Российская Академия наук
Кольский научный центр
KOLA SCIENCE CENTRE RUSSIAN ACADEMY OF SCIENCES

Ecological Safety of Mining Industries in Arctic on the Base of Innovative Technologies

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Apatity, Russia

The Russian Academy of Sciences: regional divisions and scientific centres

The Russian Academy of Sciences: priority areas, plans and programmes

Priority Areas of Science, Technology and Engineering Development in the Russian Federation

- Security and Countering Terrorism
- Energy Development and Conservation
- Live Systems
- Industry of nano-systems and Materials
- Information and Telecommunication Systems
- Rational Nature Management
- Transport, Aviation and Space Systems

The Basic *Criteria of Ecological Safety* are:

1. The high quality of environment (in the first – drinking water) providing health of the population living here;

2. High fish productivity providing needs of the population for valuable renewable food;

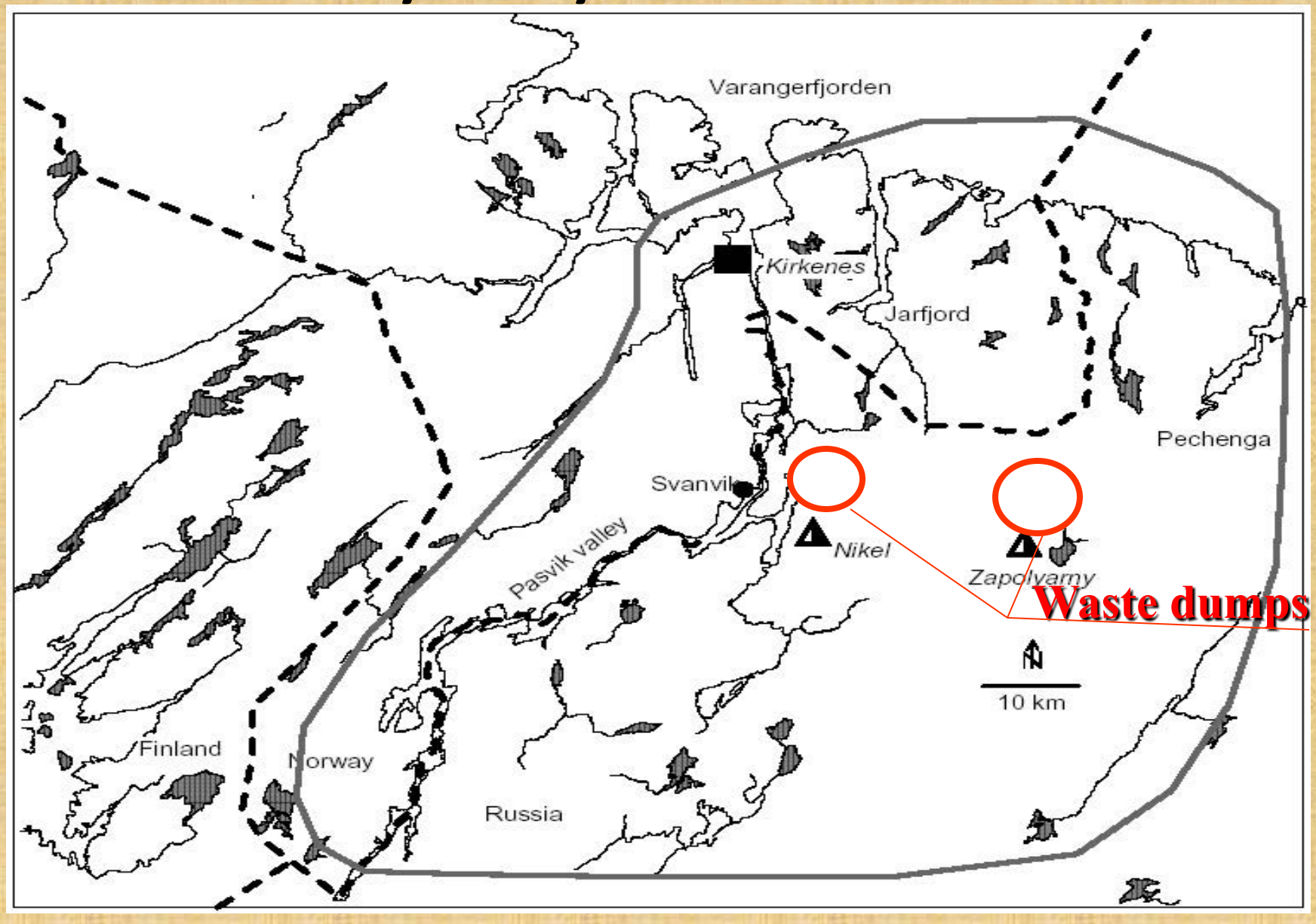
3. Sustainable functioning aquatic and terrestrial ecosystems, providing their biodiversity, ability to self-regulation and self-purification;

4. Ecologic-aesthetic appeal of natural complexes (recreation zones), providing needs of the population for relaxation and rest, education and spiritual enrichment.

The main sources of contamination of waters and terrestrial ecosystems in the Arctic:

1. Airborne contamination of watersheds by emissions of sulphur dioxide and heavy metals from enterprises of non-ferrous industry and from coal- and heavy oil power and heating stations;
2. Sewage waters disposal from mining and metallurgical enterprises into environment;
3. Leaching of pollutants (heavy metals, radionuclides, fluor, etc.) from crushed rocks storages, tailing dumps of mining and metallurgical enterprises;
4. Geochemical cycles under affecting of acidic precipitations;
5. Transboundary transport of pollutants.

Risk of the environment contamination by heavy metals in the future



Elimination of Accumulated Environmental Damage

Scope of Technogenic Loads

- Kola mining enterprises produce up to 200 million tons of solid waste and consumes up to 2 billion cubic meters of fresh water per year.

  Mining waste and tailings utilization does not exceed 3-4% of the mass produced.

  In the dumps and tailings storages accumulated more than 6 billion tons of crushed and fine powdered rocks incl. waste with high acid forming potential

MAIN GOAL OF GREEN (SUSTAINABLE) MINING IS:

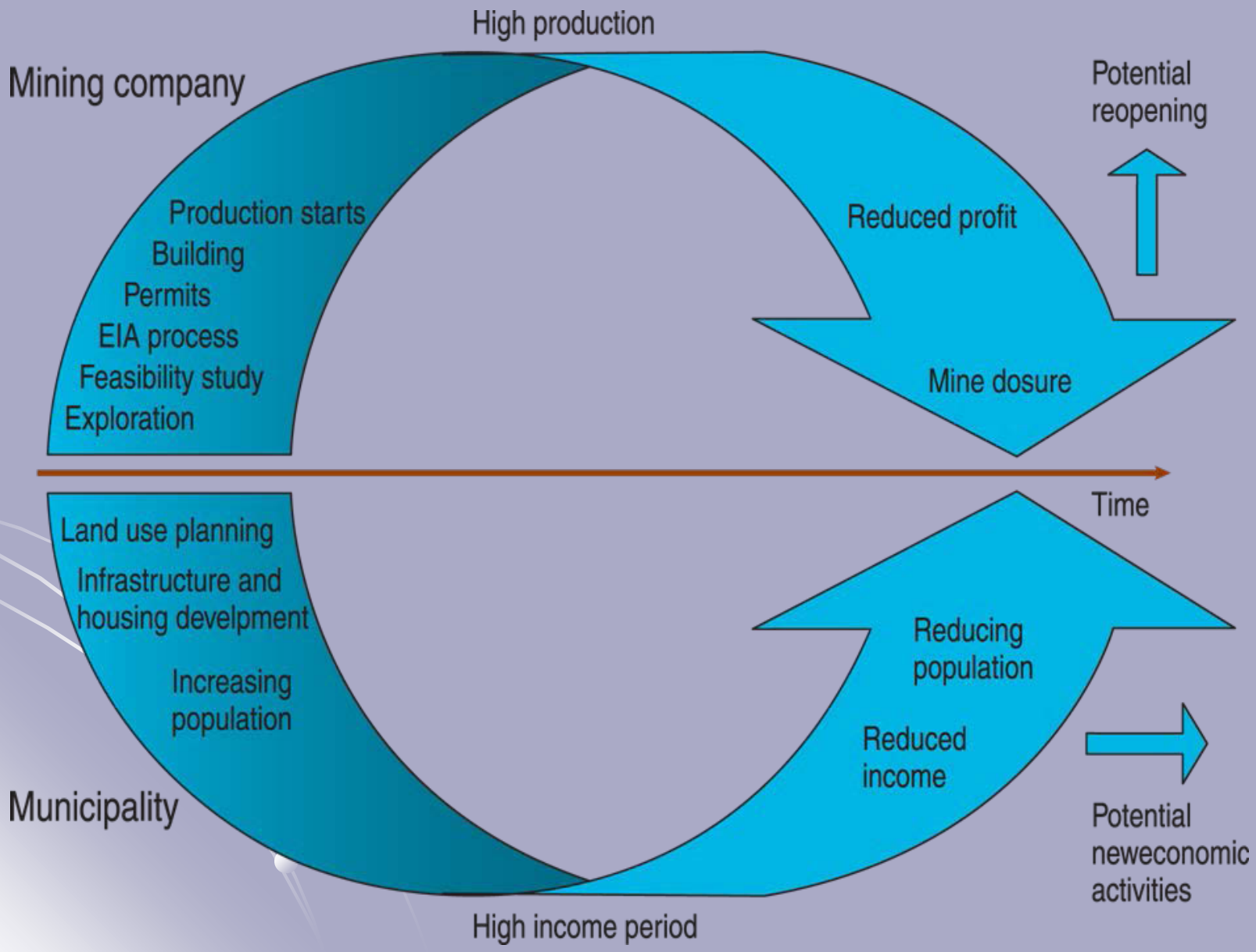
"To convert a waste product into a co-product adding enough value to generate positive economics while concurrently preserving the environment."

