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Editorial

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Editorial

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This special issue of the *Netherlands Journal of Geosciences* focuses on geothermal energy in the Netherlands, with attention given also to various other European countries in which the development of geothermal resources is to some extent comparable to the Netherlands. This issue provides a snapshot of the status of, and knowledge regarding, various aspects of geothermal energy in the Netherlands in 2019, looking at different projects, plays and challenges, as well as various disciplines.

The potential of geothermal energy in the Netherlands has been investigated since 1979, when several mapping projects were carried out by the Geological Survey in the framework of the National Research Program on Earth Heat and Heat Storage (NOA-1). This resulted in various reports describing the potential of possible geothermal reservoirs ranging from lower Carboniferous (Dinantian) to Tertiary in age, evaluated for both production and storage. NOA-1 was followed by the National Research Programme on Earth Heat and Energy Storage in Aquifers (NOAA) in 1985. It was noted that the potential of a geothermal reservoir depends on three factors: thickness, permeability and lateral continuity. Within NOAA, the Dutch Society for Energy and the Environment (NOVEM) commissioned the drilling of a pilot well near Asten in the Ruhr Valley Graben, which was carried out in the winter of 1988/1989 by the Geological Survey and TNO Groundwater Survey. The research was sponsored by the European Union, NOVEM and the Dutch Government. The aim of this well was twofold: the investigation of the geothermal potential of the Breda Formation, the Voort Sand Member and the Dongen Sand Member, and the technical and economic feasibility of a geothermal energy project for the horticulture industry. The well was completed successfully, but unfortunately it never produced any resources and it has been suspended ever since. The report 'Geothermische Reserves Centrale Slenk, Nederland' (Heederik et al., 1989, in Dutch) was published after completion of the well, but the disappointing result set all geothermal exploration in the Netherlands on hold for a long period.

With the rise in gas prices in the early 2000s there was an incentive for geothermal energy again. Since then an increasing number of geothermal projects have been installed in the Netherlands starting with the Van Den Bosch-GT01 well in 2006, which was successful. Initially, the sole focus was on heating greenhouses, but interest in district heating is gradually increasing. In recent years, this form of energy has been looked into much more as a substantial part of the energy transition in the Netherlands. A roadmap has been defined in the Masterplan Aardwarmte in Nederland (2018) which aims to upscale the geothermal energy developments and realise more projects in the coming decades. For more details on the history of Dutch geothermal activities, the reader is referred to Lokhorst & Wong (2007) and Dufour & Heederik (2019).

After decades of hydrocarbon exploration and production, knowledge and data of the subsurface in those parts of the Netherlands where exploration and production (E&P) activities took/take place are widespread and easy to come by. However, for geothermal energy this is not yet the case, and large parts of the Netherlands are 'white spots' in that sense. The Dutch Government is in strong support of exploration programmes and green deals that aim to fill in these white spots and develop the right conditions for growth of the geothermal industry. At the same time, it is of key importance to transfer knowledge, data and best practice from the E&P to the geothermal industry in order to enable a large upscaling of the Dutch geothermal industry.

Contents

The goal of this special issue is to give fresh insights into geothermal plays and projects and associated challenges, as well as to provide a broad scope of the various disciplines involved in this business. The papers were written and revised in the period between late 2018 and late 2019. A first set of papers has been published in December 2019. The complete special issue will be published in spring 2020.

The papers in this special issue are grouped into six sections. In the first section, an introduction to geothermal energy in the Netherlands is presented. This is followed by a section that provides an overview of projects in European countries close to the Netherlands that have their

own type of geothermal exploitation and plays. Learnings can be drawn from these projects and industries, some of which have been active for decades already. The third section focuses on the different geothermal plays in the Netherlands. It first gives an extensive introduction to the Dutch subsurface and its role in geothermal energy, after which a number of papers discuss a specific area within each play. These plays and areas have their own specific challenges, e.g. connectivity, presence, predictability of reservoir characteristics. In the fourth section, the role of geothermal energy in the energy transition is described and an outlook on optimization of geothermal developments with both a play-based portfolio approach and a dual hydrocarbon–geothermal exploitation is presented. The last section touches upon several operational aspects and technical hazards and risks that are (possibly) associated with the exploitation of geothermal energy.

Contributions to this special issue came from authors from a large variety of organisations (including industry, academia and government) that all play a very important role in the Dutch geothermal industry – now and in the future. This explains why some papers in this issue are more technically focused, while others have a clear non-technical content. The papers also show that the learning curve is steep, while the geothermal industry in the Netherlands is moving fast from the start-up phase to the scale-up phase.

Acknowledgements. We hope that this introduction has made you curious to read the papers in this special issue. We, the guest editors of this issue, would like to thank all the authors for their valuable contributions, as well as the many peer reviewers for their critical reviews and constructive comments. We also thank the *Netherlands Journal of Geosciences* for their help with publishing these papers. Editor-in-chief Johan ten Veen has been a great help in creating and improving this issue.

Note that all publications in this *NJG* special issue are *Open Access* and can be freely downloaded via Cambridge University Press, to ensure a large outreach. We thank the NJG foundation and EBN for their generous financial contributions to make this possible.

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