

three-eighth-inch nylon rope along the left side of the train with the loop just behind the centre of the rear sled and the ends extending about 6 ft. in front of the toboggan. Pass one loose end through a snap link on the lower front left corner of the canvas tank on the front sled, through another snap link tied to the left side of the winch, through the eye bolts (G) on the left side of the the toboggan near the front and then across the front of the toboggan. Tie the rope into a hole drilled into the front of the right ski. Pass the other loose end also through the snap link at the front left corner of the tank on the front sled, through a snap link tied to the centre of the front crossbar of the sled, through a snap link tied to the right side of the winch, along the right side of the toboggan, through the eye bolts on the right front, across the front of the toboggan and tie to the left ski. Take the loop end of the rope, determine the proper length and tie overhand loop knots (E) on each side. Fasten each loop to an outside eye bolt on the guide bar with a snap link.

Tie the end of a three-sixteenth-inch nylon cord, the "stop" rope (K), to the throttle and pass the other end backward through a snap link at the top of the jerrycan on the left runner of the toboggan and through the snap links used for the left steering rope. Tie the end to the right centre eye on the guide bar. Tie a similar rope, the "go" rope (L), to the throttle and pass it forward through a snap link tied to the steering column and then backward through the set of snap links used for the "stop" and left steering ropes. Tie this rope to the left centre eye on the guide bar. The throttle ropes should have a little slack to prevent interference with the steering ropes. It is worthwhile to tie a small flag to the "stop" rope for identification and a few knots near its end for a better grip.

The engine is started, shifted into forward gear at low throttle and left idling. The driver takes his place near the front of the rear sled and starts the toboggan moving by a steady pull at the "go" rope. The length of the steering ropes can be adjusted by retying the

overhand loop knots to obtain maximum efficiency and comfort.

Summary

Motor toboggan sled trains have established their value for antarctic trail work. The capital outlay and maintenance costs are low compared with other vehicles and the trains can be operated in relative safety and reasonable comfort. Very few mechanical troubles are encountered during the first season of use providing the toboggans receive proper care. The toboggans are large enough to move all trail and survival equipment and supplies needed by geological or surveying parties but are small enough to be manhandled into and out of aircraft when desirable. One toboggan can pull at least 2000 lbs. over normal snow surfaces and approximately 6 ton-miles of payload moving is obtained for each gallon of gasoline consumed. An average of 50 mi. per day can be travelled under good conditions. Working from a base camp trail parties can cover an area with a radius of at least 200 mi.

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ECONOMIC DEVELOPMENT OF THE SIBERIAN NORTH

Soviet scientists regard all territory to the north of the Trans-Siberian Railway as the Siberian North. The region treated in this paper is that lying between the eastern slopes of the North Ural and Polar Ural in the west and the Yenesei-Lena divide in the east. It has an area of more than 3 million km.² (1,150,000 mi.²), which is one-seventh of the whole territory of the U.S.S.R., but its population represents only 1.2

per cent of the total population of the country.

The Siberian North has a severe climate, large areas of permafrost, and extremely large natural resources, which are still not fully known. The region has few industrial centres and it is linked with the rest of the country by seasonal shipping on the great Siberian rivers, the Ob and the Yenesei, and via the Kara Sea, which freezes in the winter. Only a spur of the Pechora Railway reaches the lower Ob, terminating at the station of Lybytnangy. Apart from this there is only one other railway line, 110 km. (70 mi.) long, linking the industrial centre of Norilsk with Dudinka, a sea and river port on the Yenesei.

The Siberian North is industrially the least developed part of the northern areas of the Soviet Union. It is a forbidding land, whose development requires larger expenditures than that of the more southern areas in the zone along the Trans-Siberian Railway.

The 20-year economic plan of the Soviet Union envisages the fastest development rates for the eastern parts of the country, especially the central and southern belts of Siberia, which have climatic conditions favourable for human habitation and very large natural resources. However, the recently discovered huge oil and gas deposits, as well as the country's largest hydro-power potential and its largest timber resources are located to the north of the Trans-Siberian Railway. This is the reason for new plans that are under way now to develop industry also in the northern regions, although the effort required will be much greater than that necessary in central and southern Siberia.

The northern Ob basin

The northern part of the Ob basin includes two national districts, the Khanty-Mansi and the Yamal. They have been inhabited from time immemorial by such northern peoples as the Khanty, Mansi, Nentsy, and Selkupy. Their main occupations have been and still are reindeer breeding (particularly on the tundra), hunting, and fishing in

the deep waters of the Ob and its tributaries. The bulk of the Russian population is employed in agriculture and industry, which began to develop there in the last decade.

