GeoDetect-NMR

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Remote diagnostics and sensing of the Earth (RDSE, obtained analogue high-resolution analogue photography in the infrared spectrum by NASA - The National Aeronautics and Space Administration, US) with Nuclear Magnetic Resonance (NMR, derived from the Laboratory of Institute Geophysics and Problems of the Earth Ltd., Kyiv - IGPE) technology[1-4]- GeoDetect NMR. The technology is developed and patented in Ukraine, and approved by the National Academy of Sciences of Ukraine [5-9].

In this project for the first time will be demonstrated an updated routine for the process of exploration (Fig. 1a, b).

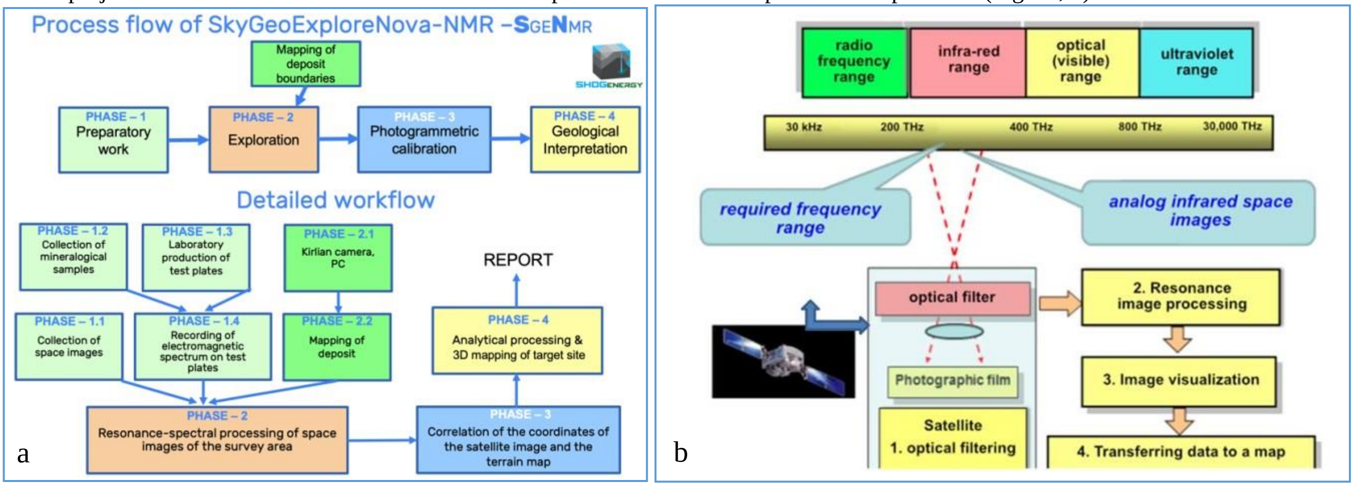

Figure 1 (a) Four main phases of GeoDetect NMR technology; (b) The frequency range used for analogue space images and a short overview of process flow for GeoDetect NMR.

Phase 1. The preparatory work phase consists of four sub-phases: a collection of (1.1) space images, (1.2) mineralogical samples; (1.3) laboratory production of test gel plates; (1.4) recording or transfer of the electromagnetic spectrum of the required substances to test plates.

1.1 Satellite images of the studied area are ordered in NASA and collected in the high-resolution analogue form made in the infrared spectrum (200-400 THz, fig. 1b). To avoid noise generated by the sun, only NASA night-time satellite images are applied.

1.2 All minerals and elements of the periodic table have their own individual passive heating radiation. The differences in wavelengths and radiation intensities are used to study the properties of a remote object. All combinations and compositions of the elements in the world are available in the database of the laboratory of IGPE. To improve the accuracy of measurements the rock sample could be collected from the explored reservoir.

1.3 The test plate with the chemical composition of the collected reference sample decoded into its own spectrum for maximum temperature detection is produced using vacuum sputtering of helium and reference minerals. It is used as a base layer for comparison with the data from NASA images (Fig. 2a, b).

