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A man from Bendery: L.S. Berg as geographer and loess scholar

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"In the laboratory, loess does not look like an attractive material. It is straw-yellow, and has a loose loamy constitution. However, in nature, everything about loess is remarkable…"

L.S. Berg

Abstract

Lev Semenovich Berg was born in Bendery, in Moldova. He had great success as an ichthyologist and geographer; he also proposed, in 1916, an interesting theory of loess formation. As a biologist he was persecuted by Lysenko and the Soviet state in the time of pseudo-science in the 1930s and 1940s. Despite his being persecuted, the loess theory became, in effect, the official Soviet theory of loess formation. This theory had to be compatible with his 'landscape' theory which did not find favour in Marxist-Leninist geography. Berg's loess theory was very much a geographical theory, as opposed to the geological theory of aeolian deposition, which was accepted outside the Soviet Union.

Berg was hugely successful in many fields, but his contributions to loess science tend to be neglected. His 'soil' theory of loess formation has been widely disparaged but still has some influence in Russia. The concept of loessification may still be relevant to the later stages of deposit formation; the slow transition from metastable to collapsible may be best described as loessification.

Keywords: Lev Semenovich Berg, theories of loess formation, landscape theory, loessification

Introduction

Lev Semenovich Berg (1876–1950) was born in Bendery, in present-day Molodova (Fig. 1). Bendery is a town which is also known as Bender, and as Tighina. It is currently located in a country known as Moldova, which was essentially the Soviet Republic of Moldavia, but even that is not strictly true. It is located in a small, widely-unrecognised country which was once called Transdniestria, but is now known as Transnistria. Most of Transnistria is on the east bank of the Dniester river, but a small part – which includes the town of Bendery – is on the west bank. When Berg was born in Bendery, it was part of Russia, part of Bessarabia. It was part of Romania from 1918 to 1940, when it became part of the Soviet Union. This is the eastern part of central Europe; the Philips Atlas places Bendery nicely in Middle Europe. However, the 1999 edition calls it Tighina.

Berg was born in the Jewish Pale of Settlement, as the son of Simon Gregorévich Berg,

Fig. 1. Map of Moldova (source: Wikipedia, 2009).

a notary, and Klara L'vovna Bernstein-Kogan. He was awarded the gold medal when he graduated from the Second Kishinev Gymnasium in 1894, and entered Moscow University where he then enrolled in the natural science section of the Faculty of Physics and Mathematics. To enrol he had to become a Christian; some authorities make him a Lutheran, others place him in the Orthodox Church. At university, Berg specialised in zoology and geography, taking course with D.N. Anuchin, the famous anthropologist. He graduated in 1898. Between 1903 and 1914, he worked in the Museum of Zoology in Saint Petersburgh (Fig. 2). His first wife, Polina, gave birth to a son, Simon, in 1911 and a daughter, Raissa, two years later, in 1913. However, Berg and his wife separated when Raissa was just six weeks old. Raissa went on to gain her diploma in genetics (equivalent to an M.Sc.) and began post-graduate studies in genetics at Leningrad University's Genetics Department. In 1939 she became a 'candidate of sciences' (approximately equivalent to a Ph.D.), having written a dissertation on 'Differences between wild and laboratory populations of *Drosophila melanogaster*: a hypothesis of genetic correlations.'

From his days as a student in Moscow until his death in 1950, Berg displayed great scholarly prowess and he excelled in many fields. Embedded in his scholarly life was a continuing interest in loess, and this is the main topic of the present contribution.

Background

Berg (Fig. 3) remains famous as an ichthyologist (see Bernstein & Bemis, 1997) and a geographer; his scholarly output was immense. He published 217 works on ichthyology, 30 works on general zoology and biology, 20 works on palaeontology, 32 works on zoogeography, 320 articles and monographs on geography, geology and ethnography, as well as 290 biographies, obituaries, and popular articles. Within this huge output of, among others, the 320 papers on geography are several very significant pieces on loess and loess formation; and not insignificant pieces, large book-length studies essentially on the problem of loess formation. Berg offered a counterview to the aeolian theory of deposition favoured by Obruchev and Richthofen. The aeolian origin of loess has been accepted since Von Richthofen's (Fig. 4) 1878 observation and interpretation of the loess in China.

Fig. 2. Early picture of the Museum of Zoology in Saint Petersburg.

