Lessons from the past – a guide for the future

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The Earth was formed about 5 billion years ago. During such a long time, it has undergone many processes that have shaped its structure, including the formation of a global supercontinent and its break-up into several migrating fragments, the formation of the oceans, the evolution of the climate and its changes, and the associated phenomena of rock weathering and the formation of sedimentary cover. A geologist can say that everything in the history of the Earth has already happened, and a number of phenomena have occurred repeatedly. The geological sciences have specialized knowledge, research methods and modern instruments to trace the Earth's climate changes in the past. It is not only the knowledge of the quality of the phenomena have they occurred, but also of their quantity, i.e. the knowledge that can give a precise answer to the questions how many times these phenomena have occurred in the Earth's history, and what are the quantitative determinants of the process (ranges and rates of temperature change, sea-level change, atmospheric gas concentrations, extent of global and regional glaciations, amount of precipitation, *etc*.). In principle, all geological events, and therefore environmental events, are cyclical (varying in scale, extent, frequency and amplitude). The migration of the continents is well-documented in terms of their original position, the duration of this migration and the climatic-environmental consequences. Similarly, the rise and fall of the oceans is well-documented.

If there is a periodicity of geological events, and a periodicity of solar activity, then there is also a periodicity of climate change. Past events can therefore be used to predict how current and future climate processes will unfold.

Science and scientists are concerned with learning natural laws and phenomena, understanding their causes and processes, and determining their effects. Science should remain impartial, objective and courageous in proclaiming the results of its achievements. It must not be constrained by censorship, and political, cultural, or environmental correctness. It should be truthful and objective. So should the discussion of the results achieved. The discussion must be *ad meritum*, not *ad personam*. No one who is involved in the debate on the causes and the course of climate change should be left out of it. The falsification of claims and paradigms is the responsibility of the scientific world. The laws of science and their development mean a constant search for contradictions in theories, or for facts to support them, to create new paradigms – these are the objective laws of scientific theory development. Climate change depends on so many factors that it must be studied by multidisciplinary research teams, as it is not possible to accept findings from just one or two sources, such as atmospheric physics or climatology. It is necessary to take a broader and multi-criteria view of this research issue, which has a very important practical message for humanity.

There have been several periods in Earth's history when the activities of the biosphere led to climatic disasters in the form of glaciations that covered most or even the entire planet. There have also been periods of much higher temperatures than today, during which life on Earth underwent a vigorous evolution.

A specific new element in the long history of the Earth is man, who, through deliberate action, significantly alters the land surface by exploiting natural accumulations of useful components. In this process, human beings produce emissions into all components of the environment: air, soil, surface water and groundwater. However, we must be aware that, throughout the history of the Earth, there has been natural erosion and degradation of large rock formations that probably host rich concentrations of metals. Some of them have been re-trapped and contributed to the formation of sedimentary mineral deposits. Continuous natural leaks and emissions of hydrocarbons into the environment from oil and gas reservoirs are well-known. These processes were also well-known in Poland already many centuries before Lukasiewicz's discovery – from the Carpathian Mountains. The Earth "breathes" all the time, emitting various gases into the atmosphere, including greenhouse gases, without any human involvement. Radon, carbon dioxide, methane, nitrogen oxides, sulphur dioxide or halides are emitted from the land surface, from the oceans, or as a result of volcanic activity.

In the public arena, the issue of climate change is being very widely discussed, but what is important is that large-scale measures are being taken to reduce the human impact on the environment. The Kyoto Protocol, a supplement to the United Nations Framework Convention on Climate Change adopted at the Earth Summit in Rio de Janeiro in 1992, serves this purpose. The countries of the European Union (including Poland) are at the forefront of these pro-environmental measures. The actions of various pro-environmental organizations and the growing support for green parties have undoubtedly contributed to the measures taken in particular by the European Union countries, to the introduction of limits on greenhouse gas emissions aimed primarily at eliminating the so-called "carbon footprint", to the energy transition, and to many other measures that make up the European Green Deal. It is hard to find people who do not want a clean environment, air and water. However, when we deal with the problem of global climate change, all aspects have to be considered on a global scale.

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The countries of the European Union are largely phasing out domestic heavy industry by reducing atmospheric emissions and switching to so-called renewable energy sources. However, we still need steel, aluminum, rare metals, rare earth elements, finished electronic products, and cars in Europe and worldwide.

Making cars requires access to huge amounts of energy and the processing of billions of tonnes of ores of various chemical elements that are mined all over the world, but preferably not in our neighborhood. So all these gases and other pollutants are produced and released into the environment in different places around the world. Moreover, with a degree of probability bordering on certainty, they are significantly higher than those in the highly technologically advanced countries of the European Union. The NIMBY (Not In My Back Yard) and BANANA (Build Absolutely Nothing Anywhere Near Anything) syndromes are doing well! On a global scale, it makes no difference whether the emissions take place in Europe or a few or several thousand kilometers away. A good example of this is the well-known case of the so-called "year without a summer". Massive eruptions of the Tambora volcano (Indonesia) in April 1815 introduced large amounts of volcanic ash. Its prolonged persistence in the upper layers of the atmosphere caused frost to destroy most agricultural crops in both Europe and North America in 1816, leading to famine. June snowstorms in eastern Canada and the USA then resulted in many deaths.

Climate research must therefore take into account the role of different climate drivers and the effects of their mutual coupling. A strategy for adapting to climate change should not be the result of speculation, but of projections based on a thorough knowledge of the Earth's climate history.

We therefore invite you to read the articles in this issue of *Przegląd Geologiczny* to better understand the processes of climate change over millions of years and their consequences, and to predict future trends.

The eruption of Vesuvius in 1767. View from Portici. From: *Abrégé des transactions philosophiqies. Histoire naturelle*. Gibelin M. Published in Paris, Buisson, 1787. Courtesy of K. and S. Wołkowicz