MIN-NOVATION
MINING AND MINERAL PROCESSING WASTE MANAGEMENT INNOVATION NETWORK

TABLE OF CONTENTS:

2 Mining waste disposal in fjords – Piotr Szmigielski
3 Communities, Fjords and Mineral Waste Disposal – a view from Rogaland – Jan Frick
4 Magma Geopark and the many values of geo-heritage
4 Highlights from the Petroleum Waste Management Conference in Stavanger, April 2012

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From its inception, the MIN-NOVATION project has shed light on the diversity of experiences with mining waste management from the Baltic Sea Region. Even though outside this region, Norway offers a perspective worth taking an interest in. One of the destinations of mining waste are fjords, one of the most celebrated natural features of this country. Whilst the appropriate regulations are in place and due care applied during the permitting process, the issue is nonetheless the source of some controversy and concern as on-going research seeks to better understand the long-term impact of such deposits on local ecosystems and surrounding communities.

**Regulatory restrictions on fjord-bed disposal**

One of the prerogatives of The Climate and Pollution Agency (KLIF), a government authority which is part of the Norwegian Ministry of the Environment is to issue permits to mining enterprises to dispose of mining waste in the bottom of fjords. The permitting is done on a case-by-case basis, and the applicant is required, *inter alia*, to present alternative options for disposal and refer to the best available technologies reference documents issued by the European Commission’s IPPC Bureau. Moreover, each permit is associated with restrictions on the volume of releases into air and water. Reporting is on an annual basis and involves disclosing the amount of waste deposited. As Harald Sørby, head of mineral and petrochemical division of KLIF informs, these and other regulatory controls have been in place since the 1981 Pollution Control Act, although Norway’s history of sea-bed waste disposal has been much longer, going back centuries. Mr. Sørby says there are currently 4-5 sites in Norway where mining waste (tailings only) is deposited at the bottom of the fjord. Two sites are currently under review by KLIF – a location for receiving waste from a titanium ore mine operated by Nordic Mining in the mid-west region of Norway and from a copper mine owned by Nussir in the far north.

**Alternative storage methods under discussion**

Bellona is a Norwegian environmental organisation with an international presence which has addressed a lot of environmental topics with a science and solution-based approach. Karl Kristensen, who is an advisor on industrial waste issues with Bellona notes that the organisation has not taken a principled stand against the depositing of mining waste in fjords, although it should only be treated as an option after very careful consideration. Much more research on the environmental impact of these deposits is needed. In the meantime other alternative disposal methods are worth investigating e.g. backfilling. The Norwegian government is in the process of writing a national mining strategy, and has expressed uncertainty about which industrial standards should be recommended or required. As a response to this, Bellona has suggested to the Ministry of Trade and Industry to organize a task force for mapping the best available technologies in mining industry as part of its work on the national mining strategy, and is awaiting the government’s response to this proposal.

**Re-use of tailings?**

There are two main re-use options currently being considered for mining waste (tailings) in Norway. One is to use the waste to cover sea-beds which are heavily polluted by shipyards that have been operated for decades in order to seal the remaining pollution. A preliminary assessment of the areas where this could be put into practice in Norway indicates approximately 20 industrial harbours, and as many as 150 shipyard sites, Per-Erik Schulze, marine biologist on the staff of Naturvernforbundet and key contact person for mining waste issues, points out. He says that if one adds the fact that marinas and small recreational harbours have similar problems with seabed contamination, the scale of intervention becomes very considerable indeed. Naturvernforbundet is an environmental organisation which takes a strict stance against fjord-based waste deposits. The other re-use option is to use the tailings as filler material in roads.
Mineral waste management in Rogaland, Norway, involves several different issues. The main sources of waste are the mining industry and the petroleum industry with cuttings from the drilling operations in the North Sea. These tonnes of waste are treated in very different ways due to legislation which mainly is concerned about the toxic content.

The only land-based disposal from the mines is in 2012 at the Titania mine. The ore is crushed into one tenth of a millimetre, the valuable part is taken out, and the remains are dumped into a closed valley. This waste is almost fluid at the start, but settles down after some time.

