Optimisation of Magnetic Anomalies via Singular Value Decomposition

Author(s)
I. M. Marobhe

Abstract

A study is made on the application of singular values decomposition of Jacobian rectangular matrix of partial derivatives in the interpretation of magnetic anomalies. The algorithm used in decomposing the matrix is the compact version developed by Nash. The Jacobian matrix is factorised in three matrices, one of which is the diagonal matrix containing singular values. The three matrices together with residual vector are used to calculate the parameter vector change required to account for the observed anomaly.

However, tests made using theoretical and field examples have shown that such a solution needs to be smoothed with a factor having a numerical value of between 0.10 and 0.90 before being used to update the initial model parameter vector. The smoothing process was found to increase the rate of convergence and minimises the occurrence of divergences. In addition, the use of a combination of three smoothing factors varying with decrease of the objective function, results in more stable iterations than using single factors. The addition of a small number less than 1.0 on singular values as damping factor, increases the rate of convergence slightly in comparison with no damping, whereas a large factor slows the convergence rate considerably. Once divergence has occurred, the singular values are used successively as damping factors starting with the smallest. This process of overcoming divergence was found to be successful in most cases.

A Turbo-Pascal program for IBM/PC's was developed incorporating the above features to optimise six parameters for dyke and slab models and seven parameters for the prism model. The program has been used to interpret aeromagnetic anomalies observed in S.W.Tanzania of which some are presented here as examples. In some cases, initial errors with values above 20% are reduced to errors of the order of 1% within the first five iterations.