Water which flows from our taps looks everywhere the same. Asked for its color we would answer that water is transparent. However, if we would be able to observe each individual water molecule under strong "microscope" we would notice subtle differences stemming from the fact that elements from which water molecules are build (hydrogen and oxygen), have their varieties which differ slightly in their masses (isotopes). Thus, in ordinary water which flows from a tap one may find several isotopically different water molecules, several "colors". Most popular are those molecules which contain ordinary hydrogen (^{1}H) and ordinary oxygen (^{16}O) - this is $^{1}H_2{}^{16}O$ molecule. However, there are also other isotope water molecules, such as $^{1}H^{2}H^{16}O$, $^{1}H_2{}^{18}O$, and $^{1}H_2{}^{17}O$. The first two were subject of interest for several decades now. It appeared that if we measure concentrations of ^{2}H and ^{18}O in water, we may learn a good deal about its origin and history.

Heavy stable isotopes of water, ^{2}H and ^{18}O, are widely used in hydrology since the 1960s. In groundwater hydrology stable isotopes of water serve as powerful tools for identification of the origin of water (e.g. meteoric vs non-meteoric, recent infiltration vs infiltration under different climatic regime), they help to quantify mixing patterns of various water types, they serve as indicators of the elevation of groundwater recharge areas in mountainous regions and they help to identify and quantify the interaction between groundwater and dependent ecosystems, just to name few. In the domain of surface water hydrology they have been successfully used for solving water balances of surface water bodies such as lakes, particularly with respect to underground components of those balances. Also, they were and are used to quantify components of river discharge under different hydrological regimes. Over the past two decades, the third isotopic molecule of water mentioned above, $^{1}H_2{}^{17}O$, has been receiving growing attention.

Concentrated salt solutions (brines) constitute a special category of water. Deuterium and oxygen-18 isotope composition of water molecules in concentrated saline solutions (brines) has been applied as a powerful tool in quantifying water balances of saline lakes, in deciphering the origin of fluids encountered in deep sedimentary basins and fluids associated with exploration and exploitation of oil and gas reserves, as well as in investigating the origin of water appearances in salt mines.

The proposed project is aimed at thorough assessment of triple-isotope geochemistry of concentrated saline solutions through dedicated laboratory experiments and extensive observation and measurement program launched in an operating salt mine. The abundance of three heavy water isotopologues ($^{1}H^{2}H^{16}O$, $^{1}H_2{}^{18}O$ and $^{1}H_2{}^{17}O$), along with the secondary isotope parameters (so-called d-excess and ^{17}O-excess), will be determined in samples of synthetic and natural brines using a dedicated laser spectrometer. The existing knowledge gaps in isotope geochemistry of brines will be addressed by the project through the following research activities:

(a) Quantification of full isotopic composition ($\delta^{2}H$, $\delta^{18}O$ and $\delta^{17}O$) of natural seawater samples subject to evaporation under controlled laboratory conditions (temperature, relative humidity). The evaporation process will be terminated when approximately 70% of the initial mass of the samples is evaporated.

(b) Comprehensive characterization of ambient atmosphere inside the operating salt mine located in Central Poland (Kłodawa Salt Mine S.A.). This characterization will consists of quasi-continuous monitoring of temperature and relative humidity of air in selected corridors and galleries of the mine during one-year period, supplemented by periodic sampling of mine atmosphere for subsequent analyses of triple-isotope composition of water vapour.

(c) Investigating the dynamics of interaction between concentrated salt solutions of different mineralization (synthetic and natural) and the ambient moisture of known characteristics (concentration and triple-isotope composition). Sets of samples of saline solutions will be exposed to ambient atmosphere, both in the laboratory and in the operating mine and temporal evolution of their chemical and isotopic composition will be determined.

To the best of our knowledge, the scope and extend of the proposed project is without precedence as far as geochemistry of brines is concerned. The project results should fill in the existing knowledge gaps in isotope geochemistry of brines and strengthen the use of isotope tracers in quantifying the origin of water appearances in the operating salt mines, thus improving their water safety.