Mathematical Geosciences Best Paper Award 2021

Roussos Dimitrakopoulos[1]

1 Introduction

The success of *Mathematical Geosciences* is owed to the high quality of papers received every year. Given the level of excellence regularly noted across these papers, the selection process for the Best Paper Award is always a challenging undertaking. This award recognizes the authors and the research that have helped advance the profession and push the boundaries of knowledge in the field. It is with great pleasure that we announce the winner of the Best Paper Award 2021:

> "Three-Dimensional Structural Geological Modeling Using Graph Neural Networks,"
> Volume 53: 1725–1749
> by Michael Hillier, Florian Wellmann, Boyan Brodaric, Eric de Kemp & Ernst Schetselaar

> Congratulations to the authors!

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Michael Hillier received a BS (Hons) (2006) in physics with a minor in mathematics from Memorial University of Newfoundland and an MS (2008) in astrophysics from the University of Waterloo. He is currently working on his PhD at RWTH Aachen University. He is a scientist who is passionate about 3D modeling of geological structures from scattered multivariate and multidisciplinary data, in complex geological terrain. He is part of the Geological Survey of Canada staff, engaged in developing interpolation algorithms for constrained 3D geological modeling. He has significant experience with algorithm development and the application of mathematical techniques for solving difficult earth science problems. His current research focuses on emerging neural network methods for performing implicit 3D modeling of geological structures.

J. Florian Wellmann studied geology at the University of Tübingen with a focus on geophysics and applied geophysics, and performed theoretical and experimental work for his diploma thesis (MS equiv.) at ETH Zürich. After his studies, he worked for two years for the German Antarctic Survey (Alfred Wegener Institute, AWI) as geophysicist and overwintering team member at the German Antarctic research station Neumayer II. Subsequently, he combined his interests in geological modeling, numerical methods, and process simulations in the field of geothermal energy in postgraduate work at the

University of Western Australia, where he completed his PhD in 2013. After a short postdoc phase at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Centre for Exploration Targeting (CET), he joined RWTH Aachen University as Junior Professor in 2014. In 2018, he was promoted to full professor, and in 2022 he took over the role of Chair in Applied Geophysics. In addition, he holds a position as group leader in Exploration and Simulation at Fraunhofer IEG.

Boyan Brodaric (PhD, Penn State University, 2005) is a research scientist at the Geological Survey of Canada with a focus on knowledge representation applied to 3D geological modeling, hydroinformatics, data interoperability, national data infrastructures, and international data standards.

Eric de Kemp (PhD, Université du Québec à Chicoutimi, 2000) is a 3D Interpretation Specialist with the Geological Survey of Canada (GSC) and an Adjunct Professor at the Department of Earth and Environmental Sciences at the University of Ottawa. His research focuses on 3D visualization and modeling of bedrock geological structures. His expertise in 3D geological analysis is coupled with a strong background in the integration of geoscience data using geographic information systems (GIS)

and remote sensing technologies. He specializes in Precambrian field-based 3D studies that combine stratigraphic, structural, and geochronologic analysis in tectonically complex regions of the Canadian Shield. His current research focuses on optimization of methods for improving regional-scale 3D geological interpretations and methods with the aim of developing subsurface models for Canada-3D, a national-scale 3D geological and geophysical integration project.

Ernst Schetselaar (PhD, Delft Technical University, the Netherlands, 2000) is a structural geologist and 3D modeling expert with 25 years of experience in applying data integration methods to geological mapping and exploration. For 17 years he conducted research and taught courses in structural geology, geographic information systems, and geological remote sensing at the Geological Survey Division of the International Institute for Earth Science and Remote Sensing (ITC) in Enschede, the Netherlands, prior to joining the Geological Survey of Canada in Ottawa in 2007. His current research focuses on 3D modeling of geological, geophysical, and geochemical data to enhance insight in ore-forming systems.

This year's award-winning paper presents a geometric deep learning approach, using graph neural networks, as an alternative to classical implicit interpolation that is driven by a learning-through-training paradigm. The authors graph neural network approach consists of a developed architecture utilizing unstructured meshes as graphs on which coupled implicit and discrete geological unit modeling is performed, with the latter treated as a classification problem. The architecture generates three-dimensional structural models constrained by scattered point data, sampling geological units and interfaces as well as planar and linear orientations. The benefits of their approach are (1) its ability to provide an expressive framework for incorporating interpolation constraints using loss functions and (2) its capacity to deal with both continuous and discrete properties simultaneously. Furthermore, a framework was established for future research for which additional geological constraints can be integrated into the modeling process.

2 In closing

The Best Paper Award honors the efforts of authors who have pursued rigorous research and have achieved excellence. Congratulations to the 2021 winners and a most sincere thanks for their contribution not only to *Mathematical Geosciences*, but also to the profession.

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Editor-in-Chief.

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