

OTTO TRÜSTEDT AND HIS IMPACT ON THE FINNISH MINING INDUSTRY

by
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Otto Trüstedt (1866—1929) became famous as the leader of the mineral exploration programme tracing the source of a rich ore float from Kivisalmi in Rääkkylä to Outokumpu where a copper deposit was discovered in 1910. The present paper was presented at an international Otto Trüstedt symposium arranged by Outokumpu Oy to celebrate the 75 anniversary of the discovery.

The paper takes a look at Otto Trüstedt's background, training, professional career as well as his achievements as mining engineer and geologist.

Key words: biography, mineral exploration, mining, history, Outokumpu, Finland.

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Otto Trüstedt is a Finnish geologist whose achievements have been honoured not only by one but by two monuments erected at public sites. One of them stands in Rääkkylä, on the spot where a rich ore float was found in 1908; the other is in Outokumpu, on the spot where Trüstedt located the source of the float and where he found the rich Outokumpu ore deposit in 1910. Hence, in this year we can celebrate the 75th anniversary of the discovery of the Outokumpu ore deposit — an event that was to have most significant impact on the development of the Finnish mining industry.

Otto Trüstedt, as the name behind the discovery, has become a legend; as a person, however, he and his deeds are less well known. I am glad that I have been entrusted to portray Otto Trüstedt and his remarkable achievements in the Finnish mining industry.

Otto Alexander Paul Trüstedt was born to German parents in Paris on 3rd March, 1866. He spent his childhood, however, in St. Petersburg and went to school in Germany. He matriculated from the gymnasium at Görlitz in 1885 and in the same summer, exactly one hundred years ago, he embarked on his career in the mining industry as a trainee at the Pitkäranta mine, where his father was mine manager. The shortage of mining engineers in the country was desperate and his father sent

him to Sweden to study mining technology. He spent the years 1885—1887 studying at the mining school of Falun, where mine captains were trained. The next year he devoted to courses on mining, mine surveying and magnetic exploration at the Technical University of Stockholm. He did not have time to get a degree, however, for he was needed at Pitkäranta, and at the age of 22 he was called by his father to work there as a mining engineer. Otto Trüstedt was quite a cosmopolitan, when in 1888 he settled in Finland, which was to become his home country. Finnish he learned only as an adult.

In 1880 the old copper and tin mine at Pitkäranta had been reopened as a copper mine. Under the supervision of mine manager O.G. Trüstedt and the Swedish mining engineer Gustav Gröndahl, the mine was constructed in the 1880s aiming at an annual output of 30 000 tonnes of ore. On a present-day scale, Pitkäranta was a very small mine. The highest annual output of copper was never more than 400 tonnes.

The young Otto Trüstedt had to supervise the daily operation of the mine, but he had also to try to find new ore to replace the rapidly diminishing ore reserves. To do that he investigated the geology of the deposit. He undertook magnetic surveying and started to speculate on



Fig. 1 Otto Trüstedt as a young mining engineer.

the feasibility of using Hertz waves for mineral exploration in areas covered by overburden. As an outcome of his geophysical investigations he published a couple of papers in 1904. One was entitled "The telemagnetometer, or a device for making magnetic observations in horizontal drill holes" and the other dealt with exploration with the aid of electricity. It should be pointed out that the first practical demonstration of electrical exploration in the Nordic countries did not take place until the following year, 1905, when two Americans used it in Sweden. Trüstedt can be considered as a pioneer of geophysical mineral exploration in Finland.

When Otto Trüstedt tried to explain the formation of the ore deposits in the Pitkäranta area he realized that his knowledge of scientific geology was insufficient. And so he visited Stockholm in 1894 and 1895 as a private pupil of professor Törnebohm, his first teacher of geology who trained him in microscopic petrography.

Professor Törnebohm did not share Trüstedt's opinion that the ore at Pitkäranta had been formed as a skarn ore in limestone from solutions derived from the rapakivi granites east of Lake Ladoga. Neither was this concept approved by J.J. Sederholm, the head of the Geological Commission. Both Törnebohm and Sederholm believed that the iron ores in the area

were sedimentary in origin. However, Trüstedt continued his studies on Pitkäranta with systematic mapping and examination of countless thin sections. He worked alone without backing of the laboratories and institutions that present-day geologists usually have. This makes the scientific findings of Trüstedt even more admirable.