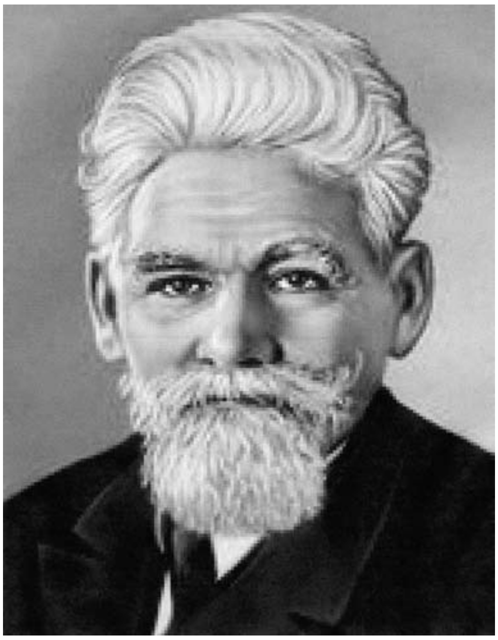

Fig. 3. Lev Semenovich Berg.

Had Bergs output been a bit less overwhelming, his loess studies would have been more easily recognised as major contributions, but their signal got somewhat lost in the overall scholarly noise. They deserve credit, however, for several reasons: (1) they offer a counter-view to the prevailing idea of aeolian deposition of loess material; (2) they run in parallel with Berg's development of the 'Landscape Science' approach to physical geography, and there may be mutual illumination; and (3) they may be correct; possibly not correct on the large scale but correct when all the separate stages in loess deposit formation are identified. A very perceptive article by Makeev (2009) has given a Russian insight into current views of loess formation and appears to add some Berg-type loessification to a basic aeolian scenario.

It is possible that, in propounding and defending his theory of loess formation, Berg was also propounding and defending his landscape-science ideas. In his entry in 'The Great Soviet Encyclopedia' his loess ideas are mentioned (in translation), as in the context of his geographical endeavours:

"Berg elaborated the study of landscapes and developed the teaching of V.V.Dokuchaev, on natural zones in his works 'Landscape and Geographical Zones of the USSR' (part 1, 1931; 3rd ed., 1947; part 2, Geographical Zones of the Soviet Union,

Fig. 4. F. von Richthofen.

1952) and 'Nature in the USSR' (1937). He studied the lakes of Western Siberia; the Aral Sea; Lakes Balkhash, Issyk-Kul', Sevan, and Lagoda; and the Kokchetav Lakes in northern Kazakhstan. Some of Berg's works are also devoted to the Caspian Sea and Lake Baikal. An expedition under Berg's leadership to Issyk-Kul' in 1928 revealed that the lake's maximum depth was 702 m. He is the author of the monograph 'Aral Sea' (1908), for which he was granted the degree of doctor of geography. To Berg belong fundamental works on climatology and paleoclimatology, including 'Climate and Life' (1922; 2nd ed. 1947) and 'Fundamentals of Climatology' (1927; 2nd ed. 1938). He also wrote works on geomorphology (he proposed the first scheme for regionalizing the topography of the Asiatic part of the country), on soil science (he proposed a soil theory for the formation of loess) and on palaeogeography and geology."

Landscape science

The Russian idea of 'Landscape science' is a current topic of discussion (see Shaw & Oldfield, 2007, 2008a,b) and the present contribution might be considered as a peripheral con-

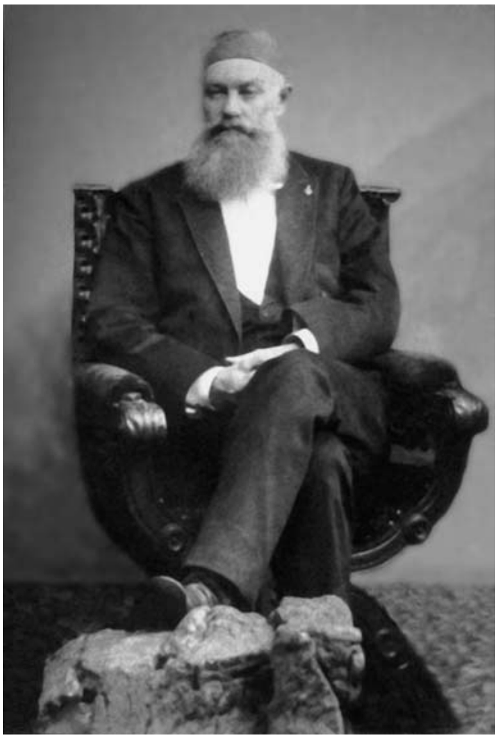

Fig. 5. V.V. Dokuchaev, who had a major influence on the ideas of Berg regarding loess and landscape.

