STATION MONDY FOR INVESTIGATION OF THE BACKGROUND TRANSPORT OF POLLUTANTS IN THE LOWER ATMOSPHERE OF THE BAYKAL REGION

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The elemental composition of aerosols is examined on the basis of experimental data obtained at the stations of monitoring of the Baykal region in 1993–1996. *Observations have shown that the station Mondy (Khamar–Daban mountain ridge,* 2000 m *above the sea level) measured the background continental aerosol unaffected by anthropogenic sources over the entire measurement period.*

1. INTRODUCTION

In the last few years much new knowledge has been obtained about the chemical composition of atmospheric aerosols in the Baykal region. In particular, in the monitoring regime seasonal samples of aerosols are taken at several observation stations near Lake Baykal.[13] Their location was selected so that they characterized, where possible, different natural conditions, global or regional background, as well as anthropogenic influence on the aerosol composition. Selected samples are analyzed by different methods in several Russian and foreign scientific institutions to obtain as many various data on the aerosol composition as possible. The station Mondy was chosen for the investigation of the background aerosol chemical characteristics of the Baykal region.

Mondy is the name of the astronomical observatory of the Institute of Solar-Terrestrial Physics. It is located on a plane top of the Khamar–Daban mountain ridge. The station supplies industrial electricity and hence has no sources of pollution. Nearest populated localities are several tens of kilometers apart from the station. The station is more than 300 km apart from large industrial centers (Irkutsk and Baykal'sk) and is surrounded by the Khamar–Daban and Eastern Sayan mountain ridges.

In addition, aerosol samples were taken at the stations Irkutsk (in the territory of the Limnological Institute) located in the Listvyanka settlement (source of the river Angara), Teleskop (the site of the Solar Observatory near the Listvyanka settlement, located 300 m above lake level), Tankhoy (eastern coast of Lake Baykal, in the territory of the park 2 km from the coast).

From the average many-year observation data above this region in the cold period of a year the direction of motion of air masses is determined by Asian anticyclone; therefore, in this period the air masses transported from the western sector predominate. In the warm period of a year, the western transport continues to dominate, but the probability of removal of terrigenous materials from the regions of Western Mongolia significantly increases.

2. METHODS FOR ANALYSIS

To analyze ion and elemental composition of aerosols, diurnal and two-day samples were taken on the Whatman–41 filters with the use of vacuum pumps having a pumping rate of 35–40 l/min. To analyze individual particles, pumping time was 2 h. Solute fraction of aerosols, after extraction from the filters by bidistillate water, was analyzed on ions by the method of highly efficient liquid chromatography (using the Milichrom A–02 chromatograph) and on cations by the atomic-absorption method (using the AAS–30 device). The error of both methods does not exceed 8%. The elemental analysis was made by the method of *X*-ray-fluorescence analysis (XRFA–SI) at the Nuclear Physics Institute (Novosibirsk) and by the neuron-activation method (INAA, USA). Individual aerosol particles were analyzed by the method of electron microzonde (ERHMA) at the Antwerpen University (Belgium).[4] The aerosol samples collected during different seasons in 1993–1996 were analyzed. A total of near 250 samples was analyzed, which seems to be sufficient for determination of the station status.

3. DISCUSSION OF RESULTS

In Ref. 3 day-to-day and seasonal variability of concentration of the basic ions at the station Mondy in comparison with the other Baykal stations in warm and cold seasons in 1995–1996 was discussed. It was shown that the total concentration of ions at this station in summer was higher than in winter, in contrast with the other stations at which this relation was opposite. The reason of these sharp differences in seasonal behavior of concentration of elements in the aerosol between the station Mondy and the other stations may be caused by two factors: less intense soil aerosol generation in winter due to the snow cover and deteriorated conditions for spread of pollutants from anthropogenic

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sources (due to temperature inversions predominating in this season), which leads to increase of the concentration of pollutants near the sources and to the corresponding decrease of their contribution to the regional background. Therefore, the decrease of the element concentration in winter at the station Mondy testifies that emissions from regional anthropogenic sources do not reach this station and it measures the global aerosol background.

