A NEW APPROACH FOR DOCUMENT PROCESSING IN THE IMPROVED DIPOLE INDUCED POLARIZATION SOUNDING METHOD

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Abstract. *A new approach for data processing in the improved dipole induced polarization sounding method has been introduced in this article proposed by the author. The theorical studies and practical test show the correctness and efficiency of this processing method.*

These obtained results have contributed to the raising the efficiency of applying the induced polarization sounding method to the distinguishing geological objects in depth and the study of structural geology.

1. Introduction

The apparent resistivity ρ_k and the apparent polarization η_k are the conventional parameters that in common have been used for processing and analyzing in the induced polarization (IP) method. As we may know, the apparent polarization is related to the apparent resistivity by the following fomula:

$$\eta_k = \frac{\rho_k^* - \rho_k}{\rho_k^*} \tag{1}$$

where ρ_k^* and ρ_k are the apparent resistivity of the polarized and non- polarized medium, respectively, corresponding to the resistivity parameters ρ_i^* and ρ_i which are related by:

$$\rho_i^* = \frac{\rho_i}{1 - \eta_i} \tag{2}$$

where i is the medium model index.

Petrovski curve ρ_p [3] which has higher investigating depth and resolution, therefore some researchers have been interested in using formulas transforming ρ_k curve into ρ_p curve, however, the transforming contains derivation $\frac{\partial \rho_s(r)}{\partial r}$, so it is not stable [2]; modifying electrode arrays to measure directly ρ_p to overcome the

unstable of the derivation $\frac{\partial \rho_s(r)}{\partial r}$. These arrays and the measurement procedure are still very complicated, so up to now they have not been used in Vietnam. Furthermore, these methods have been applied only to resistivity sounding, but to IP sounding.

One of problems which are put forward is to research and overcome these disadvantages: deriving a simple electrode array but still increasing amount of starting information; simultaneously, with the obtained information, we can apply simply and reliably transformation operator to the curves. This enables us to understand more accurately and the obtained information reflect better geologic objects that has to be approached. Carrying out this idea is our research purpose. In [5], the improved IP sounding methods with using the improved electrode arrays proposed by us are introduced, in which the improved dipole IP sounding method using the improved electrode array (KM-02) consists of:

* The improved dipole-axis induced polarization sounding (IDAIPS) electrode array.

* Perform one additional measurement by equatorial dipole induced polarization sounding (EDIPS) electrode array at final size of IDAIPS electrode array.

This method has been tested and applied effectively in resistivity sounding as reported in [4].

In this article, we only focus on presenting a new approach for document processing in the improved dipole IP sounding method by simple algebraic transformation.

2. A new processing approach to the improved dipole array in the Induced Polarization

The values $\rho_{rT}(r_i)$, $\rho_{rF}(r_i)$ and $\eta_{rT}(r_i)$, $\eta_{rF}(r_i)$ are measured in the field by the left-side and right side dipole-axis array corresponding to the sizes of electrode spacing r_i. From these values, ρ^*_{rT} and ρ^*_{rF} are calculated by eq. (2) and values of the two left side η_{rT} and right side η_{rF} dipole-axis curves are calculated according to eq. (1). A part from that, two values $\rho_{rxdT}(r_{\max})$, $\rho_{rxdF}(r_{\max})$ are measured by the left-side and right side equatorial dipole array at final size of the improved dipole-axis array.

In this method, we determine ρ_{rs} (corresponding to the improved symmetric array) by transforating values ρ_r, ρ_{rxd} through simple calculations [4]. For example, with the left-side, the $\rho_{rs}(r)$ are calculated by the following formula:

$$\rho_{rsxdT}(r_{n-1}) = K_{rxd}(r_{n-1}).(\frac{\rho_{lcxdT}(r_n)}{K_{rxd}(r_n)} + \frac{\rho_{rT}(r_n)}{K_r(r_n)}) \quad (3)$$

The $\rho_{rs}(r)$ on the right are also calculated by the eq. (3), we will obtain all values of the resistivity curve on the both sides. Finally, we obtain the average apparent resistivity values ρ_{rsxd} (corresponding to the improved symmetric array) 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 EDIPS array at final size of the IDAIPS array.

