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INCREASING THE ACCURACY OF DETECTION OF UNDERGROUND NUCLEAR EXPLOSIONS DURING ON-SITE INSPECTION BASED ON CHANGES IN RESIDUAL MAGNETIZATION

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INTRODUCTION AND MAIN RESULTS

The paper proposes a method for improving the accuracy of detecting underground nuclear explosions during on-site inspections (OSI) by analyzing changes in the residual magnetization of rocks. The physical foundations of the phenomenon, including shock magnetization and the piezomagnetic effect, are considered, key numerical results are presented (typical increases of $\Delta B \approx 2\text{-}10$ NT, duration of anomalies up to 6 months), and measurement methods are proposed:

- ground-based magnetometry;
- geoelectric measurements.

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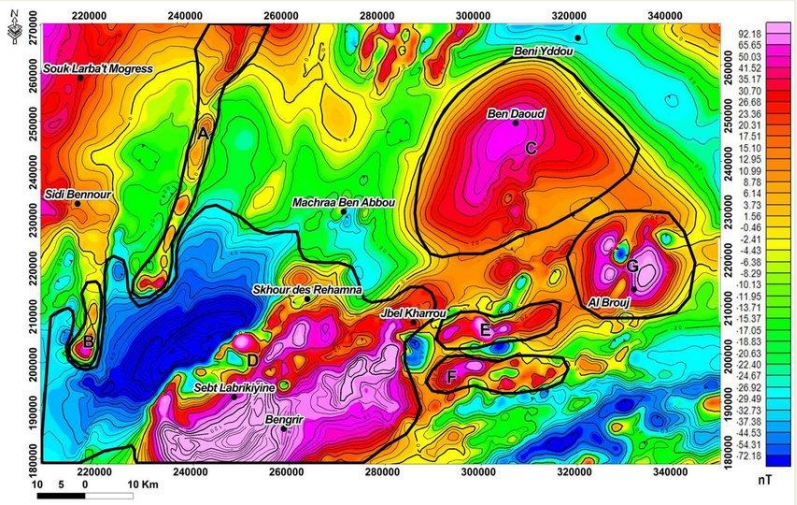
Introduction

In the context of the verification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT), the development of new methods for detecting hidden traces of underground explosions is relevant. Existing monitoring systems provide high detection but require additions for on-site inspections.

The paper proposes an approach based on the analysis of the residual magnetization of rocks resulting from deformations during an underground explosion. Changes in the local geomagnetic field, which persist for up to several months, are proposed to be used as an indicator to improve the accuracy of inspections.



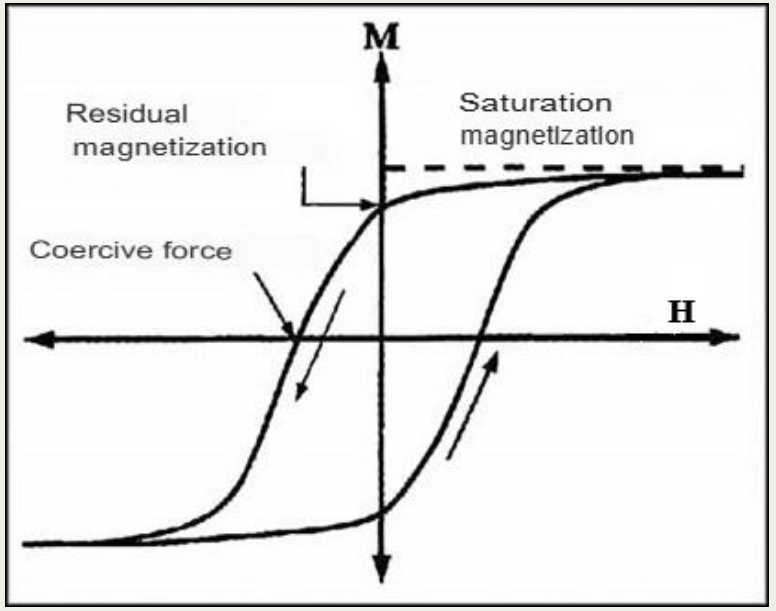
Residual magnetic field map at the Moroccan Western Meseta

Residual magnetization

Residual magnetization is a vector physical quantity that characterizes the magnetic state of a macroscopic physical body. After "removing" an external field (for example, a geomagnetic field), part of the orientation of the magnetic fields remains in the substance. In the presence of strong mechanical influences (shock waves), the rock structure can change the orientation of the magnetic grains and the coercive force, which leads to a redistribution of the residual magnetization. As a result, additional magnetic fields may occur in the subsurface volume, which are detected by magnetometers. This magnetization persists for a long time (days or months), which allows it to be used as an explosion indicator when examining an area. Having a map of the magnetization of the landfill territory, it can be assumed that tests could be carried out on the territory. As an example, the map of the magnetization of the Moroccan Western Meseta territory is given.

Conclusion

Residual magnetization is a promising marker of underground nuclear tests caused by irreversible rock changes. Anomalies (ΔB ≈ 2-10 NT) persist for up to several months. The method complements on-site monitoring, increasing the reliability of the CTBT verification due to the duration of the effect.



Ferromagnetic hysteresis loop

MEPhI