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Geologic Monitoring for Geothermal Power Station

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ABSTRACT

The paper presents analysis of reasons for monitoring geological environment, basic principles, general requirements for monitoring.

It was considered monitoring of different sub-systems, intercommunication, interaction and reciprocal improvement of all elements of the monitoring system.

1. INTRODUCTION

In the present stage of scientific and technical progress the environmental protection and rational exploitation of the environment is the problem of the whole humanity. To resolve the above problem, a number of disciplines which have been separately developed before must be united now.

The monitoring of the geological environment is a constituent of the total monitoring of the system, the latter consists of the Environment and the Geothermal Power Station.

The geological environment is the main constituent in the system of the Geothermal industry.

Therefore the Geothermal Power Station-Geological Environment monitoring is of important significance for safe exploitation of the geothermal power stations, vital activities of people and effective environmental protection.

2. GEOLOGIC MONITORING FOR GEOTHERMAL POWER STATION

Nowadays, organization of the monitoring system is in the stage of development (creation) of principal concepts and scientific, methodological and practical approaches as well.

An acuteness of the ecological situation in the country and in the whole world requires that urgent decisions must be made. Theoretical and practical problems of organization of the monitoring must be solved. The monitoring of the geological environment is a constituent of the total monitoring of the system, the latter consists of the Environment and the Geothermal Power Station. The geological environment is the main constituent in the system of the Geothermal industry.

Theoretical substantiation of the monitoring means the necessity to create a complex system for collection, accumulation, processing and use of information. Such information must show light on the particulars of each single element and component of the geological environment, of its motion, its internal and external interactions.

The monitoring of the geological environment is a dynamic system with flexible infrastructure which permits to exercise:

1. continuous control over the state of the object (geological environment) and over geo dynamic activities;

2. modeling of the geo system under different technological load;

3. issuance of forecasting estimates;

4. working out of measures for protection and rational exploitation of the geological environment;

5. taking decisions on external impacts which prevent the geological environment from disturbance of its equilibrium state ;

6. ecologically safe measures.

When the monitoring of the geological environment is worked out the following principles must be observed:

I. Principle of unity of the objectives. A common basis of concepts must be worked out because different sciences about the Earth are involved. The monitoring of the geological environment must be created on a basis of the engineering geology, the latter complies to the utmost with the program having as a special purpose an estimate of the state, control over changes in parameters and management, control over the geological environment.

II. Principle of hierarchy. The solutions of particular problems in investigation of the geological environment are included in the hierarchy of the whole monitoring system and they are coordinated. Organization of different structures in investigation of the geological environment the elements of which differ in level and type of information that has been obtained:

field determination of data,

laboratory investigations,

elaboration of forecasts,

managing decisions.

III. Principle of integrated approach. Intercommunication, interaction and reciprocal improvement of all elements of the monitoring system. This principle is a necessary condition for effective functioning of the whole monitoring program.

IV. Principle of alternative approach. The common conception of the monitoring must be implemented with allowance for several ways (options) of development of technological impacts. This principle allows to register different drastic fluctuations in the system stability and as a

result the deterioration of the ecological and geological environment.

V. Principle of system approach. The geological environment and the monitoring system are considered to be systems from two different classes which interact according to certain rules.

The principle of system approach makes possible to systematize and to substantiate the whole range (different types) of interaction of the Man and the Geological Environment. Systems and sub-systems should be determined for the problem which has been set, their hierarchy should be built. All this must be complied with the tasks of investigation of the geological environment, the character and intensity of external impacts, its changes in time and in the space must be considered.

When the system is constructed the specific character of its structure, the properties of the geological environment and the technological load must be considered.

When applied and particular problems are solved optimal solutions, as well as rational and effective management of the geological environment must be determined in order to minimize an environmental impact.

Practical execution of the monitoring of the geological environment generally makes provisions for examination of the complex binary system: Man – Geological Environment

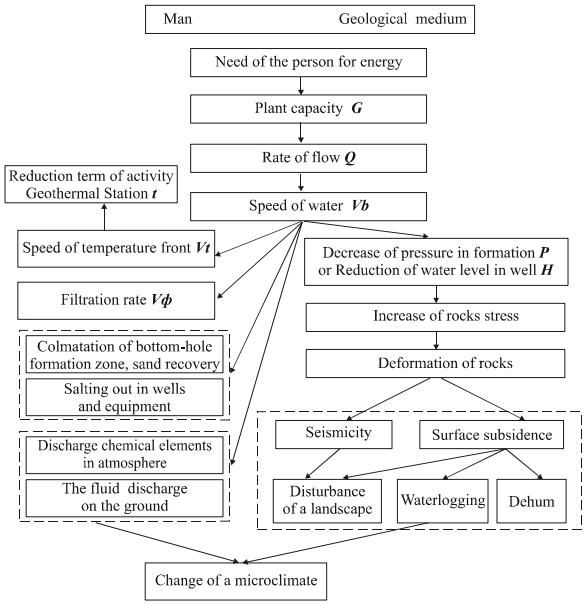

Figure 1: Block scheme of geothermal system function.

