THE ADVANTAGES OF THE NEW PROPOSALS IN THE DIPOLE-DIPOLE INDUCED POLARIZATION SOUNDING METHOD

Vu Duc Minh

College of Science, VNU

Abstract. The higher resolution, greater investigating depth, increasing reliability of geology forecasting results of the improved dipole-dipole induced polarization sounding method have been illustrated by theoretical and field medium are the advantages of the new proposals presented in this article.

I. Introduction

The new proposals, which have been introduced for data processing in the induced polarization sounding method, have proposed by the author in the article [2], specially the Petrovski induced polarization (IP) parameter η_p; as a result, we have proposed the improved dipole-dipole electrode arrays and the corresponding measurement procedure, the simple algebraic transformations (without the derivation) to apply to the resistively sounding method [1]. Basing on those researches, we also have researched developing to apply to the improved dipole-dipole induced polarization sounding method (IDDIPS) and have been tested effectively as the article [3].

In this article, we will illustrate the correctness and advantages of those new proposals in the IDDIPS by theoretical and practical medium.

II. Basics of the new proposals in the improved dipole-dipole induced polarization sounding method

• Basing on the definition η_k, we have also definite the new IP parameters [2] similarly:

- The polarization of the symmetric Induced Polarization sounding method (ISIPS): η_s
- The polarization of the dipole-axis Induced Polarization sounding method (IDAIPS): η_r.
- The Petrovski polarization: η_p

• The values $\rho_{rT}(r_i), \eta_{rT}(r_i)$ and $\rho_{rF}(r_i), \eta_{rF}(r_i)$ measured in the field by the improved left-side and right-side dipole-axis array corresponding to the sizes of electrode spacing ri. and one of values: $\rho_{rxdT}(r_{\max}), \rho_{rxdF}(r_{\max})$ by the left-side and right-side equatorial dipole array; or $\rho_s(r_{\max})$ by the improved symmetric array, or $\rho_{3c}(r_{\max})$ by the three-electrode array at final size of the improved dipole-axis array [3].

We have:

$$\rho_{s1} = K_{s1}\left(\frac{\rho_{s2}}{K_{s2}} + 2\frac{\rho_r}{K_r}\right) \tag{1}$$

Typeset by $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX where value $\rho_s(r_n)$ measured by the improved symmetric array is equivalent to $\rho_{rxd}(r_n) = (\rho_{rxdT}(r_n) + \rho_{rxdF}(r_n))/2$ measured by corresponding equatorial dipole array, i.e.:

$$\rho_{s2}(r_n) \approx \rho_{rxd}(r_n). \tag{2}$$

We have proved that the process of calculating with repetitive equation (1) from $r_{\max}$ to $r_1 (r_1 < r_{\max})$ is the process of compressing error, increasing correctness to support thę processing and analyzing with the better results.

From these, we obtain the apparent resistively values ρ_{rs} (corresponding to the use of the improved symmetric array) at the point O (the middle of AB) derived from the transformation of the values ρ_r practically measured by the IDAIPS array and one value $\rho_{rsxd}(r_{\max})$ measured by the equatorial dipole array at final size of the IDAIPS array are calculated by the following fomula:

$$\rho_{rs}(r_n) = \rho_{rxd}(r_n) = (\rho_{rxdT}(r_n) + \rho_{rxdF}(r_n))/2. \tag{3}$$

The values of Petrovski resistively sounding curve are calculated using eq.:

$$\rho_{prs} = \rho_{rs}/(2\rho_r/\rho_{rs} - 1). \tag{4}$$

Then all the necessary information will be calculated according to the schema shown on figure 1.

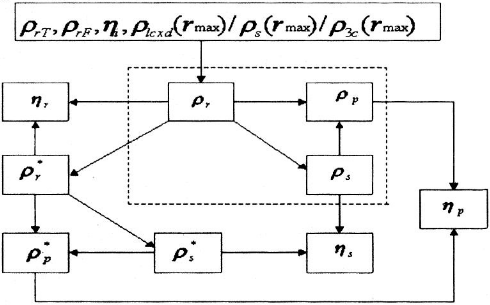

Figure 1. Schema calculating parameters by using IDAIPS array

III. Confirming the correctness and advantages of the new proposals

III.1 Calculating the polarization sounding curves

- *The three-layered geo-electrical model*

By simulation method in PC, we have built the programs of calculating the polarization sounding curves on layered geo-electrical models for different electrode array by Matlab language.

We only give a specific example of the three-layered geo-electrical model as following:

$$\rho_i = [14.51]; \qquad \eta_i = [241]; \qquad h_i = [15]; \quad \text{with} i = 1, 2, 3$$

Figure 2 shows the theoretical ISIPS curve η_s (etas) and the curve corresponding to the ISIPS curve η_{rs} (etars) obtained by transformation.

Figure 3 shows the theoretical Petrovski curve η_{ps} (etaps) and the Petrovski curve η_{prs} (etaprs) obtained by transformation.

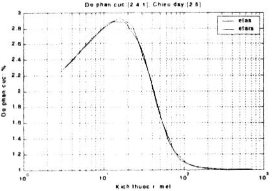

Figure 2. The theoretical curve η_s (etas) and curve η_{rs} (etars) obtained by transformation

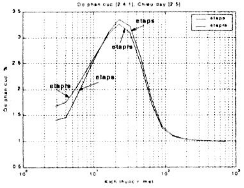

Figure 3. The theoretical curve η_{ps} (etaps) and η_{prs} (etaprs) obtained by transformation

- *The field medium*

The testing calculations have been performed in Tan Dan - Hoanh Bo - Quang Ninh and Daksong - Gia Lai. Below we only present example curves measured at point 22 of the profile S11 in Daksong - Gia Lai.