Similar pattern is also observed for the distribution of multielemental composition of aerosols. From Fig. 1 it can be seen that concentrations of the basic elements in aerosols such as iron and calcium as well as base metals and rare-earth microelements are minimum and comparable with those determined for the background regions of the Arctic coast of Siberia.[5]

From the results of INAA, the following conclusions about seasonal dynamics of multielemental composition of aerosols can be drawn. In winter aluminum, calcium, sodium, and chlorine predominate in aerosols at the station Mondy. Chromium and vanadium are predominating microelements. Concentration of other elements does not exceed 1% or is equal to the minimum detectable level for the method.

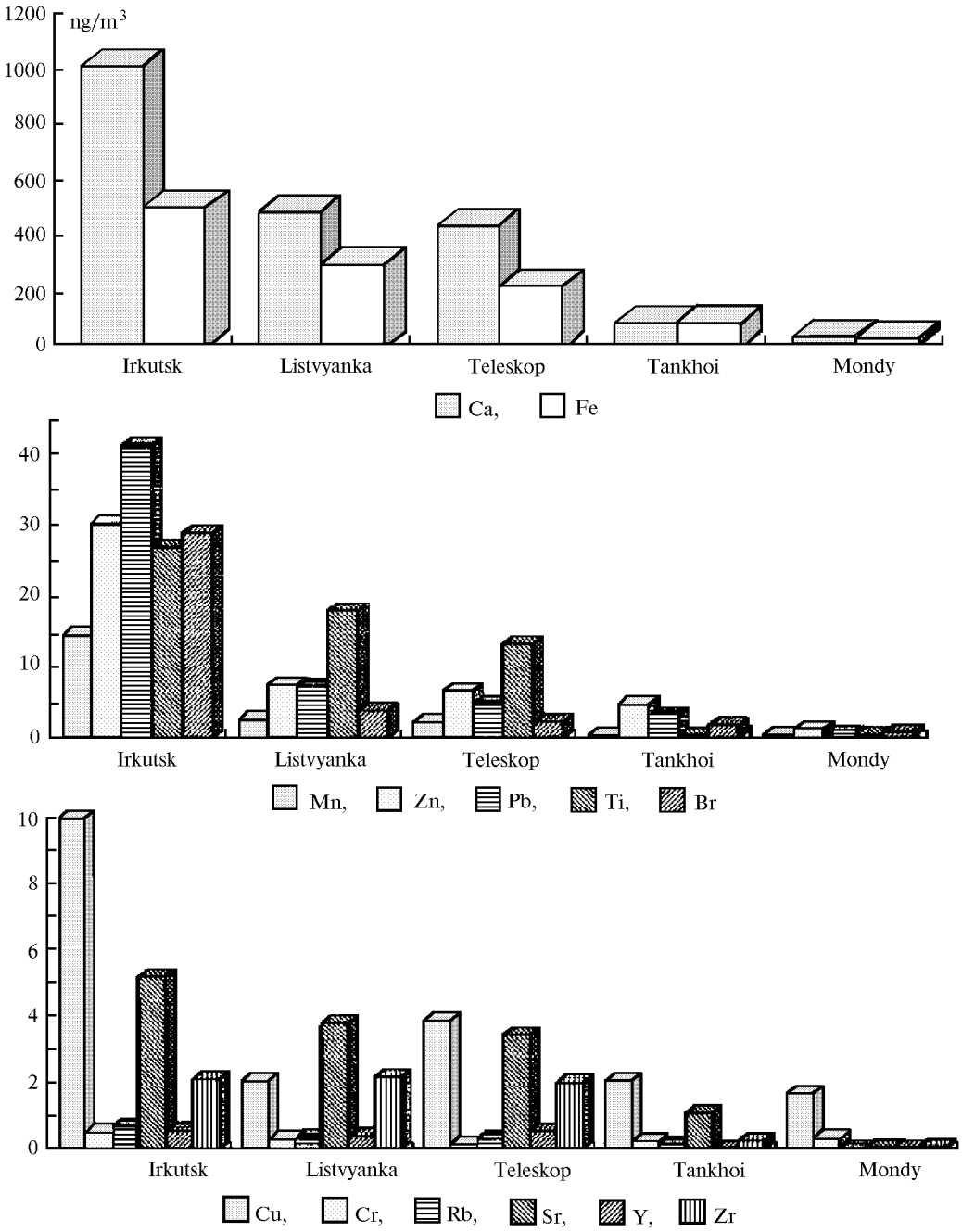

FIG. 1. Elemental composition of aerosols from the data obtained in 1995.

