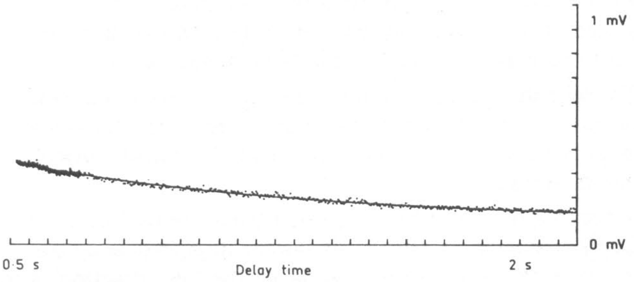

FIGURE 10
IP decay curve fitting.

ability data must be carefully screened to ensure that noise and cultural contamination problems are not affecting the interpretation. The use of resistivity variation coupled to chargeability variation may provide the productive limits of structures which will be invisible to the seismic method.

Figures 11 and 12 are Self Potential (SP) data gathered across one productive basin and one yet undrilled seismic closure using 100 m and 250 m dipoles. Both these data sets show evidence of a significant pull down associated with the petroliferous structures. The seismic interpreted extent of the pay sands are shown on both figures. Similar SP effects have been found to occur over all the tested areas to date.

The use of Self Potential exploration methods coupled to Resistivity and Induced Polarisation methods will help oil companies to determine the position and likely occurrence of oil and gas accumulations. We are presently using these exploration methods to define the most likely model of electrochemical events causing the observed variations in Eh, pH, resistivity and chargeability.

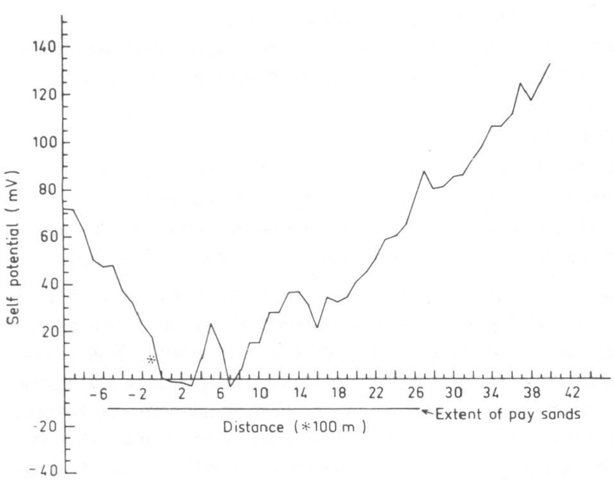

FIGURE 11
Self Potential 100 m dipole data across a gas field site 2, SW Qld.

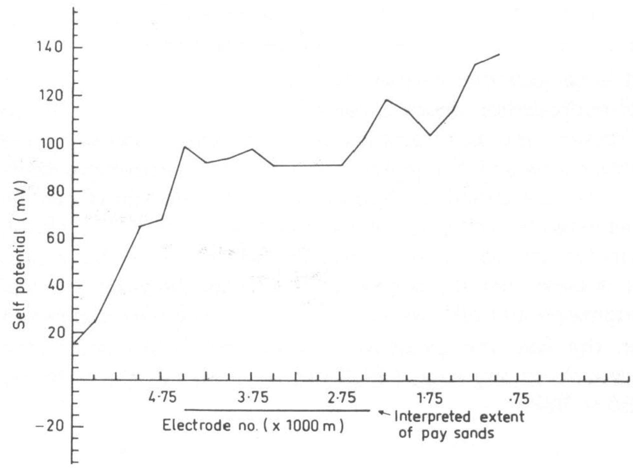

FIGURE 12
Self Potential 250 m dipole data across an oil and gas field, YB, SW Qld.

The Transiel method applied to hydrocarbon exploration: a statistical study of its results

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With the current growth of the application of electromagnetic methods to petroleum exploration, the question arises: what is their actual contribution? This paper provides a statistical evaluation of the results of 59 Transiel surveys carried out in many diverse geological settings.

The Transiel method is an improved time-domain, induced polarisation method, in terms of the accuracy of the measurement of transient decay curves and analysis of their shapes. It therefore leads to a better resolution of deep-seated, polarisable bodies. Basically, it is not the chargeability, but the time and spatial variations of the shapes of transient curves which are taken into account. In addition, residual anomalies are computed with reference to the calculated regional background transient response. Several parameters can be utilised and values are displayed on time sections.

The Transiel method is generally used as a complementary source of information to seismic data, with the aim of upgrading seismic prospects. Its use is based on the observation, increasingly confirmed, that a hydrocarbon deposit, or more likely its overburden, may display special electromagnetic characteristics. Although a rigorous explanation of this phenomenon has yet to be found, the most widely accepted hypothesis is that of a 'chimney effect' created by the migration of hydrocarbons from the accumulation, which causes disseminated pyrite to form This 'chimney' would act as a large polarisable body, the effect of which is very weak, however, due to its depth and low pyrite content. Two case histories are commented on; in a third one, spurious effects due to well casings are shown.

