

Research Paper**S&B* MINING STEWARDSHIP IN MILOS ISLAND****Michalis Stefanakis¹**¹**S&B Industrial Minerals S.A., 15 A. Metaxa, Kifissia 145 64,****Email: michalis.stefanakis@imerys.com****Abstract**

In this article the stewardship activities to ensure minimization of environmental impacts and health & safety risks arising from the exploration, extraction, processing and loading-transportation of bentonite and perlite currently mined by S&B are described. This is defined as “process stewardship”. Limited reference is also made to “product stewardship” activities associated with the downstream use of said products across their life cycle. The contribution made to local community and the infrastructure development to support parallel development of tourism and other activities is also described. The S&B mining stewardship in Milos Island subscribes fully to the S&B sustainable development goal and targets, to which reference is also made.

**Note: S&B was acquired by Imerys in March 2015*

Keywords: *Milos, mining, stewardship, sustainability*

Περίληψη

Στην εργασία αυτή γίνεται αναφορά στις δραστηριότητες (stewardship) της εταιρείας S&B για την ελαχιστοποίηση των περιβαλλοντικών επιπτώσεων και του ρίσκου για την υγεία και ασφάλεια που απορρέουν από την γεωλογική έρευνα, εκμετάλλευση, επεξεργασία και φόρτωση-διακίνηση μπεντονίτη και περλίτη στη Μήλο. Αυτό ορίζεται σαν «κηδεμονία-φροντίδα διεργασιών». Περιορισμένη

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αναφορά γίνεται στην «κηδεμονία-φροντίδα προϊόντων» δηλ. στις δραστηριότητες της εταιρείας που αφορούν τη χρήση των προϊόντων μπεντονίτη και περλίτη στη διάρκεια του κύκλου ζωής των. Αναφορά γίνεται επίσης στη συνεισφορά της εταιρείας στην τοπική κοινωνία κα στην ανάπτυξη υποδομών για την παράλληλη ανάπτυξη του τουρισμού και άλλων δραστηριοτήτων. Οι παραπάνω δραστηριότητες «κηδεμονίας-φροντίδας», είτε αφορούν τις διεργασίες παραγωγής είτε τη χρήση των προϊόντων, ανταποκρίνονται πλήρως στους στόχους βιώσιμης ανάπτυξης της S&B, στους οποίους γίνεται επίσης αναφορά.

**Σημείωση: Η εταιρεία S&B αποτελεί σήμερα μέρος του Ομίλου εταιρειών της Imerys μετά την εξαγορά της το Μάρτιο 2015.*

Λέξεις κλειδιά: Μήλος, εξόρυξη, κηδεμονία-φροντίδα, βιωσιμότητα

1. INTRODUCTION

Milos belongs to the Greek Island complex of the Cyclades in the Aegean Sea. Volcanic activity for hundreds of thousands of years gave rise to formation of a broad range of minerals such as obsidian, melian earth (kaolin), alunite, manganese, sulphur, pumice, baryte, perlite, bentonite, and other.

Mining started in the Neolithic Age (8000 B.C.) with the extraction of well-known Milos obsidian that was used as raw material for fabrication of tools and weapons. Kaolin was mined since the Bronze Age (1800 B.C) for pottery and pharmaceutical uses. In the classical period trachyte millstones were used for the milling of cereals and exported also to mill the Laurion silver ores, bentonite was used for making soap and alunite for fabrics dying and pharmaceutical uses. Small quantities of silver – lead ores were mined in the Hellenistic period and at the end of the 19th century with galena exploitation at Triades area. Sulphur mining at a bigger scale started in 1862 AD at Paliorema and was interrupted in 1958. In 1890 manganese exploitation begins at “Vani” area and is terminated in 1928. The economic boom that followed World War II and the need for raw materials triggered a new rise in the mining activity of the Island. More information on the geology is given by (Fytikas and Marinelli, 1976) and on the uses of Milos minerals by (Stamatakis et al., 1996)

