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## LABORATORY RESULTS INFORMATION

### 1. Overview

ekolive is pleased to submit this laboratory results information to support Victory Marine in achieving its goals for improving sand raw materials from new primary Resources in Croatian Baranja by providing bioleaching by heterotrophic bacteria.

#### 1.1. Objective/s

- Improve quality of raw materials

#### 1.2. Goal/s

- Achieve a final raw materials quality with Fe2O3 impurity of below 0.24%

#### 1.3. Solution

- #1: Bioleaching by heterotrophic bacteria in laboratory of the samples in necessary time (max. up to 6 weeks)
- #2: Evaluation of any other possible mechanical separation method

### 2. Results achieved

Client's Company owns a primary resource investment in Croatian Baranja on a deposit of approximately 1.5 million tons of sand. The client´s objective is to learn about the possibilities to improve the quality of this raw material to fulfil the quality requirements of end users of high-quality raw materials, especially of glass industry, in order to optimize the potential revenues.

ekolive offers an ecological biotechnology for refining locally available, but non-valuable mineral resources into high-quality raw materials as an on-site service. Metallic impurities hamper efficient industrial use of many minerals such as quartz, clay minerals, kaolin, bentonite, carbonates and others and represent an unresolved problem for all conventional methods. A similar effect can be achieved only by using dangerous and non- economic chemical leaching; this can be fully replaced by an

economic and ecological biotechnology, which also provides minimal chemical consumption and zero waste economy. This safe natural process of raw material treatment is fully accepted by society.

## 2.1. Execution

In order to evaluate the particular possibilities to fulfil the Clients objectives and goals ekolive has carried out the necessary tests and experiments in the laboratory. Following is an overview about the input material, the processes carried out and the final results.

## 2.2. Materials and Results

These are the results from Štátny geologický ústav Dionýza Štúra (State Geological Institute of Dionyz Stur, Slovakia), certified by ISO 9001/2008. Analysis was made on June 20th, 2019, number 464/2019:

| **Ukazovateľ** | **Lab.číslo: 19-006805** | | **Rozšírená** | **Medza** | **Metóda** | **Metodický** | **Typ** |
|---|---|---|---|---|---|---|---|
| | **Označenie: 1** | | **neistota** | **stanovenia** | | **predpis** | **skúšky** |
| | | | **[%]** | | | | |
| | | | | | | | |
| **SiO2** | **[%]** | 90,7 | 2 | 0,05 | RFS | IP 3.1 | A |
| **Al2O3** | **[%]** | 5,22 | 10 | 0,05 | RFS | IP 3.1 | A |
| **Fe2O3** | **[%]** | 0,23 | 30 | 0,05 | RFS | IP 3.1 | A |
| **CaO** | **[%]** | 0,48 | 30 | 0,05 | RFS | IP 3.1 | A |
| **MgO** | **[%]** | 0,10 | 30 | 0,05 | RFS | IP 3.1 | A |
| **TiO2** | **[%]** | 0,10 | 30 | 0,01 | RFS | IP 3.1 | A |
| **MnO** | **[%]** | <0,01 | | 0,01 | RFS | IP 3.1 | A |
| **K2O** | **[%]** | 0,77 | 10 | 0,05 | RFS | IP 3.1 | A |
| **Na2O** | **[%]** | 1,8 | 10 | 0,2 | RFS | IP 3.1 | A |
| **P2O5** | **[%]** | <0,01 | | 0,01 | RFS | IP 3.1 | A |
| **strata žíhaním** | **[%]** | 0,54 | 15 | 0,01 | G | IP 11.3 | A |

## 2.3 Process

Physical Modes of Treatment

The sand sample was subjected to gravitational separation on a gravity float where different density grades were separated and sorted into heavy, lightweight and intermediate (quartz) (Fig.1).

Figure 1: Separation of mineral phases on gravity float

After gravitational separation, 51.42g of the heavy product, 36.03 of the light product and 358.35g of the intermediate were obtained from the original 500g sample (Fig.2). Even after gravitational separation, the intermediate product contained a high proportion of mica, which could not be completely removed due to the very related density and / or density. weight of quartz grains. Therefore, the intermediate was given again to the gravity weir, where it was subsequently sorted with the appropriate setting for intermediate (M) and mica intermediate (SM) (higher mica content). After a second gravitational separation, 188.04g of intermediate (M) and a 170.3g of mica intermediate were obtained (Fig. 2).