Green Mining Technologies must to be developed that helps in reducing or eliminating the negative environmental impact of past mining practices.

Only Responsible Mining Creates Value (1)

Mining companies must earn a social license to mine. Support for mining development can vanish quickly. Public investments in supporting infrastructure, education and training can be justified if the mining industry acts responsibly. In order to earn their trust, the mining sector must pursue open communication with local communities, governments, clients and other stakeholders and be proactive in minimising environmental impacts. Furthermore, mining companies are expected to work with stakeholders to identify and manage social impacts, while responding to the growing demand for a reduction in environment impacts.

The life cycle of a mine from the point of view of the mining company and the municipality.



Only Responsible Mining Creates Value (2)

The clean, pristine and vulnerable nature of the Barents Region is known worldwide for its beauty and remarkable natural values. The region has faced and is facing the challenge of reconciling various different interests, such as nature protection, indigenous traditions and culture, reindeer herding, forest industry, modern development and tourism. Now the mining industry has become a serious stakeholder in this combination.

The region has a flourishing and growing tourism industry which generates significant income and offers substantial employment opportunities in the region. The mineral deposits in the Barents Region lie under an area that offers existing and potential value for tourism. For the operators in the tourism sector, their business is built on an image of clean and pristine nature.

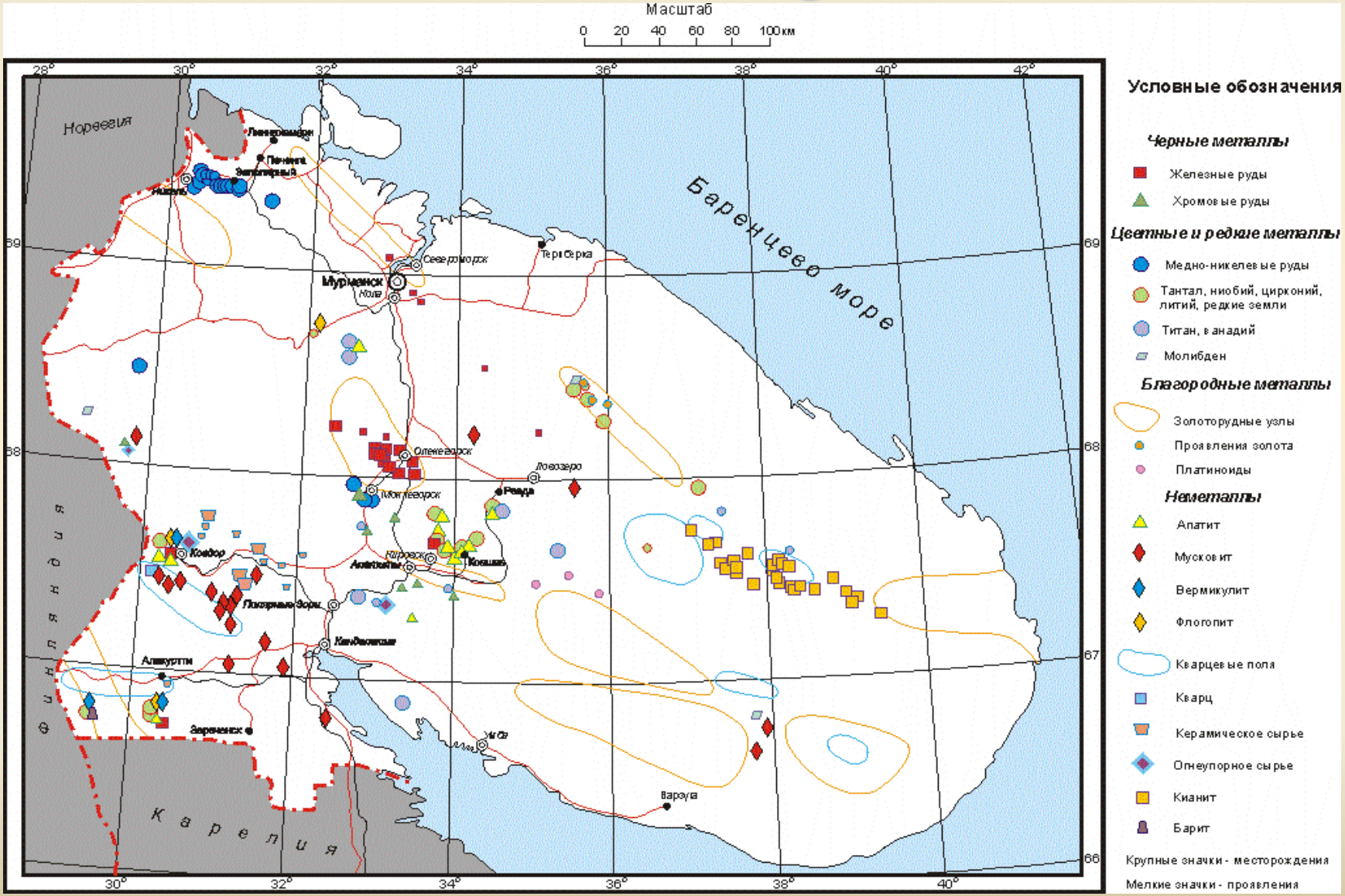
Only Responsible Mining Creates Value (3)

Safety and responsibility are important building blocks of competitive mining. Today's factors for a profitable mining business are resource efficiency and energy effectiveness, strict management of industrial processes, minimised emissions and a strong safety culture at mines. Fluctuating global metal and mineral markets pose an economic challenge to the mining industry. In order to generate shareholder value, extraction industries must apply best practices where safety, environmental impacts and resource efficiency are given a high priority.

