# PECULIARITIES AND GEOCHEMISTRY OF FLUIDS FIELD OF MEMPHIS REGION (EGYPT)

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An application of geophysical and geochemical methods for investigated archaeological objects considerably extends a range of tasks. It allows delineating locations of buried archaeological objects and extending possibilities of definition of time intervals of last geological epoch, etc.

Study of various geological structures with gas-geochemical methods is based on received in last years details of time variations of concentration of molecular hydrogen in atmosphere of soils and subsoils and on character of its ingress in ground troposphere for various geostructural zones of the Earth. The investigations carried out have allowed finding out a number of offbeat features of a field of fluids in investigated territory including shielding of a stream of hydrogen with a layer at depth of 1-2 m which contains increased concentration of fine-dispersed iron oxides. The research was carried out at the left-bank part of valley of Nile approximately within three 3 km of Sakkara pyramids in the territory of a prospective arrangement of Memphis, the capital of the ancient kingdom of Egypt. Ruins of a palace of Apriy, last pre-Roman Pharaoh, are located here as well. Archeological excavations are carried out at the territory. Seismic and gas analysis were made.

PROBLEM STATEMENT

Gas analysis is effective in a buried cultural layer where domestic, technological and other objects are probably located in which chemical processes with emission of abnormal concentration of hydrogen and its isotopes proceed. The information on zones of abnormal emission of hydric gases' concentrations and their areal distribution would allow defining an approximate area of a human economic and cultural life activity.

Besides, as research in Dahshur (the Red pyramid) has shown, the zone of Memphis was very possibly exposed to powerful influence of a gas-dust stream containing iron and its derivatives [1]

Data of this research are to be correlated with results of other geophysical methods. The applied method answer purposes of scientific novelty, low cost with autonomy, small dimensions of used equipment and satisfactory informativity of data received.

ELEMENTS OF GAS-GEOCHEMICAL SURVEY

An ability of gas, in particular, hydrogen fields, to spatially allocate zones of the raised permeability in the form of the localized anomalies is a physical basis of geochemical investigations. [1]

A role of deep hydrogen is theoretically represented as subvertical migration of the molecular hydrogen formed as a result of interaction of $H_2O$ and C at high temperature and highpressure in the main reactions as follows:

$$C\ (graphite) + H_2O\ (gas) \rightarrow CO\ (gas) + H_2\ (gas)$$
$$C\ (graphite) + 2H_2O\ (gas) \rightarrow CO_2\ (gas) + 2H_2\ (gas),$$

And equilibrium shift in this or that party depends on many reasons: concentration $H_2O$ and C, temperatures, pressure, catalytical actions of rocks and minerals etc. In accordance with these theoretical preconditions and models of an origin of deep hydrogen, a model of subvertical migration of a stream of natural gases from places of their generation to a day surface is the most theoretically based. Geochemical researches of last decades have revealed in deep streams gases ($CO_2$, $CH_4$, $H_2$, He, etc.). [2, 3]

Existential heterogeneities of anomalies of natural gas fields have correlation with a tectonic structure and a geodynamic mode of bowels. [4]. Space-time heterogeneities of anomalies of natural gas fields have correlation with a tectonic structure and a geodynamic mode of interior. [4]. Character of change of a intense-deformed condition of a rock mass, fluid conductive channels in a geological environment, abnormal inclusions of a natural and artificial origin can have an influence on fluctuations of gas fields and on dynamics of their emission on a terrestrial surface.

PROCEDURE OF GAS-ANALYTICAL RESEARCH

Property of gas-geochemical fields to spatially allocate zones of the localized anomalies as well as physical and chemical features and hydrogen and other components of a deep origin is a basis of this exploration tool. When field operations with hydrogen survey the depth of gas sampling was (0.8-1.0)

m. Definition of concentration of hydrogen in gas test in one point takes 3-7 minutes on the average. The step between points of sampling is chosen in accordance with results of geophysical reconnaissance and reaches from ten to hundred meters depending on aims and linear sizes of geological structures.

