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THE BEGINNING AND EARLY YEARS OF RADIOCARBON DATING IN RUSSIA: LABORATORIES AND PERSONALITIES

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ABSTRACT. We present an overview of the beginning and early years of radiocarbon dating in Russia. Achievements of several major scholars in this field from Leningrad (St. Petersburg), Moscow and Novosibirsk are briefly described. The existing and closed Russian laboratories are also mentioned.

KEYWORDS: history of research, radiocarbon dating, Russia.

INTRODUCTION

In this overview, we present the early history of development of the radiocarbon (^{14}C) dating in Russia (Russian Federation) because this subject is relatively unknown to the international scholarly community. In the 1960s–1980s, Soviet scholars rarely published their results and date lists in journals like *Radiocarbon* (see Butomo 1965; Liiva et al. 1966; Vinogradov et al. 1966; Burchuladze 1968; Dolukhanov et al. 1970; Sementsov et al. 1972; Punning et al. 1973; Lavrukhina and Alexeev 1977; Glushankova et al. 1980; Dergachev 1980; Versler 1989) due to severe restrictions imposed by Soviet authorities on dissemination of data outside of the USSR. More papers were released in the early 1990s, especially in the special issue of *Radiocarbon* edited by Long and Punning (1993); see also an overview by Kuzmin (2009). Limited participation of Soviet/Russian scholars in the international conferences occurred in the early 1980s (see Dergachev and Kocharov 1980), and since the early 1990s much more researchers were able to attend these meetings, begins with the 14th International Radiocarbon Conference in Tucson, AZ, USA (1991), with 11 participants from the former Soviet Union.

We do not consider here researchers and ^{14}C dating laboratories from other parts of the former Soviet Union—Ukraine, Belorussia, Baltic States, Georgia, and Kazakhstan—because this is beyond of scope of this short overview. This is also not a comprehensive history of ^{14}C dating in Russia that would require much more printed space and references published in the Russian language only.

Here we would like to mention the main *dramatis personæ* who contributed (and still contribute) to the development and application of ^{14}C dating in Russia. Before the breakdown of the USSR in late 1991, there were ca. 20 ^{14}C dating laboratories operating in several scientific centers on the territory of modern Russia—in Moscow, Leningrad (now St. Petersburg), Ufa, Sverdlovsk, Novosibirsk, Krasnoyarsk, Yakutsk, Magadan, Vladivostok, and Petropavlovsk-Kamchatskiy (see Table 1); currently, only seven laboratories are active. The major facilities were located in the "capitals" (Moscow and Leningrad) and Novosibirsk, and we will focus on researchers and laboratories in these cities.

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Table 1 List of Russian radiocarbon laboratories[1].

No.	Code	Organization	City	Status
1	LE (Le)	Institute for the History of Material Culture, USSR/Russian Academy of Sciences	Leningrad/St. Petersburg	Active
2	Mo	Institute of Geochemistry, USSR Academy of Sciences	Moscow	Closed
3	CSM	Laboratory of Cosmochemistry, USSR Academy of Sciences	Moscow	Closed
4	LU	Leningrad/St. Petersburg State University	Leningrad/St. Petersburg	Active
5	LG	All-Union Geological Research Institute	Leningrad	Closed
6	IEMAE[2]	Institute of Ecology and Evolution, Russian Academy of Sciences	Moscow	Active
7	GIN	Geological Institute, USSR/Russian Academy of Sciences	Moscow	Active
8	IGAN[3]	Institute of Geography, USSR/Russian Academy of Sciences	Moscow	Active
9	IOAN[4, 5]	Institute of Oceanology, USSR/Russian Academy of Sciences	Moscow	Closed
10	MGU[5]	Moscow State University	Moscow	Closed
11	IWP	Institute of Water Problems, USSR Academy of Sciences	Moscow	Closed
12	VSEGINGEO	All-Union Research Institute for Hydrogeology and Engineering Geology	Noginsk, Moscow Province	Closed
13	SOAN	Institute of Geology and Mineralogy, Siberian Branch of the USSR/Russian Academy of Sciences	Novosibirsk	Active
14	BashGI	Bashkirian Geological Institute, USSR Academy of Sciences	Ufa	Closed
15	IERZH	Institute of Plant and Animal Ecology, Urals Branch of the USSR Academy of Sciences	Sverdlovsk	Closed
16	KRIL	Institute of Forest and Timber, Siberian Branch of the USSR Academy of Sciences	Krasnoyarsk	Closed
17	IM[6]	Institute of Permafrost, Siberian Branch of the USSR/Russian Academy of Sciences	Yakutsk	Active
18	MAG	Northeastern Multidisciplinary Research Institute, Far Eastern Branch of the USSR/Russian Academy of Sciences	Magadan	Closed
19	DVGU[7]	Far Eastern State University	Vladivostok	Closed