From measured value ρ_r and just calculated value ρ_{rsxd}, we determine the values of the Petrovski resistivity sounding curve according to:

$$\rho_{prsxd} = \rho_{rsxd}.(2\rho_r / \rho_{rsxd} - 1) \quad (4)$$

Similarly, from eq. (2) with values $\rho_{rsxdT}(r_i), \eta_{rxdT}(r_i)$, $\rho_{rsxdF}(r_i)$, $\eta_{rxdF}(r_i)$ and two measured values $\eta_{lcxdT}(r_{\max})$, $\eta_{lcxdF}(r_{\max})$, we can calculate ρ^*_{rsxdT}, ρ^*_{rsxdF}. From eq. (1) we will have η_{rsxdT}, η_{rsxdF} and η_{rsxd} - there are IP curves corresponding to the improved symmetric induced polarization sounding (ISIPS) electrode array [5] obtained by transformation of the IDAIPS curves.

From these we also can calculate the values η_{prsxdT}, η_{prsxdF}, η_{prsxd} thanks to transformation of measured values of IDAIPS curves in combination with one value of measurement by the EDIPS array at final size of the IDAIPS array.

We have built the programs in Matlab language for WINDOW [1] of calculating the theoretical model and the field results obtained by testing measurements of the improved dipole IP sounding method. The results have confirmed the correctioness of the algebraic transformations proposed by us [6].

3. Some illustrated results

Figure 1 shows curve η_s practically measured by the ISIPS array; curves η_{rs}(etars), η_{rsxd}(etarsxd) obtained by transformation of the values ρ_r(ror) and η_r(etar) practically measured by IDAIPS array in combination with values $\rho_s(r_{\max})$,

$\eta_s(r_{max})$ of measurement by the ISIPS array, or with values $\rho_{lcxd}(r_{max})$, $\eta_{lcxd}(r_{max})$ of measurement by the EDIPS array at final size of the IDAIPS array; curve Petrovski η_{prsxd} (etaprsxd). In comparing, η_s, η_{rs}, η_{rsxd} curves are fitted, only the values at some final sizes is not the same. This proves the correctioness of the algebraic transformations mentioned above. Besides, Petrovski curve also have reflected clearly resolution ability - that is its advantages.

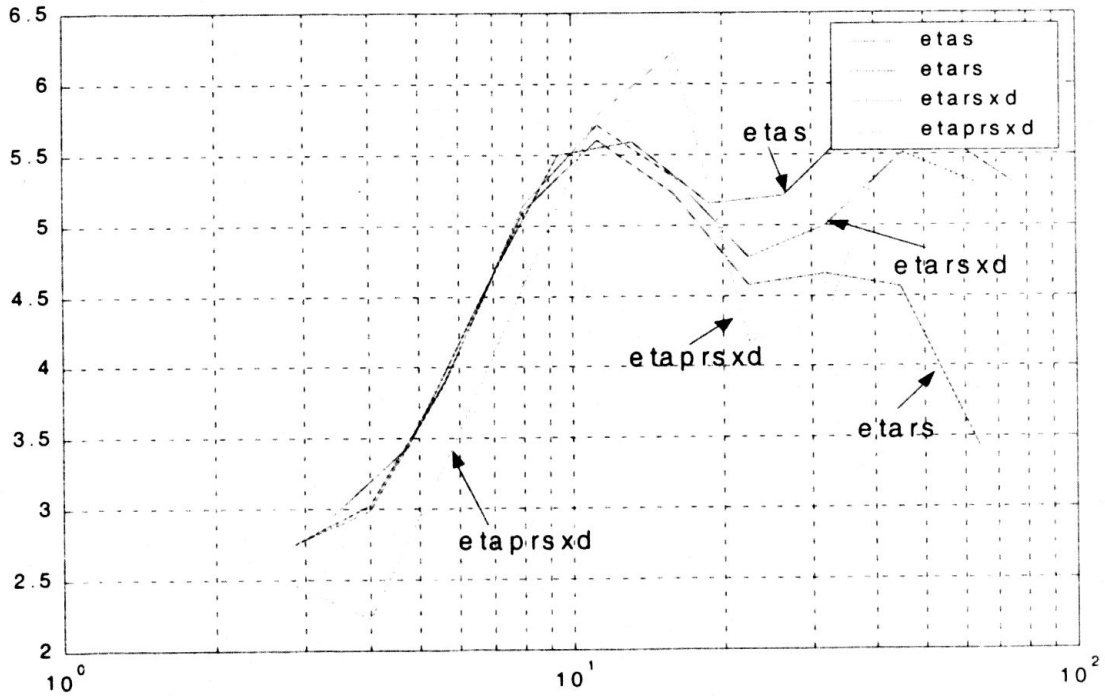

Figure 1: Curve η_s (etas) practically measured; curves η_{rs} (etars), η_{rsxd} (etarsxd) obtained by transformation; curve Petrovski η_{prsxd} (etaprsxd).