Concentration of molecular hydrogen is defined by a hydrogen sensor made on the basis of film technology ("metal-dielectric-semiconductor" structure). Sensitivity of the device at level clarke content of molecular hydrogen in ground atmosphere: $(0.5 \div 1.0) \times 10^{-40}$ volume % (0.5÷1.0 ppm):

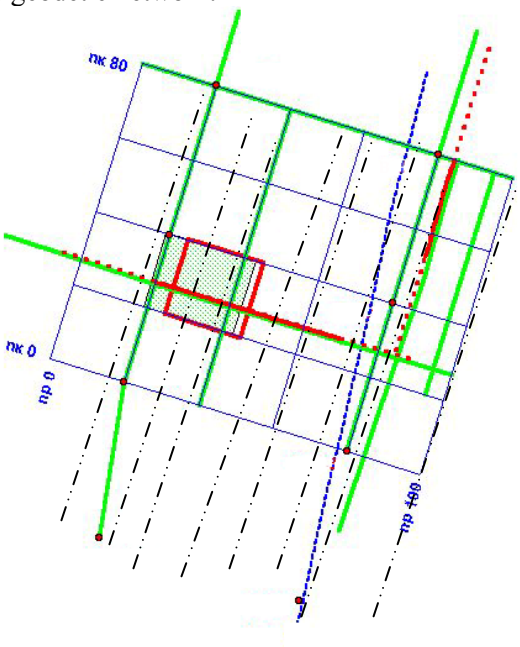
1. Measurement range of the volume content of hydrogen in air 0.000001÷0.1 volume %;
2. Limiting sensitivity 0.000001 volume %;
3. Limits of the permissible resulted basic error at measurement of the volume content of molecular hydrogen 20 volume %.

SURVEY TECHNIQUE

Subsoil hydrogen survey is carried out in the setting of stable condition of unconsolidated sediments. Dislocated subsoils and, as consequence, the raised gas exchange with ground atmosphere deform true structure gas-geochemical fields. Zones of possible technogenic influence are excluded. Sensitivity of a sensor allows measuring concentration of molecular hydrogen in natural bedding of rocks, in atmosphere of underground constructions, etc. Sampling is performed with a titanic needle about 1 meter long. Ground is perforated for sampler installation. Samples of subsoil atmospheres are entered into the working chamber of the hydrogen sensor by means of the portable vacuum pump through a system of hoses from a sampler with filter use. When carrying out a hydrogen survey readout of indications consists in difference definition between primary value of the digital indicator at the moment of sample's capture and its maximum value after an injection in the system of the investigated sample of the subsoil gas. Time of measurements is about 2-5 minutes. On completing of measurements system is pumped over by atmospheric air. The technique of such a complex subsoil radon method allows to define concentration of molecular hydrogen directly in a point of sampling. Due to this both repeated measurements and detailed study of abnormal regions during the field radon method itself are possible.

SOME DATA OF THE PREVIOUS GEOPHYSICAL RESEARCHES

The complex of electromagnetic techniques consisting of electrometric and georadar sounding and measurements of intensity of a magnetic field has been carried out previous years (2001-2003) in investigated territory in an area 100 meters by 80. All the electromagnetic measurements were made using a high-precision satellite geodetic network.




Symbols:

Profiles of hydrogen survey
The area of georadar sounding
The area of electromagnetic measurements

**Fig.1.** The scheme of carrying out a complex of geophysical works

- Magnetic measurements

Isolines of intensity of a magnetic field $\Delta T_a$ on the site have given a good correlation with forms and differences of heights (nearby 3 m), determined by geodetic measurements by means of satellite system. The average value of a magnetic susceptibility is $3x10^{-3}$ of SI unit with unique anomaly in the Northwest part of the works site at a place where the congestion of slags from possible metallurgical manufacture was revealed at small depth. (fig. 2)