Table 1 (*Continued*)

No.	Code	Organization	City	Status
20	TIG[7]	Pacific Institute of Geography, Far Eastern Branch of the USSR/Russian Academy of Sciences	Vladivostok	Closed
21	IVAN[8]	Institute of Volcanology, Far Eastern Branch of the USSR Academy of Sciences	Petropavlovsk-Kamchatskiy	Closed

[1]Some existing laboratories (SPb in St. Petersburg; BINP NSU and GV in Novosibirsk; and IMCES in Tomsk), which did not reveal in press their parameters and results of cross-checks, are not included.
[2]Or IEMEZH as transliteration of original code in Cyrillic.
[3]For graphite produced at this laboratory and measured at the Center for Applied Isotope Studies, University of Georgia (USA), the $IGAN_{AMS}$ version of this code is used.
[4]In online lists of ^{14}C laboratories (available at http://radiocarbon.webhost.uits.arizona.edu/node/11; accessed 28 May 2021), the code IORAN is also given for this laboratory.
[5]Sometimes joint code MGU–IOAN was used, when laboratories cooperated.
[6]Before 1977, the code IMSOAN was used. In online lists of ^{14}C laboratories, the code for this laboratory is given as PI (Permafrost Institute).
[7]Sometimes joint code DVGU–TIG was used, when laboratories cooperated.
[8]In online lists of ^{14}C laboratories, it is mistakenly associated with Ukraine.

THE BEGINNING OF RADIOCARBON DATING IN RUSSIA

The idea to establish a ^{14}C dating laboratory in the USSR/Russia was conceived by Academician A. N. Nesmeyanov in 1954, shortly after the beginning of radiocarbon era by Libby et al. (1949). It was decided to build it at the Leningrad Branch of the Institute for the History of Material Culture, USSR Academy of Sciences (since 1957—the Leningrad Branch of the Institute of Archaeology). An important factor in favor of Leningrad as a choice was that there was a Radium Institute of the USSR Academy of Sciences where several radiochemists were working. A well-known specialist in radiochemistry, Member-Correspondent of the Academy of Sciences Iosif E. Starik (1902–1964) was appointed as the first director of laboratory, from the beginning of operation in 1956 until his death. For the first few years, the ^{14}C dating laboratory was a joint venture of the Institute for the History of Material Culture and the Radium Institute; since 1961, it became part of the former organization.

The first ^{14}C dates from the laboratory of the Institute for the History of Material Culture were obtained in 1959 for two sites in Central Asia (Butomo 1965). The initial laboratory code was RUL- but when the date lists appeared in press it was changed to Le- (or LE-), and which is still in use today (Table 1). Among the first researchers, engineers and technicians were S. V. Butomo, V. M. Drozhin, K. V. Protopopov, E. N. Chaikhorskaya (née Romanova), D. G. Fleishman, V. V. Artemyev, K. A. Arslanov. V. P. Ulianov, A. A. Sementsov, and V. M. Molebnikov; in the late 1960s, Y. S. Svezhentsev joined the laboratory (see Zaitseva 2013; Zaitseva et al. 2007).

Because this was the one of the first ^{14}C dating facilities in the USSR along with the laboratory of the Institute of Geochemistry, USSR Academy of Sciences, in Moscow (Table 1; see Vinogradov et al. 1966), there was not much experience in conducting the work anywhere else, and anyway, the ^{14}C method itself was invented only less than 10 years before that. Radiometry by mean of liquid scintillation counting (LSC) was selected as a method to measure the content of the ^{14}C isotope in Leningrad; in Moscow, the Gas Proportional Counting was used at the Institute of Geochemistry in Moscow (see Vinogradov et al. 1966). Ethyl benzene was used as a career of ^{14}C starting in 1959; in 1964, it was replaced by benzene. In the 1960s, methods of chemical pretreatment of samples and cleaning them from contamination by "foreign" carbon were developed at the laboratory of the Institute for the History of Material Culture, using the acid–base–acid (ABA) treatment of ^{14}C-dated substances. These approaches are still in use today.