In a paper that he gave at a Nordic meeting of scientists in Helsinki in 1902 Trüstedt presented clear evidence for contact metamorphism at Pitkäranta, and he must have felt deep satisfaction when Sederholm took the opportunity to admit that Trüstedt was right.

The mineral exploration undertaken by Trüstedt around Pitkäranta was quite successful. In 1895–1896 he located by magnetometry 12 million tonnes of iron ore at the mine and in 1901 he found another iron ore deposit at Kelivaara on the shore of Ladoga. However, he was not able to discover additional copper ore and the production of copper had to be reduced accordingly. In 1903, the last whole year the Pitkäranta mine was operational, the total mine production was 55 000 tonnes of ore, of which only 18 000 tonnes were copper ore and 27 000 tonnes iron ore. The latter was smelted in a blast furnace at the mine.

Otto Trüstedt was interested in the concentration of the magnetite in the Pitkäranta ore and he experimented with electromagnetic separators. In 1895 a separator of his was patented in Sweden. In 1898 he spent some time in Germany studying magnetic separators and in the following year, 1899, his "apparatus for separating magnetic materials" was patented in the USA. Trüstedt also made some tests aimed at developing a flotation method. He can thus also be considered as a pioneer in the field of ore dressing in Finland.

While at Pitkäranta, Trüstedt co-operated closely with Gustaf Gröndahl, who, after having married the daughter of the mine manager, became his brother-in-law. The wedding was celebrated, so the tale goes, in the true miner's spirit in an abandoned stope specially prepared and illuminated for the occasion.

At the age of 25, Otto Trüstedt married Klaara Mager from Tartu in 1891. The couple had three children, a son and two daughters. The Trüstedt family lived happily at Pitkäranta, but their future was overshadowed by the diminishing reserves of copper ore and the poor profitability of the iron ore exploitation.

In 1896, the Pitkäranta mining company was reorganized into a new company named

Ladoga. In 1899, this was amalgamated with a steel foundry in St. Petersburg and in 1903 the State Bank of Russia took it over, bringing operations at Pitkäranta to an end in 1904.

The closing of the Pitkäranta mine in 1904 and of the small Välimäki iron mine a couple of years later meant that the mining of ore came to an end in Finland.

In 1905 Otto Trüstedt had to find a new job to support his family and himself. He was 39 years old and if he wanted to stay in Finland, he had to accept any work available.

In this situation he took a minor, and as it was called temporary job, with the Geological Commission, where his first task was to complete his extensive geological material on the Pitkäranta ore field into a report, which was published in 1907.

When Trüstedt came to the Geological Commission, his lack of an academic degree prevented him from getting an appointment as a geologist, and he had to work for an hourly wage of a mere one mark, which equals roughly 20 marks an hour at present rates. His merits as a mining engineer and his experience in surveying and exploration were, however, widely known and the National Board of Industry gave him several short-term special assignments with extra payments. In 1905–1907 he thus investigated the copper deposits at Brödtorp in Pohja, and at Hokka and Kyykkä in Kontiolahti as well as the limestone formations at Parainen and Lohja. The National Board of Industry also authorized him to survey the mining claims in Veteli, Kontiolahti, Sotkamo and Rautavaara.

After Trüstedt had published his comprehensive work on the geology of Pitkäranta in 1907 he earned the reputation of a mine geologist and at the Geological Commission he was appointed chief mining geologist, a post that he held from 1908 to 1919.

At that time Trüstedt was full of energy and he wrote several papers of lasting value. In 1908 he published a history on the Pitkäranta ore field and in 1909 a complete description of the Orijärvi mines. In the latter paper Trüstedt's conclusion was: "The Orijärvi ore field is one of the few in our country to have marked ore tonnages that can be used as the basis for economic calculations in the event that rational mining work could be developed there". Mining operations at Orijärvi started soon afterwards.

In 1909 Trüstedt wrote an interesting article on the outlook of the Finnish mining industry, in which he dared to propose a bright future even though, as he himself put it, there had

been no mining activity in Finland in recent years.