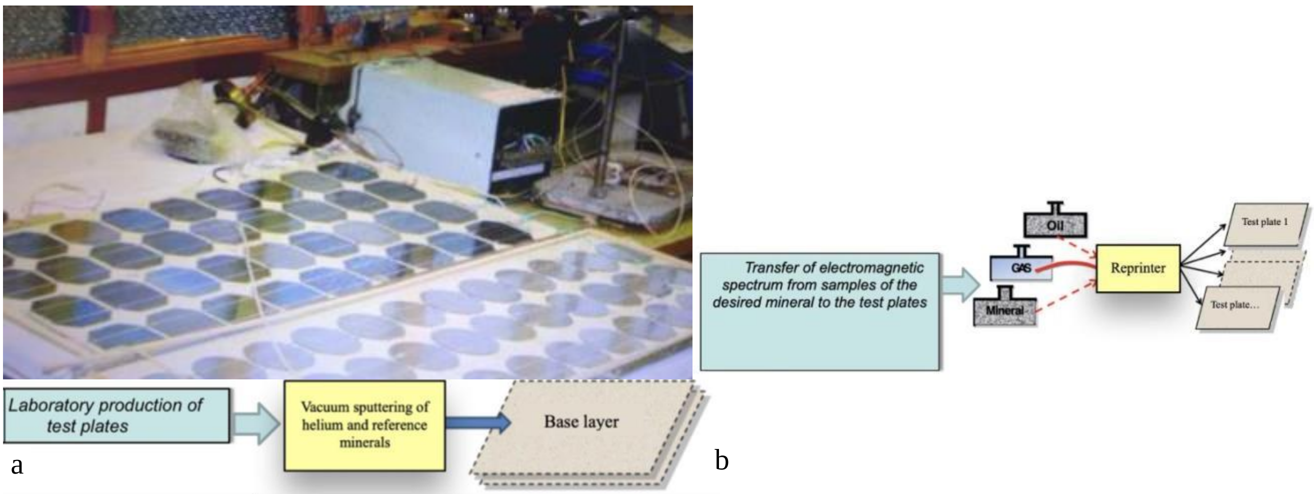

Figure 2 (a) Production of test plates for recording spectra of substances in the laboratory of IGPE; (b) Description of the workflow of the recording of the electromagnetic spectrum on test plates.

1.4 The Earth's magnetic field is used as the source of a constant magnetic field to create NMR conditions in the molecules of target fluids and minerals at depths of up to 5 km. The spectrum of resonance absorption signal of each of the target materials is pre-recorded on the test plates, which are used as a resonator in the radiation-chemical processing of analogue satellite images of the target area in the infrared band. The advantage of using such plates is that the absorption spectra of any minerals, consisting of different molecules may be transferred to them. Test plates are further used for transmitter modulation during the survey of the corresponding mineral [3-9] Fig. 2b.
The following equipment is used in **GeoDetect NMR** technology: spectrometric complex "UMF-2000", equipment for electron paramagnetic resonance, chemical processing of analogue space image negatives, stationary identification system "Spektr" for decoding resonance spectra of searched-for substances, a device for scanning and recording electromagnetic spectra from samples of minerals. The equipment used in this phase is made under custom specifications, and integrated by different modules. For reproducing the spectrum, French analogue technology is

applied. The main idea is to record, memorize, differentiate and reproduce the received spectrum signal we receive. This equipment obtains spectrum signals under different irradiations and prints them on test plates. The laser beam shoots the element, producing the spectra, filtering, recording pure signal and reproducing on the test plate.

<u>Phase 2.</u> Exploration. The exploration phase consists of two sub-phases integrated into the main resonance-spectral processing of space images of the survey area (NMR) process: (2.1) Kirlian camera and (2.2) Mapping of the deposit. 2.1 To reprint the space image data to the plates a special software (called Kirlian camera, Fig. 3a) for visualization of deposit boundaries in a high-voltage pulse field and sub-phase resonance-spectral processing of space images of the survey area (NMR) - "sandwich container processing" is applied (Fig. 3b). During this phase a unique special X-ray film will be done in coordinates of the space image to transfer deposits to the map (transformation-visualization).

