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A VISIT TO THE U.S.S.R.

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J. WM. KERR

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by

J.Wm. Kerr

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ABSTRACT

A six week geological visit to the U.S.S.R. was devoted to the study of tectonics of Arctic lands and seas. The visit was quickly arranged in less than 6 months since it was outside any established exchange agreement. Nevertheless excellent co-operation and hospitality was ensured by correspondence between high levels of the appropriate departments of the two countries.

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INTRODUCTION

I have become interested in the Arctic Ocean Basin, and hope to shed some light on its origin through the analysis of the tectonics of surrounding lands. This roughly circular basin is bordered by territory of the U.S.S.R. for nearly one-half its circumference. A vast amount of Russian literature exists and much more work is currently being done, so it was clear that consultation with Soviet scientists would greatly facilitate my studies. Accordingly I initiated and carried out a six-week visit to nine institutes in four cities of the U.S.S.R., for the purposes of surveying the important literature, learning of work in progress, and improving my knowledge of the Russian language.

The visit was outside the exchange agreement between the Academy of Sciences of the U.S.S.R. and the National Research Council of Canada. As a result, arrangements were considerably simplified and rather quick to make, less than 6 months elapsing between the initial letter to Russia and my departure from Calgary. As always though, high level official sanction on the Russian side was necessary before any co-operation could be expected. This co-operation was arranged by letters from Dr. Harrison to the President of the Academy of Sciences and to the Minister of Geology of the U.S.S.R. It was stated simply that I wished to exchange information and discuss problems of mutual interest with colleagues in the U.S.S.R. I was to travel on a tourist visa at the business rate, and at no expense to the U.S.S.R. A return visit by a Soviet Scientist would be welcomed in due course.

It is my opinion that the means used to arrange my visit were perfectly satisfactory and they can be recommended to others wishing to study in the U.S.S.R. My suggested itinerary had been approved by the Academy of Sciences before my departure from Canada. However, upon my arrival in Moscow, I took the precaution of giving it once again to an office of the Academy, and asked that the exact dates and times of arrival be passed on to the various institutes. This was done and the institutes concerned were expecting me.

The institutes that I visited were, without exception,graciously hospitable and the scientists generous with their time, information and publications.

A great deal of published and unpublished information was made available to me, and only two of my requests were ungranted. I asked first to see index maps showing the regions for which reports and maps have been written, but was told that the Soviet Union does not publish such maps. Also I was never able to see geological maps with detail greater than about 1:500,000. The reasons for the latter refusal were varied but it was usually because the man with the key was away. Later I learned that all detailed maps automatically are unavailable to foreigners. Failure to have index maps was quite unfortunate. Lack of detailed geological maps, however, was not too great a hindrance because of the regional nature of my interests, and because many detailed geological maps can be found in published papers, albeit without detailed topographic data.

In return for the hospitality I was to receive I had prepared two lectures from my research on the geology of Arctic Canada, with illustrated slides in Russian, and these were well received at each institute. This brief report is intended mainly to summarize the scientific findings that are pertinent to my tectonic studies, and describe other points of general interest.

GENERAL REMARKS

The U.S.S.R. is a union of 15 republics, each of which has a capital and some measure of autonomous government. The U.S.S.R. government is superior to the governments of the 15 republics, and any administrative unit in a republic is supervised by the All-Union government in Moscow. The largest republic in the U.S.S.R. is the Russian Soviet Federative Socialist Republic (R.S.F.S.R.), which includes 76% of the land area of the Union and 55% of its people. Smallest of the republics is the Armenian S.S.R., which comprises 0.13% of the area of the union and has 0.84% of the population.

More than one hundred major and minor ethnic groups inhabit the Soviet Union, but this number is progressively being reduced by processes of assimilation and consolidation into larger units. Those of Russsian ethnic origin comprise at least 60% of the total and live throughout the Union, making up the great majority of people in the R.S.F.S.R., a bare majority in Kazakhstan, and considerable majorities (8 to 30%) in other republics except the Armenian S.S.R. Large numbers of people of the other language groups now apparently are rapidly learning the Russian language. The Indo-European linguistic family accounts for 84% of the total population.

The Soviet Union occupies 1/7 of the world's land surface and is slightly greater in area than North America, including Canada, the U.S.A., and Mexico. It extends for 6,800 miles from east to west, crossing 11 time zones. The greatest north-south distance is about 2,800 miles. Siberia, making up 60% of the U.S.S.R., comprises the whole of northern Asia between the Ural Mountains and the Pacific, and extends southward from the Arctic Ocean to the borders with China and Mongolia. It lies almost entirely within the Russian S.F.S.R., except for a part in the southwest which lies in the Kazakh S.S.R. The population of Siberia is preponderantly Russian.

