Variability of isotopic signature of phyllosilicates in soils of mountain areas in the temperate climate zone

Earth's climate is changing constantly and those changes have a profound effect on our economy, industry or agriculture. Being able to understand them and to predict them is therefore important. Computer models can be used to predict future climate, however, such models have to be tested (calibrated) in order to verify their reliability. For the obvious reasons, thiss cannot be done using data on future climate, therefore a common practice is to use computer models to simulate past climate and check if their predictions are in agreement with paleoclimatic reconstructions based on geologic evidence.

One source of such evidence are isotopic studies on fossilized soils, called paleosols. Isotopes are simply atoms of the same element differing in atomic mass. Due to this difference, isotopes of the same element behave slightly different during various processes, such as mineral crystallization. The result is that the ratio of the number of atoms of one isotope to the number of atoms of the other isotope, for certain elements such as hydrogen or oxygen, are different in different minerals. We say that minerals have different isotopic compositions of the certain element. For a given mineral and element, isotopic composition is dependent on temperature of its formation. This means, that if we measure isotopic composition of one element in two different minerals formed in the soil of the past, we can deduce temperature of their formation, hence we can obtain information on past climate.

The problem is, however, that for a paleosols we can never be sure if the minerals truly formed in equilibrium with soil environment and if their isotopic signature was not altered by geological processes after their formation. One way to solve this problem is to compare studies on paleosols with studies on a present-day analogues, soils, according to one of the main concepts in geology that "the present is a key to the past".

The aim of the project is to provide such material for comparison, by performing a detailed mineralogical and isotopic investigation on soils form three different locations: the Tatra Mountains (Poland), the Beartooth Mountains (United States of America), and the Grampian Highlands (United Kingdom). Isotopic composition of oxygen and hydrogen will be investigated. At each study site a number of soil samples will be collected for laboratory investigation involving a number of analytical techniques such as: X-Ray Diffraction, Fourier Transform Infrared Spectroscopy, Isotope-Ratio Mass Spectrometry. The main focus on the study will be on clay minerals – a group of minerals that commonly form in soil and that are often used in paleoclimatic reconstructions. In addition, isotopic composition of stream waters in the Tatra Mountains will be monitored. This will allow to check, if isotopic composition of clay minerals reflect isotopic composition of water present in their environment.

The results of the project will allow to better understand processes governing isotopic composition of minerals in soils. The study will bring together specialists coming from different fields: mineralogy, soil science and hydrology. The results will provide a reference material for paleoclimatic studies and will also allow to better understand modern processes occurring in soils.