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Using Stable Isotopes for Karstic Water Origin Assessment in Georgian Caucasus Mts.

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ABSTRACT

In order to assess karstic water origin and groundwater flow routes, mapping of the territory of West Georgia by using stable isotope application was initiated. Isotopic composition of various karstic groundwater sources in recharge and discharge areas of karst aquifers was studied on samples taken in the territory of southern slopes of the Greater Caucasus mountains.

Keywords: *karstic water, stable isotopes, mapping*

Introduction

Due to the impact of climate change, precipitation has significantly decreased in Georgia which caused significant decrease and in some places even drying of surface water flows and depletion of groundwater sources mainly in natural springs. Herewith, the water scarce western and eastern Georgia lowland can be considered as the most affected by frequent overexploitation and deterioration of local shallow groundwater resources. In the same time, the waters recharged in the karstic aquifers, outcropping on the southern slopes of the Greater Caucasus mountains, may be considered as alternative groundwater resources for the communities living in the lowland and the adjacent foothills (major cities in west Georgia such as Zugdidi, Senaki, Kutaisi and Zestafoni as well as eastern Georgian cites of Tianeti, Kvareli, Lagodekhi and their adjacent areas). Here, about half of the renewable groundwater in artesian basins and confined groundwater systems in Georgia can be considered as belonging to the above mentioned karstic water-bearing horizon.

The use of isotopes (particularly isotopes of oxygen and hydrogen present in the water molecule) was established in hydrology and hydrogeology in the past 5 decades, complements the conventional hydrological, hydrogeological, geophysical and geochemical approaches. Isotopes can quantify variables which are not otherwise measurable – for example the mean transit time (time spent by the water in the aquifer), altitude of groundwater recharge areas, contribution and mixing proportions of river water or melted snow surpluses to production wells etc… In addition, isotopes can be used to trace for the origin and pathways of recharge or contamination, thus contributing to the assessment of groundwater vulnerability and sustainability in terms of both water quantity and quality [1-6].

Material and methods

The project of Georgian Scientific foundation FR-18-18411 "Environmental tracers for assessment of karstic water resources under climate changes in Georgia" introduces the first regional application of isotopic

and hydrochemical methods for a better understanding of Georgian karstic water resources. In order to assess these resources, the pathways between the recharge zones along the Caucasus and aquifers need to be addressed and risks of groundwater contamination along these pathways need to be evaluated.

On the territory of West Georgia, the hydrogeological and hydrogeochemical surveys were performed in order to define the main hydrogeological features of the region. In the frame of the aforementioned project, more than one hundred of water points of various nature (springs, wells, boreholes, rivers) were sampled during 2019. Physical parameters (pH, O_2, EC, temperature) were measured on site during sampling. Water samples were collected both for chemical (major ions) and isotope analyses.