The Academy of Sciences of the U.S.S.R. is a vast organization that directly or indirectly controls most scientific work in the Soviet Union. It has a self-perpetuating membership of full members or Academicians and Corresponding Members or Correspondents, that represents the cream of the scientific community. In 1960 there were 160 Academicians and 369 Correspondents. Geologists and geophysicists number 15 of the Academicians and 37 Correspondents. The total number in the Academy is fixed by the state and does not change except by state decree. The members of the Academy live in any part of the Soviet Union. They may be elected from Academy Institutes, the Universities, or from Government Ministries, but all have a vote in Academy affairs. Elections are held at irregular intervals and new people are voted into the Academy on the basis of their scientific achievements in the eyes of the current membership. Members of the Academy receive a sizeable salary

from the Academy in addition to the one they continue to receive from their Institute. Only Academicians have a vote on new full members, but they and the Corresponding Members elect new Correspondents. In 1961 the average age of the Corresponding Members was well over 60. The U.S.S.R. Academy of Sciences has nearly 200 institutes and laboratories throughout the Soviet Union that are part of the Academy and administered directly by the Academy. Prior to 1961 the U.S.S.R. Academy of Sciences not only directly operated a much larger number of institutes but was responsible for coordination of scientific research throughout the Union. At that time, a major decentralizing reorganization occurred. It had been felt that scientific knowledge was not being utilized effectively in industry. To remedy this the institutes of the Academy that were mainly concerned with practical scientific work were removed from its direct control and placed under state ministries. The Academy now exercises only supervisory control over them through advisory councils. At the same time a State Committee for the Co-ordination of Scientific Research was set up.

Fourteen of the fifteen republics have separate Academies of Sciences, named for the respective republics, and with headquarters in the capital cities. The one exception is the Russian Republic, and in this case the U.S.S.R. Academy serves also as the R.S.F.S.R. Academy. The U.S.S.R. Academy of Sciences has a separate Siberian Department,centered in Novosibirsk, that controls over 60 institutes and laboratories in Siberia. The U.S.S.R. Academy of Sciences retains supervision over the Republic Academies through a council. Each Republic Academy has a body of Academicians and Correspondents, most of whom live in that republic. Upon becoming a member of a Republic Academy a man is generally expected to move there or to work on problems of that republic.

In the U.S.S.R. geology falls under the jurisdiction of three main state bodies. These are mainly concerned with different aspects of the field but their activities interfinger and overlap. The Ministry of Higher Education is responsible for universities and, thereby, is concerned with education of geologists. The Geology and Geography Department of the U.S.S.R. Academy of Sciences is responsible for the more academic geological studies and those that go beyond the borders of the U.S.S.R. For example Soviet participation in the Upper Mantle Project and the Geological Map of the World are under the jurisdiction of institutes of the Academy. Also it has such projects as a compilation of the Circum - Pacific tectonic belt. The Ministry of Geology and Conservation of Mineral Resources, U.S.S.R. is the agency which carries out the more practical geological research and, also, is responsible for the production of oil and minerals. The highest administration of this agency is of course in Moscow, but its main institutes for geological work are in Leningrad. Most prominent of these is the All Union Scientific-Research Geological Institute (VSEGEI), which is comparable to the Geological Survey of a Western nation. In this Ministry also is the Scientific Research Institute of the Geology of the Arctic (NIIGA), which conducts work similar to VSEGEI, does some work in the Antarctic, but concentrates on the Arctic. The All Union Scientific-Research Geological Surveying Institute for Petroleum (VNIGRI), which is the main geology department of the state-run oil company, is also in Leningrad under the Ministry of Geology.

A general outline of the levels of education and their comparison with ours is as follows. A child starts school at age 7 and passes through 10 grades. He can then go to university to study a specific program which lasts, depending on the course of studies, either 5 or 6 years. If he is successful he is given a diploma saying he has graduated. It was emphasized to me several times that this is not a degree. After the diploma has been granted he can apply to become an aspirant, either at a university or at certain institutes. The normal course of this study is three years, at the end of which a man receives his first degree, the Candidate of Science degree. The level of this degree is equated there with our Ph.D. degree. Most people outside the U.S.S.R. regard it as about intermediate between the M.Sc. and Ph.D. For the Candidate of Science degree he will have qualified in three subjects regarded of about equal importance, a thesis, languages, and philosophy. I took a mock oral examination in philosophy and scored zero, having given the "wrong" answers to all the questions.

A Candidate can win a Doctor of Science degree with additional work and another and larger thesis. It is rarely achieved in less than three additional years and usually takes about ten. Most Candidates of Science do not take the Doctors degree. It is awarded only by the major universities and institutes, for example Moscow University, and VSEGEI. Some scientists are awarded the title Professor as well as Doctor and it is a title of even more esteem. Usually this title goes along with teaching some courses, but this is not strictly so. I was told that no one in Russia knows quite what the difference is between Doctor and Professor or just when the latter title is bestowed.

