PG
Petroleum Geoscience

Editorial

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Introducing the Energy Geoscience Series

I am pleased to announce that, during our 25th anniversary year, *Petroleum Geoscience* has decided to introduce a new series of papers on the theme of *Energy Geoscience*. Here, I briefly explain why we are doing this and why we think it is important for development of the Journal. If we imagine ourselves 25 years into the future, we might well look back on these years (2020 ± 5) as the turning point when human society transited from the petroleum age to the age of sustainability (see Grubb 2014 and Sachs 2015). This change is primarily being driven by the need to severely curtail and reduce emissions of CO_2 and other greenhouse gases to the atmosphere (the climate change challenge), but also because of many other harmful impacts of modern human society on the biosphere (e.g. species and habitat loss) and the hydrosphere (e.g. water quality and spread of plastic waste). Human society needs to change its behaviour into more responsible practices, and that includes how we use energy. In responding to these challenges, we can already see an acceleration in what we now call the energy transition. Deployment of renewable energy has grown dramatically over the last decades. Globally, the world produced *c.* 5.9 TWh of renewable energy in 2016 (ourworldindata.org), with hydropower representing almost 70% of this and the rest being a mix of power generated from solar, wind and geothermal sources. This represents a six-fold increase since the 1960's. Future projections anticipate that electricity (rather than fossil fuels) will become the main global energy carrier by 2050 with renewable power sources able to provide the bulk of global electrical power demand (IRENA 2019). Global demand for fossil fuels, which currently provide around 80% of global energy, is expected to peak sometime in the next decade (Goldthau *et al.* 2019), and although there are many different opinions on how soon these changes will occur and what the future energy mix will look like, rapid change is clearly under way. During the coming decades, energy supply will most likely be based on hybrid systems, for example, with gas-based power generation complementing fluctuating renewable energy sources. Ways of using fossil fuel-based energy with reduced (or net zero) levels of CO_2 emissions to the atmosphere will also be in focus.

Petroleum Geoscience already publishes papers on geoscience aspects of energy storage, CO_2 storage and geothermal energy, although our current content is mainly research related to hydrocarbon exploration and production. By introducing the *Energy Geoscience Series*, we hope to create a channel for the anticipated growth in non-petroleum related aspects of geoenergy and applied earth science. Of course, many of our papers are application blind – topics in tectonics and basin stratigraphy, flow in fractured rock, reservoir characterization and seismic imaging can be applied to many possible uses of the subsurface. Nevertheless, research focused on new and emerging topics, such as cyclic storage of gas or geothermal energy, will represent an increasing fraction of our coverage and deserve a more specific home. Unlike the thematic sets which we include in specific issues, the *Energy Geoscience Series* will run continuously, initially with about two papers per issue. We continue to invite papers on any aspect of geoenergy and

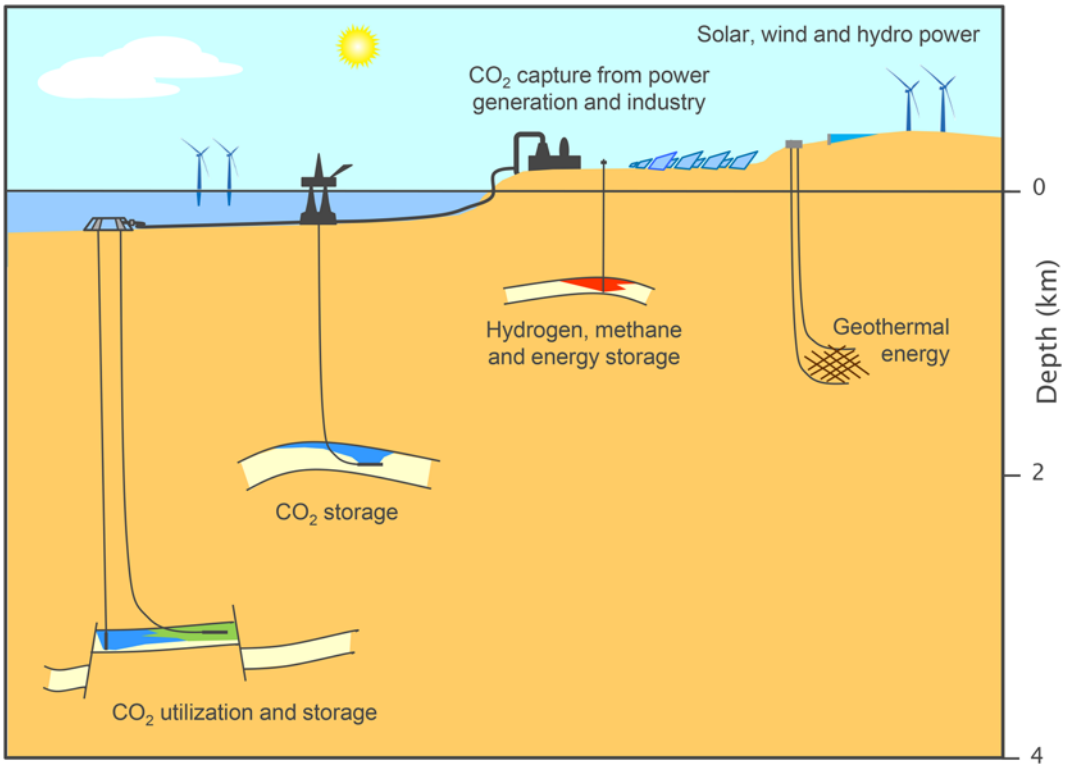

Fig. 1. Sketch illustrating the range of renewable and low-carbon energy solutions likely to dominate studies in applied geoscience during the energy transition (modified from Ringrose 2017).

applied earth science, but now authors will be able to choose between submission under Energy Geoscience alongside the traditional categories under Petroleum Geoscience (research or review article) or one of the more specific Thematic Set topics we choose to run from time to time.

It may be helpful to highlight some of the emerging topics (Fig. 1) which we expect to be in focus under the Energy Geoscience theme:

- Firstly, injection of fluids (e.g. water, carbon dioxide or hydrogen) into subsurface reservoirs results in geomechanical responses that require careful control, modelling and monitoring. The geomechanics of fractured rock is therefore a 'hot topic' – not only for geothermal energy systems but for all forms of fluid injection and storage.
- Secondly, engineered storage of methane, carbon dioxide or hydrogen entails explicit efforts on understanding the integrity of the sealing formations overlying the intended storage reservoirs. Improved understanding of both the overburden and the reservoir will be needed, using techniques such as shallow seismic imaging or acquisition of broad-band seismic data.
- The stronger focus on sustainability often means that a greater degree of surveillance and long-term assurance for management of subsurface resources is needed. These efforts are likely to include geochemical characterisation of groundwater systems, use of advanced geophysical monitoring methods, improved understanding of stress and strain evolution in rock masses and geo-systems modelling covering periods of 100's of years into the future.
- The rapid growth in new renewables (solar photovoltaics and wind turbines), has a less obvious but still clear connection to applied geoscience – the demand for green minerals (metals and rare earths) will increase the need for mapping and modelling of shallower rock units. The energy transition will entail more, not less, activity in exploration for resources.

These are, at least, some of the most important emerging themes but no doubt submitting authors will identify new aspects of applied earth science that none of the rest of us have even thought of – novel by definition. Despite this important and stimulating interest in new forms of energy, the use of hydrocarbons remains essential to human society, and novel and innovative papers on the geoscience of petroleum (derived from 'rock oil' in Greek) will continue to be a vital part of our geoscience portfolio. We look forward to receiving a continuing stream of high-quality research papers across all aspects of applied geoscience.

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