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OPINION
ON SERPENTINITE-BASED FERTILIZER MATERIAL AND ITS POTENTIAL TO REMOVE CO2 FROM THE ATMOSPHERE

The opinion concerns ANTIGORITE SERPENTINITE from current exploitation of the "NASŁAWICE" mine deposit located near Jordanów Śląski. The opinion was formulated based on the information provided by KOSD WROCŁAW Sp. z o.o., documentation[1] [2] [3] [4] and preliminary tests of material samples[5] performed at AGH, submitted for analysis in July 2022. Five samples from the Nasławice deposit were delivered, with the following names: Sample 1: Level V – North, Sample 2: Level V – Southeast, Sample 3: Level II – Northwest, Sample 4: Level III – Southwest, and Sample 5: Level III – Northwest.

[1] Wiesław Heflik, Magdalena Dumańska-Słowik, Lucyna Natkaniec-Nowak, Ocena jakości mineralogiczno-petrograficznej serpentynitu z bieżącej eksploatacji ze złoża Kopalni „Nasławice" koło Jordanowa Śląskiego, Próbka 2/3[Assessment of the mineralogical and petrographic qualities of serpentinite from the current exploitation from the deposit of the "Nasławice" mine near Jordanów Śląski, Sample 2 out of 3], October 2022.
[2] Opinion of the Institute of Soil Science and Plant Cultivation, Department of Plant Nutrition and Fertilization, National Research Institute, Puławy, August 2016.
[3] Declaration of the manufacturer of a mineral fertilizer/mineral agent supporting the cultivation of plants, New Chemical Syntheses Institute, Puławy, May 2016.
[4] Research Report No. 54/2016/Other, New Chemical Syntheses Institute, Research Laboratory, Puławy, April 2016.
[5] Report on the progress of research, AGH FoMSaC DoCaRM, February 2023

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ANTIGORITE SERPENTINITE AS A MATERIAL WITH THE POTENTIAL TO REMOVE CO2 FROM THE ATMOSPHERE

In recent years, many technologists and scientists around the world took it as their priority to conduct a constant search for new and future-proof ways to reduce CO2 emissions. Currently, one of the frequently analyzed options is the use of both natural and waste materials in mineral carbonation processes. This process, taking place also in the natural environment, is based on chemical weathering of rocks containing magnesium, calcium and iron, which leads to the capturing of carbon dioxide. Literature on the topic indicates that the process allows the removal of up to 1 Gt of CO2 per year, which is about 3% of its annual emission. It turns out, however, that the method of Enhanced Rock Weathering (ERW), which is now more and more often considered in science, can increase this value by as much as 1-2 Gt of CO2 removed from the atmosphere annually. This phenomenon is certainly of considerable significance in the context of the ongoing climate change that is currently taking place. There is no doubt that further research and industrial work is needed to optimize this long-term process. However, taking into account its advantages – i.e., mainly the durability of the reaction products, which do not release CO2 back into the atmosphere, and the positive effects for environmental protection as well as taking into account the principles of sustainable development, an opinion can be formed that the analyzed ANTIGORITE SERPENTINITE from the "NASŁAWICE" deposit near Jordanów Śląski should be considered not only as a fertilizer, but also as a long-term acting, prospective material that can be used to remove carbon dioxide from the atmosphere.

ANTIGORITE SERPENTINITE AS A PROSPECTIVE FERTILIZING MATERIAL It is widely known that plant cultivation is a process not only complex, but also composed of many intertwined stages. Above all, it requires providing the plant with optimal conditions for its proper growth and development. In addition to natural factors, i.e. ambient temperature or the availability of water and light, it is also extremely important to make sure that the plant grows in soil showing appropriate pH parameters, that the state of aggregation of elementary particles of the solid phase of the soil is optimal, as well as to ensure optimal abundance in

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nutrients or the highest possible microbiological activity in the soil. Plants receive necessary nutrition from the so-called macro- and microelements. The former include nitrogen, phosphorus, potassium, magnesium, calcium and sulphur, while the latter include, e.g., iron, boron, copper, zinc or manganese. ANTIGORITE SERPENTINITE is a type of rock formed in the processes of transformation of ultrabasic or basic rocks. Its mineral composition may be based on minerals from the group of serpentine[6], magnesite[7], but also on silica with varied opal-chalcedonic composition[8]. The presented documentation shows that the main chemical components of the analyzed material are silicon, magnesium and iron, which belong to both the group of plant macro- and microelements.

Magnesium is one of the macronutrients that plants require in the largest amounts for their proper growth and development. Magnesium is a component of chlorophyll, which affects the course of photosynthesis and energy transformation in the plant organism. It also affects the synthesis of carbohydrates, fats and proteins. In addition, magnesium is involved in the transport of assimilates (i.e. products of photosynthesis, including glucose, sucrose and starch). Magnesium belongs to the group of macronutrients also because it is a factor significantly affecting the optimal use of other key plant macronutrients (i.e. nitrogen, potassium, phosphorus), while supporting both the transport and accumulation of phosphorus in plant seeds, as well as overall condition, appearance and resistance of plants.

Silicon, long underestimated in the field of fertilization, is now considered a microelement that provides the plant with resistance to infections caused by pathogens, but also to the adverse effects of pests. Silicon, as it turns out, not only supports the proper absorption of other nutrients by plants, but also prevents excessive loss of water, increases the ability of plants to photosynthesize and has a positive effect on the ionic balance of the plant organism.

Iron also belongs to the group of ingredients found in small amounts in plants, but its main tasks include, e.g., participation in chloroplast formation, as well as in photosynthesis. This trace element has a direct impact on the growth of the plant, because it participates in the transport of electrons, resulting in the formation of organic carbon compounds, enabling the development of the plant. Literature data indicate that iron also reduces the effect of harmful

[6] E.g. antigorite ($Mg_6[(OH)_8/Si_4O_{10}]$), chryzotyl ($Mg_6[(OH)_8Si_4O_{10}]$), lizardyt ($Mg_6[(OH)_8Si_4O_{10}]$) and others
[7] Magnesite ($MgCO3$)
[8] Opal ($SiO_2 \cdot nH_2O$), chalcedony (variety of cryptocrystalline quartz SiO_2)

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nitrates, is responsible for proper growth and development, as well as proper and healthy fruiting.

Taking the above into account, it can be concluded that ANTIGORITE SERPENTINITE may be a prospective fertilizing material, rich in important nutrients for plants – both macro- and microelements. Its use as a fertilizing material can be considered satisfactory.

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