

Alexander von Humboldt's ideas on volcanism and their influence on Russian scientists

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Abstract

The article provides historical background for Alexander von Humboldt's expedition into Russia in 1829. It includes information on Humboldt's works and publications in Russia over the course of his lifetime, as well as an explanation of the Russian scientific community's response to those works. Humboldt's ideas on the existence of an active volcano in Central Asia attracted the attention of two prominent Russian geographers, P.Semenov and P.Kropotkin, whose views on the nature of volcanism were quite different. P.Semenov personally met Humboldt in Berlin. P.Kropotkin made one of the most important geological discoveries of the 19th Century: he found the fresh volcanic cones near Lake Baikal.

Soon after Humboldt's Russian expedition, and partly as a result of it, an important mineral was found in the Ilmen mountains – samarskite, which later gave its name to the chemical element Samarium, developed in 1879. At the beginning of the 20th Century, the Russian scientist V.Vernadskiy pointed out that samarskite was the first uranium-rich mineral found in Russia.

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About the author

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1. Humboldt's place in the history of Russian science

Present-day studies of the history of Russian science in the 19th century show that it is full of gaps, which we can begin to fill today thanks to the rapid arrival of new data, the use of which was restricted in the Soviet period. The main reason behind such gaps is simple: the flat-out neglect of the so-called pre-revolutionary period (before 1917) in the Soviet Union.

The first step in restoring the full picture of the history of Russian science entails combining and distilling the relevant facts. In order to understand Humboldt's influence on Russian geology it is necessary to tripod a careful analysis of his expedition to Russia in 1829 and the subsequent familiarity of Russian scientists with Humboldt's legacy.

This paper deals mainly with two prominent Russian scientists in the field of geology, P. Semenov (1827-1914) and P. Kropotkin (1842-1921), and their knowledge of Humboldt's achievements in volcanology.

The first Russian translation of Humboldt's relevant research papers was completed by Ivan Neronov (Иван Неронов) and printed in St. Petersburg in 1835. In the chapter devoted to volcanology, „On the construction and mode of action of the volcanoes in different parts of the Globe,“ Humboldt discusses the internal heat of the earth and mentions the chemical analysis of glassy volcanic tephra of Vesuvius made by G. Rose¹. In this book, for the first time Humboldt has clearly formulated the geological concept of volcanism as a *connection of the incandescent (red-hot) Earth interior with its surface*. Another important idea formulated in this volume is the possibility of global climate change caused by volcanic activity.

I. Neronov also translated and published in St. Petersburg „The Travels of Baron Alexander von Humboldt, Ehrenberg and Rose over Siberia and towards the Caspian Sea“ (1837).² The first volume of Humboldt's „Kosmos“ was published in St.- Petersburg in 1848; part 2 (translated by M.Gusev) - in 1851; part 3 (translated by M.Gusev) - in 1853-57; part 4 (translated by Ya.Weinberg) – in Moscow in 1863; part 5 (translated by Ya.Weinberg) – in Moscow in 1863.³ Of Humboldt's work „Central Asia“ a first volume of the Russian translation was published only in 1915.⁴

Humboldt's concept of volcanism has passed the test of time. This concept is one of the most fruitful in the history of volcanology and geophysics.

The great Russian scientist Vladimir Vernadskiy (1863-1945) has stressed several points concerning the place of Humboldt's heritage in the history of science in his „Essays on Geochemistry“ (Russian edition, 1933) (Vernadskiy, 1994, pp. 412-413):

1. Humboldt's scientific biography has not yet been written, and his scientific heritage should be thoroughly investigated;
2. Humboldt came very close to a synthesis of the problems of geochemistry;
3. In Russia in particular, the significance of Humboldt's research has been inadequately studied.

This last point remains true at the present time.