As a private consultant Trüstedt wrote a report on the limestone deposit at Parainen, which influenced the planning of the first Finnish cement plant there.

In winter 1907–1908 the dredging of a channel was started at Rääkkylä. The operation was supervised by Karl Johan Montin and by Ossian Asplund and Axel Eskelinen, who worked as dredge masters. The dredge ran into a boulder so big that it had to be blasted. The boulder, estimated to be about five cubic metres in size, was at a depth of about three metres. It was blasted on 2nd February, 1908, and because of its metallic lustre some people thought it must be a meteorite. Mr Montin, however realized the importance of the find and sent a sample to the Geological Commission. There, strangely enough, the specimen ended up in a store and was almost forgotten. Trüstedt was the first who paid any attention to it and asked the head of the Commission, Sederholm, where the sample came from. Obviously Sederholm had not even seen the sample and on 11th March, 1908 he wrote to Montin asking for more samples from the ore boulder to eliminate the possibility of any misunderstanding. Montin sent a new sample, which proved the importance of the find. The analysis, undertaken by Pentti Eskola, then a master of Science, showed that the boulder contained 3.74 % copper. The Geological Commission wasted no more time and sent Otto Trüstedt to Kivisalmi to get more detailed information on the discovery. He reached the site at the end of March 1908 and, among other things, took the photographs, published several times, in which Axel Eskelinen is standing by rocks blasted from the big boulder.

The Geological Commission had no funds to undertake follow-up studies, but on 4th June, 1908 the National Board of Industry ordered Trüstedt to search for the source of the Kivisalmi boulder and placed the necessary funds at his disposal. Trüstedt realized that the ore boulder was a float that had probably been transported by the glacial ice from the west in accordance with the general direction of the main ice flow. He noticed, however, the existence of glacier striae trending north-south as well. The reason why he did not start prospecting west of Kivisalmi was that he assumed that the quartzite in the ore float belonged to the Kalevian quartzites, which according to recent geological mapping, did not occur in the west at all but only north



Fig. 2. Pieces of the big ore boulder found at Kivisalmi photographed in March 1908 by Otto Trüstedt. In the picture stands the dredge master Axel Eskelinen.

and northeast of Kivisalmi. Therefore, between 20th June and 18th July, 1908, Trüstedt examined in detail almost one hundred quartzite outcrops in the north without finding a sulphide mineralization of the type he was looking for. Trüstedt could not know that the quartzite in the Kivisalmi float is now considered to be of volcanic exhalative origin and not associated with the sedimentary Kalevian quartzites at all. Hence Trüstedt started out by following the wrong trail. However, he returned to Kivisalmi several times and concentrated more closely on other floats that had been dredged there. Some of them were rather unusual, some containing amphiboles and some quartzite with pyrite and graphite. In current terminology, they could be called amphibole skarn and black schist.

When Trüstedt returned to Helsinki in late July, 1908 he showed his findings to Benjamin Frosterus and W.W. Wilkman, two geologists with the Geological Commission, who were experts on the rock types in this area. They were able to tell him that, while mapping, Wilkman had encountered similar rocks on 24th and 25th August, 1899 at Outokumpu in Kuusijärvi. He had also photographed the strange-looking hill called Outokumpu. On Thursday, 24th August he had noticed banded sulphide-bearing quartzite schist on the northern slope of the very same hill. On 6th September, 1899 Wilkman