Counting the ^{14}C activity was a challenge because the necessary equipment for detecting the low-level radioactivity in liquids was not produced in the USSR (it is not available from Russian manufacturers even today). Handmade equipment was developed by the employees; after 1961, when Anatoly A. Sementsov joined the laboratory, the registration of β-decay became more effective. Afterwards, the instruments based on semi-conductors were improved by Leopold D. Sulerzhitsky at the ^{14}C dating laboratory of the Geological Institute, Russian Academy of Sciences (Moscow), and it was shared with the facility of the Institute for the History of Material Culture.

THE MAIN *DRAMATIS PERSONÆ* IN RADIOCARBON DATING IN RUSSIA

Scholars from Leningrad

Khikmatulla A. Arslanov (born in 1932) (Figure 1) began his education in the city of Kazan (Tatar Autonomous Republic, USSR) in 1951, and in 1952 he transferred to the Faculty of

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Figure 1 Kh. A. Arslanov in his office, Institute of the Earth Sciences, St. Petersburg State University.

Chemistry, Leningrad State University. In 1956, he graduated from this university with the specialization in radiochemistry. In 1957, Arslanov was accepted to graduate school at the Radium Institute, and he was involved in the early development of the ^{14}C dating laboratory at the Institute for the History of Material Culture. Upon completion of graduate studies in 1962, he worked for two years (1962–1964) at the Radium Institute, and afterwards for three years (1964–1967) at the All-Union Geological Research Institute in Leningrad. Here, Arslanov organized the ^{14}C dating laboratory that was active in the 1960s–1970s (Table 1). In 1967, he was appointed to head the Laboratory of Paleogeography at the Research Institute of Geography, Leningrad State University, and has remained there ever since. As before, Arslanov was instrumental in the creation of the ^{14}C dating laboratory that is active to this day (Table 1). In 1987, he defended his *Dr. habil.* (D.Sc.-equivalent) dissertation titled "The Radiocarbon: Geochemistry and Geochronology." Since 2014, Arslanov has been the chief researcher of the Laboratory of Geomorphological and Paleogeographic Research in the Polar Regions and the Oceans, Institute of the Earth Sciences, St. Petersburg State University.

Arslanov's research topics are twofold: (1) development and improvement of ^{14}C technique (e.g., Arslanov and Svezhentsev 1993) and dating methods based on uranium-thorium (U–Th); and (2) the application of these methods to study chronology, geography, and climate of the last 250–300 thousand years in northern Eurasia. In the first field, the

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Figure 2 G. I. Zaitseva in the radiocarbon dating laboratory, Institute for the History of Material Culture.

synthesis of benzene from acetylene gas was developed for the first time in the USSR; since 1967, the vanadium-based catalyst, invented in the mid-1960s (e.g., Noakes et al. 1967), was introduced to Russian laboratories (e.g., Arslanov et al. 1993). As for the second field, numerous papers (e.g., Arslanov 1993; Arslanov et al. 1999) are published by Arslanov and his colleagues on the geochronology of the Late Pleistocene of the European Russia, natural environmental changes in Siberia and the Russian Far East, the Holocene tsunamis in coastal regions of the Russian Far East, chronology of the large earthquakes in the Lake Baikal region, and the dating of groundwater. Despite his advanced age, today Arslanov is an active scholar and a true veteran of ^{14}C dating in Russia.

Ganna I. Zaitseva (born in 1940) (Figure 2) was instrumental in the maintaining the ^{14}C dating laboratory at the Institute for the History of Material Culture during the 1980s–1990s. A graduate of the Polytechnical Institute in the city of Gorkiy (now Nizhny Novgorod), she attended the graduate school at the Leningrad Technological Institute. Upon defense of Candidate of Sciences (Ph.D.-equivalent) thesis in 1979, Zaitseva joint the Institute for the History of Material Culture. Here she was the head of the ^{14}C dating group, part of the Laboratory of Archaeological Technology, from 1989 to 2000 (see Zaitseva 2013).