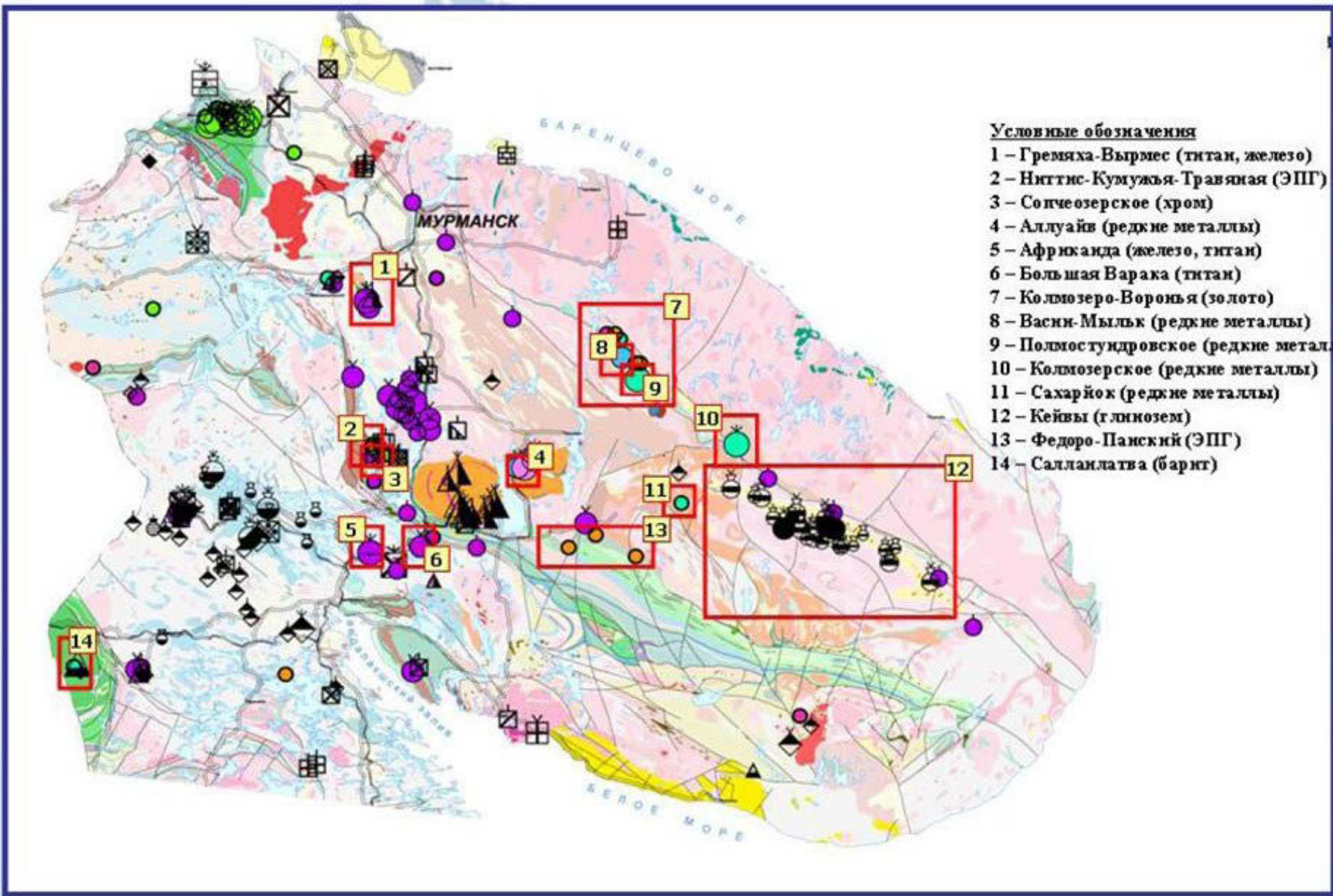
Global challenges in mining industry

- Health and safety
- Shortage of skilled labor
  - Lack of technical people
- Complex, lower grade ore bodies
- Sustainability
  - Water
  - Carbon footprint
    - Energy
    - Materials consumption
- Meeting the needs of local stakeholders
  - Demanding less environmental impact
    - Infrastructure issues
    - Land re-use – waste disposal
  - Taxes, royalties, rents

Map of main deposits of mineral raw materials in Murmansk region



Perspective deposits of Kola peninsula



LARGE PROJECTS IN MINING AND METALLURGICAL INDUSTRIES

1. Pd-Pt- Deposit "Fedorova tundra“

(Barrick Gold Corp.)

2. Deposit of apatite-nepheline ore “Olenij Ruchey” (PC “ACRON”)

3. Deposit of chromite ore «Sopcheozerskoye» (Kola MMC)

4. Construction and modernization of Kovdorslyuda mining in Kovdor based on vermiculite, phlogopite and pegmatite ores

5. Ilmenite -Ti-Magnetite ore ofGremyakha-Vyrmes deposit (Kola MMC)

Good Governance and Best Practices (1)

Mining requires intensive investments and longer-term planning. Transparent and well-functioning administrative processes, forward-looking policy-making and strict, but solution-oriented, government control are preferred conditions for responsible mining. The regulatory environment must demand careful assessment of environmental and social impacts and foster the use of best available technology and best environmental practices to minimise negative short- and long-term impacts along the whole production chain, from extraction through processing and waste disposal. Government regulations must ensure compliance with relevant international conventions

Good Governance and Best Practices (2)

Permits and licenses are not forever. National law, land use plans and competent regional and local authorities must be well-equipped to guide site selection for exploration and extraction, protect the natural and cultural heritage and manage conflicting interests between mining and other livelihoods. Governance must be able ensure that mining can be fostered without compromising environmental protection, tourism, reindeer herding, fishing, or forestry, which are all vital elements of the Barents Region.

Good Governance and Best Practices (3)

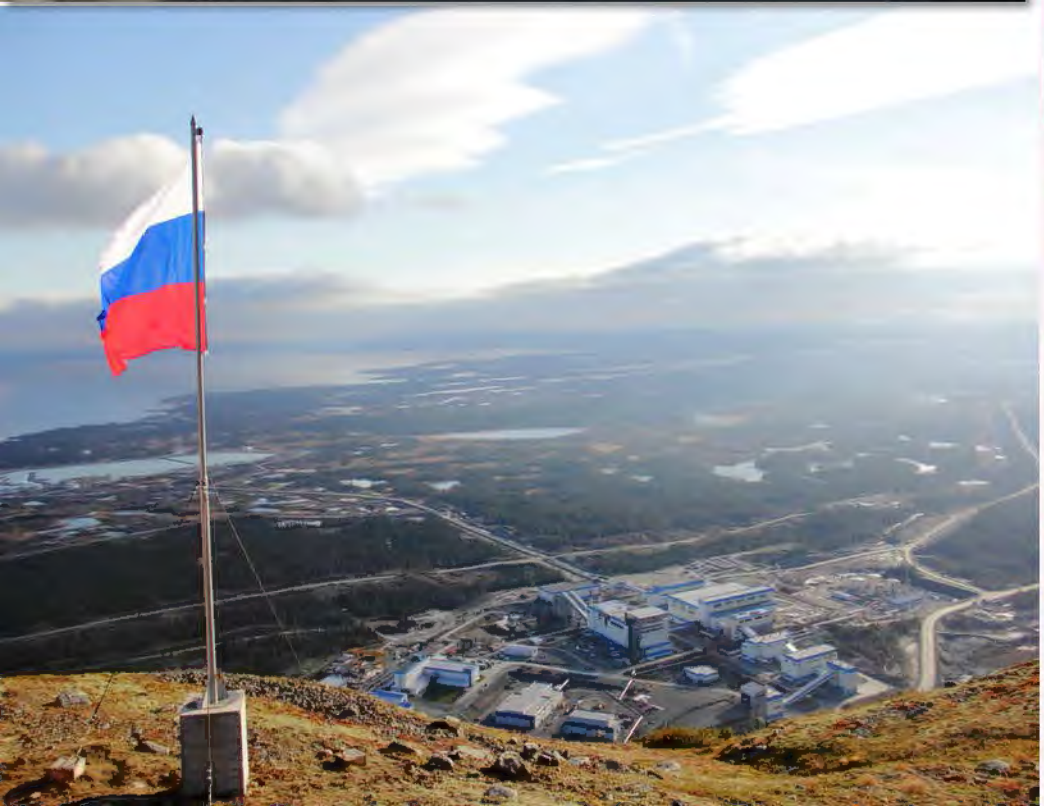
Mistakes and accidents at mines can be very costly. Failures in tailings management and chemical accidents have led to disasters, but even smaller safety incidents result in significant costs to industry and surrounding communities. Risk assessments, the strict application of safety programmes, active monitoring and the control of risk factors are important elements of mining operations. Governmental norms for risk management must be sufficient to protect the common good, but can also be used to guide the companies in better, more cost-effective management of their assets.

Good Governance and Best Practices (4)

Compliance plus. Modern environmental management systems, voluntary measures for consulting various stakeholders, active environmental reporting and corporate responsibility programmes are actions the mining companies can take, along with investments in the most effective technologies. These actions will help companies in managing stakeholder expectations and establishing the required foundations for a social license to mine. For many global mining companies who operate in a range of different environments and under diverse legislative regimes, operating responsibly and well beyond compliance, and adhering to the best international standards, is already an existing practice. These companies understand that an environmentally prudent, safe and responsible mine is also a profitable mine.

