Extracting mineral components as significant component of the complex use of geothermal resources

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The solution to the problem of extracting mineral components (halogens, alkali element and rare metals) form geothermal waters is advisable to look at frame of a complex approach and effective uses of all the geothermal carrier resources (mechanical and heat energy, dissolve gas, mineral component and the water it self).

Economical prerequisite for such an approach is the necessity to shorten the time on covering the expanses on the development and distribution of the industrial geothermal technologies. From the technical point of view, the optimized solution of technological task of extracting mineral components is impossible beyond the problem of accompanying heat utilization. The particularity of the new mineral extraction technologies lies in its directivity to use the energy of the carrier (or electrical energy), also dissolved gas (especially methane) acquired form the geothermal source.

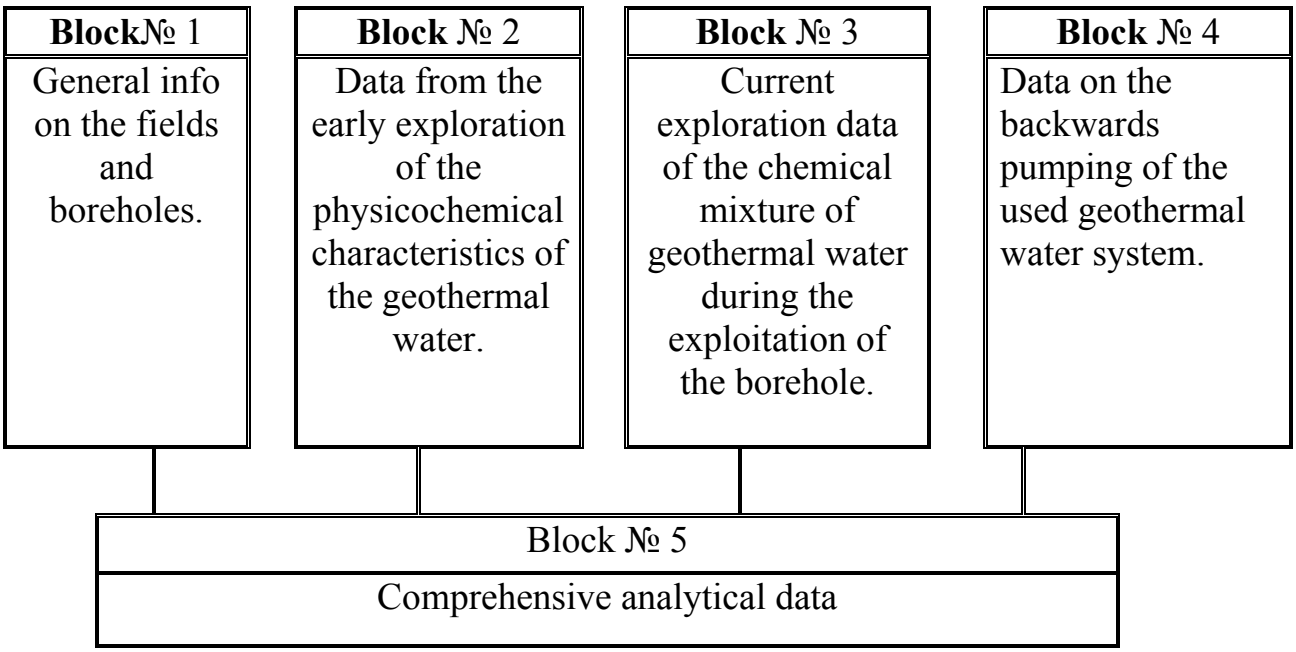
A very important task in developing technology concerning a complex max utilization of all economically worthy components from the geothermal sources lies in organization of a much rational worked out carrier usage process. Preceding conclusions testify that nearly 20-30% of previously refine and desalted water could be used for technical needs (taking into account that no less than 70% of worked out water carrier should be returned back to the geological layers).

Since, every field is characterized by an individual chemical mixture the definition of the possibilities and rationality in organizing the industrial extraction of one or another chemical element or their group there is a need in a specific basis. The basis for this can be an intensive previous study of the chemical mixture and a range of other geothermal waters characteristics on the one hand and a system of a source exploitation characteristic on the other in order to acquire data on possible day and night, seasonal and annual extraction capacity. The systematic accumulation of such information in a form of a computer database is basis that will help define initial status and potential of the geothermal source and dynamics of changes in the course of its exploitation.