An organic chemist by education, Zaitseva performed experiments on changes of the chemical composition of wood in relation to the time of burial; this was very important for development of wood pretreatment for ^{14}C dating. Other topics of her research were the chronology of the Neolithic, Aeneolithic and Scythian cultural complexes of the steppe regions in Eurasia; chronology of the oldest Neolithic (i.e., pottery-bearing) complexes in Eastern Europe; and the influence of climate on the ecosystems of southern Siberia and Central Asia at 10,000–2000 years ago (Zaitseva et al. 1993, 1998, 2007; Sementsov et al. 1998; Timofeev and Zaitseva 1999; Zaitseva and Dergachev 2009). Since 1985, Zaitseva has participated in several ^{14}C intercomparisons (see Scott et al. 2018) and encouraged other Russian scholars

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Figure 3 G. E. Kocharov in his office, Physical–Technical Institute.

to join this exercise. Throughout her scientific career, Zaitseva has published more than 400 papers, and she is still active in pursuing the Neolithic chronology of Eurasia.

Another important field where the ^{14}C dating method was widely used is the study of astrophysics. In the early 1960s, Soviet scholars were at the forefront of this kind of research (Konstantinov and Kocharov 1965). Two of them, G. E. Kocharov (Figure 3) and V. A. Dergachev (Figure 4) from Leningrad, made significant contributions to the field of "Astrophysical phenomena and radiocarbon." Along with them, the group from Tbilisi (Georgia) led by Aleksander A. Burchuladze was also very active in this field in the 1970s–1980s (Burchuladze et al. 1980, 1989, 1993; Povinec et al. 1983).

Grant E. Kocharov (1932–2007) graduated from the Leningrad Polytechnical Institute in 1956 and was accepted as an employee of the Physical–Technical Institute, USSR Academy of Sciences (also in Leningrad), one of the world's leading organizations for study the fundamental problems of physics. In the late 1960s–early 1970s, this institute was a center for theoretical studies of the ^{14}C dating method because the ^{14}C isotope is created in the upper atmosphere, and its concentration depending on activity of both the Sun and cosmic rays coming to the Earth (see Konstantinov and Kocharov 1965). In 1967, Kocharov defended his *Dr. habil.* dissertation about the problems and possibilities of the neutrino astrophysics. In 1973, he was appointed as a head of Laboratory for Study the Nuclear Cosmic Physics.

In 1998, Kocharov was elected as a Member-Correspondent of the Russian Academy of Natural Sciences (independent from the Russian Academy of Sciences). Throughout his research career, Kocharov published more than 400 papers and 5 monographs (e.g., Dergachev and Kocharov 1980; Kocharov et al. 1989; Damon et al. 1995; Ogurtsov et al. 2002; Koudriavtsev et al. 2003), devoted mainly to solar nuclear reactions and the neutrino astrophysics (see also Dergachev et al. 2008).

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Figure 4 V. A. Dergachev in his office, Physical–Technical Institute.

Valentin A. Dergachev (born in 1937) graduated from the Leningrad Polytechnical Institute in 1965 and became a researcher at the Physical–Technical Institute, USSR Academy of Sciences. In 1982, he defended his *Dr. habil.* dissertation on the ^{14}C dating method as an instrument to study the natural phenomena in the cosmos and on the Earth. Starting in 1986, Dergachev was the head of Laboratory of Applied Nuclear Physics and Cosmic Rays of the Physical–Technical Institute. In 2003, he became the head of the Laboratory of Cosmic Rays at the same institute; in 2003–2013, he was a Deputy Director of the Physical–Technical Institute.

During his scientific career, Dergachev has published more than 400 papers, mainly in the fields of astrophysical and geophysical processes, and long-term natural environmental changes; all these studies were based on the investigation of the natural archives of cosmogenic isotopes that are generated in the upper atmosphere. The works by Dergachev and his colleagues (e.g., Dergachev and Kocharov 1980; Dergachev et al. 2001; Dergachev 2015, 2019; Dergachev and Volobuev 2018) generated new data on secular and longer cycles of solar activity and long-term changes of the geomagnetic field; these results are widely accepted by the international scholarly community. Dergachev continues his research to this day.

