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Maria Glazovskaya—A Pioneer Soil Scientist and Geochemist Ahead of her Time (1912–2016)

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In the USSR and in Russia, women predominated among soil scientists despite the problems related to field research in tundra, taiga, mountains and other severe environments. One such woman was Maria Glazovskaya, who worked in highlands and semi-deserts studying little known soils, both recent and relict, primary pedogenesis, and geochemical features of hard rock weathering. Her scientific interests were diverse, and corresponded well with the social and scientific trends of the moment. She put forward new ideas and applied existing ones in several spheres of soil geography and landscape geochemistry. She proposed new approaches for compiling soil and landscape-geochemical maps, including using soil properties to predict the risks of soil pollution with heavy metals, and using landscape-geochemical methods to prospect for economic minerals. In the interdisciplinary conceptual sphere, Glazovskaya tried to bring together soil science and landscape geochemistry, and included these two subjects in the name of the department in Moscow University that she headed for more than 30 years. She was a scientist always looking for her own way in the interdisciplinary world of earth science.

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INTRODUCTION

Maria Alfredovna Glazovskaya (1912–2016)—a well-known Russian (Soviet) soil scientist, physical geographer and geochemist, Head of the Department of Soil Geography and Landscape Geochemistry in Moscow State University for more than 30 years, author of fundamental manuals on soil science and soil geography, small-scale soil maps; Honorary Professor, Vice-President and Honorary Member of the Dokuchaev Soil Science Society and the Russian Geographic Society. She prepared more than 20 PhD students and 10 Doctors of Sc. in Geography. Her last book–her memoirs–was written as she approached her 100th birthday.

Maria Alfredovna was a highly educated and charming person, extremely tolerant of other people's opinions and activities. If she disagreed with someone's judgment, she discussed it listening very attentively, asked questions, tried to understand the standpoints of her opponent, and finally said that, unfortunately, she could not support his or her argument. She herself had many ideas, and was happy if her students or colleagues assimilated them without accrediting her. In such cases she said: "OK, it is not important, but it proves that the idea was good". Although many of her ideas were implemented by students and colleagues in publications, she preferred not to join them and instead be the sole author of her books and articles. It may be that she did not wish to share responsibility for ideas that were not always in line with traditional concepts.

FIGURE 1 | Early research works in the 1950s.

FIGURE 2 | Head of the Department, early 1960s.

BIOGRAPHY AND SCIENTIFIC ACTIVITIES IN SOIL SCIENCE, LANDSCAPE GEOCHEMISTRY AND APPLICATIONS

A brief summary of the life and career of Maria Glazovskaya is presented here along with a few references to the situation at the time in the country and in science. Her last book of Glazovskaya (2012b) is entitled "My Life at the Background of Wars and Revolutions". Her contribution to Earth Science is discussed in sections with special emphasis on Soil Science.

Biography

Maria Glazovskaya was born on 26.01.1912 in Saint-Petersburg; she had a younger sister, Margarita, and their mother had an office for printing, editing, and translating books and documents. In 1919, during the Civil War, the family had to leave the city because the termination of orders meant the absence of work. They moved south in an overcrowded train, hoping to find somewhere a place with work and food.

Maria's mother was lucky to find work as teacher in a small village in Belarus, but soon she fell ill with typhoid, and Maria had to look after her mother and her younger sister during an extremely cold winter, without money and with only potatoes for food. In 1922, they returned to Saint-Petersburg (Leningrad), and after secondary school, Maria entered Leningrad University, the Geological-Soil-Geographical Faculty. As a student, she listened to the lectures of outstanding scientists–L. S. Berg, K. K. Markov, B. B. Polynov–and participated in expeditions to the Caspian Lowland. In 1934, Maria Glazovskaya became a post-graduate student of B. B. Polynov (future Academician), whom she regarded as her teacher all her life. Her first publication in 1936 concerned coastal salinity. In 1937, she successfully defended her PhD thesis "Soil Cover Micropatterns in the Caspian Lowland".