While processing the documents of the IDIPS method, we not only process each separated curve, but also perform contour sections of the obtained quantities. Below, we introduce contour sections η_r, η_{rsxd}, η_{prsxd} built only from the results measured by IDAIPS array on profile S11 in Daksong-Gialai are performed on Figures 2, 3, 4).

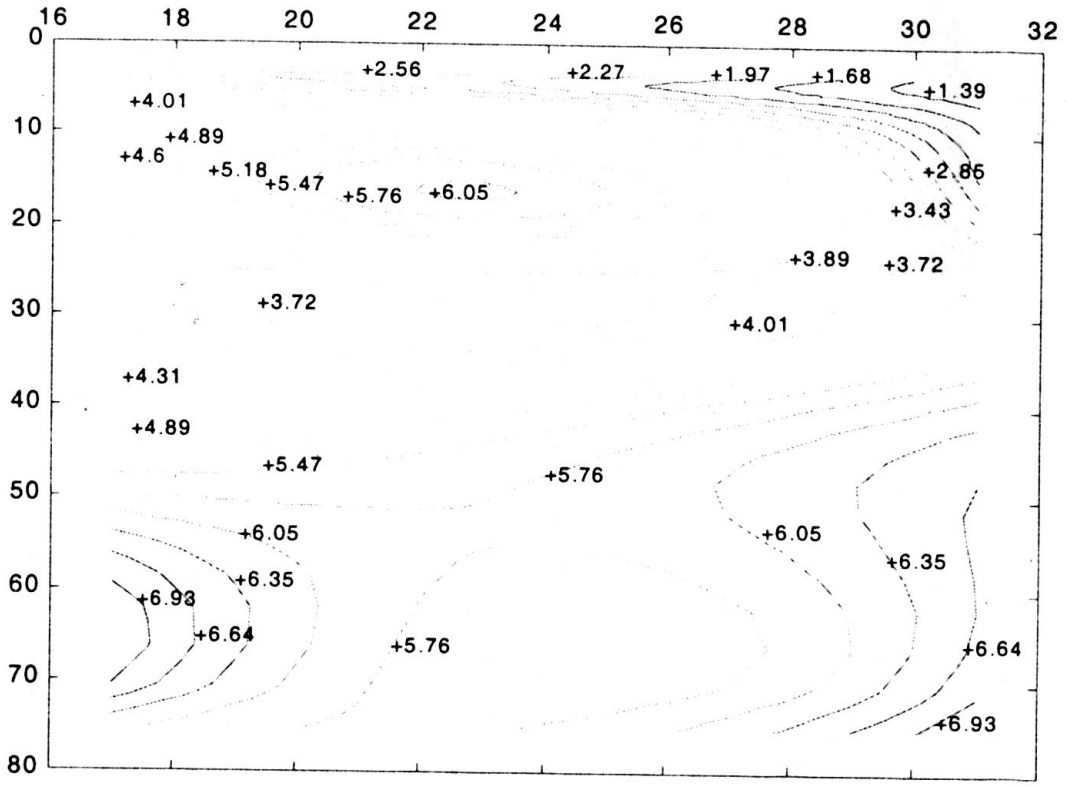

Figure 2. Contour section η_r (%)

