7. Society

Gypsum is one of the mineral resources in Switzerland which have a good long-term availability. Nevertheless around 50% of gypsum products are imported and thus most of the value creation is generated abroad. The reason for this, is that products such as plasterboard are produced in large mass production, low labour costs are particularly crucial in order to be competitive in the world market. This condition is not fulfilled in Switzerland.

On the other hand, due to a high growth in stock there is more and more gypsum waste. This waste ends up in the inert material landfills, where the sulphate can be washed out and can enter the groundwater or the landfill waste water. In addition, the available landfill volume should be conserved where possible. Given its physical and chemical properties, gypsum can in principle be managed as a sustainable resource.

Especially nowadays, that sustainable building has become the current trend, the gypsum industry should make better use of the recycling potential. Plasterboard can be recycled to a high degree, which could be a major societal selling point over other wall materials that have a much lower potential for being recycled.

Due to the high percentage of imports, it will become more and more difficult to reuse all of the future gypsum waste in Switzerland.

In addition to the production of gypsum wallboard, the cement plants are, first and foremost, the target processes for the recycling of gypsum. In theory this would represent a consumer market of around 200,000 t/y. In the longer term, however, the potential of the cement industry in Switzerland could increase due to the integration of the limestone. In regions where the impurity levels are low and there are suitable conditions, for example, the companies producing abroad will have to take back a certain percentage of waste gypsum and use it in their production on a long-term basis. Alternatively Switzerland could consider an increase of own recycling and production capacities, coupled with a reduction of imports.

Other measures and courses of action that lead to a prevention of environmental impacts and a more sustainable use of gypsum must be discussed and driven forwards in cooperation with the cement industry and, as with the importers of gypsum products. As a forward-looking stakeholder, the public sector should moderate and assist the process development, towards attaining a sustainable resource management in the gypsum industry.

8. Resource management: The overall situation at a glance

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2. Understanding the system

The recycling rate of gypsum is strongly dependent on the recovery of finished products such as plaster-/wallboard (for drywalling) and building plaster as well as raw gypsum for the production of cement is important (Fig. 3).

Switzerland requires around 800 000 tonnes of gypsum a year, which corresponds to almost 100 kg/per capita/yr. In neighbouring Germany, this figure is around 120 kg/per capita/yr. At approximately 29 kg/per capita/yr, the global average is significantly lower. Almost all gypsum is used in construction (gypsum used for modelling and as fertilizer is negligible in terms of quantity). About 24 000 000 tonnes of gypsum leave the building stock in Switzerland every year. This represents about 30% of the entire demand for gypsum. Thus the gypsum recycling rate increases annually by around 600 000 t (~ 73 kg/per capita).

Today, around 27 million tonnes of gypsum are in use in constructions in Switzerland, which corresponds to slightly more than 3 t of gypsum per capita. Between 2000 and 2012, the use of gypsum has increased by almost 50%. This trend is likely to continue due to increased experienced use in drywall construction. The demand for gypsum wall materials today in Switzerland is in the range of 1.7 m²/ (per capita/ year), while in Germany it is around 2.8 m²/ (per capita/ year) and in France 3.5 m²/ (per capita/ year). On this premise, the stock of gypsum in Switzerland could grow over 45 million tonnes by 2035. The recycling of gypsum in Switzerland today is still at a modest level: approx. 4 000 t/y.

In global terms, around 30% of the gypsum is used for the production of cement, 3% for the production of plaster and stucco (which also includes wallboards) and around 10% in agriculture (Fig. 1). Due to its low price (Fig. 2) gypsum and gypsum products are not usually transported over long distances, which in the past prevented the recycling of gypsum waste. During the past few years better technologies were developed for the increased recycling of gypsum. In regions where there are coal-fired power plants, these recycled products have to compete with cheap flue-gas desulphurization (FGD) gypsum (Chap. 3).