I was never able to obtain a clear picture of what the requirements are for the title of engineer. I suspect that the term is undergoing the same type of abuse that it is on this continent, being applied to the equivalent of our professional engineers as well as to highly skilled technicians. In all cases though it designates a higher degree of training and responsibility than that of their technicians.

MOSCOW

Geological Institute (GIN)

The Geological Institute of the Academy of Sciences directed by Academician Peyve, was the centre of my activities in Moscow. It is located at Pyzhevsky pereulok 7, Moscow G-17. There are eight divisions in the Institute and two of these deal with tectonics. These are the Division of Regional Tectonics directed by Academician Yanshin and the Division of General and Comparative Tectonics, directed by Dr. Shtreys.

It is not the responsibility of the Geological Institute to undertake systematic geological mapping and finally cover the country. Many maps are produced from their projects, but these are usually regional or compilations for special purposes. Men of the two tectonic divisions apparently work everywhere in the Soviet Union but they tend to get established in certain areas depending on the smaller group they are in. Individual geologists seem to have a reasonable latitude in choosing and carrying out their projects but are under a general direction limited by the aims assigned to their group.

I had several meetings with Dr. P.M. Kropotkin of the Division of General and Comparative Tectonics. He is regarded in the U.S.S.R. as a classical mobilist, a school of thought that has been very much out of favour there until very recently. Dr. Kropotkin has written numerous papers that suggest extensive horizontal movements in the earth's crust. In a recent paper entitled "Eurasia as a Composite Continent" which was written for the Symposium on Continental Drift in the Southern Hemisphere, he writes that paleomagnetism supports the thesis that eastern and western parts of the U.S.S.R. have approached each other by several thousand kilometers. He was sceptical of my thesis that horizontal movement between Greenland and Ellesmere Island has only been slight, and favours the earlier suggestion of many miles of movement. Dr. Kropotkin has published recently with K.A. Shakhvrastova a book entitled "Geological Structure of the Circum-Pacific Belt" and, also, has done a great deal of work on the inorganic origin of oil.

Dr. A.V. Lukianov showed me the most recent compilations resulting from his very extensive mapping east of the Black Sea and Caspian Sea. He is most interested in and is currently writing on transcurrent faults of this region. I was struck by the great number of very important faults there, most of which strike northwesterly and have many kilometers of left-lateral displacement.

I had numerous discussions also with Dr. Yu. M. Pushcharovsky, who is leader of a group in the Division of Regional Tectonics and a member of the committee for the International Geological Map of the World. His group has just completed a map entitled "Tectonic Map of the Pacific Ocean Segment of the Earth's Crust". It includes the entire Pacific Ocean and Circum - Pacific tectonic belt and shows both land and submarine geology. I was the first foreigner to be shown the entire compilation, and it was most impressive to see all the sheets laid out together. He planned to unveil the map formally 3 months later at the International Geological Congress in Prague, but has already published a very short summary in a 1967 issue of Tectonophysics. The collaborators of Dr. Pushcharovsky in this work are N.A. Bogdanov, G.B. Udintsev, L.N. Melanholina, R.A. Afremona, T.V. Molchanova, V.I. Tikhonov, and others. The map separates tectonic belts on the basis of the age of development. The thesis of the compilation is that a gigantic ring lies between the floor of the Pacific Ocean on the one hand and the ancient platforms of surrounding continents on the other hand. There has been a gradual growth of continental blocks by means of several folded geosynclinal systems, which are concentric to one another and recede successively towards the ocean floor. The belt includes Baikalian (late Precambrian), Caledonian, Hercynian, Mesozoic and Cenozoic folded zones, and recent geosynclinal formations. Dr. Pushcharovsky compiled the well known Tectonic Map of the Arctic on a scale of 1:10,000,000, that was published by the Geological Institute in 1963, and he has written a book entitled Tectonics of Eurasia. The views of Dr. Pushcharovsky seem to lie between the classical mobilists and classical fixationists.

Institute of Physics of the Earth (IFZ)

This is the most important institute in the U.S.S.R. for the study of all branches of geophysics. It has 15 departments and employs about 100 professional researchers. The address is Bolshaya gruzinskaya ulitsa, 10. Dr. V.V. Beloussov, Head of the Department of Tectonics at the Institute of Physics, is also head of a chair in the Department of Geology at the University of Moscow. He has been a leader in Soviet tectonic studies for many years and through his own writings and those of his many students has developed a school of tectonic geology that is dominant in the U.S.S.R. and is firmly fixationist. He has recently written a paper entitled "Against Continental Drift". His group has studied the relationship of seismicity to structural geology and prepared maps showing probability of occurrence and the probable intensity of earthquakes. I was shown the details of a recent study of this kind in the Crimea. Apparently when the construction of a new major building is proposed, funds are not approved until it has been demonstrated that the building can withstand earthquakes of the magnitude that his group predicts.

