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Electric fields used in resistivity survey are vectors. When horizontally layered medium is studied with traditional linear array oriented in X-direction, the second Y-component (E_y) normally is not informative being close to zero, while near 3D objects E_y does become comparable in value with the main (E_x) component (fig. 1). In latter case behavior of ρ_a is more complicated and its connection with geoelectrical model is not so evident. Calculation of ρ_a usually is fulfilled according to the simple formulae $\rho_a = E_x^t / J_{o,x}$, where $E_x^t = E_x^o + E_x^a$, is the sum of X-components of primary and secondary field, $J_{o,x}$ - X-component of current density in homogeneous halfspace. In inhomogeneous media anomalous part of electric field E_x^a may be several times as much as primary field E_x^o and does not coincide with it in sign. As a result ρ_a value turns out to be negative or different greatly from the resistivity value of the surrounding. Thus ρ_a loses its physical meaning.

This difficulty may be overcome with the help of vector measurements, including values and signs for several components. This procedure has definite advantages - firstly, we receive fuller information about electrical field in the medium, and secondly, data interpretation with vectors may be done simpler.

It is known, according to the integral equation method theory, that the electric field in inhomogeneous medium is generated by two types of current sources: by primary current sources I_o and by secondary ones I_s placed at inner boundary between media with different resistivities.

$$I_s(M) = 2 \frac{\rho_i - \rho_j}{\rho_i + \rho_j} E_n^t(M), \quad (5)$$

where E_n^t is normal component of total electric field.

$$E_n^t(M) = E_n^o(M) + \int_S I_s(P) \frac{\partial G(P, M)}{\partial n_M} ds. \quad (2)$$

Expression (1) is Fredholm integral equation of the second type for relative secondary current source density I_s placed in

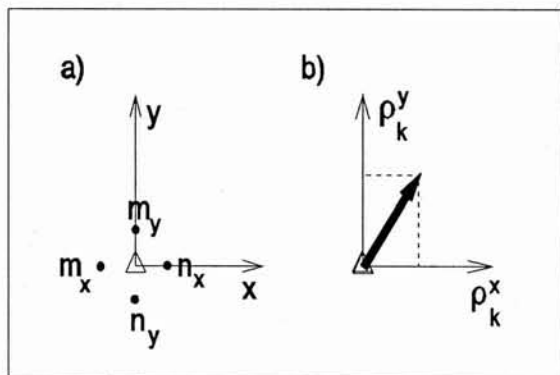


Fig.1. Vector representation of apparent resistivity.

point M on the surface of a body. The first member in expression (2) is the primary field E^0 and the second one describes the result of mutual interconnection of all secondary sources I_s or secondary (anomalous) field.

So, anomalous vectors of secondary field, being calculated as the difference between total measured field E_n^t and primary field E_n^0 , are connected only with the secondary sources I_s on the surface between the body and surrounding.

These anomalous vectors are oriented in accordance with the structure of anomalous electric field. As is known vectors tends to gather towards negative sources and diverge from positive ones. So, if we continue two vectors, these will cross in the points of the secondary sources location (fig. 2). Group of vectors measured in the vicinity of two secondary current sources will be oriented partly to one and partly to another source.

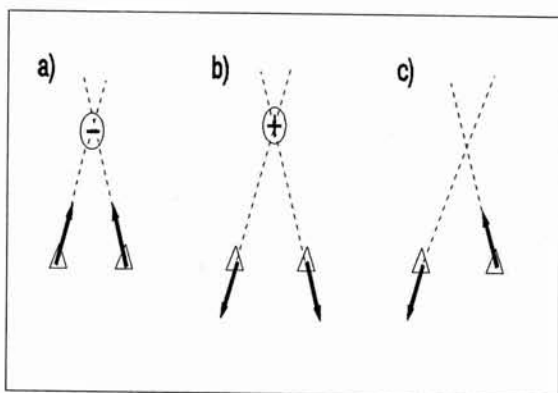


Fig.2. Gathering and divergence of the field vectors.

Fig.3 represents the structure of ρ_a vectors in the vicinity of a body of high resistivity. The primary current source is placed in point A. Surface of the body pushes electric current away. This situation is equivalent to the case with two secondary current sources with positive pole on the left body end and negative pole on the right end.

If we continued all vectors up to their cross-points, these points would be placed in the vicinity of secondary sources on body boundary. It is possible to divide all region into small square areas and to calculate the number of cross-points in each area taking into account their signs. This value may be conventually ascribed to the area center, and pseudo-tomographic map of the secondary sources distribution can be drawn. Three-dimensional measurements of the secondary sources distribution may result in 3D picture.

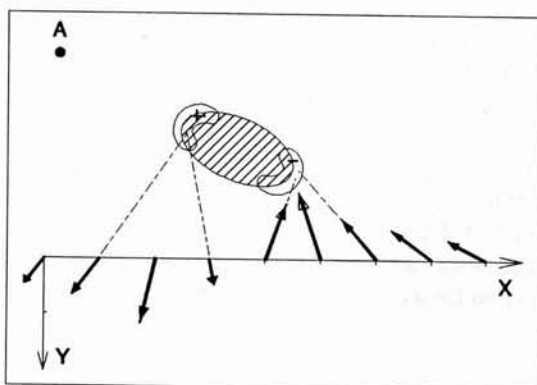


Fig.3. The behavior of anomalous ρ_a vectors near inhomogeneity.

These main ideas were checked with 3D modeling program (IE3R1) for direct current electric field calculation made in the laboratory of electrical prospecting at the geological faculty of Moscow university. Field experiments were carried out in town of Doneck (Ukraine) on water saturated zone in a rock massive with its surface occupied by buildings. Vector survey proved to be very effective in the case, when object under investigation cannot be accessible for direct measurements. For example an object located between two underground mines or objects under buildings in town, etc. In such cases traditional measurements with ordinary linear array do not appear to be effective.