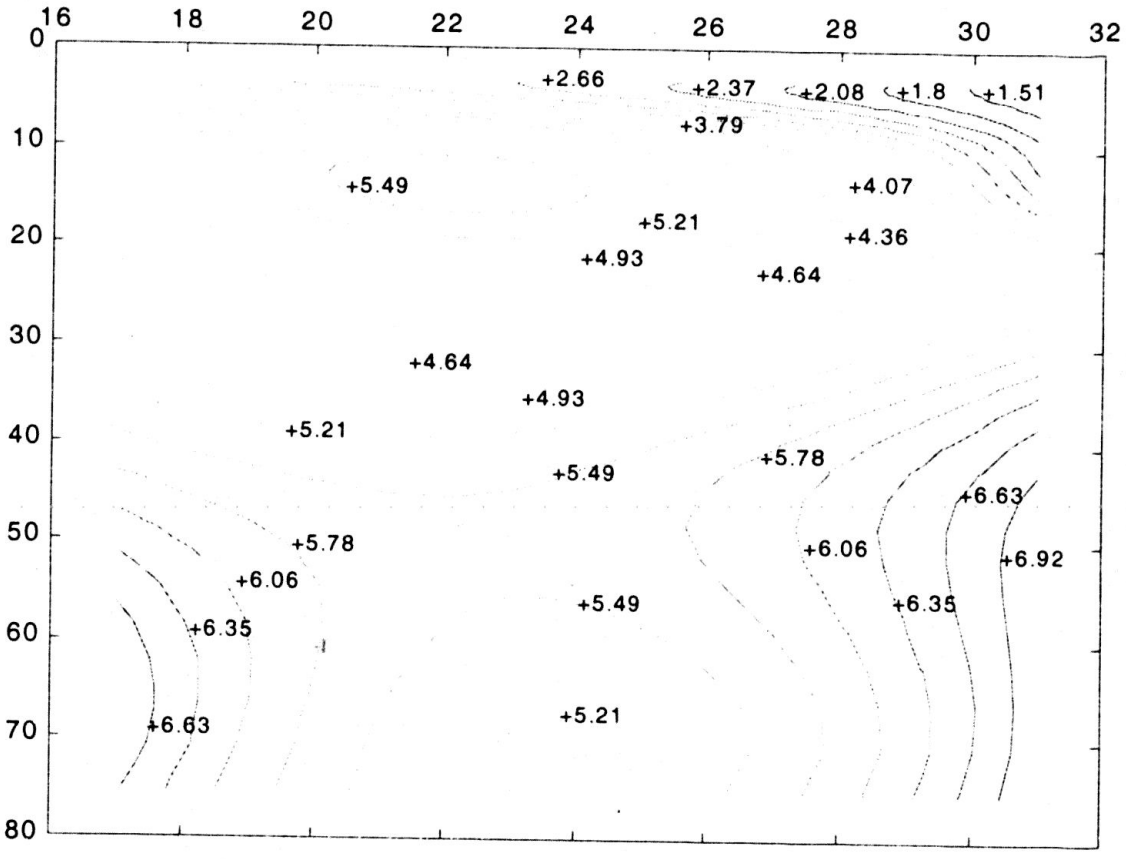

Figure 3. Contour section η_{rsxd} (%)