One of my reasons for visiting the Institute was to learn about the distribution of earthquakes. I was therefore most interested to visit the Seismological Service of the U.S.S.R. which is located at the Institute and annually compiles an atlas of seismicity entitled "Earthquakes of the U.S.S.R." The current work was being compiled by N.V. Kondorskaya and she showed me their most up to date seismic maps on which the degree of seismicity is shown by contours. On this map a narrow seismic belt that connects with a belt crossing the Arctic Ocean extends from the mouth of the Lena River southward to Yakutsk and dies out east of there. Another belt, that encompasses Lake Baikal, extends east to about 125° E. Longitude and also dies out. Each of these approaches, but neither of them connects with the Circum-Pacific earthquake belt, which is south and east of both.

Moscow State University

Moscow Lomonosov State University occupies an imposing structure built in 1953 on the outskirts of the city. It is situated on the Lenin Hills and overlooks the Moscow River. The Geology faculty which occupies a number of floors in the central block of the building is the largest and most important center for geological education in the Soviet Union. In 1967 the faculty staff numbered about 190, among them 3 Academicians and 4 Corresponding Members of the Academy of Sciences of the U.S.S.R., 36 Professors and Doctors of Science, 80 lecturers and senior scientific workers and 65 assistants and junior scientific workers. In addition there were 300 research workers, 28 of whom are candidates of science. In the faculty also were 2,078 students. Every 3 years a dean of the Faculty of Geology is elected from among the faculty professors. Professor A.A. Bogdanov is the present dean and is in his second 3-year term.

I had an afternoon meeting with Professor Bogdanov and several other professors of the faculty. Professor Vladimir Grigorevich then gave me a tour of their facilities.

The Faculty of Geology has 13 departments which, with their heads, are as follows:

Dynamic Geology	- G.P. Gorshkov
Historical and Regional Geology	- A.A. Bogdanov
Paleontology	- V.V. Drushchits
Natural Resources	- V.I. Smirnov
Geology and Geochemistry of Combustible Resources	- N.B. Vassoevitch
Petrography	- V.S. Koptev
Mineralogy	- G.P. Barsanov
Crystallography and Crystallochemistry	- N.V. Belov
Geochemistry	- A.P. Vinogradov
Hydrogeology	- B.I. Kudelin
Soil Science and Engineering Geology	- E.M. Sergeev
Permafrost	- V.A. Kudryavtsev
Geophysical Methods of Earth Crust Investigation	- A.I. Zaborovsky

LENINGRAD

Scientific Research Institute of the Geology of the Arctic (NIIGA)

This institute, which is under the Ministry of Geology, U.S.S.R., was the centre of my activities while in Leningrad. The address in Leningrad, is nab.4 - Moika 120. Of all the institutes visited my discussions here proved to be of the most value, with respect to my work. I was received most warmly by the Director, Dr. B.V. Tkachenko, who was at the Arctic Symposium in 1961 and has had a long and cordial relationship with people of the Geological Survey of Canada. The Institute studies the geology of the Russian Arctic as well as the submarine geology and geophysics of the Arctic Ocean Basin. Dr. B. Kh. Egiazarov, who is head of the Division of Regional Geology, arranged my program while there.

A large group of geologists and geophysicists at the Institute led by Dr. I.P. Atlasov prepared a Tectonic Map of the Arctic and Subarctic and published with with the Commission of the Geological Map of the World in 1966 in Paris. Other members of the group are B.Kh. Egiazarov, V.D. Dibner, B.S. Romanovich, A.V. Zimkin, V.A. Vakar, R.M. Demenitskaya, D.V. Levin, A.M. Karasik, Ya. Ya. Hakkel (deceased), and V.M. Litvin. I had a meeting with several of the geologists of this group in which Dr. Atlasov gave me a short lecture and he showed and described a more up-to-date version of this map that will be published soon. I later talked individually to workers on the tectonics of the Arctic, both geologists and geophysicists, and found that there was considerable disagreement amongst the co-authors about things on this map. For example the geologists told me they had dredged granite basement from the Chucki Cap and the geophysicists told me it was drift. Also the geophysicists do not favour the major basement faults shown on the map between Novaya Zemlya and Severnaya Zemlya, nor certain other major basement faults.

I had a most interesting meeting later with a group of submarine geologists and geophysicists led by Dr. R.M. Demenitskaya, and including also A.M. Karasik, N.N. Trubyatchinsky, Yu. G. Kiselev, and B.V. Gusev. Their newest findings show that the Mid-Ocean Ridge of the North Atlantic Ocean continues through the Nansen Basin of the Arctic Ocean and they have named it the Hakkel Ridge. It is a topographic ridge with a median rift valley and is an active seismic belt. Linear magnetic belts extend along each side of the ridge. Their patterns are symmetrical and support the sea floor spreading hypothesis in the Nansen Deep. There is at least one transform fault crosswise to the Hakkel Ridge similar to those on other median ridges of the world. Little is known as yet about motion of the earthquakes in this belt. New earthquake data suggest that the continuation of this seismic belt in Siberia bends sharply to the east instead of continuing southward from the mouth of the Lena River as was felt in the past. This latter suggestion is contrary to the strong pattern of earthquakes I had seen at the Institute of Physics of the Earth. All were emphatic that the Lomonosov Ridge is not an active seismic and volcanic belt. Dr. Karasik has tested the fit of the 2,000 m isobaths on either side of the Nansen Basin using the method of Bullard et al., and found the fit to be very close.

