

HISTORY OF TECHNOLOGY

DOI: 10.32703/2415-7422-2021-11-2-329-350

UDC 626.91:629.123:929:93:94

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The history of the world's first icebreaker “Yermak” and the significance of its first expeditions to explore the Arctic

Abstract. *In this article, the authors tried to consider and structure the stages of development and creation of the “Yermak”, the world's first Arctic icebreaker, and analyzed the stages of preparation and the results of its first expeditions to explore the Arctic. Systematic analysis of historical sources and biographical material allowed to separate and comprehensively consider the conditions and prehistory for the development and creation of “Yermak” icebreaker. Also, the authors gave an assessment to the role of Vice Admiral Stepan Osypovych Makarov in those events, and analyzed the role of Sergei Yulyevich Witte, Dmitri Ivanovich Mendeleev and Pyotr Petrovich Semenov-Tian-Shansky in the preparation and implementation of the first Arctic expeditions of the “Yermak” icebreaker. In addition, the authors considered and analyzed the assessment of Vice Admiral Stepan Osypovych Makarov and his personal contribution to the results of the first Arctic expeditions of the “Yermak” icebreaker made by Baron Ferdinand von Wrangel. The first polar expeditions showed that the idea of Vice Admiral Stepan Osypovych Makarov about the icebreaker fleet was viable*



and required further development. It is shown that the results of the first Arctic expeditions made by “Yermak” allowed to significantly develop knowledge in various scientific fields of Arctic and Earth research, namely, topography, astronomy, meteorology, hydrology, geology, magnetism, zoology, and botany. The use of these methods and approaches to scientific research allowed to retrace the way of life and professional activity of Vice Admiral Stepan Osypovych Makarov’s systematically and critically evaluate the sources used, highlight the main points in the current state of studying the subject and the results of predecessors, specify the most promising directions of research, give a description of the previous works on this issue and clearly distinguish issues that have not yet been resolved.

Keywords: “Yermak”icebreaker; Northern Sea Route; Imperial Russian Geographical Society; Vice Admiral Makarov; Arctic research; polar expeditions

Introduction.

The name of Stepan Osypovych Makarov is inextricably linked with the idea of conquering the polar ice with the help of an icebreaker. He wanted to free the shores of Siberia from the ice and provide access to its powerful rivers, connecting these rich territories with the rest of the world via a cheap sea route. Vice Admiral Stepan Osypovych Makarov was an outstanding man of his time. He was able to brilliantly combine naval service and research, addressing the issues of both oceanology and oceanography. His oceanographic research is all the more significant because it was carried out in his spare time. Being a hard-working, ambitious, active, extremely dedicated and strong-willed, perseverant and fearless person, Stepan Makarov succeeded in many ways. One of successes, and perhaps one of the most significant, was the creation of the “Yermak” icebreaker and its first expeditions (Figure 1).

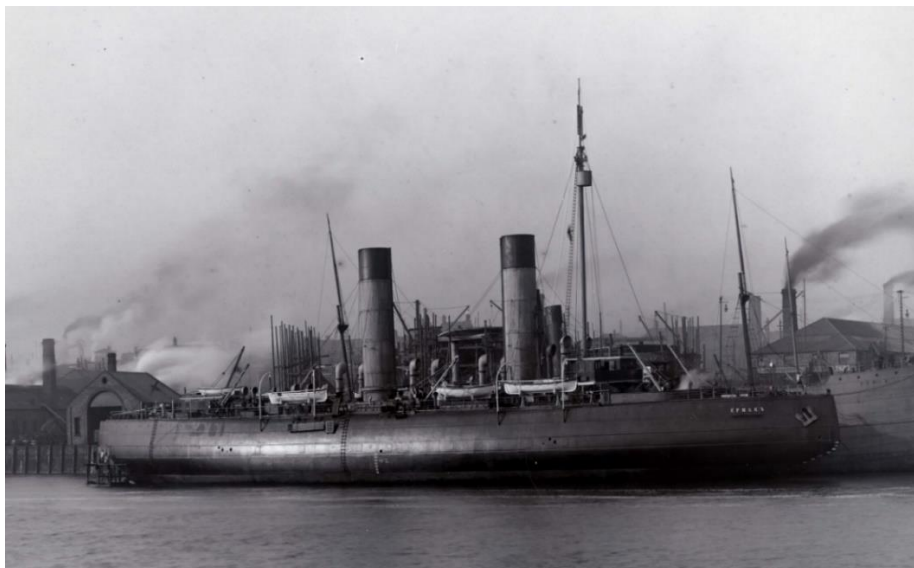


Figure 1. The “Yermak” at the in 1898 at the shipyard of Armstrong Whitworth & Co. at Low Walker on the Tyne (Tyne & Wear Archives & Museums, 2013, November 27).

The “Yermak” icebreaker brought Makarov worldwide recognition and fame and made him a national hero (Wrangel, 1913, p. 221). However, there are few scientific researches dedicated to the very idea of using icebreakers for the exploration of the Arctic, the creation of the “Yermak”, its tests and scientific achievements of the first expeditions (Avkhadeev, 2018; Fyfe, 1900; Gogorev & Samsonov, 2016; Gulston, 1901; Saunders, 2017; Sukhova & Skrydlov, 2018, Czernyadjeva, Afonina, & Kholod, 2020; Ruksha, 2000; Skrydlov, 2019). Many of them briefly mention the “Yermak” icebreaker as the first icebreaker of the Arctic class, give its technical characteristics, or mention the contribution of the first expeditions in the development of the Northern Sea Route. The authors of this work haven’t found any fundamental study that would either consider or structure the stages of development and creation of the “Yermak”, the world’s first Arctic icebreaker, or analyze the stages of preparation and results of its first expeditions to explore the Arctic. Therefore, this is the purpose and the main objective of this study.

Research methods.