There is a railway from Nadezhdinsk to the station of Polunochnaya in the north. Several iron ore deposits are being worked there, supplying ore to the iron and steel plants of the North Ural. Sawmills were built in the 1930's in Belogorie, at the confluence of the Irtysh and Ob.

The waters of the Ob are rich in fish. Up to 30,000 tons (66 million lbs.) of fish are now landed there annually, including such rare species as white salmon and sturgeon. The Yamal National District has more than one-quarter of the total number of reindeer in the Soviet Union.

The timber reserves of the northern Ob basin are estimated at 4,500 million m.³ (190,000 million board feet). The forests of this area are 2,000 km. (1,250 mi.) closer to the European part of the U.S.S.R. than those of Eastern Siberia and for this reason they have been given a high priority as regards forest development. Construction of the Ivdel-Ob railway line, which will run through the principal forests of this part of Siberia, was to be completed in 1963. The timber reserves of the forests adjoining the railway are estimated at 2,500 million m.³ (106,000 million bd. ft.). Four timber industry complexes are to be set up in this area under the development scheme. They will include paper- and pulp-mills, plants for the production of chemicals from wood, and factories for making prefabricated houses, chipboard, etc.

One of the largest oil and gas fields in the Soviet Union has been found in the West Siberian Depression. The total area of this promising field is much larger than the famous Ural-Wolga field, which is now the largest of the U.S.S.R. Individual gushers in the southern part of the Depression have yielded over 1,000 tons (7,800 bbl.) of oil a day (in the area of Surgut, Krasnoleninskoe, Ust-Balyk). The oil is of the Cambrian type, sulphur-free, and with a large percentage of light frac-

tions, a so-called "white" petroleum. Oil straight from the well head has been used experimentally as automobile fuel without prior refining.

A large deposit of natural gas was discovered in the area of Berezovo-Igrim, and construction of an 800-km. (500-mile) pipeline from Serov to Igrim was started in 1963. At Punginsk a gas field was discovered a short while ago.

This is 200 km. (125 mi.) from Berezovo and its reserves are estimated at 100,000 million m.³ (3.5 billion ft.³), which is twice that of the famous Saratov gas field in the European part of the U.S.S.R. Even greater are the gas reserves investigated in the basins of the Nadym, Pur, and Taz rivers in the northern part of the West Siberian Depression. The reserves of the Taz field alone are



Fig. 1. Resources of northwestern Siberia.

believed to be 2 billion m.³ (7 billion ft.³) and the estimated reserves of the whole West Siberian Depression amount to a total of 10 billion m.³ (35 billion ft.³). It is planned to extend the pipeline eventually a further 400 to 500 km. (250 to 300 mi.) to the east. Natural gas from the largest deposits of the West Siberian Depression will be piped to the industrial regions of the Ural and the European part of the U.S.S.R. Tentative estimates show that despite the difficult conditions under which it has to be obtained northern gas will nevertheless be cheaper in the industrial areas of the Ural than that from Central Asia, which is to be supplied to the southern Ural. Gas from the Punginsk field will be available in the Ural as early as 1965. It is planned to extract annually 45,000 million m.³ (1.6 billion ft.³) of gas in the West Siberian Depression.

Natural gas from the Ob basin will be an important fuel for the Ural, whereas oil will be indispensable for Siberia, where it is expected to replace Bashkirian petroleum.

Prospecting for oil and gas is now done chiefly along the banks of the Ob, because there are few roads in the region. Plans have been drawn up to start road construction in the near future and also to make wide use of air transport for bringing personnel, supplies, and equipment into the prospecting areas. Oil and gas occur here at a depth of approximately 1,500 m. (5,000 ft.).

The numerous expeditions dispatched to the eastern slopes of the North Ural have discovered deposits of iron ore, non-ferrous metals, and lignite. The major result of these explorations was to show that the geological structure of the North and Polar Urals is the same as that of the Central and South Urals. They have established further that the iron-ore belt of the eastern slope of the Ural, which runs through Mt. Blagodatnaya and the area of Ivdel, continues in a northerly direction.

The northern Yenesev basin

Like the Ob basin, the northern part of the Yenesev basin also includes two

national districts, Taimyr and Evenk. The exploitation of natural resources began here much earlier. Placer gold was washed on the Yenesev ridge as early as the second half of the 19th century, and this region was for a time the principal gold-producing area of Russia. It lost its importance when the deposits became depleted. However, a large deposit of complex ores was discovered there in the early 1920's. A copper and nickel combine was built at Norilsk to work these ores. The city, which now has a population of close to 120,000, is the world's largest settlement north of the Arctic Circle.