Dr. Egiazarov has in preparation a synthesis on the tectonic history of that part of the Circum-Pacific Belt extending from northern British Columbia through Alaska and eastern parts of Asia as far as Japan. His thesis is that there were successive geological revolutions each of which affected the entire length of this section of the belt. On the Siberian side these revolutions occurred side by side, successively receding toward the ocean, and resulting in a great amount of continental accretion. On the North American side they have recurred in nearly the same geographic position, resulting in much less accretion. He has tentative plans for visiting North America to discuss his work with colleagues here and to make oral presentations of his work. Before embarking on his current project, Dr. Egiazarov had also worked widely on the Arctic coasts and islands of the U.S.S.R., and now is head of the Regional Geology Division at the Arctic Institute.

Dr. F.G. Markov showed me two geological maps that he and his group are compiling. One entitled "Geological Map of the Siberian Platform and Adjacent Territories" at a scale of 1:1,500,000 is composed of 9 sheets and is dated 1968. Co-editors are M.V. Blagoveshchenskiy, N.S. Malich, and F.G. Markov. The other which is entitled "Geological Map of the Arctic and Subarctic" is at a scale of 1:5,000,000. It is edited by F.G. Markov and is dated 1967, but will not be published for a few more months.

Arctic and Antarctic Scientific Research Institute (AANII)

The headquarters of this institute are located in Leningrad at Fontanka, Dom. 34. I visited there briefly and chatted with the Director, Dr. Treshnikov. The institute is mainly concerned with geography, glaciology, meteorology. Their projects include studies of post glacial rebound, ways to lengthen the navigation season, and long range weather forecasting. The Institute has an interesting museum in another part of the city and this I also visited.

All-Union Scientific Research Geological Institute (VSEGEI)

This institute, which is commonly called VSEGEI, is comparable to a national Geological Survey. It is located at Sredny Prospect 72-b. I was given a summary of the organization by the Director, Dr. Shatalov. Dr. Borovikov who I had met previously and who led the Soviet delegation to the Devonian Symposium, is vice-director, and was away while I was there. This is the biggest and oldest geological research institute in the country and has spawned some dozens of regional Geological Surveys located all over the Soviet Union. These regional Geological Surveys are coordinated by VSEGEI under the Ministry of Geology. It is the duty of this institute to make generalizations on the local studies of the regional Geological Surveys, and to provide a scientific basement for their further investigations. The Institute has a staff of 1,900. Of these 53 hold the degree of Doctor, 317 are candidates, and 980 are Engineers.

VSEGEI publishes a geological map of the entire U.S.S.R. available on scales of 1:2,500,000 and 1:5,000,000. A new one on a scale of 1:2,500,000 has just been completed and is available with a legend in English. The Institute is now publishing a major work entitled Geology of the U.S.S.R. to commemorate the 50th anniversary of their political regime. It will include five volumes and a separate folio of maps. The volumes will cover (1) Stratigraphy, (2) Tectonics, (3) Magmatic Phenomena, (4) Useful Minerals, and (5) General Problems. The types of map in the folio are (a) Geological, (b) Quaternary, (c) Geomorphological, (d) Tectonic, (e) Hydrochemical, and (f) Metallogenic. The tectonic map which was shown to me by its originator and editor, Dr. T.N. Spizaharsky, separates regions based upon the kinds of folds or tectonics. Their tectonic maps have hitherto always separated regions based on the age of their folding. The hydrochemical map shows the chemistry and temperature of solutions in the subsurface to a depth of 10 km, by means of symbols on columns at various places.

Dr. V.A. Ounksov, chief of the Division of Regional Tectonics, made all arrangements for my appointments during my visit to VSEGEI. He took me on a tour of the magnificent SNIGRI Museum which is in the same building but separately administered. One half of this enormous museum is devoted to a display of the regional geology of the U.S.S.R. The floor plan of the displays is organized according to geological divisions of the country. Simplified maps and cross sections are on the walls, and in front are display cases containing the rocks from that region. With the comments of Dr. Ounksov, a tour through this museum was an excellent summary of the Geology of the U.S.S.R.