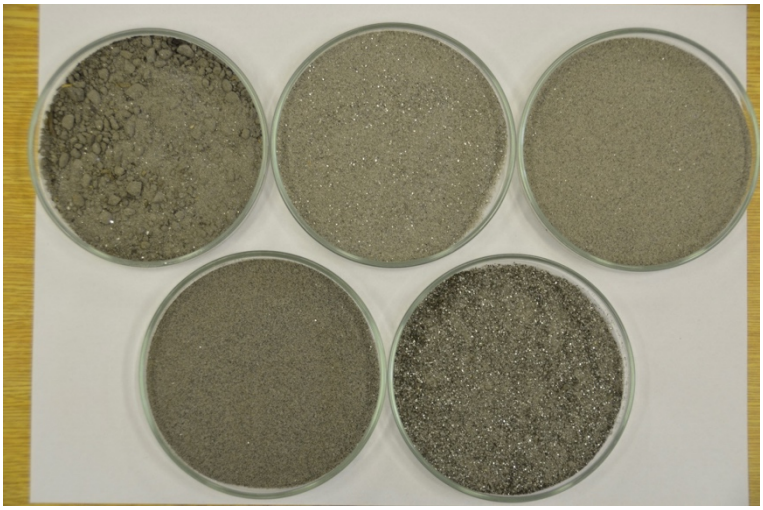

Figure 2: Comparison of sand without treatment (A) and sand after gravity separation (B- Mica Intermediate, C- Intermediate, D- Heavy Product, E- Light Product)

In the next step, samples M and SM were given to multiple sludge (wet) magnetic separations to remove heavy magnetic minerals. minerals from the mica intermediate (Fig. 3, 4).

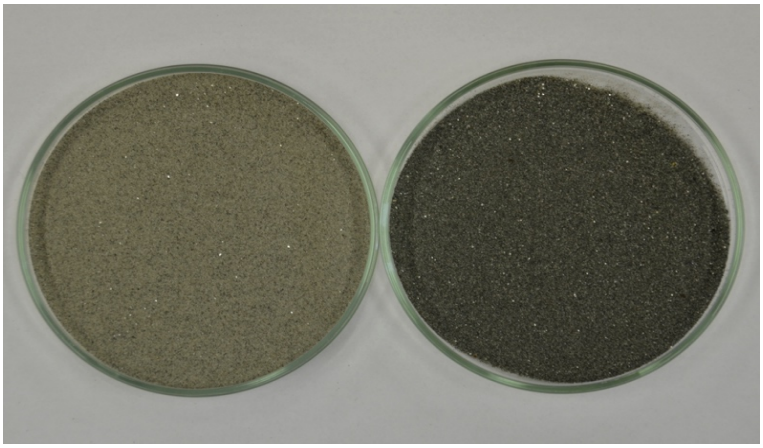

Figure 3: Intermediate and magnetic fraction after sludge magnetic separation

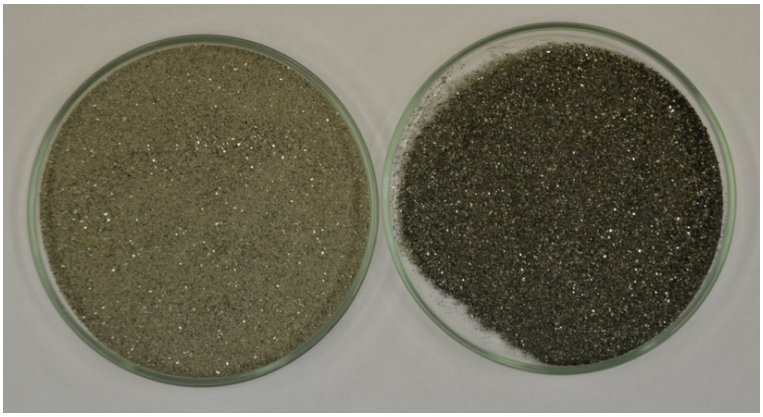

Figure 4: Mica intermediate and magnetic fraction after sludge magnetic separation

Bioleaching

The ability of the autochthonous heterotrophic bacteria to remove Fe has been investigated during biofouling of quartz sand in stable bottle conditions for 48 days. Bio-leaching involved the use of autochthonous heterotrophic bacteria whose activity was combined with chelating fertilizers. Chelates together with fertilizers and microelements contained in the nutrient medium stimulate the activity of bacteria in the dissolution of Fe.

