosity. Among the various geo electrical methods for water exploration, the resistivity method is the most popular method. The electrical resistivity of rocks is related to a series of factors, such as porosity, open or enclosed waters' amount, salinity, resistivity of host rock. Since the discovery of water resources or recognition of other components of a water table such as storage volume and depth of bedrock, there have been conducted many geo electric studies in Iran and other countries, but the principle in almost all of them is the same. In this studies by using one of arrays of electrodes related to geophysical survey conducted in the study area reached their exploratory target after processing of obtained data [5].

3. Discussion and results

3.1 Gravimetry

Earth's gravity field is typically not uniform and affected by local disturbances that is changed in the areas in which there are variation at density of subsurface materials. Although these abnormalities often has very little range and is about a millionth of the Earth's magnetic field but can be measured by sensitive measuring devices.

3.2 Application of Gravimetric method in water explorations

The main geophysical methods for groundwater studies and exploration methods are electrical methods but gravity method also can take an important role. Low-density areas may represent a suitable environment for the formation of ground water resources and are identifiable by gravity method. Jacobs and Bayer in 2008 could record the changes the storage volume of water in groundwater table using a gravimetric method [4]. Abd Alla et al in 2007, identified the depth of the bedrock aquifer using this method [1,10].

3.3 Magnetic

Earth has naturally magnetic field. Location changes in Earth's magnetic field in terms of geographical location, is accessible and predictable. Existence of magnetic minerals such as magnetite can induce a local or regional disturbances in Earth's magnetic field. Results in this method can be done by plane, helicopter or satellite due to the expansion of earth's magnetic field to miles above the earth's surface. This method can be used to identify largescale lithological changes because the igneous rocks are more magnetic than sedimentary rocks. Results in this method are simple than gravity method and analysis is more complicated than gravimetric method.

3.4 Application of magnetic method in water exploration

A brief review of previous geophysical studies related to water exploration indicates that MAGNETIC methods are used mostly in identification, investigation of fault and fracture zones like gravity method. For example, Nowruzi and Mehrnia in 1998 showed in Sar'eyn, Iran that in addition to identify fault zones, we can use Magnetic method to identify hot water zones according to their magnetic changes of dry rocks to the rocks which are in contact with water [7]. Soltan et al in 2008, when conducting a study on an aquifer in Egypt, could detect a groundwater table by combining techniques of specific resistance, gravimetric and Magnetic method. In this study we used of resistivity methods for detecting subsurface aquifer and isolating subsurface layers from each other, gravimetric method to explore the water resources through identifying the underground structural trends and Magnetic method to show the depth of bed rock and also the water table depth and sediment [9,12].

3.5 Seismic methods

This method is designed based on creating energy using an artificial source such as a blow or explosion and its propagation in the subsurface layers. Seismic energy reaches to available receiver above the surface after passing through the lower layers; With the passage time of waves through these layers and the distance between source and receiver, speed of waves passing is determined. Often, the use of different methods that are sensitive to different physical properties can complement each other and be more effective for solving heuristic problems. For example, gravimetric and Magnetic methods are often used together in this context.

3.6 Application of Seismic methods in water exploration

Application of seismic reflection method is more focused on the exploration of hydrocarbons. This is due to the high power of this imaging technique in sedimentary sequences associated with hydrocarbon reservoirs are located at depths of several kilometers. But from the application of this method is bordering refraction of low depth studies and with high resolution that can be used in fields such as engineering and water. This method can be a good way of illustration of bedrock horizon in the earth [6,11].

4. Conclusion

Using indirect methods for potentiometry of groundwater in addition to increase of speed, decreases the exploration costs. we can name geophysics from indirect methods that according to the special physical characteristics to detect includes multiple methods. Applied geophysical methods are to use in exploring water, geophysics, GPR, seismic and gravimetric methods. Usage of each of these exploratory methods according to geological and lithological characteristics of the region, it is possible to use in identifying and exploring the underground aquifers.

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