Industrial minerals of the Tiksheozero-Eletozero alkaline ultramafic-carbonatitic and alkaline gabbroic complexes in Karelia, Russia

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Abstract. The Tiksheozero ultramafic-alkaline rock and carbonatite intrusion and the Eletozero pyroxene-gabbro-alkaline intrusion in northern Russian Karelia are a Paleoproterozoic component of the continental crust of the Fennoscandian Shield. U-Pb ID-TIMS age of the Tiksheozero carbonatite: expression of 2.0 Ga alkaline magmatism. The age also emphasizes the fact that not all members of the Kola alkaline province are of Paleozoic age. Those complexes are shown to host industrial minerals such as apatite, calcite, olivine, ilmenite, titanomagnetite as well as alkaline and nepheline syenites as the sources of feldspar. Geological-technological and economic assessment of the integrated use of carbonatites from the Tiksheozero complex were tested. The Suurivaara ilmenitic ore occurrences is very attractive. Another essential industrial mineral occurrence is the Eletozero central part of nepheline syenite massif. Based on the geological and technological data obtained on ilmenitic and titanomagnetitic ores and law-iron feldspatic concentrates from nepheline syenites. These occurrences can be evaluated. And the mineral reserves are assumed to be accessible from modern geological, technological, economic and environmental points of view.

Keywords. alkaline magmatism, carbonatite, ilmenite, nepheline syenite, Paleoproterozoic

1 Introduction

Alkalic complexes are a widespread and ubiquitous component of the continental crust in the northern regions of the Fennoscandian Shield. The majority, including the economically most important ones, formed in the Paleozoic but there are also several older generations reaching into the Paleoproterozoic and the Neoarchean. The Tiksheozero ultramafic-alkaline rock and carbonatite intrusion and the Eletozero pyroxene-gabbro-alkaline intrusion in northern Russian Karelia are the Paleoproterozoic age (Fig.1).

2 The Tiksheozero intrusion

The Tiksheozero intrusion is located in northern Russian Karelia and belongs to the Karelian-Kola alkaline ultramafic and carbonatitic province, being, in terms of silicate rock composition, referred to as the transitional type between the alkaline ultramafic - carbonatitic and alkaline gabbroid rock assemblages.

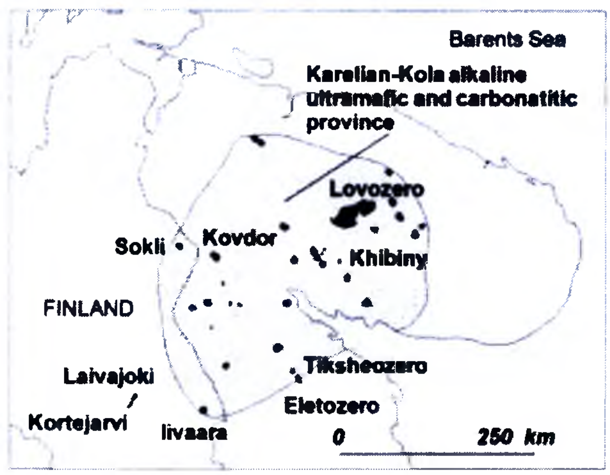

Figure 1. Alkaline complexes and carbonatites in Kola peninsula, northern Russian Karelia and northeastern Finland.

At different levels, the Tiksheozero intrusion displays weaker differentiation than the Paleozoic ultramafic-alkaline rocks and carbonatites of the Kola Peninsula. The Tiksheozero intrusion (Fig. 2) presents a north-south trending, bowlshaped body over an area of ca. 20 km2, and is split up into three large blocks: the Tiksheozero, Central, and Shapkozero blocks. They are composed dominantly of pyroxenite (80%), together with olivinite, ijolite, teralite, alkalingabbro, gabbronorite, and nepheline syenite. The core of the Central block consists of carbonatite occurring as a large body of ca. 2 km2 and numerous carbonatite veins. The carbonatite cuts gabbronorite.

The large, tabular carbonatitic body is gently dipping with an uneven upper contact complicated by bulges and apophyses, and by strike-slip faults. Carbonatite can be detected by local negative gravimetric anomalies.

The carbonatites cut the stratigraphy of the intrusion and are variously expressed in the local topography. The spatial arrangement of the carbonatitic bodies is accounted for by local N-trending fractures. They are in turn intersected by oblique northeastern and northwestern faults.