In 1973, the USSR Academy of Sciences published „The History of Geology“ (edited by I. Batyushkova). This book, a 400-page volume, is devoted to the history of Earth's sciences from ancient times to the

beginning of the 20th century. One can count the number of the leading scientists' citations in the „List of names“ in this volume:

24	V. Vernadskiy (Russia)
21	M. Lomonosov (Russia)
20	A. Karpinskiy (Russia)
18	Élie de Beaumont (France)
17	A. Fersman (Russia)
16	A. v. Humboldt (Prussia)
15	A. Inostrantsev (Russia)
14 each	J. D. Dana (USA), I. Kant (Prussia), P. Niggli (Germany), D. Sokolov (Russia)
13 each	J. Hutton (GB), Ch. Lyell (GB), D. Mendeleev (Russia), I. Vogt (Norway)

Humboldt's name ranks second among foreign scientists and sixth overall.

2. Some features of the time of Humboldt's travels to Russia (1829)

A. v. Humboldt visited Russia while the first Russian University Charter was in power (adopted in 1804). The Charter introduced the autonomy of the universities and proclaimed the Council of Professors as the highest authority at a university. The charter was in action until 1835, when the universities became subordinated to administrative heads of regional governmental education departments.

In 1823, only a few years before A. v. Humboldt traveled to Russia, the German born Count Georg Cancrin (Egor Kankrin) (1774-1845) had been appointed Russian minister of finances. It is known that Cancrin supported the exploration of precious metals in Russia, and in 1826 he granted official permission for commercial gold mining to several merchants.⁵ Cancrin supported Maurice Engelhardt's (1779-1842) expedition to the Ural mountains in 1826, during which the first Russian diamonds were discovered.

In 1807, the Mining department of the Russian Government had been established. In 1813, after a young girl by the name of Katerina Bogdanova had found a gold nugget and shown it to her parents (see Humboldt's „Central Asia,“ Russian edition, 1915, p. 230), the mining of gold started in the Ural mountains. The first platinum was found in 1823 in the Ural region by V. LubarSKIY (according to Humboldt, and in 1819 according to the Chemical Elements Popular Encyclopedia, 1973, p. 180). In 1828, 1.5 tons of platinum were mined in Russia, and in 1843, 3.5 tons (cf. Chemical Elements Popular Encyclopedia, 1973, p. 181-182).

In 1826, powder technology experiments with platinum were successfully completed. They made the coining of platinum in Russia possible. It started in 1828 and lasted until 1845, also with the support of finance minister Cancrin. The price of platinum was set to be only 3.8 times as high as that of silver.

The first successes in the mining of precious metals in Russia correspond in time with the first issue of the „Mining Journal“ in 1825.

In 1829, several expeditions to volcanic regions were organized in Russia: Friedrich Parrot's (1791-1841) expedition to Mt. Ararat, Adolf Kupffer's expedition to Mt. Elbrus mountain and Adolf Erman's travel to Kamtchatka, to measure magnetic field intensity in Russia's wide open spaces.

3. History of geological science timeline

Let us consider important facts in the history of geology and geological thinking dealing with the subject of this article.

Below is the chronology of important events:

- 1794 Immanuel Kant is elected honorary member of the St.-Petersburg Academy of Sciences (this fact is omitted in Kant's biography in the Soviet Encyclopedia (3rd edition, vol. 11 (1973))
- 1796 A. v. Humboldt for the first time uses the term „physics of the Globe“ in one of his letters.
- 1798 Th. Malthus publishes his research on population growth and mentions that regions near volcanoes are overpopulated in spite of disasters (Thomas Malthus. *An Essay on the Principle of Population*.... London, 1798)
- 1804 Watt, Gregory. Observations on basalt, and on the transition from the vitreous to the stony texture, which occurs in the gradual refrigeration of melted basalt; with some geological remarks. Publ. in the Philosophical Transactions. London, 1804.
- 1805 Hall, Sir James. Account of a series of experiments, showing the effects of compression in modifying the action of heat. Read in the Royal Society of Edinburgh, June 3, 1805.
- 1808 Humphry Davy explains volcanic activity as an interaction of alcalic metals with the mixture of air and water, penetrating deep inside through the cracks and faults in the Earth crust's upper layers.
- 1825 Leopold von Buch publishes his research on physical geology of the Canary Islands.
- 1830-33 Charles Lyell's „Principles of Geology“ (in 3 volumes) are published
- 1831 J. W. v. Goethe and A. v. Humboldt last meeting before Goethe's death on March, 22, 1832; they probably discuss the nature of volcanism
- 1834 The corps of Mining engineers is established in Russia as a military government organization, subordinated to the Finance Ministry (minister: G. v. Cancrin)
- 1835 S. D. Poisson (1781-1840) claims that the Earth's interior is solid and rigid, contrary to the idea of the liquid core.
- 1842 Leopold von Buch's article „Observations on the volcanoes of the Auvergne“ appears (uplifted craters theory formulated)
- 1845 Humboldt's „Kosmos“ is published.
- 1849 The Russian National Physical Observatory is established in St. Petersburg.