Scholars from Moscow

Lev G. Dinesman (1919–2005) (Figure 5) in 1938 entered the Faculty of Biology, Moscow State University, but in 1941 volunteered for the army and served in World War II until 1945; as a result, he did not graduate until 1948. In the late 1950s while working in Kazakhstan (southern part of the USSR), Dinesman became interested in the history of ecosystems. Realizing the necessity of using ^{14}C dating, he applied the autoradiography method for determining the ^{14}C age of long-lived mammal burrows made by marmots, ground squirrels, red foxes, and polar foxes (Dinesman 1965). He discovered that these burrows existed continuously for 6000–8000 years, preserving

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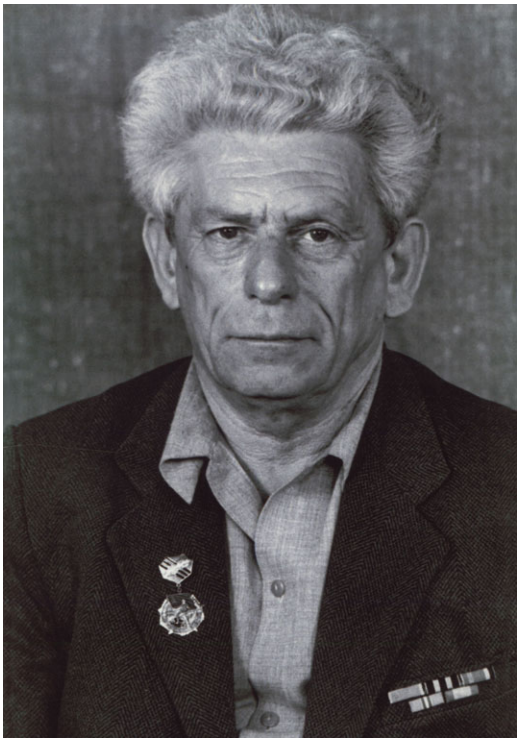

Figure 5 L. G. Dinesman.

animal bones, plant remains, paleosols, and other features (Dinesman 1967, 1971). In 1969, Dinesman defended his *Dr. habil.* thesis based on these studies.

In 1968, Dinesman organized the Group of the History of Biogeocenoses at the Institute of Evolutionary Morphology and Animal Ecology, USSR Academy of Sciences (today the Institute of Ecology and Evolution, Russian Academy of Sciences), where the ^{14}C dating laboratory (Table 1) was established. With the help of Leopold Sulerzhitsky and Alexander Ryabinin, a unique liquid scintillation device was made, operating in a dynamic mode. It measures simultaneously the ^{14}C activity of all substances—sample, background, and standard; this led to a significant reduction in both the measurement error and the volume of the sample vial for benzene, down to 0.25 cm^3.

In the late 1970s–early 1980s, extensive research was conducted by Dinesman and his colleagues on the history of Mongolian arid ecosystems in the Holocene. Analysis was carried out with the help of the variety of paleogeographic methods and was based on 516 ^{14}C dates; this made it possible to reconstruct the history of Mongolian steppes for the last 8000 years (Dinesman et al. 1989). In the late 1980s, Dinesman began working with his colleagues on the environment of the ancient maritime hunters of Chukotka (Bering Strait region). A large series of ^{14}C dates (more than 400 values) on various materials was generated. As a result, the reconstruction of the natural development for coastal Chukotka Peninsula during the last 7000 years was created (Dinesman et al. 1999; Dinesman and Savinetsky 2003).

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Figure 6 L. D. Sulerzhitsky.

Leopold D. Sulerzhitsky (1929–2012) (Figure 6) was born into world-renowned artistic family. He graduated from a Gnesins Musical College in Moscow (with specialization in piano), but passion for geology prevailed over family traditions. In 1952, Sulerzhitsky participated in his first geological expedition; in 1953, he became an employee of the Geological Institute, USSR Academy of Sciences. Together with Viktor V. Cherdyntsev and Natalya V. Kind, Sulerzhitsky founded in 1959 the ^{14}C dating laboratory (Table 1). At first, he was engaged mainly in technical works such as mounting the equipment and building liquid scintillation counters. Subsequently, having received the position of Senior Researcher (despite the lack of special education in geology, physics, or chemistry), Sulerzhitsky became one of the major Soviet/Russian experts in ^{14}C dating of both geological events (glaciations, marine transgressions, volcanic eruptions, and tree-line changes) and archaeological sites from the Upper Paleolithic to the late Middle Ages. After Kind retired in 1986, he became the head of ^{14}C dating group at the Laboratory of Isotope Geochemistry and Geochronology. Together with colleagues, Sulerzhitsky took part in the development of ^{14}C dating and the improvement of the instrumental base for it and prepared a reference benzene sample E-5 which was used by all ^{14}C dating facilities in the former Soviet Union (Veksler et al. 1988). Some details of Sulerzhitsky's life and career can be found in the obituary by Pokrovsky et al. (2012).