Dr. L.J. Salop, chief of the Precambrian Division, and N.V. Zinovevich of that division discussed with me the influence of the Precambrian basement on the later tectonics of the U.S.S.R. An excellent map for our discussions on the western one-half of the country was one published by VSEGEI in 1964. It is entitled Geological Map of the Crystalline Basement of the Russian Platform, at a scale of 1:2,500,000. In addition to showing the geology of the basement outcrops (Shield) it shows also the pattern of basement that has been deduced beneath the sedimentary cover, by wells and other means. Based on his work in the Lake Baikal

region Dr. Salop published in 1962 the Geological Map of Baikalia at a scale of 1:1,500,000. He considers that Lake Baikal lies in a rift valley which has been formed over a dome with great vertical but very small horizontal motion. Beneath the dome is a great basaltic magma body or asthenolith.

One of my most interesting days was spent in discussion with Dr. D.A. Kirikov who has worked widely in eastern and northeastern Siberia. We used a map entitled "Geological Map of the Northwest Part of the Pacific Mobile Belt" (Scale 1:1,500,000), and the text entitled "Geological Structure of the Northwest Part of the Pacific Mobile Belt". Both map and text were edited by L.I. Krasny, but Dr. Kirikov was a contributor.

All-Union Scientific Research Geological Surveying Institute for Petroleum (VNIGRI)

The institute is located at Dvortsovaya naberezhnaya 18. One day was spent at VNIGRI, where I had a meeting with several geologists in their main lecture room. Present at my meeting were N.L. Rozanov, chief of the Division of Tectonics, Yu. A. Pritula, chief for Eastern Siberia, V.D. Nalivkin, and P.K. Ivanchuk. I was shown a new tectonic map of the U.S.S.R. that this Institute is preparing. It will be published within two years. They also have prepared an Oil and Gas Probability map of the U.S.S.R., on which oil potential is shown by contours and shading. All criteria available are used and weighted appropriately in the preparation of this map.

V.D. Nalivkin of this institute is working on the formation of oil and particularly depth of formation. So far he believes that oil cannot be demonstrated to have formed at depths of less than 1,500 feet, because this is the maximum depth of the thinnest basin in which they have found oil.

This organization is similar to a geological department of an oil company, however it stops short of the actual drilling for and producing of oil. I was told that this is done by smaller regional offices that are also under the Ministry of Geology but not under either this organization or VSEGEI. This organization has done considerable work in the application of geochemistry toward outlining very large prospective areas. They strongly support an organic origin for oil.

AKADEMGORODOK (NOVOSIBIRSK)

Institute of Geology and Geophysics

This Institute is located in a new academic city of 40,000 people that is located about 20 miles from the city of Novosibirsk (population about 1,000,000) in southwestern Siberia. The academic city, or Akademgorodok as it is commonly called, was built within the last 10 years in what had earlier been a wilderness area. It now has a university and about 20 research institutes. The address is Novosibirsk 72, Akademgorodok.

The Institute of Geology and Geophysics is part of the Siberian Branch of the Academy of Sciences of the U.S.S.R., and is the main geological research institute in Siberia. It has a staff of 900 of which 400 are geologists. This includes 4 Academicians (U.S.S.R.), 8 Correspondents, 40 Doctors, and 150 candidates. The director of the Institute is Academician Trofimuk. The three divisions of the Institute and their chiefs are (1) Geochemistry (Academician Sobolev), (2) Geophysics (Dr. N.N. Puzarov), and (3) Sedimentary Rocks and Tectonics (Academician Yanshin).

A new institute will soon be formed from part of the present organization. It will be the Institute of Experimental Mineralogy and Petrography and Academician Sobolev will be the first director. He is most noted for having correctly predicted that diamonds could be found in Siberia but, also, is instrumental in compiling the metamorphic map of the world. At the time I was in Akademgorodok an International conference on experimental mineralogy was being held at the Institute of Geology and Geophysics.

The Division of Sedimentary Rocks and Tectonics has 11 laboratories and, according to Yolkin who gave me the information from memory, their names and heads are as follows:

(a) Paleozoic Stratigraphy and Paleontology	- B.S. Sokolov
(b) Mesozoic and Cenozoic Stratigraphy & Paleontology	- V.N. Saks
(c) Micropaleontology	- A.V. Fursenko
(d) Paleophytology	- T.E. Vozyennikova
(e) Tectonics	- Yu. A. Kosygin
(f) Experimental Tectonics	- I.V. Luchitskiy
(g) Neotectonics	- V.A. Nikolaev
(h) Sedimentary Formations	- M.A. Zharkov
(i) Lithology	- Yu. P. Kazanskiy
(j) Geochemistry of Oil and Gas	- V.S. Vushemirsky

Dr. Yu. A. Kosygin has studied the tectonics of Siberia and edited a map entitled "Map of the Precambrian Tectonics of Siberia", Scale 1:5,000,000 (1963). Dr. K.V. Bogolepov, who is head of a group studying Mesozoic Tectonics, has published a book entitled "Mesozoic Tectonics of Siberia" (1967) and a map entitled "Map of the Post-Triassic Tectonics of Siberia and the Far East", Scale 1:5,000,000 (1963). I had meetings with these two men together and between them they gave me most illuminating discourses on the tectonics of Siberia.