The study of the geothermal waters chemical mixture is fulfilled on a substantial scale mostly in the field of geochemistry in order to explore deep thermal processes in the earth's crust as an example method of geothermometry. That kind of works is launched in Iceland and many other countries whose territory has a typical geothermal activity [1]. The scale of the systematic exploration of the geothermal waters chemistry connected with the development of the valuable chemical elements

extraction technology is not relatively of a great extends. In many counties the extraction of the iodine and bromine is developed in a much greater volumes when lithium, boron, germanium**,** tungsten**,** rubidium, caesium. According to the USA Energy Department since 2002 such works are developed within a special California Energy Commission's (CEC's) Public Interest Energy Research (PIER) Program. The goal of this program is to increase the economic efficiency of the geothermal sources exploitation by introducing the mineral extracting technology with a use energetic component of the geothermal waters. A technology of water carrier refinement from silicon and simultaneous production of the high dispersion polyhydroxide was developed within the program. Despite the huge economical perspective, there are a few known examples of a successful disposal of the valuable chemical elements extraction from the geothermal carries. A California Energy Company "CalEnergy" (USA) has setup an industrial production of highly pure zinc. (15 t in 1998). Later a $200 mil project was completed put to radically increase the volume of highly pure (99,99 %) zinc production per year [2]. There are data on the percentage of the rare-earth metals and yttrium in the geothermal waters [3]. Active geothermal energy installation can be used as a testing area to assay chemical matters extraction from the geothermal water technology. The primary objective is the creation of the source date system and analytical information essential for the tech-economical ground and selection of the optimal technological schemes including marketing research.

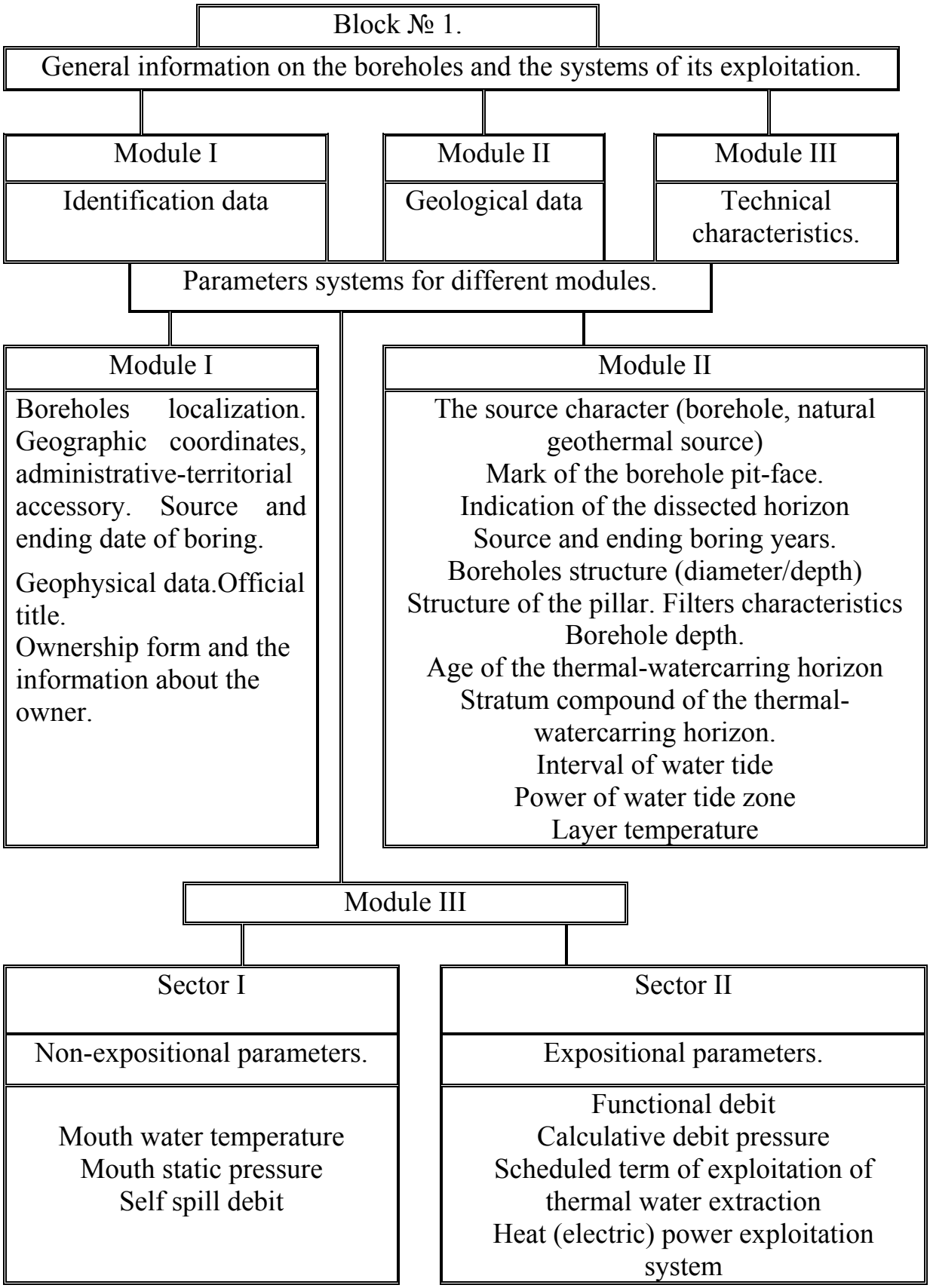
The structure of the source data for the tech-economic ground of the industrial extraction of the valuable chemical elements from the geothermal waters is given on the pic.1. The database consists of five informational blocks; four of them have descriptive character and the fifth one holds special analytical information for the direct practical use.



