Preface

The ten papers of this special issue form a subset of the forty-seven talks and posters presented in July 2003 at two sessions, "Modern magnetic surveys for regional tectonics, geohazards and environmental investigations (GAV.06)" and "Magnetic anomalies and rock properties (GAV.07)", of the IUGG2003, Sapporo, Japan. These papers reflect the broad theoretical, geographic, and geospatial scope found in the modern practice of crustal analysis using magnetic methods.

Most of the studies reported here incorporate both theoretical innovation and application. In a somewhat subjective way, we (have) organized the papers in order from more theoretical to more applied. Each study in this issue represents the analysis of measurements of spatial variations in the Earth's magnetic field. Most of the data were collected by aircraft (both fixed-wing and helicopter), although some marine and satellite data are used as well. Ground-based measurements of magnetic properties of rocks are included in several of the analyses.

Despite a long and rich mathematical history, development of new techniques for analysis of potential field data, in particular of magnetic data, is on-going today. The first two papers of this issue reflect this active research direction. Phillips reports on an elegant implementation of integral relations that can be used to infer the total magnetization direction from aeromagnetic data. This method promises to be very useful in situations, such as mapping in volcanic terrains, where significant remanent magnetization occurs. Kubota and Uchiyama develop a modern inversion technique to elucidate the detailed internal magnetic structure of a seamount from ship-borne magnetic field measurements. This technique should have broad applications to marine magnetic studies.

Analysis of magnetic data combined with other geophysical and geologic data is an important area of current research and development. The next two papers in this issue demonstrate two very different aspects of this line of study. Gettings and Bultman demonstrate a GIS-based approach for combined analysis of linear trends derived from aeromagnetic interpretation, geologic mapping, air photo interpretation, satellite images and other remote sensing information. Their paper represents a promising approach to large-scale mapping of penetrative fractures for the analysis of possible recharge pathways for flat-lying aquifers. Kim *et al*. present both method development and tectonic interpretation. Their paper is an excellent case study on the combined analysis of satellite and near-surface magnetic survey data; particularly useful because many geoscientists deal exclusively with one or the other.

The remaining six papers are primarily applied studies that seek to define or constrain upper crustal Earth structure through the interpretation of magnetic data. These studies have a number of specific goals including the understanding of volcanic processes and hazards, hydrocarbon exploration, and mapping of faults for tectonic hazard assessment. Okuma and Kanaya constrain their detailed aeromagnetic interpretations with an extensive database of magnetic property information for rocks in their study area in northeast Japan. Using these constraints, they are able to model important structural parameters relating to the depth and subsurface configuration of several plutons and faults in this seismically active region. Okubo *et al*. analyze a specially designed survey (flown in a spiral trajectory) to obtain detailed physical property mapping in an active volcanic region on Kyushu Island, Japan. Their results correlate well with mapped geology and, furthermore, allow for mapping of previous eruptive events beneath later lava flows. Aboud *et al*. apply and compare several methods for depth estimation from aeromagnetic data in order to evaluate the depth of basement in an important hydrocarbon region in the Gulf of Suez. The ability to estimate the basement depth from magnetic data is particularly important in this region because a pre-Miocene salt formation confounds seismic results there. Salem *et al*. present a high-resolution aeromagnetic survey and interpretation for the Quseir area of the Red Sea. Their study illuminates detailed structural clues for this important hydrocarbon region. Ferraccioli *et al*. show how aeromagnetic data allow for effective geologic reconnaissance in ice-covered Antarctica. They present new data and interpretation for a truly frontier area. Saltus *et al*. make a comparative study of aeromagnetic data and analyses from two tectonically active forearc regions: Puget Sound, Washington, and Cook Inlet, Alaska. The utility of aeromagnetic data for economical delineation of shallow fault structures is demonstrated in both regions, and, by inference, for other forearc basins worldwide.

We believe these papers, along with the other presentations made in the two IUGG2003 sessions, provide a representative global snapshot of the present practice of magnetic data analysis and interpretation for crustal studies. The magnetic method remains extremely viable and relevant as a method for rapid and inexpensive geologic reconnaissance at a wide range of spatial scales. Challenges remain in the development of robust interpretation, particularly in conjunction with other geophysical and geologic data. We thank all of our colleagues who made presentations at IUGG2003 and particularly those who chose to publish their contributions in this special issue.

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