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位场曲化平积分方程的迭代解

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Iterative solution of integral equation for potential field continuation from an irregular surface to a horizontal plane

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摘要 提出了位场曲化平的新方法. 给定观测曲面S上的位场、S对下方水平面P的相对高程,确定P上的位场. 利用由P向上延拓到S的积分式,建立这两个面上位场及相对高程三者所满足的方程,它是第一类Fredholm积分方程. 用Fourier逆变换式把这一空间域积分式化为波数域积分式,再由指数函数的Taylor展开进一步化为级数式. 积分方程的解采用逐次逼近法迭代计算,即用S上的位场观测值作为P上位场的初始迭代值,用导出的级数式求得S上的位场计算值、由S上的位场观测值与计算值之差校正P上的位场,多次迭代,直到满足迭代终止准则. 我们还给出该积分方程的波数域迭代计算方法. 模型算例表明,重力异常曲化平的均方差和磁异常曲化平的均方差分别为0.0008 mGal和0.0019 nT,在主频为2.26 GHz的笔记本电脑运行,2048×2048数据量,计算时间是975 s. 野外磁场实际资料处理也证实这种方法的有效性.

关键词 位场延拓, 积分方程, 逐次逼近法, 迭代解, Fourier变换

Abstract: A new method is proposed for continuation of the potential field from a measurement surface S to a horizontal plane P which lies below S. Given the potential field on S and relative elevation between S and P, we want to determine the potential field on P. According to the integral formula of upward continuation from P to S, an integral equation is established which is determined by the potential field on S, the potential field on P and the relative elevation, and it is a Fredholm integral equation of the first kind. The integral formula is changed from space domain to wave number domain by the inverse Fourier transform formula, and is further changed into a series by the Taylor expansion of the exponential function. Solution of the integral equation is gained by successive approximation iteration. That is, observation values of potential field on S are used as an initial guess of potential field on P, and theoretical values of potential field on S are calculated by the series, and the values of potential field on P is corrected by the difference between the observation values and the theoretical values, and multiple iterations are made until the termination criterion is satisfied. Wave number domain iteration method is also given for solving the integral equation. Theoretical examples show that the rms error between the reduction anomaly and the theoretical anomaly is 0.0008 mGal for the gravity model, and is 0.0019 nT for the magnetic model, and the reduction time is 975 s for a grid of 2048?2048 points by a notebook computer of which main frequency is 2.26 GHz. A field magnetic example demonstrates the validity of the approach.

Keywords Potential field continuation, Integral equation, Successive approximation, Iterative solution, Fourier transform

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