The bio-leaching process was carried out in 500 ml laboratory flasks containing 200 g sand samples and 300 ml leaching medium (Fig. 5). The biolubilization process included 3 nutrient medium exchanges in a volume of 200 ml every 16 days.

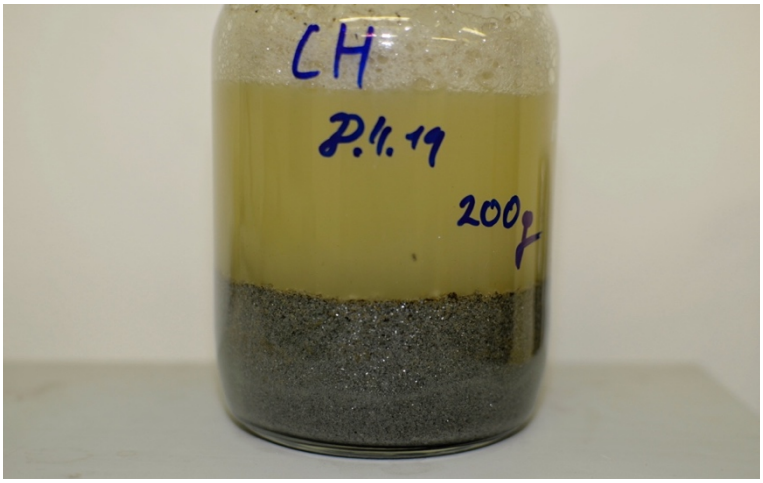

Figure 5: Bioleaching of quartz sand samples

Laboratory test for biolumination of quartz sand during 48 days with pH 7 nutrient medium confirmed bacterial activity in the extraction of Fe into solution in samples. Inoculatedalochtone-mixed bacterial cultures were able to bleach high-Fe high-sand sand by producing organic acids, while the pH of the leachate was reduced to 4 during biofouling (Fig. 6, 7). This fact points to the possibility of their use in improving the quality of sand and other non-metallic raw materials.