Pic. 1. General scheme of the source data.

On the picture № 2 is a system of factors and parameters of the database block № 1. To organize this block the selected amount of the necessary data is given in form of three modules holding identification and placement of the geological and technical (before and on the different periods of the exploitation) characteristics of the geothermal boreholes and the peculiarities of the system of their exploitation. Inclusion of the identification factors on the form of ownership has an important meaning during the development of the economical part of the project, because this factor should be taken into consideration when planning expanses. As for the geological factors, their presence in the database has no practical meaning on the source stage of the planning but can be potentially an element of high priority in the further development of works incase a specific connection between a separate geological factors and technical potential of the source is revealed. The parameters of two sectors in the third data module calculated on the base of direct measuring is necessary information for the further analysis.

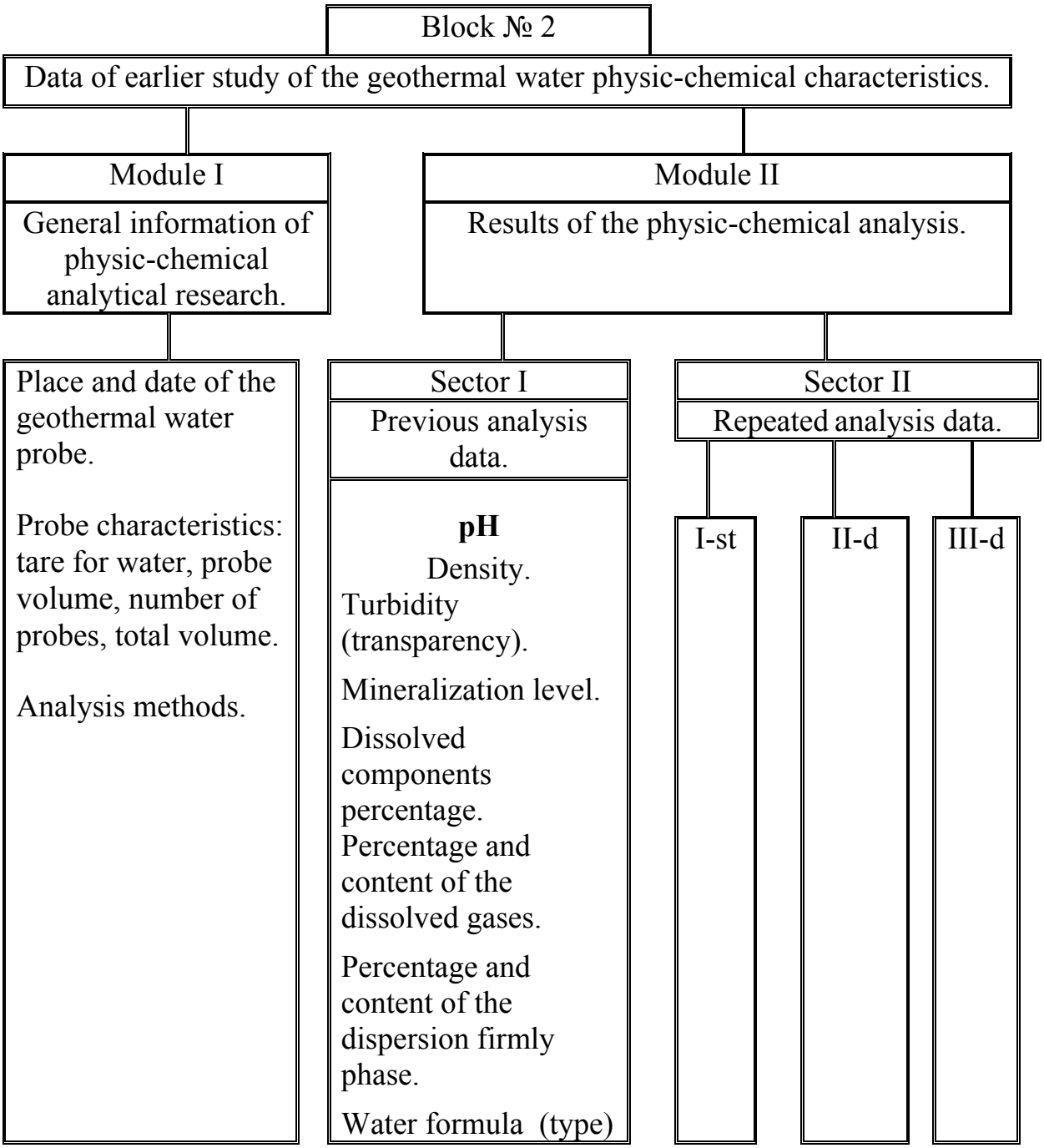
The research of the geothermal water characteristics that took place before the exploitation were preformed using temporarily close down or again bored boreholes or natural geothermal sources that don't utilize for energy supply or other variants of geothermal resources use for example balneology. As a rule, such sits have data on the preliminary analysis of the fluid physic-chemical characteristics.