Systematic analysis of historical sources and biographical material allowed to separate and comprehensively consider the conditions and prehistory for the development and creation of “Yermak” icebreaker. Also, the authors gave an assessment to the role of Vice Admiral Stepan Osypovych Makarov in those events, and analyzed the role of Sergei Yulyevich Witte, Dmitri Ivanovich Mendeleev and Pyotr Petrovich Semenov-Tian-Shansky in the preparation and implementation of the first Arctic expeditions of the “Yermak” icebreaker. In addition, the authors considered and analyzed the assessment of Vice Admiral Stepan Osypovych Makarov and his personal contribution to the results of the first Arctic expeditions of the “Yermak” icebreaker made by Baron Ferdinand von Wrangel. The first polar expeditions showed that the idea of Vice Admiral Stepan Osypovych Makarov about the icebreaker fleet was viable and required further development. It is shown that the results of the first Arctic expeditions made by “Yermak” allowed to significantly develop knowledge in various scientific fields of Arctic and Earth research, namely, topography, astronomy, meteorology, hydrology, geology, magnetism, zoology, and botany. During the preparation of the article, chronological, comparative methods of historical knowledge, classification, and systematization of historical sources and bibliographic material were used (Gaidai & Srogosz, 2021; Gutnyk, Tverytnykova, & Sklyar, 2019; Strelko, 2021; Strelko et al., 2021; Strelko & Pylypchuk, 2021). The use of these methods and approaches to scientific research allowed to retrace the way of life and professional activity of Vice Admiral Stepan Osypovych Makarov’s systematically and critically evaluate the sources used, highlight the main points in the current state of studying the subject and the results of predecessors, specify the most promising directions of research, give a description of the previous works on this issue and clearly distinguish issues that have not yet been resolved.

Results and discussion.

The name of Stepan Osypovych Makarov is inextricably linked with the idea of conquering the polar ice with the help of an icebreaker. He wanted to free the shores of Siberia from the ice and provide access to its powerful rivers, connecting these rich territories with the rest of the world via a cheap sea route. Vice Admiral Stepan Osypovych Makarov was an outstanding man of his time. He was able to brilliantly combine naval service and research, addressing the issues of both oceanology and oceanography. His oceanographic research is all the more significant because it was carried out in his spare time. Being a hard-working, ambitious, active, extremely dedicated and strong-willed, perseverant and fearless person, Stepan Makarov succeeded in many ways. One of successes, and perhaps one of the most significant, was the creation of the “Yermak” icebreaker and its first expeditions. The “Yermak” icebreaker brought Makarov worldwide recognition and fame and made him a national hero. However, there are few scientific researches dedicated to the very idea of using icebreakers for the exploration of the Arctic, the creation of the “Yermak”, its tests and scientific achievements of the first expeditions. Many of them briefly mention the “Yermak” icebreaker as the first icebreaker of the Arctic class, give its technical characteristics, or mention the contribution of the first expeditions in the development of the Northern Sea Route. The authors of this work haven’t found any fundamental study that would either consider or structure the stages of development and creation of the “Yermak”, the world's first Arctic icebreaker, or analyze the stages of preparation and results of its first expeditions to explore the Arctic. Therefore, this is the purpose and the main objective of this study.

The idea of exploring the Arctic Ocean appeared in 1892, long before F. Nansen, a Norwegian oceanographer and traveler, was sent to the Arctic Ocean (Wrangel, 1913, p. 221). Even at that time, Makarov was convinced that the polar ice could be conquered with the help of a strong ship that could break the ice. That is why he collected information about the polar ice from time to time. It should be added that before Makarov's researches, explorers could only land in the Arctic on drifting ships that froze in the ice and were carried by ocean currents. That is why there were special rescue expeditions equipped to save those ships and scientists on board.

To convince the authorities of the need to develop icebreaking in the Russian Empire, Makarov focused on the commercial advantage. In particular, he pointed out that St. Petersburg, the principal port of the Baltic Sea, was closed for 5 months due to ice, while Arkhangelsk, the main port of the White Sea, was unreachable for 7 months, not to mention large Russian rivers by the sea which were closed for 11 or 12 months. The problem of navigation in the Arctic Ocean remained unchanged under adverse conditions. February 18, 1897 during the Imperial Russian Geographical Society Council meeting P. P. Semenov-Tian-Shansky said that Vice-Admiral S. O. Makarov “expressed to many of the Society Members his thoughts on the navigation method in the polar seas with the steam icebreakers assistance”. It was finally decided to convene

an emergent the Imperial Russian Geographical Society meeting and to propose Makarov “to explain the essence more clearly” (The Imperial Russian Geographical Society Herald, 1897, February 18).

First of all, the scientist gave a lecture on this issue among specialists and researchers. The scientific community gave a cold reception to Makarov’s bold proposal and did not take him seriously. Similarly, speech at the Imperial Russian Geographical Society and the St. Petersburg Academy of Sciences did not yield positive results. Both of these institutions did not accept this idea and did not support it with their authority. In particular, some renowned scientists of the Geographical Society spoke as if they themselves had visited the Arctic Ocean. They were convinced that it was impossible to break the polar ice, that ice was subject to metamorphosis because of large quantities, and therefore no machine could break it.

Such a critical attitude insulted Makarov, but still could not destroy his goal. He decided to involve the ruling strata of society, people who were fascinated by new ideas and projects. Thanks to the help of P. P. Semenov-Tian-Shansky, the Vice-Chairman of the Imperial Russian Geographical Society, on March 30, 1897, he gave a landmark public lecture at the Marble Palace of the Academy of Sciences for people who had significant social weight and influence in ruling circles. That lecture was attended by ministers, representatives of big business and even members of the Imperial family the President of St. Petersburg Academy of Sciences, Grand Duke Konstantin Konstantinovich and Grand Duke Alexander Mikhailovich, heading the Naval Ministry were present (Sukhova & Skrydlov, 2018). At the beginning of the meeting, Makarov’s colleague the hydrograph F. F. Wrangel performed a report on the Russian polar research history. Then Makarov told about his observations results during the voyage “on the Arctic Sea” that summer. According to Makarov: “It isn’t the question to build an icebreakers or not to do it, but it’s the question to build them now or wait even longer” (The Imperial Russian Geographical Society Herald, 1897, March 30). Makarov outlined the history of the ice breaking, which originated in the Russian Empire and was widely developed in the United States, as well as already known data on the study of polar ice. The aim of his project was the scientific study of the entire Arctic Ocean and the discovery of the shortest way to the Ob and the Yenisey rivers, as well as the discovery of a way to St. Petersburg during the winter.

The ruling circles expressed their interest in this project. Emperor Nicholas II ordered Sergei Yulyevich Witte, the Minister of Finance, to get acquainted with Makarov’s project. Sergei Yulyevich referred to D. I. Mendeleev, who gave a positive response. After inviting Makarov for a personal audience, Witte was able to see that he was dealing with a serious scientist, a man of broad scientific views and practical reason. Therefore, he invited him to go to the Kara Sea, to the rivers Ob and Yenisey for the necessary practical research. After arriving from the trip, Stepan Osypovych submitted his report to the Minister of Finance, which was later included in his scientific work called “Yermak in the Ice” (Makarov, 1898).

