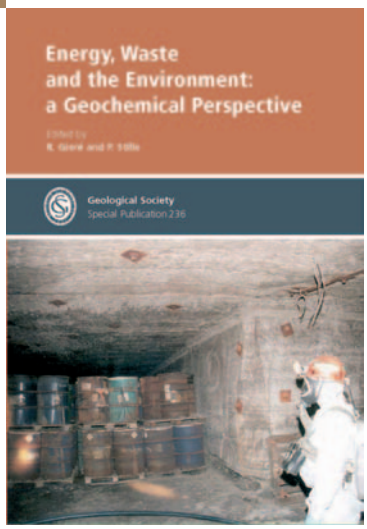
Energy, Waste and the Environment: a Geochemical Perspective

All scenarios for the 21st century, however they may differ in detail, agree on one thing: the world energy consumption should steadily increase during the next decades, as a result of both the growth of the global population and the economic development of countries like China, India, and Brazil, which will have to satisfy an increasing domestic demand for consumer goods. It is predicted that the energy needs should be about 18 GTep in 2050 and 23 GTep in 2100, compared to 9.3 GTep in 2000 (GTep: gigatonnes equivalent petroleum). This massive increase in energy production will require the solution of complex technological and economic problems, as no energy source can meet the demand alone. In addition, these developments will generate huge amounts of gaseous, liquid, and solid wastes, which will have to be properly managed if we are to control and ultimately reduce the environmental consequences. The impact of energy-related wastes, whatever the source (petroleum, nuclear, renewable sources such as wind, sun, tides and biomass), cannot be neglected anymore, as the fluxes of matter released into the environment are now large enough to directly affect (bio)geochemical cycles and basic self-regulated processes at the Earth's surface. For instance, there is now a wide consensus within the scientific community that the continuous injection of huge amounts of carbon dioxide into the atmosphere since the begining of the industrial revolution, essentially due to the consumption of fossil fuels, is responsible for global warming through the "green house effect". This will be a major issue for this century, and it will have to be dealt with in ways that will take into consideration all the political, ethical, economic, industrial, scientific, and technological aspects.

Energy,waste, and the environment are thus strongly linked terms that provide the title to this remarkable book, edited by Prof. R. Gieré and P. Stille, with contributions from a panel of world-class experts, and published by the Geological Society Publishing House. The book has an original perspective, as it focuses on geochemical approaches to the treatment, confinement, and dispersion of wastes generated by energy production and consumption. Its greatest merit is that it demonstrates that international research at the highest level is being carried out on energy-related wastes and, therefore, that the scientific community is dealing with the issue as seriously as possible. Indeed, this field has become, in less than three decades, a major area of interaction between science and society, in which diverse considerations and interests are intimately entangled. Through thirty-six contributed chapters, the reader is led to a deep understanding of the main environmental issues and the techniques developed to determine the fate of these wastes when released or disposed of in nature. In particular, emphasis is put on the use of the so-called "natural analogues" to build strategies for the confinement of toxic and radioactive components in natural systems over extremely long periods of time, a procedure that cannot be properly simulated in the laboratory. Natural analogues are diverse materials and geochemical processes, occurring in a range of geological (or even archaeological) sites, that can be investigated by scientists. Analogues contribute to the development of waste immobilization techniques, the design of disposal concepts, the confirmation of key mechanisms identified in laboratory experiments, and the testing of the robustness and credibility of models. Such a combined approach guarantees, with reasonable confidence, the stability and safe isolation of wastes in the environment. In particular, thermodynamic modeling and kinetic concepts are critical geochemical tools in this respect. All these aspects are described in the book.



The five sections of *Energy, Waste and the Environment: a Geochemical Perspective* contain numerous and thought-provoking ideas, a few of which I shall highlight. The first section deals with issues related to the nuclear fuel cycle. It is argued that advanced fuel cycles and waste management technologies must be developed if this source of energy is to contribute significantly to decreasing the carbon dioxide concentration in the atmosphere. Due to the very long time spans over which safety must be guaranteed for the underground disposal of nuclear wastes, the role of natural analogues is emphasized. The fossil fuel cycle is discussed in the second part of the book. The reduction of carbon dioxide emissions is envisaged through injection and trapping in deep geological formations. In addition, the mineralogical and geochemical characterization of mining and combustion wastes appears essential to assess the environmental impact of the extensive use of coal. Among alternative sources, the exploitation of geothermal heat, supposedly an environment-friendly technology, is described in part four of the book as generating huge amounts of waste fluids. The deep underground reinjection of these fluids is explored as a possible way to minimize their environmental impact. The fifth part of the book deals with the waste-to-energy cycle. The interesting idea of considering "wastes" as a possible source of valuable chemical components and energy (an idea already defended in the fifties but since forgotten) is discussed. Finally, water-waste interactions, which are the main ways in which toxic and radioactive elements can be released and dispersed in the environment, are carefully examined in part six.

In conclusion, this timely book demonstrates that geochemistry is a key science to help us solve the difficult environmental issues raised by the world's economic development.

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