VES Field and Processing Technology for the Case of High Level Geological Noise

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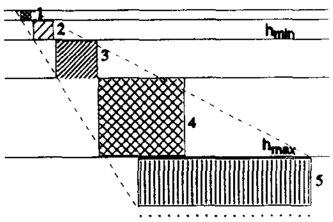

Fig.1. The basic model for TES

Many publications in last several years were devoted to the new technology in resistivity method, called as **Electrical Imaging** (R.Barker) or **Resistivity Tomography** (H.Shima). In MSU from 1980 the similar investigation was carried out for VES technology called **The total electric sounding (TES)**. In each separate case the TES field technology aims the investigation of a depth interval from h_{min} up to h_{max}. The horizontal size of any object to be visible should be approximately equal of its depth (Fig.1). The step on the profile for detailed investigation of the such object should be 2-5 times smaller of its size. The objects deeper h_{max} are not visible due to restricted penetration depth. Other objects at the depth smaller than h_{min} with proportionally small dimensions - may influence and more noticeably, the smaller their depth is, because they are closer to the points of the current and potential electrode's position. These objects (Subsurface Inhomogeneities - SSI) are considered as geological noise. Distortions of VES curves, caused by SSI may be divided into two types: caused by objects near potential electrodes (P-effect) and near current electrodes (C-effect). The main features of these two effects were described in our report P129 at EAEG conference in Vienna. These effects are not clear visibly when standard VES technology is applied. The main danger of the effects is in wrong geological interpretation of VES data. The greatest influence of SSI may be in towns, in mining regions with the artificial upper layer, in the vicinity of ditches with cables, tubes and so on. After canceling of all distortions, caused by SSI, the geological effectivity of VES may be much higher. The essence of our approach is the recognition of geological noise as the constant constituent of any medium under investigation. The model of such medium is on our opinion a combination of layered medium, deep inhomogeneities and subsurface inhomogeneities - SSI (Fig.1).

Two different approaches to the interpretation of profile VES data seem possible. In the first case the model includes all objects, which are noticeable in the experimental field. In the second approach considered as more realistic, the model includes only objects in the working depth interval without details about small upper objects. Then we should have some instrument to separate objects (or their influence on the field) into objects of our interest and the noise, and the last may be removed. That may be done with special field technology: 1.VES locations on the profile are regular with equal distances. 2.The two pole-dipole sounding (AMN & MNB) at each location are fulfilled. 3.Step in current electrodes distance growth is constant (that is linear) and equal to the sounding step. Then places for current electrodes grounding will be the same for all VES points on the profile. The best way for that is multi-electrodic field equipment, produced by Campus, ABEM, OYO, DMT and other companies. 4.Step on the profile for the h_{min}-h_{max} depth interval should be equal to h_{min}.

The field data processing to reduce SSI influence we fulfill with the IPI-2D package. Two algorithms: the principal component's method and median polishing are applied for that (MPC and MEDIAN programs). Algorithm MEDIAN appeared in 1994 and has been changed greatly after Vienna's conference. Its last version block-scheme is presented in Fig.2. The algorithm works in three stages. At the first stage ρ_a field for AMN & MNB arrays is divided into components: Horizontally-layered (HL),

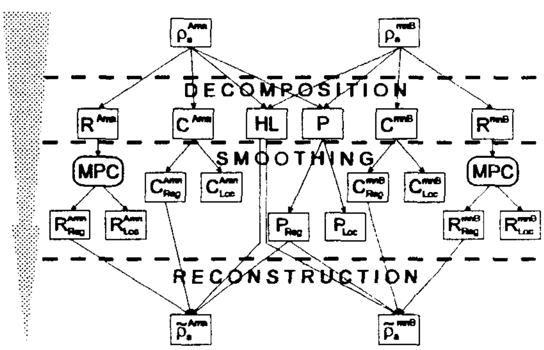

Fig.2. Block-scheme of data processing with Median program (including MPC)

C, P and the rest R. In turn C, P & R components may be divided into local and regional constituencies. Local C, P (that is C and P effects) and R constituencies should be removed. Then regional ones and HL are united in filtered ρ_a field, cleaned from SSI distortions and high frequency sporadic noise. Some filtering operations inside Median may be done with the MPC algorithm.