Changes in the geological environment caused by technological impacts may be presented as MANAGING SYSTEM - OBJECT OF MANAGEMENT

The technological impacts (managing system) and the geological environment (object of management) are open dynamic self-regulated and self-organized systems.

The geological environment exerts influence upon the managing system by means of information about its dynamics, conditions of changeableness of its components etc. The managing system exerts its influence at the expense of the negative feedback that impedes deviation of the geological environment from its static state.

Such links between the Man and the Geological Environment are ideal from the position of the management theory.

The managing system has the following infrastructure:

ENTRANCE – PROCESS – EXIT – FEEDBACK.

The entrance to the system represents the technological load, its exit represents the corresponding motion of the geological environment or a forecast of such a motion.

The sub-systems of the monitoring are DATA BANK, CONTROL, FORECAST and MANAGEMENT of the GEOLOGICAL ENVIRONMENT.

The DATA BANK is initial data.

The CONTROL is an estimate of the geological environment state.

The FORECASTING is the scientifically grounded foresight of emergence and development of geological processes.

The MANAGEMENT is a complex of impacts, which optimize the geological environment state, exclude its unfavorable development and improve the ecological and geological situation.

The chosen sub-systems are intended for operative and flexible reaction on changes in conditions of equilibrium for subjects of management (geological environment).

Investigation of different interactions and links is necessary even in a case if no evident negative impact or disturbances of the geological environment are observed.

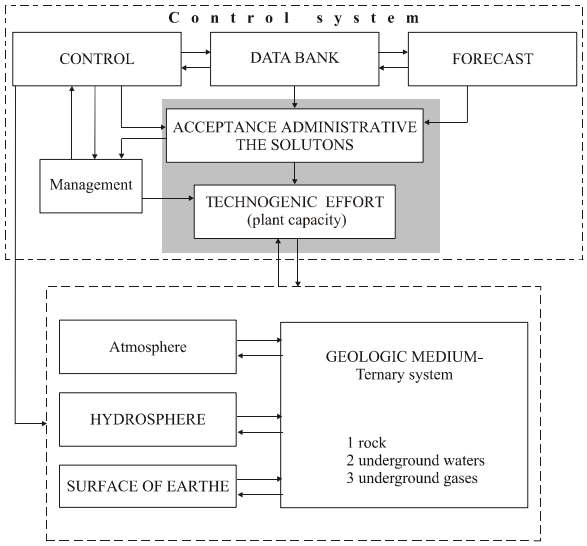

Figure 2: The block-diagram of system principle realization. Organization of geothermal complex geologic medium monitoring.

It is possible that the impact will not become apparent immediately.

It may be mediate.

Organization of the control system within the scope of the GEOTHERMAL POWER STATION and the ENVIRONMENT (geological environment).

The main (basic) subsystems of the control of geological-technogenic system Geothermal Power Station and Geological Environment.

Geochemical sub-system.

Hydrogelogical sub-system.

Engineering sub-system.

Geophisical sub-system.

Deformation sub-system.

Landscape sub-system.

Microclimatic sub-system.

At present it was created date-bank and it was estimated potential of geothermal promising areas in Crimea and Zakarpaty. Hydrochemical characteristics thermal waters of promising areas of Crimea are in Table1.

There are more ten small heat supply systems in Crimea (Table2). Geothermal heat-supply systems have control-measuring unit was created in Institute of Engineering Thermophysics of NAS of Ukraine and control measuring complex with the ITABAR –sond of firm EXPORTRONIC BETRIELSGmbH.

Mathematical models of the geosystem under different technological load, issuance of forecasting estimates, some optimal solutions were considered in works I.Moiseykina (1987, 2000, 2003), A.Stcherban (1986).

Tarchancut peninsula is very promising for Geo-power plants. There are seven promising geothermal areas. (Table 3). Demonstration gas and geothermal central heating – and – power plant Sivaska-1 is creating in the settlement Medvedevka (Crimea). Parameters of geothermal heat carrier at the mouth of producing well – pressure – 0.5 MPa, temperature – 64 C, yield-27 m^3/hour, gas content – 1,4 m^3 of gas/m^3 of water, depth of operating wells – 1700-1800 m.