Thanks to Witte's support, Makarov began work on the first domestic icebreaker. A commission was set up to work out the technical conditions for its construction, headed by Makarov. The construction of the icebreaker was entrusted to the Armstrong plant in Britain, and was thoroughly observed by the watchful eye of Stepan Osypovych. When signing the contract with this plant, it was stated that the vessel had to be tested for unsinkability by filling it with water.

Arriving in England immediately after signing the contract, Stepan Osypovych agreed on all the designs and drawings, and consulted with the builders of icebreakers from other countries to gain knowledge and practical experience.

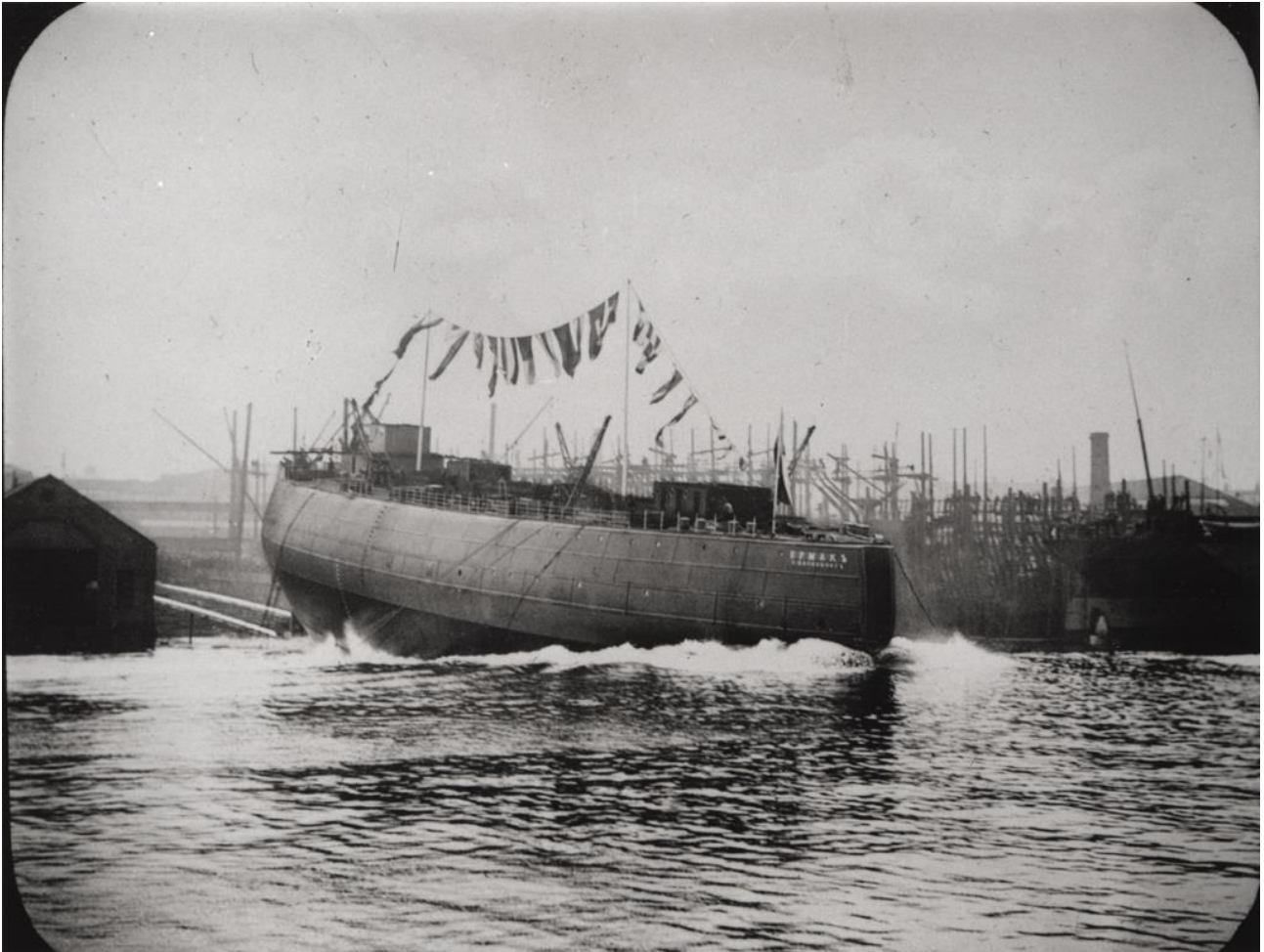


Figure 2. The launching of the “Yermak”, 1898, Walker, Newcastle-on-Tyne (Lockerby, 2011).

In the summer of 1898, Vice Admiral Makarov led the Practical Squadron of the Baltic Sea, and that is why Mikhail Petrovich Vasiliev, his devoted student, a young captain of the 2nd rank and a talented sailor had to take control over the construction of the icebreaker (later he became the captain of the “Yermak”, and died in 1904 on the Petropavlovsk battleship together with Makarov). Although Makarov could not visit the launch of the icebreaker on October 17, 1898, he was present at the ship's tests

for unsinkability. These tests were quite successful. In general, many useful constructive improvements were applied on the “Yermak” according to Makarov’s personal orders. Baron Ferdinand Ferdinandovich von Wrangel, his friend and biographer, noted in his memoirs that after the “Yermak” was built, he met with engineers and craftsmen who built the ship. The British highly valued Vice Admiral Makarov's skills and talents, respected his knowledge of shipbuilding, and admired his ability to find a way out of any difficult situation even if experienced engineers couldn’t.

The design of ships specifically intended for breaking ice is a relatively new branch in the field of naval architecture. Interest in the polar regions, as recorded by the expeditions to these areas in the early 19th century, predated by many years the development of materials and power plants required by ships to operate in these regions. The first seagoing icebreaker, “Yermak” (Figure 2), was built for the Russian government in 1898. The ship was built of steel, with 1½ inch plating along the waterline. “Yermak” displaced 10,000 tons and had engines of over 10,000 HP. Her design proved successful and she is generally regarded as the prototype of seagoing icebreakers (Hill & Coburn, 1961).

The ship, some 319 feet long and 70 abeam, was very tubby in design. Six boilers fed either three shafts aft or one forward, allowing her to back and ram if needed— now standard procedure for icebreakers but novel at the time. Speaking of the bow, she had a strengthened hull of 29 mm plate steel sandwiched with oak and cork to allow her to break sea ice at over 7 feet thick. Her twin 55-foot high stacks and round sloping bow with a small stem and flare angles made her readily distinguishable and came to typify early icebreaker design. Even today, her hull form is imitated in even the most advanced polar icebreaker design (Figure 3).