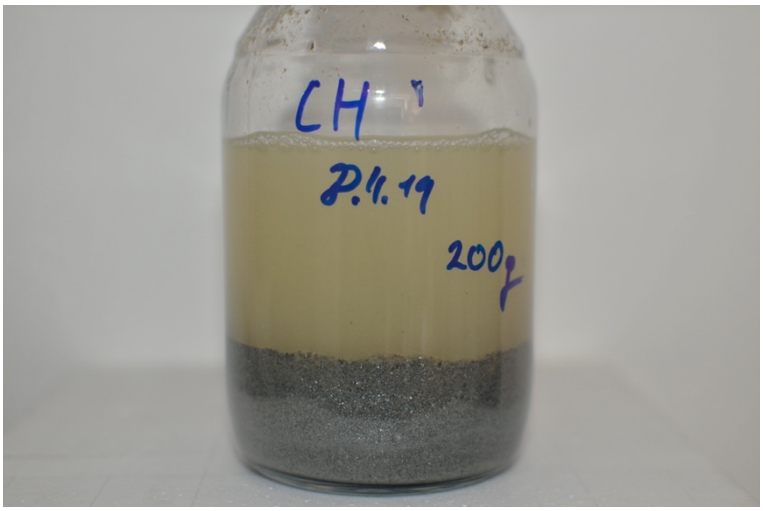

Figure 6: Sample sand during biofouling

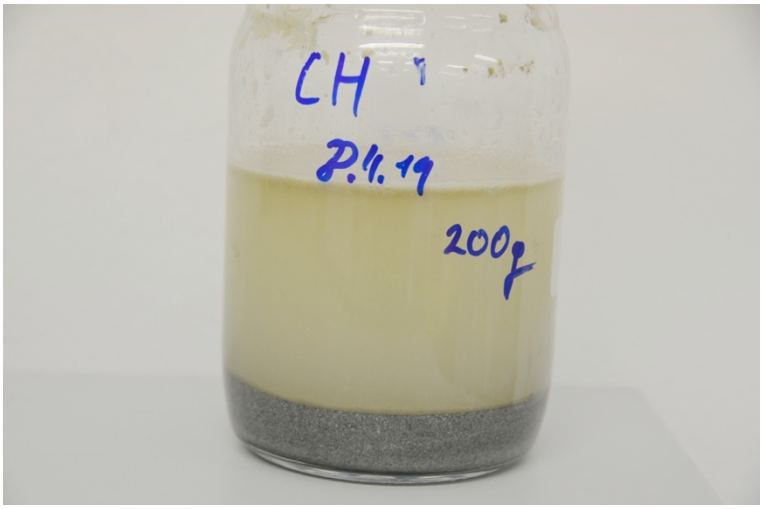

Figure 7: Sample of sand at the end of the bio-leaching process

Chemical leaching

The method of leaching samples in a low concentration acid mixture was used to extract readily and sparingly soluble Fe oxides from bioluted sand samples. Sand samples were leached for 48 h while acidic abrasion was used for 30 minutes (Fig. 8, 9).

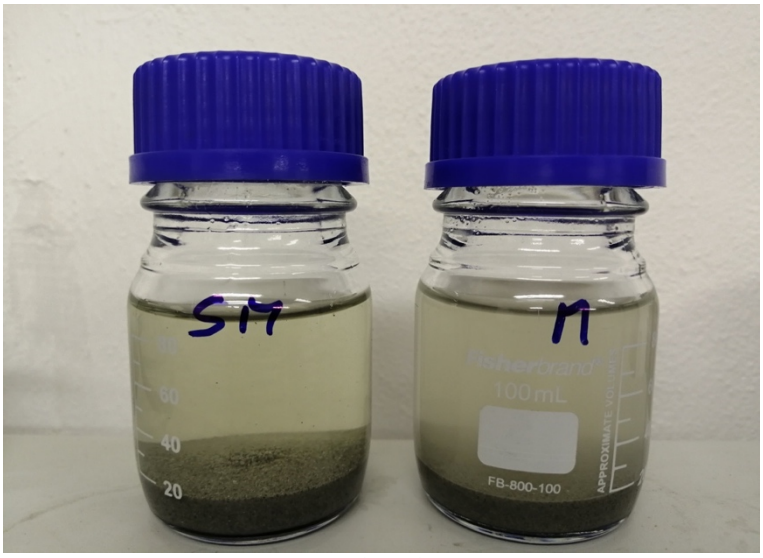

Figure 8: S and SM samples in low concentration acid

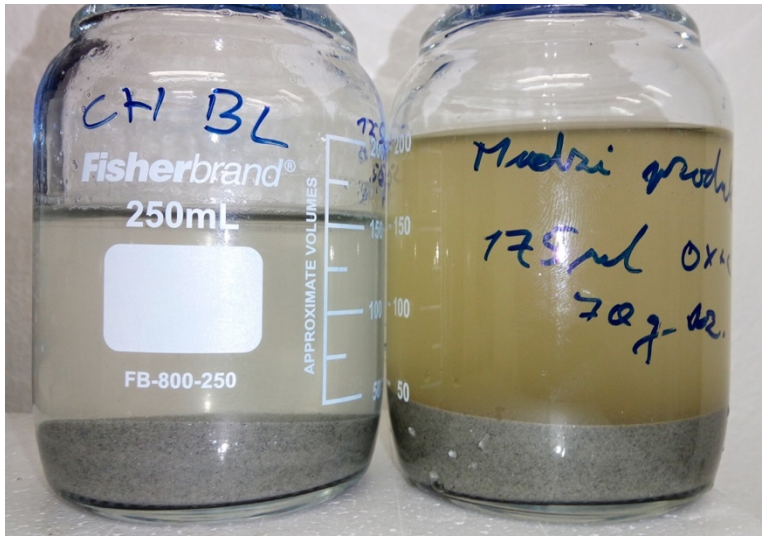

Figure 9: Sample before / after leaching and rubbing in weak acid solution

After leaching, the samples were re-taxed for sludge magnetic separation, as the clay and magnetic minerals were released by the acidic abrasion. The sludge magnetic separation again removed a considerable amount of magnetic minerals, but at a significantly smaller extent than after the gravitational separation in the 1st treatment step. Subsequently, the original sand sample, leached samples M and SM were dried and ground in an agate mill.
The sand sample after gravitational, sludge magnetic separation and leaching showed a marked improvement in whiteness (Fig. 10, 11, 12, 13).