Dr. V.N. Saks is most interested in the origin of the Arctic Ocean, and approaches the problem using paleogeography, paleoclimatology, and faunal migrations. He has written a paper entitled "Paleogeography of the Arctic in the Jurassic and Cretaceous Periods" (1961). He showed me the more up-to-date maps he has prepared since then on the Jurassic, and told me of similar maps for the Cretaceous being prepared by Dr. V.N. Vereshchagin. In Dr. Saks' group is S.L. Troitskiy who works on the Tertiary and Recent Sediments and faunal migrations of the Arctic coasts of Siberia. An interesting point to me was his statement that post glacial uplift of most parts of the northern coast of Siberia increases in amplitude northward, and this is also the case for instance on the island Novaya Zemlya.

Dr. I.V. Luchitskiy and his associates, P.M. Bondarenko, and V.I. Tromin, have a laboratory of experimental tectonics and presently are making models which simulate existing structures. Dr. Luchitskiy told me that he is firmly a fixationist. He believes that the Lake Baikal rift is a graben associated with a small couple that formed when a great magma body or asthenolith raised an arch. They have simulated the Baikal structure in model experiments. An English translation of their work entitled "Experiments in Modelling Baikal-Type Arched Uplifts" was published in Geotectonics No. 2, 1967.

IRKUTSK

Institute of the Earth's Crust

On the outskirts of the city of Irkutsk (pop. about 2,000,000) in southern central Siberia, a large academic centre is under construction. The Institute of the Earth's Crust (formerly called the East Siberian Geological Institute) is at this centre (address Irkutsk 33) and had moved into a new building there half a year before my visit. The Institute comes under the Siberian Branch of the Academy of Sciences of the U.S.S.R. It has a staff of 350, of which 120 are scientific workers. Of these, three are Corresponding Academicians, 7 hold the degree of Doctor, and 60 hold the degree Candidate of Science. The investigations of the Institute are carried out mainly in central and southern parts of Eastern Siberia. The director, Dr. Udintsev, impressed upon me that the Institute is very keen to widen its contact with foreign scientists. They like their men to travel to other countries and also welcome visitors. The ASOPROB conference was invited to Irkutsk and will meet there in 1969. The welcome that I received there certainly could not have been more kind and co-operative.

The Institute has three main divisions. The Geophysics Division is mainly concerned with Seismology, partly because of the proximity of the seismic zone through Lake Baikal. The Division of Groundwater and Engineering Geology does a great deal of work on the effects of man made lakes because dam building is so important in this region. The Geology Division is quite diversified. Because of their geological surroundings they do a great deal of work on the tectonics of platforms and on the Baikal and other rift zones.

I was met first of all by Drs. Florensov, Zamaraev, and Pinnaker, who on a Sunday took me on a sightseeing trip to Lake Baikal about 80 km from Irkutsk. This is a remarkable lake of rift origin, over a mile in depth and containing 20 per cent of the total fresh water of the world. It was a magnificent summer day and the countryside reminded me very much of the rolling foothills of the Canadian Rockies. At the village of Listvyanka is the Baikal Limnological Station. I was given a personal tour of that establishment by the director, Dr. G.I. Galaziy. A most interesting museum shows the vast number of species of plants and animals that inhabit the lake, most of them being unique to the lake. It contains land-locked seals, which presumably are a relic of a former connection with the sea. It is planned to import penguins and conduct an experiment with a control group in large cages. If they thrive and do not interfere with existing life in the lake they will be released. I tried to find out the

reason for desiring penguins there, and got no clear answer; it seemed that they will be only for curiosity. A study of the growth rings of trees near the shores of Baikal was described to me. By counting the rings and measuring their separation they have concluded that the climate of the area is warming up. This is a widely held belief by scientists and by others and I was told often that the climate has been warming within living memory. Certainly the climate that I saw in southern parts of Siberia was warmer than I had expected, and seemed comparable to southern parts of the Canadian prairies.

A few days later I returned to Lake Baikal with Dr. Zamaraev to be taken on a field trip aboard the Institute's launch Academician Bardin. Two seismologists who were visiting at the Institute also joined the trip, Dr. Yu. V. Riznichenko of the Institute of Physics of the Earth in Moscow, and Miss S. Hanum from Tashkent. We boarded the launch at the head of the Angara River and travelled along the coast to the northeast. Hiking inland we examined a major thrust of Precambrian schists onto Jurassic conglomerate. In the evening the launch took us right down the Angara River to Irkutsk and set us off at the big power dam there.

