Geophysical Research Abstracts, Vol. 8, 02680, 2006
SRef-ID: 1607-7962/gra/EGU06-A-02680

A new towed marine vector magnetometer: methods and results from a Central Pacific cruise

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The development of towed marine magnetometers has led to point where few wishes remain open as far as total field measurements are concerned. Equipped with state-of-the-art Overhauser sensors these magnetometers are relatively inexpensive, reliable, easy to handle and they can be combined to work as gradiometers. However, in many cases it is desirable not only to know the scalar value of the total field but also to have access to the magnetic field's vector components. This opens a wealth of possibilities in analysis and modelling, especially in regions where the total field anomalies have low amplitudes. These facts led to the development of a new towed marine vector magnetometer using three orthogonally oriented Fluxgate sensors in our group at the Federal Institute for Geosciences and Natural Resources (BGR).

The new magnetometer was successfully tested during cruise SONNE-180 in the Central Pacific at about 120˚W just south of the Equator. The research area is conjugated to crustal segments of the Cocos- and Nazca plates which were formed during the break-up of the Farallon plate 23 m.y. ago. It is characterized by low amplitudes of the seafloor spreading anomalies in the total field which had so far hindered a reliable identification of seafloor ages in the region. The magnetometer array consisted of i) two Overhauser sensors (SeaSpy) operating in gradiometer mode and the vector magnetometer which can be deployed on the same cable in between the two Overhausers.

A new processing scheme has been applied to the data of all sensors containing a band pass filter in time domain in order to limit purely on wavelengths related to seafloor spreading anomalies. Those pre-processed total magnetic field data entered the anomaly reconstruction free of external temporal variations by summing up the

gradiometer differences. Euler rotations by inclinometer angles provided the enhanced vertical component of the vector magnetometer which constrains forward modelling. Furthermore, vector magnetometer data enable additional analysis tools: Time domain analysis by magnetic boundary strike diagrams indicate dimensionality and strike directions of lineations even for local parts of profiles. Spectral domain methods allow to control data quality, sense distortions by external geomagnetic variations, and provide an averaged estimate for the strike direction of magnetic lineations along each profile.

The vector magnetometer proved to have a very good base stability and high resolution of the processed data so that the total field calculated from the vector components is practically identical with that measured with the Overhausers. Applying the gradient mode to a Fluxgate-Overhauser pair worked just as well as the standard Overhauser-Overhauser gradiometer. Magnetic strike lineations derived from the vector magnetic data by time and spectral domain methods are confirmed by 2D modelling.