The port of Igarka and several saw-mills to which timber is rafted from the Angara basin, were built 725 km. (450 mi.) from the Yenesev estuary, on a deep arm of the river, in 1928. The town has now a population of about 20,000. After commissioning of the nuclear-powered icebreaker *Lenin* and a number of conventional diesel-electric icebreakers it became possible to extend the arctic shipping season to 5 months a year.

The dwindling timber resources of the European part of the U.S.S.R. call for the shifting of the timber export trade to Siberia, whose northern areas have large resources. This is why the port of Igarka will play an ever increasing role in the export of timber both abroad and to the European areas of the Soviet Union. The great centre for the timber industry that is now being built at Maklakov, near the estuary of the Angara, will supply timber products that are to be brought to Igarka in barges and self-propelled craft, where they will be loaded on ships for export to different countries in Europe.

Prospecting for oil and natural gas is being carried out in the Yenesev North, and geological surveys have yielded promising results in recent years. It is possible that large deposits will be discovered there shortly.

Hydro-power stations will probably be built in the future at the mouth of the Nizhnyaya Tunguska, and also along the lower reaches of the Yenesev. They will have capacities running into many millions of kilowatts. These pro-

jects are scheduled for a more distant date, after strings of hydro stations have been completed along the middle reaches of the Yenesev and on the Angara.

The natural resources of the enormous tracts of land from Norilsk to the Angara have not yet been surveyed thoroughly, but in this region are located the Tunguski and other coal fields, the largest in the U.S.S.R. Their reserves exceed the coal resources of the Kuznetsk coal deposits in West Siberia and those of the Donets coal basin in the European part of the U.S.S.R. However, this wealth will have to wait for exploitation, because Siberia still has large quantities of cheaper coal in more accessible places.

Rich deposits of iron ore have been found in the lower reaches of the Nizhnyaya Tunguska, but they will not be tapped in the foreseeable future for the same reason. Before the more valuable and easily accessible forests in the Angara region and along the middle reaches of the Yenesev have been opened up the commercial exploitation of timber to the north of the river Podkamennaya Tunguska would not appear to be economically feasible.

Thus, except for minor scattered centres of industry, the establishment of which will be encouraged on the Kureika and Nizhnyaya Tunguska rivers for the mining of graphite and other valuable minerals, industrial development will be limited to the area between the Angara and the Podkamennaya Tunguska, 1,500 to 2,000 km. (1,000 to 1,250 mi.) from Norilsk and Igarka.

Water-power stations, as well as thermal stations, which will burn coal mined by the open cast method, are being built in the Angara-Yenesev area. The amount of electric power, the cheapest in the U.S.S.R., to be generated here, will equal in time the present total power output in the Soviet Union. The Irkutsk, Bratsk, and Krasnoyarsk hydro-power plants are to be the first in this construction effort. Three of the industrial centres, which will be created on this basis, belong to the northern zone. They include the Bratsk area, the

Ust-Ilim area on the Angara, and the Osinovskiy area on the Yenesev. The Bratsk water-power station has already gone into operation. It will reach its projected output of 4 million kw. within the next few years, and will generate eventually 20,000 million kw.-hrs. of electricity per year. An industrial centre, with plants for the production of aluminium, and various other power-consuming enterprises, is being built there. Preparations have been started for the erection of the Ust-Ilim station, which will be even larger than the Bratsk plant. The Bratsk timber combine will supply the project with building materials. There are rich forests on the right bank of the Angara and between the Angara and the Podkamennaya Tunguska. Several large timber combines are being established there and a railway line will be extended towards this area shortly.

Creation of the world's largest centre for the production of cheap electricity and the building of an aggregate of power-consuming industries in the Angara-Yenesev region will provide a springboard for further advance to the north. Widely used in the process will be the timber resources and useful minerals of the vast area from the Podkamennaya Tunguska to the lower reaches of the Yenesev.

Since the natural resources of North Siberia are not yet fully known, it is not possible to predict the future development of these lands in greater detail. However, the ground is being broken in the Ob and Yenesev basins for large-scale industrial construction and the building of an extensive transportation system, which will get under way within the next decade or so.

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STRATIFIED WATER OF A GLACIAL LAKE IN NORTHERN ELLESMERE ISLAND

Antoinette Bay constitutes the central arm of Greely Fiord and extends