There are a few extractive companies in Milos, the largest being S&B, which has been present on the Island since 1934. S&B started its operations exploiting baryte. The first name of S&B was “Silver & Baryte Ores Mining Co.” Silver concentration associated with the barite deposits was low for its economic recovery despite expectations. Over the years baryte was superseded by kaolin followed by bentonite and perlite exploitation, the latter two being the dominant extraction activities currently. S&B operates the biggest bentonite mine in the world and Greece with its Milos operations is the biggest bentonite producer in Europe. S&B raw perlite operations are the biggest in the world. Since its establishment, S&B has developed through mergers and acquisitions into a global minerals and materials group providing industrial solutions to a broad range of industrial applications. Currently, S&B is the largest miner on the Island employing directly 12% of the Island’s total workforce (Tzintzos, 2013).

Apart from its mining activity, Milos’s local economy today is also based to a large extent on tourism. Estimated visitors are 80-100000 per annum for an island of approx. 5000 inhabitants; services (including tourism) account for 55% of Milos domestic product, while manufacturing (most is mining) stands for 30%, a major contributor to the local economy (Tzintzos, 2013). Mining over the years has contributed to wealth development in the Island that has led to the development of touristic enterprises by the local population. Tourism has been supported through infrastructure facilities that include the Milos Mining Museum, the “George Eliopoulos” Conference Centre and other provided by S&B, advertisement of the Island through the markets served with mineral products all over the world and adjustment of mining activities during touristic seasons to facilitate symbiosis of mining and tourism. Mining and tourism, combined, provide for a strong and steady economy, with literally no unemployment on the Island, even during the “economic crisis” period in Greece since 2010.

1.1 FRAMEWORK FOR MINING STEWARDSHIP

Sustainable development practices, although not defined as such, have been implemented at S&B for many years. Systematic and documented mapping of goals and targets towards this end, was established at the sustainability workshop of 2012, taking into account the business priorities, the business environment and the materiality of issues on society and S&B growth. Goals and targets were developed along four pillars, namely: People, Environment, Health & Safety and Social Contribution. The outcome is summarized in Figure 1.

S&B Sustainable Development: Vision & Goals

Vision	Every S&B employee will personally contribute every year to our sustainability targets			
Pillars	People	Health & Safety	Environment	Social Contribution
Strategic Intent	We will be considered a great place to work in our sector	We strive to achieve zero accidents and continuously improve our working environment	We improve our and our customers' environmental footprint (waste/energy/land)	We build goodwill capital and relationships in every community based on the social relevance of our operations
Targets	<ol style="list-style-type: none"> 1. Improve work-life balance 2. Ensure transparent and effective internal communication 3. Align HR practices to attract, retain and develop talent 4. Foster innovation and collaboration 5. Foster inclusivity and diversity 	<ol style="list-style-type: none"> 1. Certify all operations to OHSAS18001 2. Instill a health and safety culture in all employees 3. Foster a healthy and safe working environment through the equipment and processes used 4. Minimize the health and safety impact of our products and raw materials 5. Extend health and safety policies to anyone interacting with our plant and products 	<ol style="list-style-type: none"> 1. Certify all operations to ISO 14001 2. Reduce water impact (minimize consumption and maximize self-sufficiency) 3. Reduce energy footprint (minimize use and optimize percentage of renewables) 4. Minimize emissions and waste to landfill 5. Help to improve our customers' sustainability performance by taking a lifecycle approach to product development 6. Maximize value of post-mining land use 	<ol style="list-style-type: none"> 1. Assess social relevance of operations at local level and develop programs accordingly 2. Measure and communicate social impact consistently and effectively (to all stakeholders inc. local communities and employees) 3. Enable employee involvement in specific programs 4. Implement formal intern/apprenticeship programs for local communities



18/12/2012, BoD Presentation, Sustainable Development

Fig. 1: S&B Sustainable Development Targets.

The sustainability vision calls for “every employee to personally contribute every year to the sustainability targets”, mandating engagement of shop floor and administration personnel into this endeavour. Targets are quantified to the extent possible and the following ones are monitored on a quarterly basis.