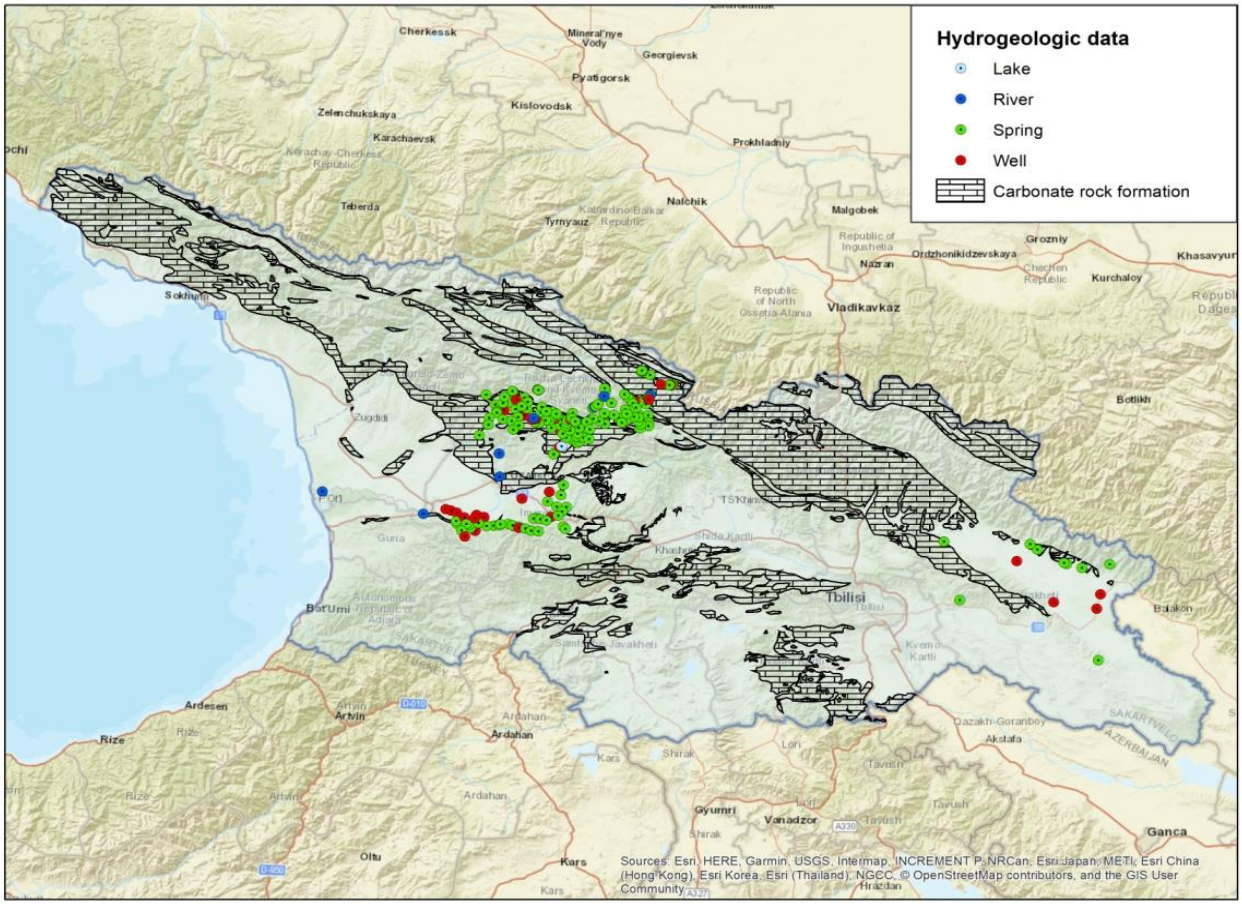

Fig. 1. Distribution of sampling point on the study area

Project activities were covering the territory of West Georgia, particularly mountain part of the southern slopes of the Great Caucasus Mountain range and part of lowland of West Georgia. Apart from karstic areas also adjacent neighbouring territories were included in the project activities. Environmental isotopes – isotopic composition of water ($\delta^{18}O$ and $\delta^{2}H$) was analysed and interpreted in laboratory of Institute of Geophysics.

Fig. 2 shows the $\delta^{18}O$/ $\delta^{2}H$ relationship in all samples taken within project activities. It reveals that waters in almost all samples are located along the global meteoric water line (GMWL).

Distribution of stable isotopes is mainly directed by water exchange between individual aquifers. Fig. 2 also reveals that modern recharge water with $\delta^{18}O$ values less than -8.5 ‰ V-SMOW is bound to the springs, boreholes, wells, and also lake and river water in the mountain areas. Boreholes tapping deep layers contain both normal and mineral groundwater with heavier $\delta^{18}O$ values between -6.5 and -8.5 ‰ V-SMOW. Thermal water samples from deep boreholes as Tskaltubo, Vani etc. reveal

presence of paleo-waters with $\delta^{18}O$ values outside of GMWL, evidently affected by geochemical processes within aquifers manifested by oxygen shift.