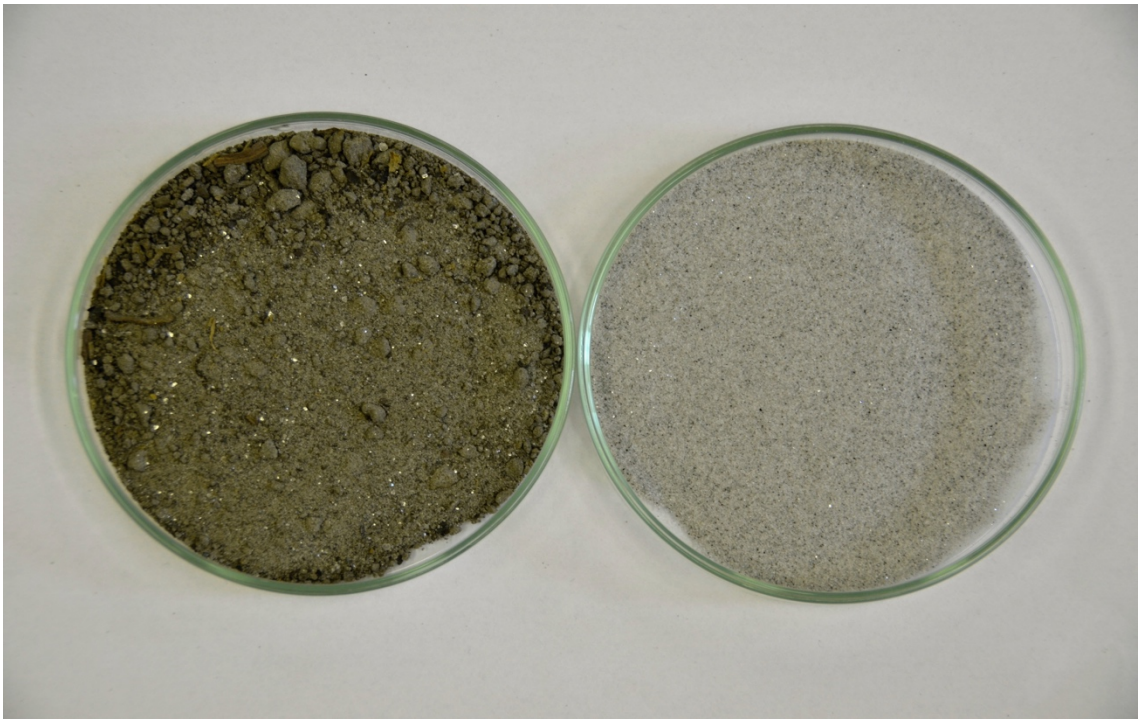

Figure 10: Comparison of sand samples before and after technological modifications


Figure 11: Comparison of original sample and mica intermediate after leaching

Figure 12: Comparison of the original sample and the intermediate after leaching

Figure 13: Comparison of mica intermediate and leaching intermediate

3. Summarizing Findings and Recommendations

- #1: By the above-mentioned modifications, we have achieved a significant reduction in the content of Fe minerals in the sand samples and thus an increase in the proportion of $SiO_2$.
- #2: By the process described a final raw materials quality with $Fe_2O_3$ impurity of below 0.24% can be achieved
- #3: With further process steps of mechanical separation even higher content of $SiO_2$ may be achieved

4. Responsibility and liability for the laboratory results

At the customer's request, ekolive has examined the above samples in its laboratory regarding the applicability of the heterotrophic BioLeaching process and the optimization of the raw materials based thereon. However, it is the sole responsibility of the customer to make business and commercial decisions based thereon. The customer accepts no liability for the resulting conclusions and decisions. ekolive's sole responsibility was to conduct tests in accordance with the customer's desired results.

5. Conclusion

We look forward to working with Client's Company and supporting your efforts to improve your resources. Based on the above listed results of our laboratory works we are confident that we can meet the challenges ahead and stand ready to partner with you in delivering effective impurity removal processes.

If you have questions on this result summary, feel free to contact us at your convenience by email at ekolive@ekolive.eu or by phone at +421 948 299 345. We will be in touch with you next week to arrange a follow-up conversation on the results.

Thank you for your consideration,

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CEO