- Workers exposure to respirable dust be 20% below the applicable legislation limit on 8-hours basis, without any face dust mask protection by the end of 2014
- Dust emissions 20% below the applicable legislation limit.
- Workers exposure to noise be below 85dB (A) on a 8-hours basis without any hearing protection.
- Safety training, 6 hours per employee/year
- Local community contribution (monetary and projects)
- Reduction of frequency and severity rate of LTA (lost time accidents) by 25, 50 and 60% in 2014, 2015 and 2016 respectively versus those of 2013.

- Reduction of Specific energy consumption by 1% each year in the next three years
- Certification of all operations per ISO 9001/ISO 14001/OHSAS 18001 by the end of 2014

Performance results are reported in the annual Sustainability report, satisfying the need of transparent sharing of information as mandated by the relevant social pillar target. More important, targets have been integrated into the S&B management systems through the decision to expand certification per ISO 9001 for quality, ISO 14001 for environment and OHSAS 18001 for Health & Safety across the Group. At the time of drafting this article, the majority of Group Facilities where 93% of direct and supervised contractor employees are employed have earned certification per ISO 9001, ISO 14001 and OHSAS 18001.

2. S&B MINING STEWARDSHIP ACTIVITIES AT MILOS

The mining stewardship activities practiced at Milos, in compliance with the goals and targets of S&B sustainable development goals and targets, comprise activities associated with “materials stewardship” and activities in support of Local Community. The “Minerals Cycle” published first in “Breaking new Ground” and adapted by ICMM in the Guidance document “Maximizing Value” (ICMM, 2006), defines the themes and activities associated with “materials stewardship” in the minerals and metals value chain. It was published in 2006 but still is very relevant. The message conveyed in above guidance is to work on maximizing value instead of minimizing impacts, which is usually the target of Regulatory Authorities. Implementing the materials stewardship requires:

- Understanding material flows, impacts and benefits.
- Interacting with all stakeholders in the value chain
- Optimizing production and application of the materials
- Sharing and reporting data and information

Exploration, extraction, processing, loading and transportation activities associated with bentonite and perlite mining fall within the “process stewardship” part of the minerals cycle and elaboration of resource efficiency and work environment activities in their interaction with local community will be made. The product stewardship part of the “minerals cycle” pertinent to Milos operations includes LCA (life cycle assessment) and SDS (safety data sheet) communication. Process and product stewardship together make up the full “materials stewardship”.

3. MINING STEWARDSHIP – RESOURCE EFFICIENCY

Efficiency and effectiveness of resources' use is the biggest challenge of our days and their optimization should be sought from mine design, development and operation to mine closure and beyond, taking into consideration potential exploitation of today's waste as a future resource. In this respect examples are given of mining stewardship activities associated with:

- exploration, mine design and reclamation to protect biodiversity and minimize land-use (Section 3.1)
- mining and processing to maximize raw materials use and programs in place to reduce energy, water, waste, other consumables and services (Section 3.2)

3.1. Land-use and biodiversity

A core element of S&B's public environmental policy since 2001 is land reclamation. Conserving and restoring biodiversity constitutes one of the basic targets of rehabilitation processes followed by S&B, as well as development of post mining land uses. The know-how developed over 35 years of systematic work and continuous research on land rehabilitation have generated good examples of mine reclamation at S&B's quarries at Milos, as described by (Petrakis and Rigopoulos, 2001) and (Brofas et al., 2013). Milos is a small Island, distinct with respect to its soil and climate conditions (long drought periods, high temperatures and strong winds), high salinity water, grazing problems, forest fires etc.

Reproducing native or endemic plants is of vital importance for successful quarry rehabilitation and the conservation of biodiversity. Endemic species are exclusively used in restoration works since 2010. In reclamation works at Milos Island, it has been found that only native plants can survive. Native plants are modulated in the specific soil and adverse hot-dry climate conditions and consequently are the only ones that can survive, due to their particular efficiency to stay dormant (hibernate) through summer and thus they need no watering during the 6-months hot-dry period. Some of them are durable in fires and/or high saline water concentration.