The carbonatitic body is dominated by fine-to-mediumgrained, grey and light grey, banded, occasionally massive and spotted varieties connected by gradual transitions with coarser-grained, leucocratic, pink and pinkish-white carbonatites. The pink carbonatite forms veinlets that cut the grey carbonatite. The contact between the carbonatite and the host rock is sharp with pronounced exocontact aureoles represented by pyroxenite metasomatically altered into katophorite-carbonate rock, zeolite aggregates with sodalite, albite, prehnite and aegirine after alkaline rocks, and with albite and aegirine after granitoid rocks. The host rock is often brecciated and cemented with carbonate substance. Mylonite developed in the exocontact of the carbonatite points to a tectonically active setting during the formation of the carbonatite. It is usually represented by dark green, fine-grained amphibole-Mg-carbonate or biotite-amphibole-Mg-carbonate schists with richterite. alcitic carbonatites predominate, while dolomite-(ankerite)-calcitic and dolomitic carbonatites are subordinate. Coarse-grained to pegmatitic varieties of the calcitic carbonatite (sevite) bond shatter zones in the pyroxenites, form tiny veins escaping into the gabbronorite, and appear in the central part of the carbonatitic body

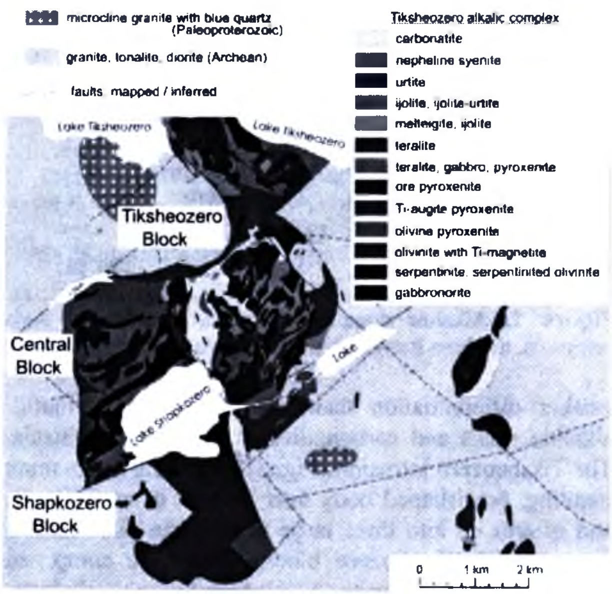

Figure 2. Geological map of the Eletozero pyroxene-gabbro-alkaline intrusion, compiled by V. Shchiptsov and N.Shchiptsova

Massive carbonatite has widespread taxitic structures associated with uneven distribution of magnetite and silicate minerals that produce spotty patterns or dark speckles in the light background of the carbonatitic rock. Geochemically it is characterized by relatively low concentrations of rare-earth elements, Sr and radioactivity. Main ore components are iron, concentrated in magnetite, and phosphorus in apatite.

Table 1. Average mineral composition of the carbonatite (%)

Cal	Do	Ap	Mt	Phl	Amf	Prcl
70	9	9	5	ca 3	ca 4	ca 1

Cal –calcite, Do – dolomite, Ap – apatite, Mt – magnetite, Phl – phlogopite, Amf – amphibole, Prc – pyroclore

Apatite formed in two stages: magmatically and metasomatically (or autometasomatically (Shchiptsov et al, 2007).

U-Pb ID-TIMS age of the Tiksheozero carbonatite: expression of 2.0 Ga alkaline magmatism in Karelia, Russia (Corfu et al)].

Geological-technological and economic assessment of the integrated use of carbonatites from the Tiksheozero ultramafic-alkaline rock and carbonatite massif is made. Their dressability is estimated on the basis of the technological study of apatite-bearing carbonatites. Several schemes for the production of apatite and calcite concentrates have been tested. The conclusion has been drawn that the production of high-quality apatite and calcite concentrates is ensured by an integrated approach to dressing schemes using the flotation and magnetic dressing methods. Gross technological and economic calculations of the integrated waste-free use of carbonatites from the Tiksheozero deposit have been made (Shchiptsov et al, 2007).

3. The Eletozero intrusion

In plan view, the Eletozero massif, which extends approximately N-S, is an concentrically-zoned ellipsoid body with a flexure-shaped axial line. It covers an area of about 100 km^2 , and extends for 18-20 km along the long axis and for 6-8 km along the short axis. Most of the peripheral part of the massif consists of gabbroic rocks and its central part is composed of alkaline and nepheline syenites. Explosion breccia supported by carbonated matrix has been identified in the northern portion of the massif (Shchiptsov et al? 2009).