tribution to that debate. Berg (1915) invented landscape science just one year before he proposed his theory of loess formation. Landscape science owed a lot to the ideas of Dokuchaev (Fig. 5), and so did the loess-formation theory. As Shaw & Oldfield (2008b) point out, Berg is nowadays recognised in geography as the founder of what is usually termed 'Russian landscape science' (landshaftovedenie), a conception of geography based on the assumption that the earth's terrestrial surface is naturally divided into integrated, biophysical units or landscapes which can easily be recognised in the field. Berg defined a landscape as: *"that combination or grouping of objects and phenomena in which the peculiarities of relief, climate, water, soil, vegetation and fauna, and to a certain degree human activity, blend into a single harmonious whole, typically repeated over the extent of the given zones of the Earth." (Berg, 1947, p 16)*

In Berg's view, the study of such natural units formed the core of geography as a scientific discipline. The study of landscapes as zones, or of zones as landscapes, reached its apogee in the seminal book 'Landscape-Geographical Zones of the USSR', which was written in response to an invitation by N.I. Vavilov and published by Vavilov's institute. Dokuchaev propounded a zonal approach to soils: great climatic zones would provide the conditions for the formation of various types of soils. Dokuchaev's two main proposals were the role of climatic zones, and the development of soils by horizonation. Berg, following Dokuchaev, and thinking of loess as a soil, might reasonably suggest development in situ by soil-forming processes, to form loess landscapes.

Loess studies

The ongoing studies by Berg regarding the origin of loess deposits culminated in studies published in 1916, 1932 and 1947 (also published in English in a 1964 work).

The 1916 loess study

In 1916, Berg published a major work, a 67-page article in an important journal, setting out the basic idea of loessification, i.e. the transition of not-loess ground to loess ground. The theory became known as the 'soil' theory, or the 'in-situ' theory, or the 'pedological' theory, or the 'eluvial' theory. 'Pedological' was the term favoured by Pyaskovskii (1946) as in: *"There can be no doubt that the most important factor in the development of our knowledge concerning loess was the fruitful idea of L.S. Berg as presented in a series of* articles and collected under the title of 'the pedological theory of loess formation'". For a wider discussion of the Berg theory, and its relation to the aeolian approach to loess-deposit formation, the reader is referred to Smalley (1971,1978), Smalley & Rogers (1997), Smalley et al. (2001, 2006a,b), and Różycki (1991).

The 1916 publication formed the basis of the loess section in the book 'Climate and Life' (Berg, 1922). When the 2nd edition of 'Climate and Life' was published in 1947, the loess section was updated, and this was eventually included in the 'Collected Works' published in 1960. This 1960 loess section was translated into English by A. Gourevitch and published by the Israel Program for Scientific Translations as 'Loess as a product of weathering and soil formation' (Berg, 1964). This translation is now seen as the acceptable, default version of the Berg loess theory; in fact many scholars refer to it as though it were a nineteen-sixties work, rather than a revised version of a 1916 article. The theory did not change and evolve from 1916 to 1964, but a series of publications (Berg, 1926, 1927, 1929, 1932), as Pyaskovskii noted, keeps it visible.

'Pedological theory' was the term favoured by Pyaskovskii, as in his 1946 statement that supported the theory, maintaining that loess was formed in the subsoil layer of the steppe and was inherent in its 'soil profile'. He attached great importance to organisms which assisted carbonate solutions in their downward penetration.