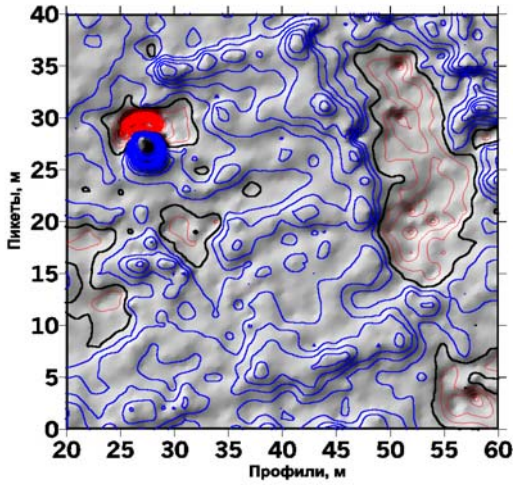



**Fig.2.** A fragment of geomagnetic survey

- Electric sounding

Methods of electric sounding have given the chance to dismember NSC (near-surface section) on several layers allocated in electric field. The upper layer has capacity of 0.8 m and resistance 100 Ohm. The second and third layers represent elements of a gradient geoelectric section in which resistance is gradually falling from 11 to 2.5 Ohm at interval of depths 0.8-5.3 m. On depth of 12.5 m a high-conductivity layer with resistance 2.5 Ohm was found. A layer with resistance 2.5 Ohm and a layer with resistance 4.2 Ohm are located lower. (fig. 3, 4).

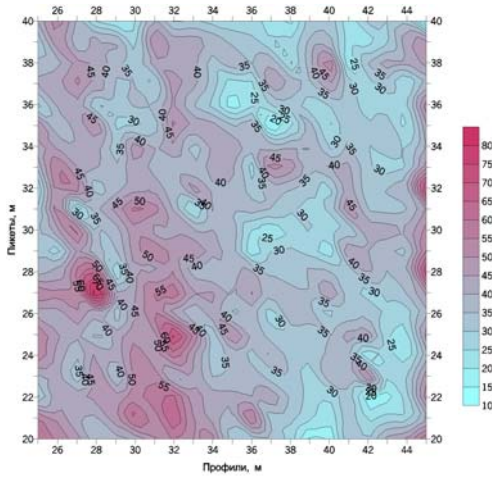



**Fig.3.** Card of electric resistance on sounding

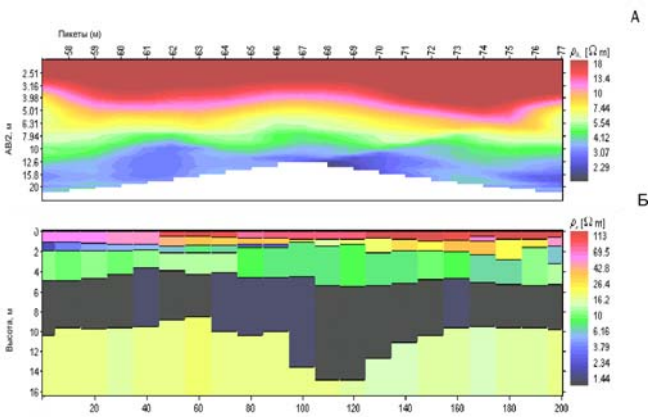



**Fig.4.** Vertical electric sounding by a profile - A
Geoelectric section by results of sounding – B

- Ground penetrating radar

The ground-penetrating radar sounding carried out by means of the «Zond-12» georadar allowed to define with acceptable accuracy two weakly expressed borders at depths of 3-5 m without localization of inhomogeneities expressed in an obvious form (**f**ig. 5).