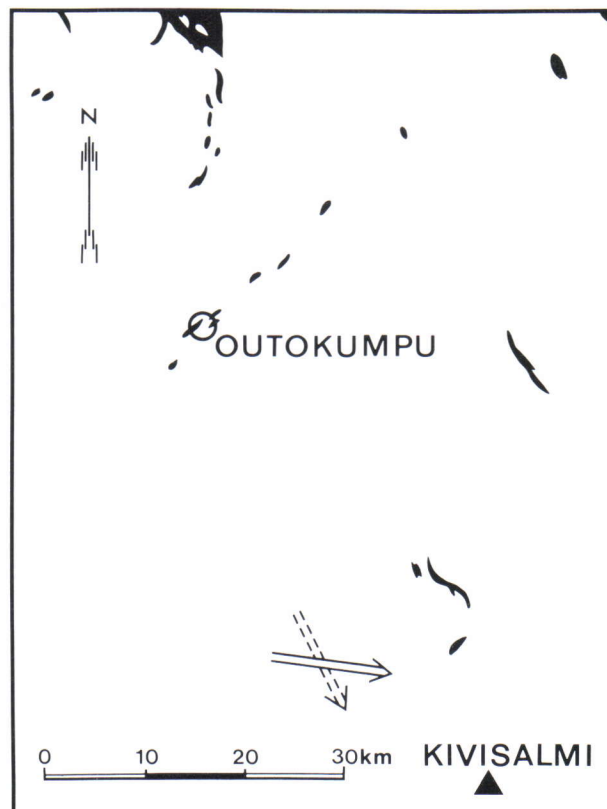


Fig. 3. Sketch indicating the occurrence of quartzites in the map Joensuu sheet revised for printing in 1913 by Benj. Frosterus and W.W. Wilkman. The direction of the striae close to the site of the copper ore float at Kivisalmi is indicated.



Fig. 4. Outokumpu in August 1899. Photography by W.W. Wilkman, who first observed sulphide minerals on the slope of the hill.

and his superior Frosterus had together made an excursion to the Outokumpu area.

The decision was then made at the Geological Commission that follow-up exploration for the source of the Kivisalmi float should focus on the Outokumpu area. It was not known, then that a zone of rocks similar to those at Outokumpu extended southwards to the western shore of the lake Orivesi, west of Kivisalmi. Happily unaware of this, Trüstedt started a systematic search for boulders in the Outokumpu area in autumn 1908. Several interesting floats were found, and on the basis of them, Trüstedt was able to delineate a boulder train that seemed to start in an area north of the Outokumpu hill. Trüstedt mapped this area with a sensitive magnetometer and found a magnetic anomaly 400—500 m long. Since the Kivisalmi boulder also contained pyrrhotite, this anomaly was considered important.

In December 1908 Trüstedt wrote a report on the studies undertaken during the year. He was very optimistic that he was on the right trail. For the follow-up studies he made it clear that the electrical equipotential method could be successfully applied to the finding of a conductive ore deposit.

In March 1909, on the proposal of the Geological Commission, the Senate granted 8 000 marks for continuing studies on the "indisput-

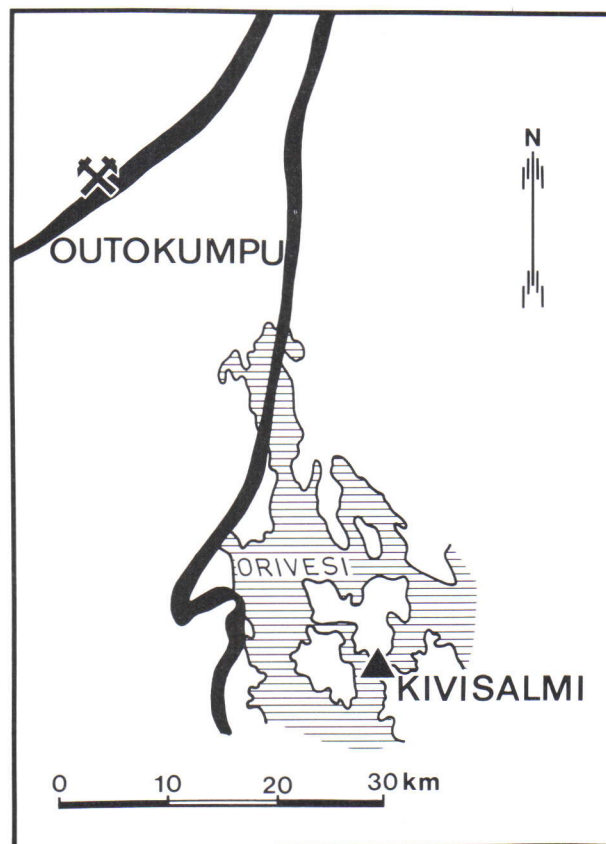


Fig. 5. Sketch indicating a part of the horizon with Outokumpu type rocks.