Mining & Processing Plant «Oleniy ruchey», Construction

Apatite-nepheline ore deposit,
Murmansk region



Cu-Ni SMELTERS - THE MAIN POLLUTION SOURCES IN THE KOLA

The Kola Peninsula is one of the most populated and polluted regions in the Arctic

During two decades we are carrying-out studies which are directed to increase understanding of the role of human dynamics on ecosystem functions and to explore development strategies to enhance ecosystem health, ecological sustainability and economic diversity

Public corporation "Kola Mining and Metallurgical Company"

Reconstruction of the roasting unit in Zapolyarny to produce hardened briquettes

The aim of the project is to replace the existing technology of "pelletizing - roasting" on a “cold” briquetting technology of sulfide concentrate:

1. Organization of a modern and environmentally friendly production, allowing to reduce sulfur dioxide emissions by industrial site Zapolyarny from 42,000 to about 1,000 tons of SO2 per year;
2. Meet the Russian environmental legislation to reduce emissions of "weak" dilution sulfuric gases and dust of heavy metals.

Public corporation "Kola Mining and Metallurgical Company"

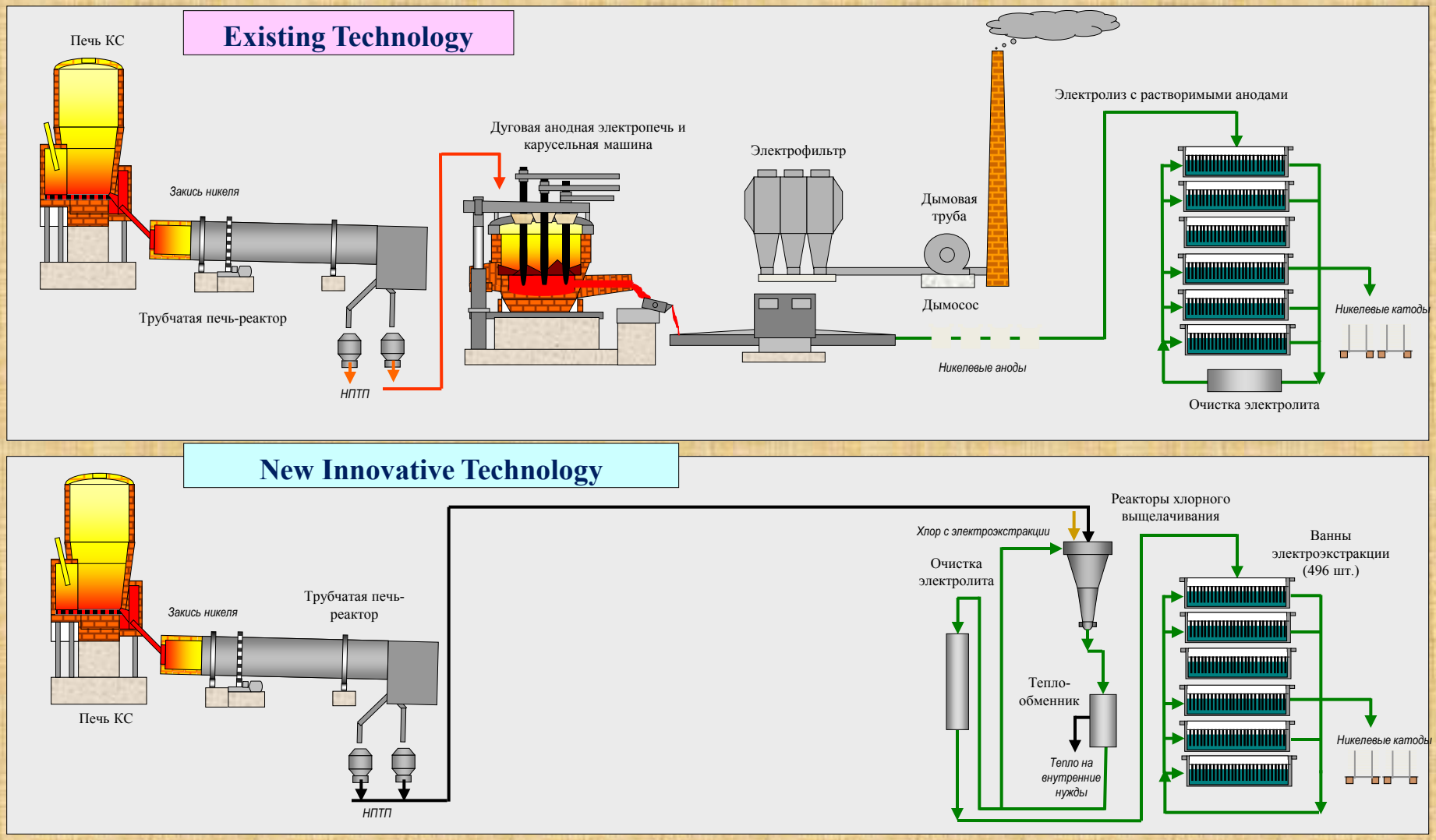
Reconstruction of Smelter in Nikel town - Environmental Project of the Company

The aim of the project is to reduce emissions of SO_2 *gases* and dust of heavy metals by the transition to the processing of raw materials with high sulfur content (briquettes of Cu-Ni-Sulfide concentrate)

As a developer of the core technology selected Finnish Company “Outotec”

Public corporation "Kola Mining and Metallurgical Company"

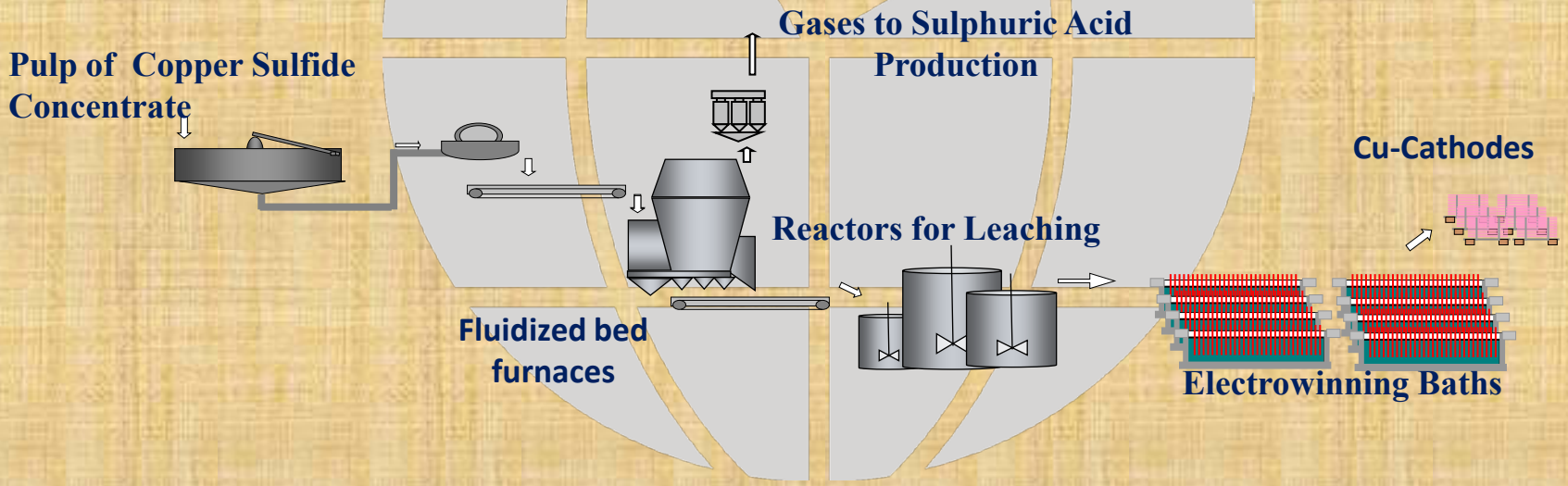
Optimization of the nickel production with the release of 120 000 tons of nickel per year with the implementation of technology "Chlorine dissolution of nickel powder tube furnaces – electrowinning" in Monchegorsk Plant



Reconstruction of copper refinery in Monchegorsk Plant

Roasting – Leaching - Electrowinning

Transition to the new technology of copper production with the replacement of the existing environmentally inefficient pyrometallurgical processing of copper concentrate on an alternative - roasting in fluidized bed furnaces, followed by the copper calcine leaching and electrowinning of metallic copper from aqueous solutions