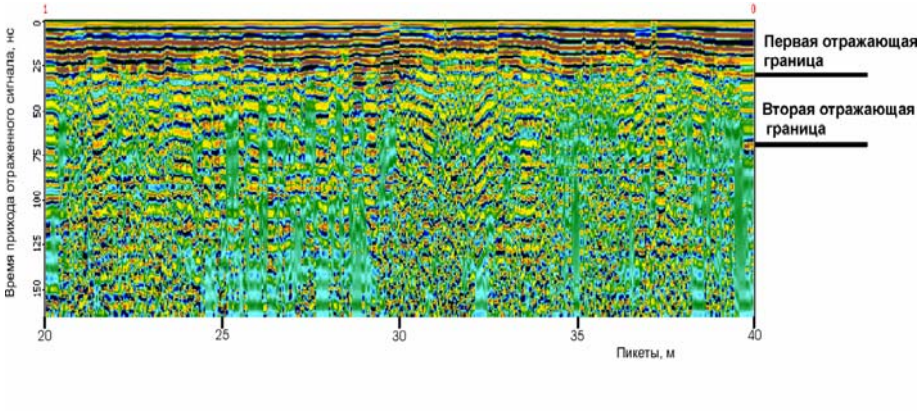



**Fig.5.** Result of georadar shooting by a profile

GEOLOGICAL STRUCTURE OF THE INVESTIGATED TERRITORY

The territory of researches is in limits of Nile's upper floodplain Nile and represents a dilapidated above flood-plain accumulative terrace. Its the most raised sites exceed level of Nile by 8-9 meters, and to the West from a site outliers of this terrace tower over Nile by 12 meters. All the territory is combined by brownish-grey alluvial loams ("Nile silt"). Visible thickness of the silt does not exceed 14-15 meters. The silt's thickness has a weak-layered structure, it is sated by a considerable quantity of ceramics. Fragments of limestones and other rocks (diabases, rhyolites, sandstones), and also a rolled pebble of ferrugnized quartz also are often marked in it. Often fragments of limestones have a deplanate shape and form low-power (10-20 cm) prolayers in the silt. Thickness of the silt is blocked by aeolian loess fine-grained yellowish-grey sand. Thickness of alluvial sand on the site of works is 40-50 m. Quarternary deposits at the territory are spread with calciferous rocks. The regional section according to Geological service of Egypt, passing through a site is presented on fig. 6