The "normal" treatment of mining waste is to dump it into a fjord like Titania used to do. And we have one such application in May 2012. The applicant is a company that takes out granite for export to e.g. the Netherlands which may be used for dam construction etc. It is seeking to obtain a permit to dump its sand-dust into a fjord. At the time of writing, a decision had not yet been made on this application. While it is not toxic, such dumping can and will have an impact on the aquatic life at the fjord-bottom for many years, so county authorities and community members have been having a debate on this topic.

Local communities are rarely against such dumping provided it is not toxic and does not destroy "too much" in the fjord. The reasons are that the mines often provide employment in rural areas where employment opportunities are rare, and once in the fjord, the waste becomes invisible. That means that the majority of the population never actually sees the mines or the waste that is generated.

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On the other hand, public opinion is very clearly against any kind of waste dumping when the waste can be regarded as toxic. This is a problem in particular for the petroleum industry. They struggle about the waste cleaning processes. If it is water-based cuttings or fluids without toxic content, then they dump it at sea. If it can be cleaned at the platform at sea by process equipment, then the clean part is dumped and the rest is transported to shore. If it is oil-based cuttings and fluids, then all is taken to shore for treatment. That may be larger cleaners or burners, but the toxic remains are collected and then deposited in places adapted for such disposal. Old closed mines are a natural selection for such. While such toxic remains are subject to special treatment and disposal regulations, one must to remember that the number of tonnes per year is small compared to waste from a mine.

Reuse of the waste from the petroleum industry has been investigated by many companies and academic institutions. As far as we can find, there are several technologies for reusing petroleum non-toxic as well as toxic waste. Solutions with toxic components require binding or encapsulating the toxic part. But the main issue is that none of these possibilities can compete with complete or partial dumping when it comes to cost.
Magma Geopark and the many values of geo-heritage

Geoparks are areas designated by UNESCO for their outstanding geological heritage which is to be used, preserved and celebrated in many different ways, together contributing to the sustainable development of communities located in and around the geopark.

Magma GeoPark covers an area of 2329 km² and spans two Norwegian counties. Rich in geological as well as industrial heritage, the geological landscape is dominated by anorthosite and norite, rare minerals which are found in Canada but also on the Moon. The industrial heritage is linked to historical deposits of molybdenum, iron and tungsten and others. To this day, ilmenite continues to be sourced here, primarily by the Titania mine, which operates within the boundaries of the geopark.

Magma Geopark, which joined the worldwide UNESCO network of geoparks in 2010, is unique amongst the 44 geoparks located in Europe in that it is the home to an active mining operation – the already mentioned Titania mine – which means that one of the pillars of the local economy relies on the geological heritage which is at the very core of the geopark concept.

Magma Geopark acts as a knowledge centre that collects geology-related knowledge about the region and makes it available to various audiences, entering into collaborations with local schools, universities, businesses and government authorities and promoting the geopark’s geological assets and local products which are tied to that heritage. It is developing as a partner for tourism in the region. Magma Geopark is also active in several European projects dealing with education and information about geology.

Highlights from the Petroleum Waste Management Conference in Stavanger, April 2012

Waste management in the petroleum sector was the subject of a one-day conference attended by over 70 participants from the private and public sector as well as students from the University of Stavanger, which organised and hosted the event. Norway’s top petroleum and gas companies gave an overview of the technologies, processes, and disposal options for offshore and onshore management of water-based mud, oil-based mud and produced water in Norway. Much has already been done to make the disposal process as energy- and resource-efficient as possible.

One of the main remaining challenges has been to convert drill cuttings which have been thermally desorbed into a useful product. According to Bjørnung Jensen of Halliburton, several companies have expressed interest in drill cuttings as a waste by-product; the logistics of transporting the cuttings to shore and delivering them to the end-user, however, currently make this an enterprise that is economically unfeasible.

Another challenge facing the Norwegian petroleum sector is how to best handle waste flows from drilling operations in the Arctic North. Professor Javad Barabady of the University of Tromso is leading a multi-year project (Northern Environmental Waste Management – http://northernwastemanagement.com/) to address this very topic, and spoke about the scope of activities which a consortium of Norway’s universities and R&D centres is carrying out.

These and other presentations and the discussion which followed showed how essential improvements in technology and greater clarity in regulations governing waste disposal are going to be for the future sustainability of the petroleum sector.