Public corporation "Kola Mining and Metallurgical Company"

Utilization of salt discharge from nickel refining in Monchegorsk Plant - Environmental Project Company

IMPLEMENTATION OF THE PROJECT:

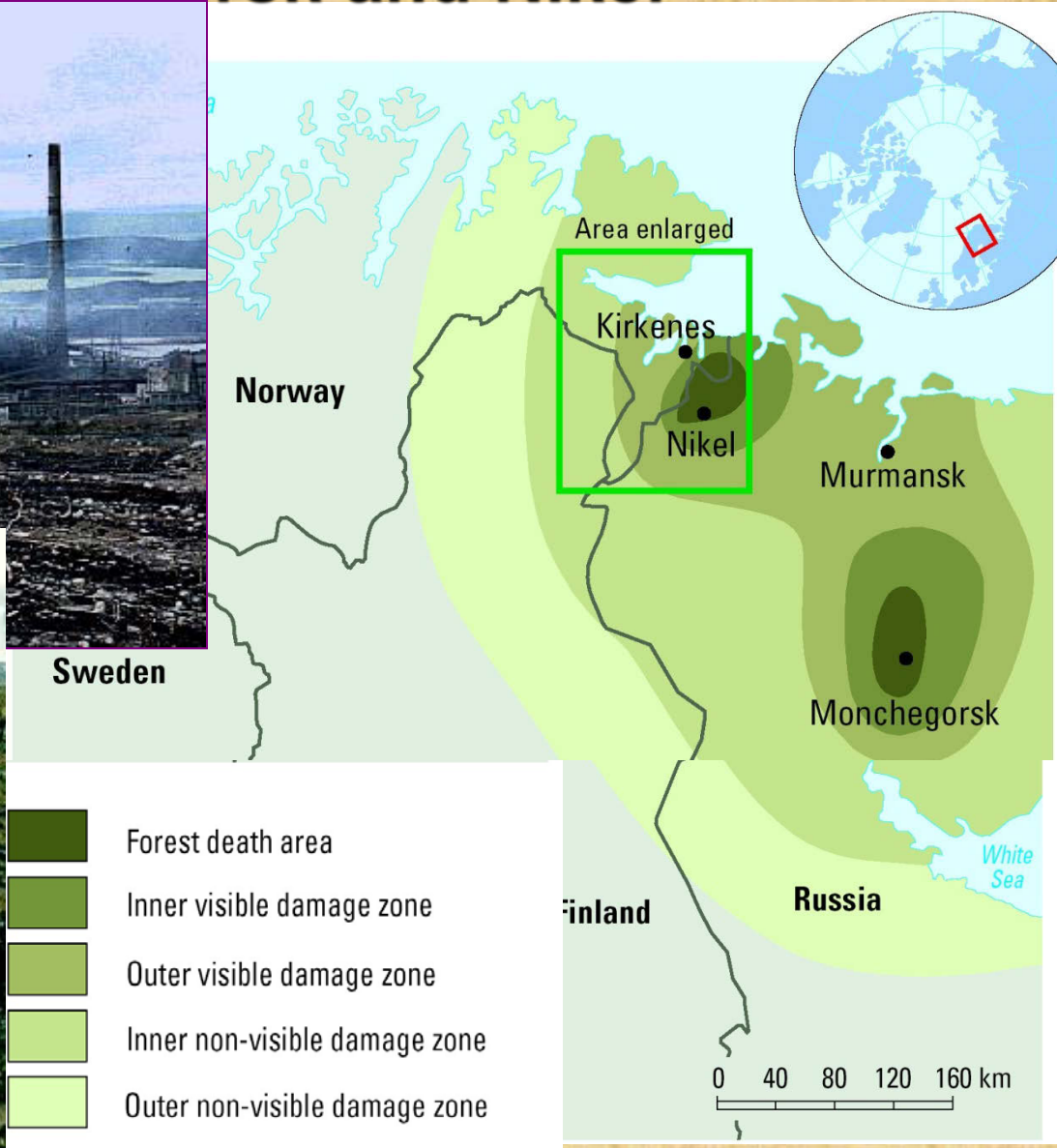
- The company GEA Messo (Switzerland) completed the basic engineering

- Completed the development of design documentation.

Nickel deposition to snow on the Kola Peninsula

Max. concentration in Nikel and Zapolarny areas in April can arrive at 100 mg/m² and more.

Forest damage zones in the vicinity of Monchegorsk and Nikel



Source: AMAP, 1998

H^+
Ni^{2+}
Cu^{2+}

Ca^{2+}
Mg^{2+}
Mn^{2+}
Zn^{2+}

Depletion of nutrients organic horizon

As result of acidification soil is enriched by heavy metals and is depleted by available for plants nutrients

Monchegorsk / Мончегорск

2003

2004

2005

2006

2008

2003 **Nickel, Zapolyarny / Никель, Заполярный**

2004

2007

Testing of rolled grass plots for the technogenic wasteland rehabilitation

- At KSC RAS has developed an innovative technology for growing sustainable rolled grass plots (turf) by hydroponics method for vermiculite substrates.
- Using such rolled grass plots enables rapid plant growth, resulting in a quality of seeds of perennial turf grasses (red fescue, Kentucky bluegrass, perennial ryegrass, timothy, Rump inermis, etc.) in just 14-20 days.
- The proposed technology is promising for planting and biological remediation of disturbed lands.
- Good results are obtained in tests for meadow formation on apatite-nepheline tailings (See below).
- Now Institute is studying possibility for remediation by this method oil-contaminated sols

VIPON – Substrate from Vermiculite for Soil Bioremediation

Sod 3 weeks after sowing of grass

Preparation of the rolled grass-plot coverings


08-Lip-05 12:17

Technogenic barren before planting

“Chevron-packing” of VIPON-substrate on waste-storage of Apatite-company

Three years later…

Kola Chemical and Technological Cluster (KC&TC)

Basis of KC&TC are resource base and low-waste technologies of production and processing of raw materials.

KC&TC for the region and the country is not just a set of technologies in one place from local materials, but KC&TC the implementing model for transition from resource-based economy to innovative and “green” economy.

Creation of KC&TC assumes the organization of wide range of products, including import substitution, strategic and structural materials, ensuring national security of RF


Норвегия
Промышленные предприятия
Образовательные учреждения
Научно-исследовательские институты
Объекты инновационной инфраструктуры
Объекты банковской инфраструктуры
Объекты энергетической инфраструктуры
Печенгский район
Североморск
Мурманск
Кола
Кольский район
Оленегорск
Мончегорск
Финляндия
Ковдорский район
Кировск
Апатиты
Полярные Зори
Кандалакша
Республика Карелия
Кандалакшский залив
Организация-координатор кластера – КНЦ РАН
Территория базирования Кольского химико-технологического кластера охватывает муниципальные образования:
1ГО город Апатиты с подведомственной территорией
2ГО город Кировск с подведомственной территорией
3ГО Ковдорский район
4ГО город Оленегорск
5 ГО город Мончегорск
6 ГП Ревда

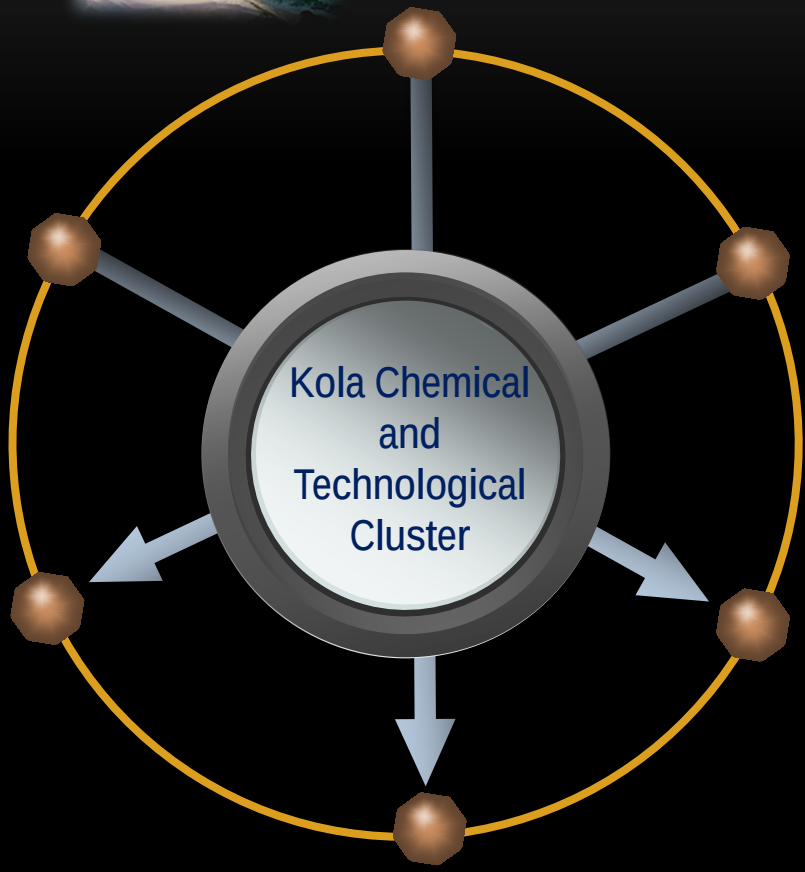
Scientific Package for Kola Chemical and Technological Cluster Formation