In 1936, Maria Glazovskaya married a geographer, Vitaliy Gordienko. He received a job in Alma-Ata (then the capital of Kazakhstan), and they moved there and lived happily, traveling in the mountains and studying landscapes and soils, until the beginning of the Second World War (**Figure 1**). Vitaliy was obliged to join the Red Army as an artillerist and was killed very soon after in Belarus.

Maria Glazovskaya stayed in Alma-Ata until 1952 and worked in the Soil Science Institute along with several other high-professional scientists who were driven to Kazakhstan by the war, and this period was creative for all of them as well as for local science. In 1952, she defended her Dr.Sc. thesis "Inner Tien Shan as a mountainous country of Central Asia" in Moscow, and was invited to the recently organized Department of Soil Geography in Moscow University, in the Faculty of Geography.

From then on, Maria Glazovskaya lived in Moscow and participated in numerous expeditions, which she arranged by

FIGURE 3 | Almost 100 years old.

locating interesting and diverse objects for study. Some were within the framework of Government programs. The first expedition was to the Southern Urals, targeted at developing geochemical methods to search for economically valuable minerals. Following this was extensive research on oil pollution in the Perm Pre-Urals area and effect of oil mining on soils. Then, there was a project in the Novgorod region within the "Man and Biosphere" International project in the 1970–1980s. As the Head of the Department of Soil Geography in 1959–1987, she initiated these and other projects involving many specialists and students (**Figure 2**).

As a Professor, she lectured on basic courses ("Fundamentals of Soil Science", "Geochemistry of Landscapes of the USSR", "Technogenic Landscapes") and more specialized courses ("Geochemical Functions of Microorganisms", "Geochemical Methods for Ore Minerals Prospecting"). An obvious emphasis on geochemistry was the reason the name of the department was changed to "Landscape Geochemistry". However, Soil Science always remained an important sphere of Glazovskaya's interest and activities, both in research and teaching, as well as a basis for new trends in the geochemistry of landscapes. Following her retirement, Maria Glazovskaya continued her intensive work as a Consulting Professor. At the age of 96 she prepared a monograph entitled "Pedolithogenesis and Continental Cycles of Carbon" (Glazovskaya, 2009), that summed up the results of her own studies and those in publications (**Figure 3**).

Contribution to Soil Science

Chronologically, the first study objects of Maria Glazovskaya were arid lands. After the Caspian Lowland with salinity issues, she worked in Kazakhstan, where she performed the routine work of a soil scientist: describing soils in the northern semi-desert which were not well-known then, including various Chestnut and Brown Soils (Calcisols in WRB), and compiling maps. Her work in the highlands was quite different: creative and exotic, although not easy. Her research topics included the weathering of hard rock as affected by microorganisms and the contribution of aeolian phenomena to pedogenesis. The initial signs of pedogenesis on glaciers were investigated in high mountains around the Lake of Issyk-Kul'. Her biogeochemical approach was manifested later as well, it concerned the ash composition of plants as a "trigger" for the solonetzic process on the plains in the areas of Chestnut and Brown aridic soils (Kastanozems and Calcisols). Maria Glazovskaya performed one more "exquisite" case study in the northern countries: in Scotland and Estonia, she gave comprehensive characteristics to soils with spodic elements–soddy subarctic soils and podzols in catenas.