Over 250 000 t of gypsum waste ends up in landfills every year. Due to the strong growth of this waste stock and the lack of counter-measures, this material stream will increase sharply in the future. Due to the environmen-tal problems of landfilling gypsum, efforts are being made across Europe to strengthen the incentives to recycle gypsum.4,10
3. Primary/secondary raw materials

Switzerland has large geogenic deposits of gypsum that are found mainly in the Triassic deposits of the Basel-Cottolsingen Quarries. The gypsum rock is currently being mined in Bex (VD), Granges (VS), Leissigen (BE) and Kernen-Melbach (OW) in open-pit mines. After excavation the gypsum rock is treated (Leissigen or Granges) and ends up either in the cement factories or is processed into hemihydrate and anhydrite using the single-, or double- or high-firing method. The product is then manufactured into wallboard (at Leissigen and Granges) or gypsum plaster and mortars (at Kernen, Melbach, Bex and Cornale, respectively). As byproducts of industrial processes large quantities of gypsum are mainly produced abroad by means of flue-gas desulphurisation (FGD gypsum) in coal-fired power plants. In Germany alone, the produced quantities of industrial by-products are consumed in nine collections and processed for large combustion plants, and are currently in the range of 7–8 million t/yr. At European level, around 15 million tonnes of gypsum were produced in 2003.11

FGD gypsum is powdery and has a residual moisture content of 10%.11 Natural gypsum and FGD gypsum have the same chemical composition (except Hg and Se).

Because it is not grainy like natural gypsum, FGD gypsum has to be dried and briquetted. This process requires 150 kWh/t for the drying and 10 kWh/t for the briquetting. Hardly any FGD gypsum is produced in Switzerland, however, some is imported from neighbouring countries to produce cement (Fig. 3).2

Dismantling and renovation activities of the building- and deconstruction industry produce large amounts of gypsum waste. Today, some 280,000 tonnes of are likely to accrue every year in Switzerland, an amount which could almost double by 2035 (Fig. 4).11

From the recycling point of view, the gypsum waste from wallboarding and drywalling are particularly of interest. They result in over half of the total gypsum waste (Fig. 6). In Switzerland a recycling system for waste gypsum has been operating for several years.2 The first waste is collected in various recycling centres and then sorted. From here it goes into the processing plant at the wallboard production site. The recycled gypsum is fed in the production process together with the primary material. Currently, the recycled content of the produced product is in the range of only 2% per cent, a percentage that could be significantly increased. However, the total volume of wallboards produced in Switzerland is too small to accommodate all of the potentially recoverable waste gypsum, which currently amounts to around 230,000 t (Fig. 3). The cement industry in turn could be a promising buyer of recycled gypsum because it requires rather a lot of gypsum, approximately 200,000 t/yr. Additionally, the cement manufacturing process specifically needs calcium sulphate dicalcium.2

The mechanically prepared gypsum could therefore be used without further processing.

During the manufacturing, this process can be reversed by adding water. Four phases of the system CaSO4 / H2O are relevant for the production of gypsum (Tab. 1). When gypsum has not been thermally treated, it is used as a set regulator in the cement industry and as a sulphate carrier in the chemical industry. β-hemihydrate is used to produce gypsum plasterboard, gypsum wallboard and indoor plaster; plaster of Paris also contains anhydrite II. Screeds (undulator boards used for floors) are divided into anhydrite and gypsum screeds. They contain, among other additives, anhydrite, or-hemihydrate or a mixture. Plaster for moulding and modelling is made from α- and β-hemihydrate.

6. Economy

In 2013, approximately 435 000 t of gypsum products were imported, but only small amounts were exported (Fig. 3). The largest share of the imports was made up of wallboard with approximately 275,000 t, followed by building plaster at 105,000 t, whilst the raw (approx. 85%) and FGD gypsum (approx. 15%) for the cement industry were produced in Switzerland (Fig. 6). However, the largest quantities come from the brown coal power plants in eastern Germany. Swiss cement plants have hardly any competition with FGD gypsum on the market. In Switzerland the costs of landfilling gypsum are 50 CHF/t, which means that if less than 25 CHF/t are spent for sorting and waste collection logistics, recycling is more favourable than landfill disposal. For cement production, the costs of the required gypsum are dependent, on the location, between 27 and 55 CHF/t, including transportation. If the gypsum recycling plants were operated in the vicinity of the cement plants, the raw material costs of the cement plants could probably be minimised. Therefore a great deal of potential can be seen in the recycling of gypsum from an economic point of view, especially since we can expect significantly increasing gypsum waste streams in the future.