The “Yermak” began its first voyage on February 21, 1898, leaving Newcastle for Kronstadt. It was at this time of year that the Baltic Fleet was cut off by ice from the whole country for 6 months. On March 4, 1898 “Yermak” approached the city of Kronstadt, accompanied by solemn applause and greetings from the icebreakers. Yermak's arrival in Kronstadt was a high day for the city. All the inhabitants of the city and its environs came out to meet the icebreaker: *“Each of those present felt proud for us, Russians, because there were people among us who were not only able to draw theoretical conclusions, but could also prove and confirm practical ideas to open new horizons”* (Wrangel, 1913, p. 247). Emperor Nicholas II telegraphed to Kronstadt: *“Congratulations on your arrival in Kronstadt at this time of year. I rejoice with you in the brilliant realization of your idea”* (Wrangel, 1913, p. 244).

While staying in the port of Kronstadt, the “Yermak” icebreaker freed 11 steamers with valuable cargoes that were in danger. The icebreaker returned to St. Petersburg with a lot of tourists on board, which evidenced the unusual and important work performed by Stepan Osypovych Makarov. After arriving in the capital, he became a national hero (Figure 4).

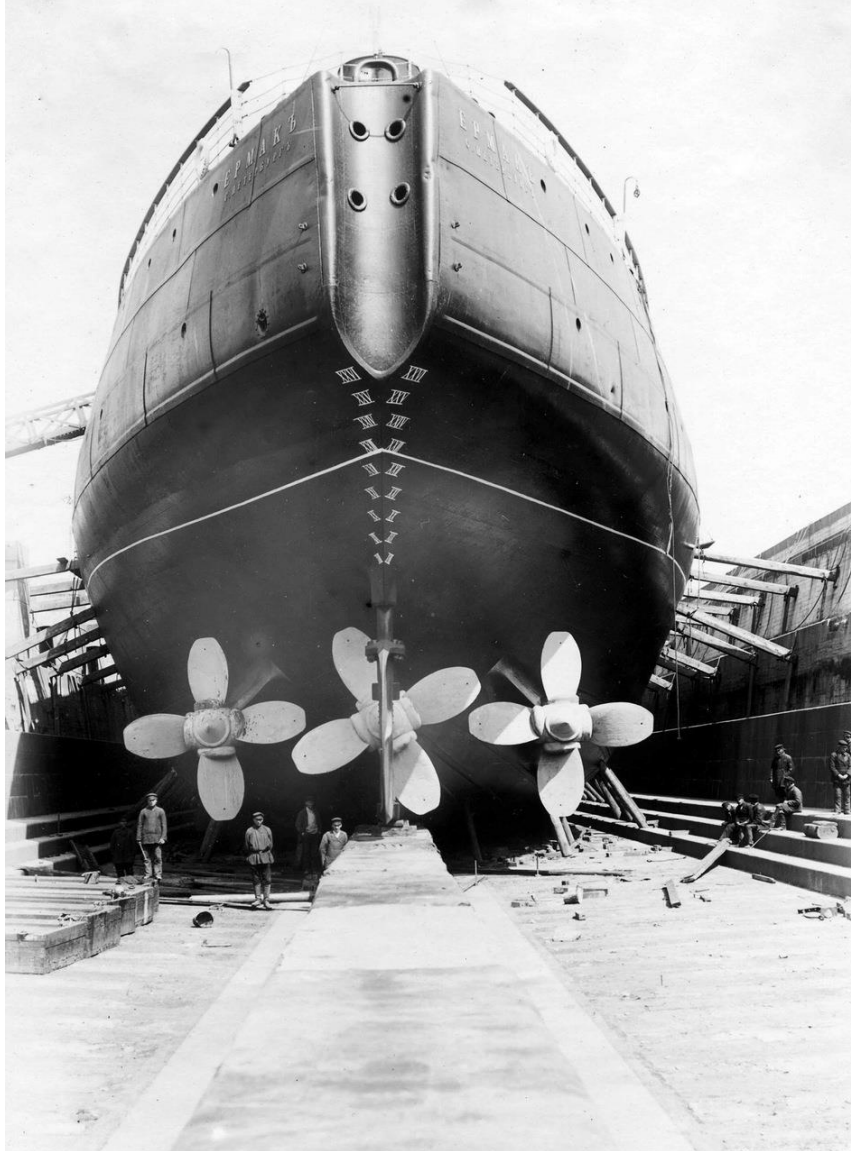


Figure 3. The icebreaker “Yermak”. Note the close arrangement of her three stern screws (Eger, 2015).

Makarov’s next goal was a more difficult voyage on the “Yermak” icebreaker in the polar ice. The Vice Admiral prepared very carefully for this trip. From the outset, the Vice Admiral emphasized that the “Yermak” was not yet powerful enough to fight the polar ice, and that a positive outcome, namely the Kara Sea, or even access to the Pacific Ocean, could only be achieved with two icebreakers. Makarov stressed that polar ice had a great resistance and “Yermak” might not be able to cope with it. Therefore, he chose a direction which, in case of falling into an ice trap, would let them return the same way with the drifting ice (and the currents beneath it).

In addition to engineering work and calculations, he decided to invite several scientists to the voyage in order to carry out important scientific research, especially in places where there no man has been before. For instance, the list included: Professor Fedor Fedorovich Vitram, the famous astronomer of the Pulkovo Observatory (his

duties included determining the latitudes and longitudes of the signs placed at different predetermined points of the icebreaker course); Lieutenant Konstantin Fedorovich Schultz, a mine officer (he was in charge of the cinematographic and electrical parts of the work, and participated in extracting water from great depths); Baron Eduard Vasilyevich Toll, a famous scientist and traveler, was invited to study geology; Lieutenant Isaac Ibrahimovich Islamov was to perform hydrographic work; Oleksandr Hryhorovych Chernyshov, a forensic scientist, was in charge of zoologic questions; Boris Pavlovich Ostashchenko-Kudryavtsev, Astronomer of the Pulkovo Observatory, was invited in order to make magnetic observations and study the physical properties of ice; geodetic works and research of the ice surface were carried out by cadastral engineer Konstantin Tsvetkov. In addition to scientists, Evhen Ivanovych Stolytsia, a talented artist and a student of Professor Kuindzhi, was invited to the ship. He was recommended by Count Tolstoy, Vice President of the Imperial Academy of Arts, and painted a number of beautiful still lives depicting the amazing polar nature.