Maria Glazovskaya is known to Russian soil scientists as the co-author (with Innokentiy Gerasimov) of a famous textbook "Fundamentals of Soil Science and Soil Geography", (Gerasimov and Glazovskaya, 1960). It was very popular in the USSR/Russia, and was translated into English and included in the 200 best publications in soil science in the world; its conceptual background remained almost unchanged until recently. "Soils of the World" is another well-known textbook in two volumes (Glazovskaya, 1972-1973; English versions published in 1983 and 1984 Glazovskaya, 1983). She had very few chances to visit foreign countries; however, a great volume of information on landscapes and soils was collected by Glazovskaya in the literature sources available in the Soviet Union. Soils of all continents (except for Antarctic) were described in detail in these books, and of special interest was Australia: in 1952 Glazovskaya published a small book on the soil geography of Australia based on her great experience in aridic soils and on the data of Australian soil scientists who were followers of Dokuchaev's paradigm, and of their scientific leader, Prof. J. Prescott, in particular (Glazovskaya, 1952). During the ISSS World Congress–1968 in Australia, in which Soviet soil scientists were permitted by State authorities to participate, Maria Glazovskaya had a wonderful chance to visit J. Prescott and to cross the continent (Adelaide-Darwin) as a participant of the scientific excursion. J. Prescott knew her book, they discussed Australian soils, and he was amazed at her deep perception of soils as related to regional environments.

In her textbooks on world soils, Maria Glazovskaya implemented some elements of her ideas on soil classification and the most general, or global, regularities of soil geography. Her system of world soils is frequently regarded as soil classification, but that is not completely correct since it concerned only the higher taxonomic levels. In the system advanced by Glazovskaya, priority was given to physicochemical soil properties: pH + redox potential at the highest level, main soil-forming processes at the next level,

type and composition of pedogenesis products formed the third level comprising groups of soil types.

In accordance with her grouping of soils, Maria Glazovskaya proposed an innovative perception of soil geography. The traditional zonal approach was not the main criterion for specifying spatial units; she paid more attention to soil properties, relief, parent material and types of soil-geochemical catenas. This was a hierarchical system of soil-geographical zonation.

Conceptually close to this system was the World Soil Map compiled together with V.M. Fridland and published in Glazovskaya and Fridland (1982), scale 1:15 million. This map was part of a special series of maps "For Higher School"; therefore, its legend was organized in a simple, but rather unusual, way: it was a matrix with two entries - Hydrological regime of soils and Heat reserves. Cells of this matrix contained several soils with similar physicochemical properties. The map's legend comprised 96 soils, and the spatial information on their occurrence was taken from Russian small- and medium-scale maps, and from some sheets of the FAO/UNESCO World Soil Map that were published and available. The map has been actively used until now in lecture courses on soil geography and soils in many universities and institutes in Russia.

Contribution to Landscape Geochemistry

While the scientific contribution of Maria Glazovskaya to Soil Science was conceptual and concerned broad spheres of pedology, her activities in geochemistry were more methodological and oriented on applications. It started in the expeditions she initiated to the Southern and Central Urals in the 1960s as a reaction to the "explosion" of geological investigations in the country and in the search for more indirect and less labor-intensive methods than those that existed in geology. The Ural Mountains with their enormous mineralogical richness were an ideal place for such research. Many young specialists were involved, and they were enthusiastic to explore new regions with new geochemical methods; chemical analyses were made of heaps of soil, plants, and rock samples to reveal geochemical anomalies indicative of precious economic minerals. In this period, a new scientific school of landscape geochemists was formed, and they considered Maria Glazovskaya among their leaders. They had their "textbook" – a book by Maria Glazovskaya entitled "Geochemical Fundamentals of Typology and Methods for Studying Natural Landscapes" (Glazovskaya, 1964); soon, it became a rarity and was re-published in 2012.

After the "golden age" of landscape geochemistry (1960–1970s) came the period of accumulating facts and looking for regional and local patterns. This work was performed by post-graduates from Moscow and other regions under the supervision of Maria Glazovskaya, Alexandr Perelman and Nikolay Kasimov. Among the study objects were geochemical catenas and barriers in various regions. The theory of geochemical barriers forwarded by A. Perelman, was further advanced and extended by Glazovskaya (2012a), and it became helpful in tackling technogenic landscapes, their sequences, and their soils.

