and animals are concentrated in the same places, and that increases the risks. Now it is known that the disappearance of species in a chain influences others, especially in an environment where the number of species is relatively small, that is the case of the Arctic. There is no need to mention the risks of pollution because of the oil and gas development.

The above-mentioned examples show that the issues of the Arctic cannot be treated in small groups. It interests worldwide and not only the riparian states. It is in this context that the continued active engagement of all the countries is of particular importance. The risks of the Arctic zone can be transformed into new possibilities not only for the Arctic region but also for the whole world. And in this situation the most important and fundamental efforts should be done by the key players of the international geopolitics of our days, namely the Russian Federation, the United States, the European Union, and the People's Republic of China.

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ASSESSMENT OF RESERVOIR TEMPERATURES OF TARYS AND CHOYGAN GEOTHERMAL SYSTEMS (EASTERN TUVA)

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The territory of the eastern Tuva refers to the continuation of the Baikal seismogenic Rift Zone and has significant reserves of geothermal resources. These hydrotherms formed due to the numerous deep faults and the presence of faults in rocks. The thermal and sub-thermal springs manifest by the high temperatures and active depth heat and mass transfer in the bowels of the Eastern Tuva[3].

One of the interesting aspects of the geothermal system study is to determine the subsurface reservoir temperatures, as one of the factors in the groundwater formation. Geothermometers are the most important and universal geochemical tool for the evaluation of reservoir temperatures. The first geothermometers developed by Bodvarsson and Palmason in 1961 were exclusively empirical and based on the link between the silicon content and the contents of some the cations with the reservoir temperature [2]. Using geothermometers involves the establishment of the chemical equilibrium in the geothermal system between a mineral and fluid

In this regard, the aim is to study the thermal conditions of the geothermal system in the Eastern Tuva.

The study of thermal waters in the Baikal Rift Zone was conducted by Lomonosov I.S. (1974), Lisak S.V. (1976), Polyak B.G. (1992), Zaman L.V. (2000), Plyusnin A.M. (2000), Golubev V.A. (2007), Shvartsev S.L. (2015) et al. Badminov P.S., Orgilyanov A.I., Ganchimeg D. (2011) studied subsurface temperature in this territory. Rychkova K.M., Duchkov A.D., Lebedev V.I. and Kamensky I.L. etc. (2007, 2010) carried out the assessment of the heat flow in the Tyva region. In Polyak's works (1994) isotopic composition, heat, and mass transfer of fluids for the Baikal Rift Zone were recorded.

The thermal springs of natural spa complexes Choygan and Tarys were selected for the geothermometric evaluation of the Eastern Tuva geothermal system. Choygan is located in the East Sayan in the north-east of the Republic of Tyva on the border with Buryatia. This is a reservoir of carbonic cold and thermal waters. Groundwater is discharged in the form of springs with the temperature on the surface of up to 39 °C, but the deep water temperature is much higher.

Tarys sources are located on the border with Mongolia, in 300 kilometers southwest from Choygan in outskirts of the Prehubsugul's plateau, it is a province of nitrogen water. The water temperature in Tarys springs reaches 50 °C. The water is considered as medicinal and used by local residents.

Hydrothermal springs of Choygan and Tarys are the hydrothermal system belongs to the southwestern flank of the Baikal Rift Zone, which is formed by heating groundwater of the regional thermal field in the process of deep circulation. The formation of these sources is associated with areas of young volcanism in the Eastern Tuva and, probably, is controlled by a large single submeridional fault [1, 5]. According to the helium isotope, the heat flow rate is 68 mW/m^2 in Tarys and 84 mW/m^2 in Choygan [3].

Table

Reservoir temperatures in geothermal systems of Tarys and Choygan

Tarys				Choygan			
№ Spring	Measured T(℃)	Na-K-Ca Fournier and Truesdell (1973), ℃	h, km	№ Spring	T(℃) on a surface	Na-K-Ca Fournier and Truesdell (1973), ℃	h, km
1	48	118,1	4,3	1	22,6	116,6	3,5
2	43	117,0	4,3	6	29,5	113,8	3,4
3	45	119,3	4,4	7	23,8	115,0	3,4
4	47	112,9	4,2	8	25,3	99,9	3,0
5	47	120,2	4,4	9	27	112,3	3,3
6	48	113,3	4,2	10	30,2	118,0	3,5
7	47	105,4	3,9	11	31,5	118,9	3,5
8	45	120,6	4,4	12	38,5	116,0	3,5
9	30	111,9	4,1	13	36,8	118,4	3,5
10	21	81,7	3,0	15	24,9	98,6	2,9
11	20	90,1	3,3	16	27	108,3	3,2
15	46	119,2	4,4	17	22,4	83,7	2,5
16	25	109,4	4,0	19	30,9	91,5	2,7
17	34	120,5	4,4	26	20,2	83,7	2,5
18	43	92,1	3,4	27	21,4	82,0	2,4
20	32	74,9	2,8	31	27,4	103,7	3,1
21	30	106,2	3,9	32	26,6	107,7	3,2
22	36	121,2	4,5				
23	37	111,3	4,1				
Average	*38,1*	*108,7*	*4,0*		*27,4*	*105,2*	*3,1*

The results of the chemical composition analysis of 19 Tarys thermal springs and 17 Choygan springs were used [4, 6]. Based on these results and water saturation [4] the reservoir temperatures were calculated using Na-K-Ca geothermometers (Fournier and Truesdell, 1973): $T = 1647/(\lg(Na/K) + \beta\lg(Ca^{0,5}/Na) + 2,24) - 273,15$, Na, K, Ca – concentrations are in mol/L, $\beta = 4/3$ for $t < 100$ ℃.