Figure 4. This photo shows the “Yermak” arriving at St Petersburg in 1899 (Tyne & Wear Archives & Museums, 2013, November 27).

In his scientific activity Makarov worked closely with the famous domestic scientist Dmitry Ivanovich Mendeleev. It was Stepan Osypovych who introduced

smokeless gunpowder invented by D. I. Mendeleev to the fleet. Dmitry Ivanovich always spoke highly and positively of Stepan Osypovich, but the “Yermak” icebreaker put an end to their cooperation and friendship. Stepan Osypovich invited Mendeleev to the voyage as a researcher, but Mendeleev emphasized that the whole expedition had to take place under the auspices of his name, reducing Makarov to the position of the Head of the Naval Unit. Mendeleev wanted to lead the expedition, to determine scientific tasks, to choose the direction, and to make the final decision on every issue. In short, the famous scientist did not want to be dependent on Vice Admiral Makarov. Shocked to the core, the Vice Admiral disagreed. Then Mendeleev called him “an upstart suffering from a mania for greatness”. This is when the friendly relations of two prominent people of the late 19th century were destroyed. Of course, the voyage started without Dmitry Ivanovich.

In our opinion, this fact is very interesting, primarily because it demonstrates how general fame and recognition can affect and spoil a person's character. Mendeleev had no right to demand this, because it was well known that the “Yermak” was the brainchild of Makarov, and he himself was not only an outstanding navigator, but also a world-renowned scientist.

The first test voyage in the polar ice began on May 29, 1899, when the “Yermak” set sail from Newcastle for the Arctic Ocean. This expedition was fundamentally different from the one in Baltic Sea, because the polar ice has different properties and structure. Two weeks later, the “Yermak” returned because, according to Stepan Osypovich, the hull was not yet strong enough to travel in the polar ice. A month later, on July 14, 1898, the second test voyage of the icebreaker began. The Vice Admiral's records show that the voyage was carried out quite carefully, as there was no experience in polar voyages yet and because the ice that needed to be broken was 1.5 to 8 m thick. Throughout the voyage, the team of sailors and scientists worked harmoniously and amicably. In addition to scientific research, they even recorded a film. What's interesting, according to the Vice Admiral's records, polar bears were killed only when food was needed. In this voyage, the “Yermak” reached 81°30' to the north, quite close to the edge of the ice frame, weakened by the warm Gulf Stream.

Another interesting observation of Stepan Osypovich was that in the Baltic Sea, freshwater ice crumbled into small pieces under the icebreaker and got stuck to the ship, hindering the movement in the water. Instead, the salty polar ice broke in great chunks, making it easier to move in the water, but touching them caused shocks that were not felt in the Baltic Sea. The polar ice did not crumble, but crumpled. However, despite the caution, the “Yermak” still got a small hole at the beginning of its journey, which did not allow to dive deeper into the northern ice. It happened near Spitzbergen. In mid-August 1898, the “Yermak” returned to Newcastle. The news that the “Yermak” had returned to England due to a hole in the bow of the ship was actively used by numerous enemies and opponents of Vice Admiral Makarov. Baron F. F. Wrangel wrote: “*I was in St. Petersburg at that time, and I could not fail to mention the open*

malice of many people when they heard the sad news of the Yermak failure” (Wrangel, 1913, p. 303).

The main problem was that the “Yermak” was going to fight the still unexplored northern ice and terrain. As you know, talented people always have a lot of enemies, so implementing daring ideas is always a huge risk. The conquest of the northern ice was one of them. Significant funds were spent on its implementation, but the most important was the reputation of Vice Admiral Makarov, a man who had never made a mistake and succeeded in all his endeavors.

This failure shook Stepan Osypovych's belief that man could conquer the polar ice. The enemies of the Vice Admiral started to inflate a kind of sensation from this fact. Baron F. F. Wrangel noted that the scandal would not be possible if Mendeleev had been on board. In that situation broken relationship with Mendeleev and the St. Petersburg Academy of Sciences exacerbated the complexity of the situation. But human pride and a stable system of values of Vice Admiral Makarov did not allow compromises, so he took the blow firmly with his head high.

In September 1898, a commission arrived in Newcastle to investigate the damage to the “Yermak”. It consisted entirely of active opponents of Vice Admiral Makarov. Later in his letter to Baron F. F. Wrangel, he wrote that his extraordinary frankness was his biggest mistake, and that he shouldn't have telegraphed to the Minister immediately about the damage to the ship:

“My frankness hurt me. After arriving in Newcastle, my frankness told me to send a telegram that the ship had a hole. My punishment for frankness was not long in coming, because the next day I received a telegram from S. Yu. Witte: “Please stay in Newcastle until the commission arrives”. I should have sent a telegram: “The Yermak breaks the ice perfectly. I'll report personally”. It would be vile, but reasonable, because with my telegram I gave my enemies a reason to arrange a commission and now the question is how I settle with it (Wrangel, 1913, p. 318).

In any case, the only problem with this situation was that the ice turned out to be much stronger than the engineers thought. No one appreciated the significant and invaluable results that the Vice Admiral achieved during those two trips in the polar ice. They only paid attention to the failure, which, unfortunately, is always inherent in the Russian people.

Stepan Osypovych regretted that, unlike Russia, England would not look at this problem as a failure, but on the contrary would welcome the new interesting information and results. In contrast to his homeland, lectures on polar travel held in Newcastle caused great excitement and admiration. Despite the complexity of the situation, when the enemies enjoyed the failure of the Vice Admiral, in late 1898 Makarov finished the 507-page monograph “Yermak in the Ice”, emphasizing that *“all polar expeditions (including Nansen's) failed to achieve their goal. But if we know anything about the Arctic Ocean, it is only due to these unsuccessful expeditions”* (Wrangel, 1913, p. 322). This fact suggests that the Vice Admiral had great strength of spirit. Under conditions when the average person step aside and reduce efficiency, he

managed to put all the data in order and complete his fundamental scientific work. As if to the detriment of the authorities of the Russian Geographical Society, Makarov detailed the physical properties of polar ice and its behavior when exposed to an icebreaker. The monograph was published in 1901 in a brilliant edition by the well-known publishing house “Blockhouse and Efron”, and consisted of 507 pages, 152 drawings (most of them were photographs of the best quality for that time), 5 maps of the polar seas with the routes of the “Yermak” icebreaker, and the results of hydrological observations.