Pic. 2. Block № 1 of source database general scheme, system of factors and parameters.

It is worth noticing that in most cases the research of the physic-chemical parameters of the geothermal carrier on the specific boreholes was made quite long time ago and using common standard hydrological and hydro chemical methods

without appropriate purpose-orientation and detail. That is why the need in another, additional analytical research, special analysis to receive a series of factors necessary to make the choice, ground and see fulfilled of the separate technological posses steal remains. The task of the sort triggers the need to expend the list of explored water parameters; in particular, a number of physical characteristics should be additionally studied, for example the presence of the mechanical admixture, their composition, and definitions in sizes. According to this the information block № 2 structure is developed; it holds the results of earlier tests of the geothermal water physic-chemical characteristics. (pic.3).

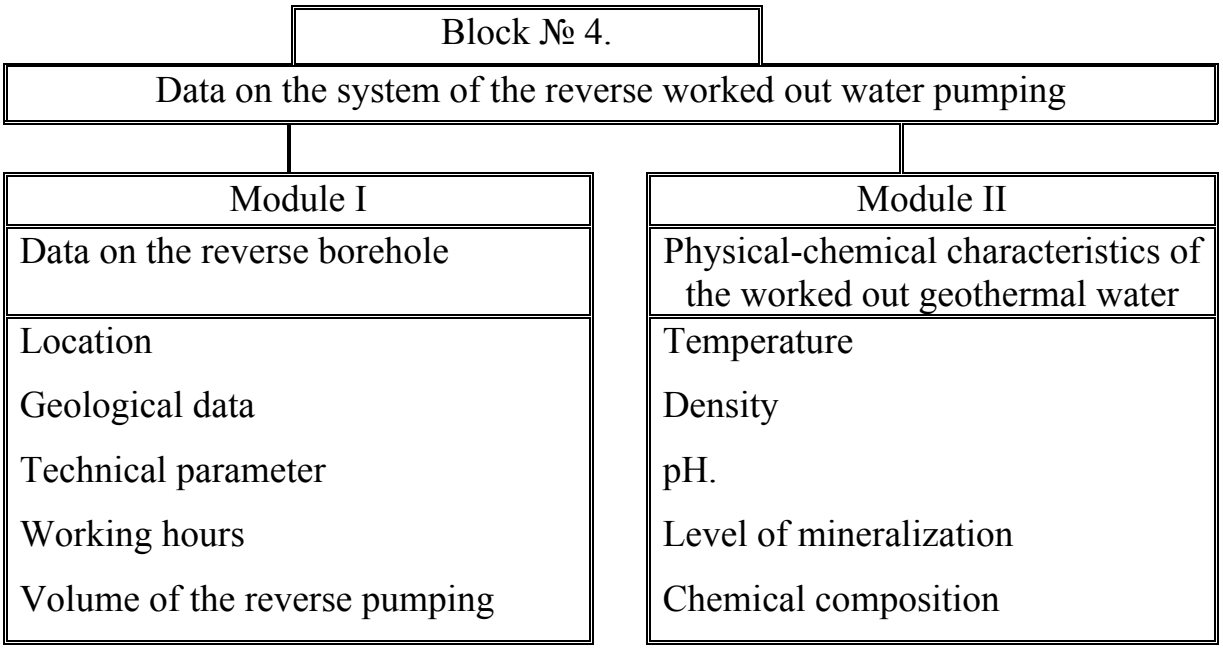


Pic. 3. General scheme of the factors and parameters system of the № 2 block source database.

Informational block named “Flow research data“ contains physic-chemical analysis of the geothermal water results, realized on the different stages of the source exploitation to figure out the level of reproducibility of the results, temporary stability of the composition and presences of dynamic variation of if (as a example seasonal fluctuation) (pic.4). General scheme of the gradual research data of block № 3 - physic-chemical characteristics of the thermal water similar to the given on the pic.3.

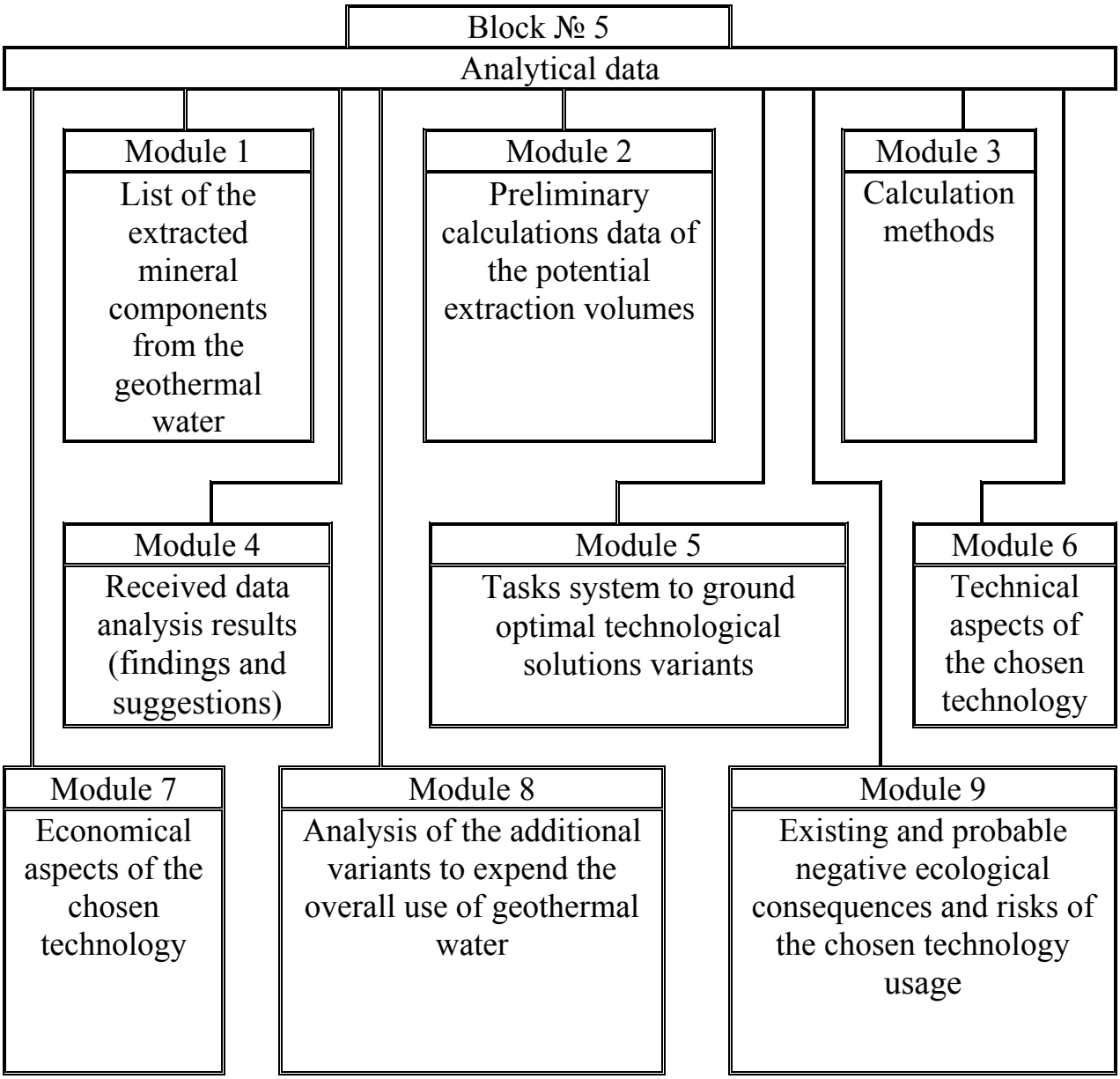
Full information on the boreholes, planed for the reverse pumping of water first of all needed for the technical and economic ground for the general project part, concerning the whole system of the carrier return. Besides it is important for the