Determination of the fluid formation depth was carried out by the formula: $h = T/\gamma$, γ – geothermic degree [1]. The geothermic degree for Tarys is 27,2 ℃/km. Taking into account the heat flow rate in Tarys and Choygan, the average heat conduction of metamorphic and igneous rocks in the mountainous regions of Southern Siberia (2,5 W/ m °C), and for Choygan – 33,6 ℃/km. The results of geothermometric are given in Table.

As can be seen from the Table, despite the fact that the measured temperature of the Tarys springs are higher than that of Choygan, their reservoir temperatures are close to each other and range from 75 to 121 °C and from 81 to 118 °C at Choygan (Figure). The range of the formation depth of Tarys thermal waters is from 2,8 km to 4,5 km, the average is 4 km. For Choygan, the average depth of water circulation is 1 km higher and ranged from 2,4 to 3,5 km. This implies that the Choygan thermal springs formed at a lower depth than Tarys springs at equal temperatures, due to the higher heat flow in Choygan.

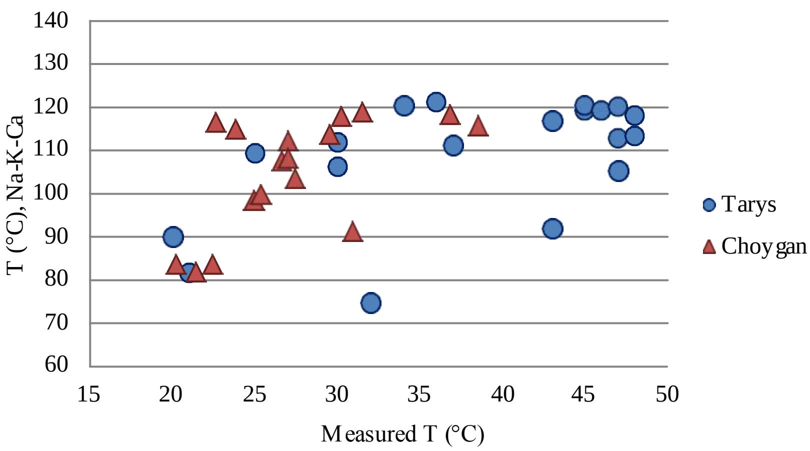

Fig. Graph of linking measured temperature at the discharge of springs and the reservoir temperature of Tarys and Choygan springs

Generally, the results of geothermometry showed that thermal waters of Tarys and Choygan have similar formation temperature. Groundwater reaches temperatures of 100 ° C at the depth of at least 2,5 km due to heating of the percolating water on fractured rocks. Thus, the presence of a single deep fault, fracturing the surrounding rock and high geothermic degree of the region are the main factors for the thermal waters formation.

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GEMS THROUGH THE EYES OF ANTIQUITY

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From the down of time the mankind has been interested in exploration of the planet they live in. In ancient times knowledge of the word around – of geology in particular – based on conjectures or religious superstitions due to lack of knowing. However, nowadays science made a real breakthrough and now we know the true reasons of one or another natural phenomena. Although, it is still interesting to cast a look at science past and glance at how our predecessors had explained the appearance of different minerals.

For example, *clear quartz* – the mineral with the most accomplished hexagonal crystals, which heats people's imagination all through the ages by its extraordinary qualities such as hardness, extremely ideal transparence and low temperature at a touch. In Aristotle's writings we can find the saying: "*Ex aqua generatur crystallus remoto totaliter calido*" which means that when water loses its' warmth in full it turns into clear quartz. In other words, ancient Romans thought that clear quartz was the ice which had forgotten how to melt down [2].

While on the quartz variety subject, let's take a look at *opal* formation legend. There is an Indian story about goddess of rainbow, who was really beautiful and for whose love lots of men had been fighting. One day the goddess was followed by group of men and when she realized that she couldn't shake off the pursuers she dapped and turned into millions of marvelous opal stones [2].

Interestingly enough, in ancient Egypt there were also a "rainbow legend" but this time it was about *tourmaline*. According to the legend, one colorless stone was walking in the skies and saw a rainbow. The stone was so impressed by the beauty of rainbow colours that he incorporated rainbow colors and became the same multicolored [4].

In The Bible and The Holy Scripture legends about stones have found their place too. The thing is, both sources called *jasper* the progenitor of all minerals on Earth. In addition, jasper is mentioned in a book Exodus, chapter 28 as one of 12 stones which were used for creating golden breastplate with four lines of jewels for Aaron, Moses' older brother:

Exodus 28:20

The fourth, a topaz, a beryl, and a jasper; they are to be fixed in twisted frames of gold.

As a matter of fact, there is a probability that jasper in Exodus was actually a *nephrite*. Such confusion could be accounted for by similarity in colour of green jasper and nephrite's coloration. Linguistic similarity brings in even more confusion. For instance, in Chinese and Japanese languages both jasper and nephrite are written by character "玉" [3]. Nevertheless, nephrite was considered as much more valuable stone than jasper at all times, so that is why the majority of geologists are sure that it is referred to nephrite in these legends.

It begs the question, if nephrite is a progenitor of all minerals, what is the progenitor of nephrite? The answer could be found in Chinese tale about The Creation. The legend tells us about a giant called Pangu, the first human on Earth who created the Universe. Pangu divided skies and earth and undersat skies with his shoulders until own death. And when his breath converted into wind, his hair became stars, grass and trees, while blood became rivers and his marrow turned into nephrite and pearls [9].

Talking about *pearl*, Pliny the Elder in his book "Natural History" narrated another way of pearl's appearance. He supposed that the oyster which produces pearls is a stone. Oyster opens at dawn and takes in the rays of stars, the moon and sun rays and drinks dew, and pearls are made of this mixture [6]. What is more, in legends pearls are