ECOBALANCE OF TALC MINERAL PRODUCTION

V. Badino *, G.L. Baldo *, M. Fornaro* and E. Salvaia **

*Georesources and Land Dept., "Politecnico di Torino", Turin, Italy.
** Luzenac Val Chisone S.p.A., Pinerolo (Turin), Italy

ABSTRACT

The application of Life Cycle Assessment methodology to the mining sector could lead to a new kind of environmental impact assessment. Life Cycle Analysis or Assessment (LCA) is an operating tool to evaluate the environmental consequences of a product, process or activity, through its life cycle, *from cradle to grave*. The assessment covers the entire life cycle of the product, from the extraction of raw materials, through the production and use, to its final disposal. An Ecobalance is a tool intended to analyse just a specific production cycle, from a comprehensive point of view, including energy and resources consumption, all kind of emissions, social effects and economic considerations. At present, talc in Piedmont, north-west of Italy, is one of the most important mining activity: the impact evaluation of the connected production activities at Luzenac Val Chisone, from exploitation to raw material's treatment, looks like being an interesting test for the application of this new analysis tool in the mining field. The paper deals with the evaluation of energy and materials consumption and global emissions of the above mentioned activity, in view of obtaining a global assessment of the environmental impact (*ecobalance*, as said above). Using standardisation and normalisation indexes for the assessment of the considered system, it is possible to build an energy-ecological profile of this production.

INTRODUCTION

The term *ecological balance* is often used to define an instrument to evaluate the environmental consequences of a product, process or activity; *eco-balance* is strictly connected to LCA (*Life Cycle Analysis*), a complex multi-dimensional tool to examine a production or an activity from an energy and ecological point of view, through its whole life cycle, *from cradle to grave*. In an eco-balance the assessment considers only the activities inside a specific production site by identifying and quantifying the energy and materials consumption and all kind of wastes released to the environment; in this way it's possible to build an *eco-profile* of the activity to be used in the decision making and marketing function; using the LCA's standardization and normalization indexes it is then possible to assess the environmental impact of the system under study in the areas of ecological health, human health and resource depletion: in this sense we

use the term *modified eco-balance* to identify an ecobalance including the impact assessment. With respect to other tools, like RA (*Risk Assessment*) and EIA (*Environmental Impact Assessment*), where an impact implies an actual environmental effect, that is measurable, currently, impact assessment in the LCAs and in the ecobalances use the *less-is-better* approach, including both emissions that do have actual effects and those that do not, either above or below the NOEC (*No-Observable-Effect-Concentration*) threshold; the arising confusion about the term *impact assessment* could be avoided adopting the term *potential impact* or better *inventory interpretation* (LCA News, 1995) for eco-balance and LCA assessment methodology. Both LCA and eco-balance are considered innovating and strategic tools amongst the industrial producers because they offer the big opportunity to advertise an *environmentally friendly* product an to support a *green marketing* activity. In particular, in Europe, the *EC Ecolabelling Scheme* and the *EC Eco-Management and Audit Regulation* offer business enterprise the opportunity to participate in a system to improve the energetic and ecological performances of production sites and to achieve a statement of participation; moreover the Regulations obliges enterprises to conduct an environmental review of the site, taking into consideration waste, pollution of soil and water and air, noise, energy and resource consumption and finally impacts on ecosystems. In this sense the Regulations suggest the performance of an eco-balance.

APPLICATION TO THE MINING FIELD

The mining activity's image is dominated by the usual concept that it has negative consequences for the environment. A test with interviews developed in U.S.A. (Bingham, 1994) showed that public think first that mining harms the environment, and then that the mining companies are not environmentally conscious. In Italy there is not the same mining situation of U.S., but we think that Italian people is sensitive to this kind of problems like the American people. For this reason, a *proactive* behaviour of the company in the environmental protection direction, can improve the negative image, leading the public opinion to an objective view of the production reality; the here presented analysis tools are probably the best way to reach both *eco-efficiency* and solutions for an acceptable image.

Mining provides basic mineral raw materials and energy: an eco-balance of this activity is first necessary to perform all the LCAs that include materials treatment and energy consumption, and then is useful to understand how the exploitation and treatment involve the environment; for example, in the case of talc, an eco-balance of mining and treatment activities is important to perform LCA of pharmaceutic, feeding or plastic products.

The *Luzenac Val Chisone*, a company of *RTZ Group* and consequently under a well defined environmental management policy, was one of the first Italian mining company that decided to perform an eco-balance of its mining and mineral treatment activities: the main goal was to assess the energy and ecological performance in order to improve the efficiency of its activities; it was a good opportunity and an interesting test for the application of these new kind of analysis tools, and gave evidence of the big interest of the mining companies in the use of these new evaluation methods. The site description, necessary for a correct data collection, can also be used to produce documents on abandonment and closure costs or activity information booklets of local interest.