4. Two prominent Russian readers of Humboldt's works

General notes should be made of two great Russian scientists who were among the first to read Humboldt's works and contemplate his ideas:

Petr Semenov (1827-1914; from 1906 – Semenov-Tien-Shanskiy).

In 1853, Semenov studied at the Berlin University; among his teachers were Gustav Rose (1798-1873, elected as member of the St.-Petersburg Academy of Sciences in 1830) and Christian Gottfried Ehrenberg (1795-1876, foreign member (1829), honorary member (1840) of the St.-Petersburg Academy of Sciences). In Berlin Semenov was personally introduced to Humboldt.⁶ According to Semenov's memoirs, Humboldt asked him to bring him samples of the Tien-Shan volcanic rocks (Semenov-Tien-Shanskiy, 1917, p. 257).

In 1854, Semenov traveled to Italy and studied the Vesuvius eruption of 1854-1855. Back in Russia, he organized a special expedition to the northern Tien-Shan in 1856-1857. He did not find any evidence of volcanic activity in this mountain range. The results of his study were published in 1856, 1859, and 1868 in the Proceedings of the Russian Geographical Society. P. Semenov came to the conclusion that Humboldt was wrong in his volcanic reconstructions. Semenov was also sure that volcanic activity depended on proximity to the sea shore, and that no volcanoes could be located deep within the continent.

P. Semenov was a prominent scientist in various fields of knowledge. In 1897, as Head of the Department of Statistics, he organized the first Russian Census. The results of this Census were used by F. Auerbach (Vienna) in his famous article of 1913 dealing with the statistics of populations in cities (later named Zipf law) (Auerbach, 1913).

Petr Kropotkin (1842-1921, Russian Prince).

The Russian Prince Petr Kropotkin read „Kosmos“ thoroughly (in German?) before he went to serve as an officer in Siberia in 1862. In his „Memoirs of a revolutionist“⁷ he remarked that a school education should be based on the philosophy of natural sciences as explained in the first parts of „Kosmos“ (Kropotkin, 1998, p. 117). In the first stage of his research, Kropotkin believed in A.v. Humboldt's idea of a regular system of mountain ranges in Asia, following the meridians and parallels (Kropotkin, 1988, p. 225).

In 1864, Kropotkin discovered extinct volcanoes in northeastern Manchuria, and during his next expedition (1865) he discovered fresh volcanic cones near Lake Baikal. At the same time (1865-1866) he participated in tests of the first Russian seismometer (Irkutsk, at Baikal). On April 4, 1874, Prince Kropotkin was arrested for active participation in an illegal organization. Later, Kropotkin became involved in international revolutionary activity as a leading anarchist (Zemtsov, 2003; Zemtsov, Markin, 2005).

The discovery of fresh volcanic forms in the Baikal rift zone in 1860s is one of the most important discoveries in the history of Russian geology and geography in the 19th century and corresponds completely to Humboldt's ideas of volcanism existing in Central Asia (Zemtsov, 2005).⁸

5. Conclusions

1. A. v. Humboldt studied volcanoes at the time of a geophysical paradigm change – from a high-temperature liquid Earth interior model (approx. 1790) to a high-temperature solid Earth interior model (approx. 1840);
2. In his writings, Humboldt came close to the ideas of seismic waves as geophysical phenomena (see text and translator's note in „Kosmos“ (2nd Russian Edition), Part I (1862), p. 175);
3. Humboldt's ideas on volcanism in Central Asia were denied by P. Semenov, whose conclusions were based on very limited field research data;
4. P. Kropotkin's research in support of Humboldt's views was neglected by the scientific community because of Kropotkin's illegal revolutionary activities;
5. Humboldt's idea of volcanic activity in Central Asia was supported by Russian geo-scientists in the 20th century.