Dr. N.A. Florensov who is Head of the Laboratory of Geomorphology and Recent Tectonic Processes is a noted authority on the structure of the Baikal and other rift zones. He has published widely on rift zones and also will have a paper in a collection of papers on the Baikal Rift Zone to be published soon in Moscow. His present research project is to determine the limits of the Baikal Rift Zone. The active rift zone continues to the east as a branch that takes off eastward from the central part of the lake, and not from the end of the lake. It continues eastward as both a rifted zone and an active seismic zone beyond 120°E. Longitude and, in places, is expressed as sediment-filled topographic basins. Where last observed the rift zone trends eastward toward Udskaya Gulf on the Sea of Okhotsk. The westward continuation of the Baikal Rift Zone is less well known. It probably branches sharply to the south to Koso Lake in Mongolia but because this is in another country they know very little about it. Dr. Florensov's group will next year have an expedition to Mongolia to work on this problem. His present knowledge is that, whereas the structure of the zone at Lake Baikal has primarily normal faults, the continuation into Mongolia has primarily reverse faults or left-lateral strike-slip faults. The normal faults that formed Lake Baikal have had very little transcurrent motion, but the vertical displacement is as great as 7,500 feet. The transcurrent movement on the continuation in Mongolia may be as great as 10 km; however, the Gobi-Altai earthquake on this zone resulted in an instantaneous offset exceeding the offset of the San Andreas fault in the great 1906 earthquake. The rifting stage of Baikal began in Middle Pliocene and continued to the present day.

L.A. Misharina is a seismologist who studies the Baikal Rift Zone especially, and in 1967 published a book entitled "Strain of the Earth's Crust in Rift Zones". From first motions of earthquakes she has come up with orientations of the principal axes of stress at various places along the rift zone. These axes are in close agreement with axes determined from Dr. Florensov's geological mapping of geological displacements. She demonstrated that at Lake Baikal the axes of greatest and least stress are horizontal and respectively are oriented parallel and perpendicular to the long dimension of the lake. Both east and west of the Lake Baikal area the axis of least stress is oriented horizontally along the rift zone and the axis of greatest stress horizontally and perpendicular to it.

Dr. V.P. Solonenko is a seismologist who is especially interested in the Baikal Rift Zone. It is his opinion that the only part of the zone undergoing extension is that part near Lake Baikal. The seismic zone east of the Lena River in the Verkhoyansk region is under compression. Dr. Solonenko contributes the data from the Baikal region that is used in the annual compilation entitled "Earthquakes of the U.S.S.R."

Dr. S.M. Zamaraev is Head of the Laboratory of General Tectonics and Structural Geology. His group has a 5-year plan under way for a major integrated study of the rift systems of Siberia. First they will prepare a map of the pre-rift tectonics, and secondly make a study of the relationship between the ancient platforms and the folded systems. Then they will consider the question of the horizontal shift of platforms relative to folded systems that has occurred in the rift zones.

For many years geophysicists at Irkutsk have held two widely diverging opinions on the thickness of the continental crust beneath Lake Baikal. Dr. A.P. Bulmasov of Irkutsk State University has maintained that the crust at the lake is abnormally thick, and this has been used by some to support the hypothesis that the rift zone there was related to an asthenolith. Dr. Yu. A. Zorin of the Institute of the Earth's Crust has maintained that the crust near the lake is abnormally thin, and this has been used by others to support the hypothesis that the rift zone there was formed by tension in the crust unrelated to any asthenolith. The prevailing opinion at the Institute of the Earth's Crust as well as at other institutes I had visited now favours the view of Zorin. I had the pleasure of discussing the problem with Zorin but did not see Bulmasov. Zorin regards the question as solved because of a great amount of new evidence favoring a thin crust at Lake Baikal. Apparently the crustal thickness of the Siberian Platform northwest of Baikal is normal, at Baikal it is abnormally small, and in the folded zone to the southeast it is abnormally great. Furthermore Zorin believes that a layer of extremely high electrical conductivity in the mantle represents a layer of equal temperature and also bulges upward beneath Lake Baikal.

IMPRESSIONS OF THE COUNTRY

My observations of the country and discussions with the people I met casually in Russia were as interesting and exciting as my geological investigations. Upon arrival I spoke only enough Russian to ask directions and order meals. However with a concerted effort to converse at any opportunity and a dictionary constantly in my pocket I was soon able to engage in varied conversations. Opportunities to speak to Russians presented themselves continuously. This was particularly so in restaurants where overcrowding makes it mandatory to share a table, as well as in trains which I rode a good deal. People were pleased to meet me, genuinely friendly, and anxious to discuss anything and everything. The first action of people in restaurants was usually to ask for two more glasses and share their vodka with my wife and me.

The overall impression of the social and economic situation of the country that I had acquired through my earlier reading was very much confirmed by my trip. I think this is a reflection of the good quality of reporting that we are given here on the U.S.S.R. On the contrary I found there to be very little understanding in the U.S.S.R. of the life we live in North America.