potential development of this plan in much remote perspective, because when calculated resources of geothermal sources will exhaust the created infrastructure, even if modified to a installation with less temperature characteristics, could be used to extract valuable chemical elements. Modern mathematical modelling methods allow us forecast the dynamics changes of heat energetic deep geothermal field's characteristics on a long-term exploitation period of the system with the reverse pumping of the cooled carrier. Processes connected to the parallel changes of the chemical composition of the geothermal water were not research that is why informational block #4 is included into the general structure of the database. Its content is looked upon in a perspective of the technical-economical ground for the long-term projects.



Pic. 4. General scheme, system of factors and parameters of the source database block № 4.

Analytical information including calculation results, general and phased ground of the definite element extraction technology chose taking into account the energy usage required by the geothermal carrier is placed in a separate ninth block according to the order of inquire and usage of these data. Accordingly information system can define not only the composition and content of the separate module but the sequence of fulfillment of the different type modules (technical, technological, economical, ecological), and interconnected and interdependent cycles of calculation and analysis. Analytic information complex holds data of preliminary planning process and statement of the tasks for its fulfilment, determination of its place in a hole structure of the geothermal installation, development results of technical, technological, ecological aspects, appropriate technology and determination of the possible additional except for two certain variants of using geothermal water resources.



Pic. 5. General scheme, system of factors and parameters of the source database block № 5.

Developing industrial technology of geothermal waters mineral components production in Ukraine is defined by the resource deposits and by corresponding technological developments. The main resources of ion- bromine waters are at the Carpathian, Donetzk regions and Crimea. In the inner zone of the Precarpathian sagging and pleated Carpathian ion- bromine waters time for sediment of chalk, polygene and neogen, while the bromine is at 300-600 mg/dm^3, iodine – 30-115 mg/dm^3. Within the limits of central Donetzk fold was found a relatively high concentration of a metal and germanium exciding minimal economical production worthy works: lanthanum (1,97 mg/dm^3), lithium (21 mg/dm^3), germanium (0,35 mg/dm^3).

Current scientific-technological and production potential of Ukraine allows us to create a range of facilities for thermal waters resources exploitation. A membrane technology is developed directed on the creation of an experimental facility to concentrate and extract a number of elements and their mixture (halogens, alkaline

and rare metals) out of mineralized geothermal waters. The new in it are the methods of the low energy solution concentration and highly selective sorption of the components. In the base of the technology lies a method of membrane distillation. The regularity of the membrane distillation process over the solutions that caring vanishing components (iodine, bromine) along with their critical concentrations and other physic-chemical parameters of the system was determined. The Methods were developed for selective separation alkaline ions and heavy metals out of the dense compositions with help of natural inorganic sorbents (silicate and zeolites), microorganisms and ions of the synthetic and natural origin. The use of the sorbents will allow us to extract elements separately from the other with their minimal loss. The technology of closed cycle was designed and a test facility constructed to desalinizaed the mineral waters and to extract such a components as iodine, bromine, lithium, rubidium, caesium, copper, nickel, cobalt and other from the concentrated technological solutions. The use of the membrane distillation method allows a high level of water refinement, concentrating inorganic electrolyte to the level when necessary materials can be extracted. Developed technologies and equipment is reasonable to use in the production of iodine, bromine, seawater desalinize stations, brine conversion factories, geothermal plants.

Literature:

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