- The technology of high-purity niobium and tantalum compounds
- Fundamentals of materials technology for acousto-optical electronics and nonlinear optics. Plant for special materials electronics is constructed.
- Technology of the crystals of lithium niobate with higher resistance to laser radiation developed.
- High-capacity tantalum capacitor powders.
- The technology of high purity zirconium dioxide developed.
- Technology of pyrophoric zirconium powder for special branches of engineering.
- Cesium iodide high-purity granular for scintillation crystals.
- Electrolytic refining of rare metals in the molten salt to produce powders and coatings with the desired properties.
- Composite materials with high content of alloying components for the transportation and storage of radioactive materials.
- Basic package of technological schemes of processing multicomponent titanium and rare-metal and rare earth raw materials of variable composition.

Khibiny Apatite deposits, incl. Nepheline and Titanite

Kovdor deposit of Magnetite, Apatite, Baddeleyite, Phlogopite and Olivine

Lovozero deposits of Loparite and Eudialite



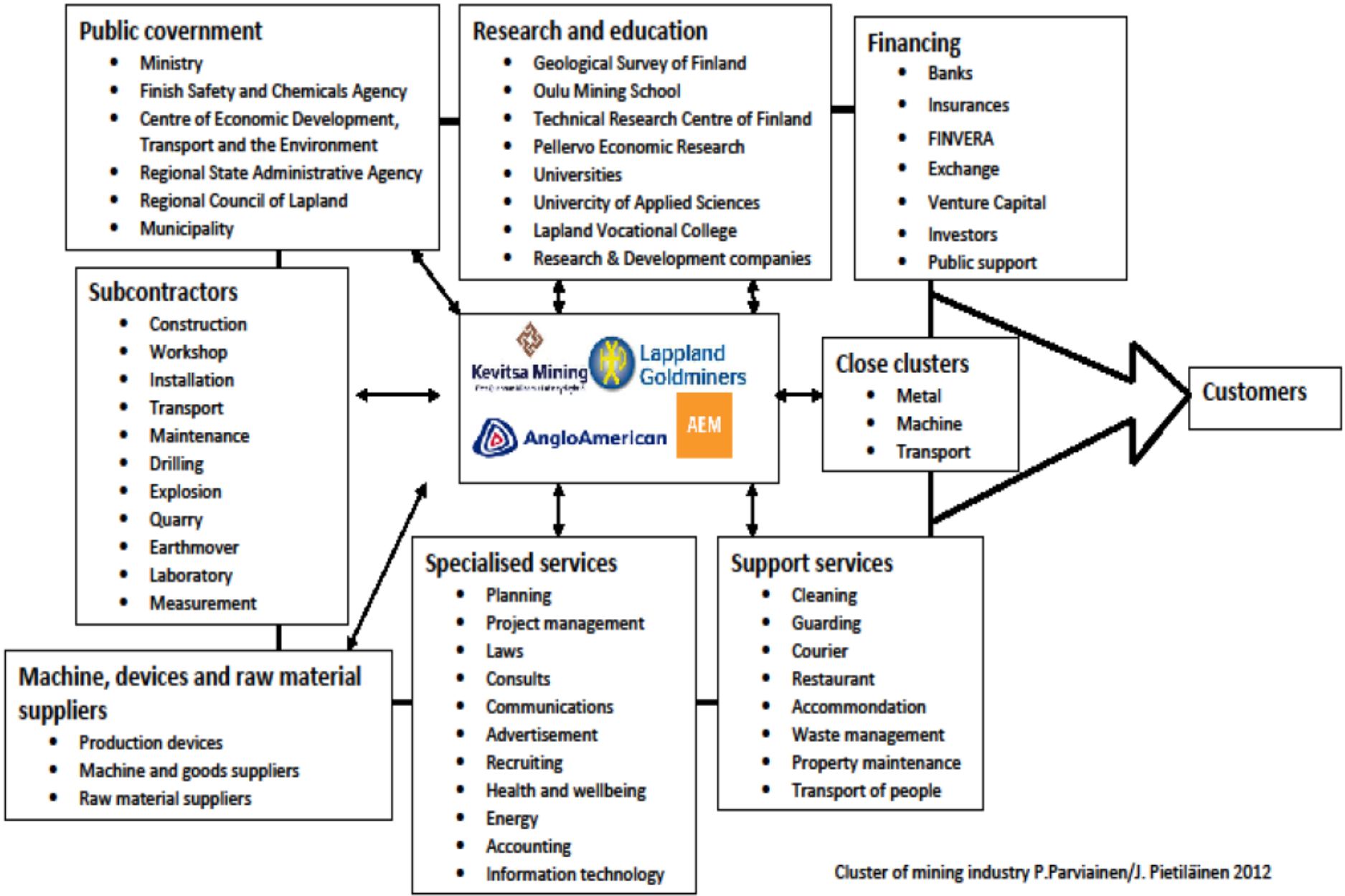
Rare earth compounds,
Welding materials,
Building materials,
Powders of niobium and tantalum
High-purity oxides of niobium and tantalum
Materials for acousto-electronics,
Zirconium for nuclear energy production and for defence industry

Welding materials,
Building materials,
Zirconium and zirconium oxide
Pigments
Scandium compounds

Rare earth compounds,
Welding materials,
Alumina,
Ferrotitanium,
Titanate, and Titanosilicate
Titanophosphate's sorbents
Titanium tanning,
Pigments
Catalysts

Sodankylä Mining Project

Cluster of mining industry Sodankylä



Cluster of mining industry P.Parviainen/J. Pietiläinen 2012

ГОРНОПРОМЫШЛЕННЫЕ ОТХОДЫ

ЗОЛООТХОДЫ ТЭЦ

1. КОМПЛЕКСНЫЕ ВЯЖУЩИЕ
2. МИКРОСФЕРА

Микросферы - полые частицы, образующиеся в золе в результате расплавления минеральной части углей

исходные микросферы при разном увеличении

взаимодействие микросфер при обжиге

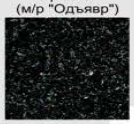
иглы муллита в конечном продукте

ОБЛИЦОВОЧНЫЙ ДЕКОРАТИВНЫЙ КАМЕНЬ

гранит (м/р "Кузрека")

гранит (м/р "Одъявр")

хибинит (м/р "Ловчорр")



габбронорит (м/р "Ёна-1")

КЕРАМИЧЕСКИЕ ИЗДЕЛИЯ

с глазурованным покрытием на основе местных глин, пироксеновых и нефелиновых концентратов, кварцевого песка - облицовочные плитки, фасонные изделия, химически- и термостойкие плиты.

ОГНЕУПОРЫ

Разработана технологическая схема получения форстеритовых огнеупоров на основе магнезиальносиликатных горнопромышленных отходов.