The 1932 loess study

Berg (1932) is a major exposure of the theory in English, in a visible geophysics journal. Its appearance demonstrates that Berg was serious about his loess work and wished it to have maximum exposure. An observation on particle size deserves some comment: *"The wind, according to its velocity, can carry either coarser or finer particles, but why should it give a preference to particles of 0.01 to 0.05 mm in diameter, has never yet been explained by any follower of the aeolian theory" (Berg, 1932, p. 134; Smalley, 1975, p. 65).*

Two fairly obvious explanations were apparently overlooked by Berg: (1) certain geological processes produce material in the designated size range; in fact it appears that crushing low quartz (a major loess constituent) produces particles with a mode size of around 30 μm, so this is the material available for loess deposit formation; and (2) certain sizes are favoured by the wind as it picks up natural particles; a compromise between weight forces and cohesive forces means that a particle at about 80 μm is most likely to be picked up. The combination of these two factors results in Berg's well sorted deposit. This is important because Berg's pedological theory always had problems with producing the required large amounts of quartz silt by chemical processes.

The 1947 loess study

The second edition of 'Climate and Life' was published in 1947, and this contained what we should regard as the definitive version of the Berg theory of loess formation. The text was ready in October 1940 but the 'Great Patriotic War' intervened and publication was delayed until 1947. The text went to the printers in April 1946. As mentioned above, the loess section of this work was included in a 1960 work and published in 1964 in an English translation, with Berg as the author, 14 years after he died.

We extract here some parts from the text that give a feeling for Berg's approach to the problem of loess formation, and a description of the mechanism which he was proposing:

"The difference between loess and its parent rock is like the distinction between soil and rock; the transformation of the latter into the former requires a soil-forming process; in the same manner, the transformation of a rock into a loess requires a loess-forming process. The process, though variable in each instance, is everywhere the same in its principle; it is a 'loessification'; and from this standpoint we are justified in assuming a single family of loessic rocks. Whether we speak of loess or loess-like rocks, they are all the result of the same cause. No other agency, except processes of weathering in situ and of soil-formation is capable of conferring a loess-like aspect to such material as morainic loam or morainic sandy-loam. It is almost impossible to conceive how else a loess-like sandy loam might have developed" (Berg, 1964, p. 14).

"The peculiar texture … and constitution of loess… are the result of particular processes of weathering and soil-formation, taking place in a dry climate. What, then, are the precise physicochemical processes which give the loess its loamy character?

According to Gedroits, those soils wherein the adsorptive complex is saturated with calcium – (and it is precisely the soils of the steppe and the desert zone that have the greatest amounts of absorbed calcium) – produce with water such systems as are coarsely dispersed; even the more clayey varieties of these soils do not contain at all, or contain in very small amounts, particles of colloidal size, i.e. of less than approximately 0.25 μm" (Berg, 1964, p. 14).

"In order that any given rock, e.g., glacial or fluvioglacial deposits, might become loess-like in an

environment of steppe climate, the following conditions are required:

1. the rock must include a considerable amount of aluminosilicates;

2. it must contain carbonates of alkali earths;

3. it must be more or less fine-grained and permeable" (Berg, 1964, p. 35).

Contrasting approaches

Both scientific and political considerations led to contrasting approaches towards Berg and his pedological theory. This culminated in 1939, when Lysenko and his allies conspired to prevent Berg from being elected to the Academy of Sciences as an academician (so that Lysenko could be elected instead; see Medvedev, 1969). Berg became attacked as a biologist whose most important book was written at the urging of N.I. Vavilov, who was the main target of the politically inspired charlatan group. In the same year, however, Gerasimov and Markov (see Różycki, 1991, p. 30) promoted the in-situ theory of loess formation as a Russian theory with links back to Dokuchaev, and they gained the approval of Stalin. The approval of Stalin gave validity to any theory, including several of the most lunatic of the Lysenko notions. The pedological theory became effectively the official loess theory of the Soviet Union, but there was on-going discussion between supporters of various aspects of this theory and advocates of the rival aeolian approach. Różycki (1991) has detailed some of the controversies:

"In Eastern Europe heated discussions concerning the origin of loess continued. Gerasimov and Markov, outstanding disciples of Berg, defended the views of their master, although they made certain concessions with respect to the possibility of a restricted share of the aeolian process in the formation of loess."

"Pyaskovskii (1946) supported the pedogenic theory, maintaining that loess was formed in the subsoil layer of the steppe and was inherent in its soil profile. He attached great importance to organisms which assisted carbonate solutions in their downward penetration."

"The situation became peculiar, because the continuous repetition of the same arguments by either side and rejection of the opponents=reasons inevitably ended in the discussion dying out. Each of the two groups acted independently, ignoring other opinions, and thus neither a definite solution nor a compromise was found" (Różycki, 1991, p. 30).

