MAXIMUM ENTROPY SPECTRAL ANALYSIS OF TWO-DIMENSIONAL MAGNETIC AND GRAVITY ANOMALIES

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A Digest Presented to the Faculty of the Graduate School of Saint Louis University in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

1980

DIGEST

In a sense the maximum entropy method (MEM) has been considered in the geophysical and statistical literature, among others, as a high resolution method for peak resolution of a given time or spatial series. The shape of the power spectrum, however, has been generally neglected. This dissertation investigates the possibility of using the MEM for accurate determination of the shape of the power spectrum of anomalies due to simple two-dimensional bodies when only a short segment of data is available. It is concluded that the type of MEM to be used in spectral shape determination should be the integrated maximum entropy method (IMEM) which gives the area of each spectral peak in the power spectrum. Since the MEM assumes that the input time or spatial series is whitened by a prediction filter, the length of such a filter is then required to be known. The criteria available in the literature have proved to be of no use in this study, particularly in the case of two-dimensional potential fields. A new set of criteria is thus presented, which are shown to work well in most theoretical and real-case anomalies studied in this dissertation.

The IMEM works well for both deterministic and random signals. A real-case anomaly profile is interpreted using both the Fourier method and the IMEM

power spectral estimators, assuming the anomaly to be due to an assemblage of bottomless narrow vertical dikes with an assumed Gaussian distribution of the upper surface magnetization. It is found that the power spectra computed using the IMEM give results which agree satisfactorily with the interpretation made by other authors using the gradient method in the space domain. The Fourier power spectrum, however, does not yield satisfactory results.

There are cases, however, when, given even a short segment of data, the structure of the observed anomaly is such that both the Fourier and the IMEM power spectra agree with each other. In these cases the Fourier method should be used instead, for its real and imaginary components are more diagnostic than the power spectrum alone.

Even though the IMEM gives a better power spectrum than the Fourier method, it is of no help in accurately determining the depth of very deep structures, because in this case the power spectrum decays very fast and, as a consequence, several of the frequencies retrieved from the data are immersed in the background noise of the power spectrum. Since the exponential method is used to compute depth, it is necessary that the power in the retrieved frequencies be relatively high, say, above - 13 dB, where the reference level at 0 dB corresponds to the maximum power retrieved from the data. This is an important point because if the power spectrum were computed at very small pre-determined frequencies using the Fourier method, one might not be able to see that the power spectrum itself decayed very fast, and as a consequence the depth estimations would be grossly in error.