2.2 In this step we receive a clear image of the deposits in the limits of the ordered coordinates (Fig. 3a).

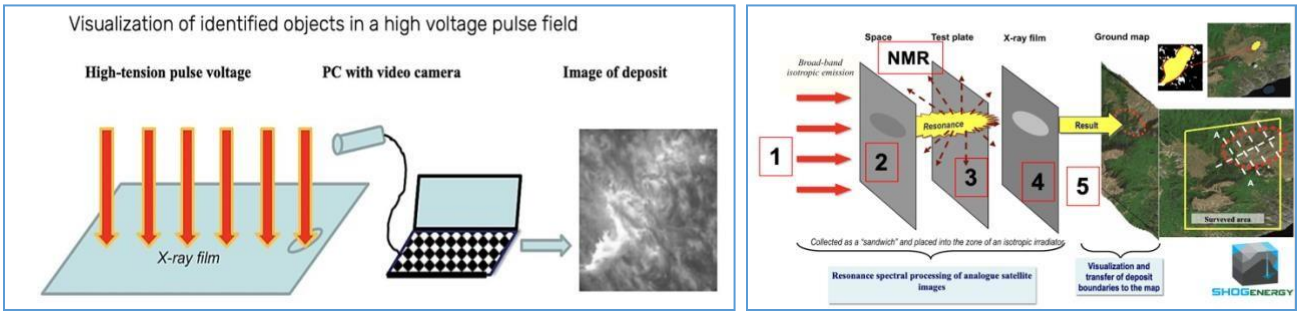

Figure 3 (a,b). (a) Description of the workflow of the Kirlian camera and visualization of deposit boundaries; (b) Resonance-spectral processing of space images of the survey area, Nuclear Magnetic Resonance (NMR) phenomenon.

Resonance-spectral processing of space images of the survey area (NMR) in the presence of the test plates is shown in Figure 3b. A deposit survey is carried out with the help of the method of point-wise measurements along the deposit's contour as well as along its sections[3]. The routine is irradiation of the "Sandwich" by α, β & γ rays in the laboratory. The "Sandwich" consists of an analogue image, and a test plate with all searched elements. Chemical composition is decoded into a spectrum. X-ray film is done in coordinates of the image to transfer deposits to the map for transformation-visualization (Phase 2.1-2.2). At the point of coincidences of the signal spectrum from the test plate and space image, we see deposits on the X-ray plate. During irradiation of the "sandwich container", between steps n. 1 and 3 (Fig 3b) the NMR phenomenon is conducted. The result we see on the X-ray film (4). After that, the result is transferred to the map (Fig. 3b, step 5).

<u>Phase 3.</u> Photogrammetric calibration. This phase is a correlation between the coordinates of the satellite image and the terrain. In this step, the previous sandwich container data is going to be represented over the topographic map.

The procedure for measuring deposit depth using analogue satellite images (Fig. 4): (1) The satellite images of the study area are used, obtained at different location angles α and β from satellites 1 and 2. (2) Point 3 of the ground mapping is obtained in two different positions: "1" for the first satellite and "2" for the second. (3) The coordinates of points 1 and 2 are calculated from different images. (4) The magnitude of the displacement "a" between them on the surface land is determined. (5) In triangle 1-2-3, side "a" and adjacent interior angles α and β are known. The value of h is determined from a system of equations:

$$h = (a - a') \cdot tg\,\alpha,\ h = a' \cdot tg\,\beta \quad (1)$$

Solving this system of equations, we get the formula for calculating depths:

$$h = a \cdot tg\,\alpha \cdot tg\,\beta \,/\, (tg\,\alpha + tg\,\beta) \quad (2)$$

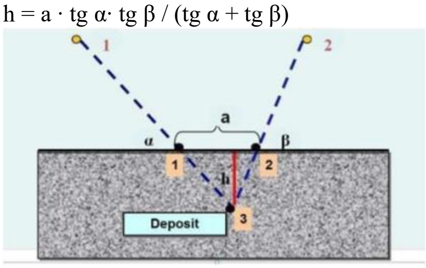

Figure 4. Diagram for measuring the parameters of deposit occurrence.

<u>Phase 4.</u> Geological interpretation. In the final stage, the analytical data processing, 3D mapping and other required for report data interpretation are done. The analysis, conclusion and recommendations are prepared. The obtained results permit the determination of the following important characteristics of the deposit remotely, without drilling exploration wells: the surface contours of the deposit or geothermal reservoir, depths and horizons of the reservoir, the volume of element we are looking for (hydrocarbons, gold, diamonds, rear elements, water, etc.), the volume of water on the horizon, depth and pressure in the horizons, depth sections, sites and points for optimal drilling, reservoir rock porosity, geothermal map and gradient of the studied area, etc. according to the needs of the exploration project.

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