Independent study sponsored by the Ministry of Environment of Greece, which was carried out by the Department of Biology of the University of Athens (Adamopoulou and Legakis, 2006), has concluded that appropriately designed rehabilitation can contribute to the creation of habitats, suitable even for rare or protected species. At the company's quarry site (Chivadolimni) at Milos Island, the results showed that there was

no difference in the number of fauna observed, in comparison to the undisturbed area used as reference. The quarry before and after rehabilitation is shown in Figure 2.



Fig. 2: Chivadolimni perlite quarry before and after restoration.

Environmental base studies have been implemented in various areas and further work in that direction is in progress, the target being to document that on cessation of mining activity, following well designed reclamation, native flora and fauna can again populate the mine.

The status of mine land-use in 2013 given in Figure 3, shows that 13% of available to rehabilitate area is not rehabilitated and this relates to leased mines for which Owners have developed alternative uses (water reservoirs), or oppose to reclamation thinking that additional minerals resources are still available in those areas.

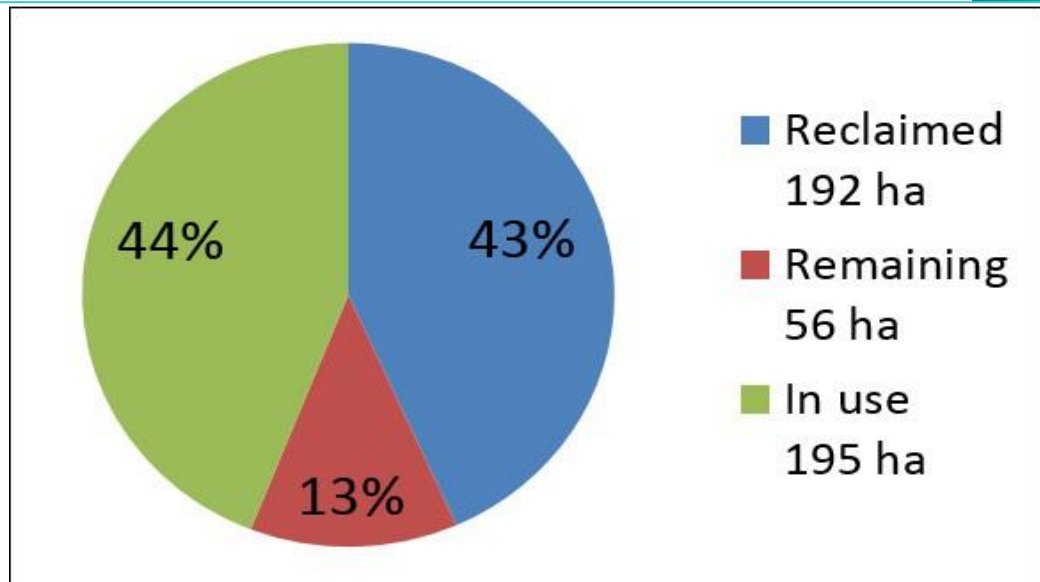


Fig. 3: S&B Milos mines land-use status.

3.2 Mining – Processing

The mining stewardship activities in place to optimize usage of natural raw materials and other supplies, include:

- Mapping of resources' volume and quality incorporating use of advanced software that facilitates mining schedule and blending to satisfy customer specifications, ensuring maximum resource exploitation without any undue quality sacrifice.
- Minimization of waste during processing and its exploitation in other uses is also ongoing, i.e. perlite fines in construction applications, overburden material from bentonite and perlite mines in cement production.
- Monitor hazardous and non-hazardous waste disposal in compliance with applicable regulations and develop procedures to eliminate/minimize hazardous substances usage in our operations. Milos is certified per ISO 14001 since 2002.
- Slope stability control programs to prevent or predict landslides that impact safety and may also result in reserves loss.
- Coordination for joint exploitation of neighbouring reserves with other mining companies to maximize recovery.
- Big emphasis has been placed on specific energy reduction because of the immediate cost savings and the contribution it has on the protection of the environment. Various programs are currently in progress for energy reduction like the flue gas economizer to capture waste heat from the bentonite driers and also recover the water evaporated, optimization of raw materials transportation using trucks and reduction of electric energy consumption through the infrastructure upgrade.