The essence of VES data processing may be shown on a flexure fold model (The central part of model is shown on Fig.3).

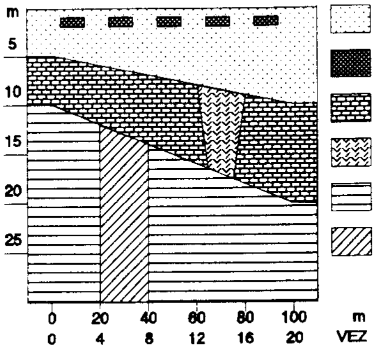

Fig.3 Full model of flexure fold with SSI and deep objects

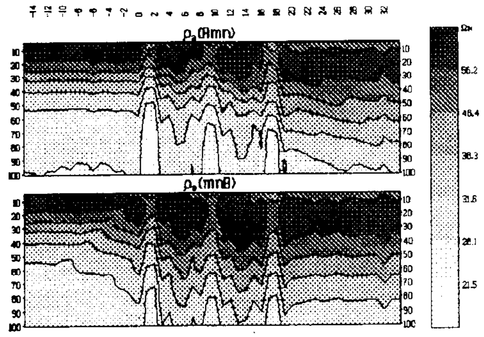

Fig.4 ρ_a field for AMN & MNB

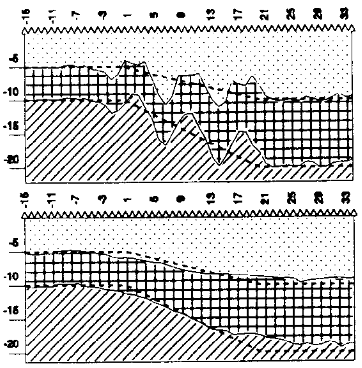

Fig.5 1D interpretation results before and after filtering

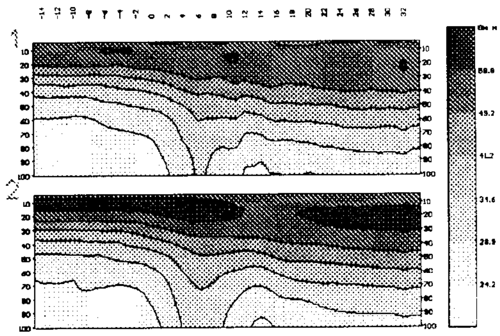

Fig.6 Comparison of ρ_a fields with deep objects after filtering(2) and calculated without SSI(1)

2D modeling data for the flexure fold added with SSI were processed with the IPI-2D package, but first deep objects resistivities were made equal to surrounding to neglect their influence.

ρ_a field for AMN & MNB arrays (Fig.4) is highly distorted by SSI and flexure itself. P-effect from SSI is clear visible on ρ_a cross-section, and C-effect is more clear visible in V-transformation. After recalculation "field's" data to AMNB array and their 1D interpretation, form of boundaries will be distorted (Fig.5a). The deep boundaries look like being seen through "broken glass" - SSI. After filtering with Median program ρ_a field looked like one, calculated for model without SSI. After filtering 1D interpretation gives the structure boundaries much more correctly (Fig.5b). Additional estimate of the filtering quality may be fitting error between VES "field's" and theoretical curves. These errors reduce noticeable after filtering, especially in the part of the profile with SSI (VES 0-20). The smaller is fitting error the more narrow are equivalence principle boundaries.

For the model with deep objects (Fig.6) during filtering all details connected with deep objects been unchangeable. ρ_a field after filtering looks as that, calculated for model with deep objects, but without SSI (Fig.6, lower).

Conclusions. Proposed field technology and data's processing allow to divide ρ_a field into components, remove distortions, caused by SSI, receive HL component for 1D interpretation and keep information about deep objects. The last step of interpretation is 2D fitting with the model found from 1D interpretation and different transformations for better seeing position and form of the deep objects .

Literature

1. I.N.Modin. V.A.Shevnin, E.V.Pervago, A.A.Bobatchev, M.N.Marchenko, A.V. Lubchikova. Distortions of VES data, caused by subsurface inhomogeneities. Report, presented at EAEG 56-th Annual Meeting, Austria, Vienna, June 6-10, 1994, P129.