6. Appendix

The story of the name of a chemical element discovered in Russia during the Humboldt expedition:

During his travels in 1829, Humboldt reached the Barnaul-Semipalatinsk region on the slopes of the Altai mountain system. Polymetallic ores were extracted here at a number of mines. At the end of the 1940s, a Soviet nuclear test site was established in this region for the first Russian nuclear explosion, on August 29, 1949.

Samarium is element number 62 in the Periodic Table. Here is the story of how it was named (after V. V. Stantso, S. Å. Pogodin in (Chemical Elements Popular Encyclopedia, 1973, p. 96-97)).

The mineral was found initially in the Ilmen Mountains by Gustav Rose. His brother Henrich Rose (1795-1864) made a thorough chemical study of the mineral and suggested naming it after Colonel Vasilii Samarskiy. The name samarskit was officially given to the mineral in 1847 (The Encyclopedia of Mineralogy, 1981 (1985), p. 449).

The significance of samarskit is stressed in the reports of the Radium expedition of the Russian Academy of Sciences in 1912-1914, edited by V. Vernadskiy. He mentioned that samarskit was the first uranium-rich mineral found in the Ilmen mountains. The results of chemical analysis of samarskit, showing the presence of uranium, were apparently published by G. Rose in 1839.⁹ However, Vernadskiy wrote that „the discovery

Endnoten

- ¹ This is a special chapter in „Baron Humboldt’s travel in America with geological and climatic studies on Asia“, published in Russian in St. Petersburg in 1835 (see pages 99-140 in the mentioned volume). On possible climate changes caused by the internal heat see pp. 129-131.
- ² Cf. Fiedler, Horst und Ulrike Leitner: Alexander von Humboldts Schriften. Bibliographie der selbständig erschienenen Werke. Berlin 2000. (Beiträge zur Alexander-von-Humboldt-Forschung. Bd. 20), p. 354.
- ³ Cf. Fiedler, Horst und Ulrike Leitner: Alexander von Humboldts Schriften. Bibliographie der selbständig erschienenen Werke. Berlin 2000. (Beiträge zur Alexander-von-Humboldt-Forschung. Bd. 20), p. 426.
- ⁴ Cf. Fiedler, Horst und Ulrike Leitner: Alexander von Humboldts Schriften. Bibliographie der selbständig erschienenen Werke. Berlin 2000. (Beiträge zur Alexander-von-Humboldt-Forschung. Bd. 20), p. 364.
- ⁵ Encyclopedia, F. Brockhaus, I. Efron (editors), half-volume 24 (1894), p. 655 (in Russian).
- ⁶ A.v.Humboldt was elected an honorary member of the St.Petersburg Ac.of Sci. on February 11, 1818.
- ⁷ First published in 1899 in Boston (USA), first Russian edition, 1902 (London).
- ⁸ To be precise it should be noted that in later years the presence of young volcanic rocks in the Kuen-Lun ridge was acknowledged by the editors of the Russian translation of Humboldt’s „Central Asia“ (1915). The several volcanic areas in Central Asia have been described by a leading Russian volcanologist (Lutschitskiy, 1971; pp. 67-75). For the Tibet plateau the presence of young volcanic cones and thermal springs is acknowledged in the Soviet Encyclopedia (v. 25 (1976)).
- ⁹ Metallic uranium was obtained in 1841.
- ¹⁰ Today this element (stable isotope - Sm149) is a well-known poisoning agent for nuclear reactors and is widely used in magnetic alloys (such as SmCo5 and SmCo17).
- ¹¹ The silver-smelting works were opened in Salair in 1815.
- ¹² This mine started its operation in 1791, after the discovery of the polymetallic ores in 1786 by the mining officer F. Ridder. In 1941 the town was renamed Leninogorsk.