- Effort was devoted in the past for the exploitation of high enthalpy geothermal energy to replace fossil fuel oil, albeit with no success because of local community opposition, associated with legacy problems of earlier trials. Recently, effort is focused on the exploitation of low enthalpy geothermal energy for partial or complete substitution of fossil fuels for minerals' drying.
- Bentonite natural drying has been practiced since 1975 in Milos and recognized by the IMA-Europe award in 2012. The practice shown in Figure 4 involves deposition of bentonite in layers and their mixing with agricultural machinery to facilitate soda activation and drying, results in savings of about 7500 tonnes heavy fuel oil per year associated with bentonite extraction of about 1 million tonnes.



Fig. 4: Natural bentonite drying at Milos Island.

- Monitor water consumption and evaluate plans for its reduction through recycling or process innovation. Rain water collected from office terraces and other open areas in our facilities at Milos is used for cleaning purposes in the administration offices and vehicles maintenance department. Water accumulated in the bentonite mines from rain or spring waters is used for road sprinkling. The scarcity of water in Milos led to selection of plant species used in mine rehabilitation for which no watering is needed.
- For consumables like soda we continuously aim to optimize soda activation and preventive maintenance programs in place aim to minimize lubricants and other materials consumption.

4. MINING STEWARDSHIP - WORKING ENVIRONMENT

For the working environment the aim is to eliminate, or minimize any factors impacting the health of direct/indirect employees and of local communities through exposure to dust, other air contaminants, noise and vibrations.

Dust

Workers exposure to respirable dust on a 8-hours basis is on the average 10 times lower than that mandated by the legislation in Greece. Noteworthy is the completion in 2011 of a warehouse to store the dried bentonite, the cost of which amounted at 12 million euros, in order to alleviate fugitive dust generation during its handling. Raw materials transportation is restricted in the summer period to minimize adverse effects on sensitive habitats and improve tourists' traffic movement. S&B actively participated in the EU Employee and Employers social dialogue agreement in 2006, aiming to improve workers' health protection through good handling of materials containing crystalline silica for which information is given in <http://www.nepsi.eu/>. Since 2006 all S&B facilities in EU, including Milos report bi-yearly on performance and achievements made. In addition, since 2000 the bentonite operations at Milos are engaged in the IMA-Europe Dust monitoring program (Houba, 2009) aiming to collection of dust and crystalline silica exposure data by job title and by mineral produced following a strict protocol. Currently the database built contains more than 22000 measurements from 154 sites in 18 European countries. The trends observed in recent years are given (Kromhout et al, 2014). This unique prospective exposure database will prove be very valuable when health effects due to exposure to respirable crystalline silica among these workers will have to be evaluated in the future.

Noise

A systematic noise source mapping study was carried out in 2011 and corrective actions have been implemented, including equipment enclosure, insulation and redesign of job activities to reduce workers' noise exposure. The target set is to limit workers exposure on an 8 hours basis below 85dB(A) not taking into account hearing protection aids. The target is very ambitious, especially for mining operations and currently 15% of workers at Milos are above this target; of course hearing protection is mandated in the latter cases.

Health Surveillance

Workers health is monitored per legislation requirements. Several campaigns have been implemented on specific topics, such as hearing loss and lung function.

Safety

Safety is one of the values of the Group and effort is continuously devoted to improve safety performance and protect all stakeholders in and around us, through:

- a) implementation of proactive safety practices, such as management safety visits aiming to bring and demonstrate management commitment on safety on the shop floor and training employees to recognize risk, as described by (Stefanakis, 2007)
- b) use of other tools like Safety barometer to measure compliance with critical safety requirements established with workers involvement
- c) Incident reporting including near misses and communication within the Group for all to learn from them
- d) Safety campaigns on communication signals that is communication of pedestrians with heavy machinery operators, safe drive training of all truck drivers, ergonomics training and improvement of job activities with potential of generating musculoskeletal disorders. Annual organization of H&S week to build awareness on topics like first aid, fire drill, Fit & Health, emergency evacuation.