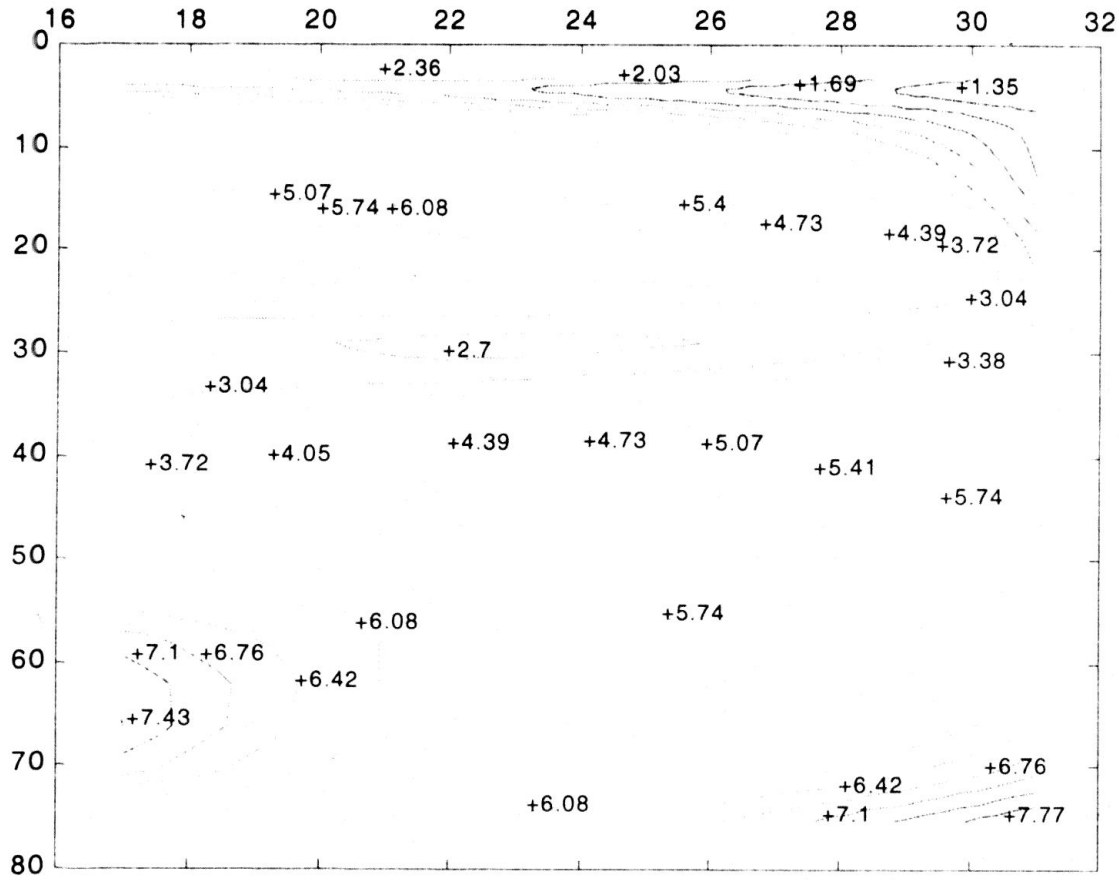

Figure 4. Contour section η_{prsxd} (%)

4. Conclusions

With the obtained results, we have some conclusions on the new approach for data processing in the improved dipole induced polarization sounding method:

1. The Petrovski IP parameters proposed by us have advantage that they exhibit higher resolution and greater investigating depth. With the above research results, it is best to use Petrovski IP parameters in processing and analyzing. This is quite a new proposal for the IP sounding method.

2. Measuring only by the IDAIPS array, we have got the two sounding curves for the two sides, in combination with a measurement by the equatorial dipole array at final size of the IDAIPS array, we can calculate ISIPS curve and Petrovski curve without direct measurements in the field. These electrode arrays are formally similar to the normal basic arrays (difference is only in size and coefficient of the array), the field measurement procedure is slightly different but simple and convenient because with one time changing size only moving one receiving

electrode, more simple improvement in comparison with the previous differential resistivity sounding. Therefore, its price is lower; it can be able to easily and immediately applied to production. Geophysists can use all knowledge and experiments accumulated during measurement procedure, resistivity document processing and analyzing, at the same time, improve and apply for IP document processing and analyzing.

3. The curve performing results, as well as the contour sections are correspond to the available geological sections, especially the performing Petrovski IP parameter η_p section expecting the nearly real geological section (source: Federation of Physic-Geology), displaying more clearly looking-for objects (high location). It can be seen that the IDIPS method proposed by us, eliminating the fundamental disadvantage that the transformation between the IP curves η_r, η_s, η_p through the unstable derivation existed for a long time. One of the advantages of our proposal is only using the simple and reliable algebraic to transform curves. The obtained results have illustrated the distinguished advantage of information transformations mentioned above. This work is of necessity, scientific and practical significance. Actually, these transformations are also a part of processing and analyzing the resistivity and IP sounding documents.

4. From all the above results and comments, we can confirm the rationalness of developing the software system of processing and analyzing IP documents by proposing a new Petrovski parameter η_p . This tendency enables us to achieve better geological effectives.

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MỘT HƯỚNG MỚI XỬ LÝ TÀI LIỆU CỦA PHƯƠNG PHÁP ĐO SÂU PHÂN CỰC KÍCH THÍCH LƯỠNG CỰC CẢI TIẾN

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Trong bài báo này, chúng tôi giới thiệu một hướng mới xử lý tài liệu của phương pháp đo sâu phân cực kích thích lưỡng cực cải tiến do chúng tôi đề xuất. Qua nghiên cứu lý thuyết và thử nghiệm thực tế cho thấy tính đúng đắn và hiệu quả cao của phương pháp xử lý này.

Các kết quả thu được góp phần nâng cao hiệu quả áp dụng phương pháp đo sâu phân cực kích thích vào việc xác định các đối tượng địa chất dưới sâu và nghiên cứu địa chất cấu tạo.