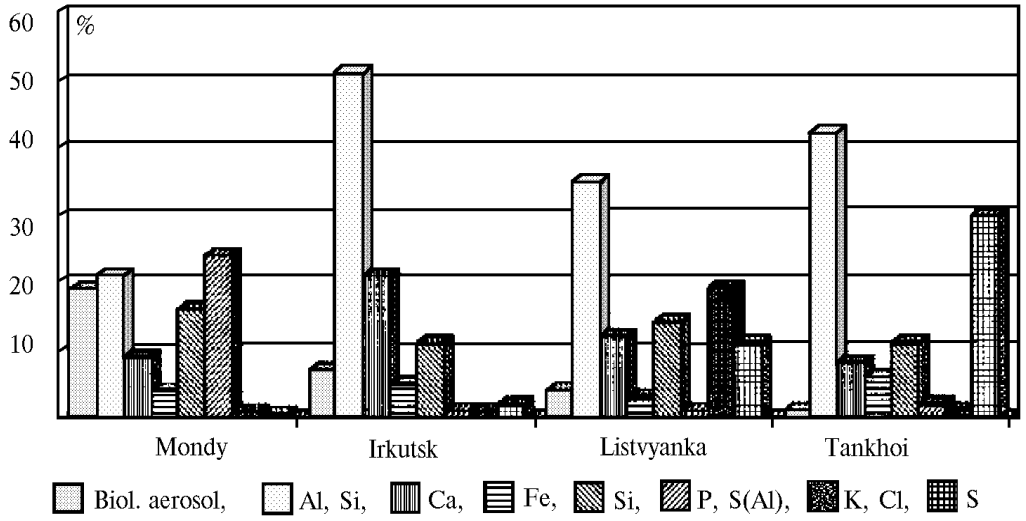

FIG. 2. Average percentage of individual particles of different types in the aerosol of the Baykal samples.

In summer the pattern of distribution of aerosol multielemental composition at the station Mondy is more complex. Percentage of the elements of soil origin (Al, Ca, Fe, and Ti) increases. Concentration of Na and Cl decreases twice. As to microelements, Mn and Zn are added, which probably are connected with plants. Analysis of individual aerosol particles shows that the origin of aerosols in the region of the station Mondy differs strongly on the origin of individual particles sampled above Lake Baykal (Fig. 2).

At the station Mondy the percentage of particles, which were not identified in other parts of the Baykal regions is high. This is the group (near 25%) of phosphor-sulfur-aluminum-enriched particles of organic origin. At the other stations the percentage of these particles does not exceed 3% of the total mass. The second place (20%) occupies the group of aluminosilicate particles. They originate from soil and are stably determined at the other stations in large quantities (50%). The large group of particles of biological origin pollen of plants, residues of insects, and other biological inclusions was also detected at the station Mondy. At the other Baykal stations, this group was less representative. The fourth place is occupied by silicon-enriched particles; under microscope they have irregular form. In the region of Southern Baykal the percentage of the group of quartz particles was also high, but under the microscope they were seen as rolled balls. At the station Mondy the source of quartz particles may be the regions near Khubsugul (Western Mongolia). Further go gypsum particles, mainly of natural origin. And finally, the group of the iron-enriched particles is observed. In the region of the station Mondy it is not large and is near 5%. Here it is connected with the soil processes.

4. CONCLUSION

Investigations of the chemical composition of aerosols at the station Mondy in 1993–1996 have shown that it primarily measures the background continental aerosol, whose composition during the year is unaffected by regional or local anthropogenic sources.

The first integrated works on studying the transport of pollutants in the background regime station Mondy should be extended at the expense of investigations of gas components and atmospheric precipitation.

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REFERENCES

1. V.A. Obolkin, V.L. Potemkin, and T.V. Khodzher, Geography and Natural Resources, No. 4, 75–81 (1994).
2. P. Koutsenogii, N. Bufetov, V. Drozdova, et al., Atmospheric Environment **27A**, No. 11, 1629–1633 (1993).
3. T. Khodzher, L. Golobokova, V. Obolkin, et al., Atmos. Oceanic Opt. **10**, No. 6, 403–406 (1997).
4. H. Van Malderen, R. Van Gricken, N. Bufetov, and K. Koutsenogii, Envir. Sci. Technol. **30**, No. 1, 312–321 (1995).
5. A.A. Vinogradova, Izv. RAN, Fiz. Atmos. Okeana **29**, No. 4, 437–456 (1993).