Express Testing of Minerals

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Abstract. A method and a device employed for testing of minerals in the field environment is proposed. The method is based on the use of information-wave technologies. It is an information wave based method comparing human being’s psychosomatic response to an object under test and its information nosode. The information nosode is an electromagnetic signal with pulse-code modulation being formed at the output of the information-wave generator. A non-invasive sensor of human being's blood vessels light penetration ability is offered as a sensor of psychosomatic response. A functional diagram of the device and a description of its operation and finally, the results of minerals testing are given in the article. The advantages and disadvantages of minerals express testing method for usage in the field environment are shown, as well.

1. Introduction
Currently state of the art X-ray fluorescence (XRF) spectrometers designed extra for field research are widely employed for mineral exploration [1].

The XRF method can be used for the chemical analysis of minerals, rocks, ores, metal alloys and others [2]. The XRF method-based analysis has undeniable advantages among other known methods due to its high-precise, fast and non-destructive features and moreover XRF devices are low-weight and a small-sized.

The major disadvantages of the XRF method are the complexity of thin samples provision and strict requirements to the material structure. In addition, mass and dimension specifications of the device intended for employment to the field exploration are not small-sized enough. The top sample weight does not exceed at least 1.5 kg.

The purpose of this study is to develop a new efficient method of rapid minerals test in the field environment.

2. Materials and methods
The information wave test developed by the authors is employed as a method of mineral types identification [3]. It is based on fixation of human body's psychosomatic reactions to the counteraction of electromagnetic pulses, pulse-code modulation and the body's response to the testable object [4]. The four minerals such as quartz, topaz, charoite, damburite are represented in figure 1 as objects under test.
Figure 1. Appearance of minerals.

The information measuring system in figure 2 includes an operator (1), an information wave tester (IWT) (2) and a PDA (3).

![Diagram](image)

**Figure 2.** Experimental information and measurement system: a) functional scheme; b) appearance

The IWT (2) includes a microcontroller (4), an antenna (5), an optical radiator (6), a light sensor (7), and a Bluetooth module (8).

The system operates as follows. The operator (1) supplies power to the IWT (2). The IWT module has a self-contained power supply from the built-in battery. The operator turns on the PDA (3) and Bluetooths the PDA across to the microcontroller (8). The PDA is equipped with a program for controlling the serial Bluetooth interface. The operator enters the name of the testable mineral into the microcontroller (4). The mineral marker is formed when using the PDA keyboard (3). The microcontroller selects a special binary code corresponding to the marker from its memory. This code
is an electronic nosode of the mineral under test. An electromagnetic signal is generated with pulse-code modulation at the output of the antenna (5). This signal encodes information about the mineral under test. The operator inserts a finger of his hand into the opening of the IWT (figure 2, b). The operator's finger (1) is irradiated by a light flux from the radiator (6). The light flux sensor (7) receives the flux when passing through the finger from the other side. The microcontroller detects the voltage from the light sensor. The measurement is repeated at regular intervals until the next value slightly differs from the previous one. It completes the calibration process. A sample of the mineral under test is placed close to or directly on the operator's hand. The operator turns on the measurement mode with his other hand when using the PDA display (3). After a specified period of time, the voltage level at the output of the sensor (7) is repeatedly measured. The microcontroller program compares the voltage levels of the calibration and the measurement voltages.

3. Results
The measurements are carried out in the laboratory by one operator. The operator sets the electronic nosode of the first studied mineral on the PDA display. The first one is a nosode of quartz. Measurements are made for each of the minerals under test (figure 1). Then an electronic nosode is assigned for the next mineral under test. Repeated measurements are made for each of the minerals under test. For each electronic nosode, 10 measurements for each mineral are carried out. The measured data are presented in relative units (r.u.). The measurement error is calculated with a probability $P = 0.01$. The results of experimental testing are presented in table 1.

| Minerals   | Quartz | Topaz | Charoite | Damburite |
|------------|--------|-------|----------|-----------|
| Quartz     | 99±1   | 76±9  | 78±8     | 76±15     |
| Topaz      | 82±18  | 98±1  | 74±14    | 71±7      |
| Charoite   | 75±9   | 76±12 | 99±1     | 78±12     |
| Damburite  | 73±13  | 79±14 | 77±11    | 99±1      |

4. Discussion
The maximum values of the measured data are highlighted in table 1. They are slightly different from 99 r.u. These data indicate the maximum correlation between the mineral and its electronic nosode. The magnitude of the measurement error at the maximum coincidence of the mineral type with its electronic copy does not exceed 2%.

If the electronic nosode does not correspond to the type of mineral under test, the measured data do not exceed 82 r.u. The measurement error can increase by 22%.

The proposed testing method allows to determine the type of mineral without establishing its elemental composition. Such a method can be used as an auxiliary rapid test in the field environment.

The advantage of this test method compared to the XRF method is the lack of necessity for physical preparation of the mineral-based rock. The weight of the experimental IWT is 85 g. The weight of the PDA used in the experiment is 230 g. The total weight of the experimental unit was 315 g. It is as much as 5 times smaller than top spectrometer models employed on the XRF method.

The drawback of the proposed method is that it does not ensure the determination of elements percentage composition in the sample under test. The method detects serious errors when doing single measurements. However, the measurement error can be reduced by improving the sensor of psychosomatic reactions and software.
5. Conclusions
Experimental studies have confirmed the possibility of employing the information-wave method for determining the type of minerals.

The IWT method enhances the development of inexpensive easy-to-use handy devices enhancing the express testing of minerals in the field environment.

6. References
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