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电性源时域地空电磁数据小波去噪方法研究

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Ground-Airborne electromagnetic signals de-noising using a combined wavelet transform algorithm

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摘要

基于飞艇的时间域地空电磁探测系统,具有勘探深度大、效率高、空间分辨率高、飞行控制容易等优势.但在低空飞行测量过程中,飞艇飞行高度、航迹、姿态等受风向、大气气流、地形、地面局部温度场变化等影响而发生变化,导致固定在艇囊前端的接收线圈发生运动,切割大地磁场,产生了电磁噪声、运动噪声、基线漂移等,从而影响电磁数据的电阻率成像质量.因此,研究地空电磁信号中多种噪声的去除方法,对数据的反演解释非常重要.由于地空电磁信号中有效信号频带与部分噪声频带相重叠,使用传统滤波或消噪方法具有一定局限性.因此,本文提出一种综合小波去噪法:根据地空电磁信号的特点,采用sym8小波基;基于小波多分辨率分析原理,利用小波高尺度近似分量估计基线漂移,以校正电磁数据中的基线;基于小波阈值收缩原理,采用5层小波分解、极小极大阈值配合硬收缩函数的消噪方法,来压制数据中的其余噪声.最后,通过异常环模型的理论响应和实测数据进行算法的验证,结果表明这种综合消噪法对多种噪声均有很好的抑制作用,是一种实用有效的时间域地空电磁数据消噪方法.

关键词 地空电磁系统, 电性源, 小波去噪, 运动噪声, 基线漂移

Abstract:

Airship-based ground-airborne time domain electromagnetic system enjoys high depth of prospecting and spatial resolution, as well as outstanding detection efficiency and easy flight controlling. However, due to low-altitude flying is markedly affected by wind direction, air flow, landform, and the difference of temperature filed around ground surface, the front-fixed receiving coil would cut earth magnetic field, which results from changes of the altitude, track, and gesture of the airship, and causes electromagnetic and moving noises, baseline drift as well. The drawbacks mentioned above could lead to inferior resistivity image formation of electromagnetic data. Consequently, to investigate methods of removing noises of electromagnetic data is of vital importance to inversion explanation. With simultaneously occurred frequency band of valid electromagnetic data and part of the noise, traditional filter technique or noise-removing ways have their own limitations. Therefore, this study proposes a combined de-noising method, which adopts sym8 wavelet basis according to the characteristic of the electromagnetic data, corrects the baseline drift using estimation of high-level approximation by applying wavelet multi-resolution analysis, and suppresses other noises by five-level wavelet decomposition with MiniMaxi threshold and Hard shrinking function by applying wavelet threshold shrinkage theory. The combined de-noising method is validated by adopting the theoretical response and wild measured data based on the Anomaly Loop Model, respectively. The final results confirm that the proposed method eliminates noises effectively, which indicates it is applicable and effectual to ground-airborne time domain electromagnetic data.

Keywords Ground-airborne electromagnetic system, Electrical source, Wavelet de-noising, Moving noise, Baseline drift

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