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PHASE METHODS FOR SEARCHING AND IDENTIFYING OF HYDROCARBON DEPOSITS IN THE MODE OF AMPLITUDE-MODULATED SIGNALS

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Abstract

The article examines phase methods of search and identification of hydrocarbon depositsin the mode of amplitude-modulated signals. Analysis of constituent components of surface impedance of media over hydrocarbon for electromagnetic waves with right-hand and left-hand circular polarization depending on signal-carrier frequency is performed. It has been found out that the phase characteristics of the surface impedance can be used to diagnose media. The obtained research results can be used in exploratory geophysics to improve the accuracy of defining boundaries of the deposits.

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The components of the tensor dielectric permittivity for the two-particle fluxare determined as follows

$$\begin{cases} \dot{\varepsilon}_1 = \varepsilon_r + \sum_{i=1}^{2} \left\{ \omega_{\Pi i}^2 \dfrac{\omega_{\Gamma i}^2 - \omega^2 - {\nu_i}^2}{({\nu_i}^2 + \omega_{\Gamma i}^2 - \omega^2)^2 + 4\omega^2 {\nu_i}^2} + j \left[\dfrac{\varepsilon_r k_m \Omega \sin \Omega t}{\omega(1 + k_m \cos \Omega t)} - \dfrac{\sigma_r}{\omega \varepsilon_0} - \right. \right. \\ \left. \left. - \dfrac{\omega_{\Pi i}^2 \nu_i}{\omega} \dfrac{\omega^2 + {\nu_i}^2 + \omega_{\Gamma i}^2}{({\nu_i}^2 + \omega_{\Gamma i}^2 - \omega^2)^2 + 4\omega^2 {\nu_i}^2} \right] \right\}; \\ \dot{\varepsilon}_2 = \sum_{i=1}^{2} \left\{ \dfrac{\omega_{\Pi i}^2 \omega_{\Gamma i}}{\omega} \dfrac{\omega_{\Gamma i}^2 - \omega^2 + {\nu_i}^2}{({\nu_i}^2 + \omega_{\Gamma i}^2 - \omega^2)^2 + 4\omega^2 {\nu_i}^2} - \dfrac{2j\nu_i \omega_{\Pi i}^2 \omega_{\Gamma i}}{({\nu_i}^2 + \omega_{\Gamma i}^2 - \omega^2)^2 + 4\omega^2 {\nu_i}^2} \right\}; \\ \dot{\varepsilon}_3 = \varepsilon_r + \sum_{i=1}^{2} \left\{ \omega_{\Pi i}^2 \dfrac{1}{{\nu_i}^2 + \omega^2} + j \left[\dfrac{\varepsilon_r k_m \Omega \sin \Omega t}{\omega(1 + k_m \cos \Omega t)} - \dfrac{\sigma_r}{\omega \varepsilon_0} - \dfrac{\omega_{\Pi i}^2 \nu_i}{\omega} \dfrac{1}{\omega^2 + {\nu_i}^2} \right] \right\}. \end{cases}$$

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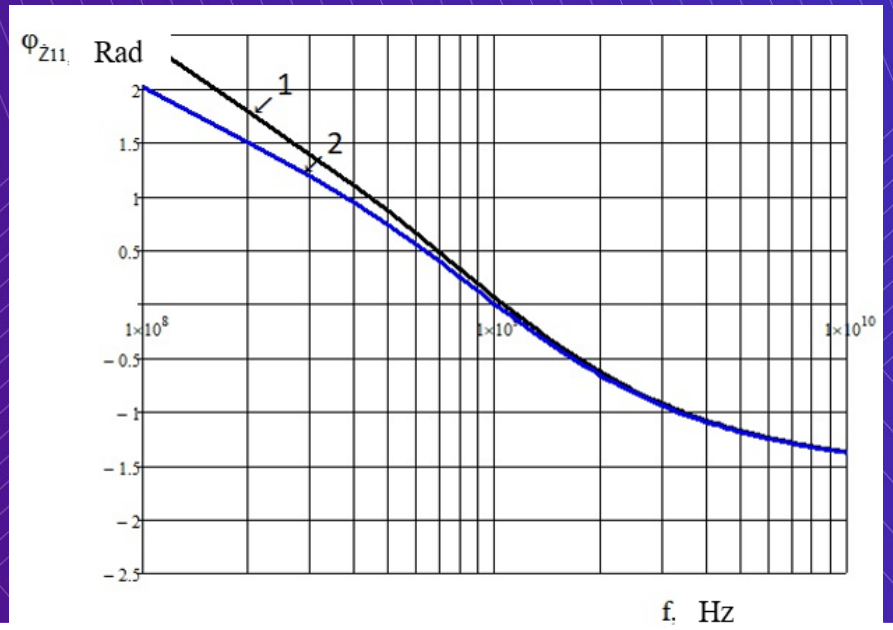