The conditions of its formation suggest that the massif is a complex multi-phase long-evolving pluton. Based on petrographic composition and the sequence of formation, the following rock classes and rock groups are distinguished: sideronitic clinopyroxenites, gabbroic rocks (a fine-grained marginal gabbro series with a transitional subseries of alternating fine-grained and coarse-grained gabbro and a gabbroic rock series proper represented by coarse-grained gabbro, medium-grained gabbro, plagioclasite-ore peridotite, leucocratic orthoclase gabbro, mica gabbro and mica peridotite), spessartine dykes, miaskite-type alkaline and nepheline syenites with their veined and dyke derivatives, and rocks associated with a carbonatite stage in the formation of the rock complex (Fig.3). It's supposed the age of alkaline and nepheline syenites generated at the final stage is similar to the age of the Tiksheozero carbonatite.

Mineralogenically, the attention is drawn by industrial mineral prospects identified as part of the massif formed, such as ilmenite and titanomagnetite occurrences as well as alkaline and nepheline syenites of the sources of feldspar.

Alkaline and nepheline syenites are common in the central part of the Eletozero massif, where they make up a body which covers an area of about 10 km^2. The chemical and mineralogical compositions of the alkaline ahd nepheline syenites are corresponding to miascite (miascite type).

The Suurivaara ore prospect of the Eletozero massif (East Ore Body) is most promising. Here, several bodies with various mineralizations represented by titaniferous magnetite and ilmenite have been located. Five bodies, namely Severnaya, Zapadnaya, Tsentralnaya, Parallelnaya and Glavnaya, are distinguished. Based on TiO_2 content , titanomagnetite and ilmenite ores fall into three grades: grade I = over 12%/ grade II = 8-12%, grade III = 5-8%.

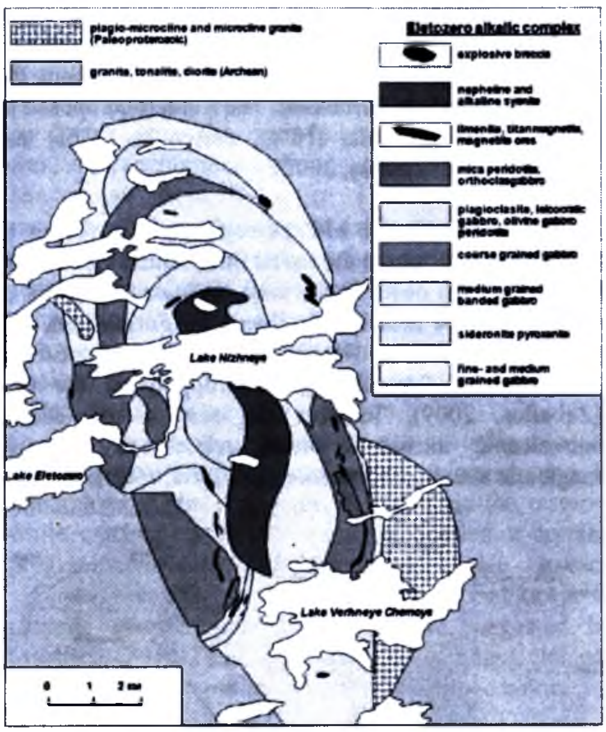

Figure 3. Geological map of the Tiksheozero alkalic complex displaying the geometry of the carbonatite body, compiled by V. Shchiptsov and N.Shchiptsova

The study of the prospects which contain such valuable minerals as ilmenite, titanomagnetite and syenite has shown their industrial significance. The updating of technological methods makes it possible to assess the accessibility of mineral resources from the modern understanding of geology, technology, economy and ecology.

4. Summary

Those complexes are shown to host industrial minerals such as apatite, calcite, olivine, ilmenite, titanomagnetite as well as alkaline and nepheline syenites as the sources of feldspar.

Geological-technological and economic assessment of the integrated use of carbonatites from the Tiksheozero carbonatite were tested.

The Suurivaara ilmenitic ore occurrences is very attractive.

Another essential industrial mineral occurrence is the Eletozero central part of nepheline syenite massif.

Based on the geological and technological data obtained on ilmenitic and titanomagnetitic ores and low-iron feldspatic concentrates from nepheline syenites. These occurrences can be evaluated. And the mineral reserves are assumed to be accessible from modern geological, technological, and environmental points of view.

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