In 1964, Sulerzhitsky became interested in the problem of activity of the ^{14}C isotope in volcanic regions; at the same time, he organized the first expedition to Kamchatka Peninsula in far eastern Russia. Overall, he spent more than 20 field seasons in Kamchatka and the Kurile Islands. Sulerzhitsky discovered the effect of wood contamination by volcanic carbon and the "aging" of ^{14}C dates (Sulerzhitsky 1970). Together with Kamchatkan colleagues-tephrochronologists, he

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did a great job on dating the tephra horizons, and this made it possible to reconstruct the volcanic activity of Kamchatka over the last 11,700 years (e.g., Braitseva et al. 1993, 1997; Zaretskaya et al. 2007).

In the 1970s, Sulerzhitsky developed a method for extraction and purification of bone collagen for ^{14}C dating. It became possible to obtain large series of ^{14}C dates on megafaunal bones from the Russian Arctic and neighboring regions of Eurasia (e.g., Sulerzhitsky and Romanenko 1999; Stuart et al. 2002; Nikolskiy et al. 2011). Sulerzhitsky actively collaborated with archaeologists; the dating of ancient burials and other sites in Eastern Europe and Siberia was of particular importance (e.g., Praslov and Sulerzhitsky 1999; Kuzmin et al. 2014). His policy was that samples were accepted from almost everyone who brought suitable material to the laboratory, in order to create a unique data bank for ^{14}C dates of natural and archaeological events and phenomena.

Sulerzhitsky was an exceptional person who possessed vast and versatile knowledge in many fields, the highest qualifications and rare spiritual qualities. Because of his help, ^{14}C dating laboratories worked not only in Moscow, but also in Yakutsk and Petropavlovsk-Kamchatskiy (see Braitseva and Sulerzhitsky 2007).

Olga A. Chichagova (born in 1932) (Figure 7) graduated in 1955 from the Faculty of Biology and Soil Sciences, Moscow State University, with a degree in soil sciences. A year later, Academician I. P. Gerasimov, Director of the Institute of Geography, USSR Academy of Sciences, invited her to organize at this institute a Biogeochemical Group, which later became the Department of Geography and Evolution of Soils. In 1972, on the initiative of Gerasimov, Chichagova along with Feliks S. Zavelsky and Aleksander E. Cherkinsky created a ^{14}C dating laboratory (Table 1) and headed it until 2015. The first scintillation counters were designed in cooperation with the scholars of ^{14}C dating laboratory at the Geological Institute, USSR Academy of Sciences. In the 1980s, a Mark-II Liquid Scintillation Counter was purchased from Nuclear Chicago (USA), and in the early 2000s—a Quantulus 1220 Ultra Low Level Spectrometer. Thanks to Chichagova, the laboratory managed to survive during the 1990s, the most difficult period for modern Russian science.

In 1972, Chichagova defended her Candidate of Sciences thesis "Radiocarbon Dating of Soil Humus," which formed the basis of a monograph (Chichagova 1985). All her further scientific activity was devoted to the study of the ^{14}C age of soil organic matter, including the development of a methodology for the isolation of the "dating fraction" for soil organic matter. Together with I. P. Gerasimov, Chichagova presented the concept of "absolute" and "relative" ^{14}C age of soils, using biologically inert and biologically active carbon, respectively (Gerasimov and Chichagova 1971). This concept, however, was later changed to the monogenetic model of ^{14}C turnover in soils introduced by Cherkinsky (1981) for the first time in the world. Chichagova accepted and used it in her research (see Chichagova and Cherkinskiy 1993; Chichagova 1996, 2005; Alexandrovskiy and Chichagova 1998). Almost from the moment of the establishment of the IGAN laboratory, close cooperation with paleogeographers, archaeologists, geophysicists, and other representatives of natural and humanitarian disciplines was introduced. Chichagova is the author of more than 250 published works, including 10 monographs. Today she is the moral support and source of inspiration for the researchers and staff in the laboratory.

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Figure 7 O. A. Chichagova.