5. MINING STEWARDSHIP - PRODUCT STEWARDSHIP

Concerning products' stewardship, it is important to understand the material flows, impacts and benefits and interact with all stakeholders in the value chain.

To this end S&B:

- Participated as early 2007 in the development of LCI (life cycle inventory) of powder and granular bentonite. This exercise has been repeated in 2014 under the umbrella of EUBA (European Bentonite Association), taking into account the developments made in LCA models.
- Cooperates with customers for understanding the product attributes needed for each application, in order to avoid sacrificing quality when not required, or tailoring quality to minimize specific consumption.
- Communicates SDS (safety data sheets) for incoming and outgoing materials to the workers on the environmental and health hazards associated with their use and those of the products to its customers. The goal is to develop procedures to eliminate/minimize hazardous substances usage in our operations and also hazardous waste.

6. MINING STEWARDSHIP – LOCAL COMMUNITY SUPPORT

Industrial mineral producers in Greece, as mandated by legislation, have to pay to the Municipality Authorities a fee amounting at 2% of the value of the mineral extracted, i.e. tonnage extracted times the in-situ price of the mineral at the mine. The overall amount paid by S&B in 2013 for its Milos operations was €177,000. This is a significant contribution to the Municipality channelled in principle to infrastructure development (roads, environmental restoration) and other works beneficial to the Community.

S&B since the start-up of its operations has helped local people and the community through donations and charity works. Systematic support in the development of other activities in the Island in accordance with sustainable development principles was integrated into its business practice since 1990.

Major initiatives undertaken are:

- Establishment of the Milos Mining Museum in 1998, which is visited by about 10000 people per annum. The mining history and the minerals wealth of Milos is exhibited with periodical organization of specific events and educational programs for students.
- The Milos Conference Centre “George Eliopoulos” founded by Mrs. Kitty Kyriakopoulos (major shareholder and honorary chair of S&B Board) was inaugurated in 2000. It is housed in a kaolin processing plant dated from 1925 with two conference facilities able to accommodate 450 conferees each time. It hosts about 5000 visitors per year
- Establishment of a partnership with the Milos Municipality “Milos Initiative” in 2007 aiming to jointly undertake development projects on the Island. In the framework of this Initiative a plant to treat the municipal liquid effluents was constructed and is in operation since 2009.
- Support of local cultural, athletic, religious and other activities like: Milos cultural festival hosting theatrical and musical events, restoration of abandoned non S&B mines in the Island, construction of football stadium, provision of scholarships and volunteerism awards, Miloterranean Geo experience and other for which information is available at S&B web site www.sandb.com

All above initiatives have contributed to the development of infrastructure that facilitates promotion of tourism and capacity building for locals. In 2014 a 5 ha vineyard field was planted at an exhausted perlite mine and this may trigger further development of another important occupation activity for locals.

7. CONCLUSIONS

Preaching sustainable development is immaterial unless integrated into the business practice and decision making. Purchasing, R&D, marketing, medium and long range planning need to consider the environmental, social and health & safety requirements and expectations of the markets to serve. These requirements have been to a large extent integrated into relevant procedures at S&B. What remains is reinforcing culture to support full implementation and continual up-date and adjustment.

The business drivers and value sought of sustainable development and therefore of mining stewardship are:

- Cost savings from efficiency improvements, informed risk management and employee productivity and morale.
- Earning and maintenance of the “social license” to operate for current and future activities.
- Ensuring continued access to markets by providing downstream applications with products contributing to reduction of their environmental footprint and health and safety risks.
- Keeping ahead of regulatory developments as mandated already by initiatives and legislation like: extended producer responsibility, integrated product policy, eco-labelling, REACH regulation.

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