able ore indication" found in Kuusjärvi. Led by Trüstedt, field work was started in June that same year. First of all, pits and trenches were dug in the Outokumpu area to expose the bedrock and to survey the occurrence of ore boulders in till. The floats suggested that the ore deposit might be located in the quartzite of the potential zone between the Outokumpu hill and the younger mica gneiss 300 m north of it. And so it was decided to supplement the survey results by drilling a hole through this zone. An expert was needed to lead this operation and Trüstedt succeeded in borrowing a mine foreman, Glaes Törnqvist, from the limestone mining company at Parainen in early September 1909. After the drill had penetrated 53 m, the contact between the ore-potential quartzite and mica gneiss had been passed and the drilling of the first hole was brought to an end on 11th October. Even though no ore had been found, the Geological Commission was so sure that ore was close by that on 15th November, 1909 it applied for 11 claims in the potential area.

After a hole drilled to intersect a critical point beyond very fractured zones had failed, another hole, 90 m long, was drilled between 24th December, 1909 and 14th February, 1910. Once more the ore was missed. While Törnqvist was supervising the drilling, Trüstedt was busy with other tasks. The National Board of Industry had ordered him to undertake geological studies in the area of the Orijärvi copper mine and

Törnqvist was not given the instructions necessary to continue drilling. In a letter dated 8th February Törnqvist demanded that Trüstedt return immediately to Outokumpu, otherwise he would resign and wind up the drilling project. This ultimatum helped and Trüstedt arrived at the site. He gave advice about the location of the third hole so that it could intersect the 70 m of the potential zone that the previous hole had failed to do. True, the funds granted for the prospecting were finished but with typical optimism Trüstedt succeeded in assuring both Törnqvist and the workers that he would get the money for their salaries and wages. Trüstedt himself hurried back to Helsinki, and the Geological Commission applied for 2 000 mk as an extra allocation to be granted as soon as possible for the exploration at Outokumpu. Törnqvist obviously had faith in Trüstedt and on the last day of February, 1910, he reported that the drill hole had reached a depth of 15.4 m and that he believed that the ore would be reached very soon. In his report dated 14th March, Törnqvist wrote to Trüstedt that the hole had advanced to 26.6 m and that he hoped that the ore would be intersected before he writes again. On 17 March, 1910 the drill encountered ore, and rich ore containing 6 % copper was intersected between 28.85 and 38.18 m. With good reason, this day is considered as the one on which the Outokumpu ore deposit was found.

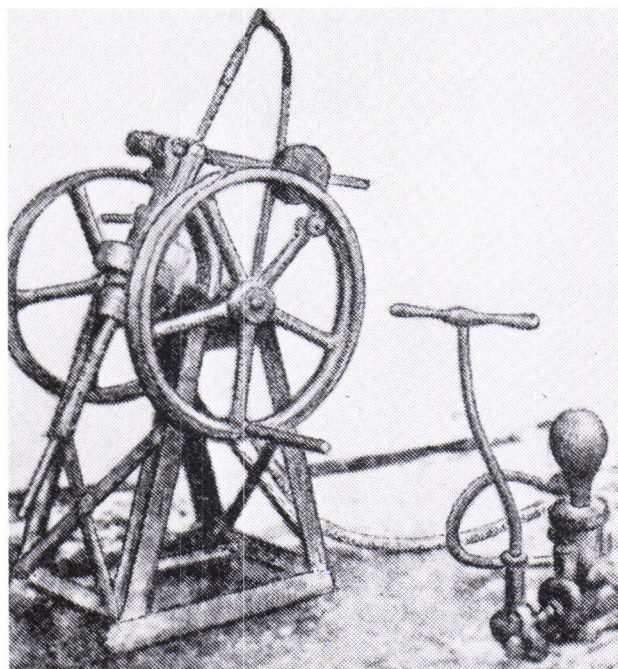


Fig. 6. The Swedish Craelius-type manually operated diamond drill. Such drills were used at the start of exploration in Outokumpu.



Fig. 7. Otto Trüstedt (right) in field survey in the Outokumpu area in 1910 (courtesy Outokumpu Oy).