This scientific work was divided into 2 parts. In the first part, the author spoke about the details of the whole expedition. Namely, he described how the idea of creating an icebreaker was born, how Makarov sought to convince the public of its necessity, the details of design and construction, a detailed description of the vessel and its testing on open water. In this part, the author also described the first attempts of the icebreaker to fight the ice of the Gulf of Finland, and the work in the Gulf of Finland to release the steamers trapped in the ice. Separate sections of the book were dedicated to the first and second test voyages in the Northern ice, all the joys and difficulties of these expeditions, the implemented scientific research, including the study of the physical properties of ice. In this section, the Vice Admiral detailed the work of the icebreaker in the Baltic Fleet campaign of 1899–1901.

The second part of this work was dedicated to reports, journals and notes on astronomy and navigation, meteorology, ice science, observations of ice strength and resistance to the motion of the “Yermak”, determination of the Earth's refractive index, experiments with models, chemical analysis of water samples and magnetic observations. Moreover, the work included the results of zoological research, reviews of rock samples found in moraine remains on a floating iceberg, and chemical analysis of water samples. A separate chapter was dedicated to a journal of hydrological and meteorological observations during navigation.

Of course, the commission headed by Rear Admiral Berilyov, Makarov's sworn enemy and opponent, decided that the “Yermak” icebreaker could no longer go into the polar ice, but should work only within the Baltic Fleet. In response, Stepan Osypovych published a rebuttal, giving a detailed description of the reasons for this failure. In this struggle the victory remained with Makarov. S. Yu. Witte, the Minister of Finance, was an outstanding strategic thinker, and took more complex paths on his way to the top, just like Makarov. As a result, the final decision was to repair the “Yermak” and use it for the winter work in the Baltic Fleet. Then he planned to build a new bow until spring and send the fortified “Yermak” to the Arctic Ocean, north of Novaya Zemlya, and determine whether it is ready for sailing in the polar ice and carry merchant ships to the mouths of Siberian rivers.

Between 1898 and 1899, the “Yermak” icebreaker was active in the Gulf of Finland. That winter, there was a certain resurgence and a sense of security among the merchants in case a commercial steamer suddenly got trapped in ice. “Yermak” escorted commercial ships across the ice to Kronstadt and rescued ships captivated in

ice. In particular, we should mention the situation with the Admiral Nakhimov, which could not leave the Baltic Sea in time due to early frosts and unplanned appearance of ice in the Gulf of Finland, as well as the General-Admiral Apraksin, which crashed into the Gotland island during blizzard, and was covered in ice (Figure 5). Thus, trade routes and connections in the Gulf of Finland were established and opened all year round, including with Kronstadt, Revel (Tallinn) and other trade hubs. But Stepan Osypovych himself no longer commanded the “Yermak” because at that time he led the Practical Squadron of the Baltic Sea, and in December 1899 he was appointed Governor of Kronstadt. The ship was under the command of Mikhail Petrovich Vasiliev, a talented navigator and a close friend of Makarov.



Figure 5. Icebreaker “Yermak” while rescuing the battleship “General-Admiral Apraksin” off the island of Gogland (Chapple, 2020).

In the summer of 1900, according to the contract, the “Yermak” went to Newcastle for the planned reconstruction of the bow. Even by that time, the icebreaker had brought a lot of benefits to the Russian Empire and had fully recouped the cost of construction. People say there is a blessing in disguise, so the first failure only prompted Stepan Osypovych to work harder, leading him to the long-awaited victory. This trend can be observed throughout the life and work of the prominent Vice Admiral. It is worth mentioning his fascination with mines, torpedoes and destroyers during the Turkish War of 1877–1878.

In March 1901, Vice Admiral Makarov again raised the question about the next voyage to the Arctic Ocean and addressed the Minister of Finance S. Yu. Witte. This time Makarov set a goal to get as close to the North Pole as possible. S. Yu. Witte sent Makarov's statement to P. P. Semenov-Tian-Shansky, the Vice-Chairman of the Imperial Russian Geographical Society, and to Admiral M. M. Chikhachov.

That time P. P. Semenov-Tian-Shansky did not support Makarov's idea (Sukhova & Skrydlov, 2018). In 1901, in a letter to S. Yu. Witte, after the polar research importance discussing, P. P. Semenov firmly stated that the "Yermak" didn't suit for the polar voyages and, consequently, for polar studies (Wrangel, 1913, p. 362–365). He might have been frightened by the public response to the Yermak's first failure, or might have changed his mind. In any case, he gave a respectful but negative response to Makarov's statement. A similar conclusion can be drawn from the response of Admiral M. M. Chikhachev, who also substantiated his thoughts on the inexpediency of the voyage. They did not doubt that the icebreaker could break the ice, but they were worried about whether the "Yermak" would be able to cope with this task. Based on these reviews, Witte withheld the "Yermak" from swimming again in the polar ice. This refusal was a severe blow to Makarov, so he wrote Witte a personal letter full of hope. After that, Witte approved the voyage.

The voyage was scheduled for the summer of 1901. The main purpose of the voyage was to study and describe the route to the Ob and the Yenisey rivers through the northern part of the Novaya Zemlya and the Kara Sea in order to determine the possibility of summer sailing to the mouths of these Siberian rivers. For the Russian Empire, establishing such a trade route was very important, because it could lead to proper shipping along the entire length of these rivers. That could have a huge impact on the development of northern Siberia with its forests, minerals and fish, and would allow transporting a huge amount of agricultural and livestock products of the temperate zone (products that could not be transported by rail). Before the expedition, Stepan Osypovych emphasized that on the basis of his knowledge about the Kara Sea and the northern ice, a powerful icebreaker could pave the way for commercial steamers in the summer, but he did not consider the "Yermak" powerful enough to do this.

That time he invited many scientists to join the expedition: Baron Volodymyr Yevhenovych Gravenitz, astronomer and fleet Lieutenant; Volodymyr Kostiantynovych Neupokoiev, meteorologist and hydrologist, fleet Lieutenant; Semen Petrovych Vulkov, physicist and magnetologist, chemist of the laboratory of the Maritime Department; Valerian Mykolaiovych Weber, geologist and mining engineer; Oleksandr Hryhorovych Chernyshov, zoologist and sea doctor; Ivan Volodymyrovych Palibin, botanist and conservator at the St. Petersburg Botanical Garden; Apollon Pavlovych Ravinskyi, topographer; and Anatolii Oleksandrovych Palibin, navigator and photographer.