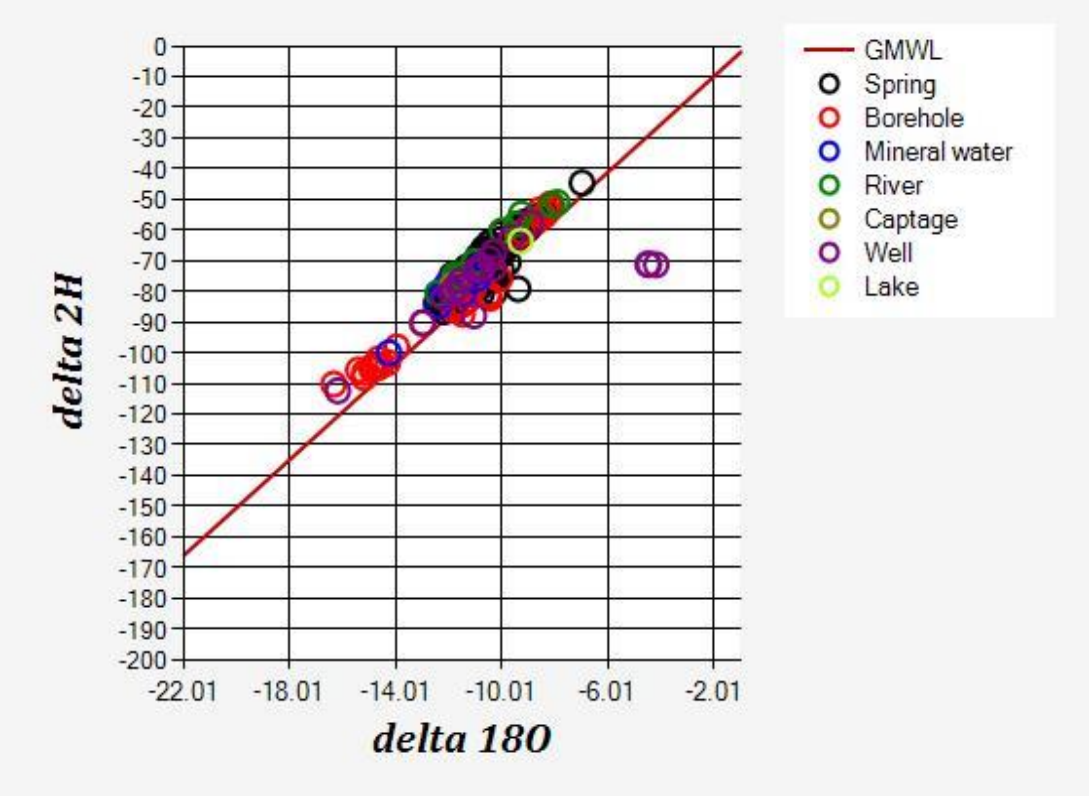

Fig. 2. Isotopic composition of samples.

In order to study groundwater flow directions, possible recharge areas and mean transit time in various seasons as well as the stability of isotope composition in various water sources, project activities will continue by sampling and monitoring of stable isotopes variation in the future.

Conclusions

Water isotopic composition in the study area evolves according to a line parallel with the global meteoric water line. According to isotopic data already available, several groups of groundwater possibly sorted by their origin are indicated. Some of these represent older waters with relative stability, majority of samples indicates the evolution of groundwater isotopic composition from the recharge area in the mountains through the river valleys to the discharge areas. Deuterium excess recorded at the majority of samples has higher values which are typical for mountain precipitation and snow, like in other mountain ranges worldwide. The conjunctive use of isotopic approaches demonstrates a high potential of this method for future studies of water resources in Georgia.

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სტაბილური იზოტოპების მეთოდოლოგიის გამოყენება კარსტული წყლების წარმოშობის დადგენის მიზნით

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ლ. ღლონტი, თ. ჭიკაძე

რეზიუმე

კარსტული წყლების წარმოშობის და გავრცელების დადგენის მიზნით დაწყებული იქნა დასავლეთ საქართველოს ტერიტორიის აგეგმვა სტაბილური იზოტოპების მეთოდოლოგგის გამოყენებით. შესწავლილი იქნა სტაბილური იზოტოპების გავრცელება ტერიტორიაზე, მიწისქვეშა წყლების წარმოშობა, მათი კვებისა და განტვირთვის არეები.

Использование методологий стабильных изотопов для установления происхождения карстовых вод

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Резюме

Для установления происхождения и распространения карстовых вод были начаты съемочные работы с использованием методики стабильных изотопов на территории Западной Грузии. Было изучено распространение стабильных изотопов на территории, происхождение подземных вод, ареалы их питания и разгрузки.