It is obvious that neither the depth, nor the lateral extent, of hydrocarbon deposits can be inferred from the observed Transiel, induced polarisation anomalies. However, the effectiveness of the method to select the seismic prospects which correspond to hydrocarbon accumulations can be evaluated by statistical analysis of the results of all Transiel surveys carried out over areas drilled before or afterwards. It is clear that the degree of correlation between Transiel anomalies and oil and gas occurrences may vary depending on the way the parameters of evaluation are taken into account. In any case, a high degree of correlation is found (50 to 85%).

Preparation of geophysical data for interpretation

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Introduction

Geophysical interpretation is being based on three-dimensional (3-D) analysis these days, as more interpretation tools become available. However, the interpreter is often restricted in his interpretation because of: (a) a lack of a complete geophysical signal; (b) the style of data presentation to work with; (c) processing which may reduce rather than enhance the signal quality; (d) a lack of time to adequately develop and confirm 3-D models.

The geophysical signal, irrespective of technique, is a signal which contains a broad spectrum of frequencies. To obtain a good 3-D interpretation, the complete signal needs to be available, initially to present the interpreter with a complete and accurate presentation; then to allow the interpreter to decide which styles of presentation are required; to decide if parts of the signal need to be enhanced or subdued; and to enhance different parts of the spectrum if required.

Three-dimensional interpretation is generally performed on gridded data because:

(1) The grid is uniformly spread across the area of interest irrespective of the original data set.

(2) Data from different techniques can be more readily compared or combined when they have a common geographic base.

(3) The spatial distribution and areal extent of anomalies can be more readily defined.

(4) Grid operations, including fast Fourier transform techniques, are faster by an order of magnitude than operations on original data.

(5) Map presentation from gridded data is generally an ideal form of presentation.

Presentation

Can a contour map adequately present the broad spectrum of a geophysical signal?

A contour map is merely the presentation vehicle of a grid. Thus the question is better phrased 'Can a grid adequately represent a broad band geophysical signal, especially the higher frequencies?' A grid can easily represent the same spectrum present in the signal if the mesh size used is less than or equal to the sample interval. However, because the geophysical data is usually irregularly spaced there has to be a compromise. The compromise takes a different course depending on the type of gridding routine used: random gridding for irregularly spaced data, or, bi-cubic spline techniques for data in parallel or sub-parallel lines.

The random gridding technique uses a modified growth method to generate mesh values, with both interpolation and extrapolation. High frequency anomalies tend not to be joined at all unless they are within two wavelengths of the next anomaly. The result is the familiar egg pattern.

The bi-cubic spline technique will carry higher frequencies between lines, provided the lines are less than three wavelengths apart and the anomaly trend is almost normal to line direction.

A technique of auto-correlation, introduced by Exploration Computer Services (ECS), allows for high frequency trends to be continuous when oblique to the line direction. The auto-correlation technique does not force trends into a map, but rather searches, within limits, for anomalies on adjacent lines of equivalent wavelength and amplitude. If the anomalies are matched then the trend is created. No other trends influence the formation of the trend, with the exception of a trend connecting stronger anomalies and passing through the same zone. This refinement ensures that there is a continuous anomaly which the interpreter can use for 3-D interpretation, rather than a series of discontinuous anomalies.

Compromises required for gridding are: (a) an almost square mesh to prevent introduction of distortions; (b) for broad spaced surveys, not more than 13 mesh points between lines. In the example of regional aeromagnetic surveys, this means reducing the mesh to sample ratio from 1:1 to 1:3.

Contour interval

It appears from published maps that the minimum contour interval used relates to mesh size rather than the type of signal to be presented, i.e. for large mesh sizes, small contour intervals are not used. This practice not only eliminates medium and high frequency anomalies, but also reduces the definition and resolution of all but the high amplitude anomalies on a map.

The minimum contour interval relates directly to the accuracy at which the data is recorded. Thus two fundamental steps will ensure that the interpreter has a grid, and hence contour maps, which accurately reflect the geophysical signal: (1) choose a mesh size as small as the data distribution will allow, but consistent with data spacing (2) choose a minimum contour interval consistent with the accuracy of the data.

Processing

Eighty percent of processing is routine and does not require manual interference at any stage. Manual input is required for three types of noise: (a) one point (spikes); (b) residual misclosure noise; (c) large noise envelopes on the signal.

The old style approach was to filter the signal until an acceptable product was achieved, at the expense of high and even moderate frequencies in the signal. The current approach is to remove noise spikes individually and correct the cause of misclosures, rather than mask them by filtering. To reduce abnormal noise envelopes, a non-linear filter with both amplitude and wavelength cut-offs is used. These filters reduce the noise without affecting a signal of the same frequency.