

## **Joint statement on magnesium availability (for struvite precipitation)**

**Magnesium and Magnesite** both figure on the EU's list of 20 Critical Raw Materials

[http://ec.europa.eu/enterprise/policies/raw-materials/critical/index\\_en.htm](http://ec.europa.eu/enterprise/policies/raw-materials/critical/index_en.htm) as does Phosphate rock.

This classification as Critical Raw Materials in fact refers to magnesium (in its elemental form = **magnesium metal**) and magnesite (**magnesium carbonate MgCO<sub>3</sub>**). This is because of processing capacity and concentration issues for magnesium metal production, and supply scarcity and concentration for the specific mineral magnesite.

Dosing of magnesium ions is usually<sup>i</sup> required as a raw material input for phosphate recovery from wastewaters by **struvite** (magnesium ammonium phosphate), because most streams do not contain enough magnesium (less than 1:1 ratio compared to phosphate), but this input is **not in critical supply and is not concerned by scarcity**.

The magnesium ions (in solution) necessary for struvite processes can come from:

- magnesium chloride, magnesium hydroxide or magnesium oxide, which can be produced by processes using lime/dolime and seawater or brine, without using magnesite or magnesium metal
- natural magnesium minerals<sup>ii</sup>
- or even by directly using magnesium ions present in seawater or desalination brine (the wastestream generated by freshwater production from seawater)

Indeed, the **magnesium ion Mg<sup>+</sup> is the second most abundant cation in seawater** (c. 1/8<sup>th</sup> of sodium). Chemicals currently used for struvite production to date include seawater, seawater desalination brine and by-products of potash or magnesium mineral processing.

Although the magnesium ions used for struvite production are not subject to scarcity, that does not mean they are not a significant input in the process, and their purchase (if high-grade chemicals are used) or pre-processing (for some by-products) can represent a significant **operating cost**, and their supply and transport should be taken into account in any **life cycle assessment** of struvite production for phosphorus recycling.

On the other hand, it should be taken into account that **magnesium is a necessary nutrient for plants, necessary for normal growth and productivity**<sup>iii</sup>. Magnesium is the central atom of chlorophyll, and magnesium deficiency in plants results in chlorosis (yellowing between the leaf veins, particularly in older leaves). In plants, magnesium is also necessary for energy metabolism and cell membrane function. Magnesium deficiency particularly occurs in acidic, light, sandy soils. Certain crops particularly have high magnesium requirements, e.g. cabbage, corn, cotton, cucumber, grape, orange, radish ...

**Therefore, magnesium ions used in struvite production are not “lost” but are integrated into the struvite fertiliser product, where they can have an agronomic value if used appropriately.**

<sup>i</sup> Magnesium addition is sometimes not needed for struvite precipitation, in waste streams with high magnesium levels (e.g. veal calf manure) or if the objective is to remove only part of the phosphorus present.

<sup>ii</sup> Naturally occurring magnesium minerals which are mined include: dolomite CaMg(CO<sub>3</sub>)<sub>2</sub> - carnallite KMgCl<sub>3</sub>·6H<sub>2</sub>O - brucite Mg(OH)<sub>2</sub> - kieserite (MgSO<sub>4</sub>·H<sub>2</sub>O) – cordierite (Mg,Fe)<sub>2</sub>Al<sub>3</sub>(Si<sub>5</sub>AlO<sub>18</sub>) to (Fe,Mg)<sub>2</sub>Al<sub>3</sub>(Si<sub>5</sub>AlO<sub>18</sub>) – diopside MgCaSi<sub>2</sub>O<sub>6</sub>.

<sup>iii</sup> See e.g. <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2621.1986.tb11127.x/abstract> or [http://www.ipni.net/publication/bettercrops.nsf/0/3C8E17A623CF806785257980006E4E1A/\\$FILE/Better%20Crops%202010-2%20p23-25.pdf](http://www.ipni.net/publication/bettercrops.nsf/0/3C8E17A623CF806785257980006E4E1A/$FILE/Better%20Crops%202010-2%20p23-25.pdf) or <http://www.tandfonline.com/doi/abs/10.1081/PLN-100103778#.VGcYvGctBbU> or <http://link.springer.com/article/10.1023/A:1016091118585> or “Magnesium”, D. Merhaut, in Handbook of plant nutrition. CRC press, 2006 <http://www.crcpress.com/product/isbn/9780824759049> or “Magnesium”, K. Mengel, E. Kirkby, H. Kosegarten, T. Appel in Principles of plant nutrition (5th edition, 2001) <http://link.springer.com/book/10.1007%2F978-94-010-1009-2>