Figure 1. Dependence of the phase component of the surface impedance $\dot{Z}_{11}$:

1 – for $k_m = 0.2$, $\varepsilon_r = 10$, $F = 10^7$ Hz, $\sigma_r = 10^{-3}$S/m;

2 – for $k_m = 0.9$, $\varepsilon_r = 10$, $F = 5 \cdot 10^7$ Hz, $\sigma_r = 10^{-3}$S/m.

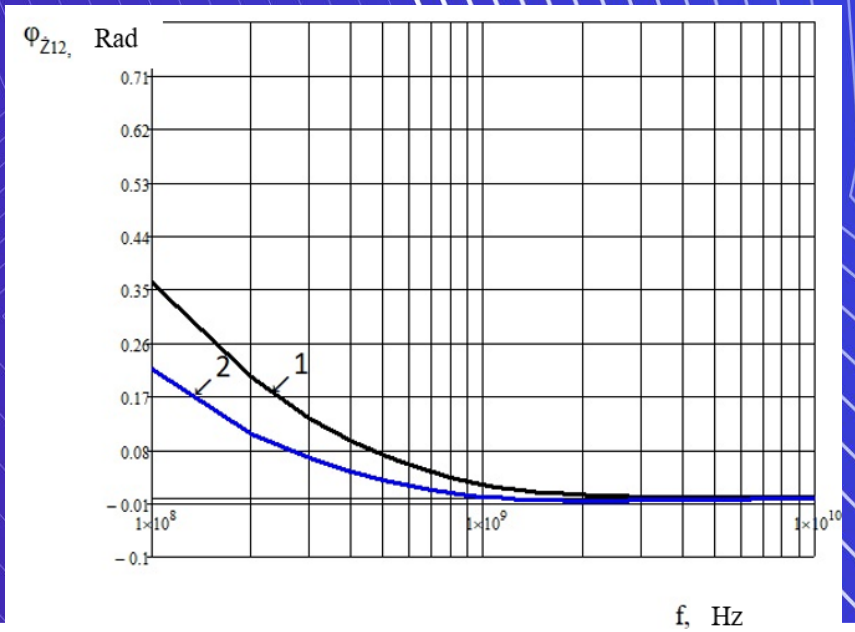

Figure 2. Dependence of the phase component of the surface impedance $\dot{Z}_{12}$:

1 – for $k_m = 0.2$, $\varepsilon_r = 10$, $F = 10^7$ Hz, $\sigma_r = 10^{-3}$ S/m;

2 – for $k_m = 0.9$, $\varepsilon_r = 10$, $F = 5 \cdot 10^7$ Hz, $\sigma_r = 10^{-3}$ S/m.

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Conclusion

The research results are the following:

A method of search and identification of hydrocarbon deposits has been developed, it can be implemented at carrier frequencies of 0.1... 1 GHz using a modulation frequency F= 10... 100 MHz with AM coefficients in the range of 0.2... 0.9;

The resolution of determining deposits location has been improved by measuring two surface impedance components

Higher efficiency of geological exploration has been achieved.