ЩЕБЕНЬ И МАТЕРИАЛЫ НА ЕГО ОСНОВЕ

–тяжелый бетон;

–подстилающий слой автомобильных дорог;

–балластировка железнодорожного пути;

–асфальтобетон

ВСКРЫШНЫЕ ПОРОДЫ

МИНЕРАЛЬНАЯ ВАТА

Основные технические характеристики мягких теплоизоляционных плит из минеральной ваты:

Объемная масса, кг/м^3, не более - 100
Предел прочности, Па, - 0,75·10^5
Коэффициент теплопроводности, Вт/м·°К, не более - 0.046
Средний диаметр волокна, мкм - 10

ШЛАКИ МЕДНОНИКЕЛЕВОГО ПРОИЗВОДСТВА

ГРАНУЛИРОВАННЫЙ ШЛАК И МАТЕРИАЛЫ НА ЕГО ОСНОВЕ

тяжелый бетон

-тяжелый бетон
-закладочная смесь
-песок
-вяжущее

вяжущее

БЕТОНЫ

ячеистый бетон

легкий бетон

жаростойкий бетон

арболит

ХВОСТЫ ОБОГАЩЕНИЯ РУД

СИЛИКАТНЫЙ КИРПИЧ

Выпускается с 1960 г. на Оленегорском заводе силикатного кирпича. Изготавливаются из силикатной смеси на основе железистых кварцевых отходов Оленегорского ГОКа и карбонатного сырья Ено-Ковдорского месторождения. Средняя марка по прочности М150.

КЕРАМИЧЕСКИЕ ИЗДЕЛИЯ

ДЕКОРАТИВНЫЕ СТЕКЛА И СТЕКЛОКРИСТАЛЛИЧЕСКИЕ МАТЕРИАЛЫ

БЕТОНЫ

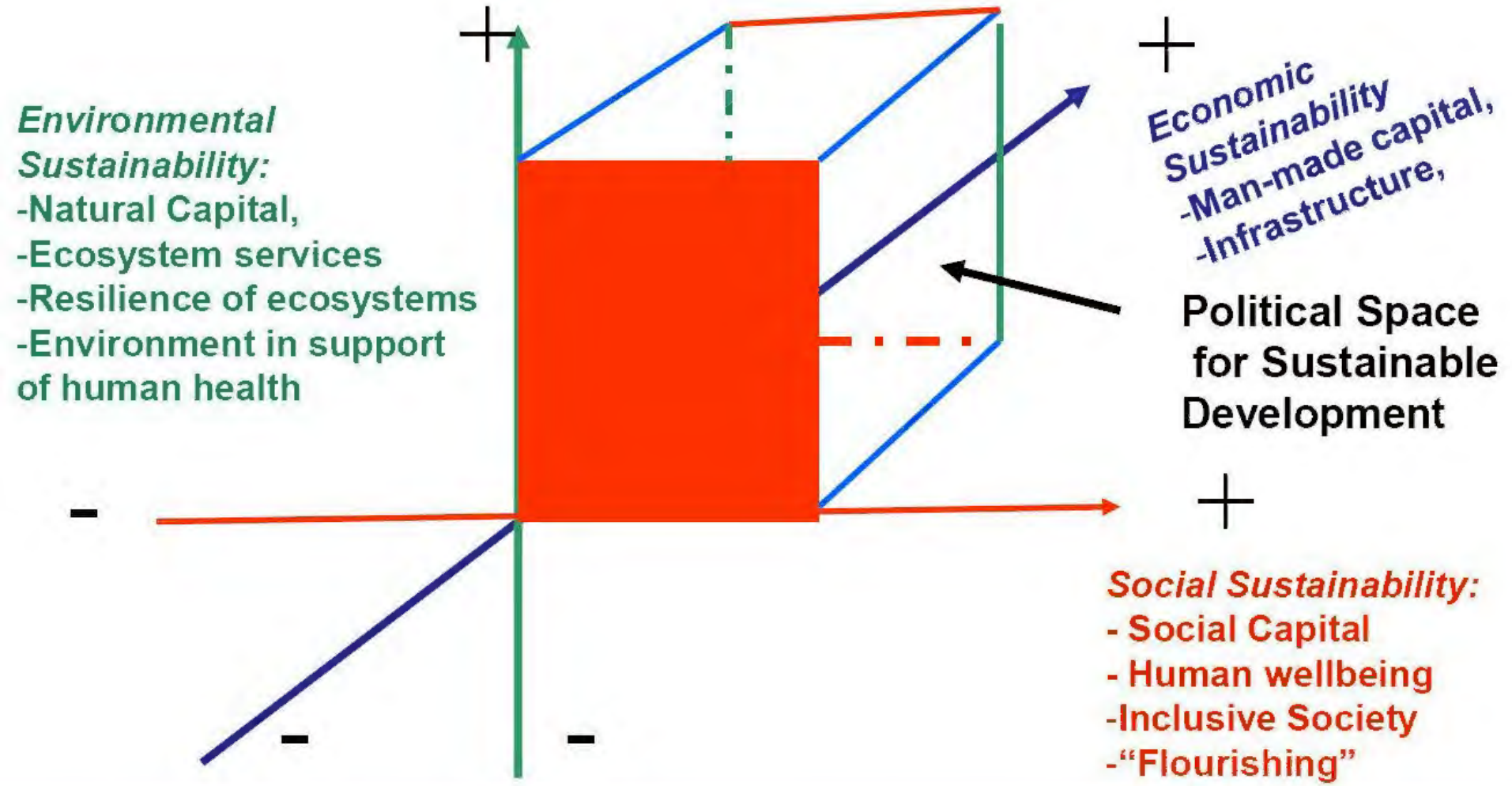
изделия из ячеистого бетона

образцы глазурованного бетона

тротуарные плитки из мелкозернистого бетона

тяжелый декоративный бетон

The three Dimensions of Sustainable Development



Priority directions of social and economic development of Murmansk Region

On the base of sustainable development to provide:

--Development of human potential, increasing of the population life level and quality.
--Increasing of the regional economy competitiveness
--Formation of effective institutes for the sustainable development of Murmansk Region.

The main goals in the sustainable management of the natural resources using in Arctic regions are:

Non-depletable use renewable and rational development of not renewable natural resources;

Protection the environment from pollution;

Preservation and rehabilitation of the landscape and biological diversity, sufficient for maintenance of ability of natural ecosystems to self-regulation and compensation of consequences of anthropogenous activity;

Adaptation to global climate changes in Arctic regions.

Collaboration with the Mining Sector in Barents Region

International agreements and guidelines regulate and provide guidance. Numerous multilateral environmental agreements provide valuable guidance for mining development and govern cross-border collaboration. In particular, the following UNECE conventions are relevant to economic activities, including mining: Convention on Environmental Impact Assessment in a Transboundary Context, Convention on the Protection and Use of Transboundary Watercourses and International Lakes, Convention on the Transboundary Effects of Industrial Accidents, and Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters. In addition, relevant OECD council recommendations on transboundary pollution provide important guidance. The Barents Euro-Arctic Region Agreement on Cooperation within the field of Emergency Prevention, Preparedness and Response is an example of a particular achievement in the region.

