It is shown that locally occurring raw materials and the by-products available in the Chernozem region are suitable for use in glass manufacture.

To assure further progress in the building-materials industry, including glass manufacture, it is a matter of crucial importance to properly assess the available resources of raw materials and to choose the most efficient ways of their utilization.

With respect to some parameters, the present-day state of supply of minerals and raw materials for the glass industry fails to satisfy the needs of glass works, and this adversely affects their economic performance and the quality of their products. Some of the operating deposits are now almost depleted, so the need has arisen to prospect for new ones, to work low-grade and hard-to-reach deposits, and to reclaim wastes or by-products from various plants [1].

The Central Chernozem region, which has a well-developed infrastructure, has been experiencing a permanent scarcity of structural, container and other glass products. Two factors responsible for the situation can be cited. On the one hand, the region lacks glass-making works. On the other hand, it has a large number of enterprises that use glass and glass products in civil engineering, in the food industry, and elsewhere. Therefore, it is advisable to expand glass-making in Central Russia by setting up glass-producing facilities right in the region: for example, sheet-glass manufacture in the Orel and Belgorod regions, container (bottle and jar) glass manufacture in the Tambov, Kursk, Belgorod, Voronezh and some other regions [2].

The Central Chernozem region has huge reserves of various natural raw materials. However, a good proportion has been poorly investigated, and nothing has been done to assess their usability in glass-making where the specific features of manufacturing impose more stringent requirements than in the ceramic and cement industries.

The Belgorod region has a commercial deposit of chalk, a material that is widely used in glass-making. In six districts, the Belgorod Prospecting Expedition, Ltd. has discovered promising areas of occurrence of natural glass-grade quartz sands. The discovery of the Severo-Volotovsk deposit of pegmatites in the Belgorod region was also an important event because the in-place reserves of feldspar in Russia are distributed very unevenly. For the most part (81.2%), the feldspar and pegmatite reserves are concentrated in Karelia and the Murman region (the North-Western region), and the balance, in the Urals and the Russian Far East (5.1%) and Eastern Siberia (5.2%) [2].

The by-products of various plants located in the Central Chernozem region can also serve as potential starting materials for the glass industry.

The Chair of Chemical Engineering of Glass and Glass Ceramics at the Belgorod State Technological Academy of Building Materials initiated studies of the usability, in glass-making, of natural raw materials and overburden rock from the Kursk Magnetic Anomaly (KMA) iron-ore deposits, alkali-containing and other by-products of various origin. It was found to be possible to use sands, quartzite sandstones, iron quartzites, ore-dressing tails, crystalline KMA shales, and other materials to make glass and glass ceramics [3 - 8].

Work in this area has been going on continuously. In 1995, for example, the present authors investigated the possibility for glass works to use sands from the Gubkinskoe and Veidelevskoe deposits and pegmatites from the Severo-Volotovsk deposit in the Belgorod region, and also potassium-containing by-products from the Rossoshansk Khimodobrec Production Association in the Voronezh region.

As chemical analysis revealed, the sands (see Table 1) carry a fairly high amount of the principal substance and a certain proportion of impurities which have to be taken into account when making a decision as to where such a material can be used.

The wt.% mineral composition of the Gubkinskoe sands was found to be as follows: >98 quartz (SiO₂), <1 kaolinite (H₄Al₂Si₂O₉) <1 rutile (TiO₂), and <1 limonite (Fe₂O₃).
The Veidelevskoe sands carry no rutile, a significantly lower proportion of limonite (< 0.3%), and traces of feldspar.

The grain-size analysis of the sands was determined by a standard technique: the material was screened into fractions, and the percentage of a particular grain size was then determined. It was found that the 0.1 – 0.6 mm grain size fraction accounts for 99.4% of the total in the Gubkinskoe sands and for 94.91% in the Veidelevskoe sands.

The shape of the quartz-sand grains was determined by taking their electron micrographs (see Fig. 1). It has thus been found that in the Veidelevskoe and Gubkinskoe sands, respectively, 23 and 20% of the grains have an angular, 65 and 61% a serrated, and 12 and 19% a rounded configuration.

By the characteristics given above and according to state standard GOST 22551-77, the undressed sands from the Gubkinskoe deposit can be classed as Grade T, and those from the Veidelevskoe deposit, as Grade PB-150-1.

To see if it is possible to upgrade the Veidelevskoe sands, experiments were undertaken which had as their objective the selection of efficient dressing methods. As was found, these sands can efficiently be dressed by “washing”, following which the sands can be classed as Grade S-070-1. When dressed by the standard rubbing-flotation technique, the sands in question can be classed Grade OVS-025-1 (state standard GOST 22551-77).

The wt.% mineral composition of the pegmatites from the Severo-Volotovsk deposit is this: 72.12 SiO₂, 15.16 Al₂O₃, 0.49 CaO, 0.245 MgO, 7.275 Na₂O, and 3.29 Fe₂O₃. When dressed, they produce a feldspar concentrate meeting the requirements of state standard GOST 13451-77.

The wt.% composition of calcium-containing by-product from the manufacture of NPK fertilizer at the Rossoshansk Khimobreniya Production Association is as follows: 78 – 90 CaCO₃, 4 – 8 NH₄NO₃, 4 – 5 SrCO₃, 0.3 – 1.3 P₂O₅, 7 – 13 H₂O, 0.4 – 0.6 CaF₂, and 0.3 – 0.9 NH₃. It can serve as an efficient calcium-containing starting material.

The natural radioactivity of the by-product was determined by measuring the background with an SRP gamma dosimeter. The radioactivity of the by-product was found not to exceed the permissible level of natural background for the Voronezh or Belgorod region, as it was 12 μR/h (the permissible level of natural background for these regions is 16 μR/h).

It was proved by experiments that the Gubkinskoe sands and the calcium-containing by-product can be used to manufacture impurity-tinted and colored glass containers. Due to the use of the calcium-containing by-product instead of chalk, the rate of glass melting can be stepped up by 12 to 16%. This increase is traceable to the presence, in the by-product, of widely known glass-melting accelerators, such as ammonium and fluorine compounds, and phosphorus pentoxide [9].

After they had been dressed by “washing” and rubbing flotation, natural sands from the Veidelevskoe deposits were made into samples of sheet and white ware glass, white and impurity-tinted glass containers. The optical and physico-chemical properties of such glasses, as determined by the generally accepted techniques, give ample reason to say that the Veidelevskoe sands can be used to advantage as silica-containing starting material for glass-making.

Sands from the Gubkinskoe and Veidelevskoe deposits and pegmatite from the Severo-Volotovsk deposit were made into laboratory samples of heat-absorbing glass and colored glass containers. In terms of properties, they do not differ from the glasses made from traditional starting materials.