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Near seafloor magnetic anomalies on oceanic hydrothermal sites: data reduction

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Like ore deposits on land, hydrothermal sites of the oceanic ridges exhibit specific magnetic signatures, which may prove useful to detect and better understand them. Two cruises, cruise Serpentine in March 2007 onboard R/V Pourquoi Pas ? and cruise MomarDream in August and September 2008 onboard R/V L'Atalante, collected near-seafloor magnetic data and rock samples with ROV Victor on hydrothermal sites at 15° North and 36° North on the mid-Atlantic ridge, respectively. In this presentation, we describe the data and the methods to analyze them.

A major difficulty is that, unlike a ship, a deep sea submersible or a ROV can not tow a magnetometer due to the close proximity of the seafloor. Instead, the magnetometer is rigidly fixed on the submersible and the magnetic measurements are affected by its magnetization, with both remanent and induced components. We used a vector magnetometer (i.e three orthogonal fluxgate sensors), which allows measurements of the field three components in a referential linked to the submarine. Getting the three components is required to determine and correct the magnetization of the submersible.

In order to estimate the remanent magnetization vector (3 components) and the magnetic susceptibility tensor (9 coefficients) of the submersible, we invert data collected on calibration loops performed at fixed depth, far from both the ship and the seafloor, during the descent and the ascent of the submersible at the beginning and the end of the dives. During these loops, the ambient field is assumed to be equal to that predicted by the IGRF. Any departure from this assumption is ascribed to the submersible magnetization, which is described by twelve coefficient inverted from the loop data by a least square method. Because the loop data sample the field for all headings but only limited values of the pitch and roll of the submersible, the inversion is regularized by using a dumping factor. Then the resulting coefficients are used to correct the dive magnetic data for the magnetic effect of the submersible, and the data are rotated to a geographical reference frame as well.

The resulting anomalies are gridded and a reduction to the pole (RTP) is applied in order to correct the magnetic anomaly map from the distorsion induced by the inclination of the magnetization and present geomagnetic field vectors. The RTP anomalies show anomalies on the top of their causative sources, as if caused by vertical magnetization and geomagnetic field vectors. The next phase of the study consists in evaluating the seafloor magnetization through the inversion of the anomalies in presence of topography, in order to facilitate the geological interpretation of the area.