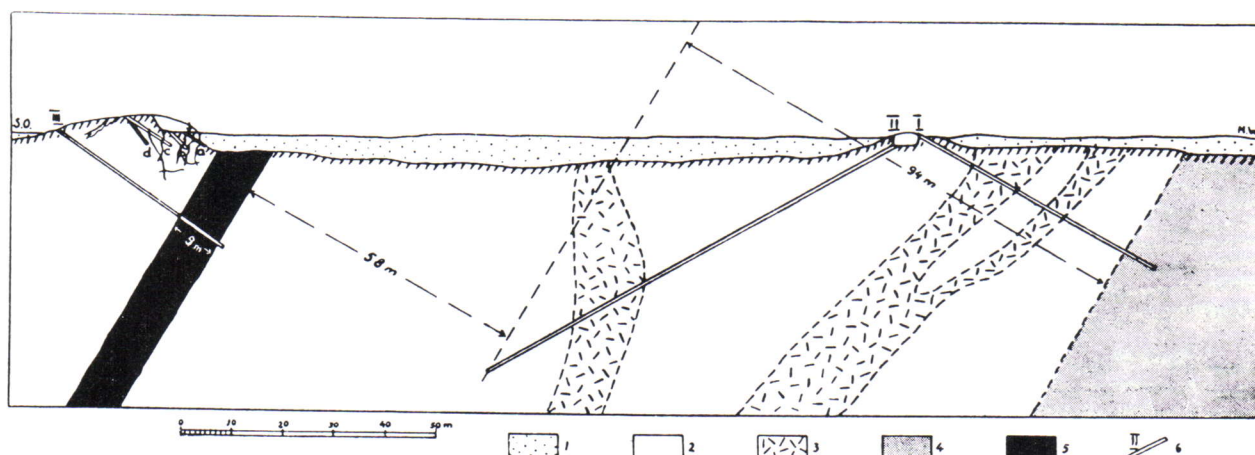


Fig. 8. The first diamond drill holes at Outokumpu. Vertical section by Trüstedt. Appended to his report of May 17th, 1910. 1. Cover of loose deposits; 2. Quartzite. 3. Olivine rock; 4. Mica schist; 5. Copper ore; 6. Diamond drill hole.

The finding of the ore deposit attracted immediate attention and Trüstedt was generally recognized as the discoverer of the ore. In 1910 Csar Nicholas II presented him with a diamond ring a customary gift in those days to persons of special achievement.

It is beyond the scope of this paper to describe the follow-up studies on the Outokumpu deposit. The orebody was delineated step by step and planning of the mining and smelting of the copper ore got under way. Three shafts, Kumpu A, Kumpu B and Kaasila, were sunk in the formation. Kumpu B, the deepest of them, reached a depth of 70 m in 1912. In the same year Trüstedt was ordered to take a general sample from the ore and to supervise its smelting in Germany. He was also sent to Norway to investigate the feasibility of using the copper smelting process developed there by engineer Victor Hybinette. This journey resulted in due course in the introduction of the Hybinette copper extraction process at Outokumpu.

One might think that from then on Trüstedt devoted himself entirely to studies on the Outokumpu deposit and to the development of mining there. However, this is not what happened. Between 1910 and 1912 he was authorized by the National Board of Industry to survey mining claims in Juuka, Nurmes, Kisko, Nilsä, Rautavaara and Kaavi and also at Outokumpu. Moreover he had his daily work at the Geological Commission, which restricted his capacity to participate in the development of Outokumpu, which of course always stayed close to his heart. In 1914 he was appointed consulting engineer to the newly established Outokumpu Kopparverk with the duties of inspecting the mining work at least twice a year, of giving

instruction and of making propositions as to how the mine should be developed. At that time, however, production was low and his contribution as a consulting engineer remained on the modest side.

In 1917, copper production at Outokumpu was leased to a company established for that purpose and called Ab Outokumpu Koppar-Outokummun Kupari Oy. Already in 1918, however, the name was changed to Ab Outokumpu Oy. Otto Trüstedt was offered a post with the new company as "controller" supervising the activities at the mine. He would have had to move to Outokumpu, however, and he declined the offer. Instead of him, the company then invited Eero Mäkinen to fill the post.



Fig. 9. Otto Trüstedt at his desk in the Geological Commission in the 1910s.