The "Yermak" began its second voyage in May 1901. First the expedition reached Spitzbergen. 60 miles (96km) away from Novaya Zemlya they hit the ice which was

23 feet (7 m) thick, so for several days they hardly moved at all. During the stop, scientists arranged tours to collect research material and samples or study ice and flora. The “Yermak” was captivated by the northern ice for almost a month, from June 25 to July 24, 1901. After the icebreaker was set free, Makarov decided to go to Franz Joseph Land (in particular, to Cape Flora), then to Novaya Zemlya (to Cape Ledyanoy), and then to Spitzbergen, conducting scientific research along the way. The team of scientists landed at Hochstetter Island to get acquainted with its nature and collect samples from the island which was unknown until then. It was the first time Makarov found warm water between Franz Joseph Land and Novaya Zemlya. Passing near Novaya Zemlya, they visited Cape Nassau, Pankratiev Islands, Krestovaya Guba, Mashigina Bay, Cape Shantz, the Admiralty Peninsula, Cape Borisov and Sukhoy Nos. After carrying out the necessary scientific research, on September 1, 1901, the “Yermak” icebreaker returned to Kronstadt.

Of course, the goal of the voyage was not achieved, because the “Yermak” was not strong enough to break thick ice. However, that expedition showed that Makarov’s idea on the icebreaker fleet was viable and required further development.

Returning from the expedition, the scientific team of the “Yermak” presented valuable research material. In particular, it included:

1. *Topographic data.* O. P. Ravinskyi, topographer, took photographs and held a coastal cypregel survey, which served as a basis for the map of the northern part of Novaya Zemlya, between Mashigina Bay and the northern part of the Krestovyi Gulf up to Sukhoy Nos. He also drew 4 maps of glaciers and ice fields.

2. *Astronomical data.* Gravenitz, astronomer, and Neupokoev, meteorologist, calculated the astronomical position of Cape Shantz and Cape Smirnov in the northern part of Novaya Zemlya, as determined by the noon heights of the sun and the North Star.

3. *Meteorological data.* Lieutenant Neupokoiev monitored all elements of the atmosphere every 4 hours.

4. *Hydrological data.* Data were collected continuously every 50 miles. A total of 107 hydrological stations were investigated.

5. *Geological data.* Weber, mining engineer, collected samples of marine soils on the landslides encountered at sea, and also conducted coastal studies of the structure of the earth's surface and the nature of the fossil animals. Professor Stukeberg studied corals from the deposits of Novaya Zemlya.

6. Data on terrestrial magnetism collected by S. P. Vulkov in various places on land and sea.

7. *Zoological data.* Obtained during hydrological stations, mainly from the bottom of the Barents Sea.

8. *Botanical data.* I. V. Palibin obtained important results in the study of marine phytoplankton, diatoms in the polar ice and terrestrial vegetation of Spitzbergen, Franz Josef Land, and the northern part of Novaya Zemlya in terms of its state and history of development (Gogorev & Samsonov, 2016). The beginning of bryophyte exploration

can be attributed to L. V. Palibin, who participated the expedition on the icebreaker “Yermak” to the Barents Sea in 1901 (Czernyadjeva, Afonina, & Kholod, 2020). He published records of 12 moss species, collected mainly at the Flora Cape, Northbrook Island, and also small collections in Hochstetter Island (Palibin, 1903–1906) (Palibin, 1903a, 1903b, 1903c, 1903d, 1904, 1906a, 1906b). A .A. Yelenkin and V. P. Savichev were responsible for the treatment of lichens, while the rest of the spore plants (mosses, fungi, algae) brought from the expedition were studied by: Professor Broterus, Kolkwitz, Gran, Nadson, Yachevsky.

9. *Soil data.* The materials collected from this area were transferred to the Dokuchaev Soil Committee and processed by Armakovskaya.

Despite the fact that at first glance the voyage had a negative result, the expedition members held a completely different opinion. After all, they were all recognized scientists who voluntarily agreed to withstand the difficult conditions in order to replenish knowledge and information for the development of the above branches of science.

Nonetheless, they thought differently in St. Petersburg. People who had nothing to do with science saw only practical meaning and economic results of the voyage. Admiral A. A. Berilyov, the enemy of S. O. Makarov, took advantage of the so-called failure and sent a scathing letter to S. Yu. Witte: *“The “Yermak” returned with nothing: the ice remained impassable, and the ship itself was unworthy, both in design and execution, to make polar voyages and open the pole”* (Wrangel, 1913, p. 402).

No matter how hard Admiral Berilyov tried to denigrate the name of S. O. Makarov, the Yermak's second voyage was accepted even more positively than the first one. It was finally decided that the “Yermak” would no longer sail in the polar part of the ocean, and would remain in the Baltic Fleet. The “Yermak” was placed at the disposal of the Port Affairs Committee. This is how they took away Makarov’s creation, to which he devoted so much work, attention and energy.

Until the very last moment, not obeying public opinion, Stepan Osypovych argued that, if the “Yermak” had not been limited in time, it would have been possible to cross the Arctic Ocean. When it was decided to equip the expedition to help Baron Tol and his comrades, S. O. Makarov suggested to use the “Yermak”, but the academic commission instructed to consider this proposal rejected his opinion.

At that time Vice Admiral's contemporaries, both his friends and enemies, wondered whether Makarov's idea of icebreakers was too self-assured. Everyone had a different opinion. At that time, there was no definitive answer to this question. Here is how Baron F. F. Wrangel wrote about this:

“There are people who only value tangible material benefit; some place the glory of the Motherland above all, others view the search of truth, the victory of man over the forces of nature as the highest task of mankind. It seems to me that in the nearest future, a renewed Russia will deploy the inexhaustible forces of its people, use the immense treasures of its natural resources, and this is when the bold opinion of the Russian hero Makarov will be realized. We will build icebreakers that will pass

through the ice of the Arctic Ocean as freely as the “Yermak” passes through the waters of the Gulf of Finland. The Arctic Ocean will be studied thoroughly by Russian sailors, on Russian icebreakers, for the benefit of science and for the glory of Russia. No one can predict the economic benefits that Russia will eventually receive from this human victory over the forces of nature. But the history of mankind proves that any enrichment of science pays off a hundredfold, not to mention the moral significance of the people's readiness and ability of their sons to give themselves to misery and danger in the name of the idea” (Wrangel, 1913, p. 404-405).

As time has shown, Makarov's voyage in the Arctic Ocean began a fundamentally new stage of Arctic conquest and exploration, as he carried it out on the world's first powerful icebreaker. In other words, the “Yermak” icebreaker created by Makarov made two expeditions to the Arctic in 1899 and 1901. But Vice Admiral Makarov's contemporaries did not realize that it was a fundamentally new stage of the conquest of the Arctic.