Scholars from Novosibirsk

Lev V. Firsov (1926–1981) (Figure 8) graduated from the Faculty of Geology, Moscow State University, in 1949, and went to Magadan (still the Gulag capital) to work at the Geological Survey. Later on, he transferred to the Northeastern Multidisciplinary Research Institute, Siberian Branch of the USSR Academy of Sciences, and created the first potassium–argon dating facility in the Northeastern USSR. In 1964, Firsov was invited to the Institute of Geology and Geophysics, Siberian Branch of the USSR Academy of Sciences (now Institute of Geology and Mineralogy, Siberian Branch of the Russian Academy of Sciences), in Novosibirsk. Here he again built a device to measure the potassium–argon age of rocks. In 1968, the first ^{14}C dating laboratory in Siberia and the Russian Far East (Table 1) started to operate. Firsov was the true motor of geochronological studies in Siberia until his death in early 1981. In 1974, he defended his *Dr. habil.* thesis based on his earlier studies of geochemistry of the gold-containing rocks in northeastern Siberia.

Like Sulerzhitsky, Firsov was a kind of "romantic" of the ^{14}C dating, and he applied this method to various objects like peat from Siberian bogs; animal bones and charcoal from archaeological sites; carbonized wheat from Crimea with more-or-less exact historical age; and many other kinds of materials (e.g., Firsov et al. 1974; Neyshtadt et al. 1974). He was also a painter and a poet, and left numerous verses and paintings.

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Figure 8 L. V. Firsov.

Firsov's "true love" was the ancient Greek colony Chersonesus (a.k.a. Chersonesus Micra in the Tauric Chersonese region), located in Crimea, where he tested different hypotheses about the ancient history of the northern Black Sea region (Firsov 1976). He was the first scholar in the USSR to recognize the potential of lime mortar as a material of ^{14}C dating, and he tested it using Chersonesus as a polygon (Firsov 1975). Here, Firsov found that contamination by "old" carbon from limestone rocks is a real problem (see also Baxter and Walton 1970) and suggested a way to eliminate it.

Viktor A. Panychev (1937–1988) and **Lyubov A. Orlova** (1944–2014) were both geologists who graduated from Novosibirsk State University, and they continued to run the ^{14}C dating laboratory at Novosibirsk after the untimely death of Firsov. Panychev was the first scholar to widely apply ^{14}C dating to alluvial deposits (Panychev 1979) and paleosols (Orlova and Panychev 1993) of southern Siberia. Orlova's studies were in the fields of the Holocene environment and climate of southern Siberia, the chronology of prehistoric cultural complexes in Siberia and the Russian Far East, and megafauna extinction in northern Asia (Orlova 1986; Levina and Orlova 1993; Orlova et al. 1998, 2004; Kuzmin and Orlova 2004). Panychev and Orlova defended their Candidate of Sciences theses in 1975 and 1986, respectively.

CONCLUSIONS

Despite the reduced number of ^{14}C laboratories, research in this field in Russia continues to flourish on the international level (e.g. van der Plicht et al. 2016). Almost all facilities are now using advanced equipment (including the Quantulus 1220 Ultra Low Level Spectrometers); the installation and testing of the first Russian accelerator mass spectrometry (AMS) ^{14}C laboratory is currently underway at Novosibirsk. Since 2015, the ^{14}C laboratory of the Institute of Geography, Russian Academy of Sciences (Moscow), has been doing

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pretreatment and graphitization of samples for the AMS ^{14}C dating using the AGE-3 graphitization system (Ionplus AG, Zürich, Switzerland). The ^{14}C measurements are carried out on AMS machine at the Center for Applied Isotope Studies, University of Georgia (Athens, GA, USA). Up to now, more than 4000 dates have been produced using this cooperation, with the $IGAN_{AMS}$ code (Zazovskaya et al. 2017).

Today, Russian scientists publish their results in international journals freely, and regularly participate in the ^{14}C intercomparisons. Constant cooperation exists between Russian and foreign scholars, and attendance of various meetings related to the ^{14}C dating—International Radiocarbon Conferences, Radiocarbon and Archaeology, and Radiocarbon and Diet—by several Russian researchers accelerates their involvement in international multidisciplinary projects.

A research grant system has existed in Russia since the early 1990s, and especially since the mid-2010s the amount of funding is sufficient to produce high level results. It seems that the future of ^{14}C dating in Russia is secure.

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