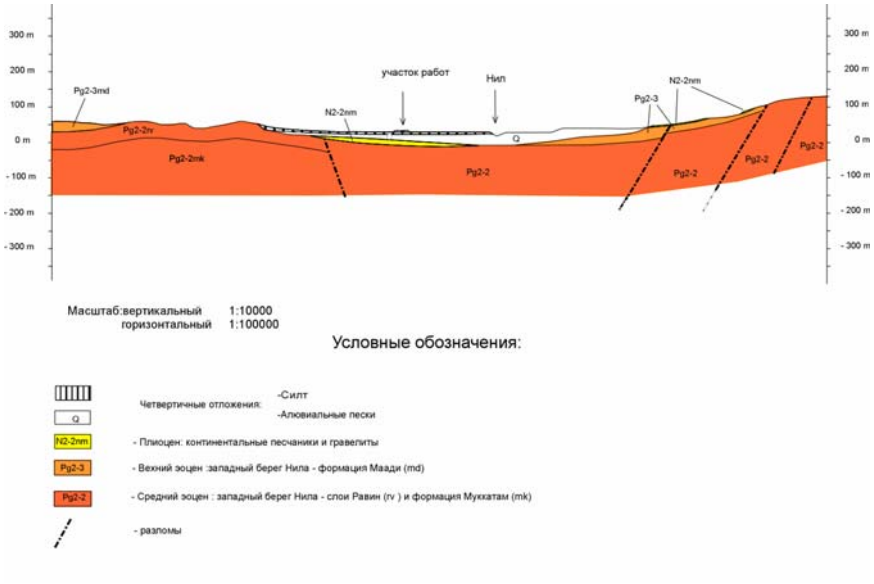


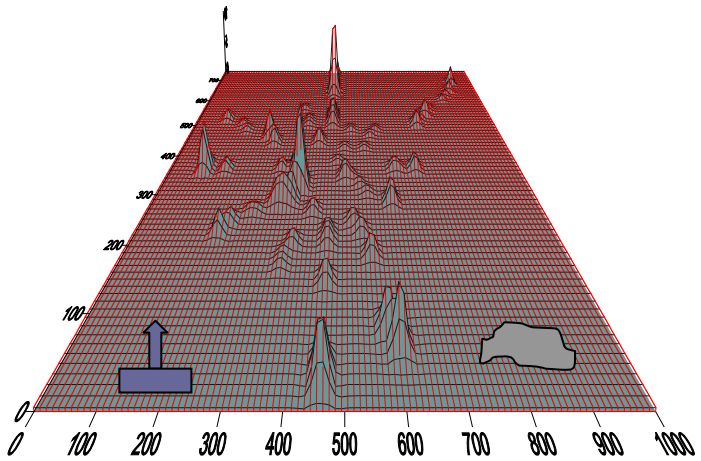

**Fig.6.** Geological section of the region of works

RESULTS OF HYDROGEN SURVEY

Taking into account the previous works hydrogen survey has been focused and fixed to known height networks. Stationary reference point XXI has been accepted as the initial one. Reconnaissance exploration was carried out at a site of the most intensive archeological excavations in this network 100 x 100 m in area. The results of the measurements were unexpected being within the range from the lowest concentration of measured values of a hydrogen field to their full absence. For an explanation of this fact it was decided to carry out trial measurements over some distance from a zone of researches, in vicinities of Sakkara pyramid over a distance of 4-5 km from the place of

archeological excavations. From the geological point of view conditions for the hydrogen survey in the given district also were rather unsatisfactory, but measurements have found out an occurrence of a weak natural background of a hydrogen field. Further the technique of gas-analytical measurements was added with azimuthal profiles, distances between sampling points was reduced up to 10 m. The result of the areal and azimuthal survey of values of a hydrogen field is presented in fig. 7. The maximum values of the measured values make 24 ppм., minimum 10-12 ppм. in the territory of Memphis.

1. For example, for the central Russia average background values of subsoils hydrogen are about 30-40 ppм. Now the central areas of Russian platform, Kaluga, Tambov Voronezh areas where in places of a disposition of ring geological structures values of subsoil hydrogen reach 1000 ppм are the most studied. Background values subsoil hydrogen in areas of Moscow syneclise are within the range of 30-50 ppм. In fault zones of seismically active regions (Dagestan, Stavropol) measured values of subsoil hydrogen (data of 1998 – 2002) reached values 200-400 ppм with increase during the periods of dump of seismic energy in nearby focal zones.

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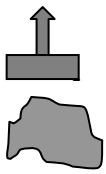

Location of the registration mark XXI

Ruins of a palace of Apriy the Pharaoh

**Fig. 7.** Distribution of fluctuations of a hydrogen field

2. The area of excavation of Memphis is close to the main African fault, now there is a steady growth of seismicity of all region. So a hydrogen stream of Memphis area is abnormal low and starts to increase poorly with removal from the zone of the researches. As these observations are in contradiction with real geophysical processes it is logical to assume an existence of an underground screen or a hydrogen absorber. Earlier it was revealed abnormal high absorption of electromagnetic emission of a georadar at a depth of 1.5-3m here, that was referred to an aquiferous layer. However, there are no aquiferous layers at these depths around excavation and electromagnetic emission is absorbed with the same intensity. For an explanation of this paradox let us refer to data of the newest researches of the Red pyramid located in 15 km from a place of excavation. [ ] It is shown, that the zone of the Red pyramid was exposed to influence of powerful gas-dust streams in 15 and 5 century B.C. twice. In addition the dust contains component $F_2O_3$ (to 47 %), and iron oxides, as is known, perfectly shield electromagnetic emission and absorb hydrogen due to restoration reactions. Thereby hydrogen survey allowed to reveal a layer of subsoil at the depth of 1.5-3 m, enriched with a space dust (in history known as “Egyptian Darkness”). Check boring at the depth of 1.5-3 m is completely in agreement with these conclusions.

3. Conclusions: Hydrogen survey has revealed remains of the space accident shocked Egypt in 5 century B.C.

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