In 1904, reporting to the Imperial Russian Geographical Society on the tragic Makarov's death during the Russian-Japanese War, the Chairman of the Department of Physical Geography, geologist F. N. Chernyshev noted that the “Yermak” creation “at first seemed to be a paradox” and after the first not quite successful navigation experience provoked “criticism of the very icebreaker idea” but finally turned out to be a world discovery (Sukhova & Skrydlov, 2018). Chernyshev, having himself participate in the 1901 expedition to Novaya Zemlya, organized by Makarov, believed that the “Yermak” was the most suitable vessel for fighting polar ice. Maritime department only after the Makarov's death realized the importance of using icebreakers for the Northern Sea Route development.

The most interesting thing in this whole story is that the North Pole was reached only 5 years after the death of Stepan Osypovych, on April 6, 1909 by the American discoverer Robert Perry. It happened as predicted by Baron F. F. Wrangel: in the 20th century, researchers have advanced thousands of miles in the study of the Arctic Ocean, making a huge contribution to the development of the Arctic. There are no more white spots on the map, and all the physical, geographical, zoological and chemical properties of this ocean have been studied.

The most important thing is that the largest ridges and plateaus of this area are named after famous domestic scientists: Lomonosov ridge, Gakkel ridge, Mendeleev ridge, Makarov plateau. Despite Makarov and Mendeleev had an argument and did not find common ground in the study of the Arctic Ocean, their names will always stay next to each other, both on the map and on the ground.

Conclusions.

The Arctic voyage of the “Yermak” icebreaker led by Admiral S. O. Makarov has initiated a fundamentally new stage in the conquest and exploration of the Arctic.

The results of the first Arctic expeditions of the “Yermak” icebreaker allowed to significantly develop knowledge in various scientific fields of Arctic and Earth

research, namely, topography; astronomy; meteorology; hydrology; geology; magnetism; zoology; botany.

Funding.

This research received no funding.

Conflicts of interest.

The authors declare no conflict of interest.

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Створення першого в світі криголаму арктичного класу “Єрмак” та аналіз значення результатів його перших експедицій для дослідження Арктики

Анотація. У даній статті, авторами вирішено завдання розгляду та періодизації етапів розробки та створення першого в світі криголаму арктичного класу “Єрмак”, а також аналізу етапів підготовки та результатів його перших експедицій у дослідженнях Арктики. Системний аналіз історичних джерел та біографічних матеріалів дозволив відокремити та всебічно розглянути умови та передісторію подій, що передували розробці та створенню криголаму “Єрмак”. Дана оцінка ролі віце-адмірала Степана Осиповича Макарова у цих подіях. Проаналізовано участь Сергія Юлійовича Вітте, Дмитра Івановича Менделєєва, Петра Петровича Семенова-Тянь-Шанського у підготовці та реалізації перших арктичних експедицій криголаму “Єрмак”. Розглянуто та проаналізовано оцінку барона Фердинанда Фердинандовича Врангеля, щодо особистого внеску віце-адмірала Степана Осиповича Макарова та результатів перших арктичних експедицій криголаму “Єрмак” під його командуванням. Перші полярні експедиції показали, що ідея віце-адмірала Степана Осиповича Макарова про криголамний флот є життєздатною і вимагала подальшого розвитку. Показано, що результати перших арктичних експедицій “Єрмак” дозволили значно розвинути знання у різних наукових галузях дослідження Арктики та Землі: топографії; астрономії; метеорології; гідрології; геології; магнетизму; зоології; ботаніці. Під час підготовки статті використано хронологічний, порівняльний прийом історичних знань, класифікацію, систематизацію історичних джерел та бібліографічного матеріалу. Використання цих методів і підходів до наукового дослідження дозволило відстежити життєвий шлях і професійну діяльність віце-адмірала Степана Осиповича Макарова, систематично та критично оцінити використані джерела, виділити основні моменти сучасного стану вивчення предмета та результати дослідження попередників, конкретизувати найбільш перспективні напрямки досліджень, надати характеристику попередніх робіт з цього питання та чітко відокремити питання, які ще не були до цього часу вирішені.

Ключові слова: криголам “Єрмак”; Північний морський шлях; Імператорське Російське географічне товариство; віце-адмірал Макаров; дослідження Арктики; полярні експедиції

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Создание первого в мире ледокола арктического класса “Ермак” и анализ результатов его первых экспедиций для исследования Арктики

Аннотация. В данной статье авторами решены задачи рассмотрения и периодизации этапов разработки и создания первого в мире ледокола арктического класса “Ермак”, а также анализа этапов подготовки и результатов его первых экспедиций в исследование Арктики. Системный анализ исторических источников и биографических материалов позволил отделить и всесторонне рассмотреть условия и предысторию событий, предшествовавших разработке и созданию ледокола “Ермак”. Дана оценка роли вице-адмирала Степана Осиповича Макарова в этих событиях. Проанализировано участие Сергея Юльевича Витте, Дмитрия Ивановича Менделеева, Петра Петровича Семенова-Тянь-Шанского в подготовке и реализации первых арктических экспедиций ледокола “Ермак”. Рассмотрена и проанализирована оценка барона Фердинанда Фердинандовича Врангеля, относительно личного вклада вице-адмирала Степана Осиповича Макарова и результатов первых арктических экспедиций ледокола “Ермак” под его командованием. Первые полярные экспедиции показали, что идея вице-адмирала Степана Осиповича Макарова о ледокольном флоте является жизнеспособной и требовала дальнейшего развития. Показано, что результаты первых арктических экспедиций “Ермака” позволили значительно развить знания в различных научных областях исследования Арктики и Земли: топографии; астрономии; метеорологии; гидрологии; геологии; магнетизма; зоологии; ботанике. При подготовке статьи использовались хронологический, сравнительный методы исторического познания, классификации и систематизации исторических источников и библиографического материала. Использование данных методов и подходов к научным исследованиям позволило проследить жизненный путь и профессиональную деятельность вице-адмирала Степана Осиповича Макарова, систематически и критически оценить использованные источники, выделить основные моменты современного состояния изучения предмета и результаты исследования предшественников, конкретизировать наиболее перспективные направления исследований, дать описание предыдущих работ по данному вопросу и четко выделить вопросы, которые еще не были до этого времени решены.

Ключевые слова: ледокол “Ермак”; Северный морской путь; Императорское Русское географическое общество; вице-адмирал Макаров; исследования Арктики; полярные экспедиции

Received 08.05.2021

Received in revised form 16.09.2021

Accepted 01.10.2021