URIR has investigated the possibility of enriching kyanitic rocks in the Sushchansk region and using them as raw materials for the production of high-alumina refractories.

Samples subjected to enrichment contained (according to microscopic analysis) 63-65% quartz, 16-20% kyanite, about 1% andalusite and viridine, 5-8% pyrophyllite, 1-2% micas and 6-8% ore minerals. The accessory minerals were rutile and zircon.

The main mass of the sample consisted of grains of quartz with a maximum size of 0.16 mm and predominant sizes of 0.05-0.1 mm. The kyanite was found in the form of elongated-prismatic, more rarely tabulated and isometric grains, measuring from 0.008 x 0.016 up to 0.04 x 0.27 mm. Some of the larger grains of kyanite contained inclusions of minerals measuring from 0.003-0.04 to 0.006 x 0.04 mm. We also encountered grains of kyanite with fine films of ferric hydroxides on the surface. The cleavage cracks of kyanite frequently contained pyrophyllite. We observed single growths of kyanite containing quartz or pyrophyllite. Andalusite and viridine were present in the form of individual grains measuring up to 0.06 mm, free from inclusions of extraneous minerals, pyrophyllite in the form of thin platelets 0.003-0.006 mm long, or coarser platelets of diameter up to 0.15 mm. Sometimes the pyrophyllite contained rutile and more rarely zircon in the form of very fine inclusions. The pyrophyllite formed mineral intergrowths with the ores. The ore minerals in the form of grains and accumulations measuring 0.003-0.12 mm consisted mainly of weathered magnetite, hematite, limonite, and possibly ilmenite.

The chemical compositions of the samples were 78.68% SiO₂, 15.09% Al₂O₃, 0.56% TiO₂, 3.9% Fe₂O₃, 0.24% CaO, 0.15% MgO, 0.11% alkalis, loss on ignition — 2.61%.

The optimum grinding size was established on the basis of results of petrographic analysis of the individual fractions of original raw material with grain sizes of less than 1.5 mm.

The fractions larger than 1 mm consisted mainly of intergrowths of quartz and kyanite, ore minerals with quartz, and more rarely with pyrophyllite. Grains of quartz without inclusions, not forming intergrowths with other minerals, were present in substantial amounts. The fractions 0.5-1.0 mm were distinguished by their high contents of free grains of quartz.

The fractions 0.2-0.5 mm, in addition to intergrowths of minerals and free grains of quartz contained elongated-prismatic crystals of kyanite measuring about 1.25 x 0.35 mm.

The finer fractions (0.1-0.2 mm) contained more easily visible kyanite, and its content increased. The finer crystals of kyanite were present in the intergrowths with other minerals and the coarse were free from intergrowths.

An investigation of the fractions finer than 0.074 mm showed that they consists almost entirely of "open" minerals.

Considering that the main costs involved in processing finely disseminated ores is taken up by the process of milling, we determined the minimum required grinding time.

The ore was ground in a laboratory ballmill with a solid:water:balls ratio equal to 1:1:8. The experimental results are shown in Fig. 1.
TABLE 2. Yield and Quality of Concentrate in Relation to the Enrichment Scheme of the Kyanite Rocks

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Yield of concentrate</th>
<th>Capital composition, %</th>
<th>Capital composition, %</th>
<th>R₂O</th>
<th>loss on ignition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SiO₂</td>
<td>Al₂O₃</td>
<td>TiO₂</td>
<td>Fe₂O₃</td>
</tr>
<tr>
<td>I</td>
<td>10.0</td>
<td>39.84</td>
<td>54.41</td>
<td>0.73</td>
<td>1.76</td>
</tr>
<tr>
<td>II</td>
<td>4.7</td>
<td>41.78</td>
<td>51.46</td>
<td>0.51</td>
<td>1.63</td>
</tr>
<tr>
<td>III</td>
<td>10.39</td>
<td>39.72</td>
<td>54.42</td>
<td>0.66</td>
<td>2.42</td>
</tr>
<tr>
<td>IV</td>
<td>8.81</td>
<td>39.48</td>
<td>54.33</td>
<td>0.77</td>
<td>1.80</td>
</tr>
</tbody>
</table>

* Content of kyanite in the tailings from the flotation obtained during reprocessing using schemes I, II, III, IV, 4-5%; and using scheme II 5-6%.

For the relatively completely open minerals, when Sushchansk kyanite rocks are being enriched, it is necessary to grind the material in a ballmill for about 25 min.

Experiments were done to enrich kyanite rock fractions 0-1 and 0-0.2 mm on concentration columns in order to find whether it was possible to separate part of the rejected product before grinding and to separate the ore minerals from the raw materials.

It was found that the use of concentration columns in the enrichment scheme substantially reduces the load on the flotation equipment, but under these conditions there is sharp increase in capital expenditure. Starting from this we cannot recommend the use of preliminary concentration of the raw materials on columns.

The iron oxides which reduce the quality of the kyanites concentrate can be separated by electromagnetic separation, flotation or both methods combined.

Studies showed that removal of the iron oxides by straight flotation is ineffective; the loss of kyanite with the tailings is substantial (not less than 25%).

As regards the raw materials of the Sushchansk source the most promising method is electromagnetic separation, by which it is possible to remove up to 85% of the iron oxides from the flotation concentrate; the loss of kyanite with the magnetic product does not exceed 6% (Table 1).

The following schemes were tested for enriching Sushchansk rocks.

**Scheme I.** The ground (up to 0.074 mm) material was sent for basic kyanite flotation. The tailings of the main flotation in this case are dump products. The concentrate of the basic kyanite flotation was subjected to flotation repurification.

**Scheme II.** Ground to 0.074 mm, the material before the basic kyanite flotation, was deslurried in regard to grains measuring 10 μm. The fraction finer than 10 μm is dumped and the coarser fraction is processed according to Scheme I.

**Scheme III.** The material ground to 0.074 mm, before the basic kyanite flotation, was processed with hydrochloric acid to remove the ore films from the surface of the kyanite grains, and then sent for the basic kyanite flotation. The subsequent process cycle corresponded to Scheme I.

**Scheme IV.** The material after grinding in a ballmill was processed in an electromagnetic separator. The magnetic fraction was extracted from the process, and the nonmagnetic fraction went for the main kyanite flotation. The subsequent processing cycle corresponded to Scheme I.

The yield and quality of the concentrate after being processed according to Schemes I, III, and IV, are about the same (Table 2).