Collaboration with the Mining Sector in Barents Region

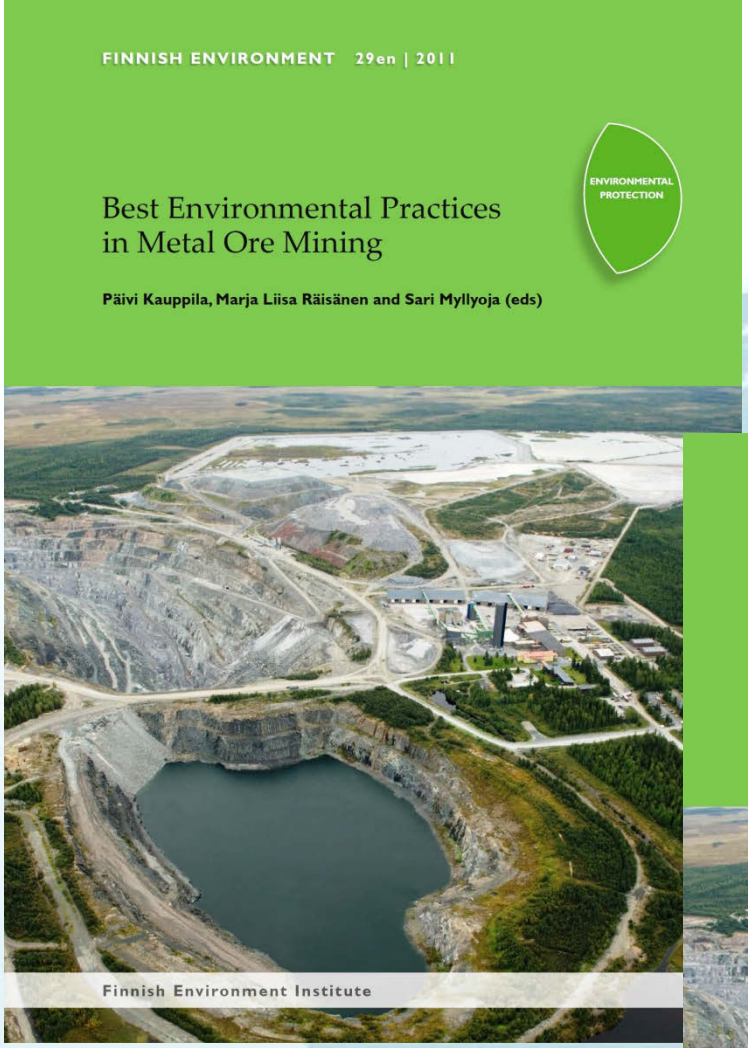
Relevant guidelines for mining operations include the following: the UNECE safety guidelines and good practices for tailings management facilities, OECD Due Diligence Guidance for responsible supply chains of minerals, IFC Environmental, Health and Safety Guidelines for Mining, the International Council on Mining and Metals (ICMM) Good Practice Guide: Indigenous Peoples and Mining (2010), Human Rights in the Mining & Metals Sector – Handling and Resolving Local Level Concerns & Grievances (2010), Good Practice Guidance for Mining and Biodiversity (2010), and the GRI Mining and Metals Sector Supplement (2010). Akwé Kon guidelines (2004) of the Convention on Biological Diversity are voluntary guidelines for conducting cultural, environmental and social impact assessments of development projects proposed to take place on, or which are likely to have an impact on, sacred sites and lands and waters traditionally occupied or used by indigenous and local communities.

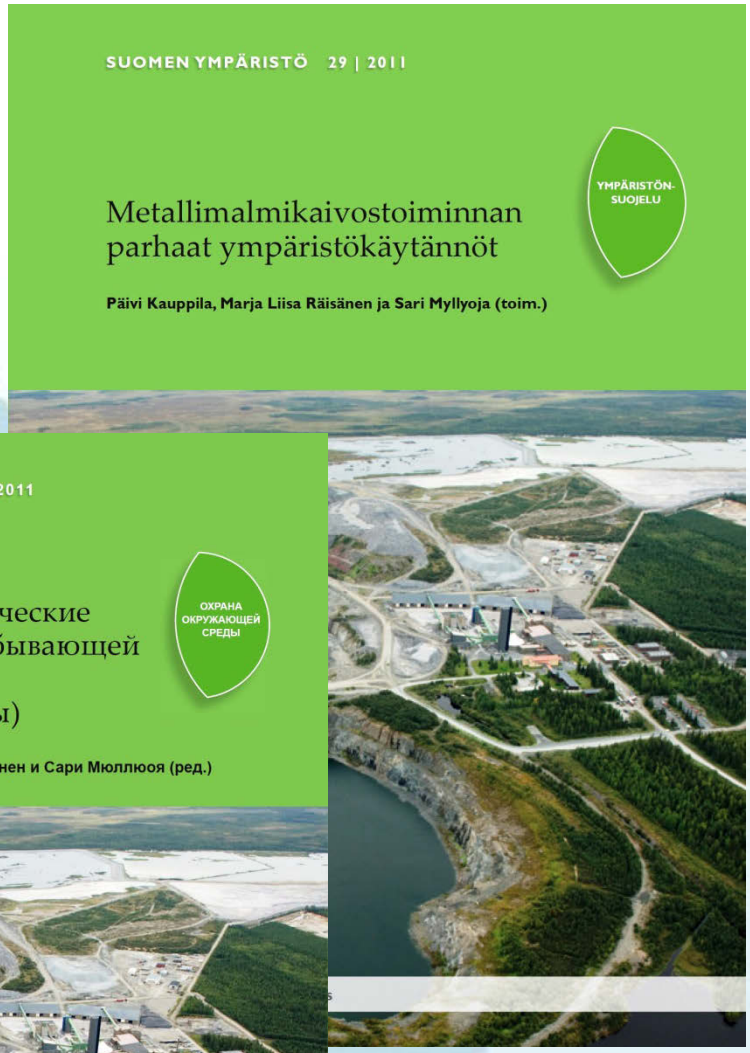
GREEN MINING CONCEPT

- Promotes materials and energy efficiency
- Ensures availability of mineral resources for future needs
- Minimizes adverse environmental and social impacts
- Improves work and organisational practices
- Ensures sustainable land use following mine closure

The Best Environmental Practice is

- to opt techniques and methods with which emissions and impacts can be minimized and which consider conservation aspects in life-circle of a mine and after the closure
  - implement the plans in practice during the accepted time table
- to promote sustainable use of raw materials to maintain acceptable standard of living and social welfare now and in future



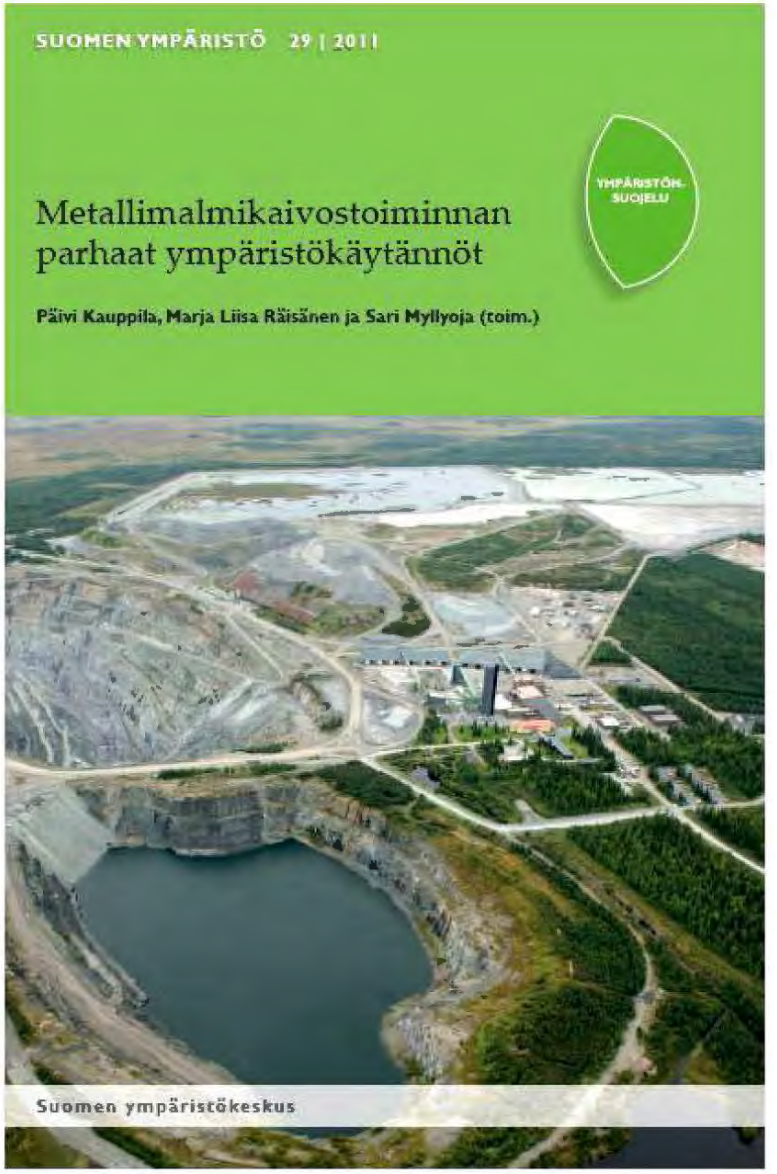


WEB-site:
www.barentsminingconference.fi

Best Environmental Practices in Metal Ore Mining in Finnish, English and Russian translation
edited by
Päivi Kauppila, Marja Liisa Räisänen and Sari Myllyoja

CONTENTS

- Metal ore mining: the mine life-cycle and processes
- Mining legislation
- Emissions and environmental impacts
- Environmental studies
- Mitigation techniques for emissions and environmental impacts
- Monitoring of activities and reporting
- Best environmental practices for metal ore mining




Thanks a lot for Your attention!