It was created technical-economic project for geo-plants in fields Tarchancut with circulating systems. Promising areas don't use because no means for building.

REFERENCES

I.Moiseykina. Transient Percolation Through an Inhomogeneously Anisotropic Jointed and Porous Bed. J.Fluid Mechanics – Soviet Research vol.16 № 3, (1987) 113-118 p.

A.Stcherban, The system of the Earth's crust heat exstraction and the methods of the calculation. Naukova Dumka, Kiev. (1986) 240 pp.

I.Moiseykina. Geothermal circulation systems is environmentally safe and pure geothermal energy technology. Proceedings World Geothermal Congress 2000. Kyushu-Tohoku, Japan, May 28 – June 10, 2000, № 3027.

I.Moiseykina. Progressive technology extraction of geothermal energy (geothermal circulation systems). Proceedings Geothermal Conference 2003, 25 – 30 May, Szeged, Hungary (P1-04).

Table 1 Hydrochemical characteristics thermal water of Crimea.

Area	Depth, H (km)	Temperatures, T (C°)	Geothermal gradients	Mineralization, M (g/l)	Gaseous factor, Γ	Waters type	Microelement (mg/l)		Gas saturation
1. Novoselovskiy	1- 1,5	55-90	3,5-5,2	of 2-3 to 35-38	from 0,01 to 0,1	-	I (0-61,5) Br (10-81,8) B (8-117,5)		-
2. Oktabrskaya	1,7-1,8	53-81 81-89	3,3-4,6	0,8-3 to 37-44	-	Chloride-sodium	I (up to 31,3) Br (up to 132,7)		methane (80-90%)
3.Dgankoyskaya	3-4	105-137	3,01-3,06	17 to 25	0,65 - 1,07	Chloride-sodium	I (15-33) Br (30-74) B (6,5-126)		methane (70-97%) nitrogen (15,2%)
4. Tarhankutskaya	2,1-3,5	105-150	4,0-4,3	13-21 to 79,6-82,6	-	Chloride-calcium	I (14-44) Br (22-50) B (22-30)	I (89,1) Br (130-132) B (140)	-
5.Northern-Sivashskaya	0,9-1,4	44-65	3,3-4,3	26 to 34	0,9 - 1,3	Chloride-sodium	I (30,1) Br (85,3) B (58,1)		methane (79-98%)
6.Genicheskaya	2-2,6	86	2,8	62,2 to 75,1	0,2	-	Li (6,1) Br (48,2) B (24,1)		hydrocarbons, mathan, nitrogen, carbonic acid
7.Tavriyskaya	1,2-1,42	51-87	3,8	12,6 to 40,4 46,7 to 130,9 20,6 to 191	0,5-1,1	Chloride-sodium	Li (20,2) Br (144,9) B (47,6) Strontium (310,0)	I (12,6-40,4) Br (46,7-130,9) B (20,6-191)	Hydrocarbons (78%) manly methan (77,6%)

Table 2. CHARACTERISTICS OF GEOTHERMAL HEAT SUPPLY SYSTEMS IN CRIMEA.

№	Settlement	Capacity, MW	Temperature, C,	Mineralization, vg/l	Objects of heat supply	Annual economy of fuel, t, oil equiv
1	Ilynka	1.0	57	8.0	settlement	500
2	Sizovka	1.0	61	18	settlement	500
3	Nova-Alekseyevka	3.0	53	1.5	milk farm	1500
4	Kotelnicova	2.0	65	30.0	settlement	1000
5	Trudovoye	1.0	53	8.0	hot house, hot water supply	500
6	Zernovoye	1.0	50	5.0	hot water supply	500
7	Rovnoye	3.0	62	8.0	settlement	1500
8	Yantarnoye	5.0	85	38	settlement	2500
9	Pyatihatki	1.0	51	8.0	hot water	500
10	Medvedevka	1.0	67	8.0	kinder-garten,settlement	1000
11	Nizinnoye	0.5	47	2.0	hot water supply	250

Table 3. PROMISING AREAS OF TARCHANCUT PENINSULA

№	Geothermal Areas	Depth, m	Temperature, C,	Effective thickness, m	Porosity,%	Well discharge of thermal water m^3/day
1	Mezvodnenska	5000	195	75-100	6-10	800-1200
2	Kuznezka	4800	170	75-100	10-12	1000- 1200
3	Kirovska	4700	160	100-110	6-10	1000-1200
4	Zyravlevska	4500	170	56-100	6-10	1200-1500
5	Berezovska	3800	115	90-100	15-20	1000-1200
6	Maksimovska	5000	175	75-100	10-12	800-1200
7	Ilinska	4300	150	100-150	10-15	1200-1500