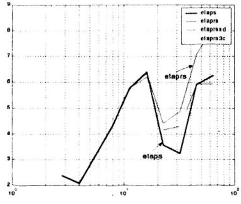

Figure 4. Curves η_{ps} (etaps), η_{prs} (etaps), η_{prsxd} (etaprsxd) and η_{prs3c} (etaprs3c).

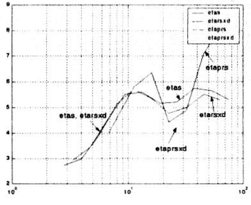

Figure 5. The practical curve η_s (etas); η_{rsxd} (etarsxd) obtained by transformation; η_{prs} (etaprs) and η_{prsxd} (etaprsxd).

Figure 4 shows Petrovski curves η_{ps} (etaps), η_{prs} (etaprs), η_{prsxd} (etaprsxd) and η_{prs3c} (etaprs3c).

Figure 5 shows curve η_s practically measured by the ISIPS array; curves η_{rs} (etars), η_{esxd} (etarsxd) obtained by transformation of the values ρ_r (ror) and η_r (etar) practically measured by IDAIPS array in combination with values $\rho_{lcxd}(r_{\max}), \eta_{lcxd}(r_{\max})$ of measurement by the equatorial dipole array at final size $r_{\max}$ of the IDAIPS array; Petrovski curves η_{prs} (etaprs), η_{prsxd} (etaprsxd).

In comparing, practical measured curves and corresponding curves obtained by transformation are nearly fitted, only the values at some final sizes is not the same. This proves the correctness of the new proposals mentioned above. Besides, Petrovski curve also has reflected clearly resolution ability - that is its advantages.

III.2 Processing document on the profile

We and Union of Physic-Geology have carried out the experimental measurements by the improved dipole- dipole induced polarization sounding method proposed by the author on the profile S11 in Daksong - Gia Lai belong to the project for investigating geologic medium and prospecting ores in Daksong and the profile in Hoanh Bo - Quang Ninh.

Below we present only the results of applying the new proposals to processing documents obtained by the IDDIPS method on the profile S11 in Daksong - Gia Lai.

• *Geological and physical characteristics of the section of profile S11(See figure 6)*

The whole surveyed profile is enclosed in the granite formations of Van Canh complex. The major components are granite-biotite, granosienite, and granosienite-porphyr. Rocks are fractured, strongly destructed and sulphurized.

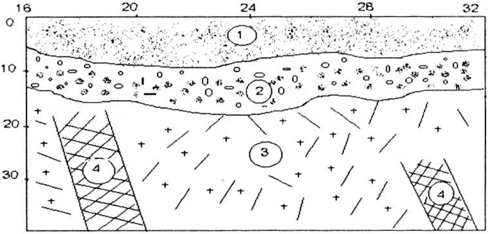

Figure 6. Geological section of the profile S11
(Source: Federation of Physic-Geology)

Their resistivity values are approximately 400 - 600 ohms.m, and the polarization of approximately 4-6%.

In the fractured zones, there are existing sulfuric seams with gold bearing polymetal surphide - quartz zones. Those vents are characterized by high polarization 5 - 8%, resistivity values rather similar to that of fractured and destroyed zones.

The upper part of section is covered by unconsolidated sediments. The major components are sand, clay, pebble and gravel. The thickness is of about 8 - 12 meters.

The task of geophysical works at this area is to define gold bearing polymetal surphide - quartz zones located in magmatic granite formation.

- *The results of applying the improved dipole-dipole induced polarization method*

Contour sections of applying the IDDIPS method have been calculated and reported. Below we only present example Petrovski contour section η_{prsxd} obtained by transformation on figure 7.

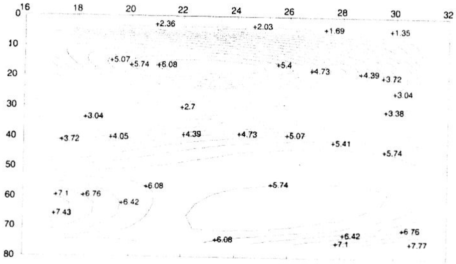

Figure 7. Contour section η_{prsxd} (%)

On the basic of the research results of applying the new proposals in the IDDIPS on the profile S11 in Daksong - Gia Lai can be seen that:

- The covered unconsolidated sediments could be divided into 2 distinct layers different in values of polarization: the upper layer has high polarization 3-6% and the lower one with low polarization 2 - 3.5% and the clear identification of boundary between the covered layer and magmatic granite formation.

- In the fractured granite parent rocks, 2 zone bodies were defined with high polarization at the 2 ends of the observed profile. The first is characterized by one end of the profile situating shallower, where as the second situating deeper in the destructed granite layer. Those two bodies relate to ore body rich in sulfur, which possibly bear gold.

IV. Conclusions

The new proposals have high scientific reliance, really usefulness, scientific and practical significance. They eliminated the fundamental disadvantage that the transformation between curves through the unstable derivation existed for a long time. One of the advantages of our proposals is only using the simple and reliable algebraic formulas to transform curves. Creating algorithms of processing and analyzing the IDDIPS documents using the new proposals basing on selecting reliable information with comprehensiveness. They also have made the geology forecasting results clearer and more reliable, reflected the nearly real IP effect of study objects, increased resolution of weak anomalies. All of those have illustrated the distinguished advantages of the new proposals.

References

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