THE CASE-STUDY

Talc exploitation and treatment at *Luzenac Val Chisone* is, at present, one of the most important mining activities in Italy. The Fontane mine is located in the Germanasca Valley, 90 km from Torino, north-west of Italy; the talc treatment activities are located at Malanaggio plant, 25 km downstream from the mine. The talc ore-body is roughly lenticular, dipping, with a thickness

ranging from some cm to 20 m The ore is exploited by selective blasting and cement filling; tests are underway to replace explosives with mechanical exploitation by continuous miner. Mucking is done by LHD and dumper. The cement fill is set in place by slinger-belt machine, mounted on a back-filling truck.
According to official guidelines (SETAC, 1993), the eco-balance case-study is divided into four main steps: goal definition and scoping, inventory analysis, assessment analysis and evaluation and improvement analysis.

Goal Definition and Scoping

The prime objective of carrying out an eco-balance is to provide as complete a picture as possible of the interactions of the activity under study with the environment. Goal definition and scoping is an integral part of the technical framework, required by those conducting the analysis to provide a clear understanding of the purposes. In this case, the first aim is to define an energy and ecological profile of the talc mining and mineral treatment activities, from the talc exploitation at Fontane Mine to refining at Malanaggio Plant. We will consider only operating energy and material consumption and direct emissions: in fact for a true eco-balance inputs are all the raw materials derived from the earth and outputs are all the waste materials returned to the earth; products are represented by materials flows within the system. The functional unit, a measure of performance which the system delivers, is, for the mining operations, one ton of exploited talc and, for the plant, one ton of refined talc.

Inventory Analysis

Data on inputs and outputs system are collected directly in the production sites, studied and presented according to the process analysis method; all information are referred to one year of activity (1994). Data quality, defined as the confidence degree in individual input and output data and the data set as a whole, was ensured by the company support, essential to provide quickly all the data to be used both in the evaluation and in the decision making steps. The system boundaries include the mine and the plant; the energy requirement for human work and the energy associated with the transport of workers to work can be ignored. The machines for mining operations are: 4 LHD (0.8 and 3 m^3), 1 shuttle-train with loco diesel and 3 electrical-loco with 10 to 15 lorries, 1 dumper, 1 backfilling truck with slinger belt, 2 drilling machine.

TABLE 1. Consumptions for mining operations.

Consumptions	Quantity/t of talc
explosive (GD and Tutagex)	0.21 kg
gravel	0.41 m^3
cement	75 kg
wood (chestnut and spruce)	0.01 m^3
bolts	0.007 units
reinforcements (steel)	0.15 kg
water	0.14 m^3
lubricant oil	0.032 kg
electric power	50.5 kWh
diesel oil	4.6 l
gasoline	0.1 l

Data are referred to 1 ton of exploited mineral

The diesel oil consumption for talc transportation to the treatment plant is included in the diesel oil value. The emissions calculated as the substances coming out from the main mine tunnel are reported in tab.2.

TABLE 2. Local emissions at mining operations

Emissions and wastes	Quantity/t
dust	65 g
NO	20 g
NO_2	2.6 g
CO	36.8 g
SO_2	2.2 g
COD	6 g
suspended solids	5 g
mineral wastes	284 kg
wood and paper	0.28 kg
steel	1.15 kg

Data are referred to 1 ton of exploited mineral

About radiation, the exposition was below 5 mSv for every miner. The average radon concentration was below 0.5 $\mu J/m^3$ (α potential energy). In 1994 the hearing conservation programme led to respect the acoustic limit value of 90 dBA.
The mineral arrives at the treatment plant by truck (rigid, 20 t) after a 25 km mountain road; the annual average is 9 truks per day. The annual refined talc quantity produced at the plant is bigger than the exploited mineral, due to stocks.

TABLE 3. Consumption at treatment plant.

Consumptions	Quantity/t
natural gas	8 Nm^3
electric power	106.4 kWh
diesel oil	0.3 l
gasoline	0.1 l
steel	0.8 kg
lubrificant oil	0.02 kg
water	0.5 m^3
bags (PP)	26 units
nylon	0.56 kg
wood (pallets)	0.02 m^3

Data are referred to 1 ton of treated talc

TABLE 4. Local emissions at plant operations

Emissions and wastes	Quantity/t
dust	180 g
NO_x	8 g
CO_2	16 kg
CO	13 g
Wood and paper wastes	1.22 kg
steel reject	0.97 kg

Data are referred to 1 ton of treated mineral

Energy and Impact Assessment

The first information we have from the inventory is the energy consumption value: the direct energy requirements to produce 1 ton of talc is about 360 MJ (0.0086 tons oil equivalent) at mine plus transports and 710 MJ (0.0169 toe) at plant, equal to 1070 MJ (0.0255 toe) every ton of saleable talc.