Contribution to Technopedogenesis and Ecological Risks

Maria Glazovskaya introduced in 1986 the notion of "technopedogenesis" - a soil-forming process affected by diverse human interventions. Three examples were discussed in her first publication on the subject: paleosols of burial mounds, intensively irrigated Chestnut soils, and assemblages of soils modified by oil spills (Glazovskaya et al., 1986). The latter theme became one of the main research areas in the department, and it was guided by Nina Solntseva - a faithful pupil and follower of Glazovskaya (Solntseva, 2009). The research is interesting in terms of soil genesis in situations when human impact is incompatible with the natural pedogenesis: soddy-podzolic soils (Albic Retisols) of taiga accumulate soluble salts from raw oil, so solonchak and solonetz properties appear in these acid soils.

Soil properties as key objects for understanding the natural environment always attracted the attention of Maria Glazovskaya. We have already mentioned her addressing soil properties as classification criteria, as the results and manifestations of pedogenesis, and interpretation of soil horizons as radial geochemical barriers. In the 1980–1990s, many scientists were preoccupied by the problems of soil vulnerability to technogenic pollution, a specific term was even proposed, "Chemical Time Bomb." This presumed that if the accumulation of toxic substances in soils reached a certain level, it could become dangerous. Revealing such time bombs was a challenge for soil scientists, since most pollutants were heavy metals. Soil resilience was evaluated by diverse methods, quantified, prognostic maps were compiled, and several international conferences were arranged on soil pollution, vulnerability/resilience and assessment of risks (Glazovskaja et al., 1991). Maria Glazovskaya and her team already had experience in compiling small-scale soil-geochemical prognostic maps. Risks of pollution (from weak to strong and even critical) were shown on such maps for individual pollutants like zinc, lead, arsenic, etc., and their associations. Risks were assessed by interpreting properties of various soils responsible for soil capacity to accumulate or modify pollutants in each soil, hence, soil units of a soil map were transferred into mapping units on a prognostic map. Information on pollution sources, such as waste emitted that contained certain elements, or urban or mining dust was added. Another ingredient of a prognostic map was the permissible concentration of an element, information which could be used to evaluate risk in a user-friendly format. These methodological issues were thoroughly analyzed by Glazovskaya and, along with her own experience, served as a basis for the guidelines "Methodological Base for Assessing the Ecologic-Geochemical Resilience of Soils", 1997.

The last scientific publication by Maria Glazovskaya was the monograph "Pedolithogenesis and Continental Cycles of Carbon," where extensive information was collected and analyzed to evaluate the contribution of soils to global carbon pools. The calculation of the carbon dioxide budget in the "atmosphere–pedosphere" system for the period 1985–2008 for Eurasia revealed a certain imbalance, hence, a possible sink of

carbon somewhere in the pedosphere. It was shown that this sink may be due to the fossilization of pedogenic carbon, including that of carbonates in deep layers of the pedosphere, which is regarded as an ingredient of the pedolithosphere. It was suggested that data on pedogenic carbon needed to be considered in developing prognostic models of the carbon budget and climate warming.

CONCLUSION

Even in this short overview, the great diversity of scientific areas in which Maria Glazovskaya found her research objects is obvious. Her first steps in science were dual: the aridic soils of the Caspian Lowland and Turgay Plateau (Northern Kazakhstan) and the Alpine landscapes of the Central Asian mountains. Two trends were always obvious in her activities, and they are reflected in the name of "her" Department–Soil Geography and Landscape Geochemistry.

At the same time, Maria Glazovskaya tried to unite these two trends, understanding well that they are mutually enriching. In her early research, knowledge of soils and their occurrence was helpful in the search of geochemical anomalies, and the anomalies explained some peculiar soil features; radial geochemical barriers would be impossible to find without interpreting soil horizons in the profile. The technopedogenesis concept she introduced might be regarded as a quick-acting or current model of pedogenesis.

In those times when she worked and had many ideas, few contacts with the western world of science were possible. Now, realizing the scale of her achievements, we can only regret that her scientific accomplishments were so little known beyond the USSR/Russia. In Russia, geographers and soil scientists remember her with immense respect, love, and gratitude; and they frequently return to her ideas.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

CONFLICT OF INTEREST

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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