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Geophysical Applications In Geomorphology

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Book Review

GEOPHYSICAL APPLICATIONS IN GEOMORPHOLOGY. Edited by Lothar Schrott, Andreas Hördt, and Richard Dikau. *Zeitschrift für Geomorphologie*, Supplement Volume 132, 2003. 190 pages and CD-ROM. EUR 89.00. ISBN 3-443-21132.

The premise of this book is that ice, rock, and sediment have different and variable electrical properties and seismic velocities. This has been long known, and investigation of geophysical variations in subsurface earth materials techniques attracted the interest of geomorphologists in the 1970s, including many investigations in glacial and periglacial environments. However, the techniques never really become part of the toolbox of mainstream geomorphological research. It is not hard to imagine why. Instruments were large and cumbersome and often had to be constructed to order. In addition, calculations were difficult and/or tedious, and the interpretation of results was based on numerous simplistic and sometimes implausible assumptions. But a lot has changed since the 1970s. Instrumentation and computational advances suggest that geophysical tools may be worth a second look.

Broadly, the volume aims to present studies that evaluate the use of geophysical techniques in geomorphology. Based on a 2002 workshop held at Bonn, Germany, this special issue of *Zeitschrift für Geomorphologie* is a compilation of 10 papers and a CD-ROM of data processing software. The authors are mostly geomorphologists, but geophysicists are also represented.

The geomorphological or related backgrounds of most of the authors give the volume a strong applied feel that significantly advances the thesis that geophysical techniques have the potential to make a contribution to geomorphological studies. The first paper, by Colin Ballantyne of the University of St. Andrews in Scotland, takes an interesting approach insofar as most of his paper concerns the construction of a model of glacial and proglacial sedimentation, with very little reference to geophysical techniques. Not until the final short section of the paper does he use published geophysical results to calibrate his model. Ballantyne thus succeeds in establishing the utility of geophysical methods, without clouding the applications in technical issues that may be of little interest to the non-specialist reader.

The remaining papers are more focused on geophysical applications, and are divided into sections on DC-resistivity, seismic refraction, other methods, and combined applications.

The DC resistivity paper by Bernd Etzelmüller and two Norwegian colleagues, Ivar Berthling and Rune Ødegård, discusses applications in permafrost studies. Although well constructed, the research points to numerous problems in data collection and interpretation that might discourage many geomorphologists. On the other hand, the paper by Christof Kneisel of the University of Würzburg discusses a wide variety of apparently successful case studies. These applications include determination of the thickness of eolian sediments and water table depth, surficial mapping and depth to bedrock determinations, depth to permafrost, and depth of a scree slope. Kneisel explores different array geometries and spacing to obtain the best results. However, he agrees with the Norwegians that resistivity should be used in combination with other techniques. The last resistivity paper, by Oliver Sass of Augsburg, looks at the moisture content of various rock faces and successfully relates resistivity-determined moisture distribution to geologic, microtopographic, climate, and weathering factors.

There are two papers on seismic refraction approaches. Thomas Hoffman and Lothar Schrott of the University of Bonn compare intercept-time, wavefront inversion, network-raytracing, and refraction tomography approaches to the interpretation of the depth of alpine talus slopes and valley fill deposits. The results suggest that different circumstances require different methods or combination of methods. The other seismic refraction paper by Stefan Hecht of the University of Heidelberg uses case studies to examine the vertical and horizontal differentiation of sediments, and loose sediments from bedrock. The case studies include differentiation of loess and fluvial sediments, the occurrence of ground water in alluvial sediments, a reconstruction of the course of the Danube based on subsurface sediments, and an investigation of a landslide area.

Other methods addressed in the volume include ground penetrating radar and radiomagnetotellurics. The ground penetrating radar approach used by Ivar Berthling and three Norwegian colleagues to investigate rock glaciers in Svalbard was successful in detecting some of the internal structure of the rock glaciers, but they were unable to penetrate to the rock glacier bed. Andreas Hordt and Gerhard Zacher describe the radiomagnetotelluric method to determine the extent of an industrial waste site, the thickness of an aquifer, and the location of subsurface voids that can collapse under the weight of agricultural vehicles. Hordt and Zacher point out the logistical advantages that radiomagnetotellurics have over DC resistivity measurements.

Combined applications are the subject of the last two papers in the volume. Christof Kneisel of the University of Würzburg and Christian Hauck of the University of Karlsruhe use resistivity, seismic refraction, and electromagnetics to investigate sporadic permafrost in the Swiss Alps, where they note that the use of a single technique would have produced incorrect interpretations in some places. In the final paper Christian Hauck again, this time working with Daniel Vonder Mühll of the University of Basel, uses an even broader range of techniques on European permafrost in the EU-funded "Permafrost and Climate in Europe" project. They conclude that a combination of DC resistivity and refraction seismic tomography provides the best results.

The volume also includes a CD-ROM copy of REFLEXW software for 2- and 3-dimensional processing and interpretation of reflection, refraction, and transmission data. The software, developed by Karl Sandmeier, is accompanied by demonstration data, a 344 page manual, and a paper on seismic refraction interpretation tools. The trial software may be used up to 50 times for noncommercial purposes.

The general sense of the papers in this volume is that geophysical methods may indeed be valuable in geomorphology, but that the results need to be interpreted with caution. Overall, the volume provides an excellent starting point for any professional or student geomorphologist interested in exploring the possibilities of geophysical applications in geomorphology.

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