Różycki's description of Gerasimov and Markov being 'disciples' of Berg may be a little misleading. They may have simply been using the pedological theory to promote their own interests. Gerasimov went on to become the director of the Geographical Institute of the Academy of Sciences, in other words the most important and influential geographer in the USSR. It seems unlikely that a disciple of Berg (who had been so comprehensively attacked) would attain the highest geographical post in the Soviet Union. Gerasimov exploited the Russian roots of Berg's theory; the link to Dokuchaev made a powerful appeal in those xenophobic times. It may be that Berg, having been attacked so that Lysenko could be elected to the Academy, had served his purpose and could be left alone. He had become a damaged biologist but he was a successful geographer, as his subsequent career demonstrated. As Różycki pointed out, the discussion on problems of loess formation continued at a high level; there was no suppression of discussion or so it would appear.

Final remarks

The Russian Geographical Society website states (2009) that Berg is strongly related to: Bender, Moldova; Saint Petersburg; geographer; climatology; biologist; Soviet Geographical Society; The outstanding people of Pridnestrovia; Vasily Dokuchaev Transnistrian Republican Bank; macroevolution; Moscow State University; Holocene; Transnistria; salmon; fossil; Central Asia; fish; Soviet Union; biological classification; Balqash; Issyk-Kul; Saint Petersburg State University; USSR State Prize; lamprey; ichthyology.

This is an impressive list of linkages, to which should be added: loess; loessification; landscape science. The publicatins by Shaw & Oldfield (2007, 2008a,b) clearly demonstrate the key role played by Berg in the development of landscape science and the importance of landscape science as a geographical idea. His influence on loess has lasted, in particular in eastern and central Europe (see Makeev, 2009; Pecsi 1990, 1995; Pecsi et al., 2000), and his 'loessification' concept is still being discussed (Smalley et al., 2007). However, within the overall world of loess investigation and scholarship his views are seen as eccentric and are usually summarily dismissed. There is a good reason for this: considering the great central problem of the mechanism of the formation of loess deposits, his ideas are nonsense, completely wrong. But on the fringes, and with careful thought and examination, it can be seen that there is relevance and value in the idea of loessification, and in the concept that soil-forming processes are important when loess systems are studied and discussed.

The aeolian approach to the formation of loess-deposits formation provides good explanations for the observed properties of these deposits, in particular the draping across the landscape and the very open structure which allows hydro-consolidation and subsidence. It also gives a convincing view of the formation of the huge deposits in North China, Central Asia and Northern Serbia. It is hard to imagine a deposit of 300 m thick being formed by a top-down weathering process; it is much easier to envisage a building up by airfall deposition over the years of the Quaternary. These very thick deposits do, however, contain distinct soil layers which indicate that soil formation is important in the whole loess system. The best way to consider the formation of a loess deposit is to see it as a series of steps or events, each of which can contribute something to the eventual whole (see Smalley et al., 2009).

Loess material has to be formed; once formed, it is usually transported across the landscape by rivers, and from floodplain deposits aeolian action moves the material to form the open-structured deposits that might, in geological terms, be considered loess. But there are post-depositional events which largely fall within the purview of soil science, and these are important in the development of loess systems (see Makeev, 2009). After the aeolian deposition event, fragipans form, chernozems formed, and – most importantly – the open metastable structure can be converted into an open collapsible structure. The overall primary mineral structure does not change but clay minerals can be concentrated at the particle contacts, and this enhances collapsibility. 'Enhances' is probably a better word than 'causes' with respect to collapsibility, but it does appear that there is a significant post-depositional change in properties. We are now in the world of soil science (with important effects in soil mechanics).

Conclusions

It is now exactly sixty years ago since the death of L.S Berg. It is timely therefore that the present contribution is dedicated to a scarcely known activity of L.S. Berg, one of the greatest Soviet geographers, whose 125th birthday was celebrated in 2001. L.S. Berg's impact on geography and biology is indelible, but in fact, as we can see now, he was also an outstanding cultural anthropologist. His biggest contribution in this discipline was his book 'Bessarabia. Country – people – economy', edited in Petro-

Fig. 6. Bust of the Russian geographer and biologist Lev Sevemenvich Berg, a laurel wreath, a map of the world and a pikeperch. Inscription (with Cyrillic letters) L.S. Berg and years 1876–1950. Mintage 1000 coins. The reverse side of the coin shows the date of minting.