Impact assessment indicates a technical and quantitative process to characterise and assess the potential loading or impacts of the system identified into the Inventory step; all the environmental releases and resource consumption listed in the inventory must be classified according to the environmental effects that they are expected to contribute to.

The considered environmental effects used for the classification are: *global warming*, quantified in a common unit of grams CO_2 equivalents, *acidification*, in grams SO_2 equivalents, *nutrient enrichment*, in grams NO_3 equivalents *and photochemical ozone formation* (*photosmog*) in grams C_2H_4 equivalents. The classification results of mining activity and transport till the plant are shown in fig.1; the conversion factors come from specific models used to describe how the different substances contribute to a particular environmental effect. Other kind of pollution, like noise, odour, waste heat and damage to the landscape, are not, till now, standardised for a classification like that mentioned above and together with human and eco toxicity, require particular studies.

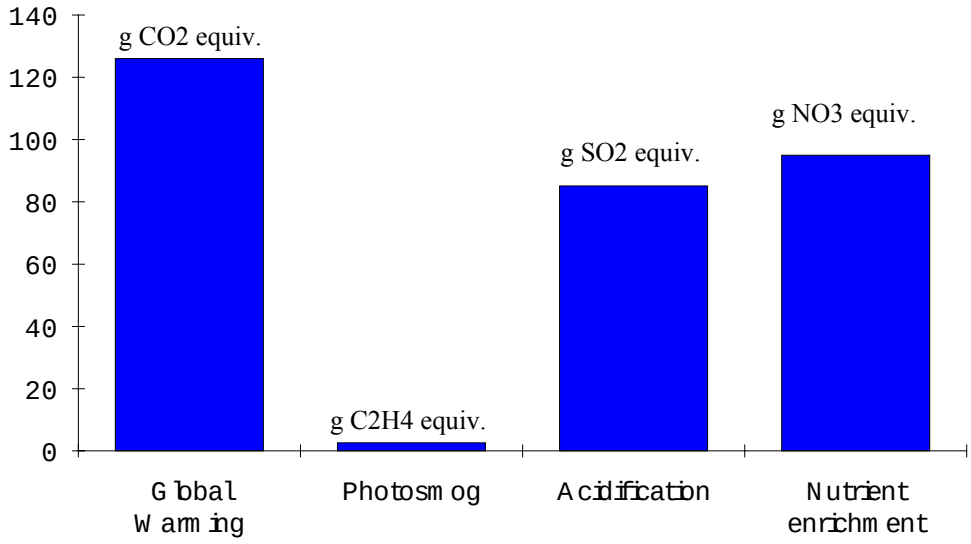

Fig. 1. Environmental effect types for 1 ton of exploited talc (mining + transport to the plant)

The treatment activities at Malanaggio increase the values of fig.1 till the figures reported in tab.5; the definitive eco-profile, as reported in tab.5, allows us to recognise the environmental effects, in the form of effect scores, that the talc production has.

TABLE 5. Environmental effect types for 1 ton of refined talc (mine + transport + plant operations)

Environmental effect types	Quantity/t
global warming	16152 g CO_2 equivalents
photosmog	3.12 g C_2H_4 equivalents
acidification	90.7 g SO_2 equivalents
nutrient enrichment	105.8 g NO_3 equivalents

Data are referred to 1 ton of saleable mineral

Evaluation and improvement analysis

The last step of an ecobalance is the evaluation of the environmental profile of the product. Usually it is used to compare different possibilities to produce a saleable material and to plan actions to reduce the environmental impact of the activities under study.

After the classification of the inventory data and the characterisation into impact categories, the aggregated data could be normalised in relation to the actual magnitude of the impacts within this category in some given area. Some examples of normalisation methods are the *Swiss eco-points system*, the *Swedish EPS system* and the *Danish person-equivalent system*. These kind of methods are, at the moment, just applied in an experimental way: therefore we will not use any normalisation method, like many other researchers, stopping the impact assessment to the characterisation phase.

CONCLUSIONS

The above analysis led to a better knowledge, from an energy and ecological point of view, of the operations at Luzenac Val Chisone. The energy results and the ecological data reported in fig.1 and tab.5 are the first information necessary to build a data-bank to be used to compare different mining activities or to compare the mining sector with other industrial productions, if the same meseaure tool has been used.

In particular the described eco-profile, first Luzenac report of this kind, will be useful to plan the enterprise' environmental policy and to produce environmental reports for the public, customers and government.

REFERENCES

Badino, V., G.L. Baldo, G. Michellone (1995). Ecobilancio di un'attività mineraria: il caso delle sabbie silicee. GEAM, 1, March 1995, 11-16.

Bingham, N. (1994). Mining's image - what does the public really think?. Mining Engineering, March 1994, 200-203.

SETAC (1993). *Guidelines for Life-Cycle Assessment: a Code of Practice*. Soc. of Environmental Toxicology and Chemestry, Brussels.