One possible reason why Trüstedt turned down the offer made by Ab Outokumpu Oy at the end of 1917 was that his health had deteriorated. The year 1912 seems to have been a turning point in his life, when he suffered an illness from which he never fully recovered.

His life continued more peacefully. Nevertheless, from 1913 to 1918 he was still surveying mining claims at Outokumpu and in Kisko by order of the National Board of Industry.

In 1913 the Senate of Finland had granted Trüstedt a reward of 3 000 mk for discovering the Outokumpu ore deposit. In 1917 the discoverers of the Kivisalmi ore boulder were also rewarded by the Senate with 5 000 mk each.

The Outokumpu company, too, then considered it appropriate that Trüstedt should get a proper reward for his discovery. In 1918 he was granted 50 000 mk in addition to which he and, after his death, his heirs would get a share of the profits of the company. Trüstedt, however made the mistake of trusting in the future of the mining company and investing all this money in shares issued by Ab Outokumpu Oy. The mining company, however, was running at a loss and the value of the shares fell at the end of 1920 to a mere 15 % of their nominal value. At the same time, owing to the heavy inflation following the First World War the Finnish mark lost most of its purchasing power. And so Trüstedt's reward lost its value. It was proposed that the Director of the Geological Commission, J.J. Sederholm, should also be rewarded. The matter was tossed back and forth and the contribution of Sederholm to the discovery was seriously put in doubt. However, eventually in 1921 Sederholm was rewarded with 50 000 mk and Trüstedt with an additional 20 000 mk. Half of the rewards was paid by the State and the other half by Hackman & Co. which at that time participated in the work of the mining company.

Trüstedt's finances were in bad shape, but they improved a little in 1918 when he was given the extra job as chief of the geological laboratory of the Renlund Foundation in Helsinki. In 1919 he was decorated as Commander of the White Rose of Finland.

At the beginning of 1919 the standing of Trüstedt improved when he was appointed state geologist of mining geology. He was responsible for all the mineral exploration activities of the Geological Commission, which in 1921 initiated the mineral exploration of Petsamo. The discovery of the Petsamo nickel ore in 1921 filled Trüstedt with enthusiasm. As a supervisor of



Fig. 10. Otto Trüstedt as a state geologist responsible for the mineral exploration activities of the Geological Commission.

the exploration program he had his own stake in the discovery. By coincidence the first ore findings there were made by Hugo Törnqvist, a summer assistant, who was a son of Claes Törnqvist, known from the finding of Outokumpu. Otto Trüstedt's health continued to deteriorate in the 1920s and he was no longer fit for field work. However, in 1924 he dragged himself to the fells of Petsamo to see with his own eyes the newly found rich nickel ore up there. From his office at the Geological Commission he continued to give instructions and advice on the follow-up studies of the Petsamo ore field.

The merits of Trüstedt in technology and science were generally recognized and in May 1927 he was awarded an honorary doctorate at the University of Helsinki. This was probably the reward he appreciated more than any other distinction; no longer could his formal competence as a scientist be questioned.

At the end of 1928, however, ill health forced Otto Trüstedt to resign at the age of 62 and soon afterwards on 11th September, 1929 his day came to an end.

It is not easy to delineate in a few words the importance of Otto Trüstedt to the development of the mining industry in Finland. His rich and varied contribution, the breadth and depth of his knowledge, his optimism and energy made him one of the pioneers of geology, mineral

exploration and mining in Finland. Above all, however, his name will always be associated with the discovery of the Outokumpu ore deposits in 1910, the event that dates the start of the modern development of the Finnish mining industry.

Otto Trüstedt has more than deserved the monuments erected at Rääkkylä and Outokumpu to commemorate his discovery of the Outokumpu ore in 1910.

REFERENCES

Annala, Vilho, 1960. Outokummun historia 1910—1959. Helsinki. 502 p.
Saksela, Martti, 1948. Outokummun kuparimalmin löytö. Geologisen tutkimuslaitoksen geoteknillisiä julkaisuja 47, 36 p.

Tanner, V., 1934. Otto Trüstedt. Minnesteckning. Svenska Tekniska Vetenskapsakademins i Finland Förhandlingar. 7, 41—51.