grad in 1918. For its comprehensive analysis, but mainly due to its humanistic approach, this book can be regarded as a model for any cultural anthropologist. The humanistic approach is an advantage that distinguishes L.S. Berg from some other researchers, including his followers in geography (particularly, L.N. Gumilev, whose works have become very popular in Russia lately), as well as from nationalistic publicists, with A. Crihan – who criticized Berg – among them. Berg's scientific approach shows how a cultural or ethnologic research can avoid dangers of respectful racism, and ignorance of some facts that are unpleasant for researcher, which is especially common nowadays. In 2001, a coin (Fig. 6) was struck by the Trans-Dniester Republican Bank (TRB), the main bank of Trans-Dniester Moldavian Republic (TMR) to celebrate his achievements. Its denomination was 100 roubles.

Acknowledgements

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Appendix: Most significant events in the life of Berg (1876–1950)

1876	Born in Bendery, Bessarabia, Russia on March, 14th.
1894	Admitted to the Physics and Mathematics Faculty of Science, Moscow University.
1898	First-degree diploma in zoology and geography, Moscow University; he won a scholarship to attend university.
1899–1903	Inspector of fisheries, Aral Sea region.
1902–1903	Studies oceanography in Bergen, Norway.
1904–1913	Working as zoologist; director of ichthyology of the Zoological Museum of the St. Petersburg Academy of Science.
1908	Publication of a major manuscript, 'The Aral Sea', for which he was awarded the Gold Medal of the Russian Geographical Society.
1909	Awarded Doctor of Science in geography.
1913–1918	Professor of Ichthyology at the Moscow Agricultural Institute.
1913	Birth of daughter Raissa, who became a considerable scholar in the field of genetics.
1913	Berg divorces from first wife.
1915	Konstantinovsky medal, Russian Geographical Society.
1915	Publication of 'Landscape Science'.
1916	Appointed as Professor of Physical Geography at the Petrograd University in Saint Petersburg.
1916	Important publication on loess: a long and clear statement of Berg's 'in-situ, pedological' theory of loess formation, requiring loessification.
1916	Publication of four volumes on the 'Study of fishes of Russia'. The fourth volume was issued in 1949 as 'The study of fishes of the Soviet Union and adjacent countries' and won him the Stalin Prize (see 1951).
1918	Berg convinced the Bolshovists to set up a geological institute in Petrograd.
1918–1930	Head of the Lake Department, State Hydrological Institute.
1922	Publication of 'Nomogenesis', the Berg view of evolution.
1922	Publication of 'Climate and life' which contains a large section on loess, based on the 1916 article.
1922–1934	Head of the Applied Ichthyology section, State Institute of Experimental Agronomy.
1923	Second marriage.
1926	First usage in the title of a publication of the term 'soil theory' in the context of loess formation.
1927	Publication of 'Fundamentals of climatology' (2nd ed. Leningrad, 1938).
1928–1946	Corresponding Member of the USSR Academy of Sciences.
1930–1934	Associate of the Geomorphological Institute of the USSR.
1932	Major English article on loess (reproduced in part in Smalley, 1975).
1934	Honoured Scientist of the Russian Socialist Federated Soviet Republic (RSFVR).
1934–1950	Head of the Fossil Fish section of the Zoological Institute Academy of Sciences.
1939	Proposed for election as Academician (in the biology section) but denied selection by Lysenko and associates (see Medvedev, 1969 for Lysenko background).
1940–1950	President of the All-Union Geographical Society of the USSR.
1946	Elected Academician of the USSR Academy of Sciences (in the geography section).
1947	Publication of 'Climate and life' (2nd edition).
1947–1952	Publication of 'Geographical Zones of the USSR'.
1948–1949	Publication of 'Freshwater fishes of the USSR and contiguous countries'.
1950	Publication of 'Natural Regions of the USSR' in English.
1950	Berg dies in Leningrad on December, 24th.
1951	Oosthumous Stalin prize.

1960 Publication of an edition of Collected Works; 'Climate and life' (in volume 3) contains the loess section which was translated as Berg (1964), and which was referred to by Makeey (2009).

1964 Publication of 'Loess as a product of weathering and soil formation' by the Israel Program for Scientific Translations (IPST) in Jerusalem; this is a translation of work essentially completed in 1940.

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